



FINAL REPORT

Parking Standards Review: Examination of Potential Options and Impacts of Car Share Programs on Parking Standards



Submitted to the City of Toronto
by IBI Group

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IBI Group is a multi-disciplinary consulting organization offering services in four areas of practice:

Urban Land, Facilities, Transportation and Systems.

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Project Scope and Overview

The City of Toronto's Zoning By-law Project will create a single zoning by-law for the entire City, replacing over 40 by-laws of the former municipalities that were amalgamated to form the new City of Toronto. The work program for the New Zoning Project has been broken into manageable tasks, one of which involves examining the potential options and impacts of car share programs on parking standards.

The City of Toronto recognizes the value of car sharing as part of a transportation demand management strategy that can reduce the need to own a vehicle and thus mitigate the associated negative impacts of automobile travel, as well as reduce parking demand. This study builds on the Phase Two parking standards review of multi-unit residential developments. It involves examining the impact of car sharing on car ownership rates and parking requirements in multi-unit residential developments that provide reserved parking for car share vehicles (referred to as "dedicated car share parking" in this report).

A review of support for car share operators worldwide found that the "provision of parking spaces is often the most important way that local authorities and developers can support car share clubs"¹. While a parking reduction for buildings providing dedicated car share parking would certainly facilitate the growth of car sharing across the City, implementing such a reduction in the zoning by-law requires carefully considering the technical validity of the reduction as well as the ability to ensure that the car share service is maintained over the long term. As such, this study adopted a broad-based approach to consider all of these issues.

Background work supporting this study includes a review of the literature and best practices, consultation with car share providers, as well as review of relevant City policy documents and by-law amendments. A survey of residents of buildings with

dedicated car share vehicles was also conducted. Using the collected data, this study presents a regression model of auto ownership to further illuminate the relationship between dedicated car share vehicles and parking demand.

Based on the background work and data analysis, a parking reduction ratio for car sharing is proposed. Recommendations regarding other implementation considerations, such as how the car share agreement is secured, required marketing, and access to/ location of car share parking are also provided.

Review of Literature and Best Practices

This section is a review of best practices and research from elsewhere that addresses the effects of car sharing on auto ownership and parking demand. Based on the impact of car sharing on parking demand and other benefits, a number of North American cities currently allow reductions in the amount of required parking for multi-unit residential developments with car sharing programs.

Effects of Car Sharing on Auto Ownership

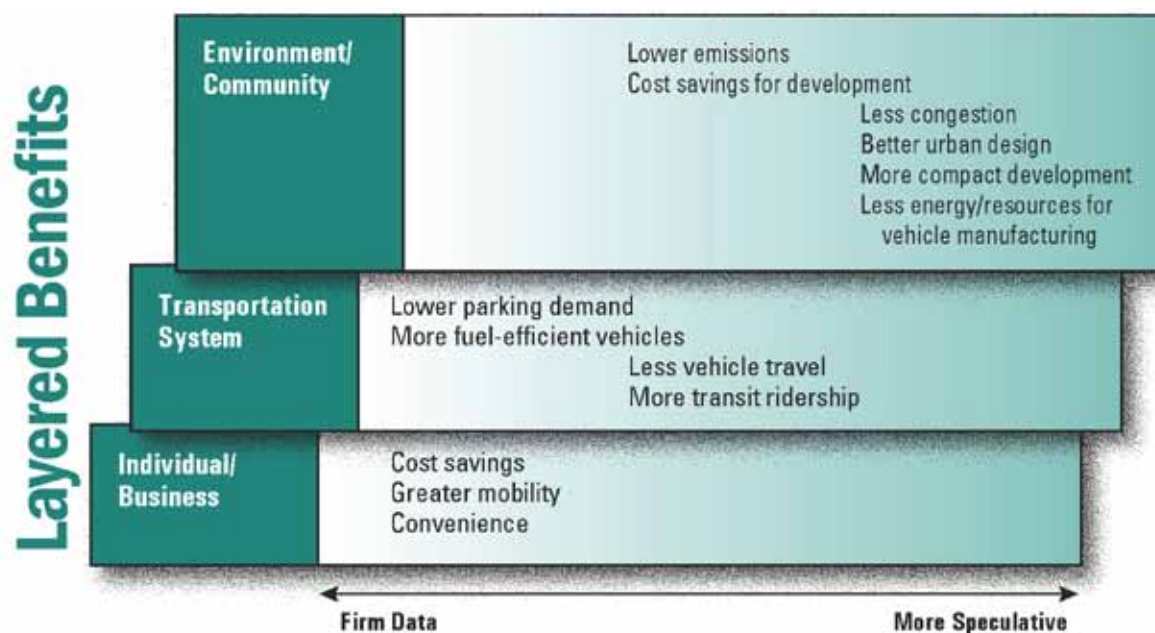
Car sharing programs have the potential to provide a number of benefits to the environment/community, transportation system, and individuals/businesses, as illustrated in Exhibit 1, of which a key benefit is the potential to reduce auto ownership. As such, car sharing can also be viewed as a parking demand management strategy. For example, the book *Parking Management Best Practices*, recommends reducing residential minimum parking requirements by 5-10% if a car sharing service is located nearby, or reducing 4-8 parking spaces for each car share vehicle in a residential building².

A Transport Canada and CommunAuto study evaluating the impacts of car sharing in Quebec

¹ Enoch, M. Supporting car share clubs: A worldwide review. Presented at the 3rd Meeting of the Mobility Services for Urban Sustainability Project. February 2002. London, U.K.

² Litman, T. (2007) *Parking Management Best Practices*, American Planning Association.

Exhibit 1: *Benefits of Car Sharing*



Source: Transportation Research Board (2005) Car-Sharing: Where and How it Succeeds, TCRP Report 108.

found significant benefits in terms of reduced auto ownership, vehicle kilometres travelled, auto emissions, and parking demand³:

- Each shared car replaces approximately 8 individual cars (average scenario). This result takes into consideration that some users shed a vehicle and others decided against purchasing one after joining this service.
- By reducing auto ownership and making the costs of driving more evident, car sharing leads to an average reduction in the number of kilometres travelled by car of around 2,900 km per member, per year.
- The average reduction in driving per member, combined with the more fuel efficient vehicles typically used by car share organizations, results in a 38% reduction in transportation energy consumption and an average annual reduction in

greenhouse gas emissions of approximately 1.2 tons per user. On average, this represents a 60% reduction of CO₂ emissions per person, per year.

According to another study that evaluated changes in travel demand data prior to and after the launch of the City CarShare Program in San Francisco, within two years, nearly 30% of members substituted their personal vehicles for City CarShare vehicles and over two-thirds deferred the purchase of a second car⁴.

3 Tecsult (2006) Le projet auto+bus:Évaluation d'initiatives de mobilité combine dans les villes canadiennes, Transport Canada and CommunAuto.

CommunAuto operates approximately 450 car share vehicles across the province of Québec in Montréal, Québec, Sherbrooke, and Gatineau.

4 Robert Cervero and Yuhsin Tsai, San Francisco City CarShare: Second-Year Travel Demand and Car Ownership Impacts, TRB 2004 Annual Meeting [available online at <http://communauto.com/images/TRB2004-002025.pdf>]

Exhibit 2: Effect of Car Sharing on Auto Ownership, Member Survey

Effect	Neither agree nor disagree	Agree	Strongly agree
Was able to sell my car	59.9%	3.9%	7.4%
Was able to sell the family's second car	26.5%	32.1%	17.5%
Postponed buying another car	16.6%	39.1%	31.4%

Source: Transportation Research Board (2005), Car-Sharing: Where and How it Succeeds, TCRP Report 108.

The impact of car sharing on auto ownership can be calculated as follows⁵:

$$\text{Vehicles Reduced} = \left(\frac{\% \text{ Members Who Give Up a Car}}{\text{Members per Car Share Vehicle}} \right) \times \text{Members per Car Share Vehicle} - 1$$

Empirical studies indicate that, on average, 21% of car share members in North America give up their primary or secondary vehicle after joining a car sharing program⁶. Exhibit 3 summarizes a number of such North American studies that examine the impacts of car sharing on vehicle ownership. Using the above equation and with average North American findings suggests that each car share vehicle typically reduces auto ownership by 3.9 vehicles among car share members. In other words, each car share vehicle reduces residential parking demand among members by almost four spaces, which represents three spaces when the car share parking space is considered. Note that this estimate is conservative as it does not account for the proportion of members who forgo purchasing a new vehicle due to car sharing.

A study conducted by AutoShare in the City of Toronto indicates that 15% of members have given up a primary or second vehicle and 25% forego purchasing a vehicle, although the company admits this data is somewhat out of date. Zipcar in Toronto also reports that approximately 40% of members have either given up a vehicle or foregone purchase of a vehicle after becoming members. Based on

reported membership rates of 20 to 25 members per car, each car share vehicle in Toronto therefore removes/avoids approximately 8 to 10 personal vehicles.

A web-based survey of 1,340 car share members across Canada and the United States provides further insight on the effect of car sharing on member auto ownership (Exhibit 2 and Exhibit 3)⁷. Of all respondents, 70.5% agreed or strongly agreed that they were able to postpone buying a car, nearly 50% agreed or strongly agreed that they were able to sell their family's second car, and 55.2% agreed or strongly agreed that they were able to sell their car, their family's second car, or both. Based on these results and an assumed average of 27 car share vehicles per member, each car share vehicle is estimated to take nearly 15 vehicles off the road (1.5 primary vehicles and 13.4 secondary vehicles).

This survey predicts substantially higher private vehicle reduction rates than the other studies in Exhibit 3 (55.2% vs. 21%). The authors of the study note that this may be due to the long-standing nature of the car-sharing members who responded to the survey – on average, they had been members for 19.5 months – which has allowed greater time for the longer term decisions related to household mobility to manifest. Alternatively, they note that it could also indicate that car-sharing operators are targeting two-car households rather than car-free households as the market matures beyond the early adopters⁸.

