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Less Parking, More Carsharing:
Supporting Small-Scale Transit-Oriented Development

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LESS PARKING, MORE CARSHARING:
SUPPORTING SMALL-SCALE TRANSIT ORIENTED DEVELOPMENT

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I. INTRODUCTION

Most cities in the United States require property owners and developers to provide a minimum amount of auto parking for each land use on a property. From their introduction in the 1920s, these minimum parking requirements gained popularity as a way to reduce parking congestion on public streets. Yet, by requiring land and construction funds to be devoted to parking rather than housing or other uses, minimum requirements have increased housing costs and become an obstacle to increasing urban densities even as land use policies encourage infill development on underutilized sites in the metropolitan core. Parking can be especially problematic for small-scale infill in the form of secondary units, or accessory dwelling units, on single family lots; minimum parking requirements entirely prevent much potential development because the required spaces simply will not fit on a property. Parking minimums also encourage car ownership and use because mandating construction of more parking spaces than the market would build artificially pushes the price of parking down, typically to zero.

Parking requirements are especially problematic in areas near transit because car ownership is lower, resulting in underutilized parking spaces. Residents also drive their cars less, so many of the vehicles in required parking spaces are used relatively infrequently. Neighborhoods near transit stations are also the ideal places for housing development because it maximizes access to environmentally-friendly and affordable transportation options. In this study, I focus on reducing parking requirements for infill development in BART station areas in the cities of Oakland, Berkeley, and El Cerrito, California.

Given the need to encourage affordable infill housing development, particularly near transit, this study investigates carsharing as a potential means to reduce the development barrier posed by minimum parking requirements while minimizing any real or perceived street parking overcrowding the development may cause. Carsharing services provide short-term vehicle rentals to members, and are designed to provide the same convenience as a personal vehicle. Cars are located in dispersed neighborhood locations and picking up a car is fast and easy. Members avoid the high fixed costs of owning an automobile, including purchase, insurance, maintenance, and parking expenses. Instead, they pay higher variable costs in the form of fees charged by the hour and sometimes per mile.

Carsharing is best-suited for neighborhoods with robust transportation options. Robert Cervero termed the relationship between TOD and carsharing a "natural marriage," suggesting that carsharing could help reduce TOD parking demands and thereby facilitate development (Cervero, 2009). To solve the political issue of potential parking shortages on the street, cities should tie a reduction in parking requirements for any particular development to neighborhood carshare provision. While Berkeley has approved larger developments with reserved carshare spaces in exchange for a reduced parking requirement, no such policy linkage currently exists in the cities of Berkeley, El Cerrito, or Oakland for small- to medium-size infill projects that could not support a carshare vehicle on their own.

This study seeks to identify whether carsharing provides a viable means to reduce parking requirements for low- to medium-density infill development in transit station areas, and what policy mechanisms would effectively link parking requirements to carsharing. The study breaks the topic into the following four research questions.

Parking Demand

The purpose of minimum parking requirements is to ensure that the demand for parking by residents and visitors of a property does exceed the number of parking spaces available and thereby result in high parking occupancy on the street. However, if requirements are set higher than demand, property owners are forced to provide excess parking that goes underutilized. City streets can also accommodate a significant number of vehicles before congested conditions make it harder to find a parking space; if little available street parking is occupied, parking requirements may be higher than necessary. This study assesses existing parking occupancy data to determine if existing parking requirements are reasonable or if they results in an under- or over-supply of parking.

Research Question 1: How many parking spaces do housing units in neighborhoods near transit need? Is parking occupancy in these neighborhoods high, or are there many available spaces?

Carshare Market Characteristics

This study proposes increasing the availability of and participation in carsharing in transit station neighborhoods as a means to encourage residents of both new infill housing units and the existing housing stock to reduce their car ownership and thereby parking demand. For this solution to work, station area residents and potential new infill development residents must be a potential target market for carsharing service. By profiling the characteristics of active carsharing users and

comparing them with current demographics, I identify the demographic groups new development would need to attract in order to support carsharing expansion. Finally, as part of this study I identify whether carshare members who do not own vehicles live in housing with dedicated parking included or whether they are typically able to select housing units that do not include parking.

Research Question 2: What are the characteristics of active carshare members in communities near transit, including their demographics, vehicle ownership, and access to parking at home? Are there similarities between these characteristics, those of other residents in the surrounding neighborhoods, and those of likely residents in new small-scale residential development projects?

Carshare Pod Viability

This study evaluates the potential for reduced parking requirements in new development accompanied by increased use and availability of carsharing. If carsharing availability is to expand, additional pods must be economically viable. However, only neighborhoods with certain characteristics are strong carsharing markets and good candidates for new vehicles. In order to determine the feasibility of expansion, I seek to identify how carshare providers measure the success of their vehicle locations and whether low- to medium-density neighborhoods near transit are strong carsharing markets.

Research Question 3: What are the limits of carshare viability in terms of neighborhood density and distance from a transit node? How do carshare providers determine where to place vehicles and what metrics do they use to evaluate the success of a vehicle?

Policy Mechanisms to Reduce Parking Requirements and Support Carsharing

Cities can most equitably and effectively reduce auto ownership, and thereby parking demand, by linking reduced parking requirements with policies to encourage car ownership alternatives. Carsharing encourages members to significantly reduce the number of vehicles they own, but the service is capital intensive and expansion may not be viable in the short run in many locations without support from governments, developers, or other partners. In this study, I review existing means to provide support for carsharing expansion and encourage infill residents to use the service. I then suggest policies that could link this support to reductions in parking requirements for new small-scale infill development.

Research Question 4: What policies could cities use to reduce parking requirements for new small-scale residential development, facilitate expansion of carsharing service, and encourage residents to use carsharing as an alternative to car ownership?

To conclude, this paper summarizes the relationship between parking requirements, carshare, and infill housing and how policy can link them more closely together.

II. BACKGROUND ON MINIMUM PARKING REQUIREMENTS

Most cities in the United States require property owners and developers to provide a minimum amount of auto parking for each land use on a property. From their introduction in the 1920s, these minimum parking requirements gained popularity as a way to reduce the parking congestion on public streets that resulted from ever-increasing automobile ownership and use in the mid-20th century (Ferguson, 2003). By about 1970, over 90 percent of U.S. cities had instituted parking requirements. Typically, city zoning ordinances specify the number of parking spaces required per square foot or unit of each land use, with requirements varying considerably depending on the land use, zoning district, or other factors. The City of Oakland, for example, requires from zero to four parking spaces per residential dwelling unit depending on its location, zone, and in some cases number of bedrooms (City of Oakland, 2010).

Most jurisdictions design their parking requirements to satisfy the maximum potential demand for free parking at every destination, and consequently most parking spaces are unused most of the time (Shoup, 2005, pp. 21-65; Willson, 1995). Because it is oversupplied, the market price for parking in most locations has fallen to zero, shifting the costs of providing parking from drivers to developers, building owners, and their tenants and customers (Shoup, 2005, p. 9). This artificial cost redistribution encourages driving while increasing costs for everything else.

The effects of minimum parking requirements have come increasingly into conflict with other planning objectives, particularly with efforts to reduce cities' environmental footprints and increase the supply of affordable housing. Minimum parking standards conflict with these objectives because they increase both housing costs and auto use. Still, most jurisdictions maintain minimum parking requirements because of continuing concern over potential spillover parking problems.

Parking Requirements and Vehicle Miles Traveled

Automobiles are a major source of greenhouse gases, with passenger cars alone generating 27 percent of California's greenhouse gas emissions in 2008 (California Air Resources Board 2010). They contribute significantly to air and noise pollution, as well. As global warming has become an issue of increasing concern, California passed a set of landmark laws regulating greenhouse gas emissions and instituting planning process changes that are intended to reduce vehicle miles traveled (VMT) (Altmaier et al., 2009). The VMT reduction plan relies largely on policies of concentrating growth in infill locations and near transit, in the form of transit oriented

development. However, significant VMT reductions may be difficult to achieve if parking remains free and oversupplied while minimum parking requirements create a barrier to infill development.

Few studies have specifically analyzed the relationship between availability of residential parking and residents' travel patterns. A comparison between two New York City neighborhoods, Jackson Heights and Park Slope, revealed little to explain the former's higher rates of auto commuting into Manhattan other than its greater availability of on-site residential parking (Weinberger, Seaman, & Johnson, 2009). In a survey of San Francisco residents, respondents living in neighborhoods with required parking maximums reported making fewer auto trips per day than those living in areas without maximums (Sherman, 2010). Additional literature explores the relationship between the availability and cost of parking at trip destinations and the travel modes chosen to reach them. California TOD residents have a 5 percent likelihood of taking transit to work if flextime is unavailable and parking is free, but the percentage doubles to 10 percent for workers who must pay for parking. If flextime is available, paid parking increases the likelihood from 40 to 70 percent that workers take transit (Lund, Cervero, & Willson, 2004). These findings suggest that minimum parking requirements, particularly at destinations, increase automobile travel.

Parking Requirements and Housing Costs

High housing costs are also a major problem in California, and the State has attempted to increase housing supply by performing regular "housing needs assessments" and requiring local governments to plan and zone for their fair share of the need (Fulton, 2005, pp. 279-283). Oversupply of parking increases housing costs, both by increasing development costs and reducing the supply constructed. Building parking in land-constrained urban areas is expensive. In *The High Cost of Free Parking*, Donald Shoup reviewed three studies that separated the cost of constructing housing from the cost of providing the associated parking (Shoup, 2005, pp. 143-152). All three cases involved either a local jurisdiction with a relatively low parking requirement of one space per dwelling unit or a project that was permitted to provide less parking than typically required; still, parking increased construction costs by 18 percent or more. In another study on the value of housing units in San Francisco, isolating parking availability from other factors influencing home values revealed statistically significant price premiums of 12 to 13 percent for homes with parking (Jia & Wachs, 1999). Twenty to 24 percent fewer households in the city could afford to purchase a home with the cost premium of parking provision.

Increased parking provision tends to reduce development density by consuming land that could otherwise be used to increase the size of buildings, thereby reducing housing supply (Shoup, 2005, pp. 142-144; Willson, 1995). For infill development on constrained urban lots, parking requirements may even be physically impossible to meet. In Los Angeles, removing parking requirements was a key component in a package of relaxed development regulations that allowed successful conversion of abandoned downtown commercial buildings into over 6,000 residential units (Manville & Shoup, 2010). In meetings held in the cities of Oakland, Berkeley, and El Cerrito, California, planning officials in each city reported that parking requirements are one of the most common regulatory barriers to approval of accessory dwelling units on single family lots. Parking requirements therefore increase housing prices both directly, via increased construction cost, and indirectly, by constraining supply. Housing costs in California are the second-highest in the nation, with over half of both owners and renters paying more than 30 percent of household income in rent (US Census Bureau, 2010). Reducing the development costs and regulatory burdens imposed by minimum parking standards could help increase housing supply and affordability.

Parking Requirements in Transit Oriented Development

The problems of minimum parking requirements are both particularly acute and potentially easier to solve in areas near major transit hubs. Transit provides an alternative to auto travel; residents of dense residential development near transit hubs (transit-oriented development, or TOD) are significantly more likely to take transit to work and less likely to drive than those who live farther from high-quality transit (Chatman, 2006; Lund et al., 2004). This effect is weaker with non-work travel, for which there is little observed reduction in auto trip rates for residents near transit. Even if they use transit for commuting, TOD residents typically use cars to make trips for shopping, dining, recreation, transporting children, and other errands. Still, households near transit drive fewer miles overall and generate fewer trips that those living elsewhere (Cervero & Arrington, 2008; H. S. Kim & E. Kim, 2004; Schimek, 1996).

Residents of transit station areas own fewer vehicles, on average, than those living farther from transit (Holtzclaw, Clear, Dittmar, Goldstein, & Haas, 2002; H. S. Kim & E. Kim, 2004; Schimek, 1996). Schimek found that over half the reduction in VMT for households near transit was associated with lower vehicle ownership, with the remainder attributable to less use of each vehicle owned. TOD residents may purchase fewer vehicles because they plan to drive less, move to TODs in greater numbers because they own fewer vehicles and desire more travel options, or reduce their vehicle ownership after moving near transit and finding they need a car less than before.

Holtzclaw et al. identified residential density, household income, and family size as other significant determinants of vehicle ownership rates; small families, low incomes, and high density all reduce car ownership likelihood (2002). A small, affordable residential unit, such as an ADU, in a dense neighborhood near transit would therefore be least likely to contribute significantly to neighborhood parking shortages.

Despite lower auto ownership near transit, most jurisdictions do not have explicit policies of reduced parking requirements within a given proximity of transit service. A notable exception is Portland, Oregon, which exempts sites within 500 feet of a transit line with 20-minute peak hour service from all parking requirements (City of Portland, 2010). New York City is an example of a jurisdiction that does not have an explicit policy but zoning districts near transit do have lower parking requirements than those in other areas (McDonnell, Madar, & Vicki Been, 2009). This is likely the case elsewhere, as well, because transit systems are often centered on downtowns and higher density corridors, where parking requirements are typically lowest. However, an explicit policy provides the advantage of allowing relaxed parking requirements for properties that are similar in character to others nearby and are within the same zoning district but are located closer to transit. Explicit policies also allow zoning regulations to change as transit is expanded. For example, the Bay Area Rapid Transit (BART) system was built later than many neighborhoods it travels through, and an explicit policy could allow parking requirement reductions nearby without entire neighborhoods undergoing zoning changes. Oakland, Berkeley, and El Cerrito have the same parking requirements for accessory dwelling units regardless of a property's distance to a transit station, for example. Parking is likely to be underutilized as a result.

