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Bus Shelter Equity: A study of the distribution of bus shelters in Los Angeles County and unincorporated communities

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Bus Shelter Equity

A study of the distribution of bus shelters in Los Angeles County and unincorporated communities

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A comprehensive project submitted in partial satisfaction of the requirements for the degree Master of Urban and Regional Planning.

Cover photo credit: Kevin Liu/Investing in Place

Disclaimer

This report was prepared in partial fulfillment of the requirements for the Master in Urban and Regional Planning degree in the Department of Urban Planning at the University of California, Los Angeles. It was prepared at the direction of the Department and the Office of Supervisor Holly J. Mitchell as a planning client. The views expressed herein are those of the authors and not necessarily those of the Department, the UCLA Luskin School of Public Affairs, UCLA as a whole, or the client.

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UCLA acknowledges the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles basin and So. Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), 'Ahihirom (Elders) and 'Eyoohiinkem (our relatives/relations) past, present and emerging.

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Executive Summary

Bus shelters are a fundamental public provision with outsized benefits to transit-dependent riders. As a matter of building an equitable transit system that serves our most vulnerable communities, the Office of Los Angeles County Supervisor Holly J. Mitchell is interested in understanding the spatial patterns of bus shelters in Los Angeles County and unincorporated communities. This research project analyzes the distribution of bus shelters at Los Angeles Metro bus stops by exploring three key questions: (1) what is the distribution of bus shelters in Los Angeles County and its unincorporated areas, (2) what are priority bus stops in need of a bus shelter in unincorporated areas, and (3) what is the process for funding, building and maintaining bus shelters in unincorporated areas. The study employs quantitative methods using data from Metro, the County, and other publicly available data to measure distribution along three geographies (Supervisory Districts, unincorporated areas, and Supervisory District 2), and four equity measures to characterize neighborhoods with unsheltered bus stops (heat exposure, access to shade, wait time, and socio-economic and transit-related conditions). The study also uses qualitative methods to examine Public Works' process for implementing bus shelters in unincorporated areas.

The analysis shows that Supervisory District 2 has the greatest bus shelter need compared to other County districts. In addition, Public Works is at a critical moment for bus shelter development in unincorporated Los Angeles County as it seeks to replace all ad-shelters and to engage with a new vendor. Public Works has an opportunity to improve data collection for evaluating past and future bus shelter siting along lines of equity.

Key findings include:

- Of the 12,033 Metro bus stops in Los Angeles County, more than two thirds (67%) do not have a bus shelter.
- Across the County and Supervisory Districts, District 2 uniquely has a significant share of the County's boardings, bus stops and unsheltered riders.
- The County has 857 Metro bus stops in unincorporated areas, of which approximately 58 percent or 492 do not have a shelter.
- Comparing unsheltered stops in unincorporated areas across Supervisory Districts, stops in District 2 have the highest boarding levels and are more likely

to be in neighborhoods with higher socio-economic and transit-related need, have less access to parkway tree shade, and experience both very short and long wait times.

- After prioritizing unsheltered Metro bus stops in unincorporated Los Angeles County, 57 stops or 58 percent of the top 20% of unsheltered stops in unincorporated communities are in District 2.
- The high cost of bus shelters has made replacing old ad-shelters difficult; in addition, the process for erecting non-ad shelters is primarily guided by number of boardings and/or its inclusion in a capital improvement project.

The project contributes to the growing interest in utilizing bus shelters as shade providing structures in the face of increasing temperatures to serve our most vulnerable populations. It complements a recent study conducted by the Lewis Center for Regional Policy Studies and provides additional forms of analysis to understand spatial patterns of inequality. The findings provide results to advocate for increased bus shelter provisions in Supervisorial District 2 and methods to compare current and future analysis on bus shelters by public agencies like Metro and Public Works to ensure their approach is incorporating the Office's equity priorities.

Introduction

Half the journey time for Metro bus riders is spent waiting for the bus on average (Metro, 2022). Combined with record breaking temperatures in Los Angeles County, bus shelters as shade-providing structures are critical to our region's climate adaptation strategy (Arango, 2019; *Outfront JCDecaux*, n.d.; Tu, 2022).

A bus stop is also the start and end of every rider's journey on the bus. Its elements can tell important information about the bus service and provide a level of comfort for passengers. Research shows that bus stop quality is linked to overall bus experience and increased ridership levels (Fan et al., 2016; Higashide, 2016; Kim et al., 2017). Transforming public transportation from a basic service to a desirable mobility option will require critical attention to the conditions surrounding a rider's waiting experience.

Among various bus stop features, bus shelters in the County have captured the attention of many transit advocates as an essential provision at bus stops. Not simply an amenity, shelters are part and parcel to a rider's experience at a bus stop that can provide an essential level of comfort, dignity, and safety while waiting for the bus (Transit Center, 2018). Among the bus stops served by Metro in the County, this study has shown that only 23 percent have shelters. While Metro owns and is responsible for installing bus stops, it is the responsibility of each municipality to add stop features and upgrades, including shelters. The dearth of bus shelters in the region has come under particular scrutiny over the past several years due to unmet bus shelter development in the City of Los Angeles and rising temperatures and extreme heat days across the County (First Street Foundation, 2022; Tu, 2022).

Like other public provisions, understanding the distribution of bus shelters across geographies and neighborhoods is a matter of racial and spatial justice. Distribution implies investment and therefore we must ask why we invest in some places and not others. As Mayorga et al writes in her paper about the disinvestment of grocery stores, "under racial capitalism, to choose to invest in one space is, by definition, a decision to not invest elsewhere" (Mayorga et al., 2022). To begin understanding why some places have bus shelters and others do not, we first need to identify where these places of disinvestment might be.

Purpose and Scope of the Study

The Office of Los Angeles County Supervisor Holly J. Mitchell is interested in understanding the distribution of bus shelters in the County and in Supervisorial District

2 to uncover the barriers and opportunities to equitably and justly fund, deploy, and maintain bus shelter infrastructure for Supervisor's constituents. The Office is particularly interested in distributional patterns in unincorporated Los Angeles County and in Supervisorial District 2 as the County is responsible for bus shelter improvements for its unincorporated neighborhoods. The Office would also like a clearer understanding of the current process for building and maintaining bus shelters in unincorporated areas to work more effectively and collaboratively with Public Works and other agencies in the process of building bus shelters.

While there have been qualitative arguments to the inequitable distribution and investment in bus shelters in the County, only recently has there been empirical research to quantify these claims (Brozen et al., 2023). This study confirms much of its findings. In addition, this study also analyzes distribution across different measures and scales, offers a prioritization methodology, as well as explores the administrative process for erecting bus shelters in unincorporated communities to document four key outcomes. The first is quantifying the distribution of not only bus shelters but riders at unsheltered Metro bus stops across Supervisorial Districts and unincorporated communities. This enables us to differentiate the magnitude of use between unsheltered bus stops rather than treating each unsheltered stop as equal. The second contribution includes a close-up analysis of distribution within Supervisorial District 2. Third, the empirical analysis offers a starting point in using various equity measures for future studies assessing priority bus stops. Lastly, a fourth contribution of this research is that it also offers a baseline understanding of the underlying processes for building and maintaining bus shelters in unincorporated Los Angeles County. Given the particular attention to District 2, interpretation of findings will focus on District 2's standing compared to other districts in the County.

This study seeks to explore:

1. What is the distribution of bus shelters in Los Angeles County and its unincorporated areas?
2. What are priority bus stops in need of a bus shelter in unincorporated areas?
3. What is the process for funding, building and maintaining bus shelters in unincorporated areas?

To answer these questions, this study constructs the environmental and socio-economic conditions of Metro bus stops in Los Angeles County and analyzes these data with geospatial analysis. The research pairs this quantitative research with interviews with Public Works and a document review of the agency's bus shelter contracts.

Major Findings

Comparing unsheltered riders in unincorporated communities across Supervisorial Districts, they are by in large in Supervisorial District 2, facing greater socio-economic and transit-related burdens, less access to tree shade, both short and long wait times and higher boardings. The following provides the major findings from this report.

Across Los Angeles County and Supervisorial Districts

1. **Of the 12,033 Metro bus stops in Los Angeles County, more than two thirds (67%) do not have a bus shelter.** Of the 8,079 stops without a bus shelter in the County, approximately 94 percent are in incorporated parts of the County and 6 percent in unincorporated areas.
2. **Across the County and Supervisorial Districts, District 2 uniquely has a significant share of the County's boardings, bus stops and unsheltered riders.** District 2 significantly out numbers boardings by absolute number and by the County's share compared to all other Districts, making up 35 percent of the County's total boardings, followed by District 1 at 28 percent. While District 2 has one third of the County's unsheltered bus stops, its unsheltered riders make up close to 40 percent of the County's total unsheltered riders, ten percentage points more than the District with the next highest share.

Across Unincorporated Communities and Supervisorial Districts

3. **The County has 857 Metro bus stops in unincorporated areas, of which approximately 58 percent or 492 do not have a shelter.** Of the 857 stops, half are in District 2 alone. The same proportion of unsheltered stops are also in District 2 alone. In addition, 60 percent of the County's unsheltered riders in unincorporated communities are in District 2.
4. **Comparing unsheltered stops in unincorporated areas across Supervisorial Districts, stops in District 2 have the highest boarding levels and are more likely to be in neighborhoods with higher socio-economic and transit-related need, have less access to parkway tree shade, and experience both very short and long wait times.** Three out of the top five unincorporated communities with the highest unsheltered riders in the County are in District 2. Along socio-economic equity, eighty percent of unsheltered riders in unincorporated areas are in Metro Equity Focused Communities, with the greatest share in District 2. When it comes to heat and shade, District 2 unsheltered riders tend to be at cooler stops but are less likely to have access to parkway tree shade compared to the rest of the County. In addition, District 2 observes a large share of wait times on the lowest and highest ends of average wait times, that is, less than 7 minutes and greater than 22 minutes.

Prioritizing Unsheltered Metro Bus Stops in Unincorporated Los Angeles County

5. **After prioritizing unsheltered Metro bus stops in unincorporated Los Angeles County, 57 stops or 58 percent of the top 20% of unsheltered stops in unincorporated communities are in District 2.** The top 20% of unsheltered stops are concentrated in only two unincorporated communities - East Los Angeles in District 1 and Florence-Firestone in District 2. Florence-Firestone in particular demonstrates bus shelter need as it also has the greatest number of unsheltered riders compared to all other unincorporated communities across the County and within District 2.

Bus Shelter Implementation in Unincorporated Los Angeles County

6. **The high cost of bus shelters has made replacing old ad-shelters difficult; in addition, the process for erecting non-ad shelters is primarily guided by number of boardings and/or its inclusion in a capital improvement project.** Bus shelters are expensive, with hard costs up to \$35,000 alone and an additional 30 - 40 percent for soft costs. Public Works has two programs - ad and non-ad shelter programs, with a total of 270 and 384 stops, respectively. The ad-shelter program is at an inflection point - Public Works is undergoing a significant capital project to replace all ad-shelters in order to attract a new vendor and is currently drafting a scope of work and RFP for a new licensing agreement. For non-ad shelters, they are built in one of two ways - in bulk through capital improvement projects, or by individual resident requests. County-owned bus shelters are constructed and maintained primarily using Proposition A, Local Returns funds. Yet, funding, high cost of shelters, together with meeting site conditions, continue to be the greatest challenges for building bus shelters for the County's unincorporated areas.

Summary of Recommendations

The following provides a summary of recommendations that will help the Office utilize this study's findings, conduct future analysis, and equip the Office to strategically engage with Public Works in the bus shelter implementation process. For full recommendations, see Part 5.

1. **Dedicate resources and bus shelter efforts to Florence-Firestone.** Florence-Firestone is by all accounts the community in greatest bus shelter need not only in District 2 but across all unincorporated communities.
2. **Encourage Public Works to collect data on bus shelters implemented, develop an equity-focused prioritization scheme for accountability and decision making, and to replace ad-shelters by priority.** Public Works should build a system to track where and through what process non-ad

shelters are built to evaluate the implications of the approval process. The agency should also develop and share a prioritization scheme that assesses shelter needs holistically across the County along lines of equity as a measure of accountability and to make decisions about future shelter placement. Finally, Public Works should consider prioritizing ad-shelter stops by relative need as opposed to replacing all ad-shelter stops as planned.

3. **Use this report's prioritization methodology to assess if Metro and Public Work's prioritization approach will address the Office's shelter and equity priorities.** The Office has an opportunity to use this report as a starting point to compare why and how Metro has prioritized the stops the way they did and what this means for mutually agreed upon priority stops with Public Works.
4. **Leverage Supervisor discretion over bus shelter approval and utilize Proposition A allocations to add more bus shelters.** Unlike the City of Los Angeles which has received criticism for its convoluted and cumbersome approval process for bus shelters, the County's process is relatively simple and straightforward, leaving much authority with the Supervisor to accept or reject proposals for new bus shelters from Public Works. Given the discretionary authority Supervisors have, while Public Works is focused on replacing all bus shelters, District 2 should utilize Proposition A allocations to add more bus shelters.
5. **Participate in Metro/Public Works discussions related to shelter design to stay abreast on potential design options for additional shelters.** Given bus shelters are costly and difficult to find sites appropriate for installation, District 2 should stay abreast to different shade structures that Metro is exploring to accommodate site restrictions and cost. Keeping to date with these discussions can help with understanding the expanding possibilities for siting bus shelters the District.
6. **Future analysis should consider:** utilizing stops from additional transit providers; conducting a refined approach to accessing tree shade using Public Works parkway tree inventory; and consider points of interest relative to stops, such as schools, hospitals, and grocery stores.

Organization

The rest of this report is organized as follows: Part 1 presents a brief literature review focused on current research in the distribution of bus shelters. Part 2 provides an overview of the research design, sources and analytical methodology. Part 3 presents the empirical analysis of bus shelters across the County and unincorporated areas, including priority stops in need of bus shelters. Part 4 describes the bus shelter programs for unincorporated Los Angeles County. Finally, Part 5 presents the study's recommendations.

Part 1: Literature Review

As regions across the country seek to expand their public transportation network, bus stops will need critical attention. Bus shelters are of particular interest as a shade-providing structure from extreme weather conditions such as rising temperatures and extreme heat days. Recent studies have shown empirical evidence that adverse weather conditions generally decrease public transport ridership (Miao et al., 2019). However, few studies have reviewed the extent to which bus shelters moderate ridership during extreme temperatures. One study in Salt Lake City, Utah found that bus stops with shelters have higher ridership during extreme low and high temperatures than bus stops without shelters, however differences, while statistically significant, were modest (Miao et al., 2019). A similar study in Austin, Texas found insignificant or modest associations between bus stop shelters, trees and ridership on high-temperature days, however it concludes that it may be attributed to the transit dependency of transit users (Lanza & Durand, 2021). The study recognizes that transit-dependent users have few options but to use bus stops, despite whether the stop has a shelter or nearby trees to provide shade.