⁵ Transportation Research Board of the National Academies, Car Sharing: Where and How It Succeeds. [available online http://onlinepubs.trb.org/Onlinepubs/tcrp/tcrp_rpt_108.pdf (2005)]

⁶ *ibid.*

⁷ *ibid.*

⁸ *ibid.*

Exhibit 3: Car Sharing Impacts on Vehicle Ownership in North

REGION	SAMPLE SIZE	VEHICLE OWNERSHIP BEFORE JOINING		% OF RESPONDENTS WHO HAVE...		MEMBERS PER CAR SHARE VEHICLE	VEHICLES REPLACED ¹	COMMENTS	REFERENCE
		NONE	ONE OR MORE	GIVEN UP A VEHICLE (PRIMARY OR SECOND)	FOREGONE PURCHASE OF A VEHICLE				
San Francisco, CA	122			12%	43%	11	1.3	Assumes 1.9 individual users per household	Cambridge Systematics (1986)
Montreal, QC	153	49%	52%	21%	61%	17	3.6		Robert (2000)
Quebec City, QC	208	38%	63%	29%	56%	17	4.9		Robert (2000)
Portland, OR	64	59%	41%	26%	53%	13	3.4		Katzev (1999), Katzev, Brook & Nice (2000)
Portland, OR	89			23%	25%				Cooper, Howes & Mye (2000)
Boston, MA and Washington, DC				15%	35%	20	3	Details of methodology not available.	Zipcar (2001)
Seattle, WA				6%				Cited in Vance (2004). Figure refers to net change in vehicle ownership, with 15% giving up a vehicle and 9% not adding a new vehicle to the household.	Flexcar (2001)
Vancouver, BC	370	86%	14%	28%	57%	18	5	Figures refer to those who gave up a vehicle 0-6 months before joining CAN. Figures for “foregone purchase” exclude “don’t know” responses.	Jensen (2001)
San Francisco Bay Area, CA	130	65%	35%	20%	63%	25	5	Excludes those who did not give an answer.	City CarShare (2002)
Washington, DC		67%	33%		42%	53		Details of methodology not available. 25 % of members who do own cars have sold or are considering selling their car.	Flexcar, unpublished survey
San Francisco, CA				24%	4%	25	6	Figures refer to net change in vehicle ownership per member (-0.25) and per non-member control (+0.04). Source for members per vehicle is City CarShare.	Cervero & Tsai (2003)
Seattle, WA	48			15%	40%			Figures refer to net change in vehicle ownership, with 23% giving up a vehicle and 8.5% not adding a new vehicle to the household.	Vance, Williams & Ruth-erford (2004)
Toronto, ON				15%	25%	22	3.3	Details of methodology not available.	AutShare, email
Quebec (4 cities)	2167			32%	77%	20	6.4		Communato (2004)
Philadelphia, PA				21%	44%	23	4.8		Lane (2005)
North American Average		61%	40%	21%	45%	22	3.9		

1 Refers to private vehicles shed by one car share vehicle. Excludes impacts of foregone purchases.
Many surveys do not distinguish between respondents who have given up a car because of car sharing, or for some other means.
Where available, the data in the table refer to those who have given it up because of car sharing
Source: Transportation Research Board of the National Academies. (2005). Car Sharing: Where and How it Succeeds

Car Sharing and Residential Parking Requirements

Given the potential impacts on auto ownership discussed above, car sharing can significantly affect parking demand, particularly if a car share provider is located within or near a residential dwelling. Berkeley, California; Aspen, Colorado; Arlington County, Virginia; and the District of Columbia all allow parking reductions for developments that incorporate demand management measures, such as car sharing. This reduction is typically negotiated in zoning amendments, similar to Toronto's current approach. Seattle, Vancouver, and San Francisco have taken it one step further and incorporated special car sharing provisions in their parking zoning by-laws related to multi-unit residential dwellings. These provide insight on how a Toronto standard might be specified. Although the phrasing and exact reductions vary, typically these car share zoning by-law requirements affect the minimum parking requirements and can be broken into two basic components:

1. A parking ratio reduction
2. Constraints on the total reduction

Seattle, Washington

In 2001 and 2006, the City of Seattle implemented lower parking requirements for developments that provide dedicated on-site parking for a recognized car share operator. These exceptions allow substituting car share spaces for resident spaces for smaller developments and reducing resident parking requirements for larger developments:

- For any residential development, the greater of 1 space or 5% of the total number of required spaces may be used to provide for car sharing vehicles and 1 space will be reduced from the number of required parking spaces for each space leased by a car share provider.
- For any residential development that requires 20 or more parking spaces, the parking requirement is reduced by 3 required parking spaces for each car share space, up to a maximum of 15% of the total number of required spaces.

In both cases approval for a reduction is also dependent on the developer establishing an agreement with an approved car sharing program and the agreement must be recorded with the title to the property⁹. At this time there are no specific operating requirements for a car share space and the City of Seattle has limited enforcement tools if the car share organization abandons the space.

Exhibit 4: *Flexcar Vehicles in Seattle.*



Vancouver, British Columbia

A Canadian example of reduced parking requirements is the City of Vancouver's zoning regulation for car sharing in new developments. Under this regulation:

"The Director of Planning and General manager of Engineering Services, on conditions that are satisfactory to them, may allow the substitution of co-operative vehicles and associated parking spaces for the required parking spaces at a 1:3 ratio, up to 1 co-operative vehicle for each 60 dwelling units, rounded to the nearest whole number, or such greater substitution of co-operative vehicles and associated parking spaces at such ratio and for such number of dwelling units as they may consider appropriate with respect to the site."¹⁰

This provision offers the same 1:3 reduction as in Seattle and provides an alternative approach to

⁹ The City of Seattle requires that the car share agreement be recorded together with title to the property with the King County Office of Records and Elections. The parties, the date of execution, and possible the duration of the obligations under the agreement are generally the requirements needed for recording with Records and Elections.

¹⁰ City of Vancouver, Parking By-Law No. 6059 Section 3.2, [available online <http://vancouver.ca/commsvcs/Bylaws/parking/sec03.pdf>]

Exhibit 5: Maximum Allowable Reduction in the Minimum Required Parking

SIZE OF DEVELOPMENT (# OF UNITS)	SEATTLE		VANCOUVER		SAN FRANCISCO (REQUIRED CAR SHARE SPACES)	
	MAX # CAR SHARE SPACES	MAX ALLOWABLE REDUCTION	MAX # CAR SHARE SPACES	MAX ALLOWABLE REDUCTION	MAX # CAR SHARE SPACES	MAX ALLOWABLE REDUCTION
10	1	1	0	0	0	-
30	2	5	1	3	0	-
60	4	11	1	3	1	-
120	8	23	2	6	1	-
250	16	47	4	12	2	-
450	28	84	8	24	3	-

limiting the total reduction allowed. The limit on the number of allowable car share spaces increases for every sixty dwelling because the City views this as the minimum number of units to support a car share vehicle.

Exhibit 6: Dedicated Car Share Parking for Vancouver's Co-operative Auto Network



San Francisco, California

The City of San Francisco has taken a different approach to car share parking spaces. To address issues such as traffic congestion in downtown area districts, the City has instituted several parking policy reforms¹¹, including a requirement of 1 car share space for dwellings with 50 to 200 units and an additional car share space for every 200

spaces above this level¹². For newly constructed non-residential uses in certain downtown areas, 1 car share space is required for developments that are required to provide at least 25 parking spaces. Beyond this, 1 car share space is required for every 50 required parking spaces.

The car share spaces are dedicated for such use through either a deed restriction, a condition of approval, or a license agreement. The nature of the car sharing requirements is recorded in a Notice of Special Restriction on the property. In all cases, the parking spaces must be designed in a manner that will make them accessible to non-resident subscribers from outside the building as well as building residents. In addition, the spaces are to be provided to the car share organizations at no cost.

Exhibit 7: Dedicated Spaces for San Francisco's City CarShare



¹¹ Ordinance 129-06

¹² City of San Francisco, Office of the Controller Budget and Analysis Division, Office of Economic Analysis, Economic Impact Report of Off-Street Parking in C-3 Zoning Districts And For Bicycles and Car Share File No. 060372 [available online <http://www.sfgov.org/site/uploadedfiles/controller/oea/ref060372.pdf>]

Success Factors for Car Sharing

Car sharing is not cost-effective for people who need a vehicle on a daily basis, however, car sharing can provide significant financial savings (in lieu of auto ownership) to those who need a car on a less frequent basis. As such, car sharing is most successful in areas where transit, walking, and cycling are viable options. For car sharing to be successful in a particular area, local residents must be able to live without a car, or with just one vehicle. As reported by a recent Transportation Research Board report, “Low vehicle ownership rates are the best predictor of a strong market for car-sharing.”¹³. This report also provides guidelines for where car sharing succeeds, as illustrated in Exhibit 8.

Exhibit 8: Guidelines for Where Car Sharing Succeeds

Variable	Low Growth	High Growth
Demographics		
% 1-person households	30%	40%-50%
Commute Mode Share		
% drive alone to work	55%	35%-40%
% walk to work	5%	15%-20%
Vehicle Ownership		
% households with no vehicle	10%-15%	35%-40%
% households with 0 or 1 vehicle	60%	70%-80%
Neighborhood Characteristics		
Housing units per acre	5	5

Note: For most variables, the values are the suggested *minimums* that are needed for a viable car-sharing service in a given neighborhood. For the “% drive alone to work” variable, the values are the suggested *maximums*.

Consultation with Car Share Providers

In order to identify key issues that car share operators face in the City of Toronto, the study team met with the City’s two primary car share operators, AutoShare and Zipcar, in July 2008. These meetings yielded important information on the state of car sharing

¹³ Transportation Research Board (2005), Car-Sharing: Where and How it Succeeds, TCRP Report 108.

in Toronto and factors influencing the financial sustainability of a particular car share vehicle.

Car Sharing in Toronto

AutoShare and Zipcar operate a combined fleet of nearly 900 car share vehicles, primarily located within denser areas of the Former City of Toronto and along subway lines. The two organizations report a combined membership of nearly 20,000, with approximately 20-25 members per vehicle.

Based on internal member surveys, AutoShare claims that about 15% of its members get rid of a car and 25% decide not to purchase a second vehicle. As a result, their study indicates that the number of vehicles reduced is equivalent to approximately 40% of members. Zipcar’s internal survey also indicates that 40% of its members gave up driving their personal vehicles or abandoned purchasing/leasing a new vehicle. Based on these results, approximately eight to ten vehicles are removed from the road for each car share vehicle.

In terms of expansion, the car share providers indicated they will likely continue to expand their service near subway stations and along streetcar routes. Despite several requests from developers in other regions (particularly the 905 region), Zipcar has always refused for lack of confidence in demand for the service.

Factors Influencing the Sustainability of Car Share Spaces

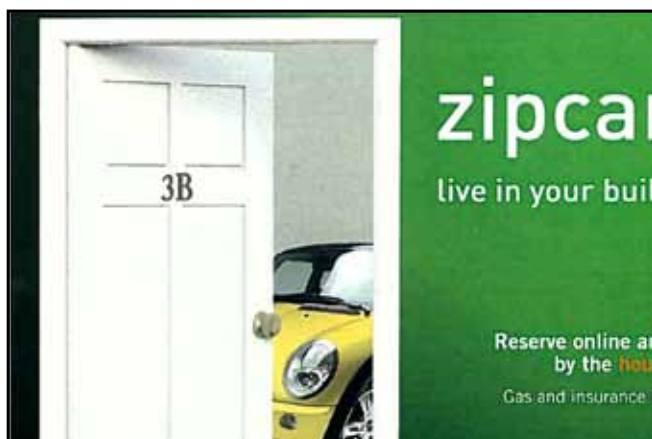
The third party nature of car sharing services is a key concern in providing parking reductions based on the presence of car share vehicles since, for a variety of reasons, it is difficult to guarantee that the car share vehicle(s) services will persist in the development. For example, car share operators will remove vehicles if they are not getting enough use, or a condo board may want to sell the car share space to an occupant to generate revenue. The car share organizations provided important insight on factors influencing the sustainability of dedicated car share spaces.

The minimum revenue required per car share vehicle is approximately \$1,500 per month, corresponding to about 200-225 hours of rental time (approximately 7

hours per day). Making a car share vehicle available to a mix of users (residents and surrounding community) greatly improves the chances of this vehicle generating this minimum monthly revenue. Restricting car share access to residents of a multi-residential building, on the other hand, is unlikely to result in a car share vehicle that is financially viable.

Based on AutoShare's experience, developers tend to focus on short-term benefits, such as earning points under the LEED rating system and reducing the number of required parking spaces. They are less interested in the long-term viability of a dedicated car share vehicle. As a result, developers will adopt the simplest approach to providing car share vehicles, which is typically to limit it to building residents. AutoShare's practice is to request that a vehicle be made publicly accessible, but they will locate car share vehicles in developments that do not make the vehicle publicly accessible provided the developer guarantees the minimum monthly revenue for a few years. AutoShare reassesses revenue and usage after 2-3 years or when the developer funding finishes, but often it is not profitable to continue a service that is restricted and visible only to residents.

