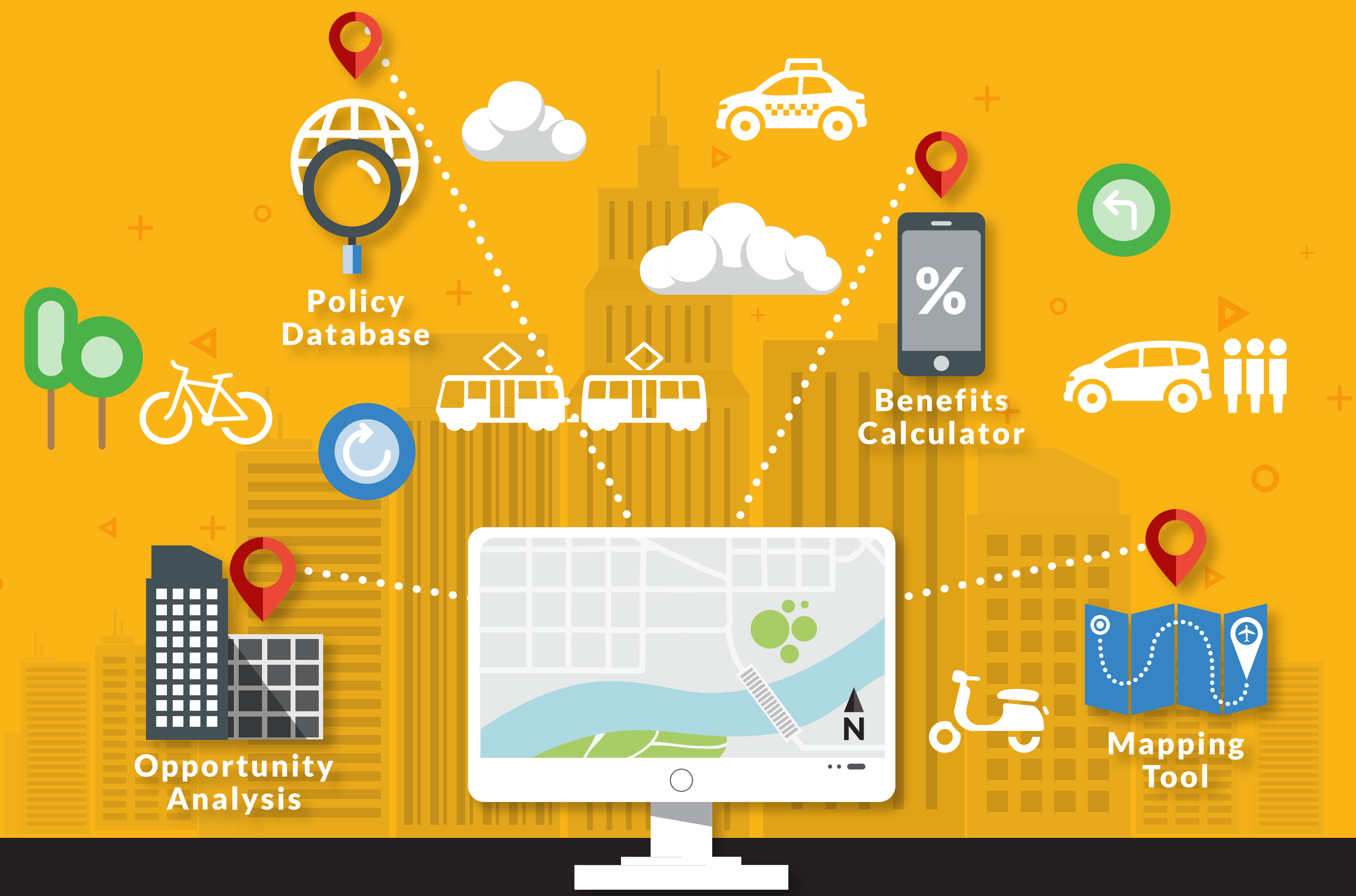



# SHARED-USE MOBILITY TOOLKIT

## FOR CITIES

WWW.SHAREDUSEMOBILITYCENTER.ORG

# TABLE OF CONTENTS




**Acknowledgements**

This report was made possible with the generous support of the Urban Sustainability Directors Network (USDN). Thanks are also due to the individual USDN cities that shared their information and guidance to complete this study. The project was managed by Albert Benedict of the Shared-Use Mobility Center (SUMC) under the direction of SUMC Executive Director Sharon Feigon. Additional research, analysis, and editorial input were contributed by Colin Murphy, Tim Frisbie and Cassie Halls of SUMC. Significant contributions were also made by Gregory Newmark, PhD, who developed the model for the opportunity analysis and Jacques Ngoie Kibambe, PhD, who developed the initial model for the benefits calculator, with further modifications made by SUMC. The Center for Neighborhood Technology played an important role early in the process to help establish the framework for the toolkit, specifically the mapping tool and policy database, which SUMC built upon to complete the project. The report was edited by Tim Frisbie and designed by Derek Berardi and Alejandro Pinzon.

# 1 INTRODUCTION

New, shared modes of transportation—such as bikesharing, carsharing, and ridesourcing—have grown tremendously in recent years as a renewed interest in urbanism and growing environmental, energy, and economic concerns have intensified the need for sustainable alternatives to a transportation system centered on private automobiles.

These technology-enabled services are helping to fill transportation gaps, create first/last mile connections with public transit, reduce traffic congestion, cut household transportation costs, and lessen harmful greenhouse gas emissions. However, they also present a challenge for cities, which must regulate in a quickly changing environment and work to ensure the public good is upheld without stifling innovation.

To provide cities with the support they need to understand these new opportunities and challenges, the Urban Sustainability Directors Network (USDN) has partnered with the Shared-Use Mobility Center (SUMC) to develop and test an interactive shared mobility toolkit. Founded in 2014 to document and explore new solutions related to shared-use transportation, SUMC is a public-interest organization working to foster public-private collaboration and help extend the benefits of shared mobility for all.



A first-of-its-kind resource, the toolkit is designed to help cities understand the impact of emerging transportation solutions, identify appropriate policy actions and set goals to maximize the benefits of shared mobility. SUMC's four-part toolkit includes:

- **Interactive Shared Mobility Mapping Tool:** This set of interactive maps identify shared-use vehicle locations and service areas from all providers in more than 50 North American cities, helping local governments understand the state and scope of shared mobility infrastructure—such as density of carsharing and bikesharing vehicles—in their regions.
- **Opportunity Analysis Tool:** For each USDN study city, this tool interprets a variety of information, including, shared-use infrastructure locations, census data, and transit quality to identify and measure opportunities to expand transportation access. Using high-quality datasets, the tool pinpoints transportation gaps to help cities better understand where greater service is needed and what shared modes the market can support.
- **Shared Mobility Policy Database:** SUMC's searchable compendium summarizes more than 600 of the most important shared mobility policies, studies, and strategic plans in North America. This database also compiles best practices and case studies to help local governments craft an effective regulatory approach to ridesourcing, bikesharing, carsharing, and other emerging transportation services.
- **Interactive Shared Mobility Benefits Calculator:** The final component of SUMC's toolkit, the benefits calculator, allows cities to model the impacts of various shared mobility growth scenarios. Cities can use the online calculator to quickly assess potential decreases in greenhouse gas emissions, reductions in vehicle miles traveled, and other benefits from implementing various transportation improvements.

The following report provides an overview of each tool, including information on how it was developed, why it is important, and how cities can use it effectively. While the interactive tools are all standalone resources, they are even more powerful when used together as a comprehensive toolkit to help identify opportunities and uncover new local solutions. To that end, the report also draws from the toolkit to provide some overall trends and takeaways for cities, ranging from policy recommendations to opportunity analyses by city size and type.

Finally, the report features shared mobility opportunities and growth scenarios for each of the 27 USDN study cities. These brief synopses suggest where the needs and potential are greatest in each city, what actions can be taken to address them, and what the potential benefits of intervention would be. The report's appendices also contain detailed methodologies for these analyses.

All of these tools, along with additional information, are available online at **sharedusemobilitycenter.org**




"The following report provides an overview of each tool, including information on how it was developed, why it is important, and how cities can use it effectively."

## SHARED MOBILITY TERMS AND DEFINITIONS

Following is an overview of common shared-use mobility terminology:

### Bikesharing



IT-enabled, public bikesharing provides real-time information and uses technology to assist in rebalancing demand for bikes at docking stations throughout a community. Bikesharing comes in a variety of forms, including dock-based and dockless systems, tech-light solutions that do not place technology in the bike or dock, and peer-to-peer bikesharing.

### Carsharing



Carsharing is a service that provides members with access to an automobile for short-term—usually hourly—use. Types of carsharing include traditional or round-trip carsharing, which requires customers to borrow and return vehicles at the same location; one-way carsharing, which allows customers to pick up a vehicle at one location and drop it off at another; and peer-to-peer carsharing, which allows car owners to monetize the excess capacity of their vehicles by enrolling them in carsharing programs.

### Ridesourcing



Ridesourcing providers, such as Uber and Lyft, use online platforms to connect passengers with drivers who use personal, non-commercial vehicles. These services were codified first in California state law and subsequently in many other jurisdictions as Transportation Network Companies (TNCs). Ridesourcing has become one of the most recognized and ubiquitous forms of shared mobility.

### Ride-splitting



TNCs have begun providing services in select cities such as San Francisco, New York and Los Angeles that combine fares to reduce vehicle trips and generate cost savings. Uber Pool and Lyft Line allow drivers to add additional passengers to a trip in real time. These services are known as “ride-splitting”—since the passengers split the cost of the trip—and continue to evolve as companies experiment with various models.



### Ridesharing/Carpooling



At its core, ridesharing involves adding additional passengers to a trip that will already take place. Such an arrangement provides additional transportation options for riders while allowing drivers to fill otherwise empty seats in their vehicles. Types of ridesharing include carpooling, vanpooling, and real-time or dynamic ridesharing services such as Tripda and Blablacar.

### Public Transit



Transit – publicly owned fleets of buses, trains, and ferries that generally operate on fixed routes and schedules – provides the foundation for most other forms of shared-use mobility.

### Microtransit



Technology-enabled private shuttle services, such as Bridj and Chariot, serve passengers using dynamically generated routes, usually between designated stop locations rather than door-to-door. Because they provide transit-like service but on a smaller, more flexible scale, these new services have been referred to as “microtransit.” In general, they draw customers who are willing to pay somewhat more for greater comfort and service.

### Shuttles



Traditional shuttle services include corporate, regional, and local shuttles that make limited stops and only serve riders from specific employers, buildings, or residential developments. One example is the “Google Bus,” which transports the technology company’s San Francisco-based employees to and from Silicon Valley each day.

### Mobility Hubs

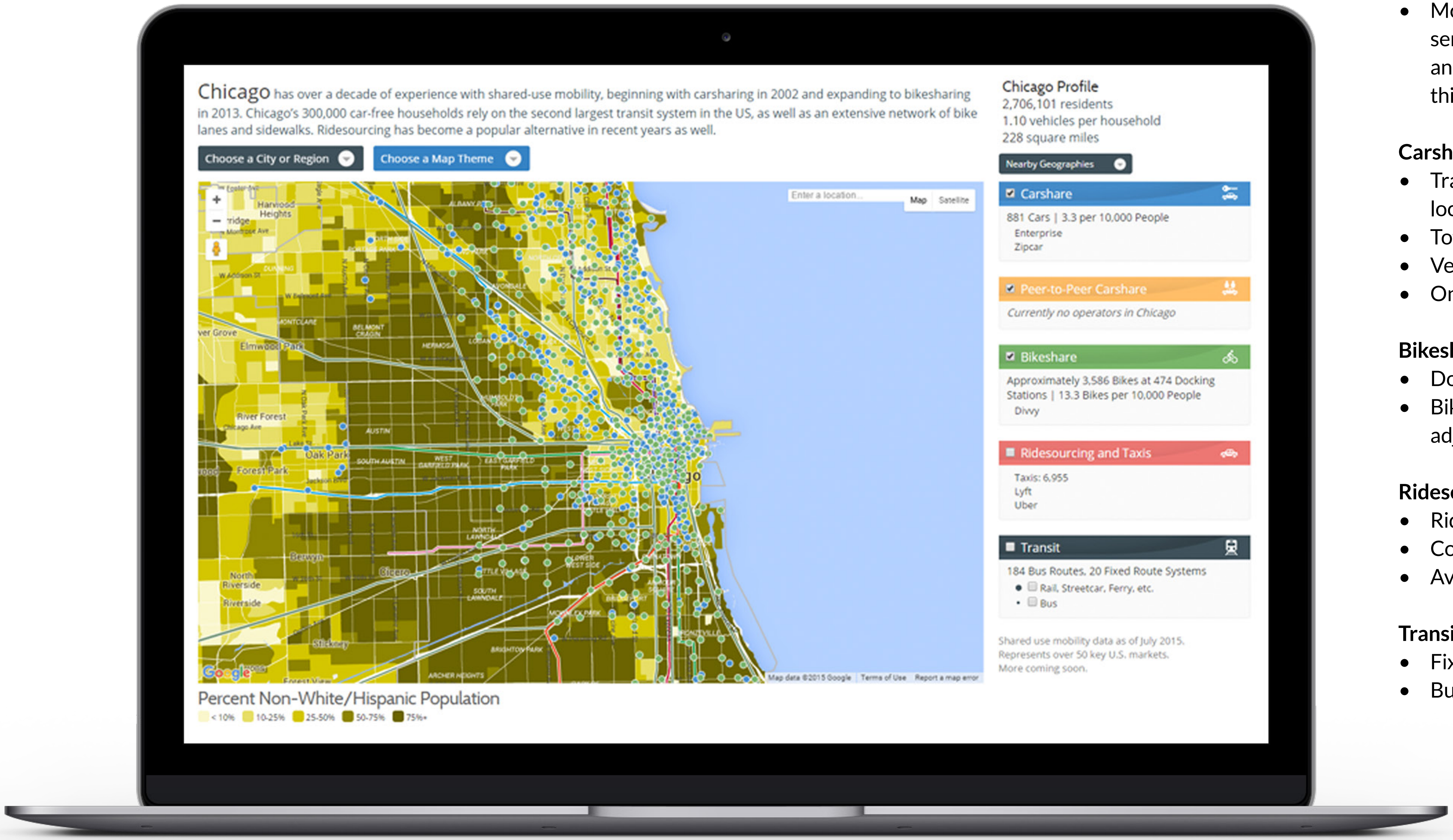


Mobility hubs are strategically located transfer points that feature facilities for multiple transportation modes (such as bikesharing, carsharing, and transit) combined in one location.

# 2
# MAPPING SHARED MOBILITY

SUMC's web-based interactive mapping tool was developed to pinpoint shared mobility vehicle locations to help local governments understand the state and scope of shared mobility infrastructure in their regions—and where greater investment and policy intervention might be needed.

The tool, which can be found online at sharedusemobilitycenter.org, features extensive mobility metrics for more than 50 North American cities and metropolitan regions, including the 27 USDN study cities.




SUMC's mapping website includes the following information and metrics for each city:

**Overview**

- Population, area, and personal automobiles per household
- Selectable base maps with block-group level measures of minority population and median income to help frame equity analysis
- Regional mobility profiles and trends

**Opportunity Analysis Mapping**

- Block-group level mapping of opportunities along with existing and potential benefits of shared-use mobility for cities
- Mobility gaps, to help cities better understand where greater service is needed, what shared modes the market can support, and how cities compare to their peers (see more detail about this tool and its findings in Section 3 and Appendix A)

**Carsharing**

- Traditional, one-way, and peer-to-peer companies operating locally
- Total and population-adjusted vehicle counts by operator type
- Vehicle locations for all local operators
- One-way carsharing operating areas

**Bikesharing**

- Docking station locations
- Bike and docking station counts, both total and population-adjusted

**Ridesourcing and Taxis**

- Ridesourcing companies operating locally
- Count of licensed taxis (if available)
- Availability of microtransit/private flexible transit

**Transit**

- Fixed-route lines and station locations
- Bus stop locations

## SHARED MOBILITY TRENDS AND GROWTH BY CITY TYPE

Shared mobility has evolved in different regions in different ways. Some cities may have extensive bikesharing systems, but are missing other relatively widespread modes such as one-way carsharing or ridesourcing. Others may possess the full spectrum of shared mobility, but have vehicles clustered only in certain neighborhoods, or offer systems that are larger than average but lack the density of fleets in smaller, more compact cities.

A comparison of mobility and demographic indicators for the USDN cities is provided in Table 1. For comparative purposes, the study regions have been divided into three size classes, based on the population of the largest city in each metropolitan area:


The table shows the variety even among cities of similar size. Washington, DC, for instance, has nearly 30 carsharing vehicles per 10,000 residents, while Seattle—a city with roughly the same population size, and where one-way carsharing is exceptionally popular—has fewer than 15 carsharing vehicles per 10,000 residents.

While the variations can be ascribed to a number of factors, one key indicator seems to be the correspondence between the level of transit in a region and the level of shared mobility. Cities with more rail lines and bus routes tend to have more carshare cars and bikeshare bikes. This supports past research, which has suggested that shared mobility can grow most quickly in regions with strong existing transit systems, with shared-use mobility and transit working together to fill gaps, provide connections and support car-free and car-light lifestyles.

New preliminary research by SUMC also suggests that the more modes people have access to, the more likely they are to sell or postpone purchasing a car. While factors such as land use, population and job density, and walkability also undoubtedly play a factor, in general cities with the most transit also tend to have the lowest household vehicle ownership rates.

## Table 1

### Basic Mobility Indicators for USDN Cities

| City | Size class | Cars per HH | Transit routes (fixed route/bus) | Carshare vehicles per 10K residents | One-way carshare as % of total carshare | Bikeshare bikes per 10K residents | Bikeshare stations | TNC operators |
|---|---|---|---|---|---|---|---|---|
| **Ann Arbor, MI** | Smaller | 1.45 | 0/37 | 5.3 | -- | 11.4 | 14 | Lyft, Uber |
| **Atlanta, GA** | Medium | 1.31 | 4/58 | 3 | -- | -- | -- | Lyft, Uber |
| **Austin, TX** | Medium | 1.6 | 1/82 | 4.6 | 88% | 4.5 | 46 | Lyft, Uber |
| **Boston, MA** | Medium | 0.91 | 25/132 | 20.4 | -- | 10.9 | 90 | Lyft, Uber |
| **Boulder, CO** | Smaller | 1.65 | 0/34 | 3.3 | -- | 28 | 38 | Lyft, Uber |
| **Buffalo, NY** | Medium | 1.05 | 1/57 | 0.6 | -- | 1.7 | 8 | -- |
| **Chicago, IL** | Large | 1.1 | 20/184 | 3.4 | -- | 17.6 | 476 | Lyft, Uber |
| **Columbia, MO** | Smaller | 1.71 | 0/9 | 0.2 | -- | 1.8 | 1 | Uber |
| **Denver, CO** | Medium | 1.5 | 7/104 | 7.8 | 71% | 11.5 | 85 | Lyft, Uber |
| **Fort Collins, CO** | Smaller | 1.88 | 1/20 | 0.9 | -- | 4.3 | 3 | Uber |
| **Houston, TX** | Large | 1.54 | 3/107 | 0.2 | -- | 1.1 | 29 | Uber |
| **Las Vegas, NV** | Medium | 1.61 | 1/32 | 0.1 | -- | -- | -- | Lyft, Uber |
| **Los Angeles, CA** | Large | 1.56 | 13/199 | 0.6 | -- | -- | -- | Lyft, Uber |
| **Miami, FL** | Medium | 1.21 | 3/54 | 8.9 | 79% | 11 | 99 | Lyft, Uber |
| **Minneapolis, MN** | Medium | 1.33 | 4/266 | 10.8 | 84% | 28 | 127 | Lyft, Uber |
| **New York, NY** | Large | 0.62 | 35/421 | 3.9 | 14% | 7.3 | 467 | Lyft, Uber |
| **Palo Alto, CA** | Smaller | 1.76 | 1/18 | 10.8 | -- | 6.2 | 5 | Lyft, Uber |
| **Philadelphia, PA** | Large | 0.97 | 25/109 | 4.5 | -- | 3.9 | 71 | Lyft, Uber |
| **Portland, OR** | Medium | 1.46 | 9/62 | 12.8 | 60% | -- | -- | Lyft, Uber |
| **Salt Lake City, UT** | Smaller | 1.54 | 5/49 | 1.1 | -- | 11.7 | 25 | Lyft, Uber |
| **San Diego, CA** | Large | 1.75 | 6/76 | 3 | 87% | 3.2 | 81 | Lyft, Uber |
| **San Francisco, CA** | Medium | 1.08 | 21/125 | 31.4 | -- | 4.1 | 35 | Lyft, Uber |
| **Seattle, WA** | Medium | 1.39 | 8/120 | 14.6 | 70% | 8.1 | 51 | Lyft, Uber |
| **St. Paul, MN** | Medium | 1.47 | 1/82 | 8.1 | 84% | 14.8 | 49 | Lyft, Uber |
| **Toronto, ON** | Large | 1.1 | 15/180 | 4.7 | 34% | 3 | 80 | Uber |
| **Victoria, BC** | Smaller | 1.2 | 0/54 | 3.9 | -- | -- | -- | -- |
| **Washington, DC** | Medium | 0.87 | 10/168 | 29.3 | 38% | 25.2 | 204 | Lyft, Uber |

## SHARED MOBILITY BY CITY SIZE—LARGE, MEDIUM, AND SMALL

Shared mobility systems, such as carshare fleets and bikeshare networks, generally grow in proportion with a city's population. However, as the city-by-city charts later in this section show, mid-sized cities tend to have the most infrastructure in proportion to their populations, with both carshare vehicles and bikeshare bikes per 10,000 residents at their highest levels.

The smaller city class is the runner-up, with large cities bringing up the rear. This may reflect the relative ease of scaling up a system—and achieving critical density—in smaller communities with fewer competing demands on the public way for curb space and parking. Additionally, the growth of some shared modes, such as one-way carsharing, has been most significant in mid-sized cities.

### Table 2

**Mobility indicator averages by size class (carshare and bikeshare values only include USDN cities with existing systems of that type)**

| Size class | Avg. pop. | Avg. veh. per HH | Avg. car-share veh. | Avg. car-share veh. /10K | Avg. one-way veh. | Avg. one-way veh./ 10K | Avg. bike-share bikes | Avg. bike-share locs. | Avg. bike-share bikes /10K |
|---|---|---|---|---|---|---|---|---|---|
| Smaller (< 200K) | 114,723 | 1.6 | 31 | 3.6 | -- | -- | 122 | 14.3 | 10.6 |
| Medium (200K-1M) | 547,047 | 1.29 | 709 | 11.7 | 403 | 7.6 | 608 | 79.4 | 12 |
| Large (>1M) | 3,196,091 | 1.23 | 956 | 2.9 | 401 | 1.6 | 2128 | 200.7 | 6 |

Many medium-sized cities also fall within extensive metropolitan areas with high populations. Boston, Washington, DC, and San Francisco particularly stand out in this regard. Others, such as Denver and Las Vegas, make up the greater part of their regional populations. Generally speaking, household auto ownership is lower in cities at the center of larger metros, and higher in regions with smaller populations.

## SHARED MOBILITY TRENDS BY MODE

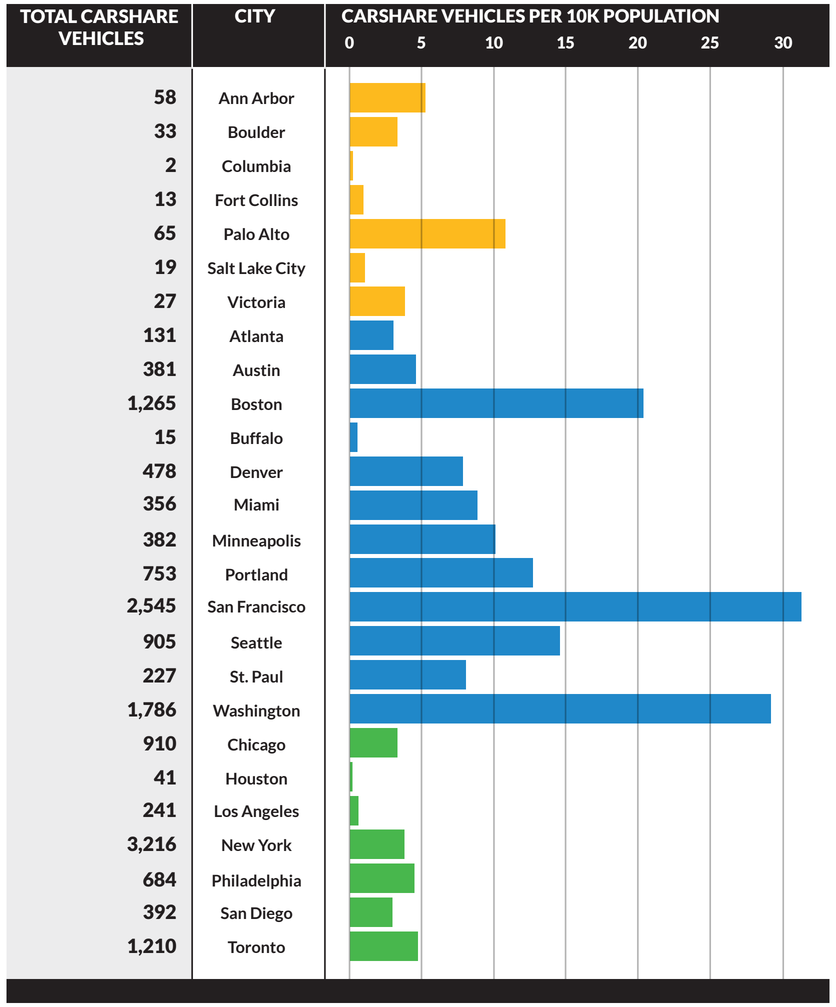
### Traditional Carsharing

The total count of carshare vehicles (Figure 1) tends to increase with city size. As in several other measures, New York stands out on the total vehicle count as a result of its sheer scale, with Toronto and Chicago distant runners-up. Adjusting for population by looking at vehicles per 10,000 residents (right-hand bars), the mid-sized cities again stand out as offering the most vehicles per capita—especially those that fall within populous metropolitan regions.

At the other end of the spectrum are cities such as Atlanta and Los Angeles that have less per capita carshare availability. One reason for this lag may be that these cities have a lower levels of existing fixed-route transit—traditionally the backbone that allows other shared modes to flourish—although both are pursuing ambitious plans for expansion. A targeted effort to expand the availability of carsharing and bikesharing could help further increase the impact of any transit investments by effectively extending the range of new lines and making them useful for a greater variety of trip types.

### Figure 1

**Total carsharing vehicle counts and carsharing vehicles per 10,000 population, USDN cities with carsharing operators as of fall 2015**



## One-Way Carsharing

One-way carsharing emerged only within the last few years and currently exists in about a dozen North American cities. As a result, few studies have examined its empirical effects. Early indications suggest that—unlike other shared modes—it may work equally well in car-dependent areas and in cities with robust transit. The basic model revolves around a "home area" or bounded geographic zone where users can pick up or drop off a one-way vehicle. One-way carsharing operators often negotiate parking agreements with municipalities and private parking owners to allow the vehicles to be left at metered spots or in garages without a direct charge to users. At this early stage in the mode's development, one-way operators still seem to be feeling out the market, in several cases having entered a region with a fairly extensive service area, only to pull back to a more compact area once patterns of demand become clear.

In the markets where it is in operation, one-way carsharing has often quickly outpaced traditional carshare. In many cities, as much as 90 percent of the regional carsharing fleet is comprised of one-way vehicles. As Figure 2 shows, one-way carsharing is more active in midsize cities at the moment, and has a significant presence in fairly car-dependent regions such as Austin, Denver, and San Diego. This points to one-way carsharing's potential to help reduce household vehicle ownership, even in places where it is difficult to get around without a car.

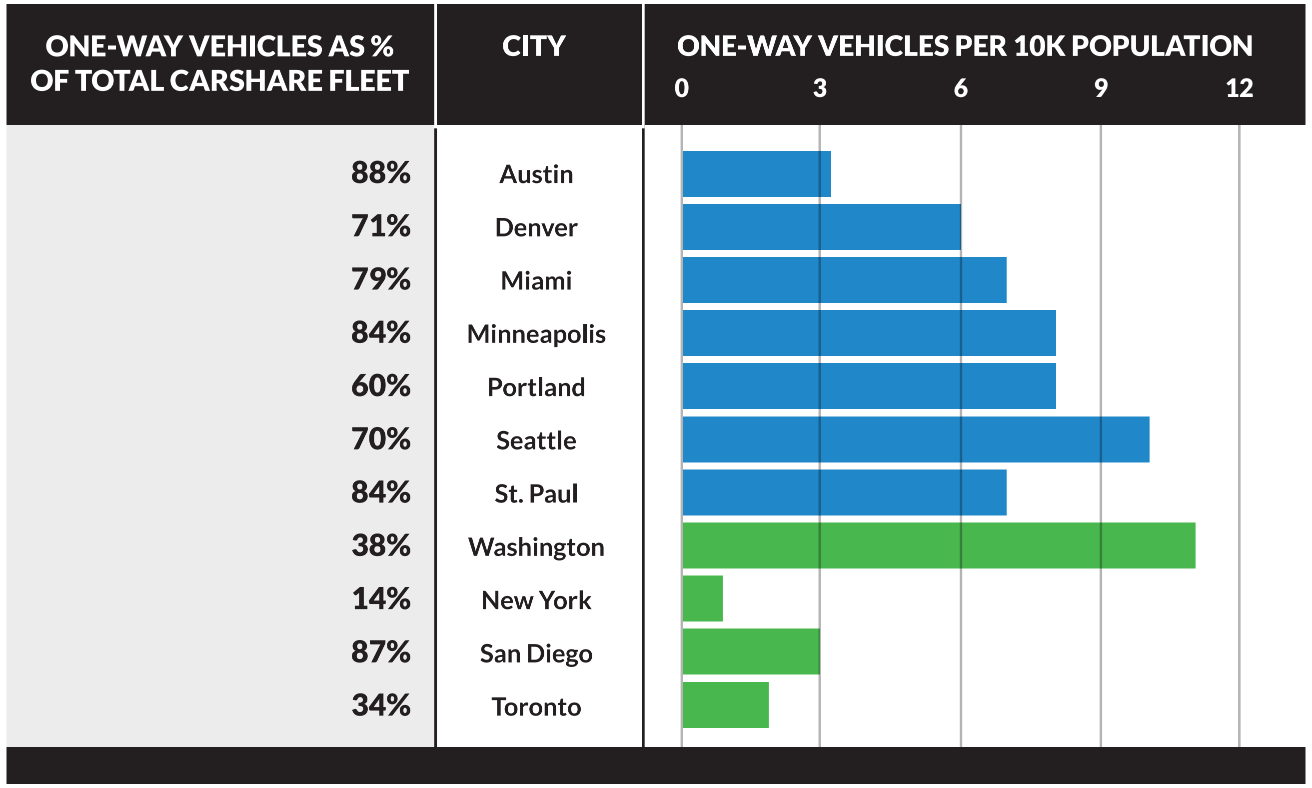



**Figure 2**

**One-way carsharing vehicles as a percentage of total carsharing fleet and per 10,000 residents, USDN cities with one-way carsharing as of fall 2015.**


"In the markets where it is in operation, one-way carsharing has often quickly outpaced traditional carshare."