While more empirical research may be necessary to determine the moderating effects of bus shelters on ridership in extreme weather conditions, qualitative research on riders suggest that shade at bus stops is a priority for transit riders to improve their experience. One Los Angeles based organization conducted a qualitative study, interviewing riders from six Los Angeles bus routes. Findings show that when asked for improvements to the bus stops, shade was the most-requested feature (Investing in Place, 2022). Metro's own customer survey of riders and non-riders on aspects of bus service led Metro to conclude bus stop shade and seating as one of five areas of improvements (Metro, 2022). The empirical and qualitative research suggest that bus shelters can be a means to improve a riders' comfort and potentially mitigate ridership losses.

There appears to be few scholarship on the distribution of bus stop amenities, and even fewer that focus explicitly on bus shelters. Limited research on bus stop amenities may likely be due to the fact that transit agencies lack consistent data collection on bus stop amenities. Agencies may provide guidance as to a stop's design, but few conduct audits of their bus stops (Moran, 2022). This gap led one researcher to conduct a bus stop audit in San Francisco, cataloging the presence of seating, signage, curb obstructions, shelters, and other amenities at bus stops and their distribution (Moran, 2022). The study evaluated distribution along bus stop level characteristics that included stop amenity inter-relatedness; stop amenities by bus route; headways; headways connected to the distribution of amenities; race; and income. The research found a relationship between

stop amenities and race where census tracts with a higher proportion of white residents are more likely to have bus stops with seating, shelters, and clear curbs. However, the study did not find that this relationship extends to differences in income.

Other scholarship has also studied the distribution of bus stop amenities and shelters, including various bus stop-level and location-specific characteristics (Law & Taylor, 2001; Miao et al., 2019; Talbott, 2011). Findings have varied related to what we may hypothesize as differences along race and socio-economic status. Such variations demonstrate the importance of empirical evidence to test the distribution of bus shelters. Even while many transit agencies evaluate bus placement based on boardings per day, there is little empirical evidence to test this assumption. For example, Miao et al. (2019) did not observe a strong relationship between bus shelter placement and ridership in Salt Lake City. In other words, while a transit agency may state its criteria for bus placement, there is not always an evaluation to confirm the agency implemented its stated criteria.

While research has looked at the distribution of bus stop amenities, these studies lack an analysis of factors that create social vulnerability and transit dependency, an evaluation that may help us understand how to prioritize where bus shelters should be built. Moran (2022) discusses different conceptions of equity to begin to evaluate what equitable distribution may look like. They take caution in evaluating bus stop shelter placement solely with ridership as it may feed into a self-fulfilling prophecy: low-amenity stops may actively deter ridership and become unable to qualify for better bus stop features while more popular bus stops will increasingly improve. Law and Taylor (2001) attempts to resolve this issue. With a focus on riders' wait time to assess bus shelter placement, they propose a methodology they call person-minutes which accounts for both the number of people waiting for a bus and the length of time (half the headway time) they are waiting. By using person-min as a measure of bus stop use, the researchers suggest selecting the most heavily used bus stops for the installation of shelters. However, they account for no other equity considerations.

The dominant framing around transit riders are “choice” riders and “captive” riders, however scholarship in transit planning is increasingly critiquing this dichotomy of a rider's travel behavior as it is not only influenced by the alternatives, but also their socioeconomic conditions (Pang, 2019). A person's status as transit dependent is generally contingent on being without private transportation, elderly (over age 65), youths (under age 18), and persons below poverty or median income levels (Lubitow et al., 2017). Lubitow (2017) suggests that race and ethnicity, gender, and physical or mental disabilities amplify the barriers experienced by the transit-dependent population.

Definitions of transit-dependent population may be different across regions and therefore further investigation may be needed to understand similarities and differences. However, Metro has already created several indices related to social-economic

characteristics and transit-service access (Metro Equity and Race, 2022). The Equity Focus Communities (EFC) identifies census tracts with high concentrations of historically disinvested and disenfranchised households and populations that might benefit from new mobility investments. It looks at three socio demographic criteria (income, race/ethnicity, vehicle ownership). This report builds on the above methodologies to understand the spatial patterns of bus shelter placement and potential ways to prioritize future placement.

Part 2: Data & Methodology

To explore the relationship between bus shelters and neighborhood characteristics, I utilize a range of data sources to analyze spatial patterns and construct a prioritization scheme. This section outlines these data sources and analytical methods.

Major Data Sources

Major Units of Analysis

To evaluate distribution, I analyze bus stops and shelters alone as well as in combination with boarding across several geographies, including across Supervisorial Districts, unincorporated communities, and by census block groups. The following describes each data source and construction.

Metro Stops and Shelters

This study utilizes Metro bus stops from October 2021, that includes a shelter presence attribute, which I obtained directly from Metro. According to Metro, this is the most accurate aggregated account of bus shelter presence at Metro stops as it was cross verified between Metro and the City of Los Angeles.

Selecting Stops and Assessing Shelter

This study uses stops only within the boundary of Los Angeles County as there are several stops that are sited outside of the County boundaries. I also use the data as reported - yes, no, and false - as not all stops have data on shelter presence. Therefore, I estimate shelter presence as what is reported in the data as yes or no and estimate proportions using all stops, including stops without shelter data.

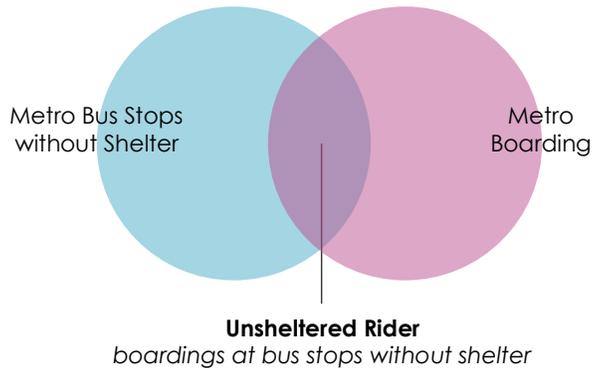
Boarding

The study uses boardings to measure a stop's level of use by riders to focus on the number of riders that would be waiting for a bus. Data was derived from Metro October 2019 boardings obtained directly from Metro. I use total boardings for October 2019 to use pre-pandemic estimates. Ridership is collected through aggregate passenger count (APC) systems which are electronic machines that count passengers getting on and off each bus stop (Caltrans Division of Research, 2022). I merged boarding with our Metro stop-level data.

Unsheltered Riders

While it is important to understand where stops do and do not have a shelter, it is important to differentiate the magnitude of use for each stop. Therefore, a key unit of analysis utilized in this study is what I call “unsheltered riders.” This measures the number of boardings at a bus stop without shelter (See Figure 2.1).

Figure 2.1. Construction of Unsheltered Riders



Geography

The basic geographic unit of analysis in this report is Supervisorial District, unincorporated communities, and census block groups (2020 boundaries). Supervisorial District and unincorporated communities are available online through the County’s website.¹ I specifically use Countywide Statistical Areas as defined by the County for our unincorporated communities.²

Major Equity Measures

Not only is it important to understand the distribution of bus stops with and without shelter, but also along measures of social-economic and transit-related equity. I selected Metro Equity Needs Index (described further below), heat exposure, access to shade, and wait times as equity measures to characterize neighborhoods with unsheltered bus stops. These measures are then used together to prioritize unsheltered stops in greatest need of a shelter. The following describes why these measures were selected and our method for constructing our variables.

¹ <https://egis-lacounty.hub.arcgis.com/maps/378b427653d9480c941150249f370ebc/about>, accessed May 2023

² <https://egis-lacounty.hub.arcgis.com/maps/7b8a64cab4a44cof86f12c909c5d7f1a/about>, accessed May 2023

Metro Equity Focused Communities

To assess potential racial and socio-economic disparities in bus shelter access, this research utilizes the existing Metro Equity Needs Index (MENI) to be consistent with current measures by Metro to identify areas of social inequity and greater needs for transportation resources. The data is published online for 2022 census tracts, however I obtained the data in Excel directly from Metro.³ MENI is a composite index that defines Metro's Equity Focused Communities designations that uses three sociodemographic indicators: income, race/ethnicity, and household vehicle ownership.⁴ According to Metro, these three factors continue to be the best indicators to identify areas with high concentrations of historically disinvested and disenfranchised households and populations that are anticipated to most benefit from new mobility investments.⁵

Land Surface Temperature

The next two sections on temperature and shade is based on research from Kelly Turner et al. (2022) on surface temperature and thermal exposure. Our report uses land surface temperature (LST) as a measure of heat exposure. Data for LST is derived from NASA Ecostress, which is collected at 70 meter resolution.⁶ Land surface temperature is a measure of how hot the Earth's surface would feel to the touch. Climate scientists have determined the significant impact land cover has on urban heat conditions with different types of urban features having varying thermal radiative properties. For example, built urban materials such as asphalt has hotter land surface temperatures as these materials absorb incoming solar radiation and reradiate as heat slowly throughout the day.

LST is most widely used among regions and municipalities monitoring urban heat conditions primarily as it is easily derived from remote sensing data at a fine resolution readily available to process at a regional scale. Other types of temperature such as air temperature (AT) and mean radiant temperature (MRT) would more accurately reflect a person's thermal burden, a subjective experience of thermal sensation based on both environmental and psychological factors that is assessed using a combination of subjective and objective thermal assessments (Middel et al., 2016). However, AT and MRT require sophisticated modeling and field data collection. Given the scope and purpose of this study, I use LST as it is responsive to urban design features, data is

³ <https://lametro.maps.arcgis.com/home/item.html?id=0b45adofef0549dd934df66cbea56524#overview>, accessed May 2023

⁴ The index assigns a percentile score for each census tracts ranked into five equity tiers based on: 40 percent of households are low-income (defined as having an household income of less than \$60,000 per year), 80 percent of people are non-white/Black, Indigenous, and other People of Color (BIPOC), and 10 percent of households have zero vehicles

⁵ Status report to BOS on 2022 Equity Focus Communities Update, File # 2022-0275. See link for additional information on the methodology

⁶ <https://lpdaac.usgs.gov/products/eco2lstevo01/>, accessed May 2023

readily available, and is available at a scale sufficient to capture temperature differences across bus stop points and a wide geography like Los Angeles County.

Because the study is interested in heat as it interacts with infrastructure, I wanted to find an image captured during the earlier afternoon and late evening and during the summer when heat is most intense. To retain image quality and time restrictions, I selected an image taken in August 2021 in the early evening.

Shade

A limitation of LST is that it is derived from remote sensing data that assesses conditions only on the surface of an object. It is unclear how reliable such data is for assessing temperatures below trees where there is shade. MRT is a composite indicator that has been used as a close approximation of how a person would experience heat. While high resolution spatial data on MRT is not available at a regional scale, research has shown that a strong predictor of MRT is shade. Shade lowers the amount of direct exposure people have to incoming solar radiation that would increase a body's heat load as well as reduce reradiated heat from the built environment (Middel et al., 2021).

Trees are a nature-based solution for providing shade and have been seen among cities concerned about extreme heat exposure as a potential climate adaptation strategy for moderating heat. Municipal or regional inventory of trees and tree canopy is difficult to come by, however Los Angeles County Public Works keeps account of its trees on public parkways in unincorporated Los Angeles County. I use its tree inventory to estimate a bus stop's proximity to shade which was directly obtained from Public Works.⁷

The study explored other means for estimating shade such as using Normalized Difference Vegetation Index (NDVI) which quantifies vegetation greenness to understand vegetation density. NDVI can be found to be correlated with Land Surface Temperature where the tops of trees are naturally low, providing a lower LST (Miller et al., 2022). Also, while NDVI gives a sense of greenness/irrigation and the likelihood of finding nearby tree shade, the threshold that would capture broadleaf trees for shade also captures overall high density of green leaves which could include irrigated grass.

The availability of the parkway tree inventory allows for more precise estimates of a stop's proximity to tree shade. However, it is not without its limitations. First, the inventory is only parkway trees and other surrounding trees are not accounted for. The tree inventory also includes all tree types. This study treated all tree types the same. However, for future iterations of this analysis I suggest evaluating the differences in creating a buffer around trees based on the tree type and spread, information included in the data but beyond the scope of this study.

⁷ <https://pw.lacounty.gov/rmd/parkwaytrees/TreeInventoryMap.aspx>, accessed May 2023

To measure parkway tree canopy surrounding bus stops, I used a Euclidean buffer of 20 feet around each tree and estimated if a stop fell within a tree's buffer. I estimate that 20 feet is a reasonable distance from a bus stop to seek tree shade without missing the next bus.

Wait Times

The following section synthesizes a literature review from Ansari Esfeh et al. (2021) on wait time and headway modeling studies. Evaluating wait times of riders can help us understand the magnitude of heat exposure to bus riders measured in time. Our study's data for wait times is derived from General Transit Feed Specification (GTFS) available online and for December 2021 to be consistent with the Metro bus stops used.⁸ A common misconception of wait time is that it is synonymous with headway, the time between when two transit vehicles arrive at a stop. There are a multitude of factors that contribute to an analysis of passenger wait time that need to consider the possible combination of heterogeneous passenger types (those who plan compared to those who do not plan their trip), and different service types (schedule-based, frequency-based, high-frequency, low-frequency). Research on waiting cost estimation has widely used the assumption of half the headway as the mean waiting time without taking into consideration the aforementioned factors or stating their assumptions. Studies that have utilized mean wait time are assuming that passengers arrive randomly at the stop, passengers are served by the first arriving vehicle, and services are regular where headways are even.

While there are limitations to a simple mean headway estimation, this study uses this formula with several assumptions and caveats. Given the study is interested in exposure to heat which is heightened in the late afternoon and early evening hours, the study looks at a typical weekday wait time during evening peak hours (3pm - 7pm). During these hours, many riders are typically traveling home from their trip origin. For this study, I then assume these are non-planning passengers with non specific arrival and non specific departure from origin on Metro's schedule based system. Using the literature's definition of low and high frequency routes, on high frequency routes (less than or equal to 10 minutes), I estimate average wait time using one half the headway assuming passengers arrive at a uniform rate at the stop and board the first bus. For such passengers at low frequency routes (greater than 10 minutes), literature suggests an average wait time of 0 minutes assuming passengers will check the time and arrive exactly on time of bus arrival. However, the literature does not mention how it accounts for passengers transferring buses. For transit dependent riders, some may take up to two to three buses to get to their final destination and are unable to control when they arrive at their next bus stop. The probability of incurring wait time costs are higher for transferring passengers. Therefore, the study also assumes one half headway as wait time for low frequency routes to account for these potential wait time costs. There is little research on

⁸ <https://transitfeeds.com/p/la-metro/184>, accessed May 2023

how to approach stops with multiple bus lines, as most literature assumes only one bus line per stop. Therefore, the study takes the average of the average wait times at each stop when there are multiple bus lines serving that bus stop.

