Impacts of a New Express Bus Service in Waterloo Region

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Bruce Hellinga
Associate Professor, Dept. of Civil Engineering
University of Waterloo
Waterloo, ON N2L 3G1
Email: bhellinga@uwaterloo.ca;
Phone: 519-888-4567 Ext. 32630

John Cicuttin
Manager Transit Development
Region of Waterloo
Waterloo, Ontario
Email: cijohn@region.waterloo.on.ca;
Phone: 519-575-4023

Abstract

The Urban Transportation Showcase Program (UTSP) is a Federal Government program with the goal of quantifying, through field deployments (showcases), the impacts that various transportation initiatives have on green house gas (GHG) emissions. The Regional Municipality of Waterloo proposed the implementation of an express bus service supported by various bus control and traveller information technologies (e.g. transit signal priority, web-based trip planner, automatic passenger counting system), community based marketing initiatives, and inter-modal integration measures. This proposal was selected as one of the showcase projects.

- The express bus service (*iXpress*), which consists of 13 stations distributed over a route length of approximately 35km, commenced service at the beginning of September 2005. The supporting bus control and traveller information technologies have been deployed incrementally. Unconditional transit signal priority was implemented at key intersections along the route at the time service commenced. Real-time passenger information displays (i.e. next bus arrival times) were deployed in late summer 2007. On bus automatic vehicle location and control system (AVLC) and automatic passenger counting system (APCS) were deployed in mid-summer 2007. An interactive web-based trip planner is scheduled for deployment during the fall of 2007.

The impact that the new service has had on travel behaviour in the Region has been monitored through the use of on-board intercept surveys, ridership tracking, and community surveys. Despite delays in technology implementation the *iXpress* has been successful in attracting riders with most recently available data showing that ridership is at 92% of forecasted levels and growing (34% increase during the period from November 2005 to November 2006). As expected, a large proportion (72%) of these riders have shifted from using local transit routes. However, the results also indicate a significant number of trips (14%) were previously made using auto. Furthermore, there is evidence that the *iXpress* service has provided increased mobility.

The analysis presented here demonstrates that *iXpress* is currently responsible for the reduction of approximately 1.5 million kilometres of personal automobile trips per year, with an associated reduction of approximately 500 tonnes of GHG emissions. Further, we estimate that if predicted ridership levels are achieved, these reductions in personal auto use will result in an annual reduction of 625 tonnes of GHG at the time of technology deployment and as many as 750 tonnes/year of GHG one year later.

Introduction

Similar to many communities across Canada, Waterloo Region is facing a daunting challenge represented by automobile travel in medium-sized urbanized areas. This challenge is characterized by: low to medium density land-use patterns developed over the past three decades; ubiquitous auto ownership; traffic congestion that occurs at relatively few locations in the road network and typically exists for relatively short periods of the day; parking that is free in most locations and relatively inexpensive where there is a charge; and travel times by auto that are generally very favourable. The resulting market share of the "drive alone by auto" option for journey to work trips is over 80%, with resulting damaging environmental impacts, particularly the creation of greenhouse gases (GHG).

This challenge, common to medium sized cities across Canada is further compounded in the case of Waterloo Region as a result of tremendous growth pressures. Population is predicted to grow by nearly 60%, from 456,000 in 2001 to 729,000 in 2031, greatly intensifying impacts on transportation infrastructure, air quality and greenhouse gases.

To help meet this challenge, Waterloo Region has initiated a limited-stop express bus service (called *iXpress*) that is supported by a number of additional initiatives, including advanced technologies, marketing, and active mode integration.

The *iXpress* service is the first significant attempt to attract longer trips to public transit along the central transit corridor of Waterloo Region. One of the key objectives of the *iXpress* is to build up ridership levels that will eventually support a rapid transit system along the central transit corridor. Rapid transit is the key transportation strategy in the Region of Waterloo's Growth Management Strategy that will create a more compact urban from through reurbanization.

This paper describes: the *iXpress* initiative; the steps taken to measure and monitor the impacts that the *iXpress* initiative has had on travel behaviour in Waterloo Region; the impacts that have been observed to date; and the plans for the future.

The *iXpress* Initiative

Project Background

On October 6, 2000, the Government of Canada announced it would establish the Urban Transportation Showcase Program (UTSP), among other initiatives contained in its Action Plan 2000 on Climate Change. The primary objective of the UTSP was to demonstrate, evaluate, and promote effective strategies to reduce greenhouse gas emissions from transportation in urban Canada. The program was formally launched June 11, 2001 and a nation-wide two-stage competitive selection process was initiated to select a number of showcase projects. Stage 1 consisted of submissions of expressions of

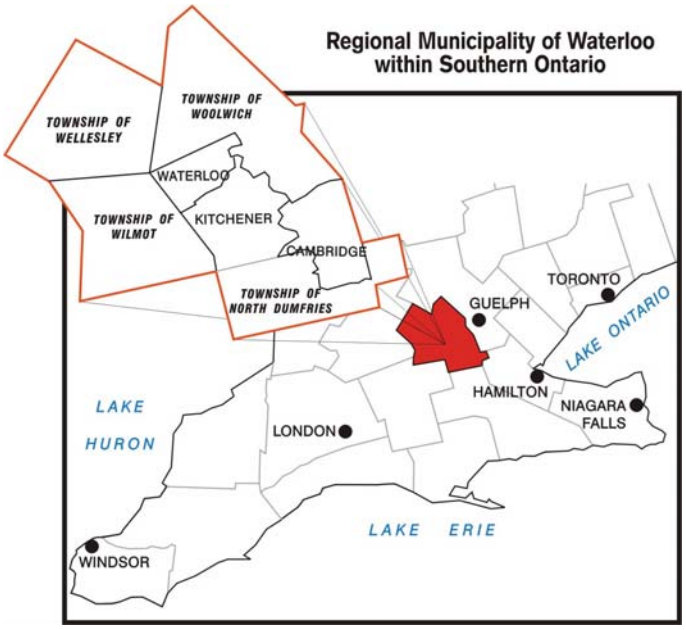
interest. On the basis of these submissions, a number of projects were short-listed and proponents were invited to submit detailed proposals by May 2003 for the Stage 2 evaluation.

On the basis of this competitive selection process, the Region of Waterloo's proposal entitled "Central Transit Corridor Express Project" was selected as one of the projects for funding under the UTSP. The announcement of the successful proposals was made by the Federal Minister of Transport on Nov. 26, 2003. Formal contractual agreements between the Region of Waterloo and the Federal Government and between the Region of Waterloo and the University of Waterloo were completed by the end of the summer of 2004.

Waterloo Region

Waterloo Region is one of the most diverse and dynamic economic regions in Canada. With a population of nearly half a million people, Waterloo Region is a significant contributor to the national economy, boasting an annual estimated regional GDP of over $16 billion. The Region is situated at the fulcrum of the Greater Toronto Area and U.S. Gateways at Windsor, Sarnia and Niagara (Figure 1). This strategic location, along the axis of the North American free trade corridor, affords access to and is connected to many of the major North American markets.

Figure 1: Location of Region of Waterloo



The Region is comprised of the cities of Cambridge, Kitchener, Waterloo, and the townships of North Dumfries, Wellesley, Wilmot and Woolwich. Collectively the municipalities represent the 10th largest census metropolitan area in Canada, the 4th largest in Ontario and the extent of Canada's

Technology Triangle. The MacDonald Cartier Freeway (Highway 401), which extends along the Quebec City to Windsor Corridor, bisects Waterloo Region.