Exhibit 9: Sample of Marketing of Dedicated Car Share Vehicles to Residents



Zipcar, on the other hand, has been successful in making their vehicles publicly accessible when located in particular developments. Where the car share vehicle is located in a secure garage, non-resident Zipcar members can show their membership card to the concierge to gain access the car share vehicle. This arrangement increases the chances that the vehicle will be sustainable over the long term.

AutoShare and Zipcar also emphasized the role of marketing in encouraging immediate and long-term patronage. Both car share operators contend that marketing campaigns contribute to the success or failure of the car share service within a building. For instance, AutoShare generally finds it easier to ensure visibility and resident participation if they are involved in the marketing of car share spaces (through discounted membership fees or the provision of information online) while the building is being developed. The operator claims there is less opportunity to promote car sharing when retrofitting buildings, particularly in apartment buildings.

Zipcar also engages heavily in marketing campaigns when residents initially move into a building in order to reduce the delay in realizing the car share vehicle's market potential (Exhibit 9). Often discounts are offered to all building residents, the degree of which depends on the size of the building. As described under "Development Applications Including Proposals for Dedicated Car Share Parking" (page 12), as part of site plan approval, a number of developers have provided residential unit purchasers free membership to the car share organization operating in the building.

Parking Challenges for Car Sharing Expansion

Both AutoShare and Zipcar identified the lack of appropriate, publicly accessible parking as an ongoing challenge, especially as both operators continue to expand their services throughout Toronto. While there are many available spaces for rent in some downtown apartments and condominiums¹⁴, AutoShare has been unable to rent these parking spaces since buildings tend to be secured and access limited to residents.

A parking reduction for car sharing would certainly be an incentive to provide car share parking and help ease the difficulties car share operators in securing dedicated parking spaces. Other opportunities identified by the car share providers include establishing an agreement with the Toronto Parking Authority to allocate specific spaces for car share vehicles as well as the provision of reserved on street parking spaces for car share vehicles.

¹⁴ Often spaces sell/rent for \$120 - \$150 per space on Craigslist.

Existing Policy / By-Laws in the City of Toronto

This section reviews relevant documents that may impact the evaluation of parking standard options related to car share programs in the City of Toronto.

City-Wide Reports

IBI Group (2005) Parking and Loading Zoning Standards Review: Phase One New Zoning By-law Project

The purpose of phase one of the parking standard's review is to consolidate the various by-laws of the former municipalities, which were amalgamated to form the new City of Toronto. As part of phase one, parking standards for multiple-unit residential dwellings were reviewed, compared, and evaluated across several municipalities. Multiple-unit residential dwellings standards are based on the number of units per dwelling.

One of the recommendations of this report is to promote car sharing as part of a transportation demand management strategy that can reduce the need for vehicle ownership as well as parking

demand. The City is encouraged to work with developers and car sharing organizations to provide car share parking spaces with new developments.

Cansult Limited (2007) Parking Standards Review – Phase Two Apartment Building/Multi-Unit Block Developments Component, New Zoning By-Law Project

One of the two parts of phase two of the City's parking study is to recommend appropriate parking standards for apartment buildings (greater than 5 dwelling units) and condominium townhouse residential developments with 6 or more units (with shared on-site parking spaces). Results from the study indicate that the number of cars per unit increase with the number of bedrooms for condominium apartments, market rental units, as well as targeted rental units. It is important to note that market rental units usually have lower auto ownership than condominium units and auto ownership also varies by location. The effects of car sharing were not considered in this study.

Recommended parking standards are based on units (measured by the number of bedrooms) and were developed from a review of empirical data, policies

Exhibit 10: Proposed Minimum Parking Standards for Apartments

Location	Resident Standard (to accommodate personal vehicles)								Visitor Parking (Minimum & maximum)
	Bachelor*		1 Bedroom		2 Bedrooms		3+Bedrooms		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	
Downtown Core	0.20	0.30	0.40	0.60	0.50	0.75	0.70	1.05	0.10
Downtown and Central Waterfront	0.20	0.30	0.40	0.60	0.60	0.90	0.80	1.20	0.10
Centres and Avenues on Subway	0.40	0.60	0.50	0.75	0.70	1.05	0.80	1.20	0.10
Other Avenues (well served by Surface Transit)	0.50	0.75	0.60	0.90	0.70	1.05	0.90	1.35	0.15
Rest of City	0.80	-	0.90	-	1.00	-	1.20	-	0.20

* 40 sm (~ 430 sf) or less

Notes:

1. Rental Apartment minimum standards are generally about 75% of the recommended condo minimum standards except for the "Rest of City" category where the standards are the same as for condos.
2. Maximum standards are 50% higher than the minimum standards except for the Rest of the City where there are no maximum standards.

Source: Cansult Limited (2007) Parking Standards Review – Phase Two Apartment Building/Multi-Unit Block Developments Component, New Zoning By-Law Project

Exhibit 11: Proposed Minimum Parking Standards for Condos

Location	Resident Standard (to accommodate personal vehicles)								Visitor Parking	
	Bachelor		1 Bedroom		2 Bedrooms*		3+Bedrooms			
	Recommended	Existing	Recommended	Existing	Recommended	Existing	Recommended	Existing	Recommended	Existing
Downtown Core	0.30	0.30	0.50	0.50	0.70	0.75	0.90	1.20	0.10	0.06
Downtown and Central Waterfront	0.30	0.30	0.50	0.50	0.80	0.95	1.00	1.20	0.10	0.06
Centres and Avenues on Subway ¹	0.60	0.85-1.1	0.70	0.85-1.1	0.90	1.0-1.1	1.00	1.0-1.1	0.10	0.1-0.25
Other Avenues (well served by Surface Transit)	0.70	n/a	0.80	n/a	0.90	n/a	1.10	n/a	0.15	n/a
Rest of City ²	0.80	0.39-1.25	0.90	0.74-1.25	1.00	0.95-1.25	1.20	0.95-1.35	0.20	0.2-0.25

Notes:

1. York -NYC condo standards (within 500m of rapid transit)
2. Range of standards for various locations

Source: Consult Limited (2007) Parking Standards Review – Phase Two Apartment Building/Multi-Unit Block Developments Component, New Zoning By-Law Project

and urban structure/targeted mixed-use growth areas. Standards for condominium apartments, rental apartments, and condominium townhouse developments reflect auto ownership/dwelling unit ratios, and auto demand. Requirements vary by area, such as the Downtown Core and outer areas of the City. Any reductions in parking requirements related to dedicated car share parking must be considered in the context of these proposed standards, presented in Exhibit 10 and Exhibit 11.

City of Toronto Staff Reports Related to Car Sharing

There are several City of Toronto staff reports that encourage the use of car share services and recommend the adoption of policies that are supportive of car sharing programs. For instance, in 1999 the City's Urban Environment and Development Committee Report No. 7 provided an overview of car sharing and its applicability to the City. The report discusses the concept of car sharing, benefits and limitations, as well as the role of government in promoting car share as a strategy to reduce car ownership.

The Commissioner of Urban Development Services report on car sharing initiatives in February 2000 took it one step further by providing a number of

recommendations for Council to support and promote car sharing initiatives. Recommendations include permit parking privileges to AutoShare and endorsing a partnership between the TTC and AutoShare that would reduce the initial AutoShare membership fee for annual TTC metro pass holders. In August 2000, the Planning and Transportation Committee recommended the adoption of a new class of on-street parking permits for car sharing vehicles. City Council adopted the recommendation during its Special Meetings held on October 6, 10-12, 2000.

Change is in the Air: Toronto's Commitment to an Environmentally Sustainable Future, 2007

In March 2007, the City released its Framework for Public Consultation to provoke discussion on what should be included in the City's Climate Change and Clean Air Action Plan. This framework sets the following greenhouse gas reduction targets for the Toronto urban area, based on a 1990 baseline:

- 6% by 2012
- 30% by 2020
- 80% by 2050

The target for reducing smog-causing pollutants is 20 percent by 2012, based on a 2004 baseline.



These are ambitious emission reduction targets and achieving them will require action on many fronts. The framework document identifies gasoline-fuelled cars and light duty trucks as a major source of both greenhouse gas emissions and air pollutants. Strategies, such as car sharing, that make it easier for households in the City to own fewer personal vehicles are required to reduce driving and auto emissions. Among other strategies, the framework recommends that individuals consider car sharing networks as a way to reduce emissions on the road. As discussed earlier under “Consultation with Car Share Providers” (page 8), finding appropriate parking for car share vehicles is a key challenge to the expansion of these systems.

Development Applications Including Proposals for Dedicated Car Share Parking

In the last few years, the City has received a number of development applications that included proposals for dedicated car share parking. This trend is expected to grow as car sharing becomes more popular, car share fleets continue to expand, and developers increasingly use car sharing as a marketing tool. If and how parking reductions for dedicated car share parking are incorporated into the Zoning By-law will also have a large influence on this trend.

To date, the City has adopted a case-by-case approach to the treatment of dedicated car sharing spaces and services through zoning by-law

amendments. This includes the parking requirement reduction allowed, if at all, and other requirements regarding the minimum length of time that the car share vehicle must be provided, free membership to residents, signage of the dedicated car share stalls, and what happens to the stalls if the car share service ceases to use these stalls.

The zoning by-law amendment for 53 and 59 Colgate Avenue was the first appearance in an amendment for car share parking in a proposed residential/work development. This amendment created a definition of a car share vehicle and car share parking space for the by-law.

Since this project, a number of developments have included parking for car share vehicles as part of the site plan application without receiving parking requirement reductions. Examples include:

- **48 Abell St.:** An 18-storey affordable housing building and 14-storey condominium building with non-residential uses which includes a minimum of 3 car share parking spaces on the lot.
- **625 Queen St. East:** A six-storey mixed-use condominium building which includes 1 space for car sharing secured for a one-year period with a car share provider. In addition, the applicant will cover the one-time membership fee for all first-time residents.

To date, reductions in residential parking requirements have been allowed for developments providing dedicated car share parking under a variety of arrangements. Examples include:

- **15 York St.:** Includes a 54-storey and a 50-storey residential condominium as well as a nine-storey podium with retail, office, daycare and hotel uses. **A ten space reduction for each dedicated car share space** was granted and the owner is required to offer residential unit purchasers, who do not purchase a parking space, free membership or initiation fees to the car share organization operating in the building.
- **1171 and 1171R Queen St. West:** A nine-storey mixed-use building and a 19-storey residential building which included parking reductions of **five spaces for each dedicated car share space, limited to no higher than**

25% of the resident parking requirement. In addition, the site-specific by-law sets restrictions on what happens to the dedicated stalls if the car share operation is not sustainable. After three years, if the car share vehicles are no longer in operation, 51% of the car share spaces shall be converted to visitor parking and 49% of the spaces shall be converted to occupant parking.

- **150 Sudbury St.: Five space reduction for each dedicated car share space limited to no higher than 12.5% of the resident parking requirement.** Similar specifications to 1171 Queen St. are indicated for when and how the dedicated stalls will revert to visitor and occupant parking should the car share service not be sustainable.
- **50, 60, and 70, Town Centre Crt.:** A three-phased development with 1,005 residential units and a small retail component: 80 spaces reduction allowed in residential parking requirement contingent on a number of conditions including:
 - A minimum of three surface parking spaces reserved for car share vehicles with pavement markings and/or signage designating the parking spaces for the exclusive use of the car-share organizations;
 - Free car share membership for each unit's initial purchaser(s);
 - Free TTC Metro Pass for one year for the initial purchaser(s) of each unit that is purchased without a residential parking space; and,
 - Secure bicycle parking.
- **90 Broadview Ave:** A 10-storey residential building for which a staff report (October 2008) proposes that **one car share space be granted, which will allow for the reduction of up to 10 spaces, provided that the maximum reduction is no more than 25% of the required residential parking requirement.** As well, under a Section 37 agreement, the applicant will provide one-year memberships to each first-time resident.