Other - Schools

Points of interest such as schools may be important to consider when designing a prioritization mechanism for deciding which unsheltered stops are in greatest need of a bus shelter. While schools are not included in our prioritization scheme, I provide an example of such an analysis in this report. Data for public schools is derived from the California Department of Education website.⁹

I select only active schools in our analysis and create a quarter mile Euclidean buffer around each school to assess which stops fall within or outside this distance from a school. I estimate that a quarter mile is a reasonable distance for a student to walk to and from school to a bus stop.

Methodology

Distributional Analysis

I created classification for each equity measure by dividing the data into quintiles. However, not all indicators can be disaggregated evenly given some data is unevenly distributed. For the shade variable, I created a binary classification. I then assigned each bus stop to each equity measure classification and geographic unit and tabulated the share of bus stops or unsheltered riders by geographic unit.

Prioritization

This study prioritizes unsheltered stops in unincorporated areas in greatest need of a shelter using the measures described above. I take the following steps to prioritize. First, I assign a point value to each measure with total points out of 100 (see Table 2.1). EFC is given the most points because the study is most interested in the socio-economic and transit-related conditions of bus stop sites. Heat, shade and wait times are given equal points but heat and shade together make up two fifths of total points in order to give greater weight to heat exposure.

⁹ <https://www.cde.ca.gov/ds/si/ds/pubschls.asp>, accessed May 2023

Table 2.1. Points for Prioritization

Measure	Points Breakdown
Equity Focus Community (EFC): 40 points	Excluded = 0 points
	Very Low Need: 8
	Low Need: 16
	Moderate Need: 24
	High Need: 32
Land Surface Temperature: 20 points	Very High Need: 40
	Q1 (61 - 78F): 4
	Q2 (78 - 80F): 8
	Q3 (80 - 83F): 12
	Q4 (83 - 88F): 16
Within 20 feet of a tree: 20 points	Q5 (88 - 96F): 20
	Within 20 feet: 0 points
Wait times: 20 points	Not within 20 feet: 20 points
	null = 0 points
	Q1 = 4
	Q2 = 8
	Q3 = 12
	Q4 = 16
Q5 = 20	
Maximum Total	100 points

After each unsheltered stop is assigned a score out of 100, I multiply each score with the natural log of boarding. I take the log as boarding is not evenly distributed and to reduce these large numbers into more manageable units for analysis. I multiply the score with boarding and do not assign point values to boardings given the distribution of boarding is very skewed and therefore categorizing boardings would hide significant differences between stops. Multiplying boarding with the score directly accounts for these differences. The final score is then organized in descending order where the highest score has the highest need.

Qualitative Interview

I conducted two interviews with Public Works and the staff managing the bus shelter program in order to understand the program’s function and process for erecting, funding and maintaining bus shelters.

Part 3: Empirical Findings

This section of the study summarizes the empirical findings. It starts with describing the distribution of bus stops and bus shelters across Los Angeles County. Stops are then analyzed using the measure of unsheltered riders by Supervisorial District, unincorporated communities and District 2. The distribution across these geographic scales are analyzed in relation to factors described in the previous section. Lastly, the study presents the results of prioritizing bus stops in need of a shelter.

Los Angeles County

To contextualize the distribution of bus shelters across districts and unincorporated areas of the County, it is important to examine the spatial pattern of bus shelters in the County as a whole.

Of the 12,033 Metro bus stops in LA County, more than two thirds (67 percent) do not have a bus shelter (See Figure 3.1). There are a total of 8,079 stops without a bus shelter and of those, 94 percent are in incorporated parts of the County with 6 percent in unincorporated areas (See Figure 3.2). Using Metro ridership for October 2019, there were approximately 20.4 million boardings and of those about 50 percent boarded the bus from an unsheltered stop (See Figure 3.3). To put this in context, approximately 67 percent of stops are unsheltered. The difference suggests that the share of unsheltered riders is not necessarily proportionate to the share of unsheltered stops. This demonstrates that an analysis of bus shelters can lead to varying results if I do not take into account the magnitude of use, that is, boarding.

Figure 3.1. Metro Bus Stops Sheltered

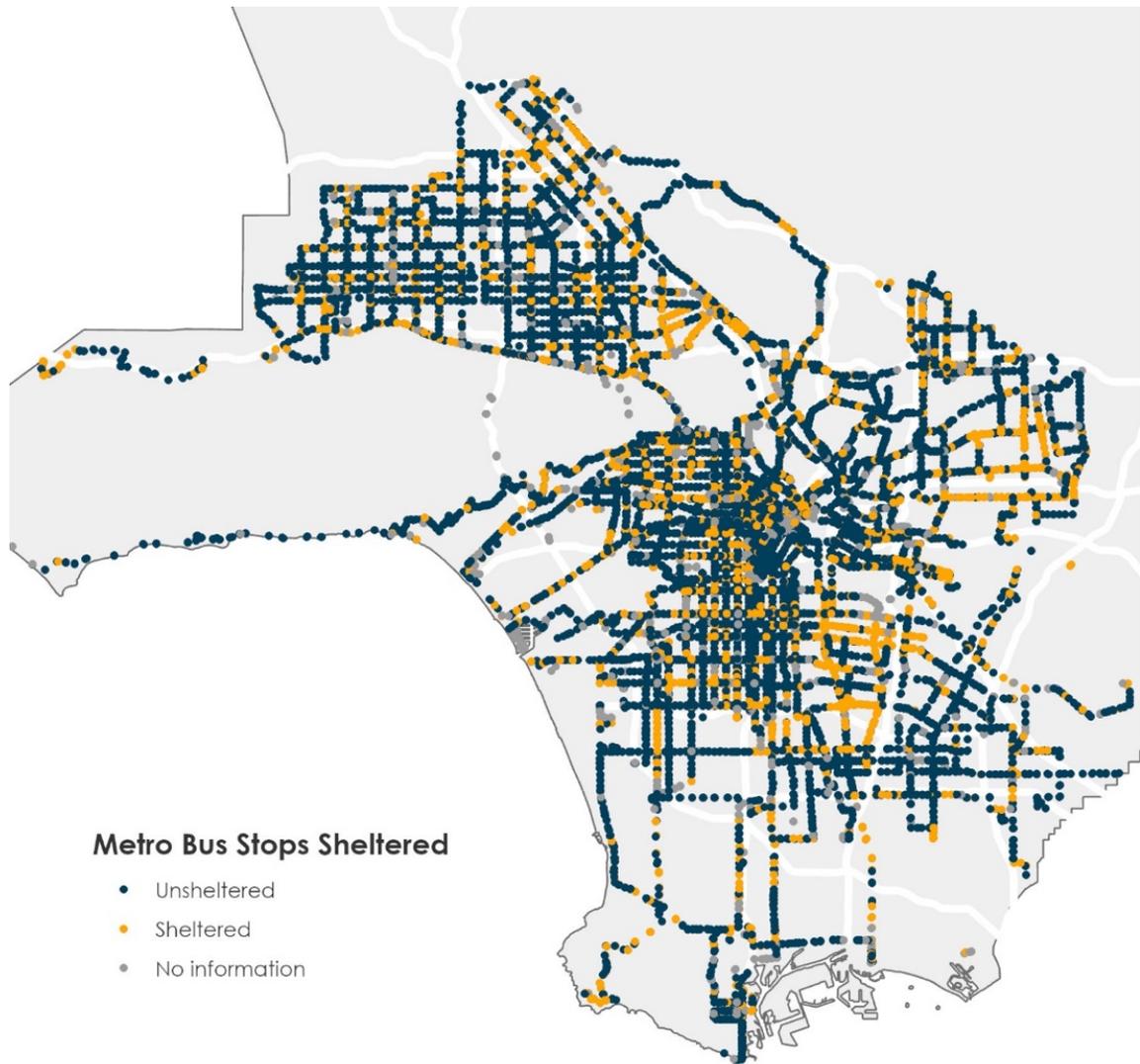


Figure 3.2. Metro Bus Stops Shelter by Un/Incorporated

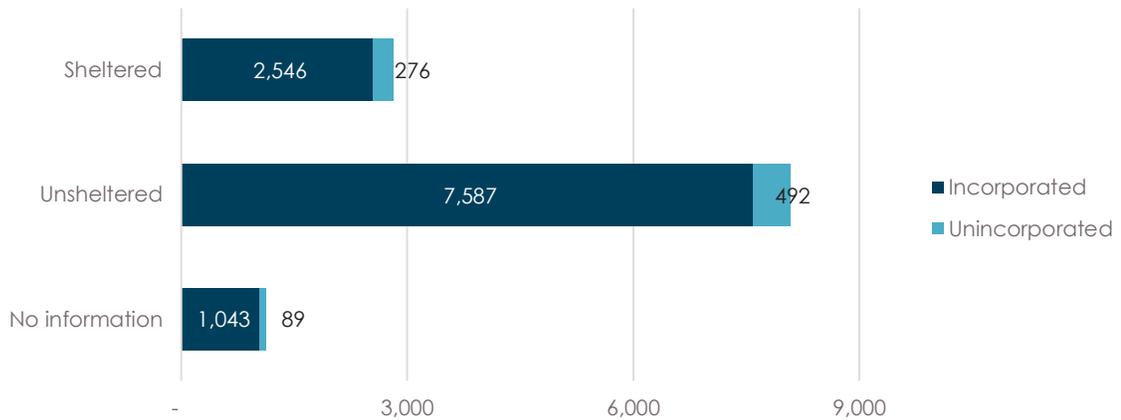
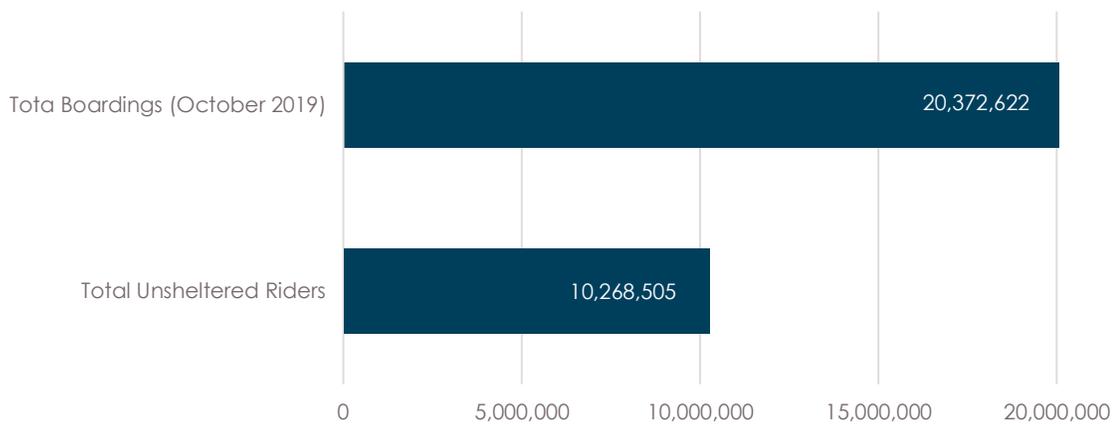


Figure 3.3. Total Boardings and Total Unsheltered Riders



Supervisory Districts

Given the backdrop of bus stops and shelter patterns in the County, the study seeks to understand how District 2 compares to the other four Districts in the County and assess distributional differences.

District 2 has the largest share of the County’s boardings and uniquely has a significant share of both the County’s bus stops and boardings compared to other districts. The district has about 27 percent of the County’s stops, a close second to District 3. However, while District 2 and District 3 have relatively the same share of Metro bus stops, District 2 significantly out numbers in boardings compared to all Districts with a share of 35 percent of total boardings followed by District 1 with 28 percent with the lowest share being 6 percent in District 5 (See Figure 3.4 and Figure 3.5).

Figure 3.4. Total Metro Bus Stops in LA County

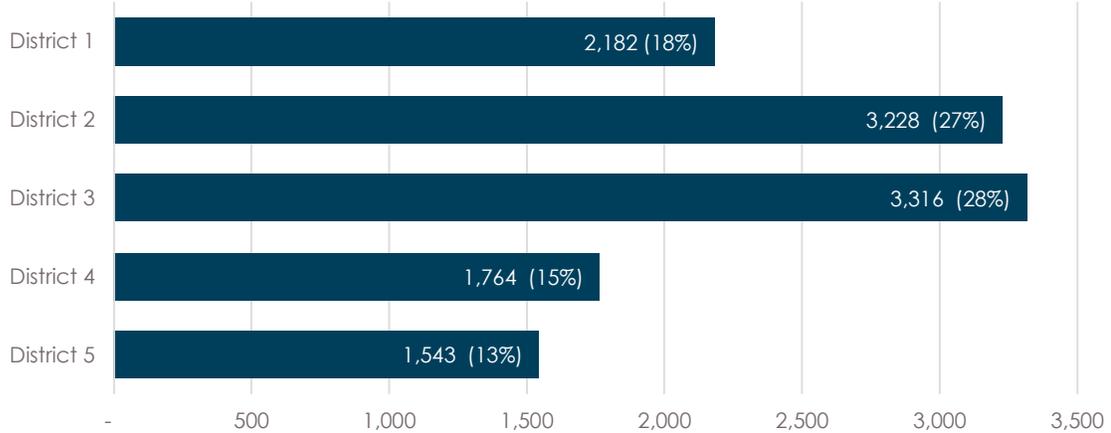
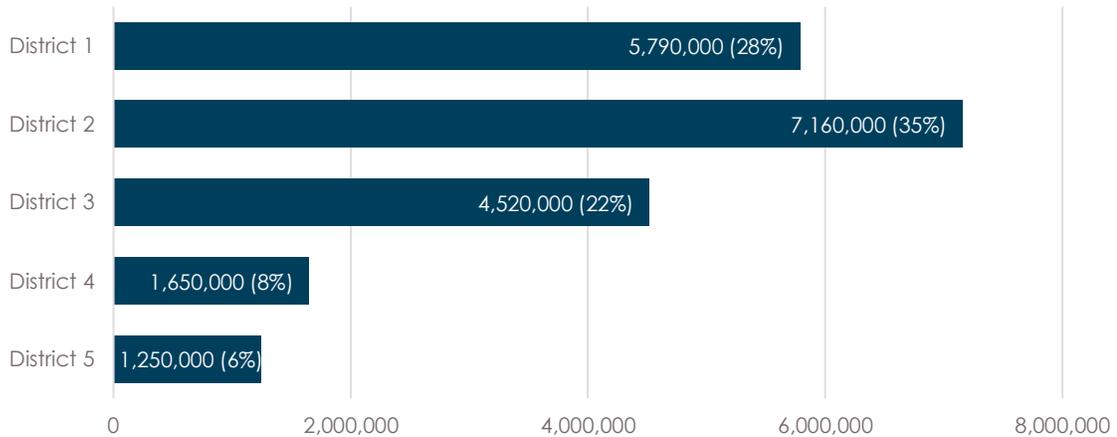
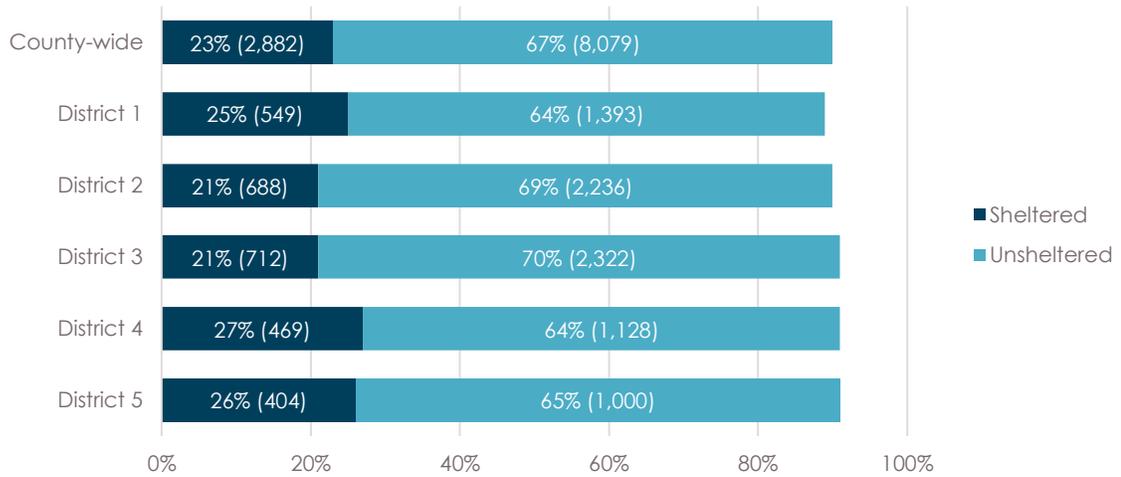