Increasing residential density near transit with TOD is particularly desirable to reduce auto dependence, but parking requirements increase the cost and decrease the feasibility of development. The underutilization of parking spaces in many TODs provides an opportunity to reduce parking requirements. Even where most street parking is neighborhoods near transit is occupied, many of the vehicles may belong to park-and-ride commuters and other non-residents. Moreover, because TOD residents drive the vehicles they do own less, they may be willing to forego vehicle ownership if a compelling alternative way to allow occasional auto travel were available.

While simply reducing or eliminating minimum parking requirements near transit would provide a solution to the environmental and housing affordability problems the regulations cause, overflow street parking might result if curb parking remains free. Perhaps more important, parking is a

deeply political and ideologically dividing issue centered on contestation of public space and mobility (Henderson, 2009). Arguments range from progressives' contention that parking availability should be reduced to the neoconservative argument that cities need more parking. In discussions, city officials in Berkeley and El Cerrito both noted the tendency of many residents to be possessive about street parking in front of their homes and wary of any change that could potentially reduce parking availability. New development is less politically palatable if neighbors fear parking spillover. Therefore, a policy to reduce minimum parking standards will be more politically acceptable if it can ensure that these fears are not realized. Reducing car ownership by encouraging carsharing as a substitute could significantly reduce parking demand, eliminating the perceived need for stringent minimum parking requirements.

III. RESEARCH METHOD

This study takes a mixed-methods approach to evaluate parking demand in residential neighborhoods near transit, establish a profile of carsharing members in these areas, identify the factors that determine carshare pod success, and ultimately suggest policy solutions that encourage carsharing use while reducing parking requirements for infill development. I explore these topics using a literature review, interviews with carshare providers, discussions with city officials, and a survey of carshare members. This section first describes the geographic area in which I focused the research, then describes how I used the literature review, interviews, and survey to address each of the study's four research questions.

Study Areas

The study focuses on the areas within a half mile radius of four East Bay BART stations: El Cerrito Plaza in the City of El Cerrito, North Berkeley and Ashby in the City of Berkeley, and Macarthur in the City of Oakland. These station areas have potential for small-scale infill development, including accessory dwelling units, because they largely consist of existing low- to medium-density neighborhoods that are not conducive to larger-scale development. I selected these station areas because they:

- Are primarily residential neighborhoods, rather than downtown areas with significant employment concentrations;
- Contain a mix of housing types, including small multi-unit apartment buildings and single family homes that provide potential for accessory dwelling unit development;
- Are well-served by transit, including both BART and AC Transit buses;
- Have minimum parking requirements for new development of one space per unit or more;
- Have existing carshare vehicle locations;
- Are in cities that are interested in encouraging infill development near transit stations; and
- Are accessible to researchers located at UC Berkeley.

These characteristics indicate that the Study Areas have potential for small-scale residential infill development, but development is currently constrained by minimum parking requirements. Given the presence of transit and carsharing, cities could apply policies in these areas to link parking requirement reductions for new development to increased resident carsharing use.

The following subsections detail how I used a literature review, survey of carshare members, interviews with carshare providers, and discussions with city officials to answer each of this study's four research questions.

Parking Demand

If residential parking demand in neighborhoods near transit is significantly less than the amount of on- and off-street parking available, then cities could reduce minimum parking requirements without causing problems with parking spillover due to new development. To estimate parking demand in station areas, I first conducted a literature review of on-street and off-street parking occupancy counts in transit station areas. I also collected vehicle ownership rates from the 2005-2009 American Community Survey for the Census tracts within a half mile of seven stations in the East Bay that I classified as "Neighborhood" stations (explained below under "Survey Method"). Lastly, as part of a survey of carshare members, also described below, I asked each respondent how frequently street parking is available on the block in front of his or her home.

Carshare Market Characteristics

Similarities between carshare members and other station area residents or potential residents of new infill development would indicate whether either group is a potential market for expanded carsharing. To establish a demographic profile of carsharing members, particularly in residential neighborhoods near transit, I conducted a survey of active carshare members living near East Bay BART stations. I also draw on demographics found in other research. However, other surveys of carshare members have not evaluated the association of membership with parking availability, nor on the relationship with housing characteristics. This study identifies carshare members' housing types to determine whether they would likely live in new infill rental housing as well as whether they have parking available to identify whether car-free households that join carsharing are able to select housing units that do not include parking.

Survey Method

I surveyed carshare members living within a half mile of East Bay BART stations with carshare vehicles nearby. The survey is limited members who actively use the service for personal travel, rather than exclusively for business. Survey questions focus on carshare member demographics, carsharing behavior, travel patterns, car ownership and parking, and housing characteristics.[1] I

[1] The full survey instrument is included in Appendix A.

expanded the survey beyond the four Study Area stations to a total of eleven East Bay BART stations. Several of the additional station areas are similar in residential densities and neighborhood character to the Study Area stations, so I included them to increase the number of survey responses received. The remaining stations are located in downtown areas with higher development densities and more commercial land uses. I included these stations to ensure an adequate survey response and enable comparisons between different types of station areas. Both City Carshare and Zipcar, the Bay Area's two major carsharing operators, agreed to participate. We conducted the survey online to maximize response rates and because both carshare providers conduct all regular communications and transactions with members online.

The survey period was from the last week of February to the first week of March, 2011. City Carshare sent a survey link to all members with mailing addresses within a half mile of an East Bay BART station with City Carshare vehicles nearby, while Zipcar sent the survey link to all members in ZIP codes that are at least partially within the station areas containing Zipcars. The station areas with Zipcars are North Berkeley, Downtown Berkeley, Ashby, Rockridge, 19th Street Oakland, 12th Street Oakland, and Lake Merritt. City Carshare has vehicles in all of these station areas as well as El Cerrito Plaza, West Oakland, and Fruitvale. In total, the survey emails were sent to 6,874 carsharing members, and 929 people responded (a 13.5% response rate).

At the conclusion of the survey period, I culled the responses to eliminate those from members who were not active carshare users living within a half mile of an East Bay BART station, or who used the service exclusively for business purposes.[2] After I eliminated these responses, primarily due to locations outside the BART station areas, 275 remained for analysis (4% of initial solicitations). I tallied results of survey questions by station area, as shown in Table 1, then grouped them by station type and location. One-hundred six people responded from the Study Areas, or the four

[2] Specifically, I eliminated responses on the following bases:

- The survey asked respondents to provide the names of the two intersecting streets nearest their homes. I eliminated responses if this intersection was not within a half mile of an East Bay BART station or if the respondent did not provide an intersection. This screen eliminated the largest number of respondents, primarily Zipcar members because the survey was sent to many living outside the station areas.
- Members who reported using the carsharing service primarily for business purposes.
- Respondents who reported making no reservations with the carshare service during the month of January.
- Members who had already taken the survey once from the other carshare provider.

stations that are the specific study focus. I also divided station areas into "Downtown" and "Neighborhood" types; Downtown Berkeley, 19th Street Oakland, 12th Street Oakland, and Lake Merritt are considered "Downtown," while the remaining station areas are categorized as "Neighborhood." The Study Area stations are a subset of the Neighborhood stations. This report reports many results for all Neighborhood stations rather than just the Study Areas because the Neighborhood results are generally very similar and have a larger sample size than the Study Areas alone. Downtown stations provide a comparison group.

Table 1: Carshare survey responses by station area

Station Area	Responses
12th Street	53
19th Street	57
Ashby	36
Downtown Berkeley	59
El Cerrito Plaza	2
Fruitvale	2
Macarthur	38
Lake Merritt	30
North Berkeley	30
Rockridge	26
West Oakland	5
Station Area Totals	
Downtown	**136**
Neighborhood	**139**
Study Areas	**106**
Oakland	**148**
Berkeley	**125**
All Station Areas	**275**

To identify how active carsharing members may resemble or differ from the general population in their neighborhoods, I compared the survey results with demographic data for each station area from the American Community Survey 2005-2009 5-year data. To best approximate the half mile radii around stations, I consolidated Census Block Groups falling at least partially within each radius to form a comparison population.[3] Due to estimated margins of error as well as differences

[3] Margins of error for the Census Block Group 5-year data are quite large, often exceeding 50% or more of estimated values. Combining Block Groups reduces these margins relative to the estimates, although exact margins of error are not available for combined geographies. The researcher estimated margins using the

between the time periods, sampling methods, and exact geographical areas covered, only large differences between Census numbers and the carshare survey results are likely to be significant.

Carshare Pod Viability

New carshare pods must be economically viable if carsharing is to expand and successfully reduce auto ownership in neighborhoods near transit. To evaluate the potential for expansion, I determined the factors that are critical to pod viability using a review of existing literature, results from the survey of carshare users, and interviews with representatives of each of the two major Bay Area carshare providers, City Carshare and Zipcar. In addition to the demographic portions of the carshare member survey, I asked respondents how far they are willing to travel to reach a carshare vehicle and how they typically access a vehicle to determine how large the service area of a single pod can be.

I interviewed Amy Anton, Director of Community Relationships at City Carshare; Anita Daley, Membership Development and Outreach Director at City Carshare; and John Williams, public relations consultant with Zipcar and former Flexcar public relations representative. The interview questions focused on what factors carshare providers use in determining where to place vehicles, what metrics they use to evaluate carsharing pod performance, how far members are typically willing to travel to reach a carshare vehicle, and, whether they are aware of any relationship between member parking availability and carshare use.[4] I also sought any vehicle usage data that providers might be willing to share, but providers prefer to keep this data private due to the competitive environment in which they operate.

By combining the data on how far members are willing to travel to a pod with the number of members needed for a pod to be successful, I estimate how many potential members must be nearby to support expanded carsharing service.

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sum of squares of the Block Group standard errors, as recommended by the Census Bureau (US Census Bureau, 2011). I combined answer categories for many results; for example, I aggregated small age group categories reported by the Census Bureau into larger age brackets to compare with survey results. To estimate margins of error for these combined groups, I used the same standard error sum-of-squares method. However, where there were many zero estimates, I added the standard error for a zero estimate only once. All final aggregated results reported here have estimated margins of error that do not exceed 50% of the population's estimated size.

[4] The full list of questions to guide the interviews is found in Appendix B.

Policy Mechanisms to Reduce Parking Requirements and Support Carsharing

Cities should encourage alternatives to vehicles ownership in order to reduce parking requirements without causing street parking spillover problems. Carsharing plays an important role in reducing vehicle ownership, but high capital costs and difficulties with short-run pod viability often necessitate start-up assistance from cities or developers. In this part of the study, I identified existing policies to facilitate carsharing as well as potential new mechanisms to link reduced parking requirements to support for carsharing and alternative transportation modes. I identify these policies through a review of literature and policies in other cities, the interviews with carshare providers, and discussions with city officials in Berkeley, Oakland, and El Cerrito. The review of literature and other cities' policies identifies examples of city incentives to encourage carsharing provision and use, particularly where linked to parking provision or requirements. In an effort to inform policy suggestions, the interviews with carshare providers included questions about partnerships, policies, and financial assistance that might encourage them to place more vehicles in neighborhoods near transit nodes as part of a parking requirement reduction program.

IV. RESIDENTIAL PARKING OCCUPANCY AND DEMAND

Cities have instituted minimum parking requirements to address the issue of demand exceeding the supply of free street parking spaces. Planners usually estimate this demand in one of two ways; either they simply copy requirements from other jurisdictions or they consult studies of parking generation by the Institute of Transportation Engineers (ITE) (Shoup, 2005, pp. 27-32). Donald Shoup argues that the ITE parking generation estimates are flawed for a variety of reasons, including that they measure "demand" as the peak occupancy of free parking spaces. He clarifies that parking occupancy and parking demand are two different concepts (Shoup, 2005, p. 36). Demand is "the relationship between the price of parking and the number of parked cars," and will therefore fluctuate depending on price. Free parking occupancy is a measure of demand where the price is set to zero. Still, this assumption generally makes sense in residential areas because neighborhood parking is almost always free for residents.

Despite its importance, measuring residential parking occupancy is difficult to accomplish accurately in mature communities near transit stations. In a neighborhood with mixed land uses, there may be spillover parking on the street from other uses. Similarly, transit riders may park on residential streets near the station. Restrictions and pricing play an important role; parking in some areas may be metered or be subject to time limits, reducing parking occupancy there and increasing it on nearby streets that are unpriced or unrestricted. The spatial unit of analysis is also important when conducting an occupancy study because demand may be highly localized. All spaces on a given block may be full while the next block has spaces available, and whether it is reasonable to expect an available space in front of your home, on the same block, or within a quarter mile is a subjective determination.