These examples show that there have been varied approaches to negotiating the provision of car share parking and the associated reduced parking requirements. In addition to the range of reductions allowed, it should be noted that there have been few examples where by-laws or site plan agreements have specified requirements related to the location, public accessibility, or minimum period of operation for these car share spaces.

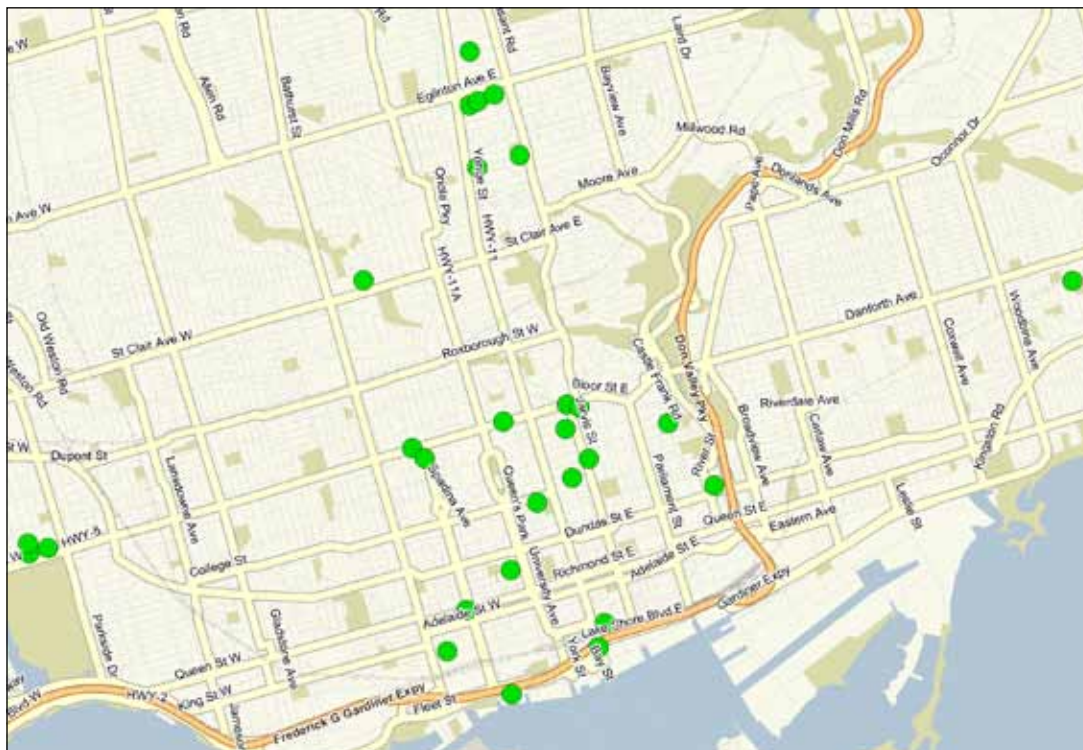
Survey Methodology and Analysis

Site Selection

Survey data for sites without car share vehicles was obtained from a previous survey conducted for the City of Toronto in 2007 which analyzed parking demand at apartment building/multi-unit block developments¹⁵. To examine buildings with car share vehicles, lists of all buildings containing dedicated car share spaces were provided by both Zipcar and AutoShare. From the 59 sites provided, which exhibited more or less equal representation of apartments and condominiums, a subsample of sites was chosen based on five criteria:

1. Each site must have had a car share vehicle for at least one year to ensure there has been sufficient time for such availability to affect auto ownership. Furthermore, the discounted memberships sometimes offered by car share operators often expire after one year.
2. The buildings could not be co-operatives or mixed use (e.g. 360 Bloor St West with its ground-level retail and personal services) as unit listings for these buildings were not available from the City's assessment data cards.
3. Where possible, there should be control data available¹⁶ from a similar urban context and of a similar assessed unit value for each site.
4. An equal number of condominium and apartment buildings.
5. Equal representation from Zipcar and Autoshare.

Exhibit 12: Residential Sites That Have Had a Dedicated Car Share Vehicle for One Year or Longer



¹⁵ Cansult Limited (2007) Parking Standards Review – Phase Two Apartment Building/Multi-Unit Block Developments Component, New Zoning By-Law Project

¹⁶ ibid. The control data provided by the City comes from this 2007 Phase Two review of parking standards for apartment buildings and multi-unit block developments.

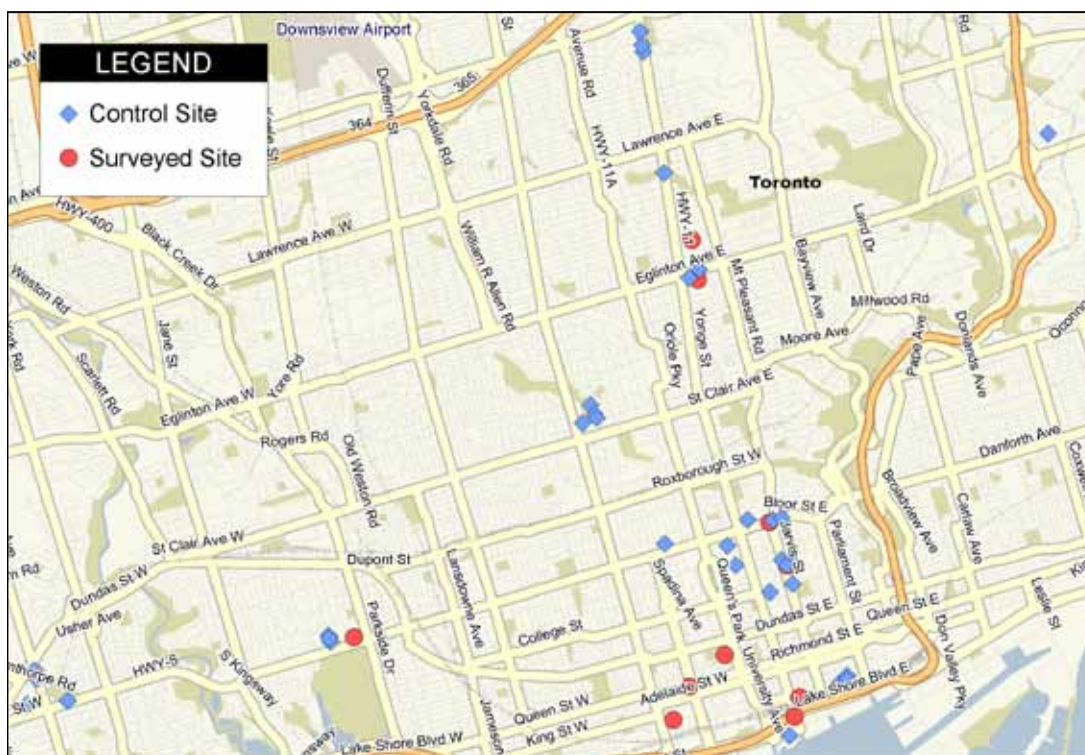
The first and second criteria reduced the number of possible car share sites to 28 (see Exhibit 12), of which 12 could be chosen to guarantee constraints four and five were met¹⁷. The final 10 sites chosen are shown in Exhibit 13, with details listed in Exhibit 19 and Exhibit 20. Given the relatively urban location of all possible survey sites, any control sites north of the 401 were discarded to improve comparability, leaving 43 control sites for inclusion in the study. Both control sites and the surveyed sites are shown in Exhibit 13. The address, resident's name, and total number of units of each site was obtained through the City of Toronto's assessment data (The Toronto Property System). MPAC data was used to also obtain the total assessed value for each property¹⁸.

For condominiums, bedroom breakdowns, gross floor area and the number of parking spaces were also obtained per unit¹⁹.

Survey Questionnaire and Distribution

Telephone surveys were deemed to onerous to implement and beyond the resource constraints of this study. Thus, surveys were mailed to a random sample of units at the 10 selected sites. In all cases, at least 27% of the units in each building were mailed a survey, with a minimum of 20 units chosen for each building. This covered 992 units out of a possible 3,623 (27.5%).

Exhibit 13: Control and Survey Sites



¹⁷ Since only three of the remaining AutoShare buildings were condominiums.

¹⁸ The total assessed property value includes building amenities, and facilities such as elevators and laundry. Thus it represents more than simply the sum of the assessed value for individual units. Also note that the total number of units is not entirely consistent with the bedroom breakdown in all cases since assessors are not always able to determine the number of bedrooms for each unit. Correspondingly, assessed value is not always available for every unit.

¹⁹ City of Toronto staff cautioned that the parking data is likely unreliable as it derives from development applications.

The entire survey was only 2 pages long, with 14 simple questions (9 for non-car share members) which were divided into 4 groups: car ownership and parking needs, car sharing, household characters, and a section specifically for car share members. A copy of the survey is included in Appendix A.

Several measures were taken to help improve the mail-out survey response rates.

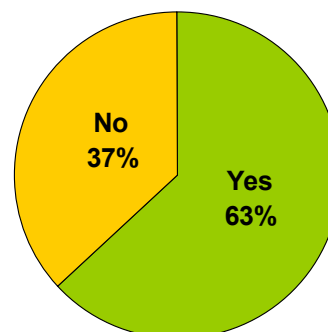
- The survey's introductory text announced a draw for respondents who completed the survey. The two prizes were a free membership and \$100 credit at the car share company of their choice.
- A simple URL was clearly indicated in the survey's introduction text to allow respondents the chance to simply fill out an online version of the survey (see Appendix B).
- Follow-up postcards were sent to households that did not respond after 2 weeks (see Appendix C).
- A brief letterhead message from the Chief Planner, Gary Wright, was included (see Appendix D).

Survey Results

Upon closing the survey two months following the initial mail-out, 248 responses had been collected, representing a response rate of approximately 25%, which was roughly the target response rate. Of these, 82 responses (33%) followed the postcard mail-out and 76 (31%) were completed online. 37 car share members responded (only 30% were Autosshare members), although only 25 were members of the same company providing vehicles in their building.

Awareness of dedicated car share vehicles seemed relatively low, with less than 2/3 of residents aware that their building contained a car share vehicle. This suggests there is considerable room for improvement on the part of building staff informing new occupants of car share availability, car share vehicle visibility, and marketing by car share operators, all of which can significantly affect car share membership levels among residents and, hence, auto ownership and parking demand for the building. Note that variations in these marketing factors from building to building are challenging to quantify.

Exhibit 14: Are you aware of the car share vehicle(s) in your building?



Respondents who indicated they were members of a car sharing organization were asked whether the presence of a car share vehicle in their building had a significant influence on their decision to become a member. In 38% of the cases, respondents indicated it was a very important factor (see Exhibit 15). Again, this further supports the hypothesis that the provision of car share vehicles within a building decreases parking demand. However, it is important to note that this result is derived from a small subsample of the total survey respondents.

The survey specifically asked about the influence of marketing on residents' decision to become car share members. The results are mixed, with approximately half of the respondents claiming marketing played at least some role in their decision to become members, while the other half stated it had no influence or that they were unaware of any marketing (see Exhibit 16).

Exhibit 15: Was having a car share vehicle in your building important in your decision to become a car share member?