Figure 3.5. Total Boardings in October 2019



The distribution of sheltered and unsheltered bus stops across districts reflect County-level patterns. The study compares the proportion of sheltered and unsheltered bus stops across the County to each Supervisorial District and finds that the distribution is relatively equal not only between the Districts and the County but across Districts as well. With the share of sheltered and unsheltered stops at 23 percent and 67 percent respectively County-wide, the range for the share of sheltered stops across Districts is 21 percent to 27 percent and 64 percent to 70 percent for unsheltered. **In terms of absolute number of unsheltered stops, District 2 has close to the highest at 2,236, almost a thousand stops more than the next highest number of unsheltered stops** (See Figure 3.6).

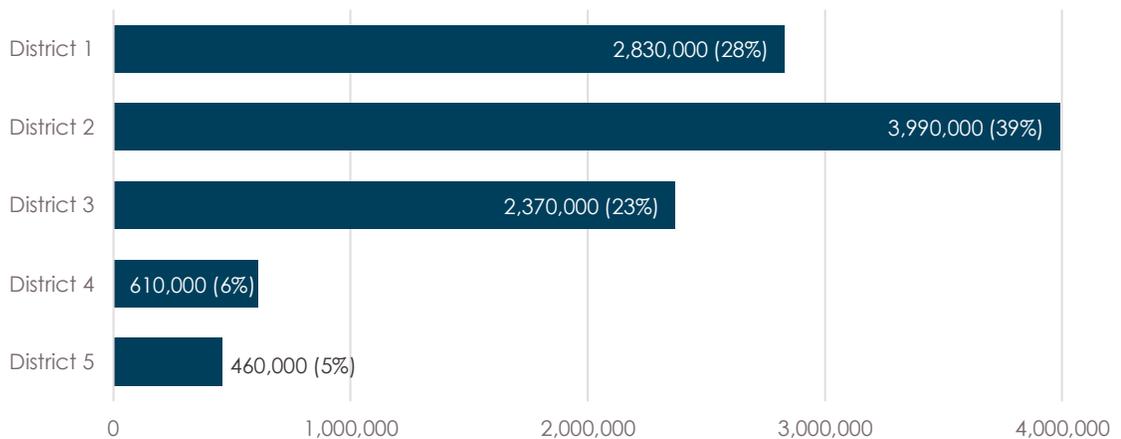
Figure 3.6. Share of Un/Sheltered Bus Stops



Note: Percentages will not add up to 100 as the remaining proportion of stops are identified as “Unknown”

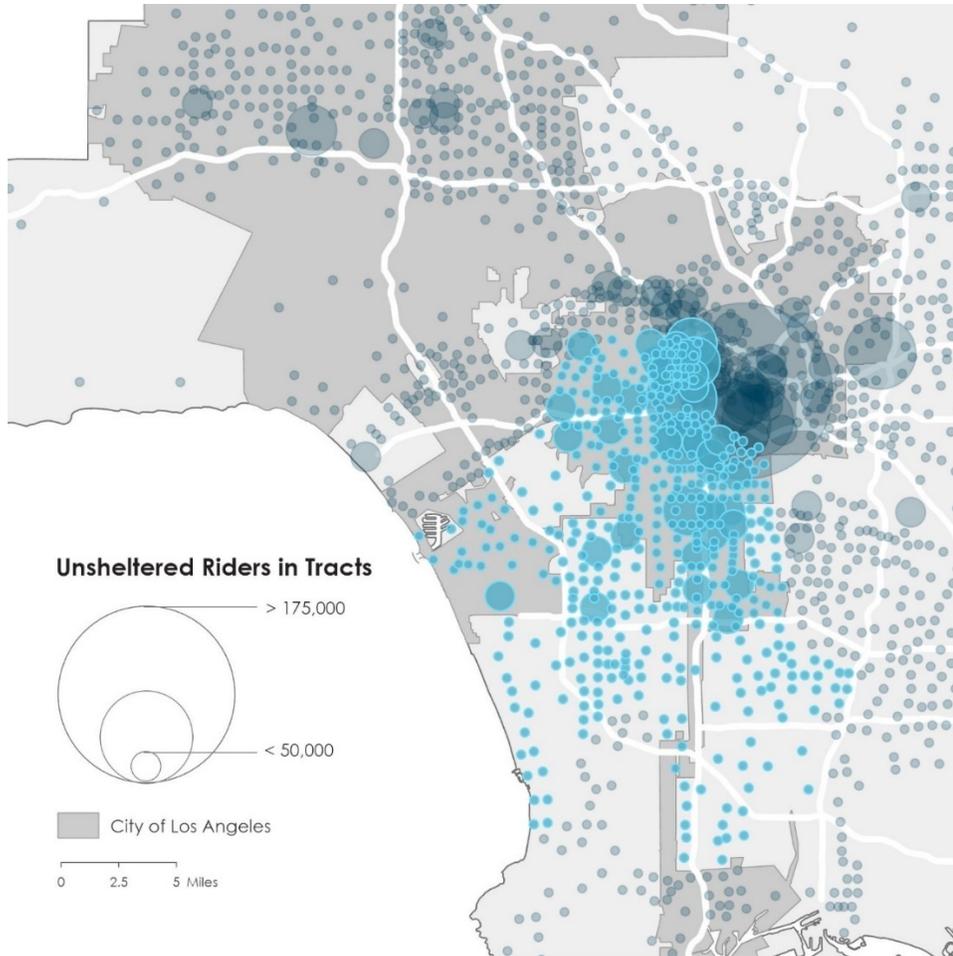
District 2 has the greatest share of the County’s unsheltered riders at close to 40 percent, ten percentage points more than the next highest share (See Figure 3.7). Observing Metro stops alone may lead to concluding each Supervisorial District has the same level of shelter need given the distribution of unsheltered stops are similar across Districts and to the County as demonstrated above. However, by taking into account the level of use at each stop through boarding, the data demonstrates substantial differentiation between Districts. These differences by in large reflect differences in overall boarding levels, which can be explained given the relative similarity in the share of unsheltered stops in each district and that the majority of Metro stops are unsheltered.

Figure 3.7. Total Unsheltered Riders



Taking a closer look at the geographic distribution of unsheltered riders, most are concentrated in the City of Los Angeles and District 2 (See Figure 3.8). Figure 3.8 maps the total unsheltered riders by census tract and is displayed using graduated circles where the larger the circle, the greater number of unsheltered riders in the tract. Light blue indicates District 2 census tracts. The map shows a high concentration of unsheltered riders clustered around Downtown, Wilshire Center, Harvard Heights, and Exposition Park.

Figure 3.8. Unsheltered Riders in Tracts



The research compared the distribution of unsheltered riders and unsheltered stops by incorporated and unincorporated communities. **While 62 percent of District 2's unsheltered stops are in the City of Los Angeles, almost 85 percent of the District's unsheltered riders are in the city**, indicating the outsized impact of ridership in the City of Los Angeles at unsheltered stops (See Figure 3.9 and Figure 3.10).

Figure 3.9. Share of Unsheltered Bus Stops by Un/Incorporated

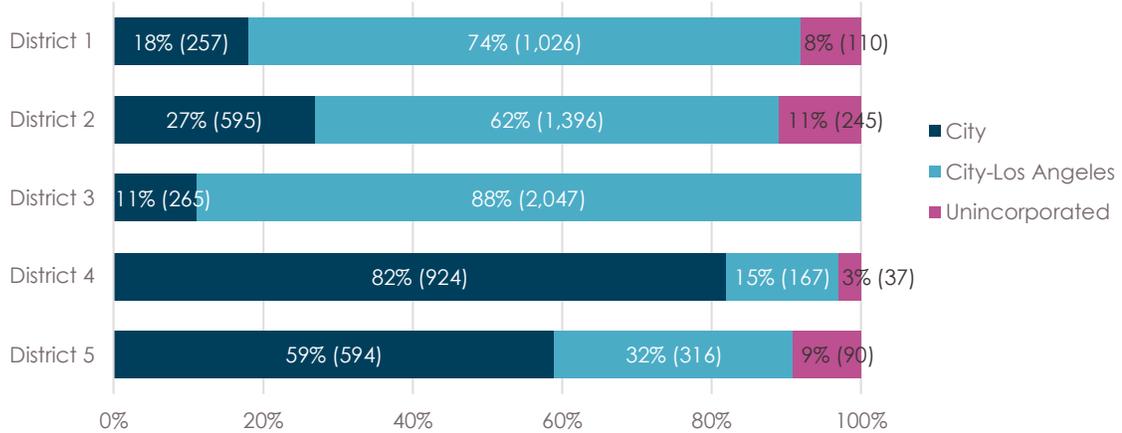
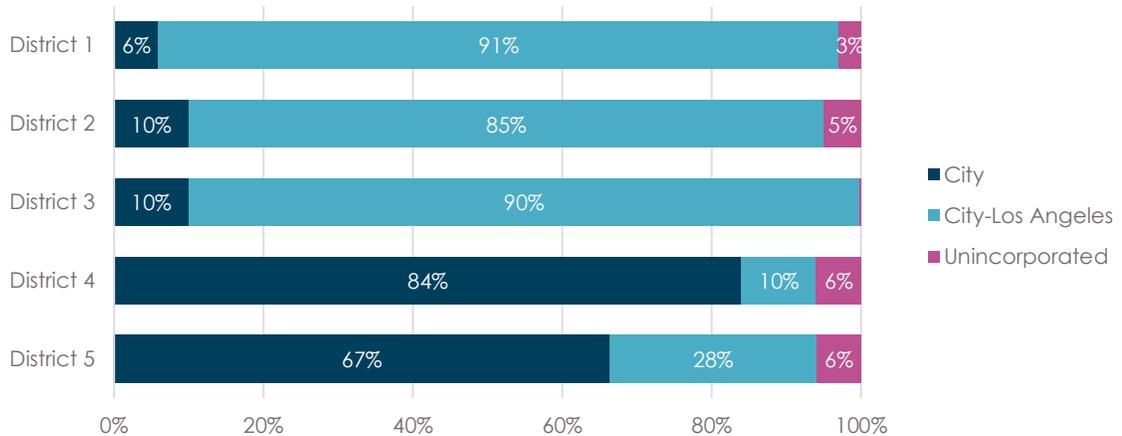


Figure 3.10. Share of Unsheltered Riders by Un/Incorporated



Unincorporated Communities

The study is particularly interested in the distribution of bus stops and shelters in unincorporated communities as Supervisorial Districts have authority and governance over bus stops in these areas.

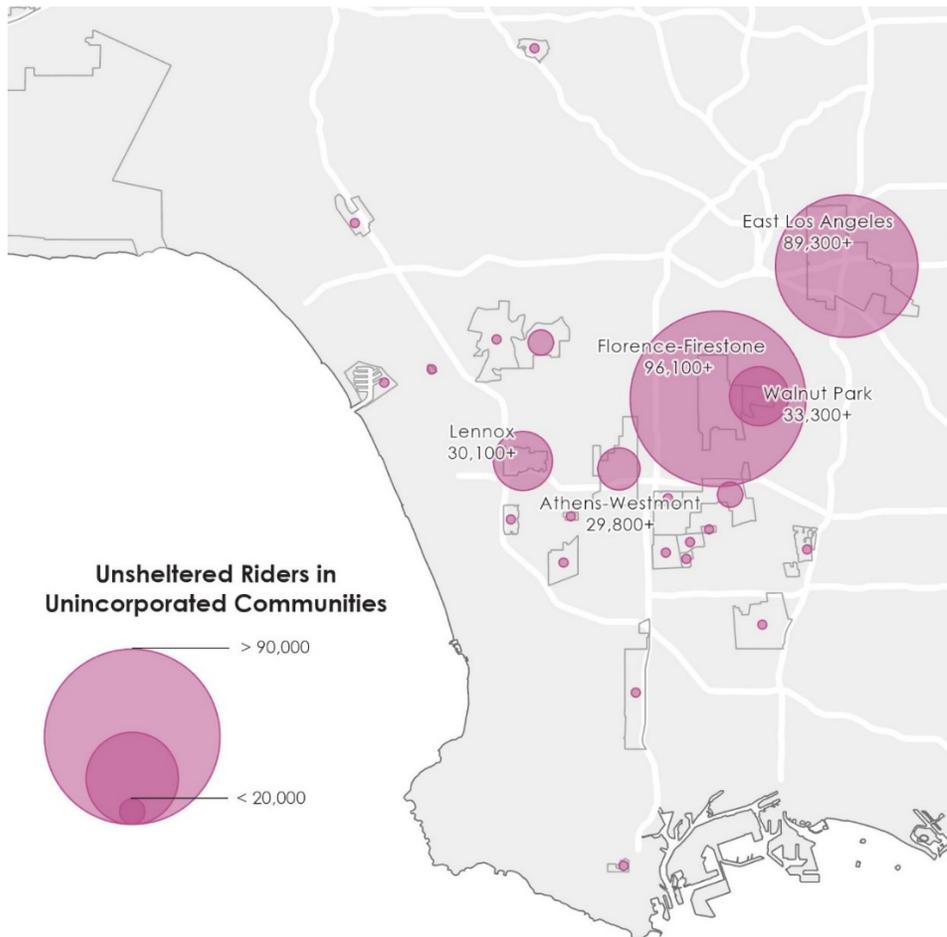
Across the County, 857 Metro bus stops are in unincorporated communities, of which approximately 58 percent or 492 do not have a shelter. **Of the 857 stops in unincorporated areas, half are in District 2 alone. The same proportion of unsheltered stops are also in District 2 alone. In addition, 60 percent of the County's unsheltered riders in unincorporated communities are in District 2** (See Table 3.1). The number of stops and unsheltered stops in unincorporated District 2 is almost double the district with the next highest number and has almost one and a half times more unsheltered riders than the next highest. **Comparing specific**

unincorporated communities and the level of unsheltered riders, three out of the top five unincorporated communities with the highest unsheltered riders in the County are in District 2 (See Figure 3.11).