The Region of Waterloo has a long history of innovation and proactive sustainable development. The hallmark of integrated transportation and land use planning will be tested during the next 40 years with the projected growth in population and employment. Recognizing the new physical, social, environmental and economic realities that accompany growth, the Region initiated the development of a Growth Management Strategy to effectively manage these new realities and channel them to the Region's best advantage. A balanced transportation system and demand management initiatives, coupled with intensified land use to support higher order transit, are viewed as critical to addressing the challenges of new growth and reducing greenhouse gas (GHG) emissions. The transit initiative embodied as part of this UTSP project is just one step forward to achieving a balanced transportation system.

Regional Growth Management Strategy

One of the six goals of the RGMS is to "Provide Greater Transportation Choice". iXpress attracts new transit users by providing a better quality service that is easier and more convenient to use. By offering limited-stop service and transit priority features, travel times on iXpress are more competitive with driving a private automobile. The iXpress continues to attract new customers who have never used transit before and have the option to drive their car, but choose not to. In addition, through the project's high quality stations and improvements to the pedestrian environment around stations, walking is becoming a more attractive option as well. A number of cycling amenities have been added as part of the iXpress project to encourage cycling to stations including bike racks on GRT's entire fleet of buses to allow 'bus n bike' trips; post and ring bike racks for on-demand use; and bike lockers available for rental at some stations. iXpress is providing greater transportation choice through improvement to more sustainable modes - transit, walking, and cycling.

More active modes also improve the public's health through a reduction in diseases related to a sedentary lifestyle. In addition, choosing transit, walking, and/or cycling over driving a single-occupant automobile will help slow the worsening of air quality and greenhouse gas emissions.

Another goal of the RGMS is to build vibrant urban places by redeveloping and intensifying core areas. A compact urban form will help protect the countryside from growth pressures and help foster a strong economy. Focusing more population and jobs in existing built up areas will concentrate trip making in the urbanized area. More human-scale and vibrant urban places are created by having lots of interaction on the street as people walk, cycle, and take transit to get where they need to go. Reducing auto dependency will reduce the Region's need for additional and higher capacity roads. Urban land can then be more efficiently used for attractive public

spaces where people can safely live, work, and play. Redeveloping core areas in this manner will attract more people and business to the Region.

iXpress is an initial step in the direction of achieving some of the goals of the RGMS. The development of a rapid transit system along the central transit corridor is the next key step to achieve the compact urban form required to sustain the economic vitality and enhance the quality of life offered by the Region of Waterloo as the community continues to grow well into the future.

The Project

The UTSP project consists of the implementation of a higher order transit service supported by advanced technologies, enhanced integration with active access modes such as walking and cycling and a new marketing approach. The following sections describe each of these components in more detail.

iXpress Service Route

The backbone of the project is a limited-stop express service branded as *iXpress* (Figure 2). The *iXpress* route, which travels from north Waterloo to south Cambridge, is approximately 35 km in length and consists of 13 stations. Along the route there are four downtowns, two universities, office complexes, major hospitals and regional shopping centres. The *iXpress* service, which commenced in September 2005, operates Monday to Friday with 15 minute headways during the morning and afternoon peak periods and with 30 minute headways during the midday. Based on numerous customer requests and successful ridership levels, the 2007 approved budget includes the provision of Saturday service beginning in June 2007 and evening and Sunday service beginning in September 2007.[1]

Local transit routes operate along portions of the *iXpress* route, including Route 7 which currently serves the corridor within the urban municipalities of Kitchener and Waterloo. Local bus service headways on King Street in Kitchener and Waterloo approach 5 minutes during the peak periods.

The *iXpress* service is provided using standard 40 foot Nova low floor buses which are differentiated from buses servicing local routes by unique exterior branding. The potential use of 60 foot articulated buses with highway coach type interiors typically used in some higher-order Bus Rapid Transit applications was considered but determined to be premature for several reasons:

1) The potential role for high-capacity articulated buses would become clearer once the environmental assessment planning process currently

[1] The new GRT Business Plan expected to be completed in early 2008 will prioritize higher service frequency on the iXpress (eg. 10 minute peaks, 15 minute off-peak) among other service priorites identified for the overall GRT network..

underway for a rapid transit system along the central transit corridor determines the preferred alignment, stations and technology.

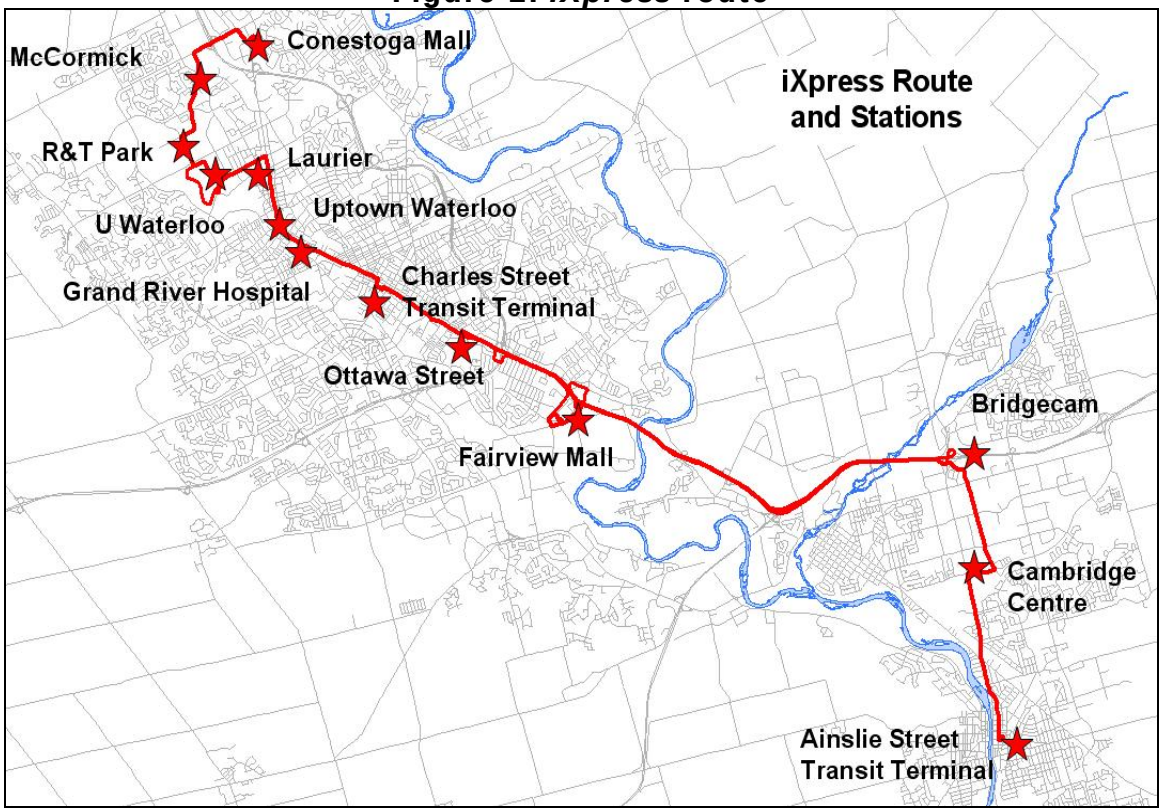
2) Maintenance facilities would need to be upgraded, eg. hoists, to accommodate the maintenance requirements of 60 foot articulated buses.