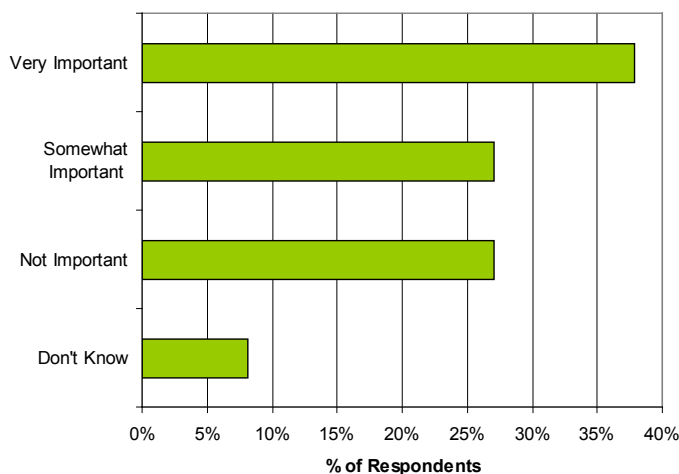


Exhibit 16: Were car share discounts and/or marketing offered through your building important in your decision to becoming a car share member?

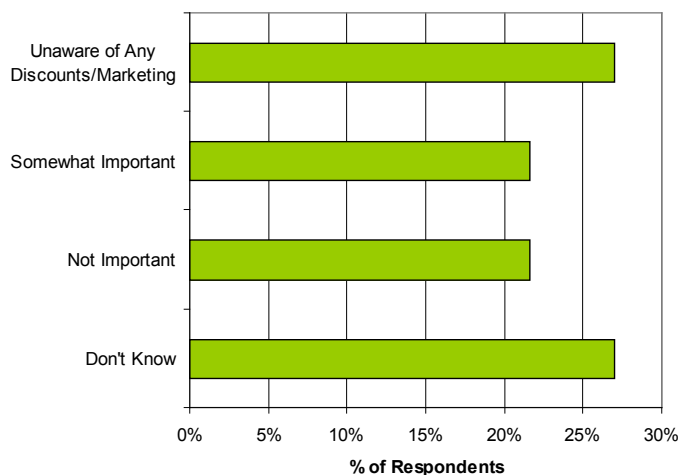


Exhibit 17: Has joining a car share organization allowed you to get rid of your car?

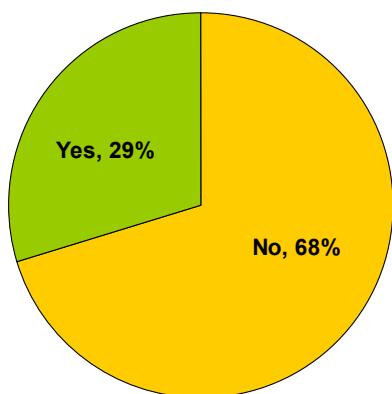
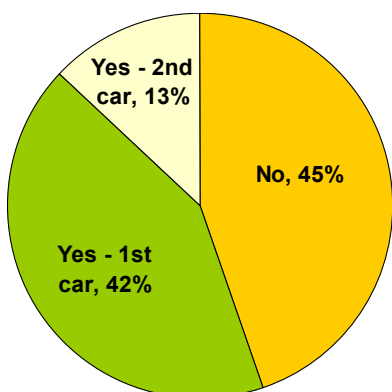


Exhibit 18: Has joining a car share organization allowed you to avoid buying/leasing your first or second car?



Consistent with the findings of other studies cited under “Effects of Car Sharing on Auto Ownership” (page 2), 29% of car share members indicated that they were able to give up a vehicle. Slightly higher than the North American average, 55% of car share members had forgone purchasing a first or second vehicle as a result of their membership in the organization.

Auto ownership was recorded for all respondents and the average per unit of each building is recorded in the last column of Exhibit 19 and Exhibit 20. This enabled a simple regression analysis to explore the impacts of the presence of car share vehicles within a building on the average auto ownership of residents and, correspondingly, a building’s parking demand.

Regression Analysis

Auto Ownership – The Dependent Variable

Auto ownership at the control site condominiums was 1.07 vehicles per unit, whereas the car share buildings had significantly lower auto ownership at an average of 0.53 vehicles per unit. This is an encouraging sign suggesting that the presence of car share vehicles within a building does in fact affect the building’s overall parking demand. However, this section will explore this finding in more depth since we can assume a more urban location bias in the surveyed car share sites. That is, car share operators explicitly acknowledge targeting the denser, more walkable, and transit accessible sites, where residents are less likely to own vehicles.

The dataset includes a handful of variables for each site which are grouped into three main categories: building characteristics, neighbourhood characteristics, and car share availability in the building (coloured blue, yellow, and green respectively in Exhibit 19 and Exhibit 20). These variables are used to control for external influences on auto ownership to further isolate the direct effects between building car share availability and auto ownership. The complete dataset for condominium buildings is shown in Exhibit 19, while that of apartment buildings is shown in Exhibit 20. Most of the variables are self-explanatory, but a few warrant further explanation:

- **Walking Distance to Subway** – The approximate distance from each site to the nearest subway station was measured following the road network (i.e. not simply the straight-line distance).
- **# Carshare Vehicles within 400m** – From a master list of all car share locations for both Autoshare and Zipcar (including all dedicated car share vehicle spaces within buildings) the total within a 400m radius of each site was determined.
- **Walkscore** - The Walkscore for each building was obtained from www.walkscore.com. Walkscore is an indicator that ranges from 0 to 100 and is based on the straight-line distances to the nearest amenities under several categories (therefore, it does not take into account a neighbourhood's pedestrian connectivity). The closer these amenities are to a particular address, the higher the Walkscore for that address. A more complete description of the Walkscore methodology is available online at www.walkscore.com/how-it-works.shtml.

Exhibit 19: Condominium Buildings Surveyed

Address	Dataset	Total Units	Building Characteristics					Neighbourhood Characteristics				Car share availability	Dependent Variable
			Parking Spaces per Unit	Average Bedrooms per Unit	Average Assessed Value per Unit	Average GFA per Unit	Assessed Value per Sq Metre	Walking Distance to Subway (m)	# Carshare Vehicles within 400m	Population within 2km	Walkscore	# Dedicated Carshare Vehicles	Average Vehicle Ownership per Unit (Survey)
1 Aberfoyle Cres	Control	291	1.21	1.85	\$382,900	1,513	\$255	400	1	39,181	67	0	1.25
100 Quebec Ave	Control	225	1.32	2.17	\$305,338	1,041	\$293	400	4	82,724	67	0	0.96
1001 Bay St	Control	566	0.62	1.31	\$253,072	810	\$313	300	4	132,724	97	0	0.60
130 Carlton St	Control	135	1.07	2.02	\$395,649	1,855	\$238	600	4	128,007	90	0	1.09
1300 Islington Ave	Control	244	1.34	2.10	\$327,632	1,232	\$268	600	0	39,032	45	0	1.06
1320 Islington Ave	Control	220	1.32	2.18	\$300,022	1,145	\$267	700	0	39,374	33	0	1.21
15 Maitland Pl	Control	243	0.96	1.17	\$216,564	890	\$246	800	5	127,114	93	0	0.71
18 Lower Village Gate	Control	83	1.61	1.99	\$516,590	1,623	\$322	700	1	95,527	80	0	1.28
19 Lower Village Gate	Control	84	1.61	2.00	\$511,048	1,622	\$323	800	2	96,747	80	0	1.26
222 The Esplanade	Control	352	0.56	1.41	\$210,970	724	\$294	1,200	3	71,086	92	0	0.78
260 Heath St W	Control	133	1.26	1.99	\$371,308	1,203	\$309	600	2	97,315	78	0	1.13
278 Bloor St E	Control	181	0.40	1.99	\$455,376	1,553	\$295	300	3	121,673	92	0	1.09
2900 Yonge St	Control	73	1.81	2.00	\$716,822	1,972	\$369	500	0	68,685	57	0	1.35
360 Bloor St E	Control	166	0.98	1.90	\$338,211	1,497	\$230	200	2	122,623	92	0	1.00
3600 Yonge St	Control	119	1.75	1.88	\$939,513	2,271	\$414	900	0	42,356	60	0	1.96
3800 Yonge St	Control	147	1.78	1.69	\$604,444	1,838	\$338	800	0	41,876	43	0	1.67
3900 Yonge St	Control	136	1.84	2.01	\$512,355	1,700	\$306	400	0	40,811	40	0	1.39
45 Carlton St	Control	330	0.97	1.90	\$279,458	1,208	\$236	200	4	130,940	97	0	0.96
50 Quebec Ave	Control	193	0.99	2.25	\$303,062	1,048	\$289	300	4	82,469	68	0	0.79
55 Harbour Sq	Control	260	1.04	1.69	\$407,801	1,408	\$291	700	3	39,857	80	0	1.11
65 Scadding Ave	Control	264	0.81	1.71	\$219,792	900	\$257	1,350	2	68,039	90	0	0.85
75 Wynford Heights Cres	Control	172	1.57	2.60	\$249,622	1,273	\$196	6,400	0	56,369	38	0	1.14
80 Quebec Ave	Control	106	1.45	2.03	\$312,151	1,025	\$305	300	4	82,641	68	0	1.04
95 Prince Arthur Ave	Control	208	0.59	0.95	\$249,635	787	\$320	200	7	121,065	87	0	0.62
Mean (building)		205	1.20	1.87	\$390,806	1,339	\$291	819	2	82,010	72	-	1.09
Standard Deviation (building)		108	0.43	0.36	\$174,749	412	\$47	1,227	2	34,770	21	-	0.31
Mean (unit)		-	1.07	1.78	\$342,474	1,213	\$284	-	-	-	-	-	1.07
Standard Deviation (unit)		-	0.42	0.39	\$150,490	398	\$41	-	-	-	-	-	0.28
438 Richmond St W	Survey	225	0.76	1.35	\$250,111	756	\$331	900	10	428,833	90	3	0.81
16 Yonge St	Survey	515	0.74	1.41	\$254,783	723	\$353	500	4	347,153	78	2	0.76
78 St. Patrick Street	Survey	34	0.94	0.38	\$228,500	748	\$306	400	4	450,463	87	2	0.38
25 The Esplanade	Survey	571	n/a	0.16	\$222,424	888	\$251	400	6	364,108	93	2	0.35
77 Maitland Place	Survey	383	n/a	1.92	\$203,321	826	\$246	700	8	498,265	95	1	0.50
Mean (building)		346	0.81	1.04	\$231,828	788	\$297	580	6	417,764	89	-	0.56
Standard Deviation (building)		219	0.11	0.74	\$21,056	68	\$48	217	3	62,324	7	-	0.21
Mean (unit)		-	0.75	1.08	\$231,558	805	\$292	-	-	-	-	-	0.53
Standard Deviation (unit)		-	0.45	0.70	\$20,257	71	\$49	-	-	-	-	-	0.18

The auto ownership levels recorded for apartment buildings were less conclusive as, unfortunately, six of the eight control sites were social housing buildings, thus presumably exhibiting considerably lower auto ownership (0.28 vehicles per unit) than would be expected for market units such as those surveyed (0.49 vehicles per unit). For this reason, as well as

the lack of GFA and bedroom data for each unit, it was decided not to include apartment units in the regression analysis. See Exhibit 20 for a complete list of the apartment buildings surveyed.