## Bikesharing

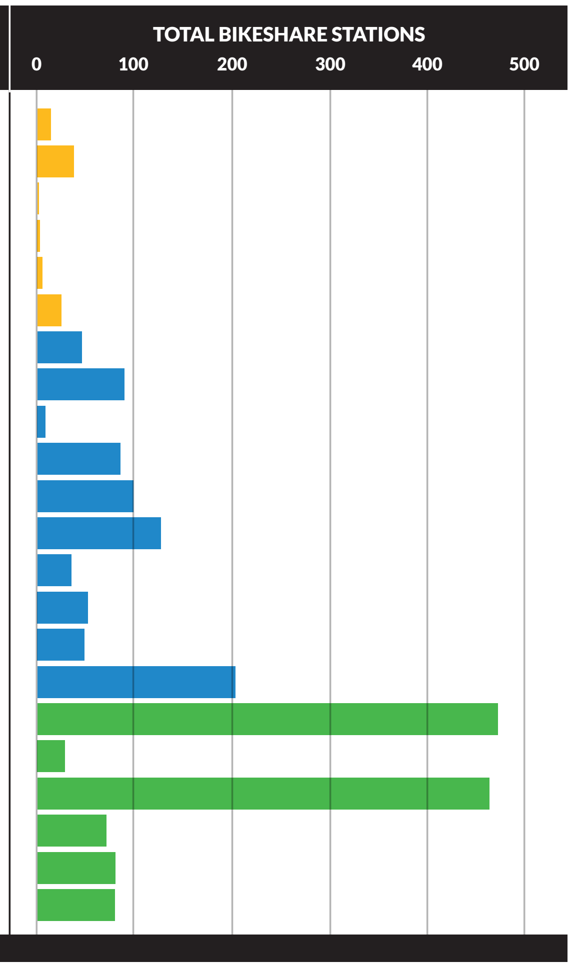
Bikesharing is a recent arrival on the shared-use mobility landscape for many cities, and in large part the extent of systems (Figure 3) is a function of their age as well as, of course, population. In the proportional measures shown in Figure 4, the standout regions among their peers are Boulder in the smaller cities; the Twin Cities and Washington, DC in the mid-sized category; and Chicago among the largest cities. With the exception of Chicago's Divvy bikeshare (launched in 2013), these systems are among the oldest operating North American municipal bikeshare networks, launching in 2010 (Twin Cities and DC) and 2011 (Boulder).

Since the utility of dock-based bikesharing systems depends on the presence of a fairly continuous network of stations—and building the network is a relatively capital- and labor-intensive task—the largest systems are the ones that have had more time to build out their networks and establish significant user bases.

### Figure 3

**Total bikesharing system size, USDN cities with bikesharing systems as of fall 2015.***

| TOTAL BIKES IN SYSTEM | CITY |
|---|---|
| 125 | Ann Arbor |
| 280 | Boulder |
| 20 | Columbia |
| 60 | Fort Collins |
| 37 | Palo Alto |
| 210 | Salt Lake City |
| 375 | Austin |
| 678 | Boston |
| 45 | Buffalo |
| 700 | Denver |
| 439 | Miami |
| 1,065 | Minneapolis |
| 328 | San Francisco |
| 500 | Seattle |
| 415 | St. Paul |
| 1,538 | Washington |
| 4,760 | Chicago |
| 225 | Houston |
| 6,000 | New York |
| 600 | Philadelphia |
| 427 | San Diego |
| 758 | Toronto |




** Station count refers to station locations, not the count of individual bicycle docks at each location. Regional system counts (in San Francisco, Washington DC, and the Twin Cities) are larger than the city totals shown here. In the case of systems that are shared across more than one USDN municipality (such as Bay Area Bikeshare or Nice Ride in the Twin Cities) bike counts are divided in proportion to the number of stations in each city, since the actual count across various jurisdictions will vary from hour to hour.*

### Figure 4

**Proportional bikesharing system size, USDN cities with bikesharing systems as of fall 2015.**

| BIKES PER LOCATION | CITY |
|---|---|
| 8.33 | Ann Arbor |
| 7.18 | Boulder |
| 10 | Columbia |
| 15 | Fort Collins |
| 6.17 | Palo Alto |
| 8.08 | Salt Lake City |
| 7.98 | Austin |
| 7.45 | Boston |
| 5 | Buffalo |
| 8.14 | Denver |
| 4.39 | Miami |
| 8.32 | Minneapolis |
| 9.11 | San Francisco |
| 9.62 | Seattle |
| 8.30 | St. Paul |
| 7.50 | Washington |
| 9.98 | Chicago |
| 7.50 | Houston |
| 12.82 | New York |
| 8.33 | Philadelphia |
| 5.21 | San Diego |
| 9.36 | Toronto |

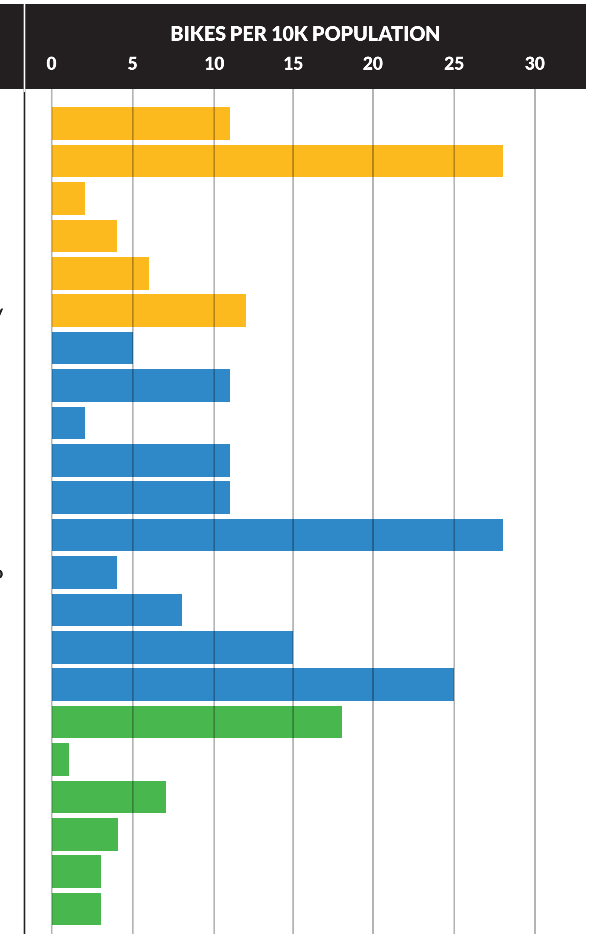



Figure 4 also shows the number of bicycles per location. On this measure, the mid-sized cities tend to be lowest, with the smaller cities packing the most bikes into each station, and the largest cities behind them. A possible explanation for this might be that in smaller cities, the main origins and destinations within the network are fairly well known. That makes it easier to get by with more bikes at fewer stations, likely concentrated downtown or near key institutions and transportation assets. As the network starts to scale in the mid-sized cities, especially in lower density ones, the number of possible origins and destinations grows geometrically and more stations are needed to cover the service area. Another possibility, of course, is that many smaller cities may not have the resources to pay for extensive systems, so instead focus on scaling up bikes, which are much less expensive than stations.

More information on each of these modes is available on the interactive mapping tool at **sharedusemobilitycenter.org**

# 3 ANALYZING OPPORTUNITIES

The second component of SUMC's shared-use mobility toolkit is a shared mobility opportunity analysis, which was created to help cities identify transportation gaps, better understand where greater service is needed, and determine what shared-use modes the local market can support.

Bikesharing, carsharing and other forms of shared transportation are often initially established in dense urban neighborhoods, where auto ownership rates are lower and incomes are relatively high. While these core areas have been instrumental to the growth of the shared mobility industry and remain key areas of focus, it is important to recognize that other markets—such as smaller cities, low-income neighborhoods, and inner-ring suburbs—may also have the necessary qualities to support robust shared mobility networks.

SUMC's tool—available at sharedusemobilitycenter.org—allows planners and service providers to identify these new opportunities, while also helping them better understand transportation access in their cities as it relates to income and other demographic factors. To date, no such rigorous, publicly available effort has been completed to assess shared-use mobility opportunity and demand on a multi-city basis. This analytical tool provides a resource for local leaders seeking to improve the sustainability, livability, and accessibility of their communities using shared-use mobility.

## Approach

To create this tool, SUMC developed an opportunity analysis that uses data at a neighborhood (census block group) level to identify the potential demand for shared-use resources. Drawing on data from the US Census Bureau, the Center for Neighborhood Technology's (CNT) All Transit data repository, and SUMC's carsharing and bikeshare databases, SUMC researchers developed a number of predictive models to identify communities that hold the necessary components to support round-trip carshare, one-way carshare and bikeshare systems.

To create its models, SUMC first examined specific city neighborhoods where carsharing and bikesharing already had an extensive presence. By evaluating the variables thought to drive demand in these areas—including factors such as household density, transit availability, employment and walkability—SUMC's researchers were able to set benchmarks and create predictive models for each mode (a full technical description is available in Appendices A and B).

The models were then tested by running calculations in cities where vehicle counts were known and comparing the results using a regression analysis, which showed that the observed data fit well with what the models predicted. After the models were refined, they were applied to the entire data set from the 27 USDN study cities to identify the predicted level of shared-use modes. The difference between the predicted values of the models and the actual values represents the opportunity for shared-use growth within a given city.

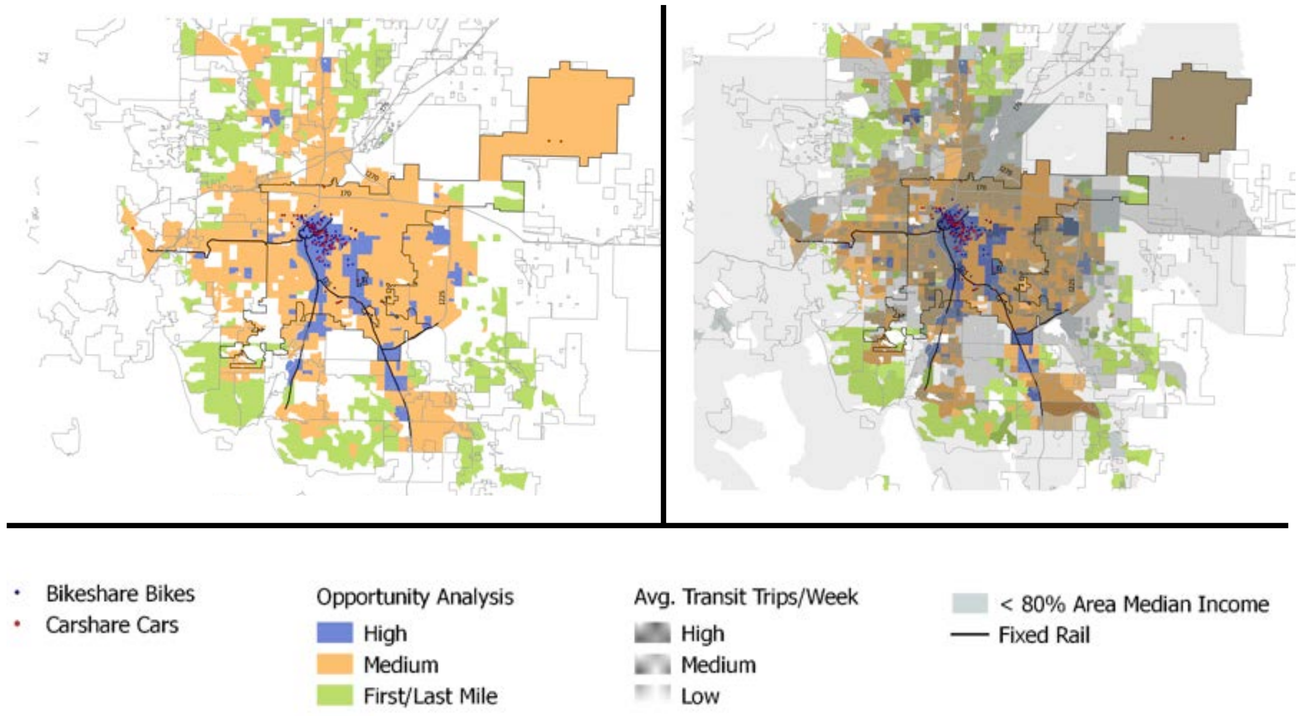
## Reading the Maps

While this research indicates that cities, regardless of their size, can benefit from shared-use mobility, not every city can make use of the same mix of modes. To account for differing needs, SUMC's research uses different sets of models to measure opportunities in small, medium and large cities. Additionally, each individual city analysis identifies opportunities in three categories—high, medium, and first/last mile—and includes overlays that display transit trips and income levels to help planners determine access to existing transportation and opportunities to fill gaps and connect modes.



## Figure 5

**Example Opportunity: Denver**




Opportunity area elements include:

***Highest Potential***

The neighborhoods in shown blue hold the highest potential for all shared modes. These neighborhoods are often city downtowns, moderate- to high-density urban neighborhoods, or suburban retail or employment centers that create islands of dense activity. All shared mobility modes can be integrated into these neighborhoods.

***Medium Potential***

The neighborhoods shown in orange are found to hold medium potential for shared mobility. These neighborhoods could support all shared modes, but strategic planning is often needed and supportive policies should be in place for shared-use mobility to fully succeed.

Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

More information on the opportunity analysis tool, along with additional examples, is available at **SharedUseMobilityCenter.org**

***First/Last Mile Connections***

The neighborhoods in green are typically low- to moderate-density suburban communities. In larger cities, such as Denver, these neighborhoods are often located along or at the terminus of a commuter rail line but offer limited transit connections beyond that service. Commercial activity is often centered in strip malls located along major arterial roadways. When modeled, these neighborhoods indicate that they could support shared modes that provide first/last mile connections to transit.

***Transit Overlay***

Based on CNT's All Transit database, the transit layer indicates the average number of transit trips available per week at a given point. The layer is categorized into three levels: high, medium and low. Not surprisingly, the example map shows that downtown Denver has the highest levels of transit service, followed by the urban neighborhoods bordering transit lines and then the neighborhoods classified as first/last mile. Many first/last mile communities, such as those along Denver's light rail line, have high levels of public transit but are still underserved in terms of the trips available on a per-capita basis.

***Income Level Overlay***

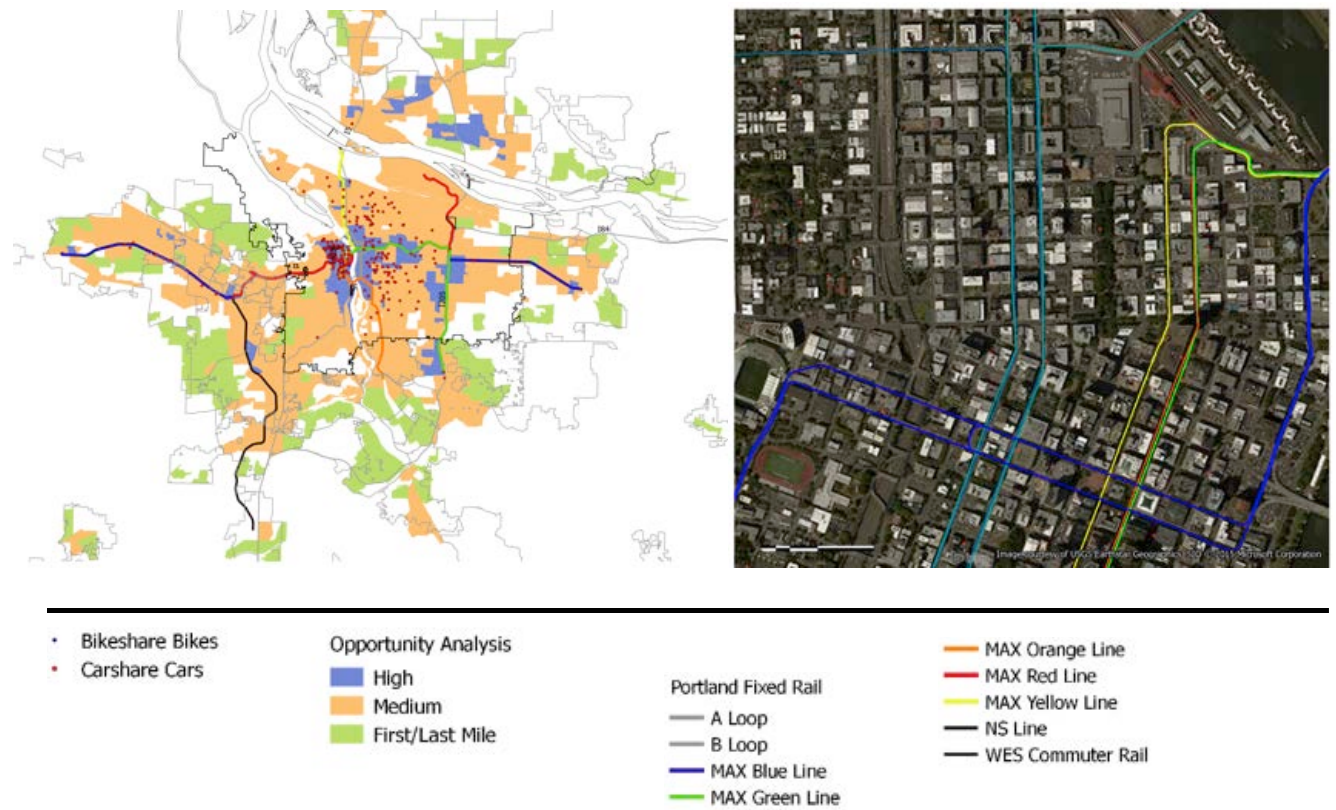
The maps also identify neighborhoods where residents earn less than 80 percent of the median income for the metropolitan area. These neighborhoods are not limited to a particular part of the city, and show varied levels of shared mobility opportunity. In these communities, additional planning and outreach may be necessary in order for residents to adopt a formalized shared mobility system. However, the potential upside is quite high since lower income neighborhoods often stand to benefit most from the availability of shared mobility.



## Identifying New Opportunities for Cities

While each city has its own unique opportunities and challenges, an analysis comparing opportunity in the USDN study cities revealed several overall trends worth noting.

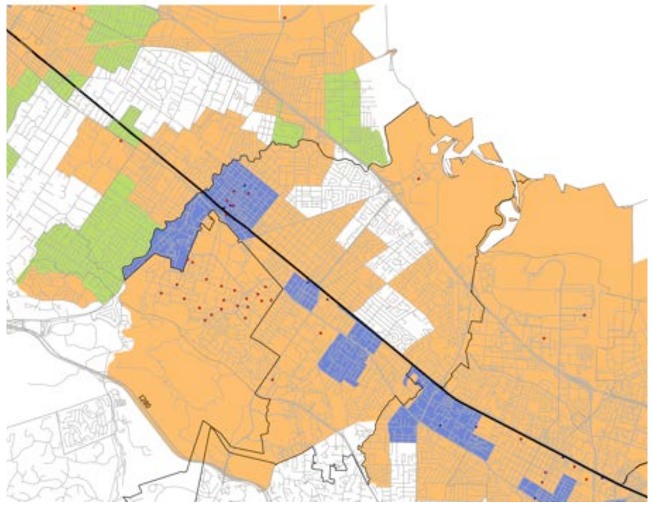
### 1 THERE IS STILL UNTAPPED POTENTIAL FOR SHARED MOBILITY IN DENSE URBAN DOWNTOWNS

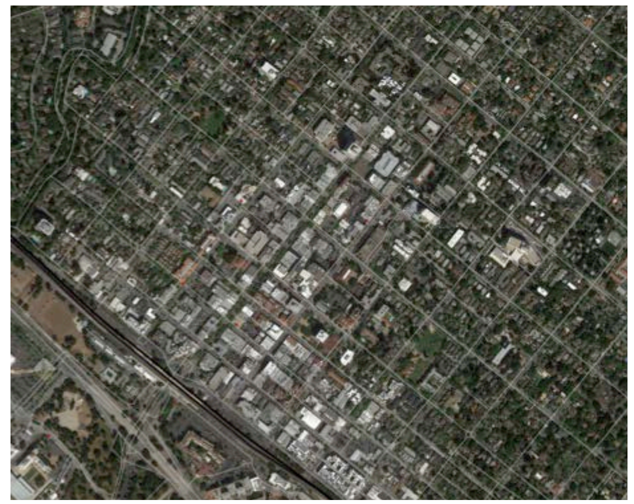



Dense urban areas have experienced more growth in shared mobility, from bikesharing and carsharing to ridesourcing and microtransit, than any other neighborhood type. However, SUMC's analysis of the USDN cities shows that some of the areas with the most opportunity to expand shared mobility—the places with the largest difference between potential and actual vehicle counts—are still the highest density neighborhoods and employment centers, often located in or adjacent to a city's downtown. These communities, particularly the ones in proximity to core urban centers, could readily absorb increased levels of transit along with all forms of shared mobility.

Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## 2 | SHARED MOBILITY CAN HELP SPUR ECONOMIC DEVELOPMENT IN SMALL CITY DOWNTOWNS







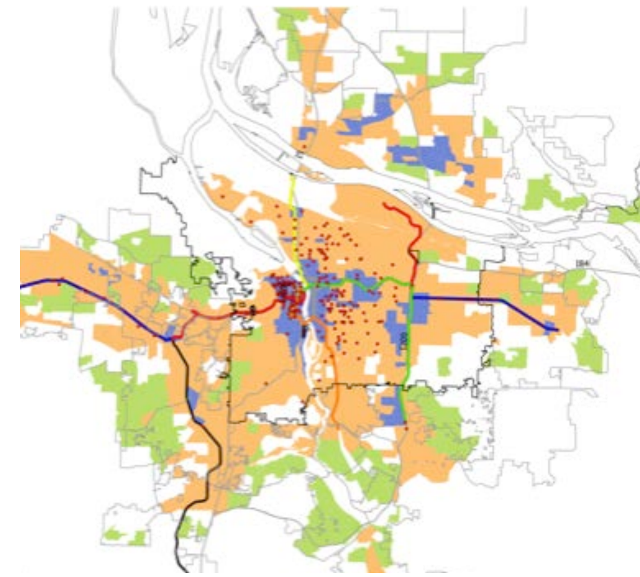
Since downtowns in many smaller cities were established before automobile use became prevalent, they are often walkable neighborhoods featuring local retailers, public facilities such as libraries and parks, and a relatively dense urban form. Some are built around a major anchor such as a university or central thoroughfare. However, due to economic changes, many small city downtowns are no longer employment centers, with residents commuting via car from their homes to office parks on the community's periphery.

Shared mobility—especially bikeshare—may help bring residents and visitors back downtown, providing economic benefits for retailers and the region at large while addressing local congestion issues. Most of these markets can also support a full suite of shared mobility modes, which could be expanded if already present or otherwise integrated into the planning process.

Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.



## 3 | MODERATELY DENSE NEIGHBORHOODS HOLD THE MOST OPPORTUNITY FOR CITIES LOOKING TO REDUCE CAR OWNERSHIP

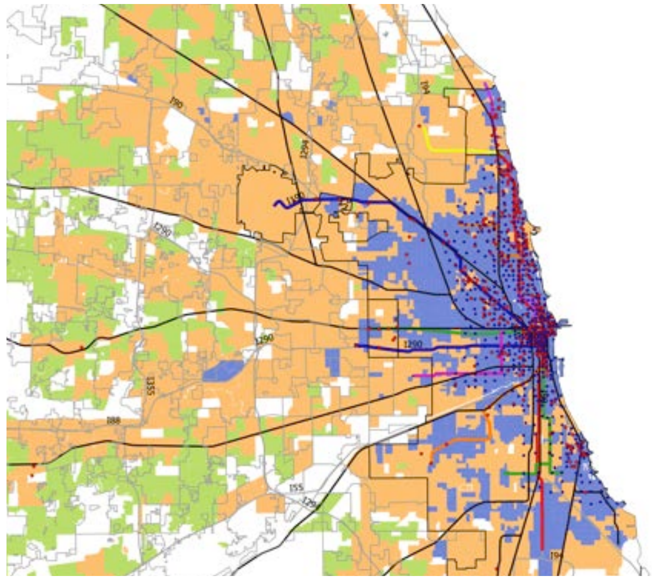


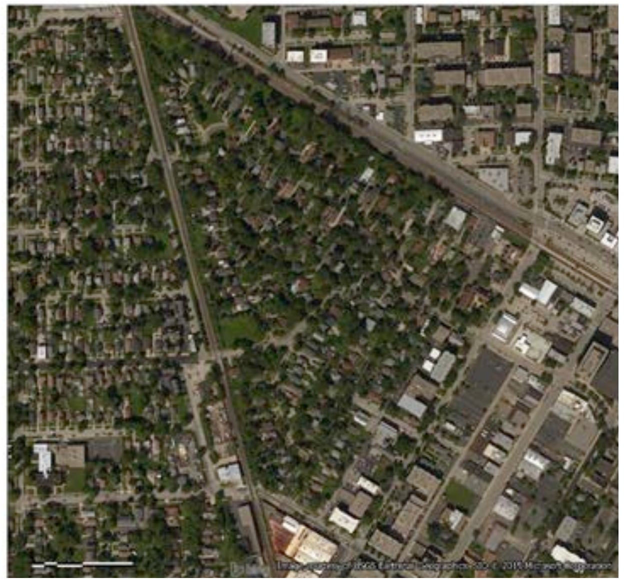


Dense urban downtowns often have the lowest car ownership rates, while car ownership remains a necessity in many outlying communities where other options are lacking. Moderately dense neighborhoods, however, tend to be relatively car dependent but can also support robust transit and shared mobility systems, making them a "sweet spot" for planners looking to shift people away from private vehicles to alternative transportation modes by scaling up shared mobility.

That is especially true of moderate-density neighborhoods adjacent to a city's downtown or transit hubs. In some cases, these communities can have a more suburban feel, with single family homes and lower density retail and employment centers. All shared modes can be integrated into these communities, but some strategic planning and implementation of supportive policies must occur for them to fully succeed.

## 4 | MANY REGIONS CAN EASILY EXPAND CITY SHARED MOBILITY SYSTEMS TO INNER-RING SUBURBAN COMMUNITIES







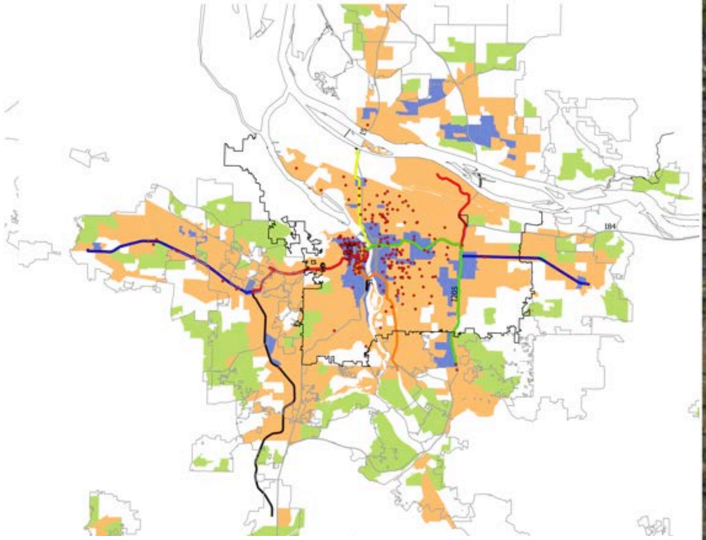
Often located just across the street from the city proper, inner-ring suburbs share many of the attributes of traditional urban neighborhoods, including relatively high levels of density, well-connected street grids, and frequent transit service. These qualities make them a natural fit for bikeshare and carshare systems that are expanding outward from the city's core.

Many of these communities also have their own vibrant downtowns, which hold a mix of uses and are typically bordered by lower-density swaths of single-family homes. When modeled, these neighborhoods indicate that they could support all shared modes, but would require some additional planning to strengthen or rebuild their orientation to transit. Despite their physical attributes, many inner-ring suburbs declined economically after World War II as residents moved to more far-flung suburban communities, so the introduction of new shared-use modes—which can help cut household transportation costs and improve access to opportunity—may be especially beneficial.

Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.



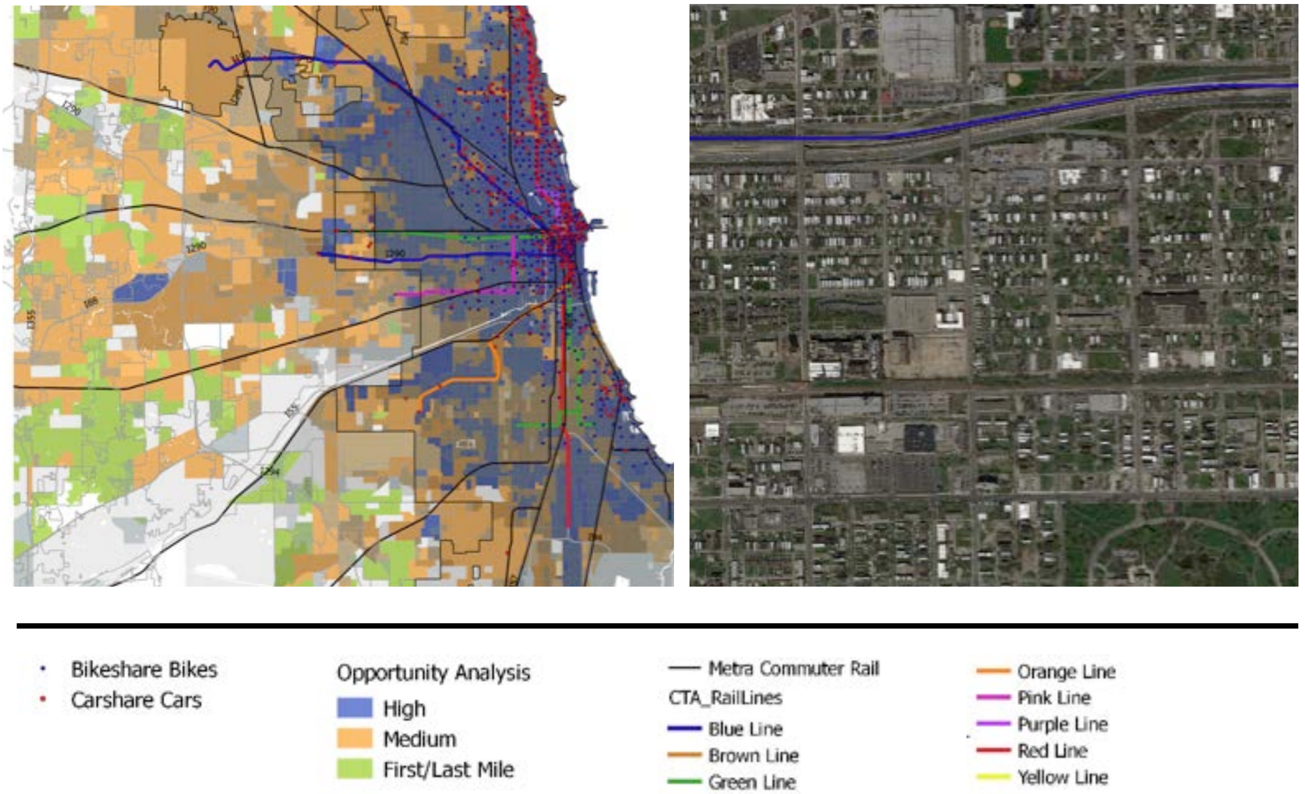
## 5 | SHARED MOBILITY CAN HELP PROVIDE FIRST/LAST MILE CONNECTIONS TO TRANSIT IN OUTLYING COMMUNITIES





Many low-density suburban communities are located along commuter rail lines, but offer limited transit connections beyond that service. Commercial activity is often restricted to strip malls located along major arterial roads, and most residents commute to the city center or to other employment centers throughout the region. The models indicate that such neighborhoods could support shared modes, such as ridesharing or vanpooling, that provide better first/last mile connections to transit networks and employment centers. Bikeshare and carshare fleets may be particularly effective when located near high-density residential clusters within these communities, such as apartment complexes and townhome developments. However, in order for shared mobility to work in these areas, it should also be coupled with strong transit investment.