3) Rapid service expansion requires the flexibility to deploy any bus to any route, means that iXpress buses would occasionally be deployed on regular routes.

4) The need for higher capacity would be more effectively met through frequency of service increases (eg. from 15 to 10 minutes) rather than deploying larger capacity buses.

Based on the above, it was determined that acquisition of 40 foot buses with a unique exterior branding would provide the necessary capacity and visibility to implement the iXpress service. The potential application of 60 foot articulated buses in the future would be determined through the results of the Rapid Transit environmental assessment planning process.

Figure 2: *iXpress* route



Advanced Technologies

The goals in developing the *iXpress* service were providing more reliable service (in terms of schedule compliance) and travel times that are more competitive with respect to auto travel times than existing local transit. One of the elements to achieving this goal was the use of advanced technologies, including:

- Transit signal priority (TSP);
- Automatic vehicle location and control system (AVLC);
- Automatic passenger counting system (APCS);
- Real-time traveller information displays at stations;
- Web-based trip planner;
- Interactive Voice Response (IVR) systems which provide information through a touch-tone telephone for all GRT routes.

At the time of the writing of this paper, TSP had been implemented at 17 intersections and was operational. The remaining technologies were undergoing deployment and were expected to be operational by the end of the summer of 2007.

The purpose of the technologies was to enhance the travel experience by improving pre-trip planning (i.e. web-based trip planner); improving transit rider knowledge (i.e. real-time traveller information panels that would display the expected arrival time of the next *iXpress* bus); and the speed, comfort and reliability of the service (i.e. TSP and AVLC). The AVLC system on 15 *iXpress* buses and APC's on 34 buses (including 15 *iXpress* buses) will significantly enhance the monitoring capability to determine ridership impacts and schedule reliability of the *iXpress* and operating performance of other routes. These data will be used by service planners to optimize *iXpress* and local route schedules, plan future service level improvements, fine-tune existing TSP location and expand TSP to new locations.

Intermodal Integration

One of the primary goals of the project in Waterloo Region was the enhancement of non-auto travel modes. The implementation of the *iXpress* service, supported by the advanced technologies, provided an additional transit mode alternative to travellers. However, recognising that unlike auto trips, transit trips are not door-to-door, there was a strong desire to enhance the active modes (e.g. walk and bike) and their integration with the *iXpress* service. Consequently, a number of intermodel integration activities were undertaken, including:

- Installation of bike-racks on all buses within the GRT fleet;
- Installation of bike lockers at several stations;
- Installation of "post and ring" bike stands at several stations;
- Improvements to pedestrian facilities at several stations (e.g. painting ladder striping at intersections, replacement of sidewalks, etc.)
- Designation of bike lanes.

Branding and Community Based Social Marketing

The express bus service was branded as *iXpress* with a tag line of "connecting you" to reflect the fast, limited stop quality of the service, and to reflect the notion that this quality of service provides individuals with travel mode choices (expressions). The graphic design uses contemporary fonts and styling to reflect the advanced technology elements of the service and the high tech nature of the community it serves. The buses servicing the *iXpress* route are differentiated from buses servicing local routes by exterior graphics (Figure 3). Typical marketing campaigns were initiated including radio and print ads to inform and educate the community about the new service.

Figure 3: *iXpress* service branding

Community based social marketing (CBSM) differs from typical marketing in that it targets and interacts with individual households and trip makers in the community. The objective of CBSM is to target specific residential

neighbourhoods within the service catchments area and identify, via surveys, their travel patterns, mode choices, and constraints. On the basis of the survey responses, individual households are approached and offered additional information and assistance in identifying alternate travel choices for their individual travel needs. A follow up survey is conducted to identify and quantify the impact that the CBSM has had on the travel patterns of the participating households.

Measuring the Impacts

Researchers from the University of Waterloo have partnered with the Region of Waterloo on the UTSP project and are responsible for identifying the impacts that the project has had, particularly with respect to greenhouse gas emissions.

An evaluation methodology was developed under the assumption that each of the project components would be deployed soon after the *iXpress* service commenced in September 2005. The method consisted of identifying a number of measurement indicators, each related to one or more of the project components. These measurement indicators are used as inputs to models to estimate the impacts that the project components have had.

The impact evaluation is still on-going and therefore this paper examines only a subset of the impact evaluation activities that have taken place. In particular, this paper describes (1) the aggregate impact of the *iXpress* service on transit ridership; (2) the methodology used to estimate the GHG emissions associated with the *iXpress* service and initial results using this methodology; and (3) the baseline results obtained from the CBSM pilot survey.

Impact of iXpress on transit ridership

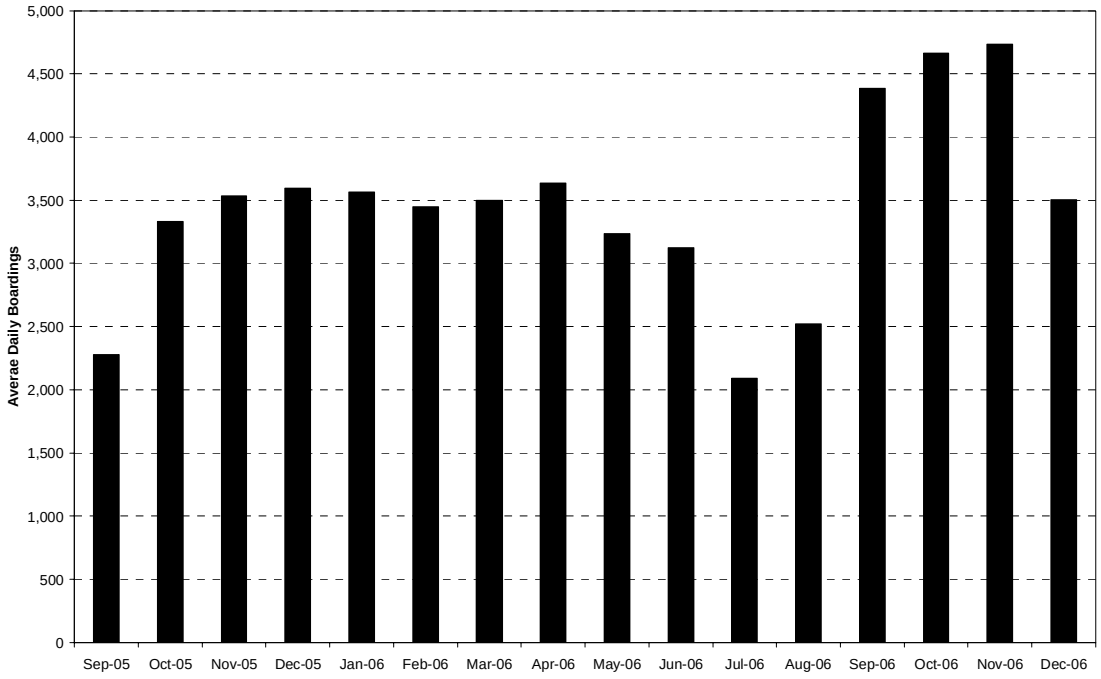
The impact of the introduction of the *iXpress* service can be measured in terms of the use of the service. Figure 4 depicts the average daily boardings for the *iXpress* service for each month from September 2005, when the service commenced, to the end of December 2006. The iXpress was the fourth busiest route in 2006 carrying approximately 5% of system ridership.