Table 3.1. Total Stops, Unsheltered Stops, and Unsheltered Riders in Unincorporated Los Angeles County

Districts	Total Stops	Total Unsheltered Stops	Unsheltered Riders
District 1	236	110	89,658
District 2	425	245	215,041
District 3	15	10	5,452
District 4	53	37	37,432
District 5	128	90	26,434
Total	857	492	374,017

Figure 3.11. Unsheltered Riders in Unincorporated Communities



Metro Equity Focused Communities

Eighty percent of unsheltered riders in unincorporated areas are in Metro Equity Focused Communities, with the greatest proportion in District 2 (See Figure 3.12). This suggests that not only are a significant number of riders boarding bus stops at unsheltered stops in District 2, the unincorporated neighborhoods these stops are located are considered communities with higher concentration of socio-economic and transit-related disinvestment.

Figure 3.12. Unsheltered Riders in Unincorporated, by EFC

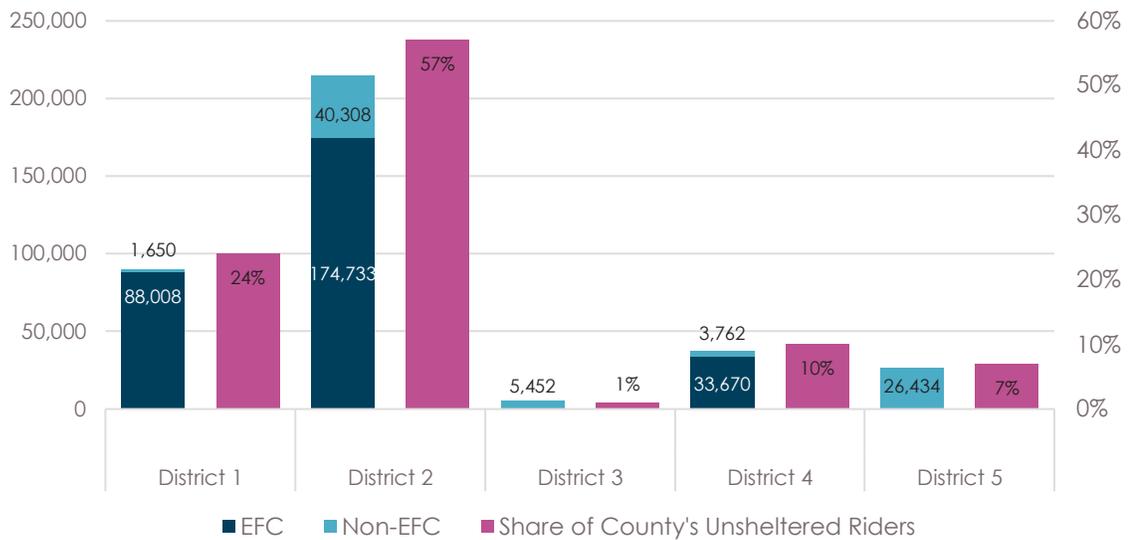
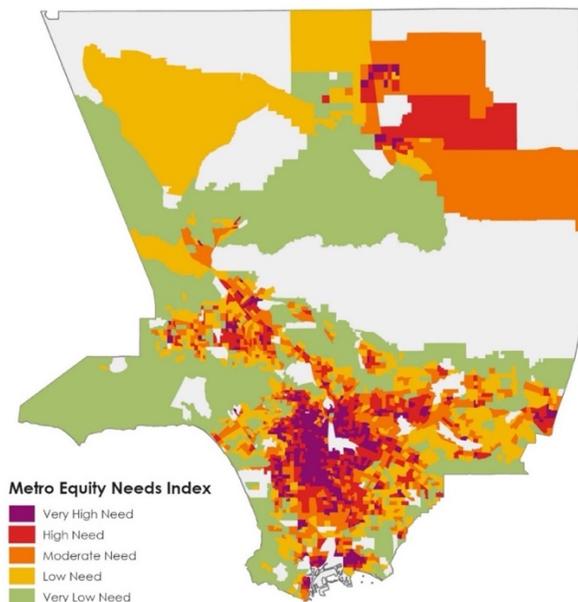


Figure 3.13. Map of Metro Equity Needs Index



Land Surface Temperature

Unsheltered riders at the hottest and coolest stops are most likely to be in District 3 and District 2, respectively. When taking the quintile of temperatures at unsheltered bus stops in the County during a summer evening, unsheltered riders at District 2 stops make up almost three quarters of unsheltered riders exposed to the coolest temperatures. This is primarily due to District 2's proximity to the coast. In contrast, of the unsheltered riders exposed to the highest temperatures, it is most likely they are from stops in District 3 (See Figure 3.14 and Figure 3.15). As Land Surface Temperature is used as a relative measure of comparison, it does not preclude the fact that temperatures across Los Angeles overall are rising and possess a public health dilemma to the entire region. From a comparative standpoint, it is clear that District 3 faces a significant threat of extreme heat in the San Fernando Valley.

Figure 3.14. Unsheltered Riders by Temperature and District, at Lowest and Highest Temperature Ranges

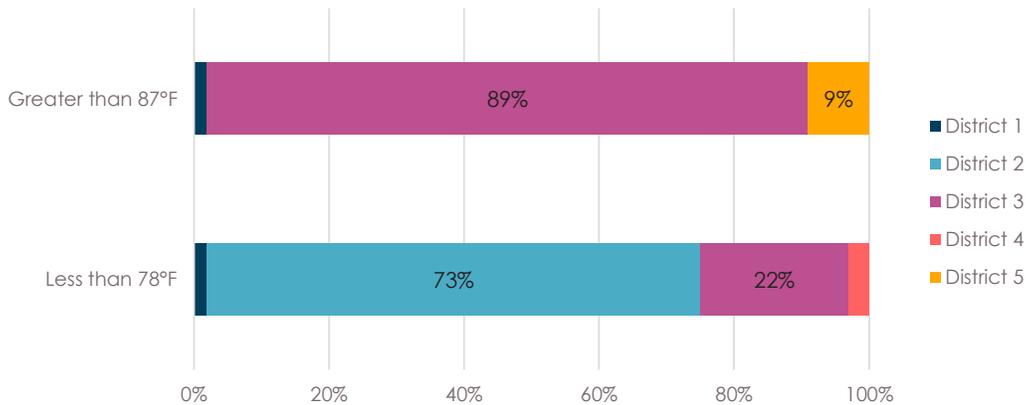
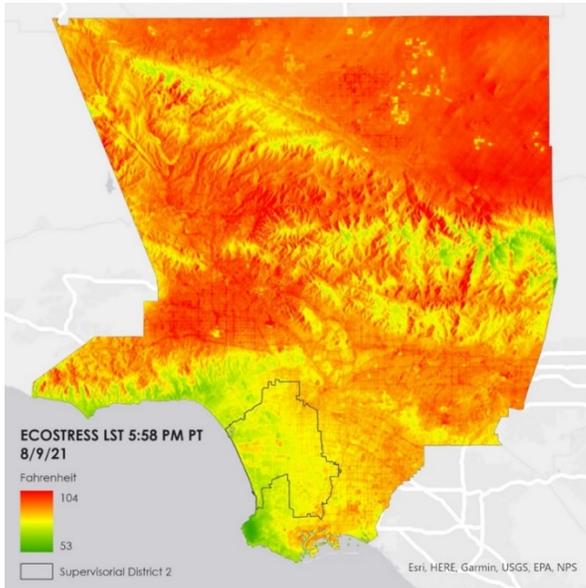
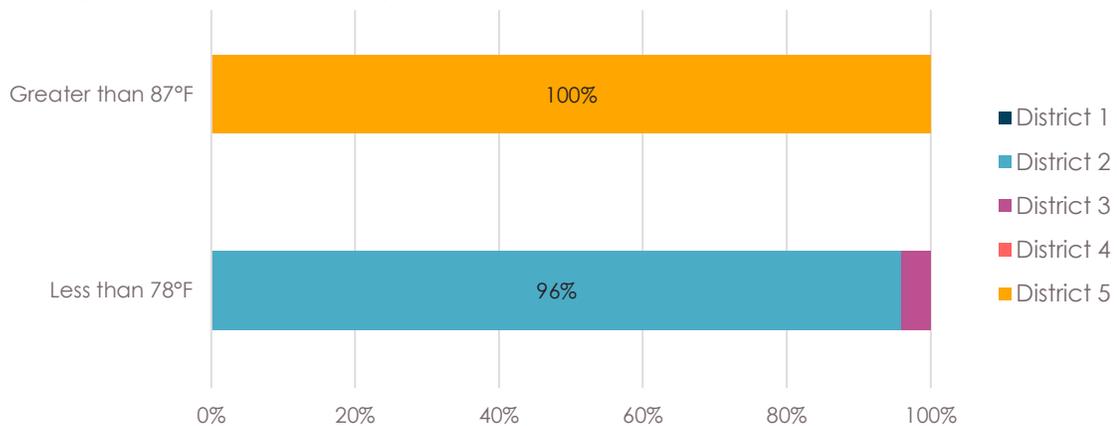


Figure 3.15. ECOSTRESS Land Surface Temperature



However, an analysis of boardings at unsheltered stops in unincorporated areas alone tells a slightly different story. Unsheltered riders in District 5 make up all of the unsheltered riders in the highest temperature range. This means that there are no other unsheltered stops from other districts in unincorporated communities that is exposed to the highest temperature range. Yet, it is important to note that District 5 has only 15 stops in unincorporated areas, of which 10 are unsheltered (See Table 3.1). By focusing only on unincorporated communities, District 2 unsheltered riders make up a greater proportion at the lowest temperature range compared to accounting for all unsheltered riders, at almost 100 percent. By all accounts, District 2 unsheltered riders are at stops with generally cooler temperatures than the rest of the County. (See Figure 3.16).

Figure 3.16. Unsheltered Riders in Unincorporated by Temperature and District, at Lowest and Highest Temperature Ranges



Shade

Our analysis of unsheltered bus stops in unincorporated areas and their proximity to tree shade showed that only ten percent of stops are within 20 feet of a parkway tree. In comparison, District 2 has only seven percent of stops near a tree. All other Districts, except for District 4, meet or exceed County-level proportions (See Table 3.2). This suggests that District 2 and 4 have unsheltered stops in unincorporated areas that are less likely to have access to parkway tree shade compared to the rest of the County.

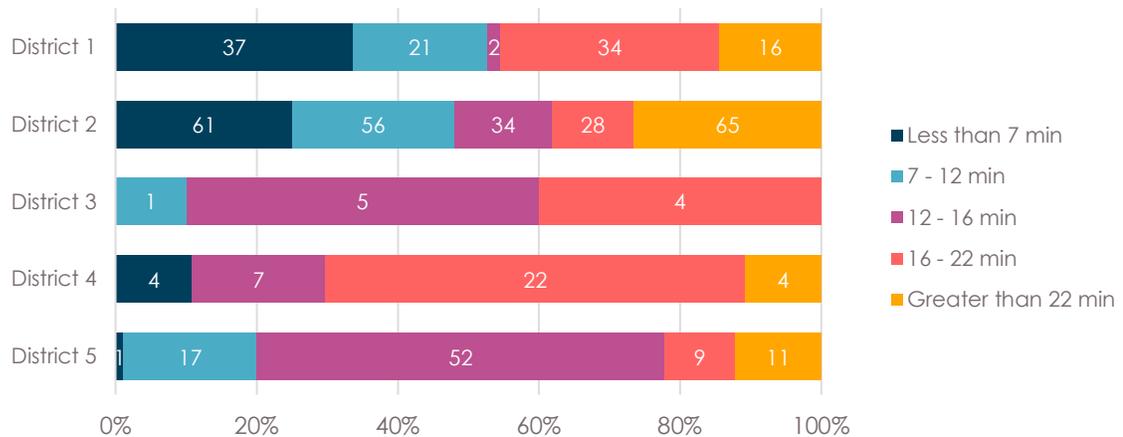
Table 3.2. Unsheltered Stops in Unincorporated within a Parkway Tree by District

District	Not within 20 ft of a tree	Within 20 ft of a tree	Share of stops near a tree
District 1	92	18	16%
District 2	228	17	7%
District 3	9	1	10%
District 4	35	2	5%
District 5	81	9	10%
Total Stops	445	47	10%

Wait Times

There are varying distributions of wait times within each District. **For District 2, wait times are more evenly distributed across its stops than other Districts. However, District 2 observes a large share of wait times on either end of average wait times.** Specifically, District 2 has the greatest share of its bus stops with the longest average wait times of 22 minutes or more. At the same time, 50 percent of its stops fall in the first two quintiles of average wait, second to District 1 with 53 percent of stops in the first two quintiles. This means that for every other unsheltered bus stop in unincorporated District 2, a passenger can expect to wait on average less than 12 minutes but for every four unsheltered stops, a passenger may expect to wait more than 22 minutes. While there are few unsheltered stops in District 4, of them about 70 percent have average times in the second highest and highest quintile of average wait times (See Figure 3.17).