# 6 DENSELY POPULATED, LOW-INCOME NEIGHBORHOODS OFFER IDEAL MARKETS FOR SHARED MOBILITY



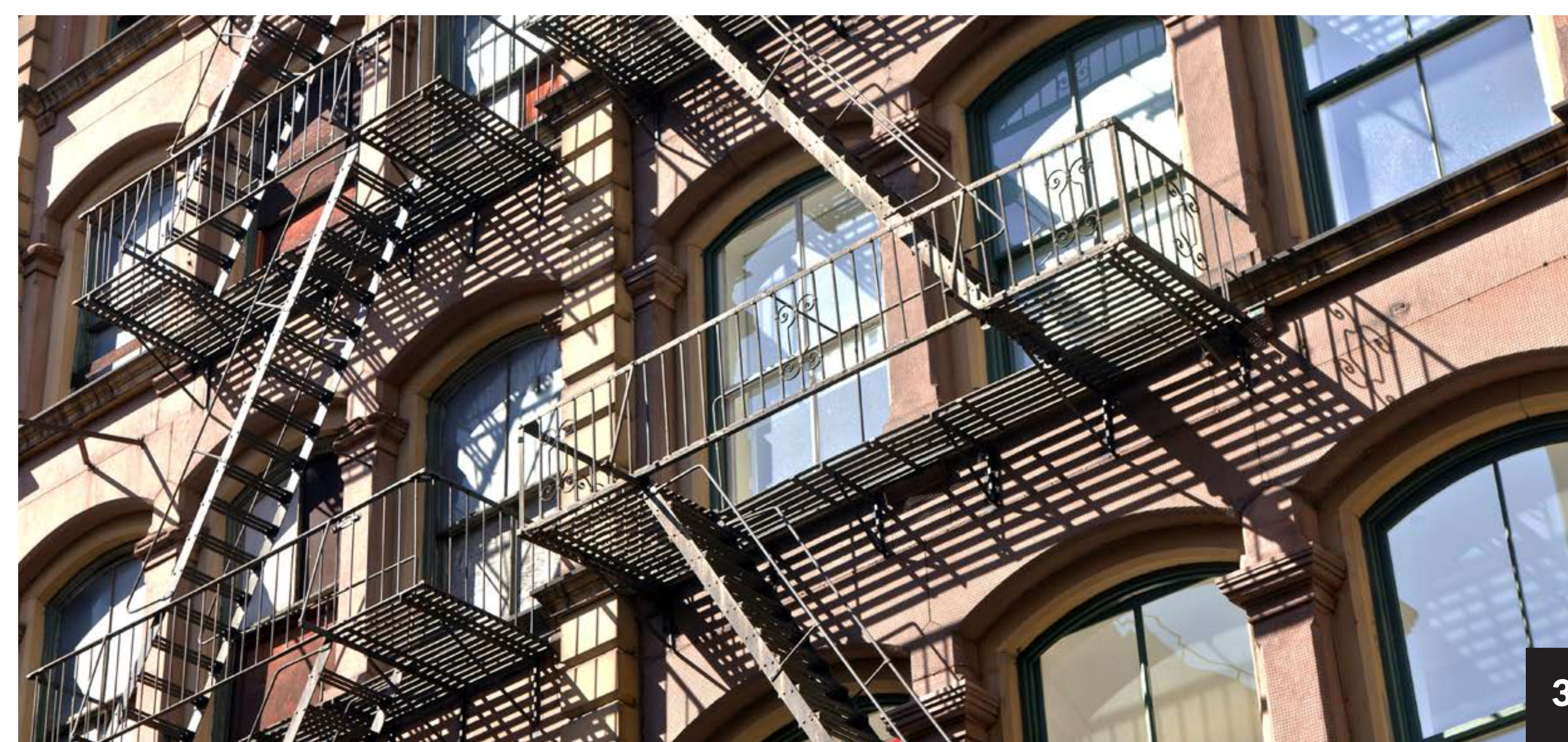

SUMC's analysis found that densely populated low-income neighborhoods, often located adjacent to core downtown areas, present a tremendous opportunity for shared mobility. While they have been often passed over by private operators, these neighborhoods have many of the key qualities—including high population density, transit access, and walkability—needed to support shared-use systems. Additionally, the opportunity to scale up shared modes in these neighborhoods is especially compelling since they stand to profit most from the benefits of shared mobility, including reduced household transportation costs and increased connectivity to jobs and opportunities outside the immediate community.

To further explore the opportunity in underserved communities, SUMC's researchers also set out to assess how shared mobility access differed across minority neighborhoods irrespective of income. To conduct this analysis, SUMC identified non-minority (more than 50 percent white) and minority (more than 50 percent all other races or Latino) neighborhoods in the USDN study cities where carshare and bikeshare resources were lacking despite the models' indication that these modes could be supported. These two neighborhood sets were then further divided into those where residents earned less than 80 percent of the area median income, and where they earned more.

While rates varied across cities, SUMC's analysis showed that access for minority neighborhoods—even those of moderate- to high-income—tended to be less than their non-minority counterparts. In Chicago, for example, only 48 percent of minority low-income neighborhoods currently had access to carshare or bikeshare, as opposed to 72 percent of low-income, non-minority neighborhoods. Analysis revealed a similar pattern in areas of Chicago where residents earned more than 80 percent of the area median income, showing that just 49 percent of these minority neighborhoods had access to carshare and bikeshare, in comparison with 77 percent of non-minority neighborhoods where residents earned similarly high wages.

In some cities, access was more evenly distributed throughout all neighborhoods. As shown on the graphs in the following pages, for instance, in Washington, D.C. all block groups studied had access to shared mobility, regardless of race or income (although the quality of access may vary). Additionally, in many of these cities, one-way carsharing is the dominant shared mode responsible for much of this access – a positive development, but one that also needs to be supplemented with a variety of additional modes to create a truly robust network of options.

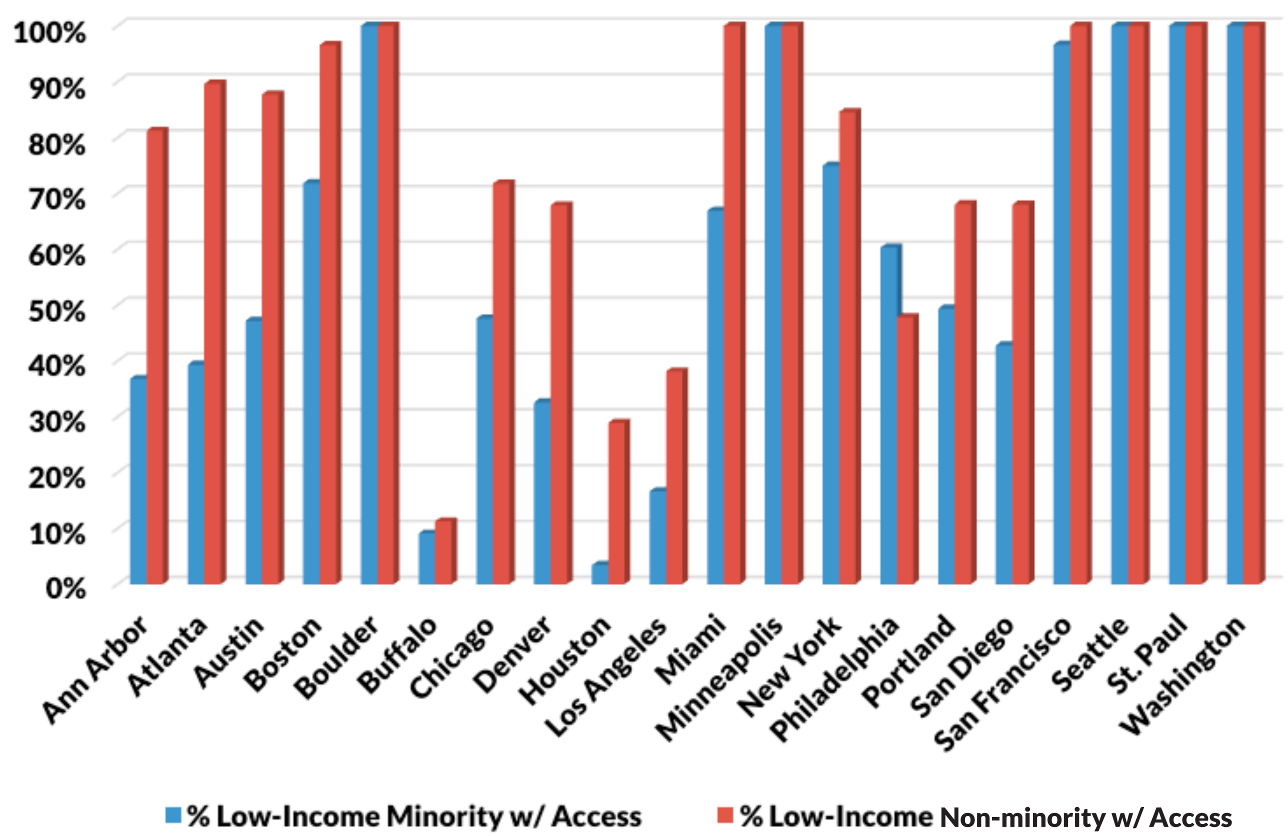
Despite significant efforts by both the public and private sector to address this disparity, SUMC's analysis suggests that much more must be done to reach these communities—especially considering the extraordinary potential they hold for expanding shared mobility and its many benefits. Also, while this analysis groups race and ethnic origin together to define a minority neighborhood, it may be helpful to conduct additional research to evaluate access to shared mobility among various individual demographic groups and in areas beyond the city boundaries studied in this report.



Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

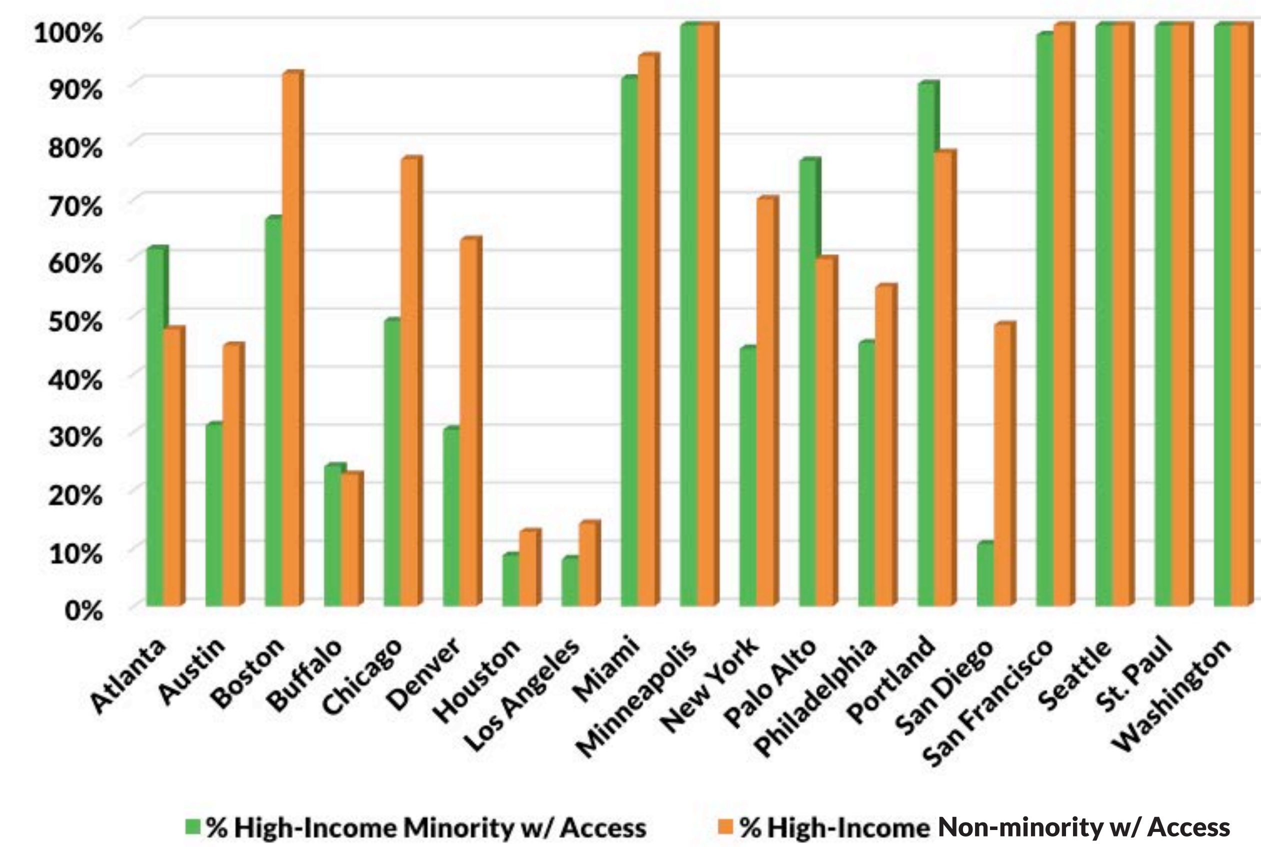
## Figure 6

Percentage of Low-Income Block Groups (<80% AMI) with Carshare or Bikeshare Access, Minority vs. Non-Minority




## Figure 7

Percentage of Higher-Income Block Groups (>80% AMI) with Carshare or Bikeshare Access, Minority vs. Non-Minority




# 4
# SHAPING SHARED MOBILITY

As the transportation industry changes and new shared mobility options proliferate, cities across the nation have worked to accelerate the passage of policies that protect public safety and maximize access to transportation without inhibiting growth and innovation.

To help local governments manage and expand the public benefits of these services, SUMC has developed a Shared Mobility Policy Database featuring a comprehensive library of shared mobility polices, plans, and studies from across the United States and Canada. In addition to serving as an information clearinghouse, the database also offers in-depth analysis of key policies and case studies to help planners, public officials, and service providers make fully informed decisions in this quickly evolving space. This full resource is now available online at **sharedusemobilitycenter.org.**

With more than 600 entries, the database continues to grow each day as SUMC documents new modes, models, and developments in shared mobility. Despite the rapid change, some best practices have begun to emerge from cities working on the front lines of urban mobility. Drawing from the innovative policies catalogued in the database, following is a series of recommendations to help cities manage the growth of new shared mobility services while maximizing their public benefits.

## 1 Embed specific requirements in requests for proposals (RFPs) to encourage utilization of common technology platforms and expand services to diverse neighborhoods and populations

RFPs not only provide cities with a means to clearly define and manage the selection process for new projects; they also offer an opportunity to set baseline requirements to ensure new services benefit the public. When crafting an RFP—whether it's for a new bikesharing system or a dynamic shuttle pilot—cities should take care to include specifications related to information sharing, software integration, and other issues that can help ensure new services operate in an efficient and equitable manner.

RFPs can include requirements for providers to:

- Share data and performance indicators at regular intervals
- Provide service to a wide range of neighborhoods and residents
- Offer ADA-accessible vehicles and passenger assistance
- Utilize payment technology and software that can be integrated with existing systems
- Meet safety and service standards


## KEY POLICIES

### City of Philadelphia Bikesharing System RFP

In the RFP that ultimately established Philadelphia's Indego Bike Share, the City stipulated that the system must serve users in minority and low-income communities and improve their access to key destinations, such as jobs and recreation. The RFP also mandated that the bikeshare service area represent a diverse cross-section of central Philadelphia in terms of age, race, income, and education, and even offered explicitly defined geographic zones of operation. Since it launched in early 2015, the Indego Bike Share system is now widely considered a leader in bikeshare equity.

### Los Angeles Metro Bikesharing RFP

In its RFP for Los Angeles' forthcoming 1,000-bike regional bikeshare system, LA Metro included a requirement the system be compatible with Metro's Transit Access Pass (TAP) card, even though it was at first unclear how precisely such integration would work. Less than a year later, the selected provider, Bicycle Transit Systems, announced that bikeshare members will be able to use specially branded TAP cards to unlock bicycles at docking stations when the system opens in mid-2016. While users' TAP cards will only link to their bikeshare accounts at first—instead of allowing riders to pay for bikeshare from their transit fare account—the integration is still noteworthy and shows how forward-thinking cities can spur the private sector into further innovation.

## 2 Open up street space to prioritize shared modes


Even cities with limited curb space can prioritize street space for shared modes of transportation such as transit, bikesharing, and carsharing, as well as for pedestrians and bicycle riders in general. While removing lanes and parking spots is often controversial, these measures can help cut congestion and increase safety by supporting more sustainable modes of transport. Street space is an important element in helping new services and systems grow, since it helps increase visibility, convenience, and availability of shared vehicles for users. From pilots to strategic plans, several cities have begun experimenting with ways to increase street space for shared mobility, including:

- Dedicating on-street parking spaces for one-way and roundtrip carshare cars
- Building protected bike lanes, pedestrian-friendly crosswalks, and other infrastructure that encourages more walking and cycling
- Replacing parking spaces with bikesharing stations
- Siting pick-up and drop-off zones for shuttles and ridesharing services

### KEY POLICIES

#### Seattle One-Way Carsharing Pilot

The initial success of a 350-space on-street parking pilot in 2013 led Seattle's city council to further expand the program in January 2015, passing new legislation that extended the pilot's service area and required new operators to serve the entire city in exchange for an increased cap of 750 vehicles per operator. Two years after the initial pilot, more than 70,000 Seattle residents are using one-way carsharing, which has resulted in thousands of people discarding their private autos, according to operator car2go. Additionally, the city estimates it will bring in $2.2 million in permit revenue in 2015 with an estimated 1,300 free-floating vehicles, and $3.4 million in 2016 with 2,000 vehicles.

#### Indianapolis Complete Streets Plan

In 2012, Indianapolis adopted a Complete Streets policy that focuses on accommodating all users, not just cars and trucks, to increase safety and enliven streets. The policy—which the National Complete Streets Coalition ranked as the best in the nation based on set of 10 policy quality measures—also establishes clear new performance metrics, including number of bike lane miles, linear feet of sidewalks, accessible transit stops, and accessibility measures for disabled riders.

#### Santa Monica Land Use and Circulation Element (LUCE)

Embedded in Santa Monica's general plan, the LUCE provides an integrated land use and transportation strategy that unites new housing and job opportunities with expanded transportation options. In 2015, the LUCE plan was amended to further focus on linking open spaces to enhanced transit systems as well as directing residential development to areas well-served by transit, particularly along the Expo Light Rail line, which connects Santa Monica to the greater Los Angeles region.

## 3 Experiment aggressively with pilot projects

One of the best ways for the public sector to experiment with innovative solutions is by implementing small-scale pilot projects. While these projects can be limited in scope, they have the potential to make an outsized impact. For instance, many of today's successful shared mobility systems—from Chicago's Divvy bikeshare to Zipcar's ONE>WAY carsharing service—began as pilots. Following the lead of the private sector, cities shouldn't be afraid to experiment and fail in the pursuit of new solutions that work for their residents.

## KEY POLICIES

### San Francisco Commuter Shuttle Pilot

In August 2014, the San Francisco Municipal Transportation Agency (SFMTA) launched an 18-month pilot program to establish a limited network of shared Muni and commuter shuttle stops. The pilot was launched in response to conflict created by the use of public transit bus stops by private commuter shuttles, which log roughly 8,000 round trips each day in San Francisco. While the shuttles themselves have been a visible target for anti-gentrification protests and remain controversial with some residents, an SFMTA evaluation of the program released in October 2015 suggested that the shuttles ultimately benefit the region by reducing solo commutes and associated traffic congestion. Additionally, the pilot is expected to generate $3.5 million for the city over the course of the program by charging shuttles a permit fee of $3.67 each time a public transit stop is used to pick up or drop off passengers.

### San Diego All-Electric Vehicle Car Share Pilot

In 2011, San Diego launched the nation's first large-scale, all-electric carsharing fleet as part of a pilot featuring the introduction of 300 car2go-branded one-way carshare vehicles. The pilot also allowed the use of municipal parking spaces for carsharing and permitted use of existing charging station infrastructure, leveraging approximately 1,000 commercial charging stations installed in 2011 for public use in San Diego. Usage of the program increased from 500 to 7,000 trips per week in less than four years, and 30,000 people have since purchased memberships. In 2015 the pilot's popularity led the city to make the program permanent and expand it from one carsharing provider to three.

### Los Angeles Low-Income Electric Carsharing Pilot

The City of Los Angeles launched a first-of-its-kind carsharing pilot project in 2015, focused on serving low-income LA residents. The goal of the three-year pilot, which is funded with $1.6 million in state cap-and-trade revenues administered by the California Air Resources Board, is to reduce greenhouse gas emissions by introducing electric carsharing fleets into disadvantaged communities. The pilot will add approximately 100 electric and hybrid carsharing vehicles and more than 100 charging stations in disadvantaged communities in and around Central Los Angeles. It also aims to recruit at least 7,000 new carsharing users, who in turn are expected to sell or avoid purchasing 1,000 private vehicles, reducing annual greenhouse gas emissions by approximately 2,150 metric tons of $CO_2$.



## 4 Eliminate minimum parking ordinances to deter single-occupancy vehicle trips in favor of shared modes

Parking minimums require developers to construct a minimum number of new parking spaces for each new residential or commercial building, often without regard to the presence of nearby transit options or actual need. While originally intended to help accommodate additional traffic generated by new developments, critics such as Donald Shoup have suggested that minimum parking requirements actually skew markets, create a de facto subsidy in favor of driving, and contribute to congestion. By pursuing transit-oriented development and related zoning and land-use measures, cities can help tip the scale back in favor of more sustainable modes of transportation such as public transit and other forms of shared mobility.

## KEY POLICIES

### Chicago Transit-Oriented Development Reform Ordinance

In September 2015, the Chicago City Council passed a transit-oriented development (TOD) reform ordinance that more than doubled the radius around train stations where dense development can be built and all but eliminated parking minimums within these areas. The new legislation amended the city's original TOD ordinance, which passed in 2013 and has been successful in spurring new building projects. Chicago's Metropolitan Planning Council has estimated that the ordinance's elimination of parking minimums creates a tenfold increase in the transit-adjacent land area available for development.

### San Jose TDM Zoning Parking Reduction

In 2013, the City of San Jose voted to amend its zoning ordinance to reduce parking requirements for certain types of land use and developments that are located near transit and that include transportation demand management (TDM) measures. The regulation allows a 15 to 50 percent reduction in minimum parking requirements for developments with qualified TDM programs, which include on-site carshare parking, vanpooling programs, transit passes, and electric vehicle charging stations. San Jose's regulations also require a minimum number of bicycle parking spaces which, depending on use, can range from one per site up to one per dwelling unit.

## 5 Pursue public-private partnerships to build first/last mile connections to transit

Bikesharing, carsharing and ridesourcing can help extend a transit system's reach by providing first/last mile connections to help riders get to transit to initiate a trip, or from transit to their final destination. For instance, a 2014 study by UC Berkeley's Transportation Sustainability Research Center showed that 14 percent of Nice Ride Minnesota bikeshare members increased rail use, and a comparable number increased bus use. More recently, ridesourcing provider Lyft has stated that more than 20 percent of its rides in the San Francisco Bay Area begin or end near a BART or Caltrain stop. Cities can support these first/last mile connections and bolster transit ridership by pursuing partnerships with private sector mobility providers. Such partnerships can include:

- Co-marketing and awareness campaigns
- Linked mobile applications
- Location of shared vehicles at transit stops
- "Guaranteed ride home" programs

## KEY POLICIES

### Washington Metropolitan Area Transit Authority (WMATA) Carshare Partnership

WMATA initiated a partnership with Enterprise CarShare in April 2015 to provide 190 carshare parking spots across 45 Metrorail stations in Washington, DC. The partnership with Enterprise extended the reach of Metrorail and Metrobus by giving riders who may not own cars easy access to vehicles. Additionally, the revenue-generating contract with Enterprise will compensate Metro throughout a five-year term and was based on a best value procurement process.

### Dallas Area Rapid Transit (DART) Ridesourcing Partnerships

In 2015, DART partnered with both Uber and Lyft in attempt to step up its "complete trip" efforts. Through its partnerships, DART's GoPass mobile ticketing application is linked to the mobile apps for both providers, allowing users to "walk through" DART's app to Uber or Lyft and hail a ride to begin or complete their transit trip. This type of connection makes it easier for travelers who start or end their trips in places not easily served by DART, but who want to use the relatively inexpensive option of a train or bus for the longest portion of their trip. To promote the partnership and reach new users, Uber also offered a free first ride (up to $20) to new customers who arrived through DART's app.

### LA Metro First/Last Mile Plan

LA Metro's plan outlines an infrastructure improvement strategy designed to facilitate easy, safe, and efficient access to the Metro system with the goal of extending Metro's reach and increasing ridership. The plan also proposes a county-wide transit access network to shorten trip length and seamlessly connect transit riders with intermodal facilities such as bike hubs, bikeshare stations, carshare parking and regional bikeways.

## 6 Set mode shift goals to prioritize actions that support shared mobility

Mode shift goals—which focus on shifting trips from private autos to more sustainable modes of transport such as biking, walking, and transit—can be an effective way for cities to help reduce single-occupancy vehicle trips. Prioritizing more sustainable modes of transport can help cities cut congestion, open up street space, and realize new economic opportunities. For instance, SUMC estimates that the United States can take one million cars off the road in the next five years by modestly expanding transit and shared mobility in 15 metropolitan regions. Such actions could reduce annual vehicle miles traveled by 2.9 billion—the equivalent of 10 round trips to Mars—and avert more than 1.6 million metric tons of $CO_2$, equivalent to planting 40 million trees.

### MassDOT Mode Shift Goal

In 2012, the Massachusetts Department of Transportation (MassDOT) announced a statewide mode shift goal to triple the share of travel in the state by bicycling, transit, and walking by 2030. According to MassDOT, the goal was underpinned by a desire to provide sustainable and healthy transportation choices, foster improved quality of life, and alleviate congestion. The agency included the mode shift goal in its GreenDOT Implementation Plan and also established a Mode Shift Working Group. In 2013, MassDOT also announced a Healthy Transportation Policy Directive that required all state transportation projects to increase bicycling, transit, and walking options.

### San Francisco Municipal Transportation Authority (SFMTA) Mode Shift Goal

In 2012, the SFMTA set an ambitious goal to reduce private car trips to 50 percent of all city trips by 2018. Three years later, the agency announced it had already surpassed its goal. According to SFMTA travel survey results, 48 percent of trips in San Francisco in 2014 were made driving alone or with others, while 52 percent were made using active and shared modes of transportation such as bikesharing, walking, and public transit. The SFMTA credited the shift to tactics such as encouraging compact development and using smart land-use and parking policy to change travel behavior.

## 7 Make equity a focus by setting rules that require accessible vehicles and service availability to all residents and neighborhoods

While North America has seen tremendous growth in shared mobility services over the past decade, much of it has yet to reach disadvantaged communities. At the same time, low-income neighborhoods are often disproportionately affected by high transportation costs and pollution from auto emissions, and stand to benefit most from increased access to jobs, opportunity, and a better quality of life. Shared mobility can also be especially valuable for senior citizens, disabled residents, and others who are not well served by traditional transportation options. In their role as regulators of the private sector, cities must take the lead in setting guidelines that ensure the benefits of shared mobility are available to all.






### DC Carshare Street Space Ordinance

Beginning in 2011, the District of Columbia Department of Transportation (DDOT) established a program to allow one-way carsharing members to park shared vehicles in residential permit parking zones throughout the city. The ordinance requires carsharing providers to maintain an area of operation that includes the entire District of Columbia and to keep at least 50 vehicles, with one percent of its fleet available in each ward of the city at any point in time. Additionally, DDOT's ordinance requires that a set number of carsharing vehicles be located in low-income neighborhoods as identified by DDOT, even if such locations are not desired or requested by the company.

### Chicago Divvy for Everyone Program

Chicago's Divvy bikeshare system offers reduced-cost annual memberships to residents through its Divvy for Everyone (D4E) initiative, which launched in 2015. Through D4E, Chicago residents with incomes below 300 percent of the federal poverty level who don't have a credit or debit card can qualify for a one-time, $5 annual Divvy membership, discounted substantially from the regular $75 fee. Participants can enroll in person at one of five LISC Financial Opportunity Centers located throughout the city using a state-issued ID and a one-time cash payment. The effort follows a major expansion of Divvy to new neighborhoods earlier in the year.

### Portland Private-for-Hire Transportation Innovation Pilot

Before Portland agreed to let ridesourcing companies such as Uber and Lyft operate within city limits, it implemented a 120-day pilot program to evaluate the companies' performance and help develop a permanent set of regulations. The Portland Bureau of Transportation (PBOT) issued permits allowing each company to legally operate within the city during the course of the pilot. To participate, companies had to pay a flat fee of $20,000 and meet several requirements, including data sharing and the provision of timely and equitable service to persons with disabilities. Each provider was required to adhere to a set of Equity and Inclusion Principles, which mandated that they:

- Provide an option for riders on the company's mobile app to request wheelchair-accessible vehicle (WAV) service
- Respond to requests for WAV service within the same amount of time as comparable requests for non-WAV service
- Offer WAV service without any additional fare charges
- Make reasonable accommodations for service animals

PBOT also required that the companies provide anonymized data reports, including WAV-related performance, and cover the cost of data analysis. Following the successful pilot, Portland's city council voted to allow Uber and Lyft to operate permanently in Portland in December 2015.

## 8 Require that shared mobility operators share data so cities can assess their impact and integrate new services into their transportation plans

While services such as Uber and Lyft are active in more than 150 cities in North America, few local governments have a clear picture of how they are affecting traffic flows, congestion, and greenhouse gas emissions without data that showing exactly how and where trips are taking place. Similarly, data from carsharing and bikesharing operators can help cities analyze travel patterns and make decisions related to demand and transit availability. In an attempt to secure such information, several cities have embedded data-sharing requirements into their agreements with private mobility operators.

### KEY POLICIES

#### Boston Uber Data Agreement

In early 2015, Uber announced it would begin providing the City of Boston with quarterly data reports showing the duration and general location of its trips. The company agreed to deliver anonymized trip-level data by Zip Code Tabulation Area (ZCTA). The agreement specified that data reports would include:

- Date and time for the beginning of a trip
- ZCTAs in which trip began and ended
- Distance traveled during trip, in miles
- Duration of trip, in seconds
- Technical support to interpret and utilize the data



Despite early predictions that the agreement could mark a change in Uber's approach to public-private sector collaboration, however, only a few other cities have since enacted similar agreements. Additionally, it is difficult to know precisely what level of detail is included in the reports since Uber also included provisions in the agreement that shield its data from Freedom of Information Act requests.