Several observations can be made on the basis of Figure 4.

1. The average number of daily boardings in October 2005 is approximately 140% of the average daily boardings for September 2005. This rapid increase in service use reflects the lag time between the beginning of service on September 6, 2005 and the change in travellers' behaviour to begin taking this service.
2. Significant seasonal variation is evident in the data. Consistent with general trends in urban transit use, the seasonal variation is strongly correlated with the school (high school and post-secondary school) year.

3. The boardings for September, October, and November 2006 are significantly larger (83%, 47%, and 34%, respectively) than the corresponding months one year earlier. This growth in ridership may reflect an increasing awareness in the community of the service. It is also noted that a universal student transit pass was introduced at one of the local universities (Wilfred Laurier University) for September 2005. Students are required to pay for the pass as part of their student fees. WLU U-Pass riders currently represent approximately 5% of the daily ridership on iXpress. As students become more aware of the iXpress service and the opportunity it provides to expand housing choices the percent of university student ridership is expected to increase.[2]

Figure 4: Average daily boardings on *iXpress* service



It is interesting to note that in the original UTSP project proposal, forecasts were made of average daily *iXpress* ridership for three future service deployment scenarios;

2005 Basic Service (*iXpress* without support technologies):	3,800
2005 Service with supporting technologies:	5,000
Mature Service (1 year after full deployment):	5,700

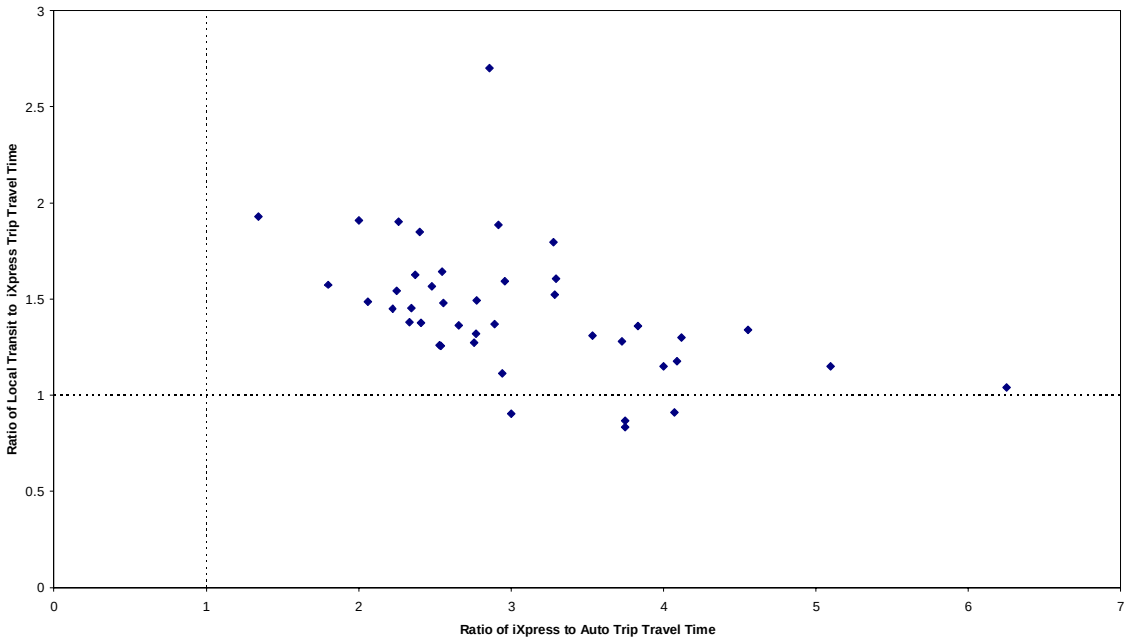
[2] A U-Pass program for the approximately 20,000 undergraduate students at the University of Waterloo was approved by student referendum in March 2007. Implementation of the program is expected to commence in September 2007.

From Figure 4 it is evident that during the 16 months of operations, daily boardings have averaged approximately 3,500 (92% of forecast). Due to delays in the deployment of the supporting technologies, this time frame most closely matches 2005 Basic Service forecast. Deployment of supporting technology is expected to be completed before the end of the summer of 2007 leading to the second forecast phase (i.e. 5,000 daily boardings).

Four additional observations on ridership can be made from initial surveys (described below) which were conducted by Grand River Transit.

1. Approximately 5.6% of the 1146 survey respondents reported that they did not have a car available to make the trip and did not previously make the trip but now make the trip at least 4 times per week. This is a direct quantification of the *social benefits* of *iXpress* – providing mobility to quality of life enhancing activities for those who do not drive.
2. Almost 14% of riders using *iXpress* 6 months after service commenced, had previously made their trip using an auto-based mode (either drove a car, were a passenger in a car, or took taxi). Preliminary analysis (Figure 5) suggests that for many of these riders, the travel time provided by the iXpress service is sufficiently improved (over local transit routes and compared to auto) as to induce some of these travellers to use the *iXpress* service. However, it is also interesting to note that for a few trip makers, trip travel time using the iXpress is actually slightly longer than using a local route. It is also interesting to note that for some trip makers, the *iXpress* travel times are not very competitive compared with auto travel times, suggesting that there are other factors that have induced these travellers to switch modes.
3. Furthermore, approximately 5.1% of survey respondents previously made their trip as a driver of a private auto and still have a vehicle available to them but now chose to use the *iXpress* service. This indicates that *iXpress* is effective in capturing *choice riders* – those for whom many travel modes are available, but transit is most desirable.

Figure 5: Trip travel time by mode for choice riders



Impact of iXpress on greenhouse gas emissions

The *iXpress* service commenced September 6, 2005. However, significant delays occurred in the deployment of most of the transit technology elements and the traveller information components. Consequently, a revised evaluation method was developed to estimate the GHG impacts that the *iXpress* service has had after approximately 6 months of service (e.g. Feb. 2006). This revised evaluation method makes use of data obtained from two revealed choice surveys and reflects travellers choices in response to the *iXpress* service conducted as it existed in the fall of 2005 (i.e. with unconditional transit signal priority and bike racks on all *iXpress* buses).

Two revealed choice intercept surveys were conducted. An intercept survey was conducted on the *iXpress* on Thursday Dec. 6, 2005 and again on Wednesday February 15, 2006. In both surveys, riders were provided with a survey questionnaire when they boarded the bus, asked to complete the survey, and to return the completed survey before leaving the bus. The responses on the returned questionnaire were entered into a database. The database was used to calculate parameter values required for estimating GHG impacts. The following sections describe the two survey methods in more detail.

<u>December 6, 2005 Survey</u>

The survey was scheduled to be conducted on all *iXpress* buses during both the morning and afternoon peak periods. However, as a result of unexpected problems with distribution of the survey cards, data were obtained only for the afternoon period.