Parking Demand in Neighborhoods Near Transit

Car ownership rates are one way to estimate parking demands. Within all East Bay BART station areas with carshare vehicles, the average household has about 1.1 vehicles. Downtown station areas have even lower ownership rates, at just 0.9 vehicles per household. The average rate in Neighborhood station areas is about 1.3 cars. These values likely provide a good estimate of parking demand, except that they do not capture housing unit vacancies or occasional vehicle absences, which reduce demand, and visitor parking, which increases demand.

Another approach to measuring residential parking demand in transit station areas is to count parking space occupancy in TODs where all residents and visitors park in on-site parking spaces. This typically means conducting counts in large suburban apartment complexes where on-street parking is not available or used. Cervero, Adkins, and Sullivan (2009) found that peak parking occupancy at 16 Suburban East Bay Transit Oriented Developments averaged 1.2 occupied spaces per unit. The same study found a sample of TOD projects in the Portland metro area averaged 1.07 occupied spaces per unit, while researchers in Santa Clara County found utilization at 1.3 spaces per TOD unit (Serafin, Swierk, Y. Smith, & Meek, 2010) and in San Diego County at 1.01 for market-rate housing projects near suburban bus lines (Katz, Okitsu & Associates, 2002). All of the studies found that a significant percentage of parking spaces at most projects were unoccupied at peak times. While on-site parking occupancy studies provide some indication of what residential TOD parking demand may be, the need to count occupancy at relatively large projects with defined residential parking locations and minimal street parking restricts the studies to primarily single-use suburban locations. Parking demand in more urban locations with a mix of uses within easy walking distance is likely to be even lower. Where available, street parking can also accommodate a portion of residential parking demand.

Station Area On-Street Parking Occupancy

A limited number of studies have analyzed parking occupancy rates near the BART stations selected as case studies. A study for BART on the feasibility of a parking benefit district near the Macarthur station included a parking survey of selected nearby blocks (Deakin et al., 2008). Many of the blocks have primarily commercial frontage, but some surveyed streets are residential in character. The study team surveyed streets at seven different times on a typical midweek weekday. Demand peaks around 10:00 am, when 68% of spaces are filled. Some of the vehicles parked on streets in the station area in the middle of the day likely belong to park-and-ride commuters or business customers and employees. The lowest demand times surveyed were at 6:30 am and 7:30 pm when 52% and 49% of spaces were occupied, respectively. These times most closely reflect times when most residents would be home and parked but there would be few drivers parking to access transit or other land uses.

While Deakin et al. found that the overall area occupancy rates are fairly low, several of the residential blocks sampled are consistently at or near parking capacity over the course of a day. The blocks on 40th and 41st Streets east of the station have occupancy rates over 75% even at 6:30 am and 7:30 pm, when most vehicles probably belong to residents. These several blocks,have many

apartment buildings with more than four units, properties with little or no on-site parking, and free unrestricted street parking, all conditions that would increase street parking occupancy. Other residential streets, including sections of 40th Street west of the station, 37th Street, 38th Street, and Clarke Street never exceeded 90% occupancy and were typically below 75%. Single-family homes and small apartment buildings (typically four or fewer units) predominate on these blocks. Most lots, but not all, include on-site parking. The contrast between blocks with different housing types may indicate a threshold above which residential on-street parking becomes congested; on-street parking is at capacity on blocks with primarily multi-unit apartment buildings but below capacity where there is a mix of single-family homes and two- to four-unit buildings.

Deakin et al. conducted a study in 2010 of Adeline Street near the Ashby BART station (Deakin et al., 2010). The study included parking occupancy counts of Adeline between Ward Street in Berkeley and Stanford Avenue near the city line with Oakland. Occupancy rates were 80% of higher in the morning and afternoon on blocks with unrestricted and unmetered parking near the BART station, but rates were much lower in areas with metered, time-limited, or resident-restricted parking. However, the study did not extend onto local residential streets adjacent to the primarily commercial districts along Adeline Street.

Street parking occupancy studies are not available in the North Berkeley and El Cerrito Plaza station areas.

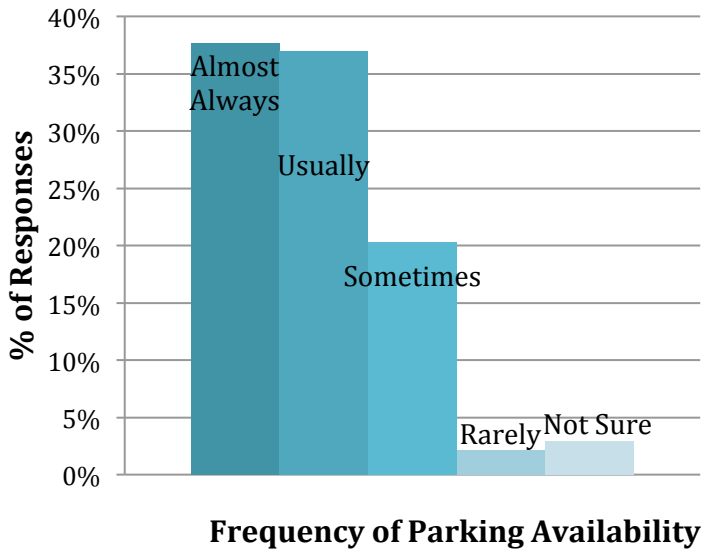
As part of recent planning efforts around San Francisco's Glen Park BART station, the City of San Francisco conducted station area parking counts. The Glen Park neighborhood is similar in scale to the Study Areas, with a small business district and a mix of small- to medium-scale residential development in an urban but not downtown setting. The Draft Environmental Impact Report for the Glen Park Community Plan, released this year, included parking occupancy counts throughout the neighborhood (City of San Francisco Planning Department, 2011, pp. III.E-23.). Parking spaces in the area are metered in the commercial area and elsewhere are largely time-restricted to 2 or 4 hours, with some areas included in a residential permit zone. Overall occupancy throughout the plan area was 65% during the weekday mid-morning period and 68% on a weekday evening, the latter likely reflecting a mix of residential and business parking demand. Spaces were available even at peak times in the neighborhood, although they may have been scattered or clustered in one area.

These studies indicate that residential street parking occupancy varies with residential density and regulatory policy. Where parking is unregulated, park-and-ride commuters and the employees and customers of nearby businesses often take advantage of available spaces on residential streets. However, even when most parked vehicles likely belong to residents, occupancy rates are very high where multi-unit apartment buildings predominate but capacity is available where densities are lower.

Carshare Member Opinions of Street Parking

Another approach to gauge actual or perceived parking availability is to ask residents' opinions of parking difficulty. As part of the carshare member survey, I asked respondents how often parking spaces are available on their block if they or a friend were looking for a space. Since carsharing members are unlikely to own cars themselves, these results may not be representative of the experience of a typical driver looking for a parking space. Still, carsharing members are likely to have some recollection of whether they see empty parking spaces on their block or not. Figure 1 displays the frequency of parking availability carsharing members perceive near their homes. Not surprisingly, residents of Downtown station areas report less parking availability than residents of Neighborhood station areas. Parking appears to be generally available in Neighborhood station areas, while finding a space on a block in Downtown station areas may be more challenging. Carsharing members living in households with at least one vehicle tend to report greater street parking availability than those in zero-car households, possibly because zero-car members are more likely to live in downtown areas where parking is scarce.

Figure 1: Perceived street parking availability on carshare members' home blocks, Neighborhood station areas



Parking Demand Findings Summary

Overall, parking demand for infill development in Neighborhood station areas is likely to be significantly less than the 1.2 spaces per unit found in suburban TODs assuming similar unit sizes and household compositions. Parking demand is likely to be higher for single family homes, which largely comprise the existing building stock. Street parking demand varies by land use intensity and parking restrictions. Unrestricted street parking in station areas appears to be heavily occupied by park-and-ride users during the day. Residential street parking demand is likely high on primarily mid-density (multi-unit apartment) streets, especially where little off-street parking is provided, but considerably lighter on blocks with fewer apartment buildings.

V. PROFILE OF CARSHARING MEMBERS

Carsharing provides an alternative to car ownership and, because many households' personal vehicles are replaced for each carshare vehicle, the service could substantially reduce parking demand in new infill housing if the new residents join. This section of the report identifies the demographic profile of carshare members to determine whom new infill development would need to attract if the new residents are likely to join carsharing. I also compare carshare members to station area residents as a whole; demographic similarities indicate that carsharing may be able to expand easily even within the existing population, but substantial differences reveal greater market challenges.

Carsharing Demographics in the Literature

Carsharing has proven attractive to people with a variety of demographic characteristics, but some clear patterns emerge in terms of the populations most likely to join. A 2005 Transit Cooperative Research Program (TCRP) Report included both a 2004 survey of North American carsharing members and a compilation of research from North America and Europe focusing on user demographics (Millard-Ball, Murray, ter Schure, Fox, & Burkhardt, 2005). The literature review found that carsharing members are typically younger adults between their late 20s and mid 40s in age, with some variation by location. Carsharing members have higher than average educational attainment, with the likelihood of early adoption highest among people with college and advanced degrees. In the 2004 survey of North American carsharing members, 48 percent had completed some post-graduate work or received an advanced degree, while less than 2 percent did not have at least some college education. The literature review found incomes are generally at or higher than area medians, but earning levels varied significantly within and between studies. Household sizes are small, with 1-2 people the norm. In the 2004 survey, 87 percent of respondents were Caucasian, with small numbers of carshare members identifying with other racial or ethnic groups. There was no evident gender pattern.

A more recent survey of North American carshare members essentially confirmed most of the earlier findings (Martin & Shaheen, 2010). The largest age brackets represented among survey respondents were 25 to 30 and 30 to 35, with a median age of 37. The number of members in each successive five-year age bracket declined above age 30, but still more than a third of respondents were older than 40. High educational attainment was again a key characteristic of members; just 2 percent had not had any college education while 82 percent hold at least a bachelor's degree and 41

percent hold an advanced degree. Incomes were distributed near national medians. Household incomes were widely distributed, with a median between $50,000 and $60,000 and the most common income brackets between $30,000 and $40,000 and between $40,000 and $50,000. Survey respondents' average household size was 1.9 persons compared with the U.S. average of 2.6, but the authors point out that this difference is partially a reflection of smaller household sizes in cities.

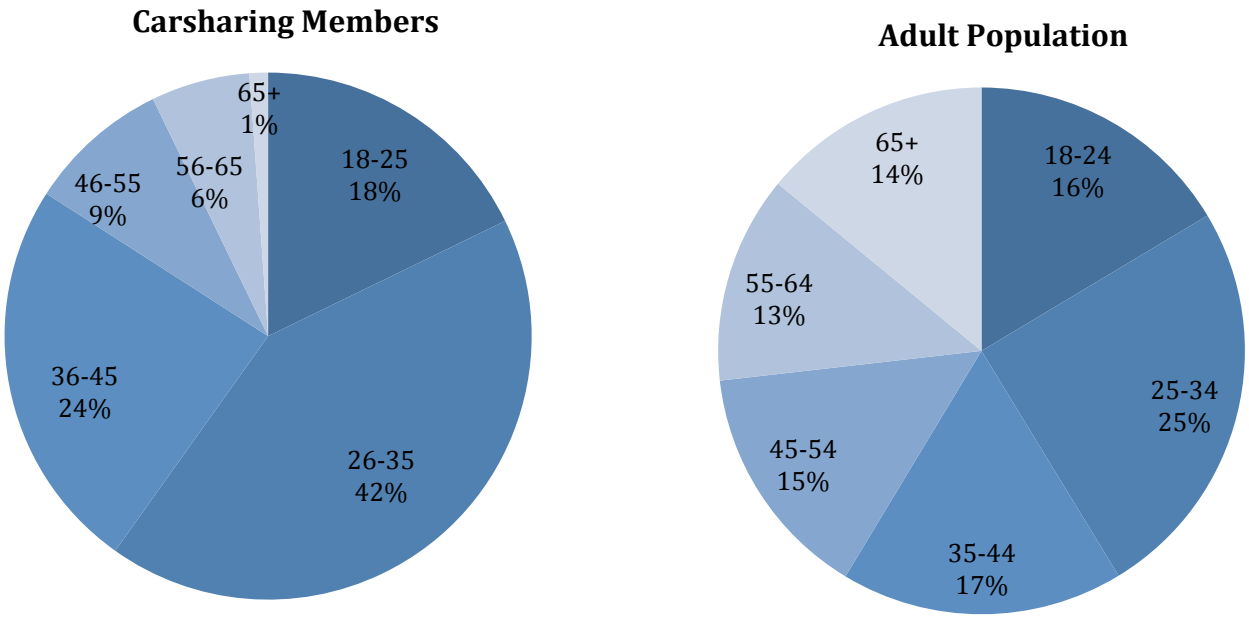
Bay Area carsharing demographics are similar. In 2005, the median City Carshare member age was just under 40 with a household income of $50,000, similar to the region's median income (Cervero, Golub, & Nee, 2007). Seventy-seven percent of members identified their race as white, compared with just under half the metropolitan area population as a whole. In a survey of members, the average household size was 1.9 for members compared with 2.3 for the City of San Francisco, indicating that carsharing serves smaller households even than live in the region's primary center-city jurisdiction. The Bay Area data confirms the industry-wide typical member profile as a younger, highly-educated adult living in a small, middle-income household.