Exhibit 20: Apartment Buildings Surveyed

Address	Dataset	Total Units	Building Characteristics	Neighbourhood Characteristics				Car share availability	Dependent Variable
			Average Assessed Value per Unit	Walking Distance to Subway (m)	# Carshare Vehicles within 400m	Population within 2km	Walkscore	# Dedicated Carshare Vehicles	Average Vehicle Ownership per Unit (Survey)
130 Eglinton Ave E	Control	266	\$80,508	300	6	81,806	85	0	0.05
15 Scadding Ave	Control	228	\$101,004	1,200	4	68,658	92	0	0.37
31 Tichester Rd	Control	169	\$83,201	400	3	99,397	78	0	0.24
40 Asquith Ave	Control	188	\$86,314	300	4	119,766	93	0	0.38
41 Mabelle Ave	Control	350	\$76,691	1,000	1	37,478	55	0	0.29
460 Jarvis St	Control	207	\$88,841	600	8	126,563	95	0	0.37
57 Charles St W	Control	232	\$143,289	200	7	129,735	97	0	0.23
78 Holly St	Control	127	\$99,150	200	7	84,129	88	0	0.41
Mean (building)		221	\$94,875	525	5	93,442	85	-	0.29
Standard Deviation (building)		67	\$21,323	381	2	31,872	14	-	0.12
Mean (unit)		-	\$93,831	-	-	-	-	-	0.28
Standard Deviation (unit)		-	\$20,876	-	-	-	-	-	0.12
235 Bloor Street East	Survey	477	\$116,128	400	3	546,370	92	4	0.11
22 Oakmount Rd	Survey	208	\$93,976	200	4	454,613	68	2	0.93
88 Erskine Ave	Survey	449	\$121,811	800	2	413,878	87	2	0.59
45 Dunfield Avenue	Survey	544	\$106,733	400	7	463,208	87	2	0.41
50 Portland Street	Survey	217	\$130,673	1,400	3	394,394	75	3	0.40
Mean (building)		379	\$97,718	682	3	458,471	82	-	0.40
Standard Deviation (building)		156	\$36,561	477	2	58,692	10	-	0.29
Mean (unit)		-	\$114,012	-	-	-	-	-	0.49
Standard Deviation (unit)		-	\$19,294	-	-	-	-	-	0.27

REGRESSION RESULTS

Following a correlation analysis of each variable to test for statistically significant relationships with auto ownership (described in more detail in Appendix E), several combinations of independent variables were examined to develop a linear regression model that best explained average auto ownership for condominium units. Two final models were produced, along with a reference model, which did not include a car share availability variable in order to test the explanatory power of car share availability. The most stable models (described further in Appendix F) incorporated four of the variables listed in Exhibit 19:

- Assessed Value per Unit
- Walkscore
- Presence of Dedicated Car Share Vehicles - a dummy variable (only model 1)
- # of Dedicated Car Share Vehicles (only model 2)

In both cases, the most important finding is that ***the presence of dedicated car share vehicles within the building does appear to have a small but significant impact on the auto ownership model's strength***. As discussed further in "Analysis and Recommendations" (page 21), this further justifies a reduction in the minimum parking requirements for buildings that provide dedicated car share vehicles.

Interestingly, model 2 implies that for each car share vehicle added to one of two identical buildings, the average vehicle ownership per unit of the building with the extra car share vehicle(s) would average 0.09 less. This ratio should be used with caution, however, due to the small sample size used in the regression model.

The results for each model also include standardized coefficients that allow us to compare the relative impact of each variable on auto ownership. These suggest that number of dedicated car share vehicles had slightly less impact than Walkscore (urban form) and, as expected, the assessed value per unit had the strongest influence on auto ownership at approximately 2.5 times that of Walkscore.

It is also worth noting that none of the models tested showed that the number of car share vehicles within 400m of each site was a significant variable. This

finding suggests that nearby car share vehicles have little effect on a building's parking demand, perhaps because car share availability is so ubiquitous where most of the survey and control sites were located. The implications of this finding are discussed further in the following section.

Analysis and Recommendations

Studies conducted on car sharing systems across North America show that each car share vehicle typically allows three to four members to get rid of a vehicle they currently own, and helps approximately twice as many members to avoid purchasing a vehicle in the first place. A web-based survey of car share members across Canada and the United States found a much larger impact, estimating that each car share vehicle allows members to sell nearly 15 vehicles (1.5 primary vehicles and 13.4 secondary vehicles). The mail-out survey conducted as part of this study elaborated on these results.

The survey showed that dedicated car share vehicles were an incentive for membership among building residents. Nearly 65% of the surveyed car share members indicated that having a car share vehicle in their building was somewhat or very important in their decision to become a member. After controlling for other factors influencing auto ownership, such as average unit value and neighbourhood walkability, the presence of dedicated car share vehicles was shown to have a significant negative influence on the average auto ownership and parking demand of building residents. Based on all of these results, there is a strong technical justification to provide a reduction in parking requirements for multi-unit residential buildings providing dedicated car share vehicles.

Parking Reduction Ratio

Determining the most appropriate parking reduction ratio (PRR) involves a number of considerations including current parking requirements, empirical findings, consultation findings and the ease of implementation. Based on these factors, the following PRR is proposed:

- For any apartment or condominium development, the minimum parking requirement should be reduced by up to 4 parking spaces for each dedicated car share stall. The limit on this parking reduction is calculated as the greater of:

- $4 * (\text{Total number of units} / 60)$, rounded down to the nearest whole number; or
- 1 space.

- Where a maximum parking ratio is specified, dedicated car share parking spaces should not count towards the maximum allowable parking supply, up to 10% of the maximum number of parking spaces.

Aside from the specific numbers in the formula, this specification is unique in that the maximum reduction in required parking spaces due to car sharing is tied to the number of dwelling units. One four-space reduction is allowed for every 60 units calculated on a sliding scale. In other words, a 40-unit development would receive a parking requirement reduction of 2 spaces if it provided one (or more) dedicated car share parking spaces ($40/60 \times 4 = 2.67$, rounded to 2). A few other development scenarios are summarized in Exhibit 19.

Exhibit 21: Scenarios for Proposed Parking Reduction Ratio

SIZE OF DEVELOPMENT (# OF UNITS)	MAXIMUM ALLOWABLE REDUCTION IN THE MINIMUM REQUIRED PARKING	CAR SHARE SPACES REQUIRED TO ACHIEVE THIS REDUCTION
Less than 30	1	1
30 – 44	2	1
45 – 59	3	1
60 – 74	4	1
75 – 89	5	2
90 – 104	6	2
105 – 119	7	2
120 – 134	8	2
135	9	3
195	13	4
255	17	5
315	21	6
375	25	7

Why this Parking Reduction Ratio?

The four space reduction per car share vehicle is within the range of expected impacts of car sharing on auto ownership from the literature as shown earlier in Exhibit 2-2. The proposed reduction is

slightly higher than the three-space reduction specified in Seattle and Vancouver; however, it is conservative when compared with the ten-space and five-space reductions allowed at a number of developments in Toronto to date. Interestingly, this ratio is also supported by the regression analysis of the survey data, which predicts that one dedicated car share vehicle in a 60-unit building will reduce auto ownership by just over five vehicles. A higher reduction ratio, especially as high as ten spaces, is not recommended given that the proposed new minimum parking standards for condominiums and apartments (shown earlier in Exhibit 7 and Exhibit 8) are considered relatively low to begin with, particularly for the Downtown, Centres, and Avenues. These lower minimum requirements are positive from the perspective of reducing auto dependency, but imply that proposed car share related reductions should be on the conservative side as it is unlikely that the proposed minimum requirements will require an oversupply of parking.

Why this Limit on the Parking Reduction Ratio?

As mentioned, the limit on the reduction in required parking spaces due to car sharing is tied to the number of dwelling units. Up to a four-space reduction is allowed for every 60 units. This is because the potential impact of a dedicated car share vehicle on occupant parking demand increases with increasing number of dwelling units. Based on the regression analysis from the survey data, each dedicated car share vehicle is estimated to reduce average auto ownership per unit by 0.09. Therefore, a dedicated car share vehicle in a 10-unit building will reduce resident parking demand by 0.9 spaces, about enough to account for the car share parking space. In a 60-unit building, a dedicated car share vehicle is predicted to reduce occupant parking demand by 5.4 spaces, resulting in a net reduction of just over 4 spaces when the car share parking space is accounted for.

While a number of by-law amendments in the City have limited the parking reduction due to car sharing based on a certain percentage of the resident parking requirement (this is also the approach in Seattle), tying the limit to the number of units is preferred (this

is the approach in Vancouver). This is because the former approach most restricts car share related parking reductions in areas where less parking is required since these typically central locations are the areas with the lowest minimum parking requirements and where car sharing is most likely to succeed.

Given a hypothetical condominium development in Toronto with 100 one-bedroom units, based on the proposed minimum parking requirements, the required parking would be 40 spaces in the Downtown and 90 spaces in the “Rest of City” (i.e., outside of the Downtown, Centres, and Avenues). If the maximum reduction in required parking spaces due to car sharing was set at 10% of required parking, this would correspond to four spaces in the Downtown development and nine spaces in the Rest of City development. Given a four-space reduction per dedicated car share vehicle, downtown developments would only be allowed one car share space whereas a development located in the “Rest of City” would be allowed up to two spaces, even though two car share vehicles would likely be more successful in the Downtown scenario. Specifying the limit based on number of units would lead to similar maximum reductions for each scenario (6 spaces based on the proposed formula), which would actually be a much higher percentage of required parking in the Downtown scenario (15%) versus the Rest of City scenarios (6.7%).

For buildings smaller than 30 units, the maximum parking reduction due to car sharing is set at one space, effectively allowing for the substitution of one car share space for one resident space. A parking reduction due to car sharing is not justified for smaller buildings, however, a small incentive for car sharing should still be provided.

Why Exempt Car Share Spaces from the Maximum Parking Requirements?

During consultation with car share providers, it was identified that some developments provide car share vehicles to ease pressure on resident parking, particularly where developers expect parking demand to be greater than the maximum allowed parking supply. This practice may increase as the proposed multi-unit residential parking standards

extend parking maximums to all of the Avenues and Centres. However, there will likely be other cases where developers wish to provide more parking than the maximum and may not want to give up occupant parking for car share parking. Given that promotion of car sharing is desirable, it is proposed that dedicated car share parking spaces not be counted towards the maximum parking supply allowed, up to 10% of the maximum number of parking spaces. As discussed below, if the car share spaces are no longer in operation after three years, then all spaces above the maximum will exclusively revert to visitor parking.

Dedicated Car Share Vehicles vs. Nearby Car Share Vehicles

In some residential development applications, developers have successfully argued for parking reductions where they subsidized car share organizations to provide additional car share vehicles at a nearby, off-site location. While car share vehicles near a site may influence the auto ownership and parking demand of building residents, it is not recommended that the zoning by-law explicitly provide a parking reduction for car share vehicles provided off-site for a number of reasons:

- Unlike dedicated car share vehicles, results from the mail-out survey did not indicate a significant relationship between auto ownership and the number of car share vehicles within walking distance of a building. The importance of dedicated car share vehicles is reinforced by the nearly 65% of responding car share members who indicated that the car share vehicle in their building was somewhat or very important in their decision to become a member.
- The survey conducted as part of the multi-unit residential parking standards review included quite a few buildings with car share vehicles within walking distance (although none with dedicated car share vehicles). As such, the proposed standards already include the effect of nearby car share vehicles to a degree, particularly in the Downtown, Centres, and Avenues.
- It is particularly difficult to ensure that car share vehicles be maintained over time if they are provided off-site. This is because it is more

difficult to enforce off-site conditions, which may change frequently. In addition, the building operator or condo board does not have direct control over these parking spaces. As such, the basis for a parking requirement reduction is tenuous.

Implementation Considerations and Other Requirements

In implementing the parking reduction ratio for car sharing in the zoning by-law, there are a number of factors that should be put in place to help guarantee the sustainability of the car share spaces and vehicles over time. These factors include how the car share spaces and agreement are secured, the location and design of the spaces, signage, marketing, and conversion of car share spaces.