A total of 615 surveys were returned by respondents. The actual number of *iXpress* riders during the survey period is not known. However, the average daily number of boardings computed over a three month period beginning October 2005 is approximately 3500.

The survey questionnaire consisted of 22 questions (Appendix A); however, only the following four questions were relevant for the purposes of estimating the impact of *iXpress* on GHG:

Question 6: *I got on this bus at:* _____ <*iXpress* stop name>

Question 8: *I am getting off this bus at:* _____ <*iXpress* stop name>

Question 13: *I take this trip:* _____ *times per week*

Question 17: *Before iXpress, how would you have made this trip? Select from*

- *Local route # ____*
- *Passenger in car*
- *Drove car*
- *Bike*
- *Walk*
- *Taxi*
- *Other*
- *Did not make trip*

Of the 615 returned survey questionnaires, only 484 contained complete answers for these four questions and therefore only these responses constituted the survey sample that was used for further analysis.

February 15, 2006 Survey

Due to a limited number of surveyors available to conduct the survey, the survey was scheduled to be conducted over two consecutive days with surveyors on half of the *iXpress* buses on each day. Unfortunately, on the second day of the survey period (i.e. Feb. 16) a winter storm resulted in the closure of the University of Waterloo, Wilfred Laurier University, and all public and Catholic elementary and high schools in the Region, as well as many day care centres, offices, and other businesses. Obviously, these closures would have had a significant impact on travel patterns, including the use of the *iXpress* service, and consequently the survey was cancelled.

Nevertheless, data obtained on the first day of the survey (Feb. 15, 2006) captured ridership over the period from 5:30 AM to 6 PM for approximately half of the *iXpress* fleet.

A total of 1146 surveys were returned by respondents. The actual number of *iXpress* riders during the survey period is not known but there were 3,450 daily boardings on average for the month of February.

The survey questionnaire used on the Feb. 15, 2006 survey was different from the questionnaire used on the Dec. 6, 2005 survey. During the Dec. 6th survey, feedback from the respondents indicated that the questionnaire was

too long. Consequently, the questionnaire was revised for the Feb. 15th survey and several questions were omitted. The questionnaire consisted of 15 questions (Appendix B); however, only the following four questions were relevant for the purposes of estimating the impact of *iXpress* on GHG:

Question 5: *I got on this bus at:* _____ <*iXpress* stop name>

Question 7: *I am getting off this bus at:* _____ <*iXpress* stop name>

Question 12: *I take this trip:* _____ *times per week*

Question 14: *Before iXpress, how would you have made this trip? Select from*

- *Local route # ____*
- *Passenger in car*
- *Drove car*
- *Bike*
- *Walk*
- *Taxi*
- *Other*
- *Did not make trip*

Of the 1146 returned survey questionnaires, 995 contained complete answers for these four questions and therefore only these responses constituted the survey sample that was used for further analysis.

Analysis Method

The impact of the new *iXpress* service on GHG emissions arises from three different sources, namely (a) the emissions created by the new service, (b) the elimination of emissions from express route 101 which the *iXpress* service replaced, and (c) elimination of emissions associated with auto trips no longer made because the trip makers have switched from using an auto-based mode to using *iXpress*. This section describes this last impact.

The GHG impact was estimated using the method illustrated in Figure 6. From the survey the previous mode used (M_i) and trip length (d_i) was determined for each respondent *i*. For each trip previously made using an auto-based mode (e.g. Driver of Car, Passenger in Car, and Passenger in Taxi), the estimated annual fuel savings (in Litres) was calculated as the trip length × average fuel consumption rate × trip frequency. This was summed across all respondents *i* to find the total fuel (*T*) saved. Using a constant conversion rate, fuel was converted to mass of GHG emissions saved (*E*).

Figure 6: Emission calculation methodology

Survey Responses

Respondent (i)	Origin (O_i)	Destination (D_i)	Mode (M_i)	Frequency (f_i)
1 2 . . . N				

Calculations

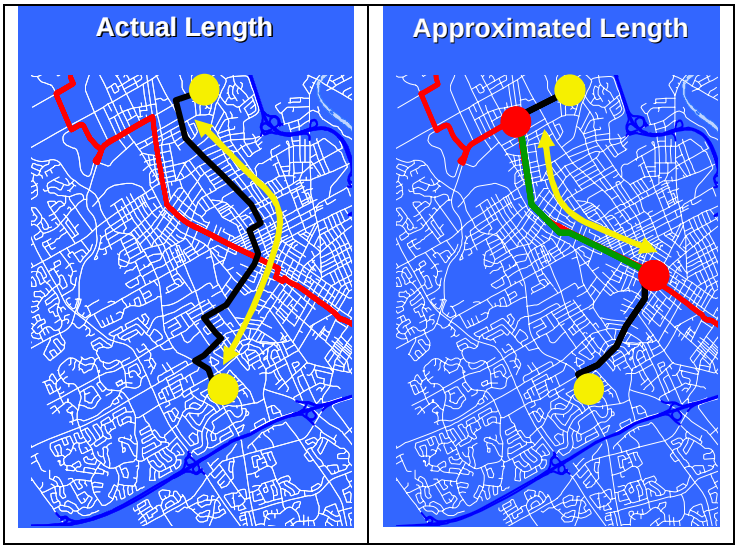
Trip Length (d_i)	Fuel (F_i)

Total Fuel	T
Total GHG	E

Trip length was computed on the basis of the origin and destination data provided by the survey respondents. Respondents were asked to provide their trip origin and destination by street address or major intersection and were also asked at which station they boarded the *iXpress* and at which station they planned to depart the *iXpress*. Many respondents provided no or incomplete data for trip origin and trip destination and therefore, trip origin (O_i) was considered to be the *iXpress* station at which the rider boarded the *iXpress* and the trip destination (D_i) the station identified by the respondent at which they would be departing the *iXpress*.

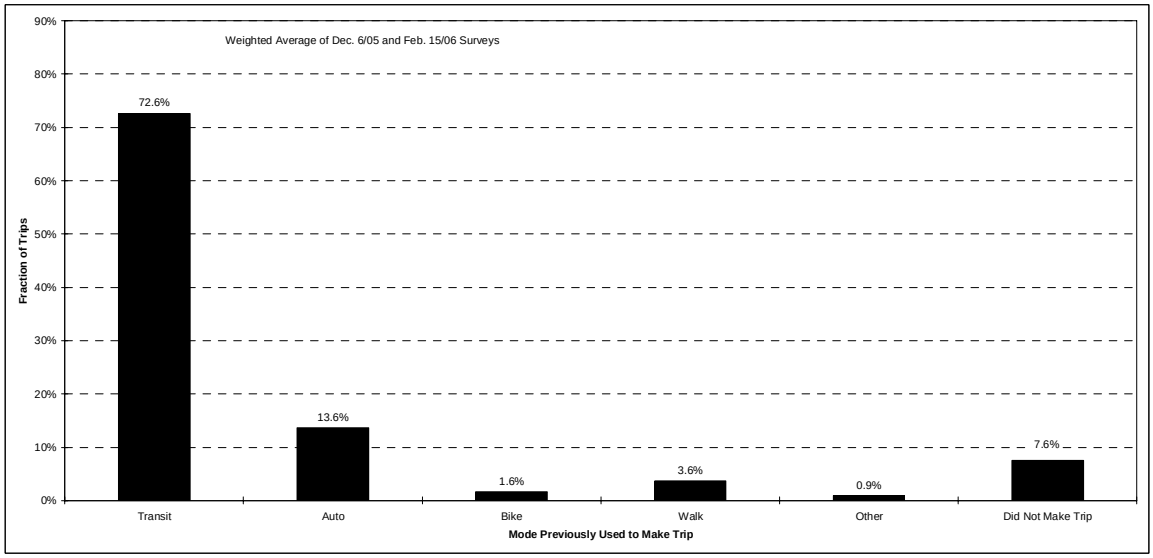
It is recognised that these origins and destinations reflect only the locations at which the rider boarded and departed the *iXpress* and therefore represent only a portion of the total trip. Furthermore, as illustrated in Figure 7, the trip distance (d_i) computed from these origins and destinations likely under-estimates the actual trip length; however the magnitude of this underestimation is not known.