Existing studies also show that carshare members do reduce their car ownership. A study of City Carshare members found that 29% of members either sold vehicles or avoided planned vehicle purchases when the joined the program (Cervero et al., 2007). In a more recent national survey, carshare members reduced their vehicle ownership from an average of .47 autos per household before joining a carshare program to .24 vehicles after joining (Martin, Shaheen, & Lidicker, 2010). Notably, most of this reduction was due to one-car households becoming zero-car households, with many fewer two-car households joining and reducing their auto ownership. Over half of carshare members were in zero-car households when they joined, and remain so. Still, enough households shed a vehicle after joining carshare, or avoided purchasing a vehicle, that each carsharing vehicle replaced 9 to 13 private vehicles.

Demographic Findings of Survey Results

This study's survey results largely confirm the established demographic profile of carsharing members. Survey respondents were disproportionately young adults compared with the general population in transit station areas, as shown in Figure 2, and the population over age 55 was significantly underrepresented. Carshare members are also less likely to have children or seniors living in their households than other residents.

Figure 2: Age of carshare members and station area adults

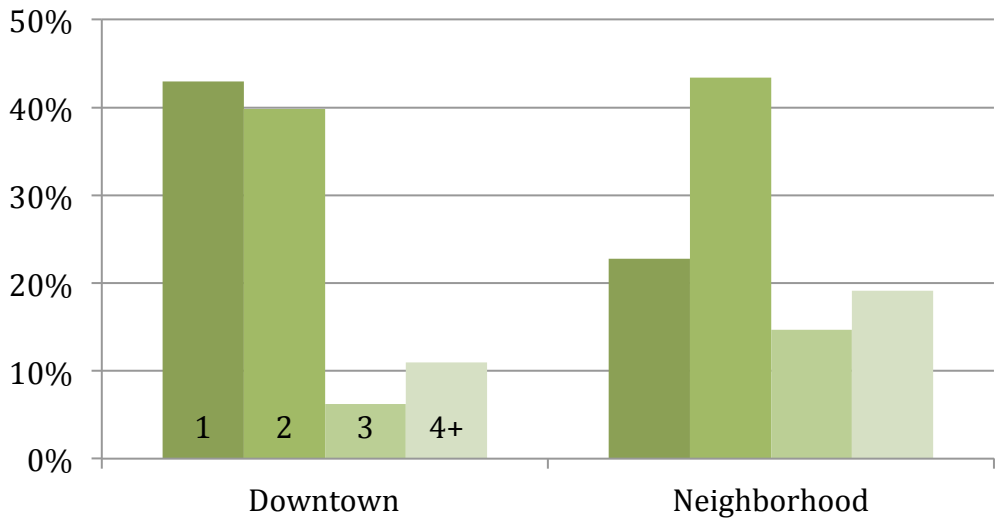


Source: 2005-2009 American Community Survey

The carsharing demographic remains disproportionately white, with other racial and ethnic groups composing just one-third of survey respondents despite making up more than half the population of the station areas. Carshare members are less likely to be Black, Asian, or Latino than residents as a whole. Indeed, the two station areas with the highest proportions of non-white residents, Fruitvale and West Oakland, are two of the three stations surveyed with the fewest carsharing vehicles and survey respondents.

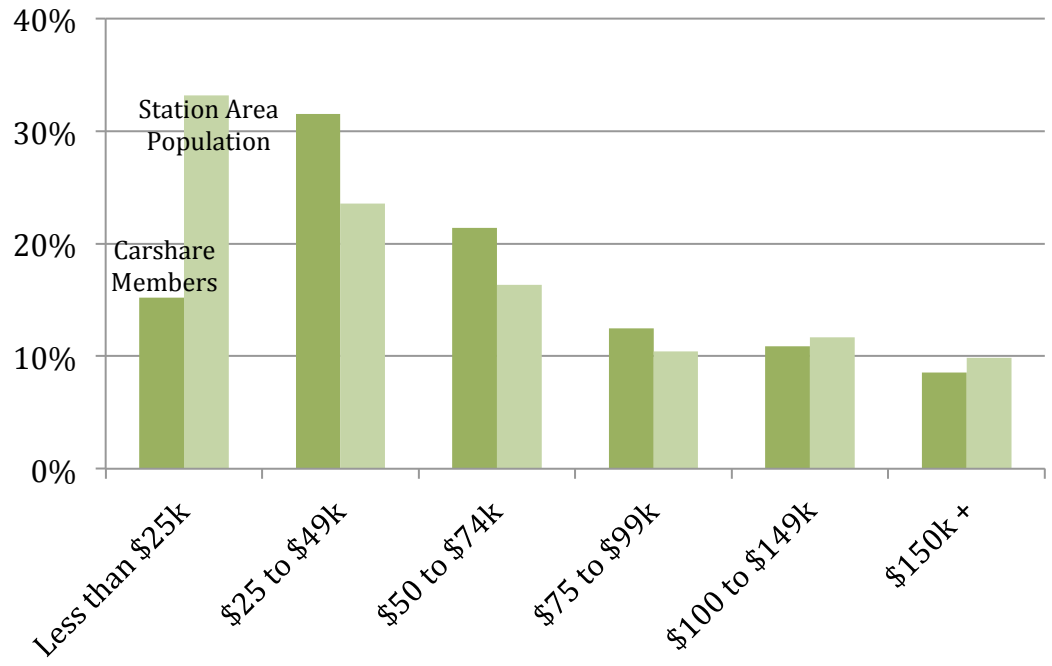
The average household size of surveyed carsharing members is 2.2 people, which virtually matches the statistic for all station area residents. This result is unexpected given the smaller household sizes that previous studies have found. Members living near Downtown stations have notably smaller households, as illustrated in Figure 3, than those living in Neighborhood station areas.

Figure 3: Member household size by station area type



The carsharing members surveyed were more likely to have mid-range household incomes between $25,000 and $75,000 than the station area populations. Figure 4 shows that members were about as likely as the population as a whole to earn more than $75,000, and carsharing even attracts households earning over $150,000 almost on par with their proportion of the population. However, survey respondents were less than half as likely as the population as a whole to be in the lowest income bracket (under $25,000). In addition, almost half the carshare members in this bracket are full-time students. Despite the cost savings many members enjoy when they replace car ownership with carsharing, providers have been largely unable to extend the reach of this service to low income populations.

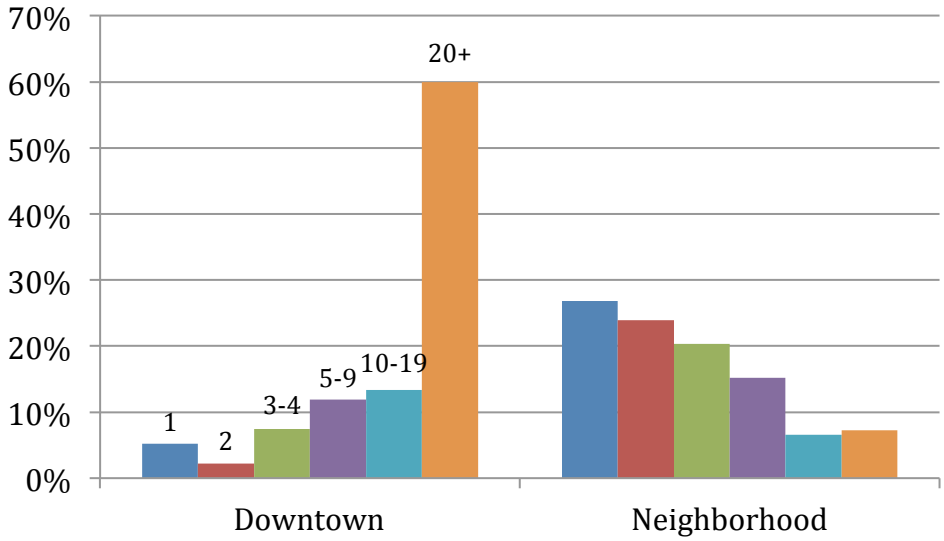
Figure 4: Household income of carshare members and station area residents



As researchers have found in previous studies, carsharing members tend to be highly educated. 87% of those surveyed have a college degree, while nearly one-third have completed graduate school.

In terms of housing characteristics, 83% of members rent compared with 68% of station area households. Neighborhood station areas have higher homeownership rates overall than Downtown areas, and carshare members in these neighborhoods are also more likely to be owners, but still nearly 3 out of 4 members living in Neighborhood areas rent. Survey respondents are just half as likely to live in a single-family residence as are households in their neighborhoods, with over 70% of members living on properties with three or more dwelling units. Figure 5 illustrates the significant divide between members' housing in Downtown station areas, a majority of which is on properties with 20 or more units, and in Neighborhood station areas, where most live on properties with just one or two units. The distribution of housing unit sizes in terms of number of bedrooms is very similar between carshare members and station area populations, with about half of all units containing one or no separate bedrooms.

Figure 5: Number of housing units on properties where carshare members live



Vehicle ownership and parking

Carshare members, as expected, have very low rates of vehicle ownership. Table 2 shows that while just 23% of all station area residents live in households without a vehicle, among carshare members fully 65% are in zero-vehicle households. More carshare members in Neighborhood station areas are in households with cars, but still more than half are not. Notably, car ownership is significantly higher among the overall population in Neighborhood areas, where just 17% of households have no car and more than one-third have two or more. This is clearly a challenge for carsharing feasibility because car owners are less likely to join, but if they do, it offers an opportunity to reduce car ownership and use. Indeed, about half the respondents to the survey had shed vehicles since joining a carsharing service, with an average change in vehicle ownership across all respondents of -0.7 cars.

Table 2: Carshare members by number of vehicles in household

	Vehicles in Household					
	Carshare Survey Respondents			Census Households		
Area	0	1	2+	0	1	2+
Downtown	75%	18%	7%	34%	50%	16%
Neighborhood	55%	29%	16%	17%	47%	36%
All Station Areas	**65%**	**23%**	**12%**	**23%**	**48%**	**29%**
N=264						

Just over half of carsharing members' households have at least one dedicated off-street parking space at home, as shown in Table 3. Consistent with vehicle ownership rates, households in Neighborhood station areas have more dedicated parking spaces than Downtown area households. Comparison with the vehicle ownership rates in Table 2 indicates that carshare members' households have a significant number of dedicated but unused parking spaces.

Figure 6: Parking spaces dedicated to carshare members' households

	Parking Spaces Dedicated to Household			
Area	0	1	2	3+
Downtown	57%	33%	2%	7%
Neighborhood	46%	37%	13%	4%
All Station Areas	**51%**	**35%**	**8%**	**6%**
N=273				

Of members who do own cars, almost 60% park them in an off-street location at home, while about 40% park them on the street. Most provided spaces are free or included in housing costs; less than one-third of car owners with off-street parking pay rent for the space.

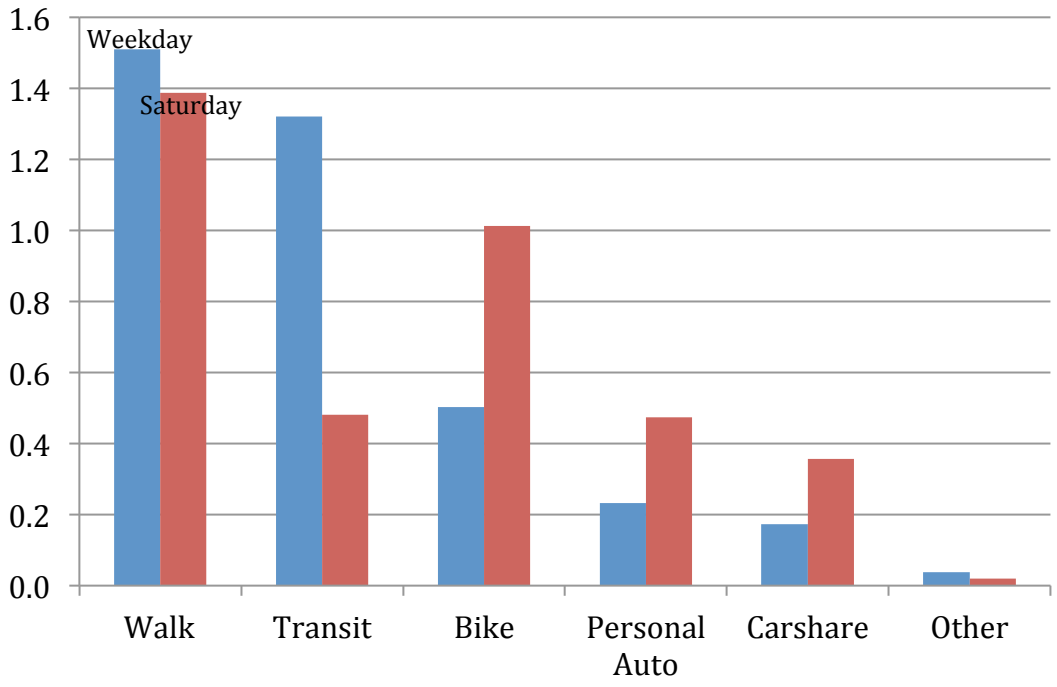
Carshare use and travel patterns

The carshare respondents surveyed made, on average, 3.4 reservations during the month of January, reserved vehicles for a total of 12 hours, and drove 68 miles in carshare vehicles. This is only representative of active carsharing members, not infrequent users who had not made any reservations during the month.