#### San Francisco On-Street Carshare Pilot Participation Requirements

As part of the on-street carsharing pilot that the SFMTA initiated in 2013, the agency required carsharing operators to provide regular data reports to measure their impact and ensure they honored commitments regarding vehicle placement and availability. The SFMTA specified that the operators' quarterly data reports include:

- Total number of carshare members who reside in San Francisco by zip code
- List of all current vehicle locations (off-street and on-street)
- Date and time of the start and end of all trips, as well as miles traveled
- Average utilization rate for each permitted on-street parking space, including percentage of time a vehicle was used, how often each on-street space or vehicle was not available for use by members, and how often each vehicle was parked but not used by a member
- Average unique users per vehicle per month

The SFMTA also required operators to survey their members about travel behavior, vehicle ownership, and carsharing use at least twice during the two-year pilot, and share the results with SFMTA.

While these policies represent some of most innovative thinking by cities in relation to shared mobility, more action is needed to address new developments such as microtransit services, electric bikeshare bikes, shared autonomous vehicles, and new public-private partnership models. SUMC plans to continue tracking best practices and maintaining the Shared Mobility Policy Database as the industry evolves.

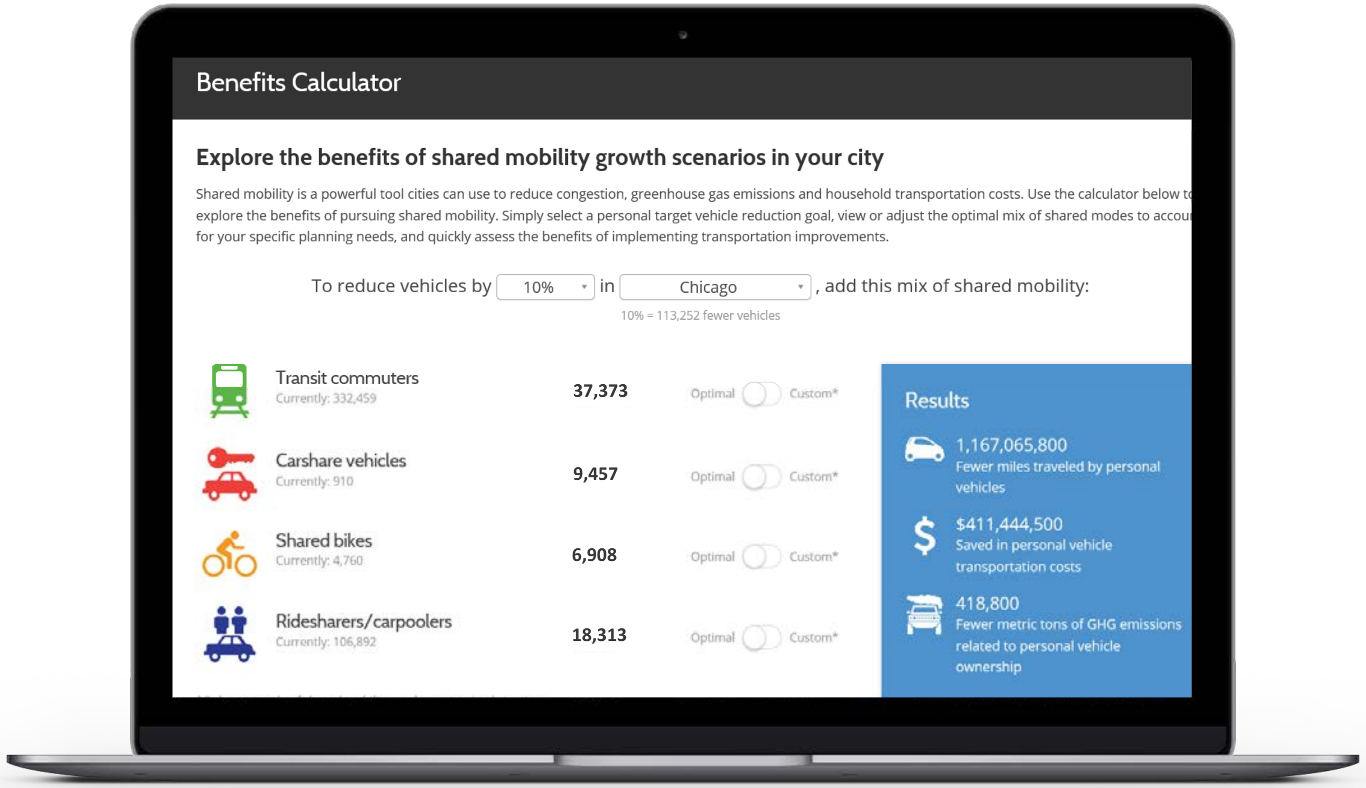
**For more information on these case studies and best practices – as well as access to more than 600 of the nation's leading shared mobility policies, plans and studies – visit SUMC's interactive policy database at sharedusemobilitycenter.org**

# 5
# CALCULATING THE BENEFITS

The final component of the shared mobility toolkit is an interactive calculator that allows cities to easily view the benefits of pursuing various shared mobility growth scenarios. Local governments can use the tool to quickly calculate potential decreases in greenhouse gas (GHG) emissions, vehicle miles traveled (VMT) reductions, and other potential benefits from implementing transportation improvements.

While many studies have looked at the impact of shared mobility on auto ownership, these reports have often been based on survey data from carsharing or bikesharing users, which make it difficult to determine how growth of these services might affect the general population. By using actual data from cities, SUMC was able to overcome these limitations and provide a new framework for evaluating the impact of shared mobility on auto ownership.

Drawing from this data, SUMC's online calculator tool shows scenarios for more than 50 cities across the United States and Canada, including the USDN's 27 study cities. This easy-to-use tool will help city governments to set targets, identify effective strategies, and build support for new sustainability initiatives.




## Shared Mobility Benefits Calculator Approach

To create the benefits calculator, SUMC used a set of simultaneous equations to estimate changes in vehicle ownership that could be expected from several explanatory variables. While the opportunity analysis in the previous section was based on Census block group data in order to evaluate specific opportunities, these metrics are designed to assess the impact of shared mobility at the city level and define an optimal mix of shared modes to reach vehicle and GHG reduction targets (see Appendix B for model details).

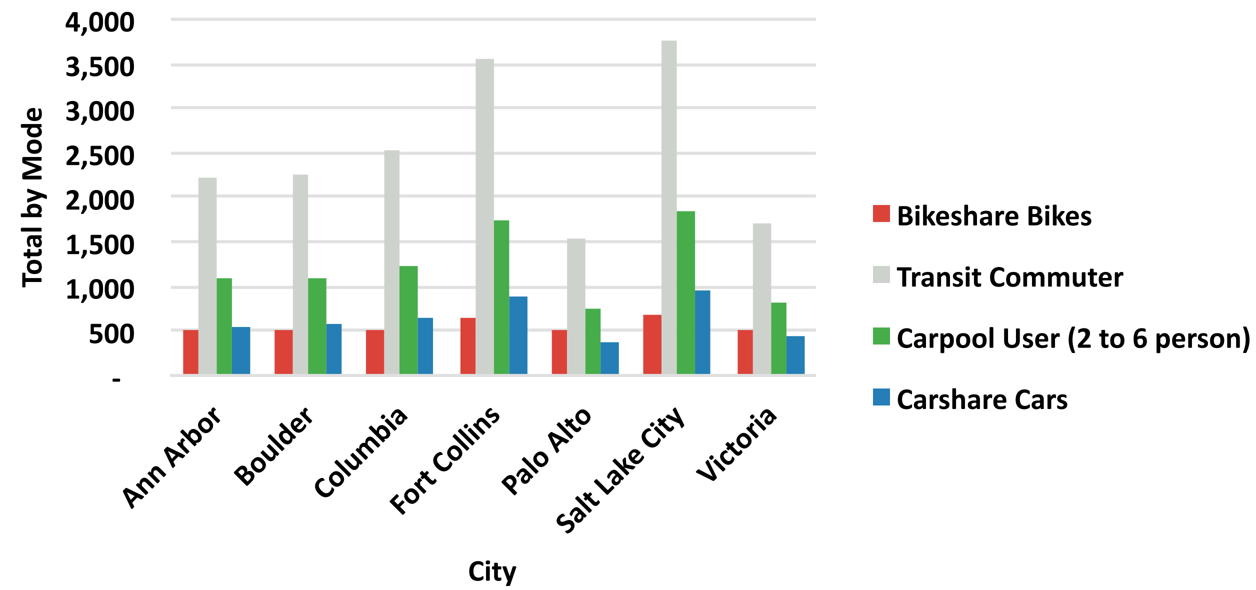
## Optimal Mix of Shared Mobility

The calculator tool provides an optimal mix of shared mobility modes that an individual city can use to reach a targeted vehicle reduction goal. For example, in order to achieve a 10 percent reduction of existing cars in Chicago—about 113,000 vehicles off the road—the optimal allocation of shared modes suggested by the model would be roughly 9,500 carshare vehicles, 7,000 bikeshare bikes, 18,000 new carpool/rideshare users, and 37,000 new transit commuters.

The following graphs show the optimal mix that each USDN study city would need to reduce the total number of cars on its roads by 10 percent. While the proportion of modes needed to reach the goal is similar for each city, the amount varies significantly based on current vehicle ownership rates. For instance, Figure 8 indicates that Palo Alto needs roughly 390 carshare cars to hit its 10 percent goal, while Salt Lake City—which has a larger vehicle base—needs more than 900 carshare cars.

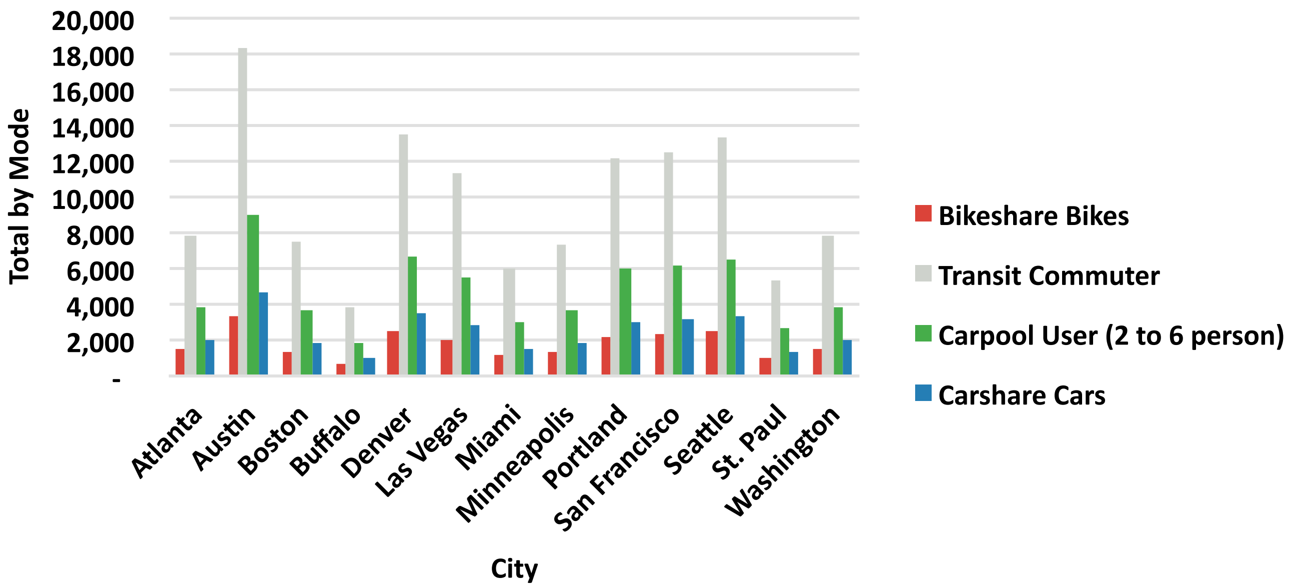
### Figure 8

**Small Cities Optimal Mix of Shared Mobility to Reach 10% Target Vehicle Reduction**



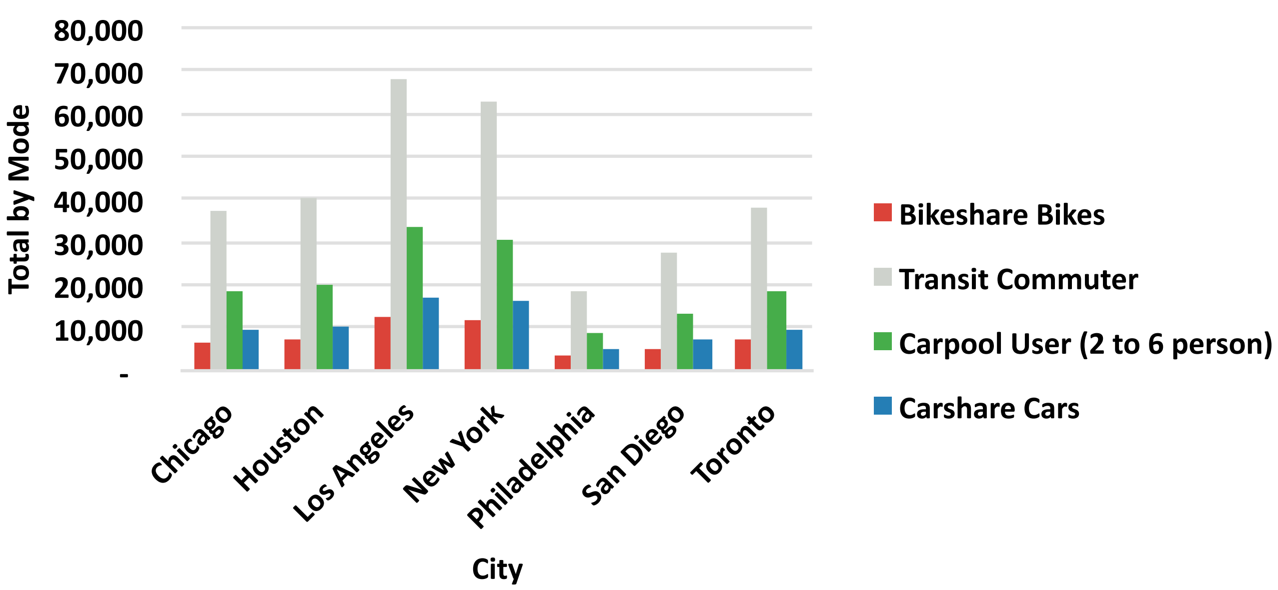
## Figure 9

Medium Cities Optimal Mix of Shared Mobility to Reach 10% Target Vehicle Reduction




## Figure 10

Large Cities Optimal Mix of Shared Mobility to Reach 10% Target Vehicle Reduction




## Aggregating the Benefits

When small changes are aggregated across the 27 USDN study cities, the tremendous environmental and economic impacts that shared mobility can offer become much clearer. Under the 10 percent vehicle reduction scenario included in this study, SUMC's tool suggests that the United States could take more than 1 million vehicles off the road, with the resulting benefits shown in Table 3.

## Table 3

Aggregate Benefits of Shared Mobility

| | |
|---|---|
| Personal vehicles removed from the road | 1.3 Million |
| VMT savings | 14 Billion |
| Greenhouse gas emission reductions (metric tons $CO_2$e annually) | 5 Million |
| Annual household transportation savings | $5 Billion |

| 5 million metric tons CO2 is equivalent to the emissions from : | | | | | |
|---|---|---|---|---|---|
| 550 million gallons of gasoline consumed | 5 billion pounds of coal burned | 128 million incandescent lamps switched to CFLs | 11 million barrels of oil consumed | 204 million propane cylinders used for home barbeques | 191,000 trees planted |

Source: Greenhouse Gas Equivalencies Calculator (http://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator). Transportation savings are based on the estimated number of cars taken off the road and the average cost of owning and operating a vehicle according to Consumer Expenditure Survey Table 1202 ($6,753 total) compared with the estimated yearly transportation costs associated with not owning a vehicle ($3,120).

# 5 CONCLUSION

SUMC's shared mobility toolkit provides cities with new tools and information to help expand transportation access, meet emission reduction goals and foster more sustainable, livable communities. These tools, and the underlying research, were only made possible thanks to the partnership of the USDN and its member cities, who were instrumental in sharing information, guidance, and support to make this project a reality.

Ongoing study is needed to build our understanding of how shared modes of transportation such as bikesharing, carsharing, and ridesourcing are working in cities across North America. Fortunately, it seems as though more information is available each day as public and private sector leaders continue to communicate more openly about their operations. Recent trends such as the creation of a General Bikeshare Feed Specification (GBFS), the emergence of new "smart city" initiatives to capture traffic patterns and other information using high-tech sensors, and the increased willingness of ridesourcing providers and other private sector operators to collaborate with local governments and transit agencies, are all causes for optimism.

As shared mobility continues to grow and mature as an industry, the report suggests more must also be done to reach new areas—including disadvantaged neighborhoods, low-density communities, and other non-traditional markets—where the benefits of these new modes can have an outsized, and much needed, impact. In all cases, it is clear that cities will continue to play a leading role in driving innovation and action both locally and on the global stage, where, by pushing the envelope on new policies, pilots and priorities, they can help deliver change on a grand scale.

Additional report materials, including technical information, is included in this document's appendices. More information about SUMC and the tools outlined in this report can also be found online at **sharedusemobilitycenter.org.**

# 6

# USDN STUDY CITY SHARED MOBILITY PROFILES

The following section contains profiles of all 27 USDN study cities. Each profile consist of the following elements:

- An overview of the regional transportation picture and current modal split, existing shared mobility resources, and potential of the built environment to support shared modes
- A shared mobility opportunity map and narrative, drawn from SUMC's opportunity analysis tool (see Appendix A for details on this modeling)
- Details on the optimal mix of new shared mobility infrastructure and transit use needed to reach a 10  percent reduction in personal vehicle ownership in the core city of each market (see Appendix B for additional details on metrics and modeling)
- Modeled annual reductions in VMT,  gasoline consumption, GHG emissions, and citywide household transportation savings that would be produced by the 10 percent reduction goal




S M L

City Size

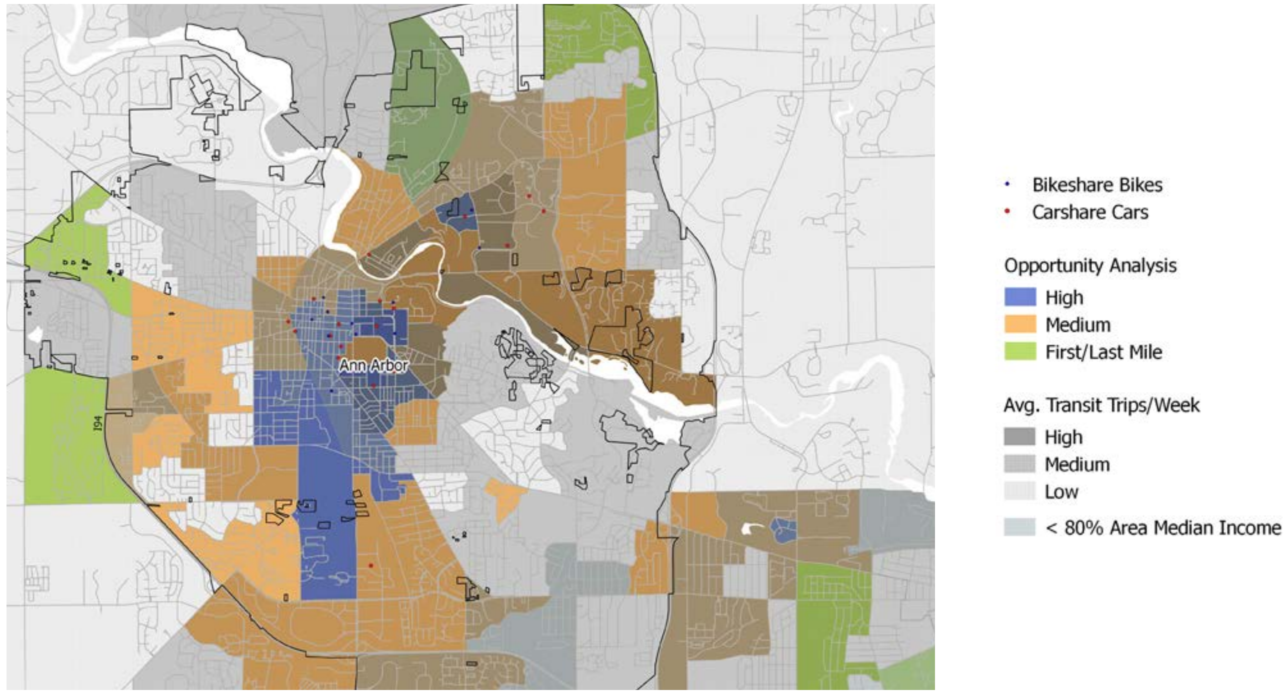
# Ann Arbor, MI

Population: 117,770 (est. 2014)
Area: 27.8 sq. mi.
Pop. 4,094 per sq. mi. (est. 2010)

Ann Arbor continues to expand its ArborBike system, adding seven new bikesharing stations in 2015.

## Existing Conditions

Ann Arbor has a strong culture supporting active transportation. Approximately 30 percent of residents walk, bike, or take public transit to work, despite the fact that nearly 90 percent of households own a vehicle. Carsharing arrived in Ann Arbor in 2007, and ridesourcing companies currently operate there as well, though their legality is still unresolved. The city also launched a 125-bike bikeshare system in 2014. Many neighborhoods in Ann Arbor are walkable, have good access to public transit and are close to jobs.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas for shared mobility in Ann Arbor are located downtown and around the university. Bikeshare, carshare and ridesourcing are well suited for these markets and can serve both work and non-work trips. The adjacent neighborhoods hold medium opportunity and can support complementary services that feed into the downtown or university centers. First/last-mile connections are located on the periphery of the city. These neighborhoods are best suited for carpool/ridesharing.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 6,689 | 500 | 2,207 | 1,082 | 559 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 68,930,377 | 2,771,906 | 24,377 | $24,301,137 |

S M L

City Size

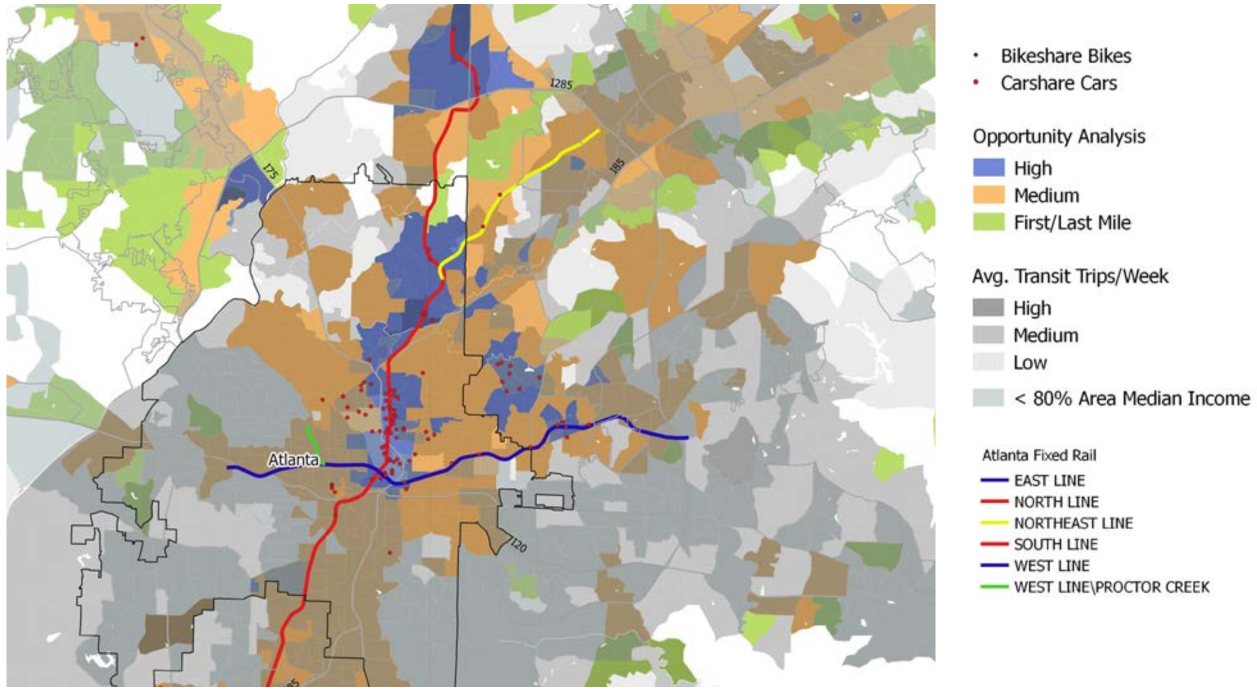
# **Atlanta,** GA

Population: 456,002 (est. 2014)
Area: 133.2 sq. mi.
Pop. Density: 3,154 per sq. mi. (est. 2010)

Atlanta's MARTA system launched the nation's first transit/Uber partnership in January 2015.

## Existing Conditions

Atlanta has long struggled with accessibility, air quality, and congestion issues as job centers and development have sprawled throughout the region. However, it is also a city with many walkable neighborhoods, and has recently made significant expansions to its bike infrastructure. Carsharing and ridesourcing companies are both active in Atlanta. The city undertook a bikeshare feasibility study in 2012 and is moving forward with plans to launch in summer 2016 with 500 bikes. CycleHop was recently chosen as the vendor.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest shared mobility opportunity areas are located downtown and along the city's transit lines. These areas could support all shared modes, particularly carshare, bikeshare, ridesourcing, and private shuttles. Adjacent medium opportunity areas could support shared mobility feeder service to higher density markets. First/last-mile connections also exist on the city's periphery, where existing transit service is limited. In these neighborhoods, additional transit improvements are needed to achieve long-term growth. In the short term, however, shared modes—including carpools, vanpools and private shuttles—can help fill transportation gaps and alleviate traffic congestion related to work trips.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 23,547 | 1,436 | 7,771 | 3,808 | 1,966 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 242,661,927 | 9,758,196 | 87,070 | $85,549,521 |

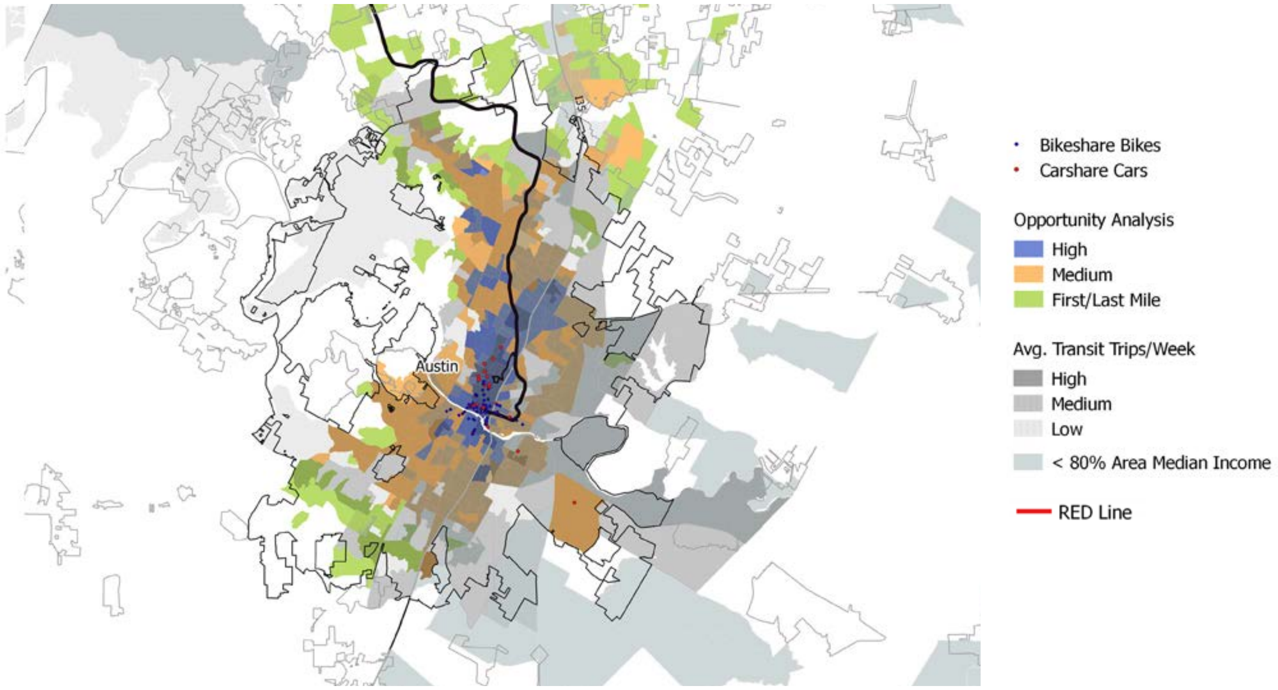

# Austin, TX

Population: 912,791 (est. 2014)
Area: 322.48 sq. mi.
Pop. Density: 2,653 per sq. mi. (est. 2010)

Austin was car2go's first US market and continues to pursue several sustainable transportation initiatives.

## Existing Conditions

Austin has many sustainable transportation initiatives. The city launched an on-street carshare parking pilot in 2009, which became an ongoing program in 2011. A 2013 planning ordinance requires developments to include bicycle parking and reduces minimum parking requirements for developers that include carshare parking. The city also has a goal of making its operational fleet carbon neutral by 2020. Austin passed an ordinance in October 2014 allowing ridesourcing companies to operate in the city and has a moderately sized bikeshare system, which launched in 2013. Yet, Austin still remains a very auto-oriented city. Just 7 percent of households are car-free, which is less than the national average, and only 9 percent of workers commute by walking, biking, or taking transit.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Central Austin and neighborhoods located along the city's light-rail line hold the highest opportunity for shared mobility. One-way carshare, which already operates in Austin, is well positioned to capture this market, although the city's downtown and its immediate adjacent neighborhoods could also support a substantial bikeshare fleet. The ridesourcing market extends throughout Austin—particularly in the highest and medium opportunity areas—but this mode can also provide important first/last-mile connections along the city's periphery.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 55,314 | 3,374 | 18,254 | 8,944 | 4,619 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 570,013,722 | 22,922,036 | 204,528 | $200,956,125 |

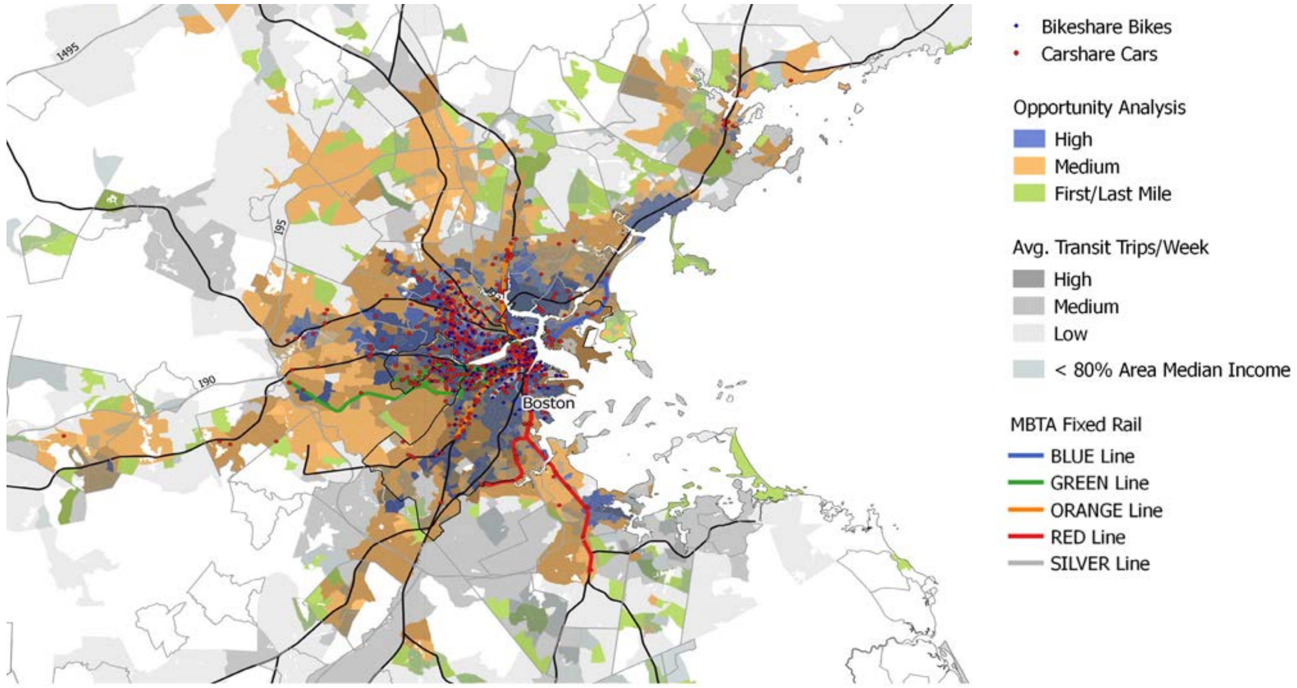

# Boston, MA

Population: 655,884 (est. 2014)
Area: 48.3 sq. mi.
Pop. Density: 12,793 per sq. mi. (est. 2010)

Home to Zipcar's corporate headquarters, Boston has been a carsharing leader since 2000.