Figure 3.17. Average Wait Times at Unsheltered Stops in Unincorporated



Schools

During my analysis, I noticed a visual pattern of unsheltered stops with high ridership near schools. I further analyzed my visual inspection by estimating the number of unsheltered stops within a quarter mile of a school. Across unincorporated Los Angeles County, 46 percent of unsheltered stops are within a school. District 1 is the only district higher than County-level proportion, with the second highest proportion District 2. In absolute terms, District 2 has the most number of stops near a school at 105 (See Table 3.3)

Table 3.3. Unsheltered Stops in Unincorporated within School by District

District	Not within 1/4 mile of a school	Within 1/4 mile of a school	Share of stops within 1/4 of a school
District 1	34	76	69%
District 2	140	105	43%
District 3	9	1	10%
District 4	23	14	38%
District 5	62	28	31%
Total	268	224	46%

Prioritization

In order to prioritize investments in bus shelters, I developed a prioritization mechanism to assess which unsheltered stops in unincorporated Los Angeles County are most in need of a shelter based on the variables described in the previous section.

There are a total of 492 unsheltered stops in unincorporated Los Angeles County. Out of the 98 bus stops in the top 20% score, almost all (90 percent) are located in District 1 and 2. While unsheltered unincorporated stops in District 1 and 2 account for the greatest proportion of stops across all quintiles of scores, the share is the most in the top quintile. Within the stops in the top quintile, 57 stops or 58 percent are in unincorporated District 2 (See Figure 3.18). **It is clear that based on the prioritization I used, District 2 has a particular interest and need of investments in delivering bus shelters for its unincorporated communities if accounting for Metro bus stops only.** Figure 3.19 is a map of the spatial distribution of all unsheltered stops in unincorporated areas in blue and of those, the stops with the top 20% score in yellow. Table 3.4 is a list of all unincorporated communities with prioritized bus stops.

Figure 3.18. Quintiles of Priority Score of Unsheltered Unincorporated Stops by District

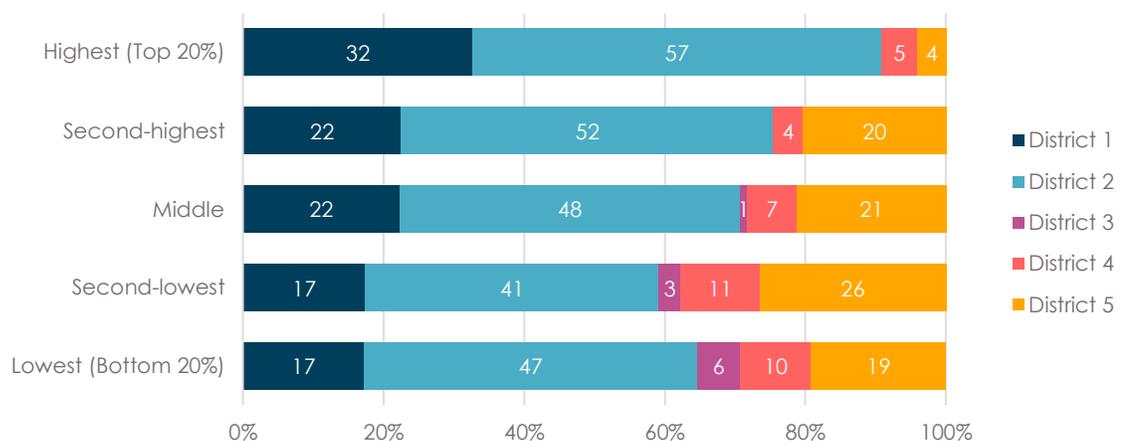


Figure 3.19. Top 98 Unincorporated & Unsheltered Stops

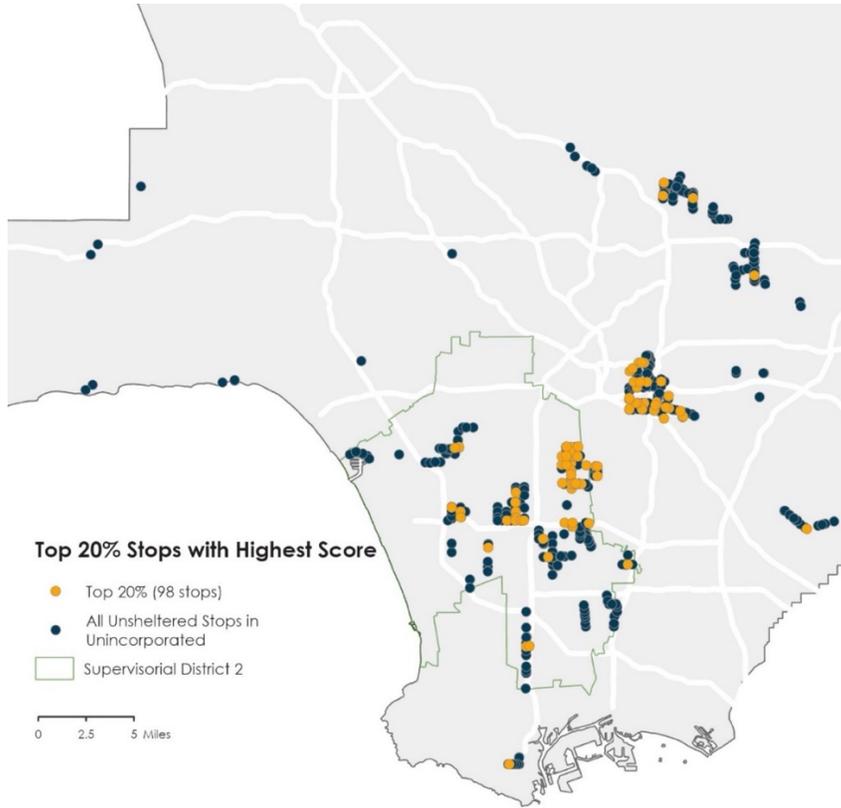


Table 3.4. Unincorporated Communities with Prioritized Bus Stops

Unincorporated Community	Num. of Stops	District
East Los Angeles	32	District 1
Florence-Firestone	30	District 2
Athens-Westmont	11	District 2
Willowbrook	5	District 2
Lennox	4	District 2
Walnut Park	3	District 4
Altadena	3	District 5
West Carson	2	District 2
View Park/Windsor Hills	2	District 2
South Whittier	1	District 4
Northeast San Gabriel	1	District 5
La Rambla	1	District 4
Hawthorne	1	District 2
East Rancho Dominguez	1	District 2
Athens Village	1	District 2
Total	98	

Supervisorial District 2

I looked closely at patterns of unsheltered stops and riders within unincorporated areas of District 2. As seen in Table 3.5, District 2's unincorporated communities have 425 bus stops, of which 245 are unsheltered (57 percent) which accounts for approximately 215,000 unsheltered riders.

By analyzing unsheltered riders by block groups, the spatial distribution is clearer within District 2. High concentrations of unsheltered riders are within the boundaries of Los Angeles, particularly in the neighborhoods such as Wilshire Center, Little Bangladesh, Harvard Heights, Exposition Park, and University Park (See Figure 3.20 and Figure 3.21).

Figure 3.20. Unsheltered Riders in District 2 by Block Groups

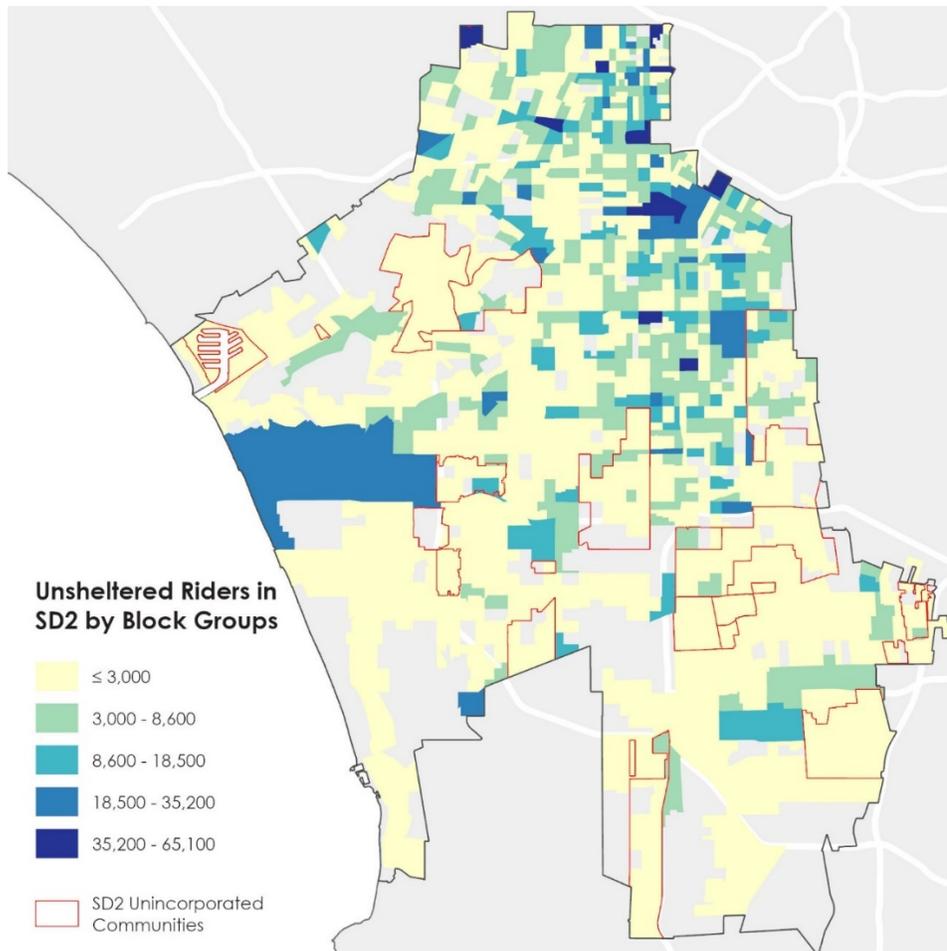
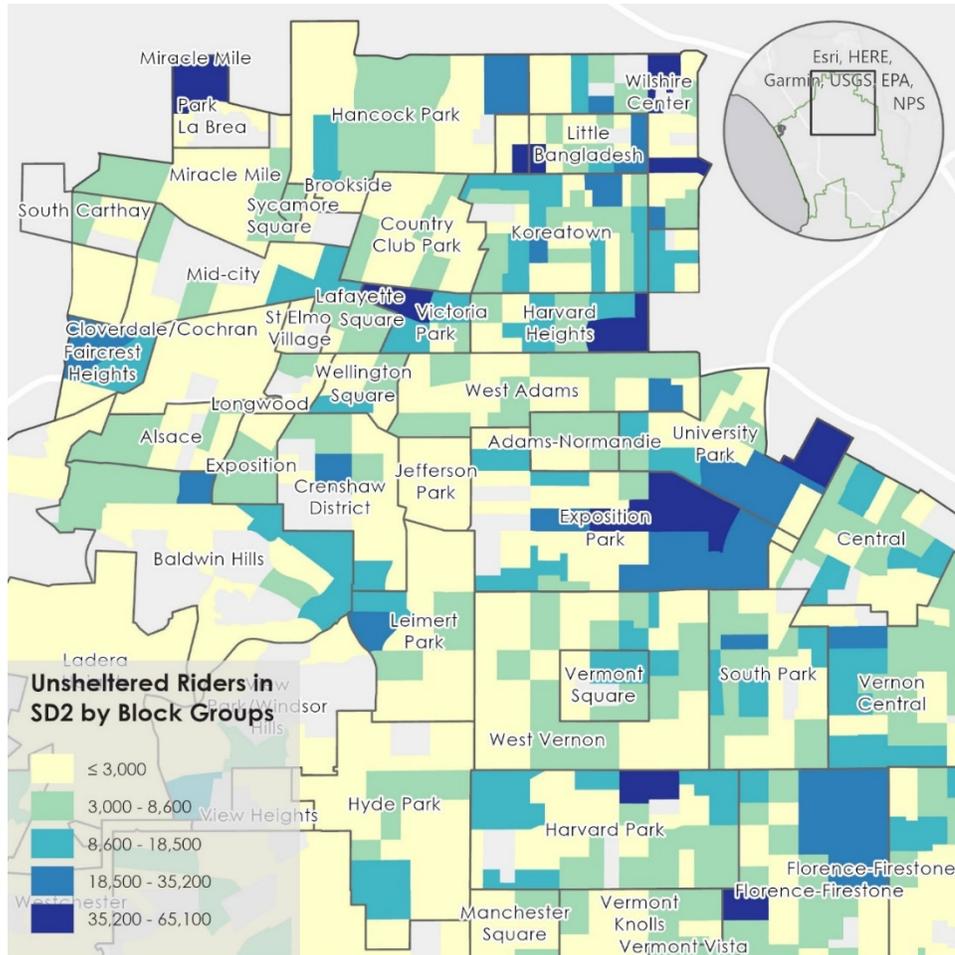


Figure 3.21. Unsheltered Riders in District 2 by Block Groups, close-up



Observing District 2’s unincorporated communities alone, Florence-Firestone outpaces all other communities in terms of unsheltered riders. Florence-Firestone has more than three times the unsheltered riders than the community with the next highest number of unsheltered riders (See Table 3.5). While Lennox has four times less stops than Athens-Westmont, they both have approximately the same number of unsheltered riders, demonstrating the importance of evaluating stops by un/shelter and boardings.

Table 3.5. Stops in Unincorporated District 2

Unincorporated Community	Total Unsheltered Riders	Total Stops	Share of Unsheltered Stops
Florence-Firestone	96,176	89	62%
Lennox	30,105	15	87%
Athens-Westmont	29,857	67	49%
View Park/Windsor Hills	16,485	21	57%
Willowbrook	11,900	64	52%
West Carson	9,096	31	48%
Ladera Heights	4,122	22	64%
Athens Village	3,887	8	63%
Hawthorne	3,865	3	100%
Rosewood/West Rancho Dominguez	3,007	15	60%
East Rancho Dominguez	2,215	14	50%
Rancho Dominguez	1,370	31	84%
El Camino Village	1,283	13	38%
Marina del Rey	1,279	17	59%
West Rancho Dominguez	211	3	33%
Rosewood	90	4	25%
Del Rey	71	2	50%
Wiseburn	22	2	100%
Rosewood/East Gardena	0	4	0%
Total	215,041	425	57%

Figure 3.22 shows a map of the concentration of unsheltered riders by Supervisorial District 2 unincorporated communities, all unsheltered bus stops, and unsheltered bus stops in the top 98 prioritization score. While most priority stops are in communities with high levels of ridership, it is not always the case. Using the criteria in our prioritization scheme, Table 3.6 lists the top priority stops in District 2's unincorporated areas. The top three communities with the greatest number of priority stops are Florence-Firestone, Athens-Westmont and Willowbrook.