Figure 7: Actual and approximated trip length



Survey respondents were asked to indicate the mode they used prior to the availability of the *iXpress* service and how many times per week they made the trip. Figure 8 illustrates the average fraction of trips previously made using each available mode. These data can be interpreted as the modes from which *iXpress* riders have switched. As expected, a large number (72.6%) of *iXpress* riders have switched from local bus routes. However, a relatively large proportion of riders (approximately 14%) switched from auto-based modes (7.5% from driving a personal automobile; 4.8% from being a passenger in an automobile; and 1.4% from using a taxi).

Figure 8: Mode that was used prior to availability of *iXpress* (Average of Dec. 6, 2005 and Feb. 15, 2006 surveys)



It is also interesting that 7.6% of respondents did not previously make the reported trip. Two possibilities can be identified that explain these previously unmade trips.

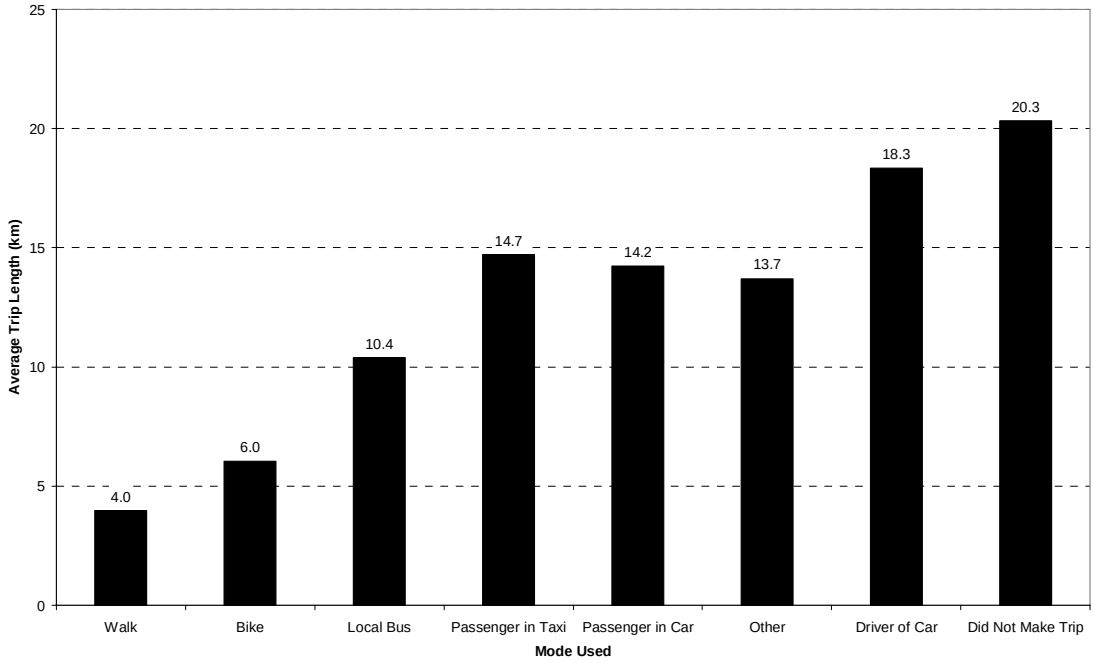
1. These trips may be new because of a change in the trip makers' travel generation circumstances, such as a change in employment location; employment status (i.e. may not have been employed previously and now is employed); or change in place of residence.
2. The person may not have made the trip previously because the trip was not sufficiently attractive given the travel modes available to the trip maker. However, after *iXpress* became available, the trip time and/or cost were sufficiently reduced to make the trip attractive representing an increase in trip maker mobility. This explanation may be particularly applicable to discretionary trips such as trips made for shopping and entertainment.

It is difficult to conclude what impact previously unmade trips may have on GHG. If it is assumed that these trips would have been made by some other mode if the *iXpress* had not been available, then these trips should also be considered in the calculation of GHG reductions resulting from the *iXpress*.

In identifying the impact that mode shift from "Passenger in Car" to *iXpress* has on GHG emission, it is speculated that some portion of the total km associated with "Passenger in car" trips likely were still made after the passenger switched mode to take the *iXpress*. However, the survey data do not provide any information from which this proportion can be estimated. Consequently, it has been assumed that 25% of the total kilometres associated with former "Passenger in car" trips are still made. The validity of this assumption remains to be determined.

Figure 9 illustrates the average trip length by previously used mode. The relationship between average trip length and previous mode used is consistent with expectation. Shorter trips were made via Walk and Bike modes. Longer trips were made via local transit and even longer trips were made by auto mode. Interestingly, trips that previously were not made are on average the longest. This seems to indicate that the presence of the *iXpress* service has provided access to mobility that was previously unavailable.

Figure 9: Average trip length by mode used prior to availability of *iXpress*
(Average of Dec. 6, 2005 and Feb. 15, 2006 surveys)



Results

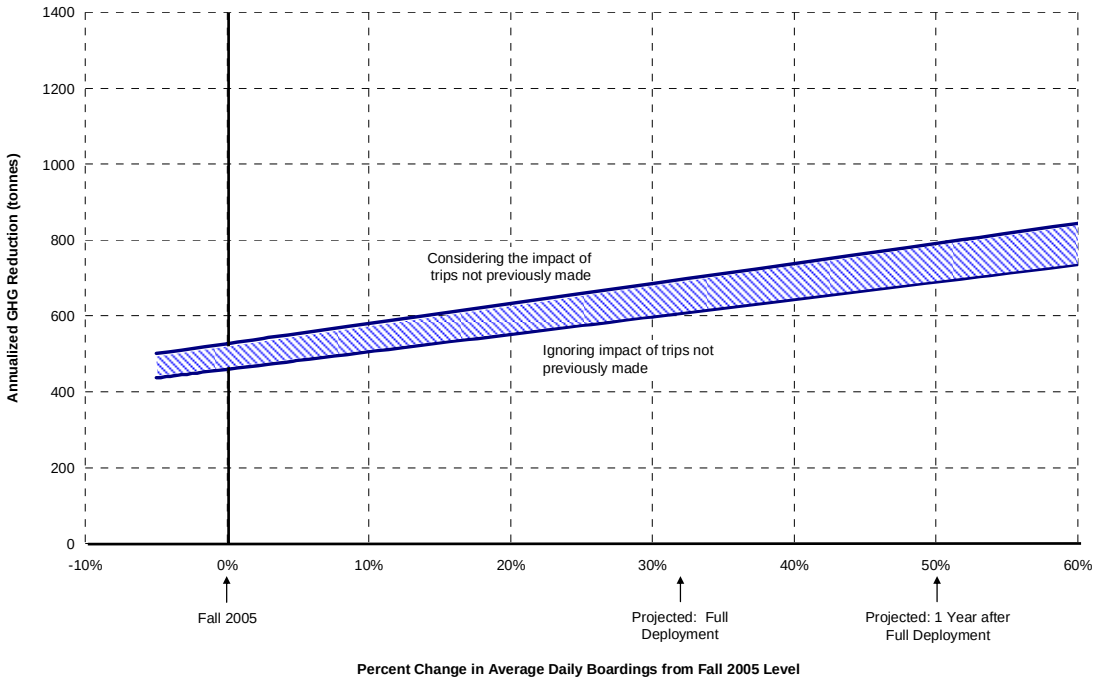
On the basis of these data it is estimated that for ridership levels as experienced during the first 4 months of service, travellers switching from auto mode to *iXpress* has resulted in a annualized reduction of approximately 1.5 million kilometres of auto travel and a corresponding savings of approximately 170,000 litres of gasoline and approximately 450 tonnes of GHG.