## Existing Conditions

Boston's dense, historic neighborhoods and strong transit system have long made it a city where residents can meet most daily needs without driving. Indeed, 36 percent of households do not own a car, and the city averages less than one personal vehicle per household. A remarkable 50 percent of commuters travel by biking, walking, or taking transit. Shared-use mobility has been well incorporated into the city's transportation infrastructure. Carshare launched in Boston in 2000, and the city is home to Zipcar's corporate headquarters. The city also rolled out a bikesharing system in 2011 and is home to microtransit provider Bridj. Ridesourcing companies have been able to freely operate in Boston under existing law but are now required to provide operations data to the city.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

While Boston has a large shared-mobility base, the analysis indicates that the city could support additional services, particularly in the highest opportunity areas that cluster downtown and radiate out along fixed transit routes. Shared-mobility travel options in these neighborhoods are well positioned to capture both work and non-work related trips. The city also has a number of medium and first/last-mile opportunity areas that hold potential for important shared mobility connections to transit service.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 22,995 | 1,403 | 7,588 | 3,718 | 1,920 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 236,967,365 | 9,529,199 | 85,027 | $83,541,925 |

S M L

City Size

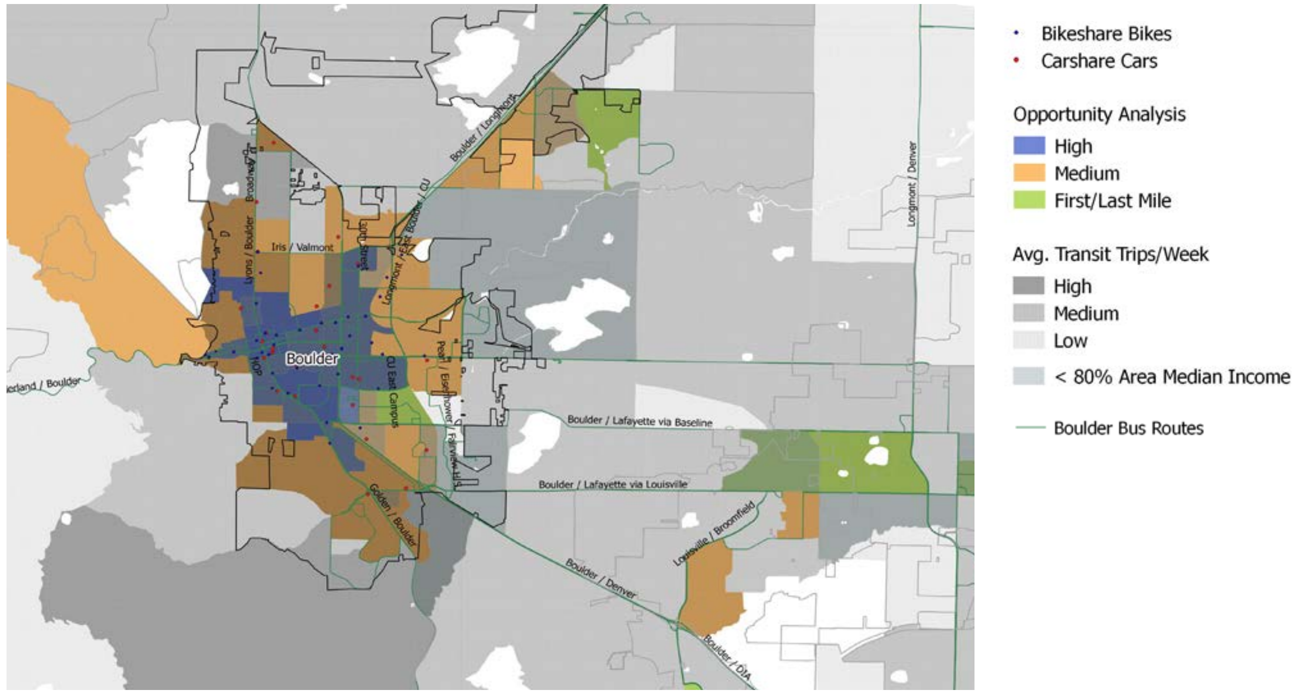
# **Boulder,** CO

Population: 105,112 (est. 2014)
Area: 25.7 sq. mi.
Pop. Density: 3,947 per sq. mi. (est. 2010)

Boulder's Neighborhood EcoPass program provides subsidized transit passes to encourage neighbors to drive less and use transit more frequently.

## Existing Conditions

A small city with a strong culture of environmental awareness and transportation innovation, Boulder is fairly walkable, with 29 percent of its workers commuting by walking, biking, or public transit. The city's Eco Pass program allows employers and neighborhoods to purchase bulk transit passes at steeply discounted rates. Planned transit expansions to better connect Boulder to Denver will soon give travelers even more options. Boulder has a strong bicycle culture, and bikeshare first launched there in 2011. The local carsharing organization, e-GO, grew out of a carsharing co-op that began in the 1990s. Ridesourcing companies serve Boulder as part of their Denver service area.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Boulder's highest opportunity areas are located downtown and around the University of Colorado campus. While carshare and bikeshare already exist in these areas, the analysis indicates that they could support even higher service levels. The university population in particular offers a strong market for these expanded services and can also help sustain a strong ridesourcing market. The medium opportunity areas hold potential for shared mobility to provide important connections to these two centers. Given the walkable environment and bicycle culture in Boulder, shared mobility can help further reduce the need for private vehicles as it can capture both work and non-work trips.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 6,833 | 500 | 2,255 | 1,105 | 571 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 70,414,302 | 2,831,579 | 25,266 | $24,824,289 |

S M L

City Size

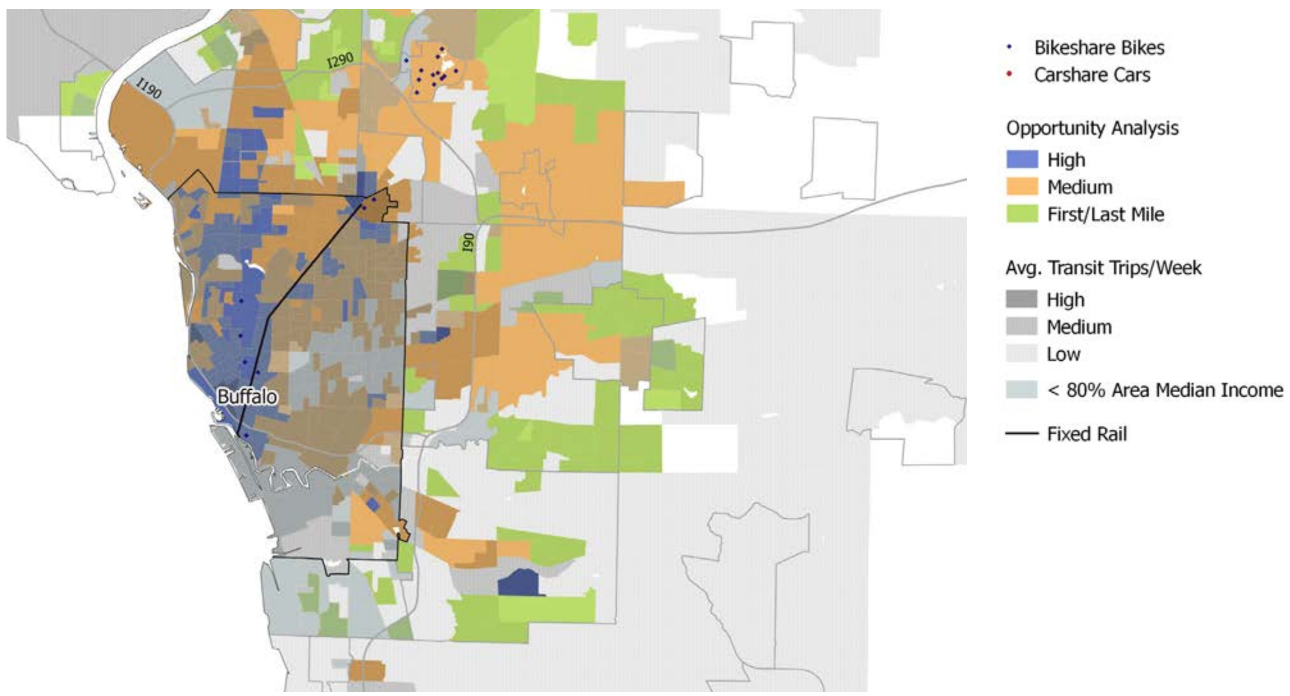
# **Buffalo,** NY

Population: 258,703 (est. 2014)
Area: 40.4 sq. mi.
Pop. Density: 6,471 per sq. mi. (est. 2010)

Buffalo is notable as a smaller-sized, moderate-income city that has pursued shared-use mobility with gusto.


## Existing Conditions

Buffalo is notable as a smaller-sized, moderate-income city that has pursued shared-use mobility with gusto. Buffalo has a low auto ownership rate—29 percent of its households own are car-free—so transportation alternatives are essential to mobility. The area is well served by transit and is quite bikeable and walkable. Bikesharing launched in Buffalo in 2013, and Zipcar is launching an innovative approach to serve lower-income neighborhoods by extending the service of Buffalo Carshare after that nonprofit provider shut its doors due to insurance concerns. No major ridesourcing companies operated in Buffalo as of early 2016.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Downtown Buffalo holds the most potential for shared mobility, followed by the residential neighborhoods along the transit line to the university. Many of the opportunities in Buffalo are in low- to moderate-income areas that could especially benefit from these services, which can help households increase wealth by reducing transportation-related expenses.

## Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 11,780 | 719 | 3,888 | 1,905 | 984 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 121,397,431 | 4,881,771 | 43,559 | $42,798,193 |

S M L

City Size

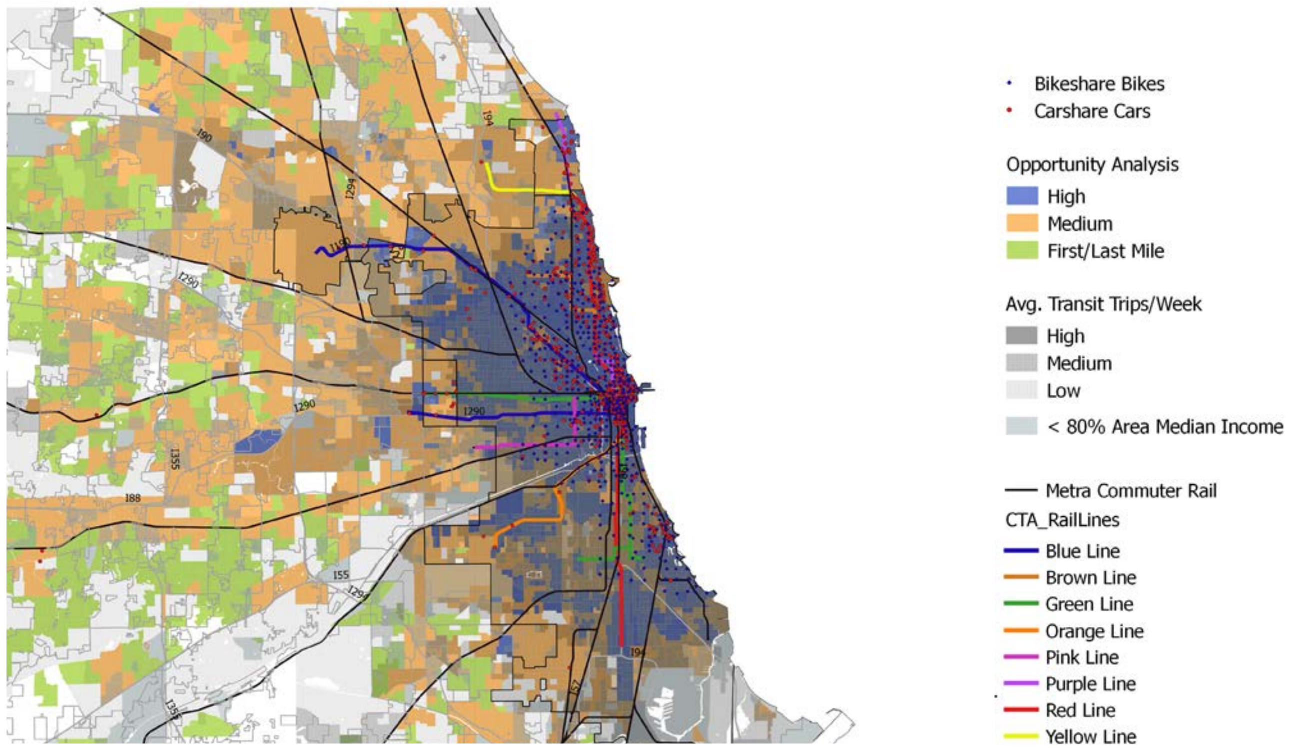
# Chicago, IL

Population: 2,722,389 (est. 2014)
Area: 227.6 sq. mi.
Pop. Density: 11,842 per sq. mi. (est. 2010)

Chicago was an early carshare adopter and recently launched Bus Rapid Transit service. The city's Divvy bikeshare is the largest system in North America in terms of geographic service area.

## Existing Conditions

Chicago has more than a decade of experience with shared-use mobility, beginning with carsharing in 2002 and expanding to bikesharing in 2013. Chicago has the most bikeshare stations and largest service area in the U.S. Approximately 300,000 car-free households rely on the nation's second largest transit system, as well as an extensive network of bike lanes and sidewalks. Ridesourcing has become a popular alternative in recent years as well.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest levels of shared mobility opportunity are found throughout the city of Chicago. In these areas, expanded or new carshare can be supported along with the well-received Divvy Bikeshare. Carshare should be a mix of traditional and one-way (not yet operating in the city) to best serve these urban neighborhoods. There are also strong ridesourcing and taxi markets throughout the city. Lower-income areas on the west and south sides of Chicago are equally well positioned to support these services given their density and urban form. However, these neighborhoods might require different approaches to promoting these services until they are more widely recognized by residents. Medium opportunity areas are typically located in higher density inner-ring and streetcar suburbs spaced out along rail corridors, followed by first/last-mile connections further out on commuter rail lines. The medium opportunity areas could support an expanded or new carshare fleet and targeted bikeshare program in the local downtowns and higher density neighborhoods. The first/last-mile areas could support important connections to the commuter rail line.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 113,252 | 6,908 | 37,373 | 18,313 | 9,457 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 1,167,065,793 | 46,931,368 | 418,758 | $411,444,516 |

S M L

City Size

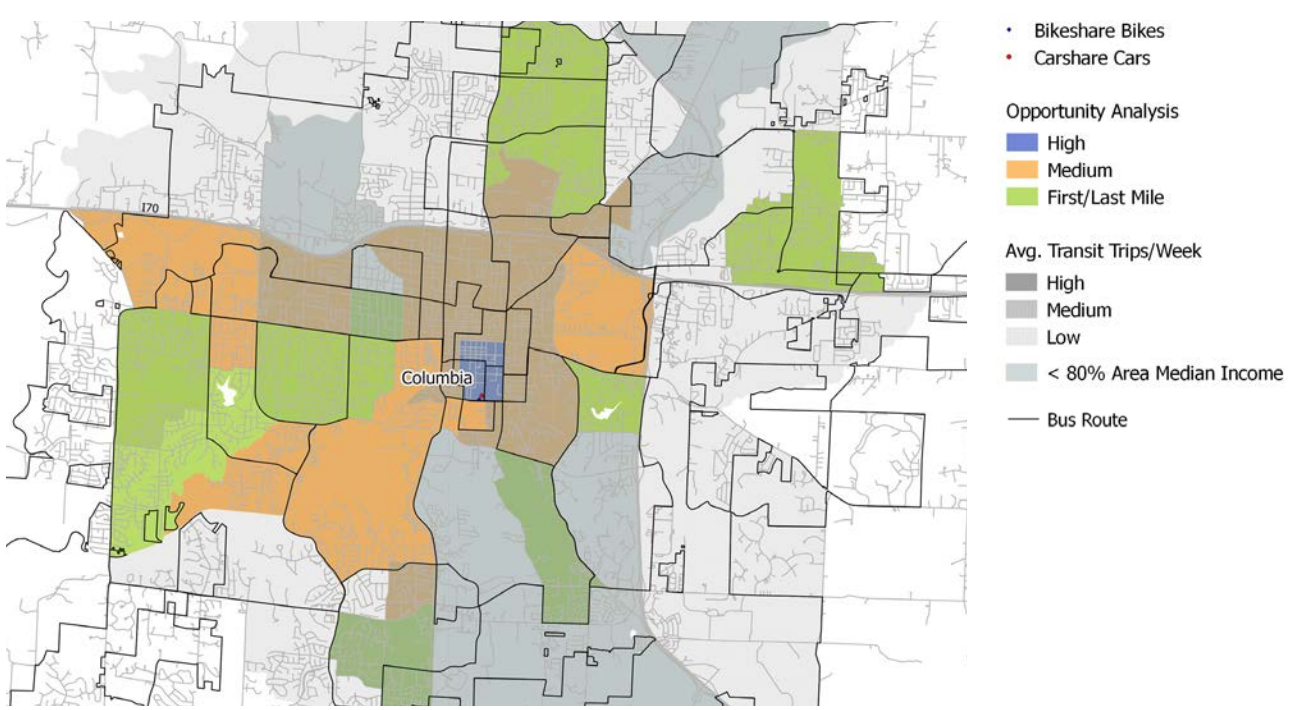
# Columbia, MO

Population: 116,906 (est. 2014)
Area: 132.2 sq. mi.
Pop. Density: 978 per sq. mi. (est. 2010)

Columbia's Mizzou Bike Share launched in 2012 to provide University of Missouri students with a free, sustainable transportation option.

## Existing Conditions

Columbia has one ridesourcing company operating locally as of early 2016. Otherwise, the city has relatively few shared-use mobility options, with only a limited university operated bikeshare program and just two carshare vehicles available. Many neighborhoods in Columbia have limited access to public transportation, and less than 1 percent of workers take public transit to work. Despite this, the shared mobility opportunity analysis indicates that there is a market for expanding its carshare and bikeshare fleet. This expansion should focus on the university and downtown neighborhoods and expand to other neighborhoods once it is viewed by its residents as a viable transportation option.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity area is located downtown followed by the university campus. A bikeshare and carshare program could be supported in these neighborhoods particularly given the student population. TNCs are also well positioned to serve these markets. These neighborhoods would serve as the core area for shared mobility.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 7,617 | 500 | 2,513 | 1,232 | 636 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 78,488,297 | 3,156,260 | 28,163 | $27,670,745 |



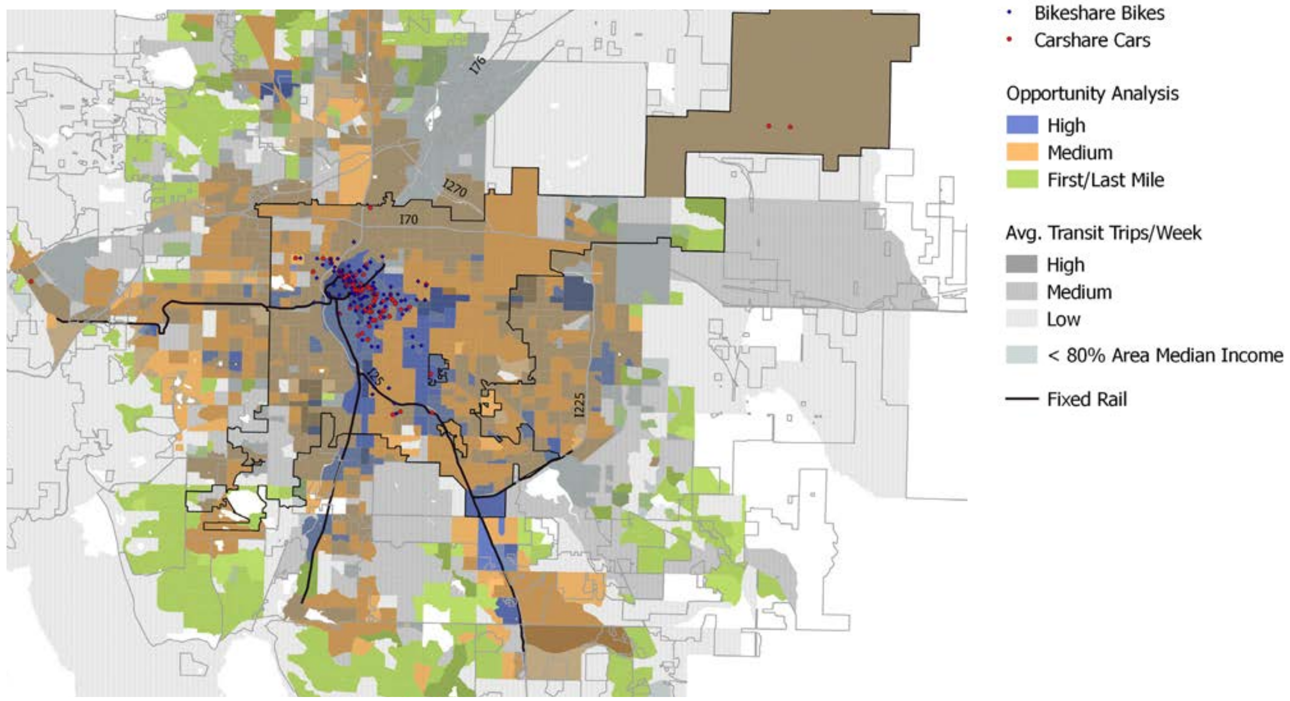
# **Denver,** CO

Population: 663,862 (est. 2014)
Area: 153.0 sq. mi.
Pop. Density: 3,923 per sq. mi. (est. 2010)

Denver launched Denver B-cycle in 2010 and is currently working to expand its transit system and change land use to encourage greater walkability.

## Existing Conditions

Denver has made great strides in mobility in recent years with a major regional rail transit expansion. The city was an early adopter of bikesharing, with Denver B-Cycle launching in 2010. Colorado's 2014 legislation authorized ridesourcing companies to operate in the state—notable because ridesourcing authorizations in other states have come from agency-level regulation, rather than through legislation. However, despite these innovations, auto ownership in Denver remains relatively high.





Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest shared mobility opportunity areas are located downtown and along the fixed rail lines to the south. There is a strong market for new and expanded carshare and bikeshare in these neighborhoods, particularly the closer they are to downtown. These neighborhoods are also strong markets for TNC and taxi service. The medium and first/last-mile opportunity areas could support a one-way carshare program and strategic two-way carshare sites. Private shuttles and vanpool could also provide important connections to existing transit service.

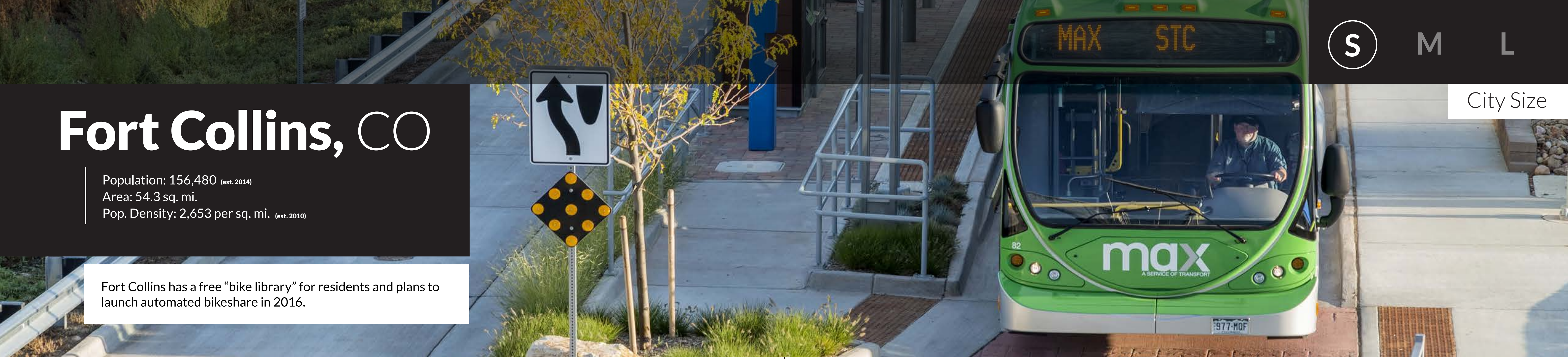
### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 41,071 | 2,505 | 13,554 | 6,641 | 3,430 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 423,241,173 | 17,019,852 | 151,864 | $149,212,033 |




S M L

City Size

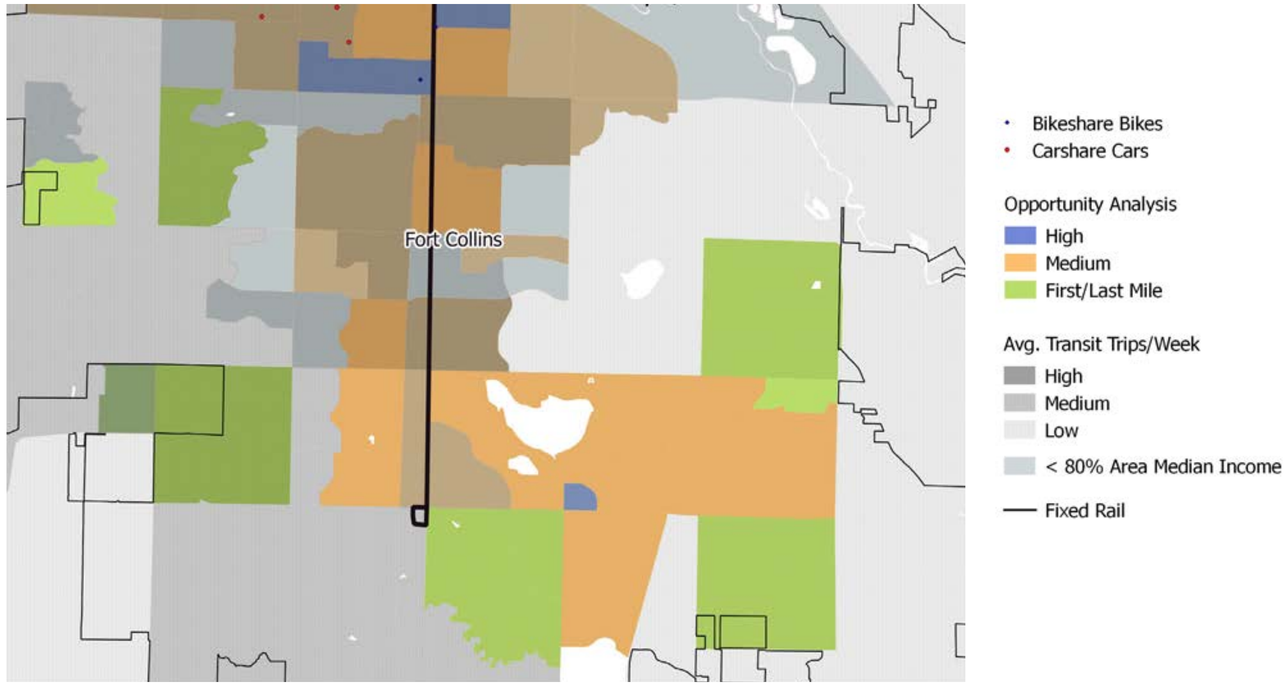
# Fort Collins, CO

Population: 156,480 (est. 2014)
Area: 54.3 sq. mi.
Pop. Density: 2,653 per sq. mi. (est. 2010)

Fort Collins has a free "bike library" for residents and plans to launch automated bikeshare in 2016.

## Existing Conditions

Fort Collins has a bike-friendly street system and strong biking culture, with nearly 7 percent of workers biking to work. Fort Collins currently has a "bike library" where over 60 bikes can be borrowed for short periods of time, and the city also plans to implement an official city bikeshare in 2016. Carsharing is available, but the fleet is quite small. Ridesourcing companies have been operating in Fort Collins since mid-2014 when Colorado became the first state to pass legislation outlining a regulatory framework for these companies.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest and medium opportunity areas are located downtown and at the university. The new BRT service also serves these two centers and can be used as a focal point to concentrate shared mobility, particularly carshare and bikeshare. The university population is a ready market for these services.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 10,736 | 655 | 3,543 | 1,736 | 897 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 110,629,700 | 4,448,766 | 39,695 | $39,002,072 |

S M L

City Size

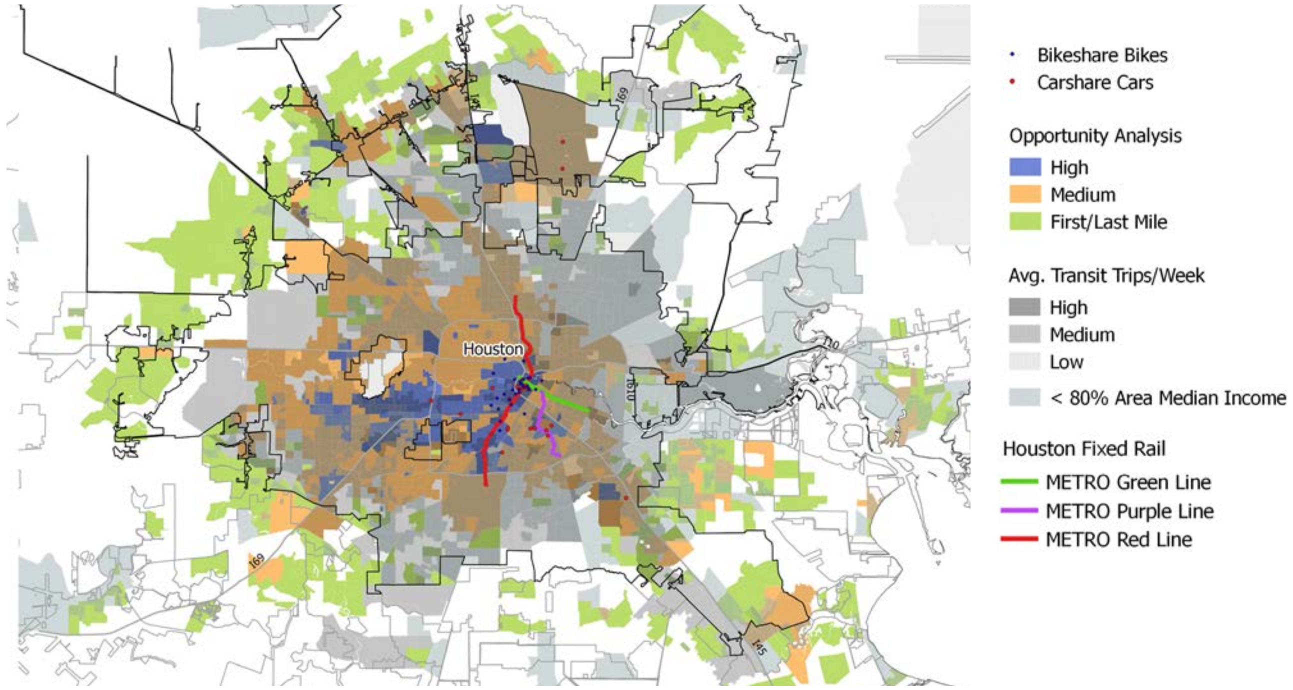
# Houston, TX

Population: 2,239,558 (est. 2014)
Area: 599.6 sq. mi.
Pop. Density: 3,501 per sq. mi. (est. 2010)

Houston launched two new Metrorail lines in 2015 and plans to expand its bikeshare system.