- **Securing the agreement** – Granting the parking reduction at the zoning approval stage should be contingent on the applicant providing an agreement with a recognized car share operator to provide one or more car share vehicles at the building for at least three years. This agreement is to be tied to the condominium declaration and the (pending) respective condominium board. The case of apartment buildings is more challenging and would require a review of the landlord tenant act to determine how the City might ensure that some form of agreement could be included into lease agreements.
- **Location and design** – Public access to car share vehicles is vital to their success. The zoning by-law should state that “car share parking spaces must be designed in a manner that will make them accessible to non-resident subscribers from outside the building as well as building residents”. Public access to the car share spaces can be verified at the Site Plan Approval stage. In addition, Staff should work with developers to ensure that car share spaces are in highly visible locations, to maximize their potential demand. Preferred locations in descending order include: surface parking visible from the street and close to the building entrance, surface

parking not visible from the street, and first floor of an underground parking garage.

- **Marketing** – Marketing of the dedicated car share vehicles to building residents is key to achieving predicted reductions in parking demand. As such, the agreement entered into securing the on-site car sharing space(s) should provide for a pool of memberships that would be available to all occupants free of charge. This pool of memberships (for example, could consist of securing one membership for every unit plus an additional 10%) would be transferable to the condominium board upon registration and in turn issued to all new occupants as required. In the event the condominium board runs out of memberships (resulting from sales of units and/or tenant turnover), subsequent memberships could be secured, if desired from the respective car share company.
- **Conversion of car share spaces** – If dedicated car share spaces can be easily converted to occupant spaces, (assuming this would not contravene any other applicable by-law(s)), this may create an incentive for condominium boards to consider selling the car share spaces to residents to generate revenue for other projects. To further discourage this practice, the zoning by-law could stipulate that if at any time car share service ceases to be provided in the dedicated spaces and there is a desire to convert these spaces to general use, 67% and 33% of the spaces shall be converted to visitor and occupant parking respectively (assuming such a conversion would not contravene any other applicable by-law(s)). However, any car share spaces are in excess of the parking maximum can only be converted to visitor parking. Again, introducing such stipulations in the case of apartment buildings would be challenging since there is no equivalent to a condominium agreement and a more detailed review of the legal challenges associated with discouraging conversion of car share spaces in apartment buildings is required.
- **By-law conformance over time** – In this climate of increasing pressure on governments to reduce greenhouse gas emissions, long-term predictions of rising fuel costs, and public

health concerns over automobile dependence, there is little reason to believe that demand for car sharing services will decline in dense urban environments such as central Toronto; Toronto's two car share operators continue to expand their fleets and each is anxious to secure more dedicated parking spaces. However, assuming the City does not enter the business of operating car share services, there is no way to absolutely guarantee long-term provision by third party operators at dedicated car share spaces. Thus, by-law conformance cannot be predicated on service provision. It is possible that specific parking spaces may not work well for car sharing and might be abandoned for not being economically sustainable. This risk can be minimized by ensuring that the mandated car share spaces are highly visible and fall within the most likely to succeed geographic areas (e.g. the downtown core or near high-order transit facilities).

In re-writing it's zoning by-law, the City has made it clear it is not interested in eliminating parking requirement minimums, thus the only other way to guarantee long-term by-law conformance with respect to all mandated car share spaces would be to take the San Francisco approach and require developments (likely only those within particular areas of Toronto) to provide car share vehicles. This assumption could be automatically built into all multi-unit residential parking requirements.

Appendix A

MAIL-OUT SURVEY QUESTIONNAIRE

Residential Parking Survey 2008: Effects of Car Sharing

The City of Toronto is conducting a special survey of residential buildings with car share vehicles. Your household has been selected to be a part of this important survey.

Complete the survey for your chance to win a free membership and \$100 credit at the car share company of your choice – AutoShare or Zipcar.

You have two options for completing the survey:

- **Online** – Go to <http://www.toronto.ca/planning/carshare/> . You will need your ID number printed at the top of this page.
- **Mail back** - Please answer all the questions as accurately as possible and return this questionnaire in the postage paid envelope provided.

Your cooperation is very much appreciated and will assist the City in planning for future parking needs.

Car Ownership and Parking Needs

1. How many vehicles does this household have? Please include all cars, vans or light trucks that are brought home and parked overnight.
 - ☐ 0
 - ☐ 1
 - ☐ 2
 - ☐ 3 or more
2. Where are the vehicles mentioned in Question 1 usually parked overnight? (check all that apply)
 - ☐ In your building's parking lot or garage
 - ☐ On the street near your building
 - ☐ Elsewhere (examples: public parking facility, private garage, on the street far away)
 - ☐ Not applicable
3. How many parking spaces do you own or rent in your building?
 - ☐ 0
 - ☐ 1
 - ☐ 2
 - ☐ 3 or more
4. When do you use your principle vehicle? (check all that apply)
 - ☐ This household does not own a vehicle
 - ☐ To go to work/school
 - ☐ To go shopping/run errands
 - ☐ For leisure activities

Car Sharing

5. Are you aware of the car share vehicle(s) in your building?
 - ☐ Yes
 - ☐ No
6. Are you a member of a car share organization? (check all that apply)
 - ☐ Yes - AutoShare
 - ☐ Yes - Zipcar
 - ☐ No

Questions continue on the back...

Household Characteristics (All respondents should answer these questions)

1. How many bedrooms are in this unit?
 - ☐ None
 - ☐ One bedroom
 - ☐ Two bedrooms
 - ☐ Three or more bedrooms
2. How many people with a driver's license live in this unit?
 - ☐ 0
 - ☐ 1
 - ☐ 2
 - ☐ 3
 - ☐ 4 or more
3. Do you own or rent this unit?
 - ☐ Own
 - ☐ Rent

Car Share Members (Only answer these questions if you are a member of a car share organization)

4. Was having a car share vehicle in your building important in your decision to become a car share member?
 - ☐ Very important
 - ☐ Somewhat important
 - ☐ Not important
 - ☐ I don't know
5. Were car share discounts and/or marketing offered through your building important in your decision to becoming a car share member?
 - ☐ Very important
 - ☐ Somewhat important
 - ☐ Not important
 - ☐ I'm unaware of any discounts or marketing
6. Is the car share vehicle in your building the primary car share vehicle that you use?
 - ☐ Yes
 - ☐ No
7. How often do you use the car share vehicle in your building?
 - ☐ Very often (more than four times per month)
 - ☐ Often (more than once per month)
 - ☐ Rarely (less than once per month)
 - ☐ Never
8. Has joining a car share organization allowed you to (check all that apply):
 - ☐ Get rid of your car?
 - ☐ Avoid buying/leasing your first car?
 - ☐ Avoid buying/leasing your second car?

Thank you! Upon receipt, you will be entered into a draw for the survey prize.

Appendix B

ONLINE SURVEY QUESTIONNAIRE

Residential Parking Survey: Effects of Car Sharing

1. Introduction

Thank you for participating in this survey. The City of Toronto is conducting a special survey of residential buildings with car share vehicles.

Complete the survey for your chance to win a free membership and \$100 credit towards the car share company of your choice – AutoShare or Zipcar.

Please answer all the questions as accurately as possible. Your cooperation is very much appreciated and will assist the City in planning for future parking needs.

*** 1. Do you have your Survey ID Number (printed on the paper copy of the survey you received)**

☐ Yes

☐ No

Residential Parking Survey: Effects of Car Sharing

2. Survey ID

*** 2. Please enter your Survey ID (printed at the top of the paper copy of the survey you received)**

Residential Parking Survey: Effects of Car Sharing

3. Address Information

Address information is collected so that IBI Group staff can remove your address from the mailing list as soon as your survey is completed and so that we can contact you if you win the survey prize. Your name or address will never be used in our analysis.

*** 3. You can still proceed without your Survey ID. Please enter your address.**

Name:

Address:

Address 2:

Unit #:

ZIP/Postal Code:

Residential Parking Survey: Effects of Car Sharing

4. Car Ownership and Parking Needs

*** 4. How many vehicles does this household have? Please include all cars, vans or light trucks that are brought home and parked overnight.**

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

5. Where are the vehicles mentioned in question 4 usually parked overnight? (check all that apply)

- ☐ In your building's parking lot or garage
- ☐ On the street near your building
- ☐ Elsewhere (examples: public parking facility, private garage, on the street far away)
- ☐ Not applicable

*** 6. How many parking spaces do you own or rent in your building?**

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3 or more

7. How do you use your principle vehicle? (check all that apply)

- ☐ To go to work/school
- ☐ To go shopping/run errands
- ☐ For leisure activities
- ☐ This household does not own a vehicle

Residential Parking Survey: Effects of Car Sharing

5. Car Sharing

8. Are you aware of the car share vehicle(s) in your building?

☐ Yes

☐ No

*** 9. Are you a member of a car share organization (e.g. AutoShare or Zipcar)?**

☐ Yes - AutoShare

☐ Yes - Zipcar

☐ No

Residential Parking Survey: Effects of Car Sharing

6. Car Share Members

10. Was having a car share vehicle in your building important in your decision to becoming a car share member?

- ☐ Very important
- ☐ Somewhat important
- ☐ Not important
- ☐ I don't know

11. Were car share discounts and/or marketing offered through your building important in your decision to becoming a car share member?

- ☐ Very important
- ☐ Somewhat important
- ☐ Not important
- ☐ I am unaware of any discounts or marketing

12. Is the car share vehicle in your building the primary car share vehicle that you use?

- ☐ Yes
- ☐ No

13. How often do you use the car share vehicle in your building?

- ☐ Very often (more than four times per month)
- ☐ Often (more than once per month)
- ☐ Rarely (less than once per month)
- ☐ Never

14. Has joining a car share organization allowed you to (check all that apply):

- ☐ Get rid of your car?
- ☐ Avoid buying/leasing your first car?
- ☐ Avoid buying/leasing your second car?

Residential Parking Survey: Effects of Car Sharing

7. Household Characteristics

15. How many bedrooms are in this unit?

- ☐ None (studio or bachelor unit)
- ☐ One bedroom
- ☐ Two bedrooms
- ☐ Three or more bedrooms

16. How many people with a driver's license live in this unit?

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4 or more

17. Do you own or rent this unit?

- ☐ Own
- ☐ Rent

Appendix C

FOLLOW-UP POSTCARD



City Planning Division

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Toronto ON M5H 2N2

Gary Wright
Chief Planner and Executive Director

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E-mail: gstewart@toronto.ca
www.toronto.ca/planning

August 19, 2008

To Household (or Unit Occupant):

One week ago, a special City of Toronto survey was mailed to you, asking for information that is needed to determine the Zoning By-law requirements for new multi-unit residential buildings that provide space for car share vehicles. **If you have already completed and returned your survey form, please accept our sincere thanks. If not, could you please complete and return the survey to IBI Group as soon as possible.**

Your response is important. Your household has been selected to be part of this survey in order to estimate the parking demands of buildings that are similar to yours. If you have not yet received the questionnaire or have misplaced it, please fill it out at www.toronto.ca/planning/carshare/ or call Joshua Engel-Yan at 416-596-1930 extension 427 and he will be happy to send you another one.

Thank you for your contribution to this important study.