Walking is the most frequent travel among carshare members mode both during the week and on Saturday. The survey asked members how many round trips they took on the most recent midweek day (Tuesday, Wednesday, or Thursday) and Saturday by each mode of travel. Walking was closely

followed by transit as the second most frequent mode on weekdays, but on weekends transit use is much lower while members bicycle about twice as frequently. Carsharing, as expected, plays a supporting role, with members reporting about one trip per week and much higher usage on the weekend. Respondents in Neighborhood station areas took fewer walking trips than Downtown residents and appear to use other modes slightly more.

Figure 7: Daily round trips per carshare member by mode



Carshare Member Profile Implications

Most of this survey's demographic results confirm earlier findings in the literature. Carshare members are typically younger than the station area population as a whole, rent their homes, and more likely to be white, middle-income, and well-educated. Household sizes are generally small, as are housing units, but similar to those of the station area population at large. Neighborhood BART station areas are significantly different in housing character than Downtown areas, with both carshare members and other residents more likely to own homes, live in lower density housing types, and have more bedrooms in their units. Active carshare members are unlikely to own vehicles, but still about half have dedicated off-street parking spaces. Travel patterns indicate that carshare members primarily walk and use transit on weekdays, and trade bicycling for transit as

their second mode on weekends. Carsharing is a supporting mode, with members reserving a vehicle about once a week.

These results suggest that carsharing members likely have many commonalities with small-scale infill housing residents given their youth, typical renter status, small household sizes. However, the survey data also suggest that expanding carsharing in Neighborhood station areas may be challenging given high rates of car ownership and parking space availability among the existing population. Carsharing may also be difficult to match with low-income tenants given the difficulty carsharing organizations have meeting the needs of this market segment.

VI. CARSHARE POD VIABILITY

If carsharing is to allow a reduction in minimum parking requirements, there must be an adequate customer base to make pod locations economically viable. This section describes the types of neighborhoods in which carsharing is likely to be successful, the metrics carshare providers use to evaluate pod success, and how members access a pod. If new carshare expansion accompanies new small-scale residential infill development in existing neighborhoods, the service will need to serve two markets: existing residents, most of whom currently own vehicles, and residents of the new units, some of whom may be car-free and self-select into units that do not have parking but do have carsharing available nearby.

General neighborhood characteristics

Neighborhood characteristics are critical in determining a viable location for carsharing. All the criteria for a promising market need not be present; strength in some areas may outweigh weakness in others, but more marginal locations require greater marketing and outreach efforts to attract a given level of membership to the location (City Carshare, 2005). Residential density is perhaps the most significant and easiest-to-observe factor, although there is no defined threshold for a viable density (Anton, 2010). A denser neighborhood has more people within a five to ten minute walk of a given pod location. By increasing the population that falls within this radius, density reduces the market penetration needed to have enough members to support a pod. Density is also closely related to other important factors, including low vehicle ownership, difficult parking, and a walkable environment.

Low vehicle ownership rates are very important to the success of carsharing in a given neighborhood. While carsharing gradually reduces vehicle ownership, most members already do not own a vehicle prior to joining (Martin et al., 2010). Based on Cervero's findings on the changing membership of City Carshare over time, zero-vehicle households may be more likely to join soon after the service is offered, while car owners join more slowly (Cervero, 2003; Cervero et al., 2007). Therefore, attempting to support a pod by relying on people who currently own cars but might shed them would be particularly difficult in the short run.

Accessibility to transit and neighborhood amenities are important factors because they provide alternatives to driving for many trips (Anton, 2010; Williams, 2011). Carsharing is viable where other transportation modes can fill residents' needs for most trips. Nearby shopping, services, and

recreational activities allow many activities to be accomplished on foot or by bicycle. High-quality transit provides access to destinations farther away. Transit service provides the additional benefit that some users may use it to reach the carshare location, expanding the pod's potential market and increasing transit ridership by making it a competitive travel option where it might not be without carsharing.

Mixed nearby land use is an asset to carsharing pods because it broadens the available market to include business customers (City Carshare, 2005). Businesses typically use carsharing most during the workday, while residents use the vehicles most at night and on weekends. Pods in mixed-use neighborhoods benefit from demand that is less peaked and more distributed throughout the day and week.

Lastly, a difficult neighborhood parking situation strengthens the viability of carsharing (City Carshare, 2005; Williams, 2011). Costly or hard-to-find parking renders car ownership a hassle and carsharing a more attractive alternative.

Many of these criteria are often correlated; for example, dense neighborhoods tend to have lower vehicle ownership rates, more challenging parking situations, and more transit and amenities within walking distance (Holtzclaw et al., 2002). In practice carshare providers may use the data that is easiest to obtain and map, including population density, car ownership rates, and existing member locations, to initially identify prospective sites or expansion areas before conducting a detailed analysis.

Pod Revenue and Costs

In order to be viable, carshare pods must be able to earn sufficient revenue to cover their costs. Variable costs, such as gasoline and some maintenance, increase with the number of miles driven in each carsharing vehicle. However, pod viability is primarily dependent on achieving high enough rates of vehicle use to cover the pod's high fixed costs. The largest fixed cost of a carsharing pod is that of the vehicles themselves, which could be owned or leased by the carsharing provider and are typically replaced after several years. Technology, in the form of sophisticated reservation and card-locking systems, is also a major fixed cost. Parking rates paid by carsharing providers vary widely, from free spaces provided in development projects or other partnerships to market-rate spaces costing several hundred dollars per month. Providers are willing to pay high rates for parking in neighborhoods with the strongest carsharing markets, which not coincidentally often

have the highest parking costs, but lower-demand areas require lower parking costs to remain viable.

Carshare providers use a variety of metrics to measure performance of their pods in achieving adequate revenue to cover costs. Revenue per vehicle is clearly an important metric, since it determines whether the vehicle's costs can be met. Revenue per member and per trip varies considerably because some members use the vehicles frequently while others do so only occasionally and trip durations vary. City Carshare also charges by the mile, so trip distance variations affect revenue. Both providers offer standard and premium vehicles at different rates. In the fourth quarter of 2010, Zipcar reported earning $59 in usage revenue per vehicle per day on average across all of its markets (Zipcar, Inc., 2011a, p. 69), although it continues to operate at a loss. The San Francisco Bay Area is one of Zipcar's most mature markets, so it is reasonable to assume that revenue locally is higher, and probably covers costs, than in markets the company has entered more recently. Multiplying Zipcar's daily usage revenue for a typical 30-day month yields $1,770, which is similar to the revenue per vehicle City Carshare estimates is needed to support operating costs and overhead (Anton, 2010). City Carshare also provides vehicles to low income housing residents at a 50% discount, and these pods are subsidized by others.

In order to meet revenue targets, vehicles must be in use for a significant portion of each day. The vehicle utilization rate, or percentage of each 24-hour day a vehicle is reserved, is a key indicator of pod's success and the success of a carsharing organization as a whole. Mobility Switzerland, one of the world's largest and most successful carshare providers, achieves a rate of about 40 percent, meaning each vehicle is in use more than 9 hours per day (City Carshare, 2005). Zipcar's CEO, Scott Griffith has stated that his company aims to meet or exceed that rate, while cautioning that if the rate is too high members become displeased with the lack of vehicle availability (Griffith, 2008). At typical East Bay hourly rates of $7.50 to $9.75 for standard vehicles (Zipcar, Inc., 2011b), 6 to 8 hours of daily vehicle use would be required to earn the company's average $59 in daily revenue. City Carshare seeks to have vehicles in use about 8 hours per day to cover costs (Anton, 2010).

The number of members needed to support a vehicle varies considerably depending on how many people use the vehicles frequently. As few as 15 members could support a vehicle if they were very heavy users, but 60 to 70 infrequent users would be needed (ibid). Zipcar had an average of 66 members per vehicle across all of its markets at the end of 2010 (Zipcar, Inc., 2011a, p. 69), although some portion may be inactive. Given the need for each vehicle to earn about $1,700-

$1,800 monthly in revenue at maturity, assuming an all-inclusive rate of $8 hourly, and using the survey average of 12 hours of use per member, each vehicle would need about 18 to 19 active members within a half mile radius.

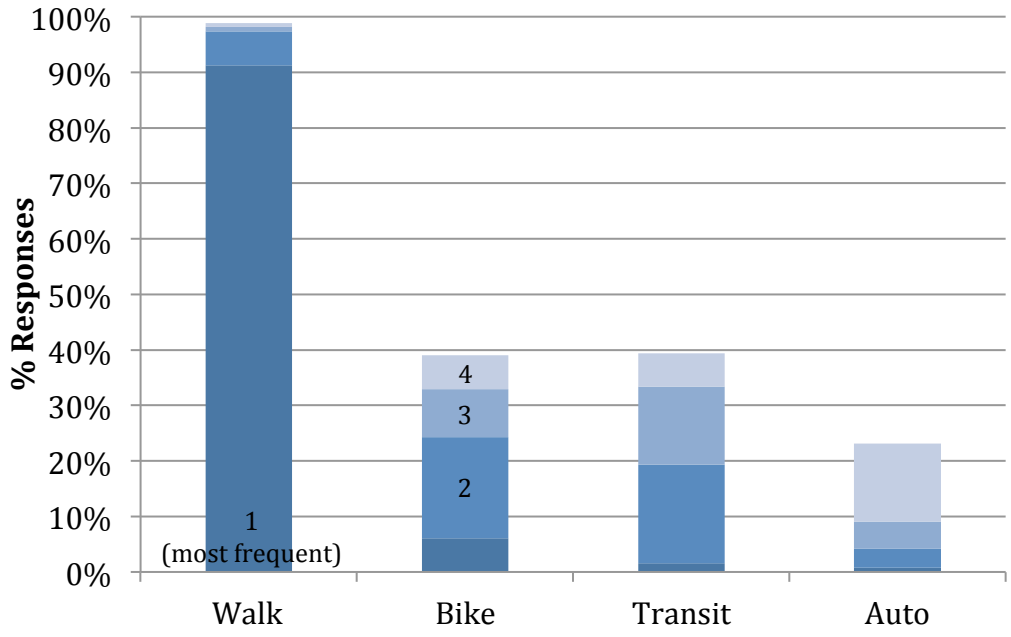
Even where carshare pods might be self-supporting in the long-term, starting a new pod may not be financially viable without assistance. The start-up capital costs are considerable, especially for vehicles and technology, but also parking space setup and marketing. Once opened, it takes about 6 months for a pod to reach a "critical mass" of members (Anton, 2010). Residents who own cars at the time of pod launch join at a slower rate than those who do not, typically after reaching a critical "decision point," such as a major vehicle repair bill or the need to add another car to the household. As a result, pod age is a significant predictor of the usage its vehicles receive (Stillwater, Mokhtarian, & Shaheen, 2009).

Carshare vehicle access modes and distances

The distance carshare members are typically willing to travel to reach a vehicle is key in determining how successful a pod is likely to be. At certain carshare pods, particularly those at BART stations in outlying areas, a significant proportion of vehicle use is from members using transit to access a vehicle and continuing by car to reach places that are not easily transit accessible (Daley, 2010). However, most vehicle locations rely primarily on support from members living or working nearby. The majority of City Carshare members live within a half-mile walking distance of the nearest carshare pod, and fewer than 20% live farther than six-tenths of a mile away (Cervero et al., 2007). At a typical walking speed of three miles per hour, this equates to an approximately ten minute walk.

In this study's survey of station areas, 90% of active carshare members most frequently access a vehicle on foot, as shown in Figure 8. Bicycles and transit are also important for vehicle access, with about 20% of members reporting that each is their second most frequent means to reach a pod. Given that it is the primary means of access, most pods must rely primarily on members within easy walking distance for support.

Figure 8: Carshare vehicle access modes ranked by frequency, all station areas



Most carshare members are willing to walk up to about a half mile, or 10 minutes, to reach a vehicle for a typical trip, although a significant proportion is willing to go farther. Most members are willing to walk more than a quarter mile. Table 3 compares survey respondents living within the half mile radius of BART stations with those living outside the station areas but within ZIP codes that overlap the station area. Those living outside the station areas are generally willing to walk farther than those living closer, but still a majority are willing to regularly go a half mile or less. Since cars are located directly at each station, these results may simply be a function of how far members must walk to reach a vehicle, and that they are less willing to walk to a pod that is not the closest one, wherever it may be. Still, to best ensure a new pod will be successful, carshare providers must typically plan to rely primarily on potential users within a half mile walk.

Table 3: Maximum distance carshare members are typically willing to walk to vehicle, by home location

Respondent's Home Location	Maximum Walking Distance			
	1/4 Mile	1/2 Mile	1 Mile	Over 1 Mile
Within 1/2 Mile of BART	15%	57%	20%	7%
Farther than 1/2 Mile	12%	45%	30%	13%
All Station Areas	**14%**	**52%**	**25%**	**10%**
N=222				

Other pod viability factors

Given the relatively slow rate at which new members join carsharing when a new pod opens, carshare providers often work outwards from areas where the service is most viable (Williams, 2011). They can then build awareness of the service before expanding. Some members also travel relatively long distances, either by transit or bicycle, to reach a pod. Mapping where members live, identifying clusters that are far from existing pod locations, and then placing new vehicles there is an effective strategy to both identify promising areas and have a guaranteed revenue base at launch (Daley, 2010).