## Existing Conditions

Houston is a geographically enormous city at 600 square miles. Auto ownership is relatively high, and only 7 percent of workers walk, bike, or take transit to work. A small fleet of carsharing cars currently serves central parts of the city. Only one ridesourcing company was operating in Houston as of early 2016, with another having ceased operations in November 2014 citing policy constraints. Houston's bikeshare program launched in 2012 and has aims to grow from its initial 250 bikes to 2,000. The city has also entered a unique partnership with Zipcar to expand its carshare program on library parking lots.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are found downtown and along the fixed rail line running to the south. West of downtown also holds high potential for shared mobility, as these neighborhoods are moderate to higher density and have a concentration of retail and office centers. These higher density neighborhoods could support carshare, bikeshare, and other shared mobility modes and have the potential to help with both the work and non-work related trips. The medium opportunity areas could also support these services on a more strategic basis to help provide important feeder service to existing transit. The first/last-mile opportunity areas border the city. In these neighborhoods vanpool and carpools could provide opportunities to connect people to employment centers and transit service.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 122,509 | 7,473 | 40,428 | 19,810 | 10,230 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 1,262,459,500 | 50,767,447 | 452,986 | $445,075,197 |

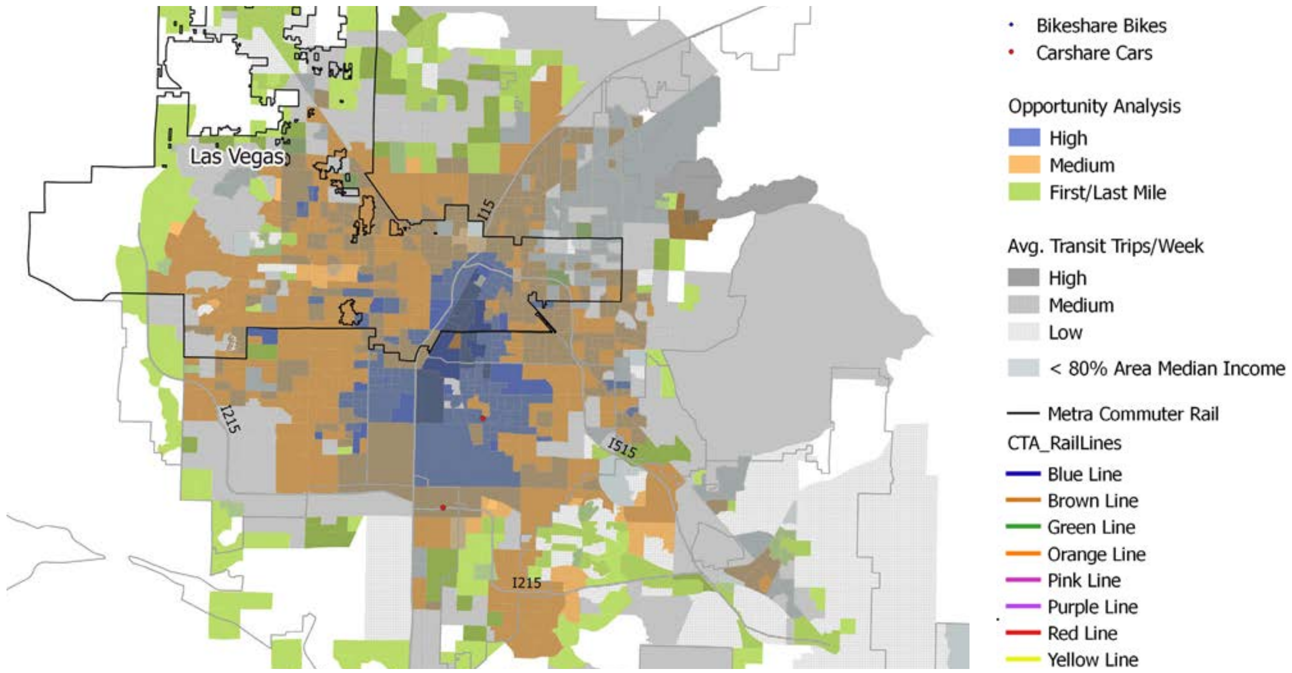
# Las Vegas, NV

Population: 613,599 (est. 2014)
Area: 135.8 sq. mi.
Pop. Density: 4,298 per sq. mi. (est. 2010)

Las Vegas is now served by both Uber and Lyft, and will launch a 120-bike bikeshare system in 2016.

## Existing Conditions

Las Vegas is an auto-oriented city and auto ownership is relatively high. Tourists are served by the city's many taxi and limousine operators as well as a bus system that also extends into residential neighborhoods. But only 6 percent of the city's workers walk, bike, or take transit to work. Shared-use mobility has yet to gain a real foothold in the city and there is only a small fleet of carshare vehicles. There has been a regulatory struggle over the operation of ridesourcing companies in Las Vegas. The State of Nevada's taxi authority has cited ridesourcing companies as unlicensed carriers and impounded vehicles. However, ridesourcing companies have returned to Las Vegas after the Nevada Legislature recently passed bills that allow these companies to operate in the state. Bikeshare is planned for Las Vegas in 2016.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Downtown Las Vegas holds the greatest opportunity for shared mobility. All modes could be supported in these areas, particularly carshare, bikeshare, and TNC/taxi service. The medium opportunity areas hold more limited opportunities but one-way carshare could help reach these neighborhoods. The first/last-mile opportunity areas could benefit from transit service improvements. In the short term, shared mobility could provide connections to employment and other destinations but must compete with the private vehicle culture in the city.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 34,181 | 2,085 | 11,280 | 5,527 | 2,854 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 352,240,514 | 14,164,693 | 126,388 | $124,181,026 |

S M L

City Size

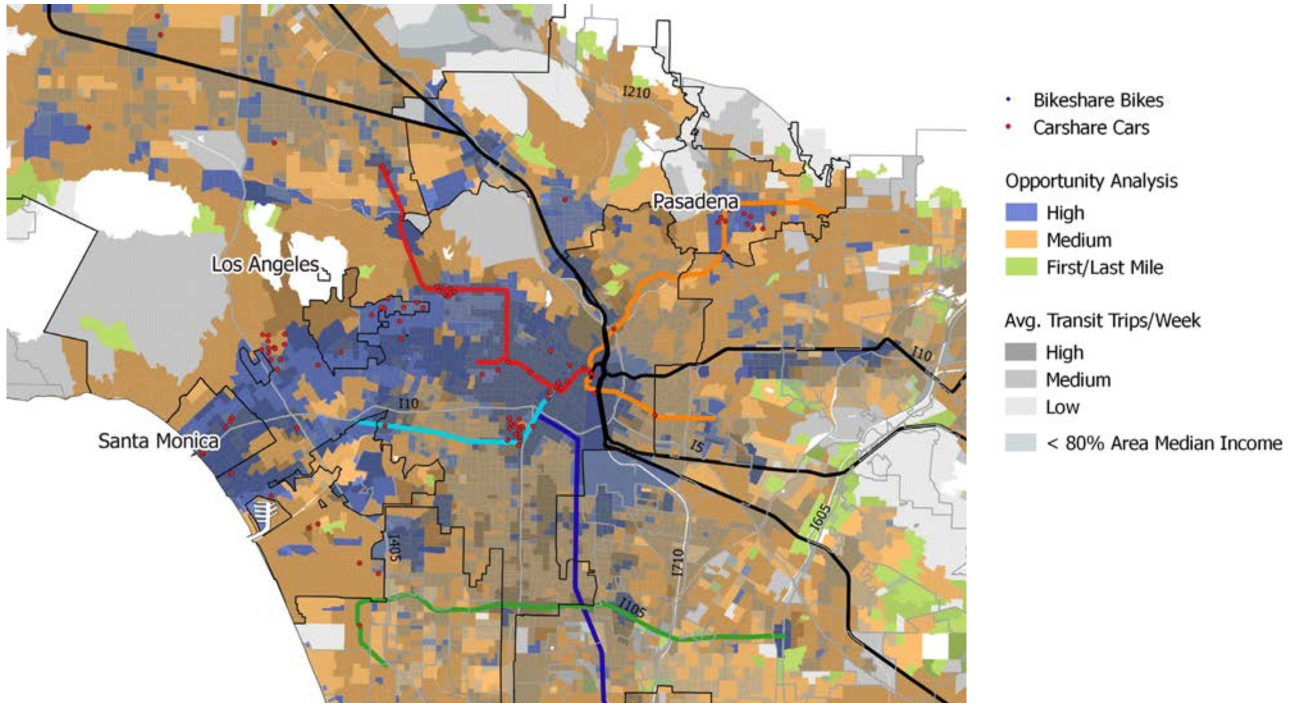
# Los Angeles, CA

Population: 3,928,864 (est. 2014)
Area: 468.7 sq. mi.
Pop. Density: 8,092 per sq. mi. (est. 2010)

Los Angeles is reinventing its transportation system at a rapid pace, including several transit expansions and a planned bikeshare system to debut in 2016.

## Existing Conditions

Los Angeles may be long known for its auto culture, but the city has been adopting shared-use mobility at a fast pace. Transit expansions over the past decade, combined with bicycle improvements and the resurgence of a walkable downtown, have made living and working in LA without a vehicle easier than ever. There is a modest carshare fleet in the city, but plans to grow its fleet with electric vehicle technology are underway. The State of California's early adoption of a regulatory structure for ridesourcing companies made LA a very active rideshare market. Bikeshare is planned for LA in 2016. But the city covers a very large geographic area, and while 13 percent of households in LA are car free, overall auto ownership remains high.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are located from Santa Monica to Downtown L.A., followed by higher density neighborhoods located along the rail lines and smaller downtown centers, such as Pasadena. In these neighborhoods, all shared-mobility modes could be supported and could help with both work and non-work related trips. Carshare and bikeshare could provide important alternatives to driving and help to establish LA as a leader in shared mobility. Many of these neighborhoods are also low to moderate income and could therefore benefit from reduced household transportation expenses if these services were more widely available. The medium opportunity areas also hold potential for all shared mobility but services must be more strategic in their placement. The city is then followed by neighborhoods that require first/last-mile connections to existing transit service. In these neighborhoods, vanpool, carpool, and more targeted carshare and bikeshare programs should be explored, especially along higher density corridors.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 207,008 | 12,628 | 68,313 | 33,473 | 17,287 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 2,133,228,752 | 85,783,804 | 765,429 | $752,061,517 |


S M L

City Size

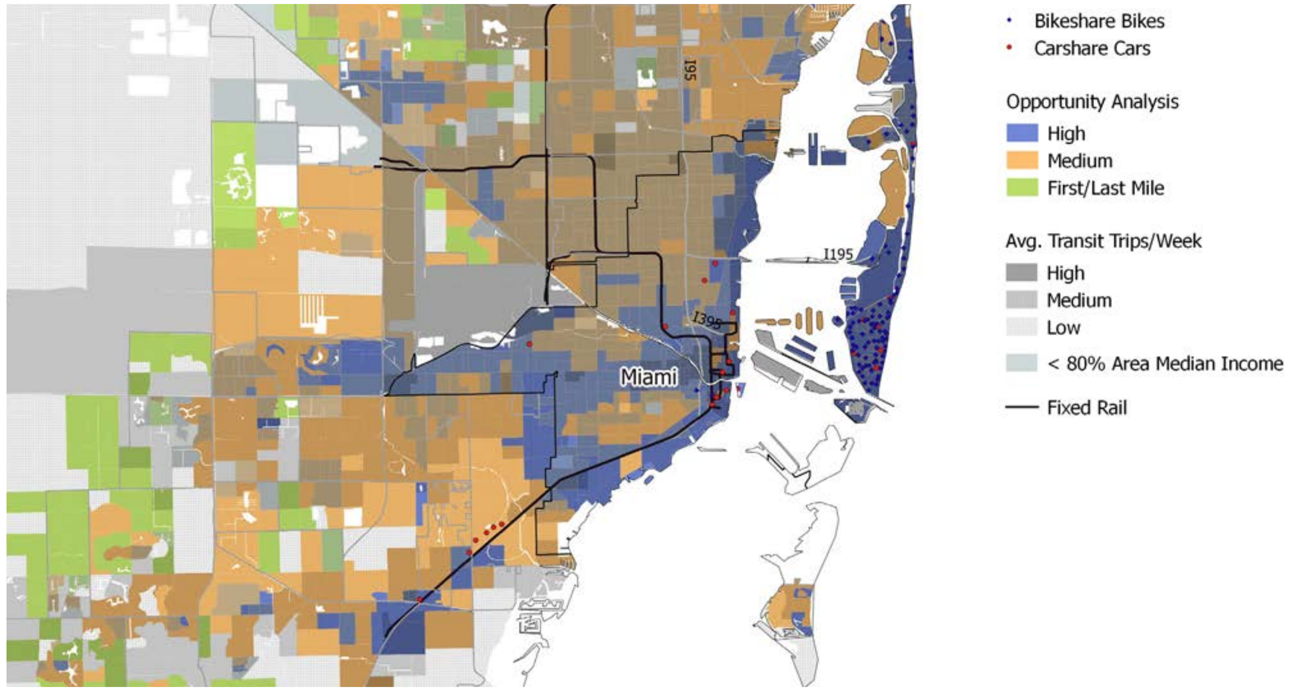
# **Miami,** FL

Population: 430,332 (est. 2014)
Area: 35.9 sq. mi.
Pop. Density: 11,539 per sq. mi. (est. 2010)

Bikeshare launched in Miami in 2011, and the city is also home to carshare and an active ridesharing market.

## Existing Conditions

Miami has some compact, walkable neighborhoods, as well as rail and bus transit. Still, just 16 percent of workers walk, bike, or take transit to work, though over 20 percent of households in Miami are car free. Miami is a relatively small city geographically, which has the potential to make walking and bicycling popular. Bicycling has gained support from the city government with infrastructure expansion. Bikeshare launched in Miami in 2011, and there is a moderate fleet of carshare vehicles as well as an active ridesharing market.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are located in downtown Miami and along Miami Beach. These areas are the highest density and have the greatest mix of retail and employment concentrations. All shared modes could be expanded or implemented in these neighborhoods, particularly the one-way carshare fleet and bikeshare programs. The medium opportunity areas could also support all shared modes but placement of services must be more strategic to maximize use. The first/last-mile opportunity areas need greater connections to transit service if shedding a vehicle is to become a viable option.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 18,419 | 1,124 | 6,078 | 2,978 | 1,538 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 189,804,313 | 7,632,625 | 68,104 | $66,914,774 |

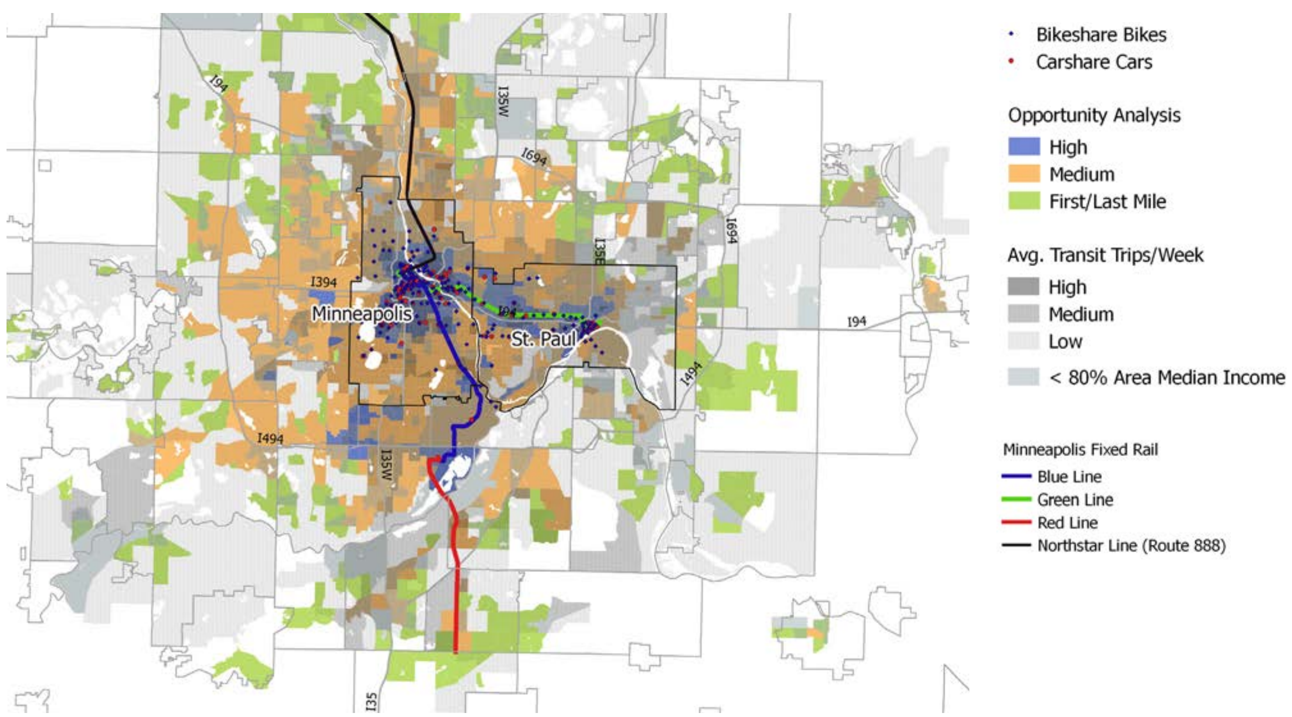
# Minneapolis/St. Paul, MN

Population: 704,847 (est. 2014)
Area: 106.0 sq. mi.
Pop. Density: 6,286 per sq. mi. (est. 2010)


Despite hot summers and extremely cold winters, Minneapolis has developed one of the strongest bicycle cultures in the country.

## Existing Conditions

The Twin Cities have made major recent investments in light rail expansion and transit-oriented development. The Metro Green Line opened in 2014 and is the first light rail line to connect the Twin Cities' downtowns. Even before that expansion, 24 percent of Minneapolis workers walked, biked, or took transit to work. About 18 percent of households in Minneapolis do not own a car. Despite hot summers and extremely cold winters, Minneapolis has developed one of the strongest bicycle cultures in the country, aided by extensive bicycle infrastructure. Minneapolis was an early adopter of bikeshare, starting in 2010. There is a fairly large carshare fleet in the city and an active ridesharing market.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are located in downtown Minneapolis and St. Paul, followed by the adjacent urban neighborhoods and university campus. All shared modes could be supported in these neighborhoods, but as with any neighborhood, strategic placement of services must be considered to maximize their use. Evaluating the use of these services must be ongoing to assure that they are being utilized. This is true not just for this region, but is noted here given that Car2go recently announced its plans to scale back the service area of its one-way carshare service. However, given the employment and amenities clustered in these areas, it still appears to be a strong shared mobility market. These high opportunity areas are then followed by medium opportunity and first/last-mile areas located on the outskirts of the core. These areas could benefit from increased transit service, and shared mobility could help make the necessary feeder connections.

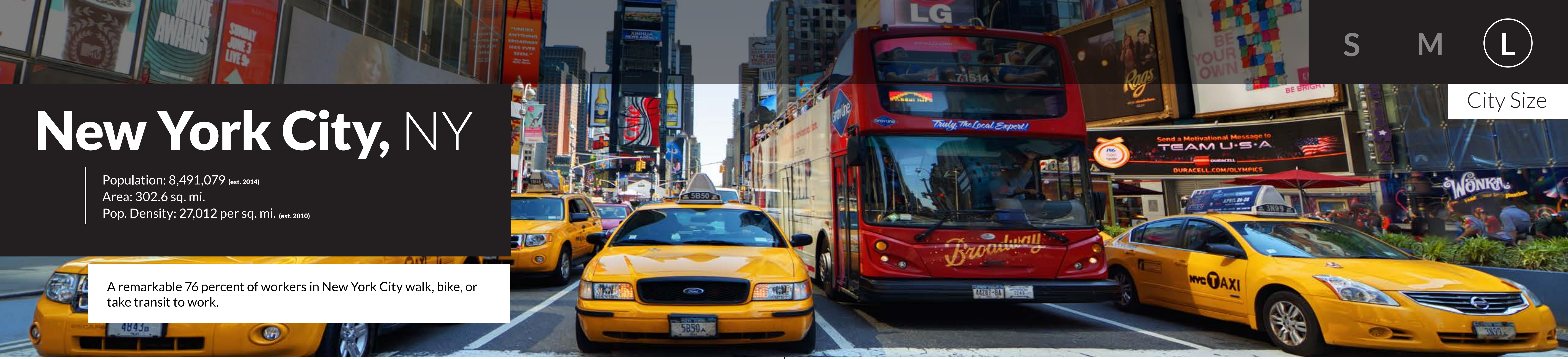
### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 38,670 | 2,359 | 12,761 | 6,253 | 3,229 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 398,495,693 | 16,024,759 | 142,985 | $140,488,110 |



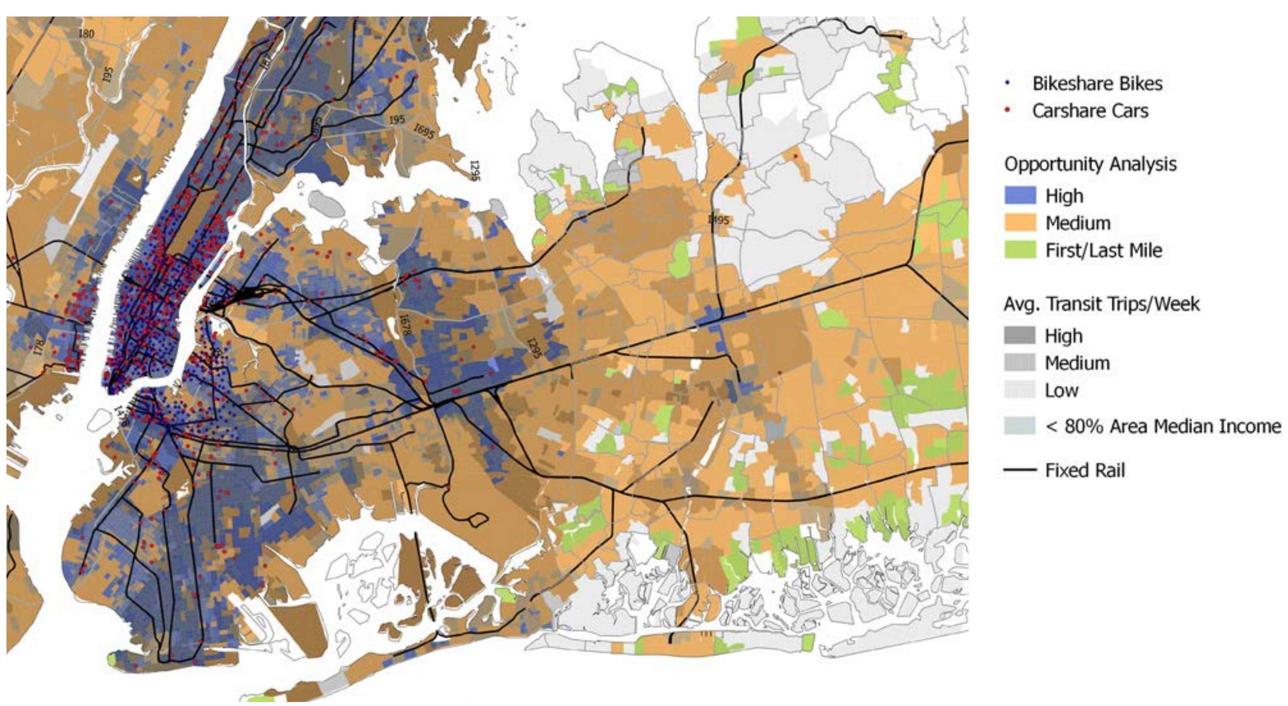
# New York City, NY

Population: 8,491,079 (est. 2014)
Area: 302.6 sq. mi.
Pop. Density: 27,012 per sq. mi. (est. 2010)

A remarkable 76 percent of workers in New York City walk, bike, or take transit to work.

## Existing Conditions

New York is not a city of private automobiles. A remarkable 76 percent of workers in New York walk, bike, or take transit to work and 55 percent of households are car free. New York has, by far, the largest transit system in the country, and the city's taxicabs are legendary. While licensed limousine drivers have been operating as part of ridesourcing companies in New York since 2011, ridesourcing companies faced regulatory struggles with other business models, such as individual ridesourcing drivers in personal cars after such services launched in 2014. There is a large carshare market in New York with many different providers. New York's bikeshare system, which launched in 2013, has the largest fleet of bikes of any system in the country.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Given its population, density, and extensive transit network, New York City is in a league of its own. All shared modes could be supported throughout large parts of the five boroughs. With that said, the highest opportunity areas are Manhattan, Brooklyn, and parts of Queens. These neighborhoods will continue to support ridesourcing/taxi service and expanded bikeshare and carshare. Beyond these highest density areas, shared mobility could provide important connections to existing transit service and local destinations.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 190,873 | 11,643 | 62,988 | 30,864 | 15,939 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 1,966,949,803 | 79,097,207 | 705,766 | $693.440,519 |

S M L

City Size

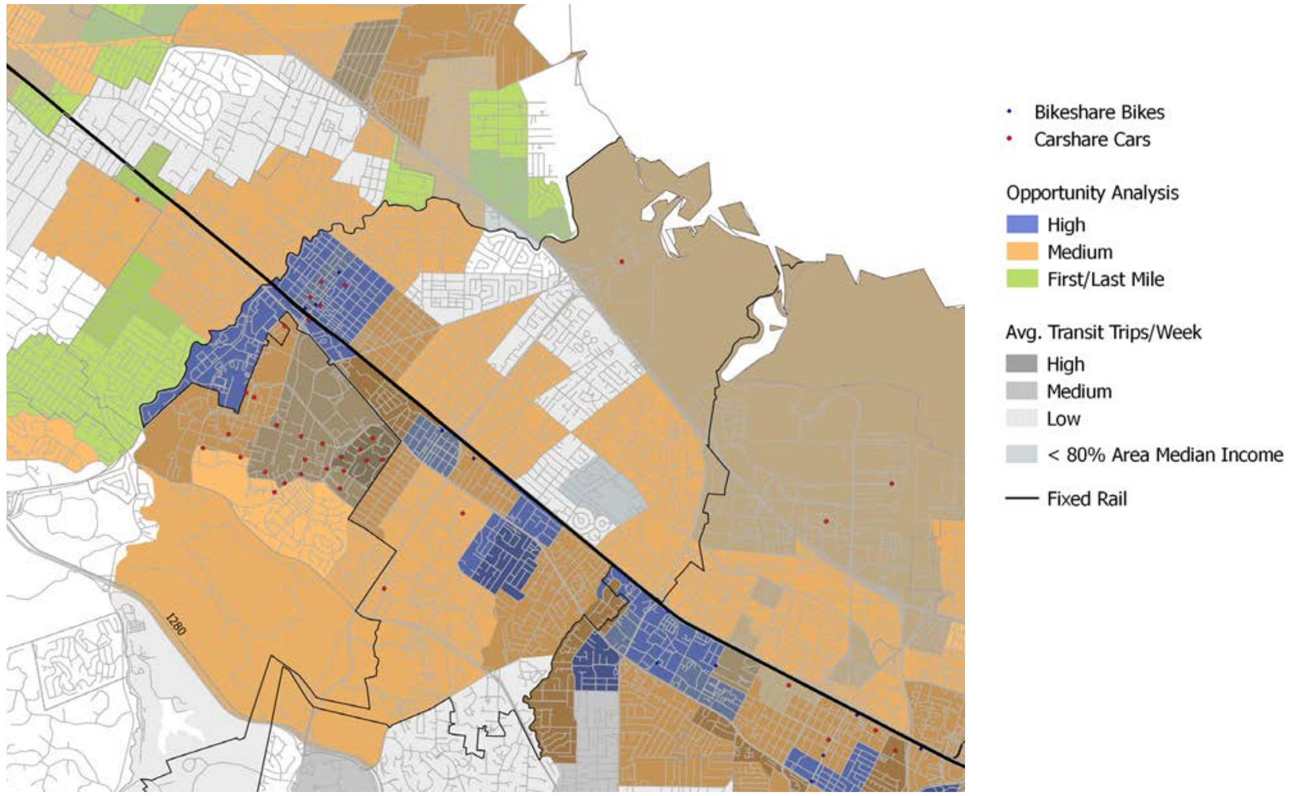
# Palo Alto, CA

Population: 66,955 (est. 2014)
Area: 25.8 sq. mi.
Pop. Density: 2,500 per sq. mi.

Nearly 20 percent of Palo Alto workers bike, walk, or take public transit to their jobs.