Gary Wright
Chief Planner and Executive Director
City Planning Division

Appendix D

LETTER FROM CHIEF PLANNER



City Planning Division

Toronto City Hall
100 Queen Street West
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Toronto ON M5H 2N2

Gary Wright
Chief Planner and Executive Director

Tel: (416) 392-8772
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Refer to: Greg Stewart at (416) 392-2691
E-mail: gstewart@toronto.ca
www.toronto.ca/planning

To the Household (or Unit Occupant):

Residential Parking Survey 2008: Effects of Car Sharing

The City of Toronto has retained the IBI Group to conduct a survey of residents in high-rise buildings that provide parking spaces for “car share” vehicles. These vehicles are available to members of car share organizations and offer an alternative to private car ownership. Your household has been selected to be a part of this survey.

The survey is designed to measure the impacts of car sharing on the demand for parking. The survey results will help determine the future Zoning By-law requirements for parking in new, multi-unit residential buildings.

Completing this survey will take only a few minutes of your time. You can either complete the survey online (see the attached questionnaire for the online address) or fill in the attached questionnaire and return it in the postage paid envelope provided.

The identification number on the questionnaire is for tracking purposes only. Your name and address will be kept confidential and will never be used in our analysis.

Please return the questionnaire within one week. If you have any questions about the survey, or if you need assistance to complete the questionnaire, please call Joshua Engel-Yan at IBI Group, (416) 596-1930 extension 427, or Pauline Craig, City Planning, (416) 392-9396.

Thank you for your contribution to this important study.

Gary Wright
Chief Planner and Executive Director
City Planning Division

Attch.

Appendix E

CORRELATION BETWEEN CONDOMINIUM VARIABLES

Since each car share provider indicated explicitly targeting more urban neighbourhoods, the correlation matrix for condominiums buildings (see Exhibit E-1 and Exhibit E-2) reveals and expectedly high correlation between the neighbourhood characteristics and car share availability.

Furthermore, correlation between auto ownership and each of the variables available in the dataset (the bottom row, highlighted in orange) reveals the expected signs for each correlation and helps to guide developing a linear regression model. Among the building characteristic variables, assessed value per unit and average GFA per unit show the strongest correlation. Both, however, are tightly correlated with one another. The average number of beds per unit is also relatively correlated with auto ownership, but not as strongly. As expected all four of these variables show a positive correlation against auto ownership.

Considering the neighbourhood characteristic variables, only 'Walking Distance to Subway' was clearly insignificant. Given that car share availability tends to be more prominent in the more urban areas, it is not surprising that the number of car share vehicles within 400m of each site is strongly correlated with both the site's surrounding population density and the Walkscore. All three of the significant neighbourhood characteristic variables show a negative effect on auto ownership, as expected.

The most important of these initial results is a significant and negative, but mild correlation between the building car share availability variables and auto ownership, implying there is a relationship worth exploring further. This is explored further in the simple regression analysis of Appendix F.

Exhibit E-1: Cross-Correlation Coefficients

		Average			Walking Distance to			# Carshare			Population			#			Average
		# Beds Per Unit	Assessed Value per Unit	Average GFA per Unit	Subway (m)	400m	within 2km	Walkscore	Carshare Vehicles On-Site	Building Has Car Share	Average Vehicle Ownership per Unit						
Building Characteristics	AvgBedPerUnit		0.321	0.480	-0.115	0.311	-0.505	-0.579	-0.509	-0.604	-0.590	0.612					
	Assessed Value per Unit	0.321		0.902	0.644	-0.101	-0.570	-0.423	-0.402	-0.328	-0.360	0.860					
	Average GFA per Unit	0.480	0.902		0.285	0.014	-0.655	-0.529	-0.421	-0.473	-0.493	0.875					
Neighbourhood Characteristics	Assessed Value per Sq Metre	-0.115	0.644	0.285	-0.349	-0.100	-0.137			0.131	0.055	0.395					
	Walking Distance to Subway (m)	0.311	-0.101	0.014	-0.349	-0.243	-0.130	-0.352	-0.352	-0.070	-0.082	0.119					
	# Carshare Vehicles within 400m	-0.505	-0.570	-0.655	-0.100	0.731	0.691	0.491	0.491	0.613	0.945	-0.729					
Car Share Availability in Building	Population within 2km	-0.579	-0.423	-0.529	-0.021	0.731	0.691	0.491	0.491	0.881	0.957	-0.663					
	Walkscore	-0.509	-0.402	-0.421	-0.137	-0.352	0.691	0.491	0.491	0.289	0.317	-0.618					
	# Carshare Vehicles On-Site	-0.604	-0.328	-0.473	0.131	-0.070	0.613	0.881	0.289	0.945	0.945	-0.504					
Auto Ownership (Dependent Variable)	Building Has Car Share	-0.590	-0.360	-0.493	0.055	-0.082	0.613	0.957	0.317	0.945	0.945	-0.574					
	Average Vehicle Ownership per Unit	0.612	0.860	0.875	0.395	0.119	-0.729	-0.663	-0.618	-0.504	-0.574						

Exhibit E-2: Cross-Correlation Significance

		Average # Beds Per Unit	Assessed Value per Unit	Average GFA per Unit	Assessed Value per Sq Metre	Walking Distance to Subway (m)	# Carshare Vehicles within 400m	Population within 2km	Walkscore	# Carshare Vehicles On-Site	Building Has Car Share	Average Vehicle Ownership per Unit
Building Characteristics	AvgBedPerUnit	0.090	0.090	0.008	0.552	0.101	0.005	0.001	0.005	0.001	0.001	0.000
	Assessed Value per Unit	0.008	0.008	0.000	0.000	0.602	0.001	0.022	0.030	0.083	0.055	0.000
	Average GFA per Unit	0.552	0.000	0.134	0.134	0.942	0.000	0.003	0.023	0.010	0.007	0.000
Neighbourhood Characteristics	Assessed Value per Sq Metre	0.101	0.602	0.942	0.064	0.064	0.605	0.915	0.478	0.497	0.779	0.034
	Walking Distance to Subway (m)	0.005	0.001	0.000	0.064	0.203	0.000	0.000	0.061	0.720	0.672	0.537
	# Carshare Vehicles within 400m	0.001	0.022	0.003	0.915	0.500	0.000	0.007	0.007	0.000	0.000	0.000
Car Share Availability in Building	Assessed Value per Sq Metre	0.005	0.030	0.023	0.478	0.061	0.000	0.007	0.007	0.129	0.094	0.000
	Walking Distance to Subway (m)	0.001	0.083	0.010	0.497	0.720	0.000	0.000	0.129	0.000	0.000	0.005
	# Carshare Vehicles On-Site	0.001	0.055	0.007	0.779	0.672	0.000	0.000	0.094	0.000	0.001	0.001
Auto Ownership (Dependent Variable)	Average Vehicle Ownership per Unit	0.000	0.000	0.000	0.034	0.537	0.000	0.000	0.000	0.005	0.001	

Appendix F

LINEAR REGRESSION ANALYSIS

Several combinations of independent variables were explored to develop a linear regression model that best explained average auto ownership for condominium units, using the correlation analysis of Appendix E as a guide and accepting only variables with a confidence level above 95%. Among the building characteristic variables, the assessed value per m² was never significant, as suggested by the correlation matrix. Although the average number of beds per unit was the least correlated with the other three variables, it produced mixed results and we were unable to produce a stable model that included it as an independent factor. Since assessed value and average GFA per unit were so strongly correlated, the more stable models used only one of these two variables, with the former producing slightly better results.

For the neighbourhood characteristics, as expected, walking distance to subway stations was never significant in any of our models. Interestingly,

neither was the number of car share vehicles within 400m of each site. This may be due to interference with other variables. This interesting finding thus suggests that nearby car share vehicles have little effect on a building's parking demand, perhaps because car share availability is so ubiquitous where most of the survey sites were located. Population density and Walkscore both produced strong model results, however those involving Walkscore were more consistent. Despite apparent weak correlation between these two variables, none of the models tested were stable when both of these variables were included. Two final models were produced, along with a reference model to test the explanatory power of car share availability. They are summarized in Exhibit F-1, Exhibit F-2, and Exhibit F-3. Model 2 includes the number of car share vehicles in each building as an independent variable, whereas Model 3 simply substituted this for a dummy variable, which resulted in a slightly stronger model.

Exhibit F-1: Model 1 – Reference, Without Car Share Availability

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.884	0.164		5.41	0.000
Assessed Value per Unit	1.54E-06	0.000	0.729	8.20	0.000
Walkscore	-0.006	0.002	-0.325	-3.66	0.001

Model Summary	
N	29
R Square	0.828
Adjusted R Square	0.815

$$\begin{aligned} \text{Auto Ownership per Unit} = & 0.884 \\ & + (0.00000154 * \text{Assessed Value per Unit}) \\ & - (0.006 * \text{Walkscore}) \end{aligned}$$

Exhibit F-2: Model 2 – Including the Number of Car Share Vehicles On-Site

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.903	0.150		6.04	0.000
Assessed Value per Unit	1.43E-06	0.000	0.679	8.12	0.000
Walkscore	-0.005	0.001	-0.288	-3.49	0.002
# Car Share Vehicles On-Site	-0.088	0.035	-0.199	-2.48	0.020

Model Summary	
N	29
R Square	0.862
Adjusted R Square	0.845

$$\begin{aligned} \text{Auto Ownership per Unit} = & 0.903 \\ & + (0.00000143 * \text{Assessed Value per Unit}) \\ & - (0.005 * \text{Walkscore}) \\ & - (0.088 * \text{\# Dedicated Car Share Vehicles}) \end{aligned}$$

Exhibit F-3: Model 3 – Including a Dummy Variable for the Presence of Car Share Vehicles On-Site

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.908	0.139		6.51	0.000
Assessed Value per Unit	1.39E-06	0.000	0.660	8.40	0.000
Walkscore	-0.005	0.001	-0.274	-3.54	0.002
Building Has Car Share	-0.233	0.071	-0.250	-3.29	0.003

Model Summary	
N	29
R Square	0.880
Adjusted R Square	0.865

$$\begin{aligned} \text{Auto Ownership per Unit} = & 0.908 \\ & + (0.00000139 \times \text{Assessed Value per Unit}) \\ & - (0.005 \times \text{Walkscore}) \\ & - (0.233 \times \text{Building Has Car Share}) \end{aligned}$$

With an adjusted R Square of 0.865, Model 3, although simple, is a good predictor of auto ownership for the survey data collected. This is illustrated in Exhibit F-4, which plots observed versus predicted auto ownership (a perfect model would show a perfectly straight line at 45° and passing through the origin).

In both cases, the most important finding is that **the presence of dedicated car share vehicles within the building does appear to have a small but significant impact on the auto ownership model's strength**. This is indicated by the 0.03 to 0.05 increase in the adjusted R Square when the car share dummy variable is introduced. As discussed further under “Analysis and Recommendations” (page 21), this further justifies a reduction in the minimum parking requirements for buildings that provide dedicated car share vehicles.

Interestingly, model 2 implies that for each car share vehicle added to one of two identical buildings, the average vehicle ownership per unit of the building with the extra car share vehicle(s) would average 0.09 less. This ratio should be used with caution, however, due to the small sample size used in the regression model.

The results for each model also include standardized coefficients that allow us to compare the relative impact of each variable on auto ownership. As can be seen by their relative magnitudes, they suggest that the number of dedicated car share vehicles had slightly less impact than Walkscore (urban form) and, as expected, the assessed value per unit had the

strongest influence at approximately 2.5 times that of Walkscore.

It is also worth noting that none of the models tested showed that the number of car share vehicles within 400m of each site was a significant variable. This finding suggests that nearby car share vehicles have little effect on a building's parking demand, perhaps because car share availability is so ubiquitous where most of the survey and control sites were located. The implications of this finding are discussed further under “Analysis and Recommendations” (page 21).

Exhibit F-4: Model 3 – Observed versus Predicted Auto Ownership