Members should be able to access multiple carshare vehicles within reasonable proximity. Both City Carshare and Zipcar prefer to establish pods with at least two vehicles or within easy walking distance of other pods in order to increase the likelihood that one will be available at any particular time (Anton, 2010; Williams, 2011). With only one vehicle in an isolated area, members find the service too unreliable to depend on. Therefore, a new isolated pod location must have market demand for not just one, but at least two vehicles. Aside from existing member locations, this is another reason why it is easier to expand incrementally from established locations; a new car can be placed farther out but within walking distance of existing vehicles, incrementally expanding the number of people with carsharing access.

Carsharing viability with smaller-scale infill development

The findings on carsharing pod viability for infill in Neighborhood station areas are mixed. New carshare pods require potential members to live within an easy half mile walk, and at least two vehicles should ideally be within that distance. Neighborhood characteristics are key in determining the likely success of carsharing. Density is important, but even moderate-density neighborhoods may be viable if car ownership is low, high-quality transit is available, and there are

many destinations within an easy, safe, and pleasant walk. Pods require about $1,700 to $1,800 monthly to cover their costs and organizational overhead, which probably requires about 18 to 19 frequent users. Startup capital costs for carshare pods are high, and it takes about 6 months to reach a sustainable level of membership, so providers prefer to expand incrementally into areas that already have some existing members. This makes incremental expansion from BART stations outward relatively easy, but expansion into entirely new areas, like the next BART station on the line, particularly challenging.

VII. POLICIES TO REDUCE PARKING REQUIREMENTS AND SUPPORT CARSHARING

This section first reviews policies that cities have used to facilitate carshare expansion, then proposes mechanisms to link parking requirement reductions while encouraging carsharing.

Established public policies for carsharing support

Many local governments encourage and support carsharing because it is closely associated with reduced vehicle ownership and driving. Carshare pods need to be self-supporting in the long term, but the high capital costs of establishing a pod and the relatively long period before revenue covers costs make it financially difficult to establish pods quickly or where the market may be marginal in the near-term. Public sector assistance can provide financial backing to support the service and minimize the provider's financial risk, particularly for new pods in places where the carsharing market is not yet established.

Providing public parking spaces for carshare vehicles

Providing parking is one of the most important and popular ways local governments can facilitate carsharing expansion, and most North American carshare providers have access to public parking spaces (Millard-Ball et al., 2005; Shaheen, Cohen, & Martin, 2010). Parking often represents a significant cost associated with a carshare pod, and securing access to convenient privately-owned parking spaces can be a serious challenge to carsharing providers. Local governments own large supplies of parking spaces, including on-street curb parking and off-street lots. On-street parking spaces are located in particularly convenient locations and have the advantage of high visibility, essentially advertising carsharing to everyone who walks by a parked vehicle. Challenges with on-street spaces are enforcement against illegal parking in the spaces, street cleaning, and potential political backlash against reserving spaces for a private entity where street parking demand is high.

Setting a clear policy for providing public parking to carsharing providers helps to ensure that a public benefit is provided and exchange and to maximizes community support. City Carshare recommends clearly defining "carsharing", setting criteria that providers must meet to qualify for spaces, and ensuring merchant and neighbor support for the spaces (Daley, 2010). Qualifying criteria could include using the on-street spaces for service expansion, rather than replacement of off-street vehicles, documentation of auto ownership and driving reductions or other desired outcomes, or fuel efficiency standards for the vehicle fleet. The city would also need to determine how to allocate spaces. Whether carsharing providers should pay for the use of reserved public parking spaces is an area of unsettled policy among local governments, with some cities charging

the market price for spaces, others discounting the price, and many providing spaces for free (Shaheen et al., 2010).

Requiring developers to include carsharing spaces

Another approach cities can take to ensuring a ready supply of parking for carshare vehicles is to require that developers provide dedicated carshare vehicle spaces in new projects. San Francisco's ordinance requires residential developments with 50 or more units and on-site parking to provide dedicated carsharing spaces at no cost to the carsharing organization (City of San Francisco, 2010). Other vehicles may occupy these spaces unless or until a carsharing provider requests them. Cities can also require carsharing spaces as a mitigation in developments that provide less than the standard amount of parking; in the City of Berkeley, developer Patrick Kennedy built the downtown Gaia building with an exception to the required minimum parking ratio but was required to include dedicated carsharing spaces (Millard-Ball et al., 2005, pp. 5-25).

Aside from the clear benefit to carsharing providers of free parking spaces in neighborhoods with new infill development, carshare parking in residential buildings allows for valuable marketing partnerships with building managers. Both City Carshare and Zipcar actively reach out to developers to make the case for carsharing as a building amenity and encourage them to include vehicles in their buildings and actively market them to tenants (Daley, 2010; Williams, 2011). Developers often have concerns about non-resident access to vehicles in secured areas on their property, but maintaining access to the vehicles by all carsharing members is strongly preferred by providers and usually essential to ensure an adequate support base for the pod. A single building can rarely support a pod on its own, so carsharing providers evaluate locations in new developments by examining neighborhood characteristics just as they would for other new pods (Anton, 2010; Williams, 2011).

Cities have not applied mandatory carshare parking requirements to smaller projects, likely due to proportionality concerns with requiring small developments to subsidize a parking space that would serve a much larger population than is housed on the site. However, cities could negotiate a carshare parking requirement in a smaller project in exchange for reduced parking requirements.

Startup costs or revenue guarantees

Cities can also support carsharing expansion by assisting with startup costs, either with direct financial contributions or grant funds. Many cities have successfully applied for Federal grants to fund new vehicle acquisition, parking space set-up, technology installation, and other capital costs

for new carsharing locations (Millard-Ball et al., 2005, pp. 5-17). Another approach is to offer a revenue guarantee, in which a city (or developer) pays the provider the difference between monthly vehicle revenue and a predetermined amount for a set period of time. City Carshare, for example, might ask a developer to guarantee monthly revenue up to $1,500 for a new carshare pod in their building for the first 6 months. The developer might pay much of the $1,500 the first month, but as revenue increases they pay less or nothing at all. This type of arrangement as a good way to both reduce the capital outlays required for a pod and encourage developers to enthusiastically market the service to tenants (Anton, 2010). Arlington County, Virginia used a similar 6-month revenue guarantee to successfully encourage carshare providers to fast-track the launch of pods throughout its transit corridors (Millard-Ball et al., 2005).

Cities can also provide financial support for carsharing with fleet sharing. The local government replaces a portion of its vehicle fleet with fewer vehicles managed that are managed more efficiently by a carsharing provider. Whereas other forms of financial support may cost the city money, fleet sharing is designed to save money by allowing the city to reduce the size of its vehicle pool. For the carsharing organization, the guaranteed revenue provided by the agreement can help cover capital costs of expanding service nearby. The City of Berkeley has a fleet sharing agreement with City Carshare that also allows the vehicles to be used by the public during evenings and weekends, when carsharing demand is highest (Daley, 2010). However, fleet sharing may not directly help expand carsharing into new neighborhoods that do not have a nearby government presence.

Marketing and promotion

Marketing and outreach support, either directly by cities or by developers, is also a valuable benefit to carsharing providers. Local jurisdictions can assist directly by promoting carsharing along with other alternatives to car ownership and regular use. Arlington, Virginia includes a carsharing section on its commute options website, www.commuterpage.com, that explains how carsharing works and promotes membership as a way to reduce household car ownership. “Options poles,” pioneered in Portland, are brightly colored poles at on-street carsharing locations that feature alternative transportation themes and marketing information about carsharing (Millard-Ball et al., 2005). When City Carshare opened a new pod in the City of Alameda’s Webster commercial district, the City put a banner over the street to raise awareness (Anton, 2010).

Developers are also important as marketing partners because of the direct access they have to potential members. Effective marketing strategies include posting information about carsharing in common areas, distributing it to residents, advertising it to potential tenants, and distributing membership materials as part of the leasing process (Daley, 2010). These activities can be encouraged or required by cities as part of development Transportation Demand Management agreements, or a developer may promote carshare simply to keep a pod on-site that he or she values as an amenity.

Combined policy approach

Providing parking, assisting with startup costs, and contributing to marketing and outreach are the most significant ways to facilitate carsharing expansion, but a combined policy approach allows these elements to work together in a self-reinforcing manner. For example, citywide policy encouraging developers to incorporate carsharing and special marketing efforts can be combined with startup funding for pods that are in new, untested market areas. But given that difficult or expensive parking is important to carsharing success, achieving greater reductions in car ownership and use can best be accomplished with a linked suite of parking and carsharing policies.

Parking and carsharing: potential policies

These policies represent possible applications of parking and carsharing policies in small- and medium-size infill projects to reduce the negative impacts of minimum parking requirements while ensuring that serious parking overflow problems do not result. These policies must be appropriate for both projects built by commercial developers and property owners building additional secondary dwelling units. Individual owner-builders may be less able to navigate complex city approval requirements or pay high permit fees, and their relationships with tenants are often familial or friendships, rather than purely business relationships. Therefore, to avoid discouraging development, policies must manage vehicle ownership while minimizing the complications and costs of project approval and requirements. Cities should also avoid placing complicated conditions that require ongoing enforcement on numerous small-scale development projects to minimize monitoring costs over time.

Reducing parking requirements

One policy option is to simply reduce parking requirements for infill development, especially near transit, without adding any other restrictions on property owners. Cities could also implement policies to facilitate carsharing without establishing a defined link with parking regulations. The parking demand evidence indicates that parking requirements in many jurisdictions could be

reduced in BART station areas while still accommodating residents' vehicles and not causing spillover problems. This is especially true in cities with parking minimums greater than about 1 to 1.3 spaces per unit.

Even cities that already have less stringent parking requirements could likely reduce them further for accessory dwelling units by accepting that street parking will meet residential parking demand will be met on the street. For example, if single family lots are an average of 45 feet wide, there is curb space for just over two vehicles to parallel park if there is no driveway curb cut. With two units on every property in duplexes or a single family homes with secondary units, even if every property had zero off-street spaces, there would be room on the street for each unit to park about one vehicle. While current average vehicle ownership in Neighborhood station areas is higher, in reality most property owners would retain their existing driveways. New accessory dwelling units would also be likely to have significantly lower auto ownership rates than the existing single family building stock because they accommodate smaller households.

Where new infill development is dispersed in small individual projects, rather than concentrated on a few sites, any overflow from reduced parking on-site may be absorbed without placing a significant burden on neighborhood streets. The City of Portland has eliminated parking requirements within close proximity to frequent transit lines, and some new developments on transit-served arterials outside downtown have taken advantage of the relaxed requirements (P. Smith, 2011). According to the City's planning staff, there have been few complaints resulting from those developments and they have not become a major political issue. Although there has been no follow-up study of the regulation change, the absence of controversy may be because the new development has been dispersed enough that the low car ownership rates in the new units have not caused a concentrated parking shortage. This suggests that efforts to implement dispersed infill development with reduced parking requirements may encounter fewer political issues than if parking requirements are reduced in larger projects concentrated together.

Reducing parking requirements without additional policy changes would benefit housing construction by reducing costs and possibly allowing density to increase. Yet, it may only incentivize a reduction in auto ownership and use if it causes street parking to become less readily available. Once parking becomes more challenging, residents would be more inclined to search for alternatives to car ownership. Policies to financially support carsharing expansion, such as an on-street parking policy, could be implemented simultaneously. Still, I recommend that cities provide

more direct incentives for residents to use car ownership alternatives. A policy that specifically incentivizes use of carsharing and other modes would reduce car ownership earlier better support carshare pod establishment, and avoid political fears of parking spillover from new development.

Limiting residential parking permits

Residential parking permits (RPP) are required in order to park for more than a few hours on streets in certain areas of Berkeley, Oakland, and El Cerrito that have high non-residential parking demand. The intent of RPP districts is to reserve on-street parking for residents rather than commuters accessing business districts or transit stations. The City of Berkeley has exempted some new developments' residents from RPP permit eligibility in order to prevent reduced parking requirements or unbundled parking from resulting in overflow on neighborhood streets. Cities could extend similar restrictions to builders of smaller-scale infill development, including accessory dwelling units, in other neighborhoods with RPP programs. Limits on the number of RPP permits available to all units on the property would be particularly warranted if off-street parking to meet typical demand rates is not provided. For example, a single family residence and new accessory dwelling unit with no off-street parking could be restricted to a combined maximum of two parking permits, which would approximate the number of vehicles that could be accommodated in front of a 40-foot wide lot.

This strategy would virtually guarantee that relaxing off-street parking requirements would not result in excessive parking overflow, but would require additional City recordkeeping to track the number of parking permits available and issued for each property. It would be impractical to permit between zero and one parking permit per unit for multi-unit buildings because the city would need a mechanism to allocate the permits fairly among multiple property owners or tenants. Of course, this system would not work where RPP is not in place, and it would provide only indirect support for carsharing by limiting vehicle ownership. It may also seem more punitive to potential builders of accessory dwelling units and their tenants than other strategies because it only restricts transportation options rather than providing incentives to promote alternatives. Moreover, residents of different properties may have different car ownership needs over time, for example when jobs change between places with different degrees of transit access, and the RPP limitation system does not provide flexibility to allow adaptation to new life circumstances.