The following constants were used in the GHG estimation calculations:

- Average automobile fuel consumption rate = 11.21 L/100km (Canadian Vehicle Survey, 2001),
- Conversion of gasoline to mass of GHG (Transport Canada, 2006): 2,503.86 tonnes/million litres of gasoline

The gross annualized reduction in GHG emissions due to this mode change is a function of the number of riders making use of the *iXpress* service. Figure 10 illustrates the change in GHG reductions as a function of the average number of daily boardings.

Figure 10: Estimate of annualized gross reduction in GHG emissions due to mode shift to *iXpress*



CBSM – Baseline Survey

Another aspect of the UTSP project is the exploration of whether or not lack of knowledge of transportation alternatives (including local and *iXpress* transit, and walking and cycling links) is a barrier to the use of non-auto modes. The CBSM components of the project will help to explore this issue. A pilot CBSM survey was conducted in September, 2006. The purpose of the survey was to collect detailed household travel data to establish a baseline measure for evaluating the impacts that community based social marketing (CBSM) activities have on modifying travel behaviour and to identify suitable candidates to participate in the CBSM activities.

The neighbourhoods within approximately 1500 metres surrounding the Ainslie Street Transit Terminal in Cambridge (which the iXpress and several local transit routes service) were selected as the target area. A phone number database of this area was purchased and 1925 households were randomly selected.

Each of the 1925 households were sent a letter of introduction to the project, followed by another letter one week later which included a link to the on-line survey in addition to a paper copy of the survey. Several attempts were made to contact the household by telephone, to confirm mailing had been received, encourage participation and answer any questions.

The survey consisted of three parts, namely (1) Household profile information; (2) Household member information; and (3) Trip information. A

total of 794 surveys were begun[3] of which 174 (22%) households conducted the survey on-line and the remaining 620 (78%) on paper copy. However, a number of survey respondents created duplicate household profiles. Duplicate entries were identified and either merged or deleted as required. This resulted in the removal of 9 records. From the remaining 785 surveys, 28 (3.6%) consisted of household profiles only, as the second part of the survey was not completed (i.e. did not provide information on trip makers). Consequently, 757 (95.3%) of the 794 surveys returned were considered complete and used to establish base-line travel behaviour.

The survey respondents' characteristics and travel behaviour can be summarized as follows:

- Average of 2.4 persons per household.
- Average of 1.5 motorized vehicles per household.
- 13.5% of households had no motorized vehicle.
- 44% of trip makers are employed full time; 11% employed part-time; 27% unemployed and 18% are students.
- 73% of trip makers have a valid driver's license.
- A total of 5,308 trips were reported. For approximately 8.5% of these trips, no personal automobile was available to the trip maker. Fifty-eight percent of these trips were made by walking, 15% by transit, and 9% by bike.
- For those trips for which at least one vehicle was available to the trip maker; 64% were made by driving a car, 24% as a passenger in a car, and 9% by walking. Only 1.2% of these trips were made by transit.
- Approximately 32% of trips were less than 2 km in length. Median trip length was 5 km.
- Average of 7.0 trips reported per household per day.
- Average of 3.0 trips per day per trip maker.

These characteristics define the existing demographics and travel preferences for the surveyed households. It is clear that, similar to many medium-sized communities, personal auto is the dominant mode choice, even for relatively short trips. Furthermore, car ownership is generally understood to be a strong determinant of mode choice. Average car ownership for the survey respondents (1.5 vehicles/household) is on the same order as the average for the Greater Toronto Area and surrounding municipalities (1.4 vehicles/household), as determined from the 2001 Transportation Tomorrow Survey (TTS, 2001).

Despite the current dominance of auto use, approximately 17.4% of trip makers indicated that they were interested in receiving additional information about non-auto modes of travel. These trip makers will be the target for phase 2 of the CBSM pilot study in which they will be provided with information concerning alternate transportation options, etc. A subsequent

[3] For respondents using the on-line survey, "begun" means that they completed at least one of the three portions of the survey - typically the household profile information portion.

survey will be conducted in the late spring of 2007 to determine the impact of the CBSM on trip making behaviour.

Concluding Remarks

This paper has described the central transit corridor project being undertaken in Waterloo Region as part of the Urban Transportation Showcase Program. The methods being used to monitor the impacts of this project have been introduced and impacts observed to date were reported. Several important components of the UTSP project have not yet been deployed and consequently, their impacts cannot yet be measured.

On the basis of the impacts that have been quantified it was observed that:

1. Almost 14% of riders using *iXpress* 6 months after service commenced, had previously made their trip using an auto-based mode (either drove a car, were a passenger in a car, or took a taxi). This mode change represents an estimated annualized reduction of 1.5 million auto km; 170,000 litres of fuel, and 450 tonnes of greenhouse gas emissions.
2. Almost 8% of riders using *iXpress* 6 months after service commenced reported that they had previous not made that trip. This may indicate that the *iXpress* service has provided increased mobility (e.g. access to jobs, recreation, shopping, etc.).
3. The *iXpress* service has experienced an increase in ridership (measured in number of boardings) of 37% during the period of Sept. through Dec. 2006 compared to the same period in the previous year with no change in the number of hours of service.

Acknowledgements

This research was financially supported by Transport Canada (Urban Transportation Showcase Program), the Regional Municipality of Waterloo and the Natural Science and Engineering Research Council of Canada.

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GRT GRAND RIVER TRANSIT

Travel Survey 2005 No: ☐

Complete this survey for a chance to win an iPod!

Name: _____

Address: _____ (##) _____ (Street Name)

☐ Kitchener ☐ Waterloo ☐ Cambridge ☐ Other _____

Postal Code: _____ Phone #: _____

When finished *please* hand this survey back to surveyor.