## Existing Conditions

Palo Alto is fairly walkable and most neighborhoods have access to public transportation. Nearly 20 percent of workers bike, walk, or take public transit to their jobs, despite the fact that only 7 percent of households do not own a vehicle. In the past few years both carsharing and bikesharing have arrived in Palo Alto, and ridesourcing companies are another option for shared-use mobility.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center. For a full list of systems included see http://alltransit.cnt.org/

## Opportunities

The highest opportunity areas are located downtown, near the Stanford University campus, and in the neighborhoods located along the Caltrain line. In these neighborhoods, all shared mobility modes could either be expanded on or started if not currently available. Shared mobility can create important connections to local centers for work and non-work trips, such as the California Avenue business district, the Stanford Research Park and other commercial districts. Beyond the neighborhoods that could support the highest levels of shared mobility are the more suburban neighborhoods on the outskirts of the city. These areas typically are categorized as first/last-mile connections. In these neighborhoods shared mobility could help fill the gaps that currently exist with public transit, particularly with work trips. The university campus did not model as a high opportunity market area given it already has carshare available. However, the carshare and bikeshare models indicate that it could support additional shared mobility at a high degree.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 4,660 | 500 | 1,538 | 753 | 389 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 48,018,370 | 1,930,969 | 17,230 | $16,928,690 |


S M L

City Size

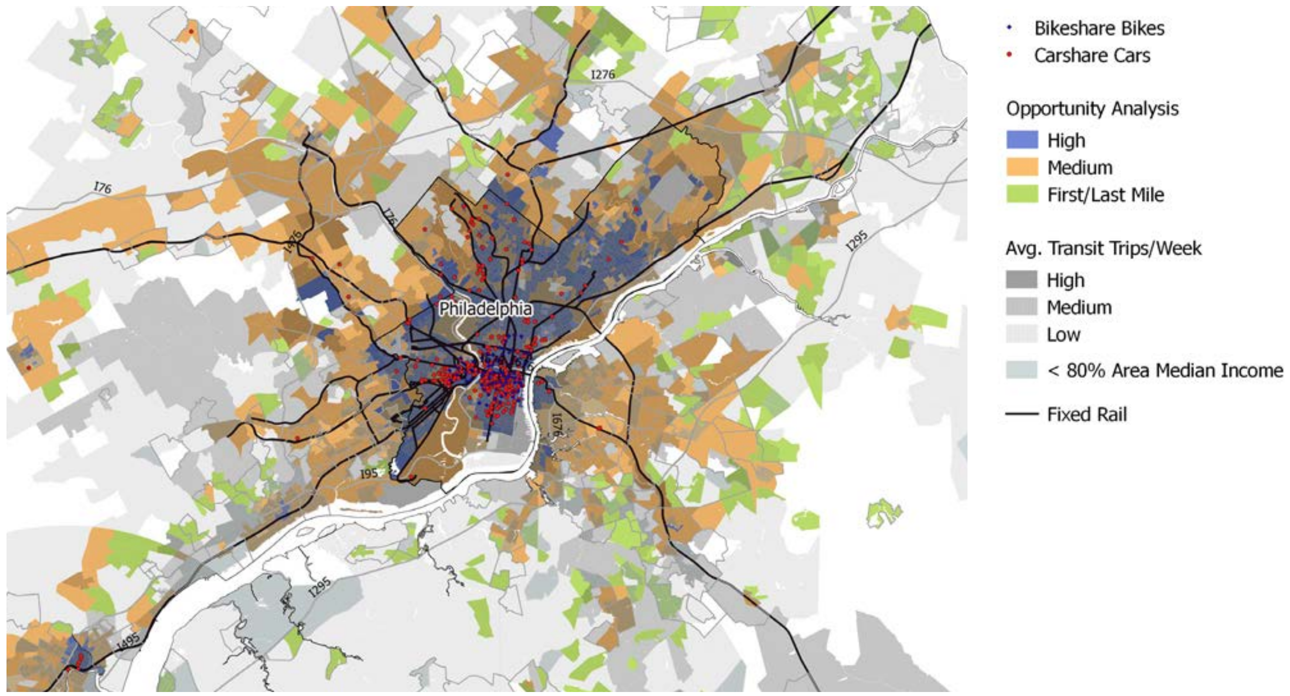
# **Philadelphia,** PA

Population: 1,560,297 (est. 2014)
Area: 134.1 sq. mi.
Pop. Density: 11,379 per sq. mi. (est. 2010)

Philadelphia's Indego bikesharing system is a model for serving low-income communities.

## Existing Conditions

Philadelphia is a very walkable city with a historic central core and excellent transit access. As a result, 37 percent of workers in Philadelphia walk, bike, or take transit to work and 34 percent of households are car free. Ridesourcing companies are beginning operation in Philadelphia but have faced challenges acquiring the proper license, along with protests from a vocal taxi community. Carsharing is well established in the city, having begun in 2002, and its bikeshare program is a model for serving low-income communities.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

Much of Philadelphia is categorized as a high opportunity area for shared mobility. This is in part due to the walkability of the city, its strong public transit network, and high urban density. These neighborhoods could support all shared modes, which would complement the already strong culture for walking, biking, and using transit. The medium and first/last-mile neighborhoods could support and benefit from shared mobility that provides important connections to transit. Carpools and vanpools are important shared mobility modes in these neighborhoods.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 56,571 | 3,451 | 18,668 | 9,148 | 4,724 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 582,968,181 | 23,442,975 | 209,176 | $205,523,170 |


S M L

City Size

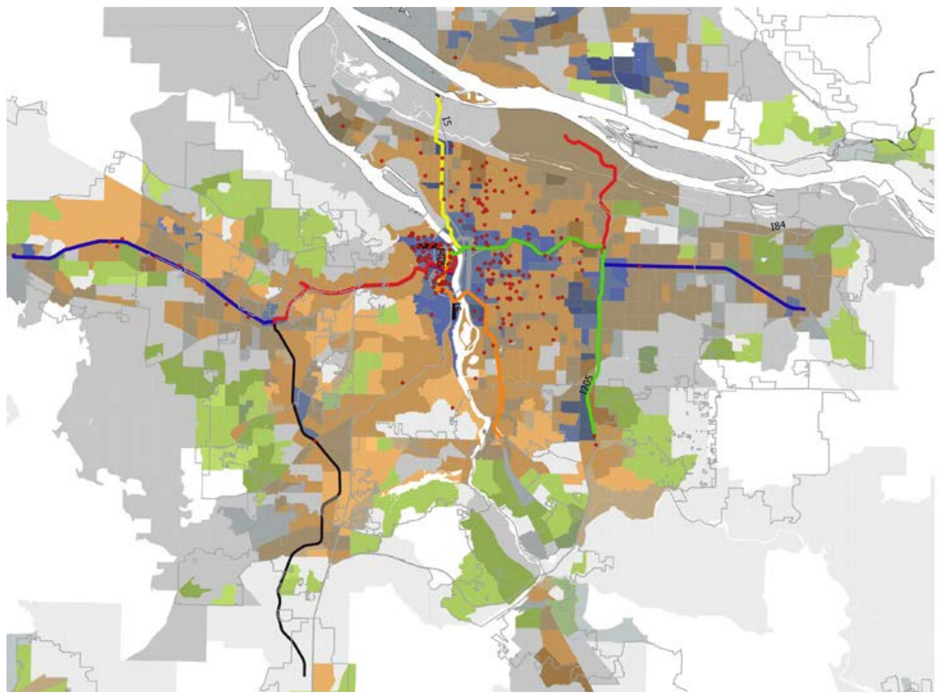
# **Portland,** OR

Population: 619,360 (est. 2014)
Area: 133.4 sq. mi.
Pop. Density: 4,375 per sq. mi. (est. 2010)

Portland is known for its cutting-edge transportation and land-use innovations.

## Existing Conditions

Portland is known for its cutting-edge transportation and land-use policies, as well as its strong bicycle culture—24 percent of workers in Portland commute by walking, bicycling, or transit. A bikeshare system is slated to launch in 2016. Portland has a very large carsharing fleet by any measure, and especially for a city of its size. Portland has been an innovator in "leveling the playing field" among ridesourcing and taxi companies—evidenced in the "Taxis Gone Wild" initiative it launched in 2015, which deregulated the market for a period of time where it collected trip and user data to evaluate the service levels between these two similar modes.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest ranking shared mobility neighborhoods are located downtown, in adjacent neighborhoods, and along the fixed transit routes to the east of the city. These neighborhoods hold opportunities to support all shared mobility for both work and non-work trips. A number of neighborhoods ranked as medium opportunity areas—it should be noted that these are strong markets but the opportunity analysis took into consideration existing carshare access, which is extensive in Portland, thus a portion of the shared mobility demand is already met. The first/last-mile opportunity areas could support and benefit from important connections to transit, particularly to support work trips.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 36,935 | 2,253 | 12,189 | 5,972 | 3,084 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 380,616,458 | 15,305,779 | 136,570 | $134,184,855 |


S M L

City Size

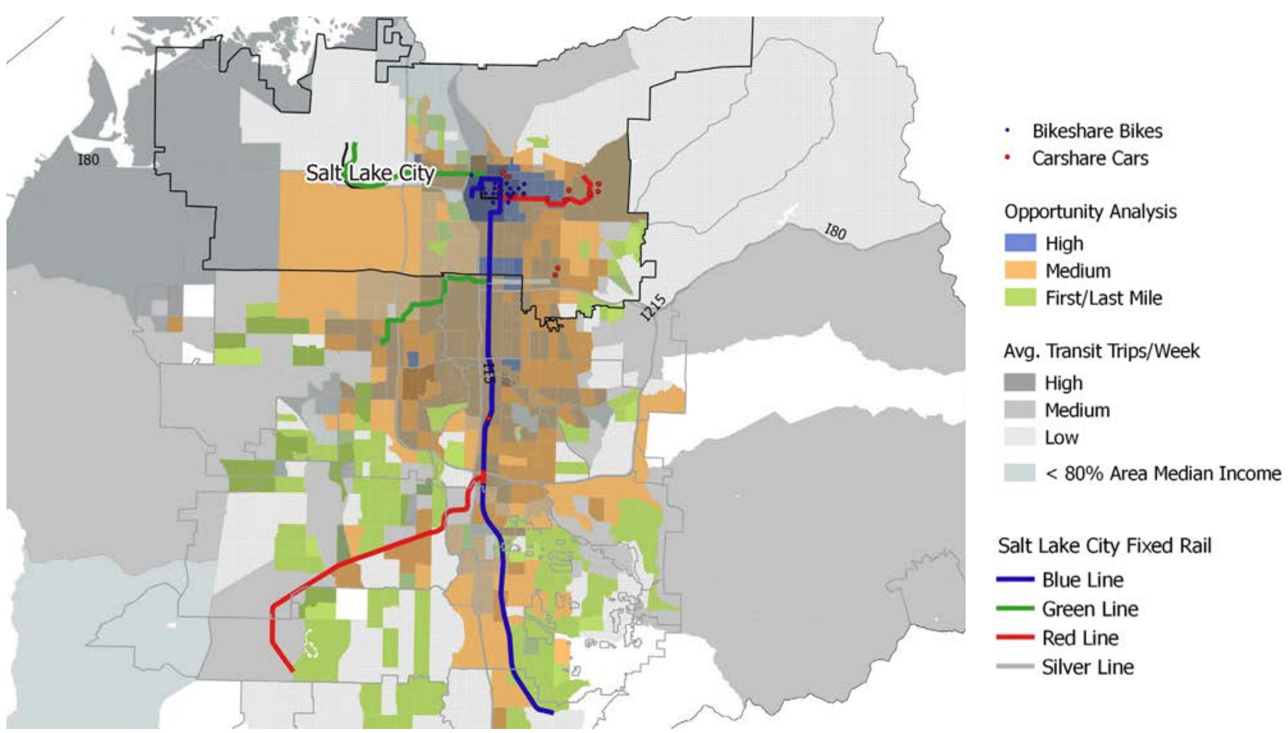
# Salt Lake City, UT

Population: 190,884 (est. 2014)
Area: 111.1 sq. mi.
Pop. Density: 1,678 per sq. mi. (est. 2010)

Salt Lake City has a diverse set of shared-use mobility options.

## Existing Conditions

Salt Lake City has a diverse set of shared-use mobility options, with ridesourcing, carshare, and bikeshare operating in the city. Light rail and bus transit combine with walkable areas and bicycle amenities to support non-auto commuting at a rate higher than the national average. However, a large number of jobs are located outside of the city center.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are located downtown and near the University of Utah. All shared mobility can be expanded on or supported in these neighborhoods. The university campus provides a strong population base to further build out bikeshare and carshare to reach the neighborhoods that are located south of downtown along the fixed rail lines. These neighborhoods are lower to moderate income (less than 80% of area median income) so could further benefit from shared mobility given the reduced transportation costs that are associated with reduced reliance on the private vehicle. Shared mobility could also help create important first/last-mile connections to existing transit—vanpools, carpools, ridesourcing, and targeted carshare and bikeshare sites could help with these connections.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 11,377 | 694 | 3,754 | 1,840 | 950 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 117,240,380 | 4,714,603 | 42,067 | $41,332,641 |

S M L

City Size

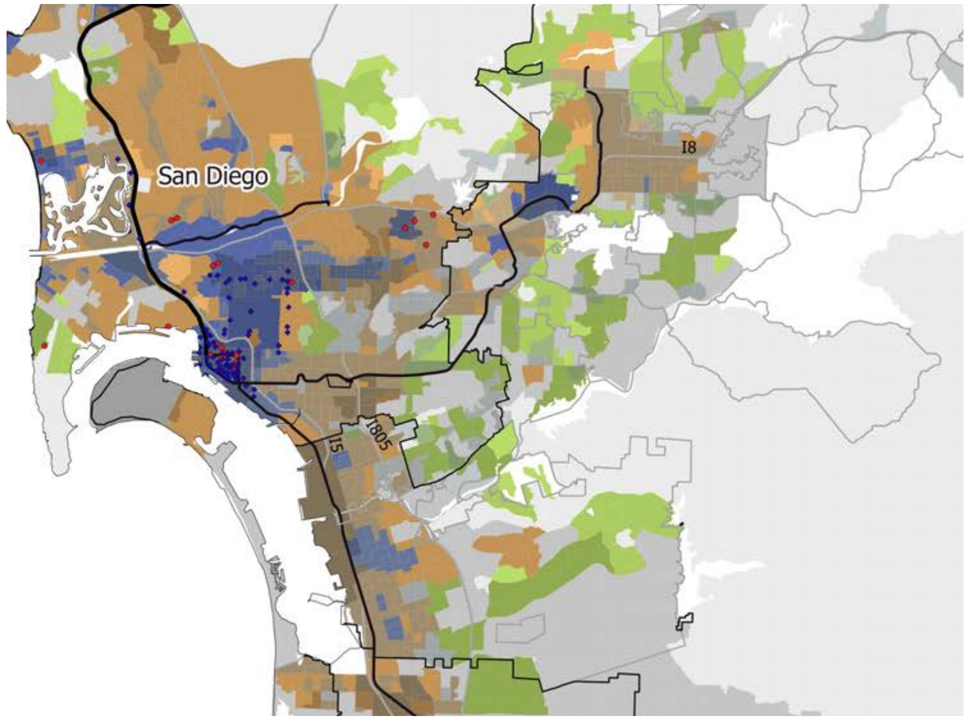
# San Diego, CA

Population: 1,381,069 (est. 2014)
Area: 325.2 sq. mi.
Pop. Density: 4,020 per sq. mi. (est. 2010)

San Diego launched its DecoBike bikesharing system in 2014 and is home to the nation's first all-electric, one-way carsharing fleet.

## Existing Conditions

San Diego launched DecoBike bikesharing in 2014. The State of California's early adoption of a regulatory structure for ridesourcing companies has helped set the stage for an active ridesourcing market in San Diego. The city has some compact and walkable neighborhoods. But San Diego is a large city geographically, at 325 square miles, and remains quite car dependent, with a greater auto commuting rate than the US average.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest ranking neighborhoods for shared mobility opportunity are located downtown and along the waterfront. These are the neighborhoods where existing carshare and bikeshare are concentrated, but additional shared mobility could be supported in many of these areas. One-way carsharing is well suited to serving these highest opportunity areas, as well as to provide shared mobility options for residents in the medium and first/last-mile areas. Ridesourcing, carpool, and vanpool should also be encouraged in these neighborhoods. Traditional carsharing also provides important shared mobility infrastructure to help residents meet their non-work travel needs. The combination of these shared modes could help San Diego reduce the portion of its carbon footprint attributable to personal transportation.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

| STRATEGIES | Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|---|
| | 84,218 | 5,137 | 27,792 | 13,618 | 7,033 |

| BENEFITS | Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|---|
| | 867,869,415 | 34,899,745 | 311,402 | $305,963,994 |

S M L

City Size

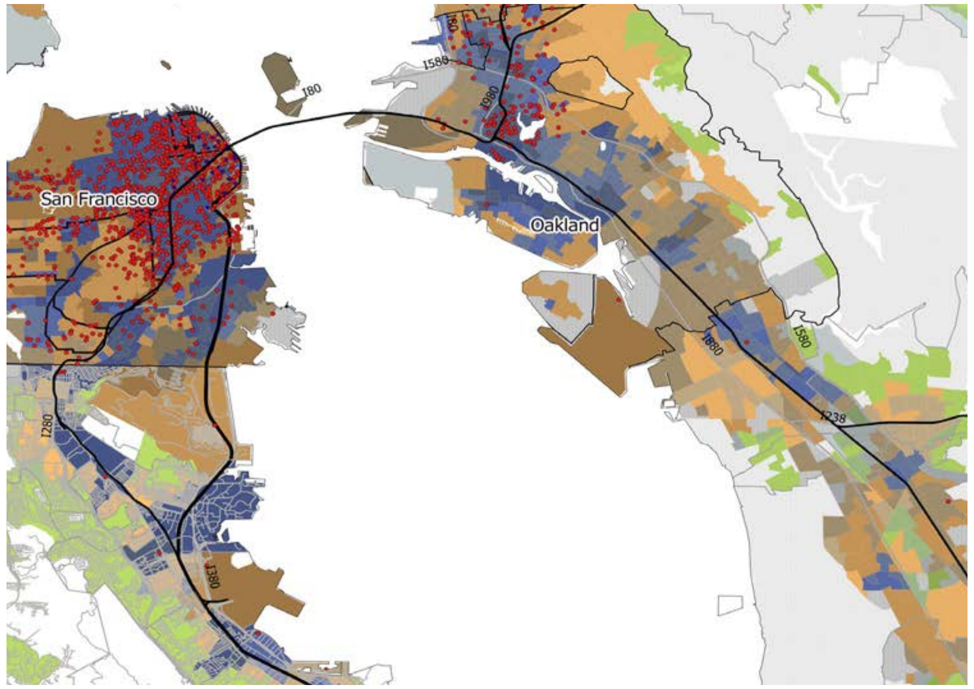
# San Francisco, CA

Population: 852,469 (est. 2014)
Area: 46.9 sq. mi.
Pop. Density: 17,179 per sq. mi. (est. 2010)

San Francisco is a hotbed of shared mobility innovation.

## Existing Conditions

San Francisco boasts a world-class public transportation system and is very pedestrian friendly. In fact, over 40 percent of people in San Francisco walk or take public transit to work and 30 percent of households do not own a car. As the home of several shared mobility companies, San Francisco is a proving ground for new forms of ridesourcing, not to mention peer-to-peer carsharing and four different carshare operators that together provide more than 1,500 vehicles. The bikeshare program in San Francisco, launched in 2013, has been somewhat limited with 328 bikes in the city proper and around 700 in the region, but will soon expand to 4,500 bikes regionally—making it the second largest bikeshare in the country.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

San Francisco has one of the most extensive shared mobility networks in North America. In addition to the strong public transit system, most of San Francisco ranked as a highest-opportunity area for expanded shared mobility. This is particularly interesting given the amount of carshare, bikeshare, and other shared modes already operating in the city. The combination of these modes makes it possible for many San Franciscans to live a car-free lifestyle. Looking across the bay to Oakland, a number of low- to moderate-income communities currently have limited carshare and bikeshare, but ranked high in their ability to support a carsharing network. Investing in shared mobility in low- to moderate-income communities has the added benefit of helping residents make work and day-to-day trips without a personal vehicle, which can help reduce household transportation costs.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 37,684 | 2,299 | 12,436 | 6,094 | 3,147 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 388,334,929 | 15,616,163 | 139,339 | $136,905,972 |

# **Seattle,** WA

Population: 668,342 (est. 2014)
Area: 83.9 sq. mi.
Pop. Density: 7,251 per sq. mi. (est. 2010)

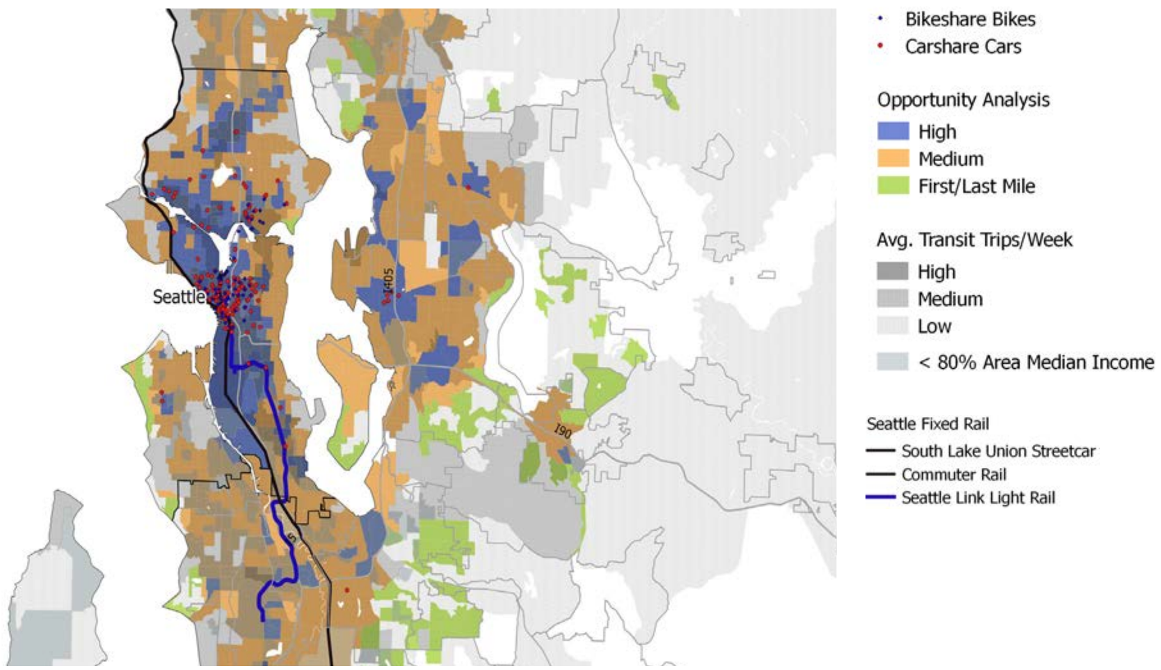
Car2go has nearly 65,000 members in Seattle – the most of any U.S. city.

S M L

City Size

## Existing Conditions

Seattle's walkable neighborhoods and recent transit expansions support the 31 percent of its workers who walk, bike, or take transit to work. As home to one of the first carsharing companies in the country, Seattle has significant experience with shared-use mobility. A free-floating carshare pilot launched in 2013 with 500 on-street parking permits. Seattle's first regulatory framework for ridesourcing companies capped the organizations at 150 drivers per company. That cap was repealed in 2014 and there is now no limit on the count of drivers, as long as they meet safety and insurance standards. Seattle's bikeshare system, Pronto, launched in 2014. The city is relatively unusual in having a bicycle helmet requirement for adults, which has prompted the bikeshare system to provide helmet rentals.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity neighborhoods are located downtown and in adjacent neighborhoods. In these neighborhoods, carshare can be further expanded, and Seattle's one-way carshare providers are well positioned to provide critical connections. Bikesharing could also be expanded in these neighborhoods, but the area's hilly topography has been an obstacle to bringing its bikeshare system to scale comparable with other cities of its size. An electric bike system is currently being explored to help serve hillier neighborhoods (see Shared Mobility Policy Database E-Bike Case Study at sharedusemobilitycenter.org). The medium and first/last-mile opportunity areas could also support and benefit from shared mobility, as shared mobility can provide important transit connections and help Seattle further reduce its transportation-related carbon footprint.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

| STRATEGIES | Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|---|
| | 40,162 | 2,450 | 13,254 | 6,494 | 3,354 |

| BENEFITS | Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|---|
| | 413,872,866 | 16,643,123 | 148,503 | $145,909,273 |


S M L

City Size

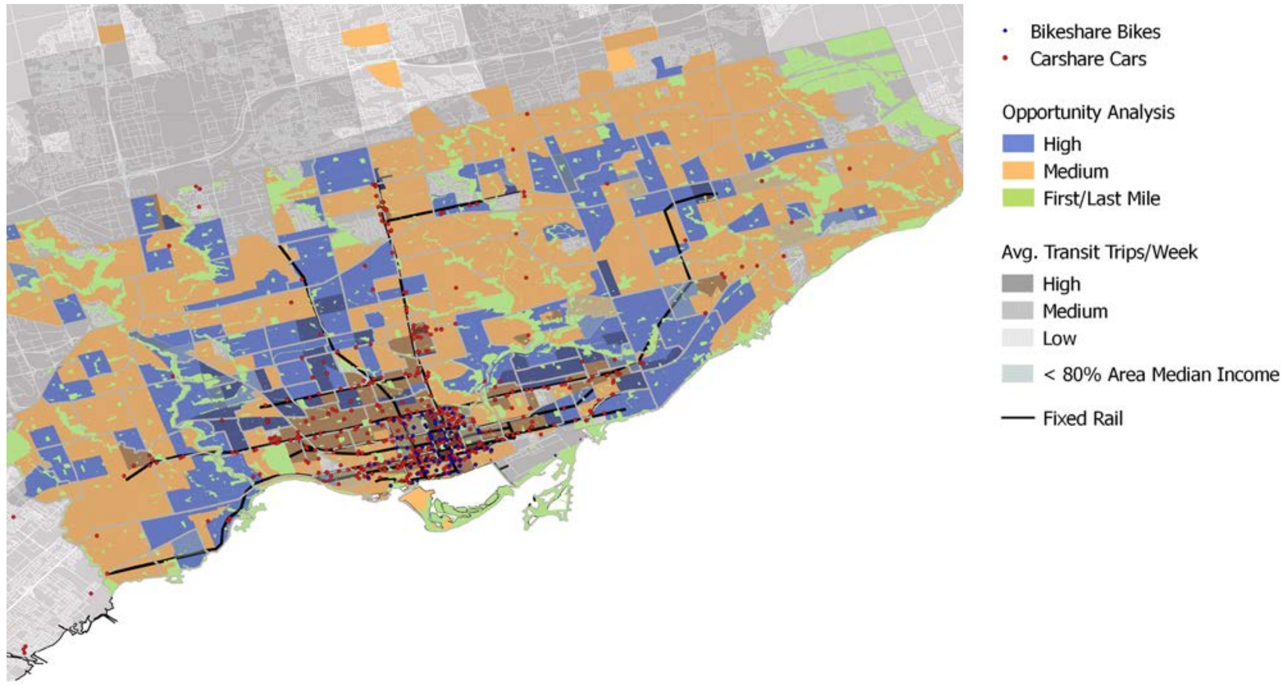
# Toronto, ON

Population: 2,615,060 (est. 2011)
Area: 243.33 sq. mi.
Pop. Density: 10,747 per sq. mi. (est. 2011)

Toronto has an extensive public transit network and diverse shared mobility market.

## Existing Conditions

Toronto has an extensive public transit network along with a large shared mobility market, which includes carshare, bikeshare, ridesourcing, and shuttle service. Toronto is a dense city, a fact reflected in the results of the carshare and bikeshare models that show potential for expanding shared mobility beyond current service areas. A number of these opportunity areas are lower-income neighborhoods. In these cases, shared mobility could have an even greater impact as it can help reduce household costs through a reduction in household vehicle ownership.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest potentials for shared mobility are downtown and the adjacent urban neighborhoods. In these neighborhoods the bikeshare and carshare programs can be expanded. Ridesourcing and taxi companies will also compete for those higher density markets. Carpool and vanpool could then help support the demand found in the medium opportunity areas, particularly in regard to work trips.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 115,266 | 7,031 | 38,038 | 18,639 | 9,626 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 1,187,823,225 (1,911,611,429 km) | 47,766,089 (180,814,231 liters) | 426,206 | $418,762,468 |

S M L

City Size

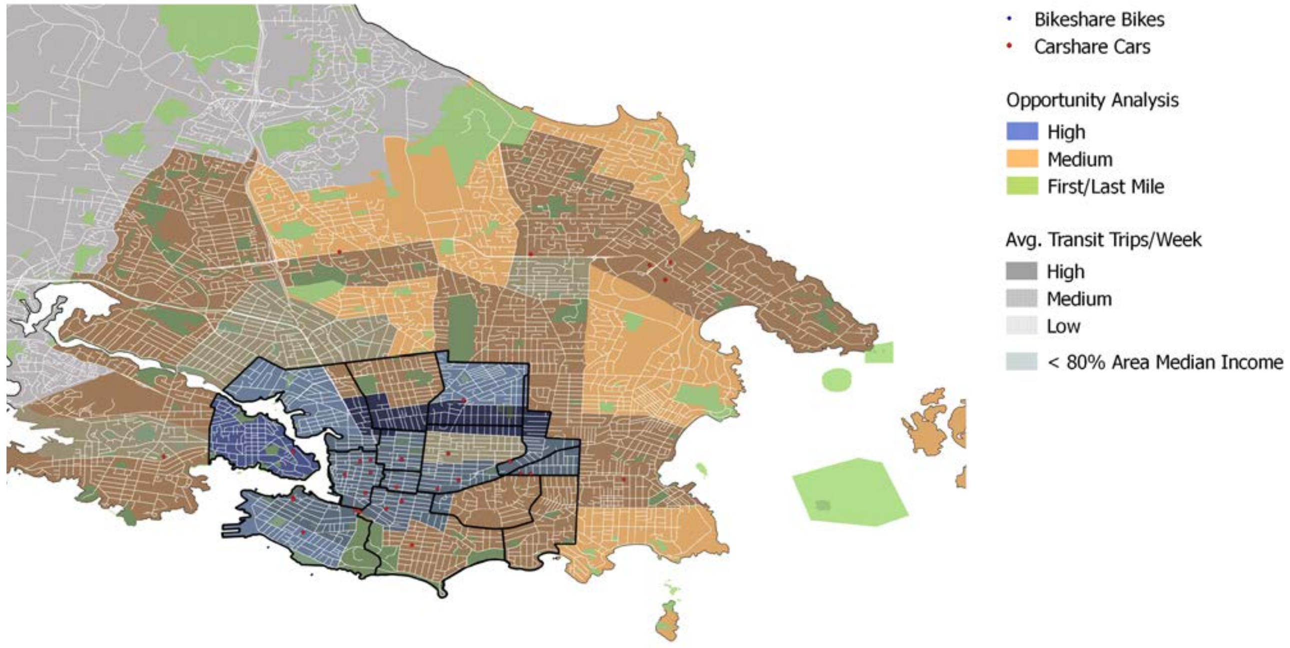
# **Victoria,** BC

Population: . 80,032 (est. 2011)
Area: 7.25 sq. mi.
Pop. Density: 10,643 per sq. mi. (est. 2011)

Nonprofit carsharing providers Modo and Victoria Car Share Co-operative merged in 2015.