Figure 3.22. Unsheltered Riders in District 2 by Unincorporated

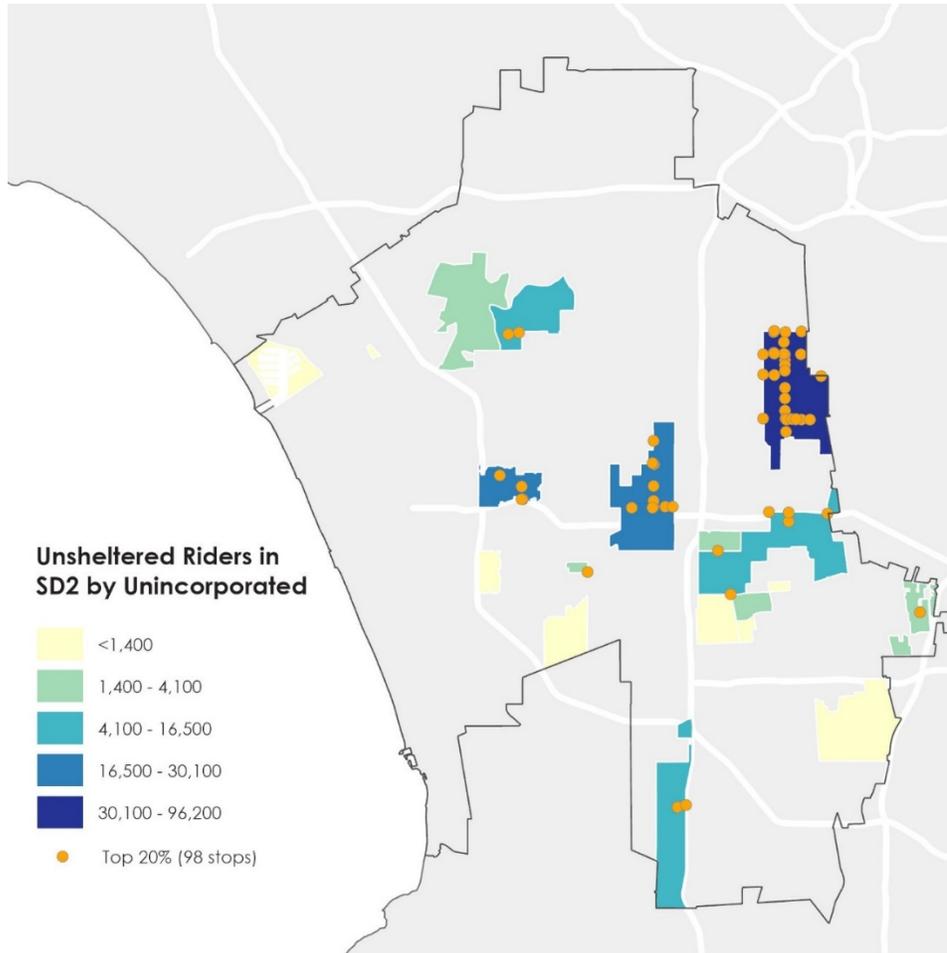


Table 3.6. Tops Stops in Unincorporated District 2

Unincorporated Community	Total Stops in Top 20% Score
Florence-Firestone	30
Athens-Westmont	11
Willowbrook	5
Lennox	4
West Carson	2
View Park/Windsor Hills	2
Hawthorne	1
East Rancho Dominguez	1
Athens Village	1
Total	57

Part 4: Bus Shelter Implementation in Unincorporated Los Angeles County

The Los Angeles County Department of Public Works manages the provision of the County's bus shelters for its unincorporated communities. Starting in 1990, the County began its Advertising Bus Stop Shelter Program that allows for a single long-term licensee to own, install and maintain advertising bus shelters. In 2003, the County added its Non-advertising Bus Stop Amenities Program in which the County installs and maintains bus shelters that are County-owned. Today, there are approximately 270 advertising bus shelters and approximately 384 non-advertising bus shelters across the unincorporated County areas.

Current Shelter Designs, Costs and Site Specifications

Shelter Design and Costs

Public Works has two standard bus shelter designs, one for its non-advertising bus shelters and one for its ad-shelters. Public Works' non-advertising standard surface-mounted bus shelter has solar powered lighting, pitch roof with floral decorative rear and side panels that are available at several local manufactures. These shelters are approximately 14 feet wide and 5 feet in depth (See Figure 4.1). The advertisement shelters are slightly larger to accommodate an advertising panel (See Figure 4.2). Non-ad bus shelter hard costs are anywhere between \$26,000 and \$35,000 each, depending on features included. Ad shelters cost approximately \$35,000 to install given its larger dimensions. Soft costs are an additional 30 - 40 percent of total hard cost, which includes but is not limited to planning, design, construction engineering/management, and inspection. Altogether, a bus shelter can cost up to \$50,000 each.

Figure 4.1. Example Public Works Standard Non-Advertising Bus Shelter without Panel



Source: LA County Public Works website¹⁰

Figure 4.2. Example Public Works Standard Advertising Bus Shelter



Source: LA County Public Works website¹¹

¹⁰ <https://pw.lacounty.gov/transit/TransitCapital.aspx#pageTitle>

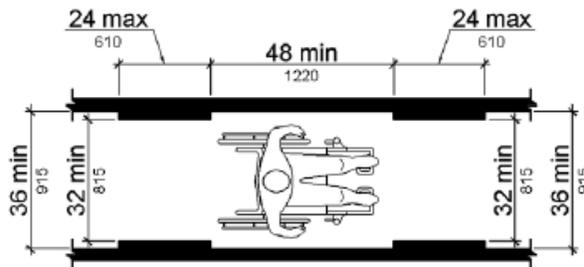
¹¹ Ibid.

Shelter Placement

The placement of the bus shelter requires a large footprint in order to meet the Americans with Disabilities Acts (ADA) Accessibility Standards. Various factors can cause a bus stop to be infeasible for a bus shelter such as narrow or uneven sidewalks, or obstructions near the bus stop, etc. The following are several key ADA site requirements:

- **Accessible Route and Clearance Width for Walking Surface:** Accessible route minimum requirement for walking surfaces is 3 feet (See Figure 4.3).¹² However, Public Works follows an accessible route clearance width of 4 feet for its new bus shelter construction as is suggested by the Proposed ADA Public Right-of-Way Accessibility Guideline.¹³ An accessible route must also be provided on either side of the bus shelter in order to allow people using a wheelchair to maneuver around the shelter.

Figure 4.3. Clear Width of an Accessible Route



Source: US Access Board, ADA website¹⁴

- **Bus Stop Boarding and Alighting Area:** The minimum unobstructed boarding area must be 8 feet in length (perpendicular to the curb) and 5 feet in width (parallel to the curb) (See Figure 4.4).¹⁵ This accounts for a wheelchair waiting area and wheelchair ramp to serve the waiting area.¹⁶

¹² https://www.access-board.gov/ada/#ada-403_5_1

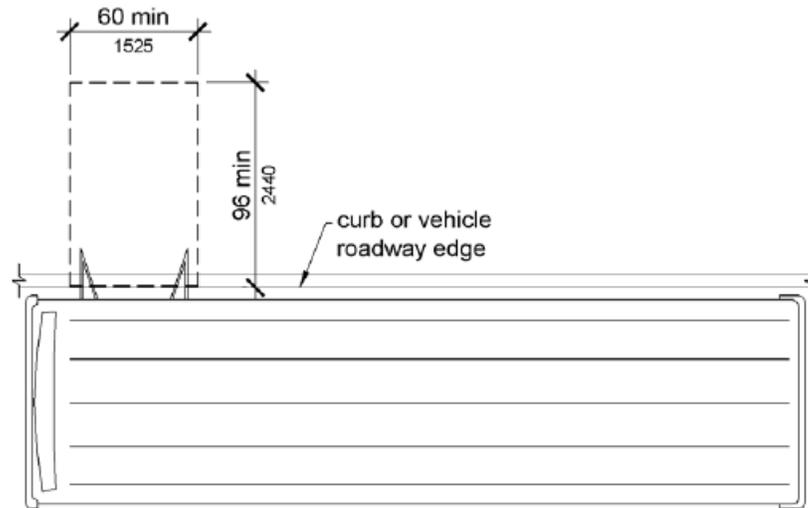
¹³ <https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r3023-continuous-width>

¹⁴ <https://www.access-board.gov/images/ada-aba/standards/ADA-AB20.gif>

¹⁵ https://www.access-board.gov/ada/#ada-810_2_2

¹⁶ <https://nacto.org/publication/transit-street-design-guide/stations-stops/stop-design-factors/accessible-paths-slopes/>

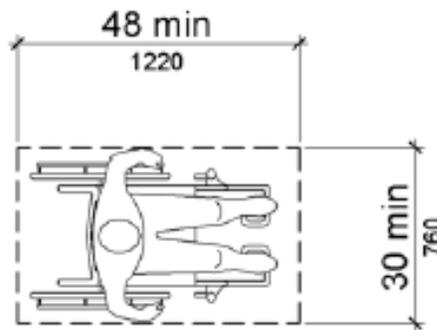
Figure 4.4. Dimensions of Bus Boarding and Alighting Areas



Source: US Access Board, ADA website¹⁷

- **Bus Shelters and Connection to an Accessible Route:** A bus shelter must provide a minimum clear floor within the shelter of 2.5 feet by 4 feet (See Figure 4.5).¹⁸ The shelter also needs to be connected by an accessible route to the boarding and alighting area (See Figure 4.6).¹⁹

Figure 4.5. Clear Floor or Ground Space



Source: US Access Board, ADA website²⁰

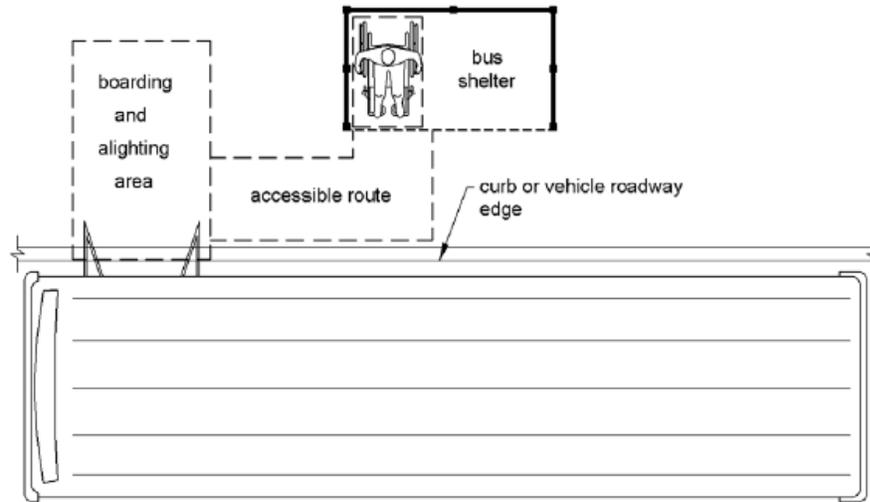
¹⁷ <https://www.access-board.gov/images/ada-aba/standards/ADA-AB112.gif>

¹⁸ https://www.access-board.gov/ada/#ada-305_3

¹⁹ https://www.access-board.gov/ada/#ada-810_3

²⁰ <https://www.access-board.gov/images/ada-aba/standards/ADA-AB7.gif>

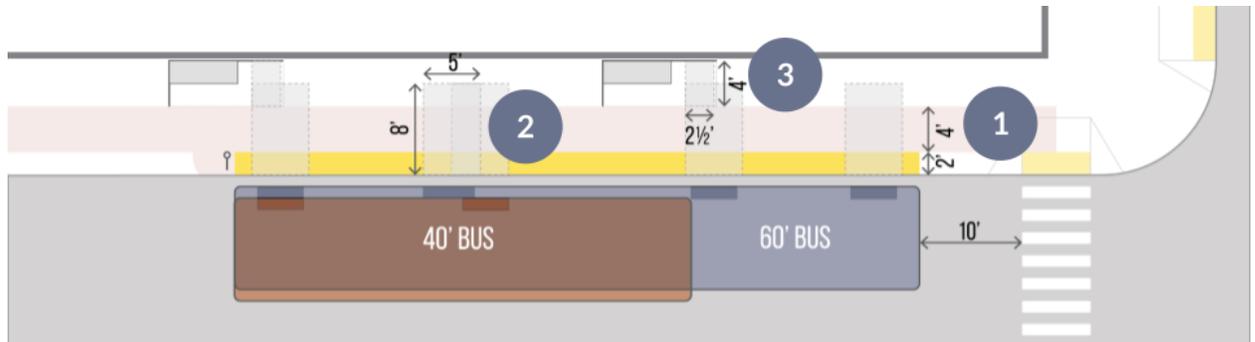
Figure 4.6. Bus Shelters



Source: US Access Board, ADA website²¹

Figure 4.7 shows an example of a bus stop on a 10-foot sidewalk with bus shelters at the building line.²² Included in the diagram is a visual example of the aforementioned ADA requirements, including 1 - Accessible Route; 2 - Boarding Area; and 3 - Minimum Clear Floor within the Bus Shelter.

Figure 4.7. Bus stop on 10-foot sidewalk with shelters at building line



Source: National Association of City Transportation Officials²³, edited by report author

Advertising Bus Stop Shelter Program

Public Works entered into an agreement with Metro Display Advertising Inc. (MDA), which later was acquired with a company name change to ClearChannel Outdoor. The initial license agreement began in 1990 for a term of ten years and was extended

²¹ <https://www.access-board.gov/images/ada-aba/standards/ADA-AB113.gif>

²² <https://nacto.org/publication/transit-street-design-guide/station-stop-elements/stop-elements/small-transit-shelter/>

²³ Ibid.

multiple times anywhere from 2 to 5 years. As part of the contract, ClearChannel installs and maintains bus shelters and provides twice-a-week cleaning and trash collections, along with any as-needed pressure washing and repairs. ClearChannel can make more maintenance visits if conditions warrant and as required by Public Works. The agreement gives the vendor the exclusive right to erect shelters in and around the locations specified by the agreement. In exchange, ClearChannel shares 15 percent or \$100,000 of the ad revenue per year with the County, whichever is greater. For Public Works, the value of the advertising bus shelter program is not the revenue but the maintenance cost that is covered by the contractor, approximating \$1,000 per shelter per year for basic maintenance. With 270 total ad shelters, this amounts to \$170,000 in maintenance costs per year that is offset by the vendor contract.