Transportation demand management and parking in-lieu fees

Many cities require certain developers to incorporate Transportation Demand Management (TDM) measures in new developments, which might include initiatives such as parking pricing unbundled

from housing costs, free transit passes, or carsharing parking spaces in the building and subsidies for residents. However, many of these strategies are more difficult to apply and enforce for smaller projects. In Berkeley, TDM agreements have been negotiated in major developments, for example downtown, but are not applied to small as-of-right development elsewhere (Nelson/Nygaard Consulting, 2010). In San Francisco, the requirement to provide carshare parking applies only to buildings with 50 or more units. AC Transit provides an innovative EasyPass program in which residential communities can purchase bus passes for all residents at discounts of more than 90 percent, but only projects with 100 or more units are eligible. (AC Transit, 2010).

Parking in-lieu fees are a means to permit reduced on-site parking provision for new development if the developer pays a fee instead. The fees are collected in a fund dedicated to either providing public parking or encouraging use of alternative modes to reduce parking demand. The Berkeley Zoning Ordinance, for example, permits the establishment of parking in-lieu fees in commercial and industrial areas where a fund to construct public parking exists (City of Berkeley, 1999). The ordinance provides the option for payment to be either upfront at the time a certificate of occupancy is issued, or as an ongoing annual fee.

Cities could establish funds in specified transit-served residential districts to assist with the challenge of applying transportation and parking demand management strategies to small- and medium-scale infill. Contributions required from developers could fund initiatives to reduce auto ownership. Payments could be required from all new development, or only from projects that do not meet parking standards. The districts would allow these smaller projects to take advantage of the programs and policies available for larger developments. For example, combined upfront one-time fees could subsidize the startup costs of new carsharing pods in the neighborhood, or provide temporary revenue guarantees in areas with unproven markets for carshare. Alternatively, low ongoing annual fees could fund the purchase of bulk transit passes and discounted carsharing memberships that would be distributed free to each household on properties paying the fee.

Green transportation districts

This strategy would be an aggressive effort to reduce auto ownership among all households by increasing residential parking permit prices and using the revenue to fund alternative transportation incentives. Rather than restricting car ownership among just the residents of new infill development, it would offer a disincentive to vehicle ownership for all households. Currently, residential parking permit fees are typically set to cover only the costs of administering the

program. Under this proposal, the districts would be redefined as "green transportation districts" with increased fees for parking permits. Similar to the parking benefit districts described by Shoup (Shoup, 2005, p. 519), the fees would be used to benefit residents of the district in the form of programs and incentives to encourage the use of alternative transportation modes. Free carsharing memberships and a small amount of free driving credit annually could be combined with free bulk-purchased transit passes or fare value, gift certificates to local bike shops. The program could also fund programs to improve the experience of those using alternative transportation modes by upgrading pedestrian and bicycle infrastructure, planting street trees, calming vehicle traffic, and improving transit stops.

Clearly, significant increases to parking fees would be challenging in a political environment that values free and easily available parking. This proposal may not be any more politically palatable than simply reducing parking requirements; while reducing parking requirements would make street parking potentially less available, the green transportation district would instead increase parking costs. However, the two proposals combined could have numerous positive impacts, improving infill housing feasibility while reducing auto use and providing benefits to encourage alternatives among for all neighborhood residents.

On-Street Carshare Parking

Providing free on-street parking spaces for carshare vehicles would reduce the costs and difficulty for carsharing providers to find spaces for expansion. It would also provide highly visible locations to increase the prominence of carsharing in neighborhoods and potentially improve membership rates. As previously discussed, cities would need to set clear policy defining "carsharing", the public benefits expected in return for providing free reserved street space, and how to determine the allocation of parking spaces. Establishing an on-street carsharing policy is an important supportive policy to encourage carsharing, but only improves carsharing viability at the margin and does not address problems with residential parking requirements. On-street carsharing should be combined with policies that directly encourage carsharing use and reduce minimum parking requirements.

IV. CONCLUSION AND RECOMMENDATIONS

Minimum parking requirements increase housing costs, decrease the feasibility and density of infill development, and encourage greater auto ownership and use. The requirements are especially problematic in transit station areas, where additional density is most desirable but vehicle ownership and use are lowest. However, reducing parking requirements alone may result in political backlash due to fears of overcrowded street parking. By providing convenient access to vehicles only when residents need them, carsharing reduces the need for vehicle ownership and parking demand. This study evaluates the potential for linking decreased parking requirements with carsharing by evaluating parking demand, profiling the market for carsharing, specifying the requirements for carshare pod viability, and identifying potential policy mechanisms to reduce parking requirements and replace auto ownership with carsharing. The study focuses on small- to medium-scale development in non-downtown transit station areas because existing policy solutions are particularly lacking in this context.

Data on parking occupancy and TOD vehicle ownership suggests that parking requirements in many station areas could be reduced without resulting in a spillover problem, especially where they are higher than about 1.0 to 1.3 spaces per unit. Further reductions are possible in low-density areas if cities assume that some parking demand can be accommodated in front of each property on the street. A difficult parking situation motivates people to reduce their auto ownership, so if policy were aimed at reducing vehicle use without regard to parking challenges, then requirements could be eliminated altogether.

Carshare members are, in some ways, similar to likely infill housing residents; they are generally young renters in small households. They also tend to be well educated and middle-income. The low proportion of low-income members may make it difficult to attract residents of new low-income housing unless the service is subsidized. Carshare members typically do not own a car, and walk, take transit, and bicycle as their primary modes of transportation. Relative to the population in Downtown station areas, residents near Neighborhood stations have larger households, live in lower-density housing types, are more likely to own their homes, and have higher vehicle ownership, indicating possible challenges in expanding carsharing there. However, if enough small rental housing units are built, the neighborhood profile could begin to change.

There are certainly challenges with expanding carshare access and use in lower-density station areas. Given moderate residential densities and less favorable demographics, there is a smaller market for vehicles within an easy walking distance. Still, since fewer than 20 frequent users are needed to support a vehicle, expansion could be achieved with incentive programs or even with relatively small increases in target population groups through infill development. Outward expansion from successful existing pods at stations would likely be easier than establishing entirely new pods at stations far from the established market and member base. Given capital costs, expansion would be more feasible and faster with strong policy support, especially for more challenging locations.

Existing policy mechanisms to support carsharing include providing public parking spaces, requiring developers to include dedicated parking, assisting with pod startup costs, and promoting and marketing the service. These strategies could be simply combined with reduced parking requirements to facilitate infill development while increasing support for carshare. However, a more explicit effort to link parking requirement reduction to reduced car ownership would more effectively reduce parking demands and strengthen the market for carsharing.

Limiting access to residential parking permits for new development offers one strategy that is virtually guaranteed to solve potential parking overflow problems, but takes a punitive course by permanently restricting auto access to certain neighborhood residents while only indirectly supporting alternative transportation modes.

An approach that focuses instead on incentivizing alternatives would be to require payment of infill development fees into a demand management fund on a one-time or ongoing basis. The fund would then be used to pay for temporary carsharing start-up support or ongoing provision of carsharing memberships and bulk-rate transit passes for all infill development residents, strongly incentivizing auto ownership alternatives.

Finally, potentially the most ambitious strategy would be to charge increased residential parking permit fees to all residents of a "green transportation district" in order to fund a more broad-based program of transportation incentives and non-automobile infrastructure improvements. This alternative would manage parking demand while providing direct user subsidies for carsharing and transit as well as funding local pedestrian, bicycle, transit, and streetscape improvements.

Given that low- to moderate-density neighborhoods typically have higher vehicle ownership and are naturally weaker carsharing markets than denser downtown areas, strong incentives are needed to encourage residents to switch from owning and driving a personal automobile to walking, bicycling, riding transit, and carsharing. Transit station areas are the ideal locations to encourage this shift because transportation options are readily available and reducing parking requirements to facilitate infill development is particularly important. Comprehensive strategies to reduce parking requirements while encouraging carsharing and alternative modes would most effectively reduce barriers to new housing construction while reducing demand for street parking.

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APPENDIX A: CARSHARE MEMBER SURVEY INSTRUMENT

City Carshare Member Survey

1. Beginning the Survey

Thank you for participating in the online survey for our research project at the Center for Community Innovation at the University of California, Berkeley!

At the conclusion of the survey, you may enter a raffle to win a $50 City Carshare driving credit plus $50 in BART fare.

Before we begin the survey, please review the following very important consent information. You cannot begin the online survey until you have indicated that you have read through it and understood it.

Please click Next to proceed.

2. Introduction and Purpose

My name is Karen Chapple. I am a faculty member at the University of California, Berkeley in the Department of City and Regional Planning. I work in the University's Center for Community Innovation (CCI). I would like to invite you to take part in my research study, which concerns the relationship of carsharing to neighborhood characteristics, parking availability, and transportation choices.

Procedures

If you agree to participate in my research, I will ask you to complete this online survey/questionnaire. The survey will involve questions about your carshare use, neighborhood, household, and travel choices, and should take about 15 minutes to complete.

Benefits

There is no direct benefit to you from taking part in this study. It is hoped that the research will benefit society by contributing to knowledge of where carsharing is most successful and how it might expand into additional neighborhoods.

Risks and Discomforts

Some of the research questions may make you uncomfortable. You are free to decline to answer any questions you don't wish to, or to stop participating at any time. As with all research, there is a chance that confidentiality could be compromised; however, we are taking precautions to minimize this risk. These precautions are described in detail in the next section.

3. Confidentiality

City Carshare Member Survey

Your study data will be handled as confidentially as possible. The research team does not have access to any of your personal information, except what you choose to provide by answering the survey questions. If results of this study are published or presented, any personally identifiable information that you provide will not be shared.

City Carshare is partnering with the research team to administer the survey, but City Carshare is not part of the research team. The research team will not share your survey data with any outside parties, with the sole exception of City Carshare. City Carshare will have access to the survey data and will handle the survey information you provide in accordance with the City Carshare Privacy Policy.

In our survey, we ask you to indicate whether or not you would like to be entered into the prize raffle. If you decide to participate in the raffle, you will be asked to provide your City Carshare Member ID number for the purpose of contacting the winner. City Carshare will contact you if you are the winner and will not share your contact information with the research team without your consent.

When the research is completed, I (Professor Karen Chapple) may save the data for use in future research done by myself or others. I will retain these records for up to 5 years after the study is over. The same measures described above will be taken to protect confidentiality of this study data.

4. Your Rights and Questions

Your Rights

Your participation in this research is completely voluntary.
You are free to decline to take part in the project. You can decline to answer any questions and are free to stop taking part in the project at any time. Whether or not you choose to participate, to answer any particular question, or continue participating in the project, there will be no penalty to you or loss of benefits to which you are otherwise entitled.

If you have any questions about this research, please feel free to contact me (Karen Chapple). I can be reached at (510) 642-1868 or chapple@berkeley.edu.

Questions

If you have any questions about your rights or treatment as a research participant in this study, please contact the University of California at Berkeley's Committee for Protection of Human Subjects at 510-642-7461, or e-mail subjects@berkeley.edu.

5. Indication of Understanding and Consent

City Carshare Member Survey

Please take your time to carefully review the information displayed previously. If you have read and understood the consent information, and if you agree to fill out this online survey, then please indicate your acceptance by checking the box below. You may want to print out a copy of this page for your records.

*** 1. Please indicate your consent to participate in the survey by clicking on the button below.**

◯ I have read and fully understood the consent information above. I willingly agree to participate in this online survey.

6. Membership Information

Thank you for taking the time to fill out this survey. As detailed previously, your individual answers will remain confidential and will not be shared outside City Carshare and the research team.

Some questions may be easier to answer if you open your carsharing bill from last month (go to the account section after logging in and select the Usage tab.)

1. About how many years have you been a City CarShare member?

Years:

2. Are you or have you ever been a member of another carshare provider?

◯ I am a current member of another provider.

◯ I am a previous, but not current, member of another provider.

◯ I have only been a member of City Carshare.

7.

1. Have you already filled out this Center for Community Innovation survey with another carshare provider sometime in the last week?
(If yes, you may still enter both prize drawings.)

◯ Yes

◯ No

8. Reservations

1. How many City CarShare reservations did you make in the month of January?
(Checking a recent bill may be helpful if you cannot recall.)

◯ Zero

◯ More than zero. Please enter the number below:

City Carshare Member Survey

9. Hours and Miles

1. How many hours did you reserve City CarShare vehicles last month? (Checking a recent bill may be helpful if you cannot recall.)

Hours:

2. How many miles did you drive in City CarShare vehicles last month? (Checking a recent bill may be helpful if you cannot recall.)

Miles:

10. Personal and Business Use

1. Do you reserve City CarShare vehicles for business or personal use?

- ◯ Almost exclusively for business use
- ◯ Almost exclusively for personal use
- ◯ Both business and personal use

11. Vehicle Access

1. Do you usually access a City CarShare vehicle from work, home, or another location?

- ◯ Usually from work
- ◯ Usually from home
- ◯ I access vehicles from work and home with about equal frequency.
- ◯ I am usually coming from somewhere other than work or home.