## Existing Conditions

Victoria currently has a small carshare fleet operated by two providers—Zipcar and Modo, a non-profit carshare—along with plans for a bikeshare fleet. Victoria is unique in that it also has ferries and commuter aircraft that fall under its shared mobility fleet. Victoria's downtown is very pedestrian oriented, as are many of its residential neighborhoods. This compact nature lends itself to supporting additional shared mobility throughout the city and its surrounding suburbs.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The highest opportunity areas are located in downtown Victoria, adjacent neighborhoods, and near the University of Victoria. These neighborhoods were found to support new or additional carshare, as well as a bikeshare program. The bikeshare market is further strengthened by the walkability of Victoria along with the university anchor to the north and downtown Victoria to the south. Ridesourcing would also have a strong market base in these neighborhoods. The medium opportunity areas could also support shared mobility but the placement of these services must be more strategic to assure they are fully utilized.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 5,155 | 500 | 1,701 | 833 | 430 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 53,118,332<br>(85,485,456 km) | 2,136,054<br>(8,085,841 liters) | 19,060 | $18,726,662 |


S M L

City Size

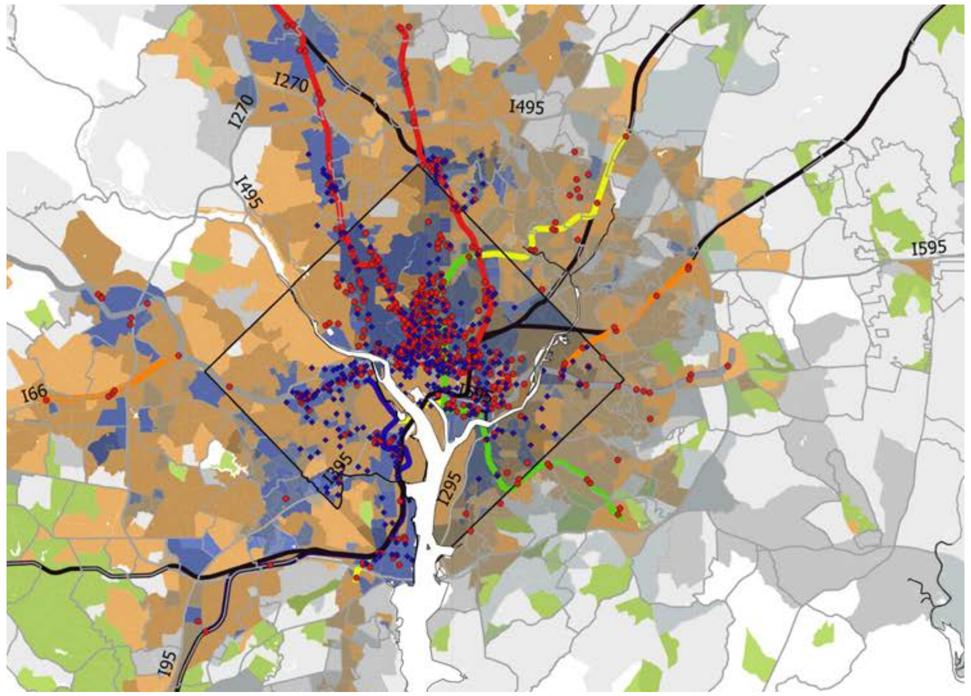
# Washington, DC

Population: 658,893 (est. 2014)
Area: 61.0 sq. mi.
Pop. Density: 9,856 per sq. mi. (est. 2010)

DC's Capital Bikeshare is one of the oldest and largest systems in the country. The city also continues to work on increasing walkability and transit access.

## Existing Conditions

Washington, DC, is one of the most walkable and bikeable cities in the country. It has an extensive and well-established regional transit system and a culture of non-auto travel, where 54 percent of workers commute by walking, biking, or transit, and 36 percent of households do not own a car. Shared-use mobility has blossomed in the city in recent years. Capital Bikeshare is one of the oldest and largest bikeshare systems in the country. Notably, the city is on its second iteration of a bikesharing system: SmartBike DC launched in 2008, but the system faced many challenges and did not succeed. In 2013, the District began allowing carshare cars to park in reserved on-street spots. Regulatory changes in 2013 and 2014 have enabled a growing market of ridesourcing companies to operate in the city.




Data used in maps was provided by a variety of sources including: shared mobility companies, government agencies, and the American Community Survey. Transit trip data was provided by the Center for Neighborhood Technology. Analysis was performed by the Shared-Use Mobility Center.

## Opportunities

The capital region has a strong public transit system coupled with an extensive carshare and bikeshare program. However, the opportunity analysis indicates that these markets could support even more shared mobility, including private shuttles and ridesourcing options. Beyond the District, the highest ranking opportunity areas are located at transit stations along the rail system. All shared modes can be supported in these neighborhoods, and similarly to the central area, could support both work and non-work trips. The medium and first/last-mile opportunity areas could benefit from targeted carshare and bikeshare expansions along with other modes to provide connections to the public transit network. Carpool and vanpool are also good shared modes in these neighborhoods.

### Additional Shared Mobility Needed to Reach 10% Vehicle Reduction Strategy

**STRATEGIES**

| Target Vehicle Ownership Reduction | Additional Bikeshare | Additional Transit Commuters | Additional Carpool/ Ridesharing | Additional Carshare |
|---|---|---|---|---|
| 23,579 | 1,438 | 7,781 | 3,813 | 1,969 |

**BENEFITS**

| Annual VMT Savings | Gasoline Consumption Savings (Gallons) | GHG Reductions (Metric tons CO2 annually) | Household Savings (Transportation) |
|---|---|---|---|
| 242,978,292 | 9,770,918 | 87,184 | $85,661,054 |

# APPENDIX A
## OPPORTUNITY ANALYSIS METHODOLOGY

SUMC's opportunity analysis estimates potential demand for carsharing and bikesharing by calculating the disparity between existing resources and new resources that a given market can absorb. To conduct this analysis, SUMC developed a series of models for predicting availability of carsharing and bikesharing within a census block group, based on the key demographic factors in markets where demand and supply are thought to be most balanced. SUMC's researchers used their professional judgement to select areas with the longest and most intensive experience with carsharing and bikesharing in order to set these benchmarks. The resulting "balanced" model was then applied to more than 50 cities across North America, using the difference between predicted and actual levels of carsharing and bikesharing to identify opportunity areas.

This project looked at more than 50 US metropolitan areas and three Canadian cities. The basic carshare and bikeshare models were developed for the US cities and then applied to the Canadian cities with small differences given the difference in availability of data between the two countries. The US and Canadian models are described separately within this appendix.

## U.S. MODELS

### Data sources

The underlying data for the US models were drawn from products of the US Census Bureau, the Center for Neighborhood Technology's (CNT's) All Transit data repository, and SUMC's carsharing and bikeshare databases.

#### *Response Variables*

Using training sets made up of a few of the study cities, SUMC estimated models for each of the shared mobility modes of interest: traditional carsharing vehicle count, one-way carsharing vehicle count, and counts of both bikesharing docks and bikesharing ridership. The outputs for each of these variables correspond to the amount of each shared mode that the model estimates a given area could support. All response variables were calculated by identifying locations of carsharing and bikesharing resources, buffering those locations to show their walkable access shed, identifying the share of each block group covered by those buffers, and summing those shares for each block group. However, the determination of the point locations and the radius of the buffers vary among the shared resources.

For traditional carsharing, the point locations are defined as the vehicles' established parking spots. For one-way carsharing, the point locations are defined as the locations of available vehicles at six different times throughout the day. These data were pulled for a multi-day period from the application programming interface (API) of car2go, the largest one-way carsharing operator in the United States, and then averaged by the number of readings taken. While the data were regularly pulled four times daily over a 12-day period in October 2015, due to problems with the API, the actual total number of readings per city varied between 50 and 54. These numbers were further adjusted based on the regional total reading at 3:00 a.m.—presumably the time of day when the fewest vehicles were in use, and thus uncounted by the API—to account for the share of vehicles in use at any time. For both traditional and one-way carsharing, one-half mile was chosen as the buffer radius to represent the reasonable willingness to walk 10 minutes to access a vehicle.

For bikesharing, the point locations were defined in two ways. The bikeshare stations defined the point locations for one analysis, while bikeshare trips originating from a station defined the point locations for the other analysis. In the latter case, the usage data was adjusted based on the regional total of bikes in the system. In both cases, a buffer radius of one-quarter mile was used, which assumed a somewhat lesser willingness on users' parts to walk to bikesharing locations.

This approach has two advantages. First, these measures can be directly plotted to show a density map of access to carsharing and bikesharing resources. Secondly, these measures can easily be scaled by the size of the block group to calculate the fractional share of the bikesharing or carsharing resource that is "tied" to that block group. These shares can be summed at any geography.

#### Predictor Variables

The predictor variables represent the factors thought to drive the demand for carsharing and bikesharing. These are all measured at the census block group level.

| Type | Variable Name | Description |
|---|---|---|
| **Population** | **Population** | **Total population** |
| | Population between 18 and 24 | Population between ages 18 and 24 |
| | Households | Total count of households |
| | Households with Kids | Count of households with children less 18 years old |
| | Households without Kids | Count of households without children |
| **Employment** | LAI Local Job Density | A measure of job density within one-half mile of the block group centroid used as part of the HUD Location Affordability Index |
| | Total Workers | Total employed persons (Census defined age 16 or older) |
| | Car Commuters | Employed persons who drive to work |
| **Transit** | Average Transit Trips Per Week | Average available transit trips per week (Center for Neighborhood Technology All Transit Database) |
| | Transit Accessible Jobs | Jobs accessible by 30-minute transit ride (Center for Neighborhood Technology All Transit Database) |
| **Urban Form** | Intersection Density | Intersections per acre |
| | Acres | Block group area in acres |

### Transit Accessibility

To evaluate transit accessibility, this research relies on the Center for Neighborhood Technology's All Transit Database to classify the average number of transit trips per week into three categories. The breakpoints were established based on the distribution of the city type.

**Average Transit Trips/Week**

Center for Neighbor-hood Technology All Transit Database. http://alltransit.cnt.org/

| City Size | Low | Medium | High |
|---|---|---|---|
| **Smaller** | <179 | 179 to 432 | >432 |
| **Medium** | <179 | 179 to 539 | >539 |
| **Large** | <169 | 169 to 486 | > 486 |
| **New York** | <369 | 369 to 844 | >844 |



### Training Set Selection

This research identified several training locations for each model. These cities were chosen given their long and engaged commitment to each of the specific shared modes. The market characteristics in these cities were then used to help develop the carshare and bikeshare models for the opportunity analysis.

| Model | Training Set Cities |
|---|---|
| **Traditional Carsharing** | **Boston-area cities:** Belmont, Boston, Brookline, Cambridge, Malden, Somerville, Watertown<br>**Northern California cities:** Berkeley, Emeryville, Mountain View, Oakland, Palo Alto, Sacramento, San Francisco, San Jose, San Mateo, Sunnyvale, Santa Clara |
| **One-Way Carsharing** | Seattle, Washington, DC |
| **Bikesharing: Docks** | Chicago, Minneapolis, Washington, DC |
| **Bikesharing: Usage** | San Francisco Bay Area, Washington, DC |

### Model estimates: Traditional Carsharing

The traditional carsharing model was estimated based on data from on a number of cities in the Massachusetts Bay Area and Northern California. The final model, shown below, incorporated density of households without children, local job density, and transit service—each of which is positively associated with traditional carsharing availability. Local job density, as well a number of variables in the proceeding models are transformed from their natural log to adjust for the skewed nature of the data.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| **(Intercept)** | -23.58 | 1.01 | -23.34 | < 0.001 | *** |
| **Households Density (Households without Kids)** | 1.372 | 0.047 | 29.05 | < 0.001 | *** |
| **ln(LAI Local Job Density + 1)** | 9.557 | 0.536 | 17.85 | < 0.001 | *** |
| **Average Transit Trips Per Week** | 0.029 | 0.002 | 16.8 | < 0.001 | *** |

*Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '*
*Residual standard error: 4.121 on 910 DF; Adjusted R-squared: 0.51*
*F-statistic: 313.2 on 3 and 910 DF, p < 0.001*

### One-Way Carsharing

The one-way carsharing model was based on carsharing resources available at the neighborhood level in Seattle and Washington, DC. The final model, shown below, incorporated the ratio of households with children to all households, population density, and transit access to jobs. One-way car sharing is negatively associated with households with children, but positively associated with population density and transit access to jobs.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -26.273 | 1.606 | -16.364 | < 0.001 | *** |
| Households with Kids / Households | -3.584 | 1.088 | -3.293 | 0.001 | ** |
| ln(Population / Acres) | 2.386 | 0.185 | 12.927 | < 0.001 | *** |
| Transit Accessible Jobs ^0.25 | 1.091 | 0.058 | 18.681 | < 0.001 | *** |

*Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '*
*Residual standard error: 14.52 on 1606 DF; Adjusted R-squared: 0.6*
*F-statistic: 559.9 on 4 and 1606 DF, p < 0.001*

### Bikesharing: Docks

The bikesharing docks model is estimated based on bikeshare resources as measured in Minneapolis, Washington, DC, and Chicago. The final model, shown below, incorporated intersection density, population density of young adults, local job density, and transit service—all of which are positively associated with bikesharing availability.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -21.199 | 1.317 | -16.092 | < 0.001 | *** |
| Intersection Density | 0.005 | 0.002 | 3.033 | 0.002 | ** |
| Population 18 to 24 / Acres | 0.251 | 0.056 | 4.522 | < 0.001 | *** |
| ln(LAI Local Job Density + 1) | 13.63 | 0.378 | 36.098 | < 0.001 | *** |
| Average Transit Trips Per Week | 0.012 | 0.002 | 6.625 | < 0.001 | *** |

*Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '*
*Residual standard error: 14.52 on 1606 DF; Adjusted R-squared: 0.6*
*F-statistic: 559.9 on 4 and 1606 DF, p < 0.001*

### Bikesharing: Usage

The bikesharing usage model is estimated on a number of cities in the San Francisco Bay and Washington, DC, areas. The final model, shown below, incorporated intersection density, density of non-car commuters, local job density, and transit service—with bikesharing usage positively associated with each measure. (The maps in the report are based on the bikesharing docks model because it had a higher R-squared value. However, this model is included as a resource in the technical appendix as it offers another perspective on how to evaluate bikeshare programs.)

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -37.326 | 2.277 | -16.395 | < 0.001 | *** |
| Intersection Density | 0.006 | 0.003 | 2.437 | 0.015 | * |
| (Total Workers – Car Commuters) / Acres | 0.138 | 0.037 | 3.703 | < 0.001 | *** |
| ln (LAI Local Job Density + 1) | 12.525 | 0.61 | 20.538 | < 0.001 | *** |
| Average Transit Trips Per Week | 0.022 | 0.003 | 8.513 | < 0.001 | *** |

*Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '*
*Residual standard error: 20.02 on 1185 DF; Adjusted R-squared: 0.5*
*F-statistic: 291 on 4 and 1185 DF, p < 0.001*

## Mapping the Results

The results of the models were mapped for each of the 27 USDN study cities in this report to show where shared mobility opportunities are located. The predicted values represent the estimates for carsharing and bikesharing resources that could be absorbed by the population given the levels of service demonstrated in the training cities. The opportunity areas were classified into three categories based on the distribution for each city size class. This demand is estimated at the census block group level. If a block group were to realize some or all of its modeled potential then it would impact the demand of its neighboring block groups as access extends beyond a census block group's boundary.

### Highest Opportunity Areas

These neighborhoods fell within the top 40 percent in terms of their modeled potential to support new, or expand on existing, carshare. Given the ability of different-sized cities to support varied levels of shared mobility, this classification changed for each of the city size classes.

### Medium Opportunity Areas

These neighborhoods showed growth for carshare when compared to cities of similar size, but ranked in the lower 60 percent in terms of their modeled capacity to absorb new or expanded carsharing. Similar to the Highest Shared Mobility Areas, the number of carshare vehicles changed based on the city size class. Also included in the Medium Shared Mobility Area is whether the model indicated there was a market for one-way carshare or bikeshare.

### First/Last Mile Opportunity Areas

First/last mile opportunities were calculated based on the gross household density of a census block group that was higher than 1.5 households per acre, but where transit availability was less than 0.1 trips per household. These neighborhoods were further evaluated using a rank index optimization score that looked at the walkability and jobs access compared to other block groups of similar density, the idea being that these neighborhoods held the basic qualities needed for shared mobility to be successful but further transit expansion and transit oriented development planning were needed.

## CANADIAN MODELS

### Data sources

The underlying data for this project were drawn from the products of Statistics Canada and the SUMC carsharing database.

### Response Variables

As with the US model, all response variables were calculated by identifying point locations of carsharing and bikesharing resources, buffering those locations, identifying the share of each block group covered by those buffers, and summing those shares for each census tract; however, the determination of the point locations and the radius of the buffers vary among the shared resources.

### Predictor Variables

The predictor variables represent the factors thought to drive the demand for carsharing and bikesharing. These are all measured at the Census tract level.

| Type | Variable Name | Description |
|---|---|---|
| **Population** | Households | Total households (2011 Census) |
| **Transit** | Transit Index | Average number routes available at census tract level (see Transit Availability, below) |
| **Urban Form** | Intersection Density | Intersections per acre |
| | Acres | Number of Census tract acres |

### Transit Availability

Due to data limitations (the All Transit Database is based only on U.S. transit agency service data), an alternate transit availability measure was created for the two Canadian cities in the study. The transit measure is based on the bus and rail stop data. A quarter mile buffer is created for each bus stop and half mile buffer is created for rail stop and the fractional accessibility at the census tract level is then summarized and then divided by the census tract area. The result is a transit availability measure that looks at the average number of routes that are accessible at the census tract level.[2]

| Transit Availability | | | |
|---|---|---|---|
| | Low | Medium | High |
| Victoria | < 3 | 3 to 6 | >6 |
| Toronto | <13 | 13 to 26 | >26 |

### Training Set Selection

This research identified training locations for each model.

| Model | Training Set Cities |
|---|---|
| Traditional Carsharing | Vancouver |
| One-Way Carsharing | Vancouver |
| Bikesharing | Toronto |

### Model estimates

### Traditional Carsharing

The traditional carsharing model was estimated based on Vancouver's data. The final model, shown below, incorporated the density of households, the intersection density, and the transit index, with traditional carsharing availability being positively associated with each measure.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -7.635 | 0.699 | -10.924 | < 0.001 | *** |
| (Households / Acres) ^0.5 | 7.464 | 0.894 | 8.345 | < 0.001 | *** |
| Intersection Density ^0.5 | 9.159 | 1.462 | 6.264 | < 0.001 | *** |
| Transit Index | 0.617 | 0.110 | 5.599 | < 0.001 | *** |

Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '
Residual standard error: 8.13 on 453 DF; Adjusted R-squared: 0.5036
F-statistic: 155.2 on 3 and 453 DF, $p < 0.001$

[2] Transit measures adapted from a method outlined in these two studies: "Estimating Transportation Costs by Characteristics of Neighborhood and Household". Center for Neighborhood Technology. Transportation Research

### One-Way Carsharing

The one-way carsharing model was estimated on Vancouver's data. The final model, shown below, incorporated the density of households, intersection density, and the transit index, each of which is positively associated with one-way carsharing.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -4.118 | 0.869 | -4.737 | < 0.001 | *** |
| (Households / Acres) ^0.5 | 2.850 | 0.855 | 3.334 | 0.001 | ** |
| Intersection Density ^0.5 | 5.402 | 1.408 | 3.837 | < 0.001 | *** |
| Transit Index | 0.892 | 0.102 | 8.721 | < 0.001 | *** |

Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '
Residual standard error: 5.715 on 186 DF; Adjusted R-squared: 0.6113
F-statistic: 100.1 on 3 and 186 DF, p < 0.001

Comparing the one-way carsharing availability predicted by this model with the actual availability measured yields the following graph with the red line demonstrating perfect prediction.

### Bike Sharing: Docks

The bikesharing (docks) model is estimated based on Toronto. The final model, shown below, incorporated household density and transit service as well as the interaction of those two variables.

| Variables | Estimate | SE | t value | p value | Sig. |
|---|---|---|---|---|---|
| (Intercept) | -43.442 | 16.337 | -2.659 | 0.011 | * |
| (Households / Acres) ^0.5 | 30.970 | 12.265 | 2.525 | 0.015 | * |
| Transit Index | 3.396 | 0.729 | 4.656 | < 0.001 | *** |
| (Households / Acres) ^0.5 * Transit Index | -1.230 | 0.552 | -2.227 | 0.031 | * |

Significance codes: < 0.001 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '
Residual standard error: 19.49 on 49 DF; Adjusted R-squared: 0.4151
F-statistic: 13.3 on 3 and 49 DF, p < 0.001

## Application

The predicted values represent the estimates for carsharing and bikesharing resources that could be absorbed by the population given the levels of service demonstrated in the training cities. Negative predictions are censored at zero.

The actual values are subtracted from the predicted values to identify the difference and therefore growth potential for each census block group. Once again, negative differences (meaning that the current resources exceeds the predicted) are censored at zero. This censoring assumes that the vagaries of local conditions justify the current supply and that that supply should not be diminished.

Finally, the area values are converted into absolute values by calculating the fractional portion of each resource linked to the specific block group. These fractional values are summed to calculate the estimates for increased carshare and bikeshare resources at the regional level.

### Highest Opportunity Areas

The neighborhoods that fell within the top 40 percent in terms of their modeled potential to support new or expand on existing carshare. Given the ability of different size cities to support varied levels of shared mobility, and that the model is only available for Victoria and Toronto, the classification was unique for each city.

### Medium Opportunity Areas

These neighborhoods showed growth for carshare, but ranked in the bottom 60 percent in terms of their modeled capacity to absorb new or expanded carshare. Similar to the Highest Shared Mobility Areas, the number of carshare and bikeshare resources was based on the modeled results for Victoria and Toronto separately. Also included in the Medium shared mobility area is whether the model indicated there was a market for one-way carshare and bikeshare.

### First/Last Mile Opportunity Areas

Due to data limitations, first/last mile opportunities were not considered in this analysis.

## Opportunity Characteristics by City Size Class

The following table contains a summary of demographic information underpinning SUMC's Shared Mobility opportunity analysis tool. Shown here are communities with high, medium, and first/last mile opportunities to scale up shared mobility, categorized by city size class. These data provide a framework that cities can use to establish benchmarks for shared mobility and assess potential impacts on auto ownership. In general, the areas with the greatest shared mobility opportunity are those with the highest public transit use and availability, lowest vehicle ownership rates, and greatest walkability as measured by average block size.

| Shared Mobility Opportunity Characteristics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| City Size Class | Shared Mobility Opportunity | Households per Acre (Gross Density) | % Drove Alone to Work | % Carpooled to Work | % Public Transit to Work | Average Vehicles/ Household | Average Transit Trips/ Week | Average Block Size |
| Smaller | High | 5.8 | 48% | 5% | 10% | 1.2 | 432 | 6.9 |
| Smaller | Medium | 3.1 | 61% | 9% | 7% | 1.5 | 272 | 9.3 |
| Smaller | First/Last Mile | 2.4 | 76% | 11% | 2% | 1.7 | 102 | 10.4 |
| Medium | High | 8.5 | 46% | 7% | 24% | 1.0 | 644 | 5.1 |
| Medium | Medium | 3.5 | 62% | 10% | 15% | 1.3 | 395 | 7.2 |
| Medium | First/Last Mile | 2.9 | 80% | 9% | 3% | 1.6 | 81 | 12.8 |
| Large | High | 10.1 | 54% | 9% | 22% | 1.0 | 652 | 4.0 |
| Large | Medium | 3.7 | 69% | 11% | 10% | 1.5 | 386 | 7.4 |
| Large | First/Last Mile | 2.9 | 80% | 10% | 2% | 1.8 | 84 | 13.3 |
| New York City | High | 36.8 | 15% | 4% | 61% | 0.4 | 958 | 4.3 |
| New York City | Medium | 7.5 | 37% | 7% | 46% | 0.9 | 718 | 5.4 |
| New York City | First/Last Mile | 5.5 | 60% | 12% | 23% | 1.4 | 46 | 4.6 |

American Community Survey 2013 data summarized from the Census block group level. Average transit trips/week compiled from the Center for Neighborhood Technology's All Transit Database.



# APPENDIX B
## SHARED MOBILITY METRICS

Shared mobility is an emerging field and as such data on use and potential benefits are limited. To help fill this gap, SUMC's research offers an alternate approach to evaluate the impacts of shared mobility on auto ownership.

SUMC's interactive shared mobility metrics calculator was created to allow cities to easily view the environmental and economic benefits of pursuing various shared mobility growth scenarios. To create the tool, SUMC developed a nonlinear simultaneous equation model (SEM) using the three-stage estimation technique and data from 54 North American cities.

### Method

SUMC's model estimates vehicle ownership using American Commuter Survey (ACS) 2014 data on journey-to-work trip patterns and current carshare and bikeshare vehicle locations as explanatory variables. The table below outlines the data used for each of the six metrics examined in this study.

| Model Variable | Purpose | Data Source |
|---|---|---|
| Current Carshare Cars | Total carshare market | Carshare operator APIs (carshare sites) |
| Current Bikeshare Bikes | Total bikeshare market | Bikeshare operator APIs (bikeshare station sites) |
| Transit Commuters | Total public transit commuters | ACS Journey to Work: total workers reporting public transit as primary mode for work trips |
| 2 to 6 Person Carpool | Proxy for ride-splitting/ carpooling market | ACS Journey to Work ACS: total workers reporting carpool (2-6 persons) as primary mode for work trips |
| 7+ Person Carpool | Proxy for vanpooling market | ACS Journey to Work: total workers reporting carpool (7+ persons) as primary mode for work trips |
| Total Workers | Density calculation | ACS: total workers |

The metrics are based on a three-stage least squares (3SLS) simultaneous equation. This study also utilizes the bootstrapping statistical technique and found that the cities in this project offer a broad representation of cities of varying size and characteristics. This statistical test offers an additional level of confidence that what the model estimates has applications beyond the 54 cities studied in this project. The results of the model were highly significant with an adjusted R-square in the high 90s. Testing showed the model was able to strongly predict changes in vehicle ownership based on different levels of shared mobility through a set of coefficient estimates. SUMC then used this information to build the metrics calculator. The finished tool shows how much of each variable is required in order to achieve a specific vehicle reduction target, as well as how changing one mode can affect others.

### Shared Mobility Metrics and Impacts

The table below outlines the shared mobility metrics generated by SUMC's model. The coefficients presented in the second column—the number personal vehicles added or removed from the road by each variable—were used to model the optimal combination of shared mobility services for each city. [†] The model suggests public transit is an effective mode in terms of removing cars from the road, displacing one single occupancy vehicle for about every five new transit riders added. Carshare also has a large impact, removing around 11 vehicles per carshare car, while it takes 6 bikeshare bikes to displace one car (and only after a minimum 500-bicycle threshold is surpassed).

| Variable | Effect on Vehicle Ownership |
|---|---|
| Carshare | 11.27 fewer cars per carshare vehicle |
| Carpool /Ride-splitting | 0.2 fewer cars per carpool user |
| Vanpool[3] | .26 fewer cars per vanpool user |
| Bikesharing | 0.16 fewer cars per bikeshare bike |
| Transit Commuters | 0.22 fewer cars per new transit commuter |
| Working Population | 1.31 cars added per person |

The carshare metric is based on the impacts of round-trip carshare vehicles across all USDN study cities. While not included in the model, SUMC also evaluated the impacts of one-way carsharing on vehicle ownership. For the most part, one-way carshare was shown to have a greater impact than the vehicle reduction of round-trip carshare, with an average of 13 private vehicles displaced for every one-way carshare vehicle.

† The optimal mix of modes was based on ACS 2014 data. As a result, the carpool metric does not reflect ridesourcing, which SUMC research indicates holds a large potential to capture that market share. To accommodate for growth in the ridesourcing market, the reported carpool/ridesourcing mix is adjusted. Similarly, bikeshare data used in the analysis was based on 2015 bike counts by city. With new bikeshare systems and technologies becoming available, the potential for bikeshare to grow exceeds the baseline data that was used to calibrate the model, so the reported numbers are adjusted to reflect this potential growth. Transit is also likely to increase beyond the baseline data given the mutual reinforcement of shared mobility modes.

3 The impact of vanpools were modeled but are not reported in the results as they are believed to be captured in the carpool metric.

4 Elliot Martin, Susan Shaheen, and Jeffrey Lidicker, "The Impact of Carsharing on Household Vehicle Holdings: Results from a North American Shared-use Vehicle Survey." Transportation Research Record 2143 (2010, Transit, Vol. 1): 150-158. doi: 10.3141/2143-19

5 Susan Shaheen et al, "Public Bikesharing in North America During a Period of Rapid Expansion: Understanding Business Models, Industry Trends, and User Impacts." Mineta Transportation Institute, Report 12-29 (2014), cited in Shaheen and Chan, "Mobility and the Sharing Economy: Impacts Synopsis, Shared Mobility Definitions and Impacts," UC Berkeley Transportation Sustainability Research Center (Spring 2015).



However, given that one-way carsharing is relatively new and is not as widely available it was not possible to directly include its impact into the calculator. As such, using the round-trip carshare metric of 11.27—which is less than the one-way average of 13 that this analysis revealed—the benefits of carshare on vehicle ownership are conservatively estimated in the shared mobility calculator.

### Literature Review

The majority of research previously conducted on shared mobility's ability to displace privately owned autos is based on user surveys, rather than on statistical models as in this approach. With that said, there are several studies worth noting as they have helped advance the field of shared mobility and offer a baseline against which to compare the alternate approach that this study outlines.

Studies on round-trip or traditional carsharing such as Cervero and Tsai (2004), Liu et al (2015), Addison (2010), Bunt et al (1998), and Cullinane (2002), provide results that are consistent with the findings of SUMC's research on carsharing's impacts on vehicle ownership. Martin et al found that each traditional carshare vehicle displaces 9 to 13 vehicles owned by carsharing members. [4] Similar research on bikesharing systems by Shaheen et al found that 58 percent of bikeshare members surveyed increased their cycling and 5.5 percent of members sold or postponed the purchase of a vehicle. [5]

The impacts of ridesharing (carpooling and vanpooling) on auto use have also been studied. The California Transportation Plan 2040 recognizes carpooling as a key shared mobility strategy to achieve vehicle miles traveled (VMT) and greenhouse gas reduction goals. [6] In another study, Shaheen notes that carpooling can help reduce VMT and lower transportation costs, though specific impacts on auto ownership are not cited. [7]

As previously noted, few studies have examined the empirical impacts of one-way carsharing specifically, since it has emerged only within the last few years and so far exists in only a handful of cities. However, early indications suggest that one-way carsharing is a model can be especially effective in reducing reliance on private autos, and one that works equally well in car-dependent areas and in places with robust transit. Preliminary research by SUMC as part of a forthcoming study for the Transit Cooperative Research Program found that among survey respondents who were carsharing users, a majority of whom were one-way users, between 20 and 25 percent said they had either postponed purchasing or sold a vehicle since beginning to use their favored shared-use modes. [8] While this study was limited in its sampling and geographical extent, these findings so suggest that one-way carsharing can have a significant impact on reducing household vehicle ownership.

6 California Department of Transportation, "California Transportation Plan 2040" (draft, March 2015).

7 Shaheen et al, "Shared Mobility: Definitions, Industry Developments, and Early Understanding" (white paper for Caltrans) UC Berkeley Transportation Sustainability Research Center (November 2015).

8 Shared-Use Mobility Center. "The Impacts of New Technology-Enabled Mobility Services on Public Transportation" (working paper, Transit Cooperative Research Program report J-11/Task 21, Washington, DC, 2016).

**The Shared-Use Mobility Center (SUMC)** is a public-interest organization working to foster collaboration in shared mobility (including bikesharing, carsharing, ridesharing and more) and help connect the growing industry with transit agencies, cities and communities across the nation. Through piloting programs, conducting new research and providing advice and expertise to cities and regions, SUMC hopes to extend the benefits of shared mobility for all.

SHARED-USE
MOBILITY CENTER

www.sharedusemobilitycenter.org