The initial agreement set out to erect approximately 280 shelters, which MDA successfully met, but met financial challenges when it agreed to install additional shelters. According to the agreement's first amendment in 1999, MDA erected all 280 shelters outlined in the initial agreement and agreed to build up to an additional 500 shelters. By early 2000, ClearChannel acquired MDA and continued erecting ad shelters to its peak number at approximately 375 shelters.²⁴ However, the additional 500 shelters did not materialize due to the excessive amount of capital funding required to build the additional shelters. Overtime, ClearChannel recognized that the investment of capital would not be compensated by the advertising revenue generated from the shelters. Instead of erecting more bus shelters, they maintained what they built and removed shelters when they were damaged or stolen, down to the 270 ad shelters that exist today. Given the lack of additional bus shelters since the early 2000, the current ad shelters are more than two decades old. In 2022 the last extension to ClearChannel's contract expired but continues to maintain and operate the ad-shelters through permits.

Replacement

In 2012 and again in 2018 the County released a Request for Proposal to have a new licensing agreement for the ad-shelter program but has been unsuccessful in finding a proposal that would include replacing all 270 advertisement shelters. This is primarily because the outlay in capital cost is too high to recapture advertisement revenue, making it unprofitable for the vendor to replace shelters. As a solution, the County is going to contribute the capital cost to replace all existing ad-bus shelters with new shelters while Public Works solicits a new vendor to operate and maintain all ad-shelters. Replacement of aging shelters with new bus shelters through County funds would make the advertising bus stop shelter program more attractive to advertisers.

By the time the ad shelters are replaced, all bus shelters in unincorporated Los Angeles County would be County-owned for the first time. Public Works will replace the ad bus shelters in multiple phases. It is currently developing the bid package that will include

²⁴ According to historical records available, it is not clear how MDA selected bus shelter locations.

bus shelter design and outline the scope of work. After the bid package is finalized, it will go to the board for approval. The bid package will be the first phase and pilot for replacing ad-shelters. Out of 270 shelters, the pilot will include forty that will be divided between Supervisorial Districts proportional to its number of current ad-shelters. The pilot will serve to assess efficiencies and identify areas for improvement to help accommodate doubling the quantity for future phases. The department will release the bid package and expect construction to begin tentatively for summer 2024. Future shelter replacement phases will be highly dependent on funding becoming available from state and federal dollars. Currently, Public Works is exploring various grant opportunities, including the federal omnibus grant for transportation infrastructure.

In parallel to the capital project, Public Works is working on an RFP to solicit a vendor for a new licensing agreement. The new service contract may begin before all bus shelter structures are built. While ClearChannel is currently operating and maintaining current ad-shelters, the new contract will take over maintenance and pay for exclusive advertisement privileges.

Non-advertising Bus Stop Amenities Program

In 2003, the County initiated a Non-advertising Bus Stop Amenities Program and built 150 bus shelters at Metro bus stops through a capital project funded by a federal grant. Over time, the number has grown to 384 non-advertising bus shelters. There are two key pathways non-advertising bus shelters are built: 1) capital projects in bulk and 2) individual requests through a Master Agreement with the County's Internal Service Department.

Capital Projects - Bus Shelter Installation in Bulk

Capital improvements through grant funded bus shelter projects, streetscaping and beautification projects can be an opportunity to replace or build new bus shelters along an entire corridor. As part of developing a full scope for a capital improvement project, a project manager may approach Public Works to provide an assessment of the feasibility to replace or add bus shelters. This assessment would work in tandem with a proposed landscape architecture around the bus shelter and wayfinding signs that enhance a rider's experience and beautify the corridor. In such projects, there is typically no need to prioritize bus stops for shelters as the project itself includes funds for this work; the primary focus then is to construct what is feasible. For consistency, shelter designs will be the same along the whole corridor with the Board of Supervisors ultimately deciding the shelter design and approving the capital project.

Master Agreement - Bus Shelter Installation by Individual Request

Along with large batch installation of bus shelters through capital projects, Public Works installs shelters at an as-needed basis through individual requests by the public or Board of Supervisors. Seating Component Manufacturing Inc. is the bus shelter manufacturer

vendor that has a master agreement with the County’s Internal Service Department (ISD) to provide bus shelter structure, bench and trash receptacles. Constituents can submit a bus shelter request through the Public Works website.²⁵ Once Public Works receives a request, staff make a determination of need based on ridership, site feasibility and adjacent property. Consideration for bus stop shelter installation will be prioritized by daily ridership with a minimum of 25 daily boardings. Staff will visit the site to assess site feasibility, which includes meeting footprint specifications and ADA compliance as described above for a bus shelter. If site feasibility is met, Public Works will take into account adjacent property and will only install a shelter if it is not adjacent to retail front or a single-family home. When bus shelters have been proposed near these property types, Public Works has received complaints for obstructing the property’s view or inhibiting the regular operations of the business. When ridership, site feasibility and adjacent property conditions are met, Public Works will send an email to the Supervisor’s deputy for which the stop is located and request the use of the Supervisor’s Proposition A funds for the capital to build and maintain the new bus shelter. Once the deputy approves, the bus shelter is built within two months. Public Works has shared it has not encountered issues of equity when assessing the distributional patterns of bus shelter development by individual request as Public Works does not receive many individual requests. A majority of non-ad shelters are constructed through capital projects and corridor specific streetscape/beautification projects. While Public Works does not keep track of how many shelters are installed through individual requests, the majority of non-ad bus shelters are in Supervisorial District 1 and District 2 (See Table 4.1).

Table 4.1. Total Number of Non-ad Shelters by Supervisorial District (inclusive of all transit operator stops)

District	Total Non-ad Shelters	Share of Non-ad Shelters
District 1	141	37%
District 2	142	37%
District 3	0	0%
District 4	7	2%
District 5	94	25%
Total Stops	384	100%

Source: Los Angeles County Department of Public Works

Maintenance and Funding

The County contracts out maintenance of bus stop amenities, including County-owned bus shelters. Maintenance contracts perform weekly safety inspections, collect trash two

²⁵ Constituent can complete an “Ask your Question” form to submit a request by navigating to the bottom of the Department’s website to “Contact Public Works” then selecting the link “Ask a Question” or “Send Public Works an Email”
<https://pw.laCounty.gov/general/faq/index.cfm?action=NewQuestion>

to three times a week, pressure wash bus stops every six weeks, and repair amenities as needed. Shelter Clean Services, Inc. currently maintains all 384 non-advertising bus shelters, costing approximately \$1,400 per shelter per year to maintain.

Funding for maintenance and construction of County-owned shelters comes from Proposition A, Local Returns Program whereby Metro collects a half-cent sales tax dedicated to transportation funding. Twenty five percent of Proposition A expenditure plan is designated for the Local Return Program to be used by cities and the County in developing and/or improving local public transit, paratransit and related transportation infrastructure (“Propositions A and C,” n.d.). Local Return funds are allocated to jurisdictions on a per capita basis. For the County, the Public Works - Transit Operations Fund is primarily financed by Proposition A dollars. Transit services financed by this fund include Dial-A-Ride services, fixed route transit services, recreational services such as the Summer Beach Bus, special events charter bus transportation, bus stop amenities including construction or installation and maintenance of shelters and trash receptacles, and the operation and maintenance of four park-and-ride lots (County of Los Angeles, 2023). The County receives approximately \$20 million in Proposition A funding which is allocated to each district proportionate to its unincorporated population.

Building and maintaining bus shelters is costly and finding funds to adequately cover current expenses is taking much creativity. In addition to Proposition A dollars and seeking federal grants, Public Works is an active government partner in opportunities like Affordable Housing and Sustainable Communities (AHSC) Program that provide a potential avenue to include shelter improvements such as one opportunity in Florence-Firestone.

Part 5: Recommendations

Through this report, the Office sought to understand the distribution of bus shelters along factors of equity, and the process for developing, maintaining and funding bus shelters in unincorporated Los Angeles County. With this in mind, I provide several recommendations that will help utilize the findings, conduct future analysis, and equip the Office to strategically engage with Public Works in the bus shelter implementation process.

1. Dedicate resources and bus shelter efforts to Florence-Firestone.

Florence-Firestone is by all accounts the community in greatest bus shelter need not only in District 2 but across all unincorporated communities. Strategic resources for bus shelters will be a productive use of public dollars and support communities that will benefit the most from transit-related investments.

2. Encourage Public Works to:

- a. Track where and through what process non-ad shelters are built to evaluate the implications of the approval process. Data collection to the extent feasible on how and where bus shelters are approved or rejected can illuminate potential patterns of equity or inequity that may not be readily discernible. The two pathways to build non-ad shelters can potentially lead to inequitable shelter distribution as individual requests may likely be submitted by those with capacity, knowledge, and time who tend to be affluent, white residents. As for bulk development, bus shelter development is subject to capital beautification projects which may not account for priority bus shelter needs. Building an assessment quantifies the outcome of these approval processes that has implications for the County's constituents in unincorporated communities. However, data first needs to be collected. By collecting and tracking this kind of data for each shelter and proposed stop now will position Public Works to assess where and how bus shelters are built in the future.
- b. Develop and share a prioritization scheme that assesses shelter needs holistically across the County along lines of equity as a measure of accountability and to make decisions about future shelter placement. Currently, the decision-making process for non-ad shelter stops is inadequate to demonstrate that Public Works is spending public resources for bus shelters in the most productive and equitable manner. As noted above, the

main method for assessing need is boarding or at the behest of capital beautification projects. While Supervisorial Districts have much discretion over where bus shelters are built, they rely on the analysis of Public Works to provide a recommendation based on a holistic assessment of need. There is a significant opportunity to develop a more robust, nuanced, and holistic approach to prioritizing stops with greatest need across the County. Such an analysis will be required to assess performance relative to equity and identify future opportunities for investments based on factors beyond boarding.

- c. Consider prioritizing ad-shelter stops by relative need as opposed to replacing all ad-shelter stops as planned. As described in Part 4, Public Works is currently in the process of replacing all ad-shelters. However, it is not clear why Public Works has decided to replace all ad-shelters instead of first prioritizing which stops, that are either unsheltered or currently an ad-shelter, need a shelter based on the County's priorities. What may once have been a financially profitable stop for a shelter may no longer be the case. Not only as a matter of profit, the stop may not be a priority for the County based on equity factors. Together, replacing the shelter would be an unproductive allocation of public resources. This is a critical moment for Supervisorial District 2 to understand why Public Works is approaching shelter replacement the way they are as there might quickly be a missed opportunity to allocate funds toward building shelters that are most critically in need according to measures of equity that can also accommodate ad-based revenue incentives.

- 3. **Use this report's prioritization methodology to assess if Metro and Public Work's prioritization approach will address the Office's shelter and equity priorities.** As the Office already knows, Metro has undertaken their own prioritization process for Metro stops within and outside the City of Los Angeles. Metro is also working with Public Works to understand mutually agreed upon Metro stops that are a priority for both Metro and Public Works. The Office has an opportunity to use this report as a starting point to compare why and how Metro has prioritized the stops the way they did and what this means for the mutually agreed upon stops with Public Works. For example, Metro is prioritizing stops in need of investments in its totality and does not consider the presence of a bus shelter. Metro's prioritization also accounts for both boarding and alighting (not just boarding as in this study) and uses a heat measure that may be considered too coarse in resolution or a composite that measures heat in ways that may not advance the goal and purpose of Metro's prioritization. Such a comparison was outside the scope of this report, however the Office can use the report's analysis on various equity measures to ask Metro and Public Works critical questions of their prioritization approach. Finally, the Office may be able to leverage the opportunity that Metro and Public Works are reviewing mutually agreed upon priority stops to find funding

either from Metro or use such cross-agency collaboration as a leverage point to seek and/or allocate funding for these stops in District 2.

4. **Leverage Supervisor discretion over bus shelter approval and utilize Proposition A allocations to add more bus shelters.** Unlike the City of Los Angeles which has received criticism for its convoluted and cumbersome approval process for bus shelters, the County's process is relatively simple and straightforward, leaving much authority with the Supervisor to accept or reject proposals for new bus shelters from Public Works. No other departments or agencies are typically involved in the approval process. For the ad-shelter program, this may be because no additional bus shelters have been erected since the program's first ten years. Majority of non-ad shelters are built through capital projects and therefore go through the standard capital project approval process. If individual shelters are requested, only an email approval from the Supervisor's deputy is required. Given the discretionary authority Supervisors have, while Public Works is focused on replacing all bus shelters, District 2 should utilize Proposition A allocations to add more bus shelters. Replacement of non-advertisement shelters will not be considered until all ad-shelters are replaced. However, this does not preclude Supervisorial Districts from adding more shelters with its Proposition A funds.

5. **Participate in Metro/Public Works discussions related to shelter design to stay abreast on potential design options for additional shelters.** Given bus shelters are costly and difficult to find sites appropriate for installation, District 2 should stay abreast to different shade structures that Metro is exploring to accommodate site restrictions and cost. For example, the Kaleidoscope Bus Stop Shelter (See Figure 5.1) needs a significantly smaller footprint yet still provides overhead shade for riders. However, it requires building a foundation for its poles, making this design expensive. Keeping to date with these discussions can help with understanding the expanding possibilities for siting bus shelters the District.

Figure 5.1. Kaleidoscope Bus Stop Shelter



Source: LA County Public Works website²⁶

²⁶ <https://pw.laCounty.gov/transit/TransitCapital.aspx#pageTitle>

6. Future analysis may incorporate the following considerations:

- a. Utilize stops from additional transit providers. This study used Metro bus stops given Metro is the primary transit provider in the County and unincorporated area and has readily available shelter provision and ridership data for all its stops. In addition, significant coordination would be necessary to obtain boarding level data for all other transit agency stops servicing unincorporated Los Angeles County, which is beyond the scope of this report. However, this latter effort is necessary to have a complete picture of the distribution of bus shelters. The next potential step in this analysis is compare ad and non-ad shelters to conduct a baseline comparative analysis for how the two programs have sited bus shelters relative to the equity measures used in this report.
- b. Conduct a refined approach to accessing tree shade using Public Works parkway tree inventory. As described in Part 2, the study treated all trees the same in this report's analysis. For future opportunities to iterate on this study, I recommend understanding the various tree types, height and width (characteristics included in the data) to assess potential shade coverage provided by each tree type. Future analysis may also want to compare parkway tree shade to other shade analysis such as NDVI (as described in Part 2) or Land Cover Zones to see which may be the most accurate analysis of shade in unincorporated areas.
- c. Consider points of interest relative to stops, such as schools, hospitals, and grocery stores. Taking into account points of interest for the purposes of prioritizing resources can help target resources toward specific vulnerable populations who rely on public transportation. For example, including an analysis of a stop's proximity to schools and its ridership can help target shelter resources to bus stops serving school-aged children.

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