1. **I paid for this bus trip using:**
☐ Cash ☐ Adult Ticket ☐ Senior/Student Ticket ☐ Adult Pass ☐ College Pass
☐ Laurier OneCard ☐ University Pass ☐ Corporate Pass ☐ Senior/Student Pass

2. **My age is:** ☐ 16 or less ☐ 17-25 ☐ 26-35 ☐ 36-55 ☐ 56-64 ☐ 65+

3. **My gender is:** ☐ Female ☐ Male

4. **On this bus trip I am coming from:**
☐ Home ☐ Work ☐ School ☐ Shopping ☐ Recreation ☐ Other

5. **Which is located at:**
Address _____ (##) _____ (Street Name) Postal Code _____
or Closest Intersection _____ (Street Name) & _____ (Street Name)
☐ Cambridge ☐ Kitchener ☐ Waterloo ☐ Other _____

6. **I got on this bus at:**
☐ Conestoga Mall ☐ McCormick ☐ R & T Park
☐ U Waterloo ☐ Laurier ☐ Uptown Waterloo
☐ Grand River Hospital ☐ Charles Terminal ☐ Ottawa
☐ Fairview ☐ Bridgecam ☐ Cambridge Centre ☐ Ainslie Terminal

7. **I got to this bus by:**
☐ Transfer from Route # _____ ☐ walking ☐ dropped off ☐ bike ☐ other

Important! Please Fill Out Back of Form!

Collection Notice: Personal information requested on this form is collected under the authority of the Municipal Act and will be used to assist Region staff and Regional Committees regarding transit service. All information is confidential. **Region of Waterloo employees or their families are not eligible to win.**

FOR ADMINISTRATIVE USE ONLY
Bus #: _____ Run #: _____ Time: _____ Surveyor: _____

Travel Survey 2005

GRT GRAND RIVER TRANSIT

8. **I am getting off this bus at:**
☐ Conestoga Mall ☐ McCormick ☐ R & T Park
☐ U Waterloo ☐ Laurier ☐ Uptown Waterloo
☐ Grand River Hospital ☐ Charles Terminal ☐ Ottawa
☐ Fairview ☐ Bridgecam ☐ Cambridge Centre ☐ Ainslie Terminal

9. **My FINAL destination for this bus trip is:**
☐ Home ☐ Work ☐ School ☐ Shopping ☐ Recreation ☐ Other

10. **Which is located at:**
Address _____ (##) _____ (Street Name) Postal Code _____
or Closest Intersection _____ (Street Name) & _____ (Street Name)
☐ Cambridge ☐ Kitchener ☐ Waterloo ☐ Other _____

11. **I will get to my FINAL destination:**
☐ on this bus ☐ by transferring to Route # _____

12. **I will arrive at my FINAL destination by:**
☐ walking ☐ being picked up ☐ riding my bike ☐ other

13. **I take this trip:**
☐ _____ times per week ☐ once a month ☐ other

14. **For this trip my total travel time is: _____ minutes**
(include walking, waiting and riding time).

15. **Did you have a vehicle available to use for this trip?** ☐ Yes ☐ No

16. **Is your iXpress trip today:** ☐ one-way ☐ round trip

17. **Before iXpress, how would you have made this trip?**
☐ Bus (Route # ____) ☐ passenger in car ☐ drove car
☐ bike ☐ walk ☐ taxi ☐ other ☐ did not make trip

18. **How do you keep informed about GRT?**
☐ Website ☐ Rider alerts ☐ newspaper ☐ terminal poster
☐ shelter posters ☐ Transit Talk ☐ radio
☐ information on bus ☐ friends ☐ other _____

19. **There is/are _____ vehicles(s) at my home.**

20. **There is/are _____ person(s) living at my home.**

21. **Typically, Mon. through Fri., I make _____ one-way trips on GRT.**

22. **Typically, on the weekend, I make _____ one-way trips on GRT.**

GRT GRAND RIVER TRANSIT

Travel Survey No: ☐

Complete this survey for a chance to win an iPod!

Name: _____

Address: _____ _____ ☐ Kitchener ☐ Waterloo ☐ Cambridge ☐ Other _____
Street Name

Postal Code: _____ Phone #: _____

1. **My age is:** ☐ 16 or less ☐ 17-25 ☐ 26-35 ☐ 36-55 ☐ 56-64 ☐ 65+
2. **My gender is:** ☐ Female ☐ Male
3. **On this bus trip I am coming from:**
   ☐ Home ☐ Work ☐ School ☐ Shopping ☐ Recreation ☐ Other
4. **Which is located at *(please fill out at least one of the categories below)*:**

   Address: _____ _____
   ## Street Name
   OR
   Closest Intersection: _____ & _____
   OR Street Name Street Name
   Postal Code _____
   ☐ Cambridge ☐ Kitchener ☐ Waterloo ☐ Other _____

5. **I got on this bus at:**
   ☐ Conestoga Mall ☐ McCormick ☐ R & T Park
   ☐ U Waterloo ☐ Laurier ☐ Uptown Waterloo
   ☐ Grand River Hospital ☐ Charles Terminal ☐ Ottawa
   ☐ Fairview ☐ Bridgecam ☐ Cambridge Centre ☐ Ainslie Terminal
6. **I got to this bus by:**
   ☐ transfer from Route # _____ ☐ walking ☐ dropped off ☐ bike ☐ other
7. **I am getting off this bus at:**
   ☐ Conestoga Mall ☐ McCormick ☐ R & T Park
   ☐ U Waterloo ☐ Laurier ☐ Uptown Waterloo
   ☐ Grand River Hospital ☐ Charles Terminal ☐ Ottawa
   ☐ Fairview ☐ Bridgecam ☐ Cambridge Centre ☐ Ainslie Terminal

Important! Please Fill Out Back of Form! ➡

Travel Survey

8. **My FINAL destination for this bus trip is:**
   ☐ Home ☐ Work ☐ School ☐ Shopping ☐ Recreation ☐ Other
9. **Which is located at *(please fill out at least one of the categories below)*:**

   Address: _____ _____
   ## Street Name
   OR
   Closest Intersection: _____ & _____
   OR Street Name Street Name
   Postal Code _____
   ☐ Cambridge ☐ Kitchener ☐ Waterloo ☐ Other _____

10. **I will get to my FINAL destination:**
    ☐ on this bus ☐ by transferring to Route # _____
11. **I will arrive at my FINAL destination by:**
    ☐ walking ☐ being picked up ☐ riding my bike ☐ other
12. **I take this trip:**
    ☐ _____ days per week ☐ _____days per month ☐ other
13. **Did you have a vehicle available to use for this trip?** ☐ Yes ☐ No
14. **Before iXpress, how would you have made this trip?**
    ☐ Bus (Route # ____) ☐ passenger in car ☐ drove car
    ☐ bike ☐ walk ☐ taxi ☐ other ☐ did not make trip
15. **How many vehicles are at your home?** ☐ 1 ☐ 2 ☐ 3 ☐ 4+

Thank you for completing this survey!

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Authors' Information

Bruce Hellinga, PhD, PEng
Associate Professor
Department of Civil and Environmental Engineering,
University of Waterloo
200 University Ave. West
Waterloo, Ontario, N2L 3G1, Canada
Tel: (519) 888-4567 ext. 32630
Fax: (519) 888-4349
E-mail: bhellinga@uwaterloo.ca

John Cicuttin
Manager of Transit Development
Regional Municipality of Waterloo
150 Frederick Street
Kitchener, ON N2G 4 J3
Tel: (519) 575-4023
Fax: (519) 575-4449
Email: cijohn@region.waterloo.on.ca