12. Vehicle Access

1. When you access a City CarShare vehicle from home, how do you most often reach it? (Please check all transportation modes that you use to access vehicles, ranking by frequency. Omit modes you never use.)

	1 (Most frequent)	2	3	4
Walk	◯	◯	◯	◯
Bike	◯	◯	◯	◯
Public transit	◯	◯	◯	◯
Auto (i.e. getting dropped off by someone in a car)	◯	◯	◯	◯

13. Neighborhood Identification

City Carshare Member Survey

The next three questions ask you to identify an intersection near where you live. This enables the research team to learn about the relationship between neighborhood characteristics and your carshare use. As with the rest of the survey, your individual responses will be kept confidential.

1. In what city do you live?

2. What is the name of your street?

3. What is the name of the closest cross street, meaning a street that intersects your street, to your home?

14. Vehicle Access and Parking

1. For short trips (rather than an all-day reservation), what is the farthest that you are usually willing to travel to access your City Carshare vehicle?

- ◯ 1/4 mile (about a 5 minute walk)
- ◯ 1/2 mile (about a 10 minute walk)
- ◯ 1 mile (about a 20 minute walk)
- ◯ More than 1 mile

2. How many dedicated parking spaces are available on your property to members of your household?

Spaces:

3. If you or a visitor were looking for a space to park your car on the street of your block at various times of the day and week, how often would you or your visitor be able to find one?

- ◯ Parking on my block is almost always available.
- ◯ Parking is usually available, but I see that all spaces are full at least once a week.
- ◯ All parking on my block is full for part of each day, but empty at other times.
- ◯ There is rarely an available parking space on my block.
- ◯ Street parking is not permitted on my block.
- ◯ Not sure

15. Housing

City Carshare Member Survey

1. Think back to when you chose your current home. Did you consider any of the following to be important factors in selecting the location of your home?
(Please check all factors you considered, ranking by importance. Omit items you did not consider important.)

	1 (most important)	2	3	4	5	6
Parking availability on-site	◯	◯	◯	◯	◯	◯
Parking availability on the street	◯	◯	◯	◯	◯	◯
Nearby transit	◯	◯	◯	◯	◯	◯
Destinations easily accessible via walking or bicycling	◯	◯	◯	◯	◯	◯
Safe walking and bicycling routes	◯	◯	◯	◯	◯	◯
Nearby carshare vehicles	◯	◯	◯	◯	◯	◯

17. Home Selection

1. Imagine that you are moving to a new home. Would you consider any of the following to be important factors in selecting the location of your new home?
(Please check all factors you would consider, ranking by importance. Omit items you would not consider important.)

	1 (most important)	2	3	4	5	6
Parking availability on-site	◯	◯	◯	◯	◯	◯
Parking availability on the street	◯	◯	◯	◯	◯	◯
Nearby transit	◯	◯	◯	◯	◯	◯
Destinations easily accessible via walking or bicycling	◯	◯	◯	◯	◯	◯
Safe walking and bicycling routes	◯	◯	◯	◯	◯	◯
Nearby carshare vehicles	◯	◯	◯	◯	◯	◯

18. Alternatives to Carsharing

City Carshare Member Survey

1. If carsharing were not available to you, how else would you make the trips you usually make in a City Carshare vehicle? (Please check up to five alternatives you would choose, ranking by the number of City Carshare trips you would replace with each choice.)

	1 (largest number of trips replaced)	2	3	4	5
Borrow a car from someone I know	◯	◯	◯	◯	◯
Ask for a ride from someone I know	◯	◯	◯	◯	◯
Rent a car	◯	◯	◯	◯	◯
Buy a car (or an additional car)	◯	◯	◯	◯	◯
Taxi	◯	◯	◯	◯	◯
Take public transit	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯
Walk	◯	◯	◯	◯	◯
I would not make the trip(s) at all.	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯

19. Vehicle Ownership

1. Prior to joining carsharing, how many cars did you own or lease, including jointly owned vehicles?

◯ 0 ◯ 1 ◯ 2 ◯ 3 ◯ 4+

2. How many cars do you now own or lease, including jointly owned vehicles?

◯ 0 ◯ 1 ◯ 2 ◯ 3 ◯ 4+

3. What is the total number of cars owned or leased all members of your household, including yourself, family members, and housemates?

◯ 0 ◯ 1 ◯ 2 ◯ 3 ◯ 4+

The following section asks one or two questions about parking for each car (up to 4) that is owned by members of your household. We'll call each car "Car 1", "Car 2", etc.

20. Car 4 Parking

City Carshare Member Survey

1. Where is Car 4 most often parked when it is at your home? (Please select one)

- ◯ On your property in a driveway or parking lot
- ◯ On your property in a garage or carport
- ◯ On-street (i.e. at the curb)
- ◯ Off-street somewhere else in your neighborhood
- ◯ Further than walking distance from your house

21. Car 4 Parking

1. If Car 4 is parked on the street, how far from your home is it most often parked? (Please select one)

- ◯ Right in front of your home
- ◯ Not right in front of your home but within 1 block
- ◯ Between 1 and 2 blocks away
- ◯ 2 or more blocks away

22. Car 4 Parking

1. If your household pays to park Car 4 off-street at or near your home, what is the monthly cost of its parking space? If the space is free, enter 0 (zero).

$ _____

23. Car 3 Parking

1. Where is Car 3 most often parked when it is at your home? (Please select one)

- ◯ On your property in a driveway or parking lot
- ◯ On your property in a garage or carport
- ◯ On-street (i.e. at the curb)
- ◯ Off-street somewhere else in your neighborhood
- ◯ Further than walking distance from your house

24. Car 3 Parking

City Carshare Member Survey

1. If Car 3 is parked on the street, how far from your home is it most often parked? (Please select one)

- ◯ Right in front of your home
- ◯ Not right in front of your home but within 1 block
- ◯ Between 1 and 2 blocks away
- ◯ 2 or more blocks away

25. Car 3 Parking

1. If your household pays to park Car 3 off-street at or near your home, what is the monthly cost of its parking space? If the space is free, enter 0 (zero).

$

26. Car 2 Parking

1. Where is Car 2 most often parked when it is at your home? (Please select one)

- ◯ On your property in a driveway or parking lot
- ◯ On your property in a garage or carport
- ◯ On-street (i.e. at the curb)
- ◯ Off-street somewhere else in your neighborhood
- ◯ Further than walking distance from your house

27. Car 2 Parking

1. If Car 2 is parked on the street, how far from your home is it most often parked? (Please select one)

- ◯ Right in front of your home
- ◯ Not right in front of your home but within 1 block
- ◯ Between 1 and 2 blocks away
- ◯ 2 or more blocks away

28. Car 2 Parking

1. If your household pays to park Car 2 off-street at or near your home, what is the monthly cost of its parking space? If the space is free, enter 0 (zero).

$

29. Car 1 Parking

City Carshare Member Survey

1. Where is Car 1 most often parked when it is at your home? (Please select one)

- ◯ On your property in a driveway or parking lot
- ◯ On your property in a garage or carport
- ◯ On-street (i.e. at the curb)
- ◯ Off-street somewhere else in your neighborhood
- ◯ Further than walking distance from your house

30. Car 1 Parking

1. If Car 1 is parked on the street, how far from your home is it most often parked? (Please select one)

- ◯ Right in front of your home
- ◯ Not right in front of your home but within 1 block
- ◯ Between 1 and 2 blocks away
- ◯ 2 or more blocks away

31. Car 1 Parking

1. If your household pays to park Car 1 off-street at or near your home, what is the monthly cost of its parking space? If the space is free, enter 0 (zero).

$ _____

32. Travel

City Carshare Member Survey

1. Thinking back to the most recent Saturday, not including today, estimate the number of round trips you took throughout the day. This includes all modes of transportation, like walking, bicycling, or taking a bus.

If a trip includes more than one mode, count the mode that covered the longest distance for that round trip. (For instance, if you walk to BART and ride BART to work, count it as a BART trip only.)

Walk	
Bicycle	
BART	
Other local transit (e.g. AC Transit)	
Driving or riding in a personal vehicle (owned by you or someone else)	
Driving or riding in a carshare vehicle	
Other	

33. Travel

1. Thinking back to the most recent Tuesday, Wednesday, or Thursday, not including today, estimate the number of round trips you took throughout the day. This includes all modes of transportation, like walking, bicycling, or taking a bus.

If a trip includes more than one mode, count the mode that covered the longest distance for that round trip. (For instance, if you walk to BART and ride BART to work, count it as a BART trip only.)

Walk	
Bicycle	
BART	
Other local transit (e.g. AC Transit)	
Driving or riding in a personal vehicle (owned by you or someone else)	
Driving or riding in a carshare vehicle	
Other	

City Carshare Member Survey

34. Demographic

The final questions of the survey ask about demographic information. As with the rest of the survey, your individual answers are confidential.

1. What is your age?

- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ 66-75
- ◯ 76+

2. What is your gender?

- ◯ Male
- ◯ Female
- ◯ Prefer not to specify

3. How many people live in your household (including yourself)?

- ◯ One (just me)

More than one. Please enter number below:

35. Demographic

1. How many people who live in your household are members of a carsharing service?

Number:

2. How many children (people under the age of 18) live in your household?

Number:

3. How many of the people (including yourself) living in your household are age 65 or older?

Number:

36. Demographic

City Carshare Member Survey

1. What is your race?

- ◯ White/Caucasian
- ◯ Black/African American
- ◯ Asian or Pacific Islander
- ◯ American Indian or Alaska Native
- ◯ Other
- ◯ More than one race

2. Are you Hispanic, Latino, or Spanish?

- ◯ Yes
- ◯ No

3. Do you speak a language other than English at home?

- ◯ No
- ◯ Yes (please specify)

37. Demographic

1. Are you currently a full-time student at a college or university?

- ◯ Yes
- ◯ No

2. What is the highest degree or level of school that you have completed?

- ◯ High school diploma or less
- ◯ Some college credit
- ◯ College degree
- ◯ Some graduate study
- ◯ Graduate degree

City Carshare Member Survey

3. What was your household's approximate pre-tax income in 2010?

- ◯ Less than $25,000
- ◯ $25,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $149,999
- ◯ $150,000 or more

38. Completion and Raffle Entry

Thank you! We appreciate the time you have taken to fill out this survey.

If you would like to be entered in a drawing to win a $50 City Carshare driving credit plus $50 in BART fare, please provide your City Carshare Member ID number below. Your survey responses will remain confidential, and we will only use this information to reach you if you have won a prize.

1. City Carshare Member ID number:

Thanks again for your participation!

APPENDIX C: CARSHARE PROVIDER INTERVIEW QUESTIONS

Note: The research team will not share any information you would like us to keep confidential, and will use it only to inform policy recommendations.

Background information:

1. How long have you been involved with this organization?
2. What is your role?

Data sharing:

3. Does your organization collect data on your car-share members such as their distance from transit, distance from car-share vehicles, neighborhood density, or off-street parking access on carshare membership and usage?
    a. If so, have you analyzed the data in any reports you could share with us?
    b. Would you be willing to share the raw data with us? (This would be kept confidential.)

Relationship between car sharing membership and residence near a rail station:

4. Are people more likely to become members of your car sharing organization if they reside close to a BART station? If so, how close to a BART station do you start to see differences?

Sensitivity of car share membership and usage to distance from nearest car share vehicle:

5. Do you observe a cut-off distance from home to the nearest car share vehicle beyond which people are unlikely to become a member of your organization?
6. For people who are members, is there a similar cut-off distance from home to the nearest car that significantly reduces the likelihood of regular carshare use?
7. Is there a minimum residential density that you observe makes a carshare vehicle viable?

Relationship between off-street parking access and car share membership/usage:

8. Do you find that your members are more, less, or equally likely to become car share members if they have access to an off-street parking space where they live?
9. For your members, do you find that they use carsharing more, less, or the same if they have access to an off-street parking space where they live?

Feasibility of neighborhood-oriented car share vehicles:

10. In terms of the characteristics that make a neighborhood viable for carsharing:
    a. Is location within the region important?
    b. Is a mix of land uses important?
11. Do you see residential neighborhood locations as viable for car share vehicle placement, as opposed to commercial districts or transit hubs?

Costs, revenues, and subsidies:

12. Does the viability of a marginal neighborhood location improve if a subsidy of some type is provided?
13. If we assumed for a moment that such a vehicle got no usage whatsoever, how much subsidy would be needed for a one-car pod to break even? In other words, what are the approximate fixed costs associated with an additional vehicle?
14. About how many members do you need to regularly use a vehicle to cover the fixed costs?
15. What other key numbers do you look at to gauge the performance of a given vehicle or pod, and what thresholds would indicate a successful pod?
16. Do you have preferred means of subsidies or other assistance (e.g. operating subsidy, marketing, revenue guarantee, free parking, etc.)?

Carsharing in development agreements:

17. I am aware that your organization has worked with developers to place cars in free spaces provided in new developments. Have you worked on projects like this?
18. What criteria do you look for in deciding whether to place a vehicle in a new development?
19. Are there situations in which you would decline to place a vehicle, even if the space were free?
20. Is there a minimum development project size you would look for, or does viability depend more on the surrounding neighborhood?