School Travel Planning Benefit-Cost Report for Toronto & Wellington-Dufferin-Guelph

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CONTEXT

This School Travel Planning (STP) project serves as the second Benefit-Cost Analysis (BCA) conducted in Canada. The first BCA was performed collaboratively with Green Communities Canada, Metrolinx and the University of Toronto, showing STP to be 'a relatively cost-effective intervention' (ratio= 1.8) among 19 projects in Ontario (Metrolinx et al., 2014). In collaboration with the University of Toronto, this BCA extends the previous in four notable ways.

First, projects costs were recorded on an on-going basis relative to the retrospective-recall approach from the first BCA that likely contained issues around recall biases. Second, the benefits measured included benefits from kilometres cycled, in addition to the increases in kilometres walked and reductions in kilometres driven as included initially. Third, the benefits and costs were collected for Year 1 and subsequently projected for a hypothetical 3-year and 5-year STP implementation period. Based on current STP practices in Canada, the first 3-5 years is a more realistic and applicable time period to discuss the programs cost-effectiveness relative to the hypothetical 11-year duration used in the original BCA. Fourth, results are provided at the aggregate, community, and school levels. This breakdown in analyses can help shed light on the differences in travel mode share, benefits, and costs between urban and rural-based schools.

Our collaborators at the University of Toronto – who have focused on STP evaluation in Canada (Buliung et al., 2011; Mammen et al., 2013; Mammen et al., 2014; Mammen et al., 2015a; Mammen et al., 2015b) – were contracted to conduct the analysis for this work. This BCA examined the costs and benefits of 13 STP projects in Ontario (Table 1) during 2014-2015, spanning two communities: Toronto (*n*=8) and Wellington-Dufferin-Guelph (WDG; *n*=5). The following section outlines the methodology employed for this cost-effectiveness study.

Table 1: STP projects included in study

School name	Project ID	Community - Type	School Size
Rolph Road Public School	1	Toronto - Inner Suburban	408
Northlea Public School	2	Toronto - Inner Suburban	760
Annunciation Catholic School	3	Toronto - Outer Suburban	331
Cassandra Public School	4	Toronto - Outer Suburban	277
Pierre Laporte Public School	5	Toronto - Outer Suburban	343
St. Raphael Catholic School	6	Toronto - Outer Suburban	550
Gateway Public School	7	Toronto - Inner Suburban	940
Valley Park Public School	8	Toronto - Inner Suburban	964
Glenbrook Elementary School	9	WDG - Suburban	462
J.D.Hogarth Public School	10	WDG - Suburban	575
Minto-Clifford Central Public School	11	WDG - Rural	377
Montgomery Village Public School	12	WDG - Urban/Suburban	523
Rickson Ridge Public School	13	WDG - Urban/Suburban	439

METHODOLOGY

Three sources of data were required to calculate the cost-effectiveness of STP: i) Change in travel modes ii) Benefits of mode shift; iii) Costs of STP implementation. The following will explain how each data source was collected and analyzed in helping determine benefit-cost ratios at the aggregate and community levels.

Data Source- Change in travel modes

The first step involved in the BCA was to determine changes in travel mode between baseline and follow-up measurements across schools. Classroom 'hands-up surveys' were administered for 5 consecutive days at baseline and again approximately 1-year later. In this validated and reliable student reported survey (McDonald et al., 2011) students raise their hand to identify which mode of travel they used on the way to school, and which mode they will be using to travel from school. Appendix A provides the classroom survey template used by the schools. 0

With analyses of mode share change, the first step in modelling was to multiply the mode share for each STP project by their respective student population and calculate the total daily trips to/from school for each travel mode. From that, the change in trips and change in mode share were calculated by dividing the number of trips of each AST mode (i.e., walking, biking) by total number of trips (i.e., all modes of transport). AST change in the a.m. and p.m. time periods was calculated by subtracting baseline AST rates from follow-up AST rates. The resulting values were then used to calculate the benefits of STP.

Data Source- Benefits of mode shift

Using the mode shift data, the primary benefits were calculated as related to reductions in kilometres driven increases in kilometres walked, and increases in kilometres cycled. Table 2 displays the assumptions applied in generating the associated benefits of reduced driving and increased AST behaviours following STP implementation. The average walking, walking part-way, and car trip distance assumptions are informed by bus eligibility distance thresholds, and results from the Metrolinx "Greater Toronto and Hamilton Area School Travel Household Attitudinal Study Report" (Metrolinx, 2010). The car trip distance accounts for the return trip home for parents making dedicated trips to school or those going on to travel from the school to another destination.

Table 2: School Travel Assumptions

Assumption	Value
Number of school days in a year	190
Average one-way walking distance (km)	1.0
Average walking-part way distance (km)	0.5
Average one-way driving or cycling distance (km)	1.8

To calculate the economic benefits of reduced driving and increased AST, the study used values from the Victoria Transport Policy Institute's "Evaluating Active Transport Benefits and Costs" report (VTPI, 2013). Only benefits relevant to school trips were included in calculations, and the "overall average" values were used in recognition that the STP projects were in both urban and rural environments, and morning trips are made during peak and off-peak hours. The VTPI report was selected due to its Canadian origin, conservative benefit values, and its breakdown into individual benefits that could be customized for school travel applicability. The benefits used in the analysis include:

- A benefit value of **$0.79 per vehicle kilometre travelled (VKT) reduced**. Table 3 displays the breakdown of societal monetary benefits to obtain the $0.79 benefit. Appendix B provides the definitions for each of the benefits.

Table 3: Monetary Benefits of Vehicle Kilometres Travelled (VKT) Reduced

Benefits of VKT Reduction	Monetary Benefit per VKT Reduced
Congestion reduction	$0.04
Pollution reduction	$0.03
Parking cost savings	$0.16
Vehicle cost savings	$0.14
Energy conservation	$0.02
Reduced barrier effect	$0.01
Roadway cost savings	$0.03
Avoided chauffeuring driver's time	$0.36
Total	**$0.79**

- A benefit of **$0.51 per additional kilometre walked**. Table 4 displays the breakdown of societal monetary benefits to obtain the $0.51 benefit. This health benefits value is conservative compared to those used in other jurisdictions, such as New Zealand, which exceed $2.00 per kilometre walked (Auckland Regional Transport Authority, 2010)

Table 4: Monetary Benefits of Additional Kilometres walked

Benefits of Walking	Monetary Benefit per Additional Km Walked
Health benefit	$0.31
User benefits	$0.16
Options value	$0.02
Equity objectives	$0.02
Total	**$0.51**

In addition to the economic benefits noted above, this BCA calculated benefits in further ways including:

- The annual reduction in carbon dioxide (CO2e) and Criteria Air Contaminants from the annual vehicle kilometres travelled reduced figure, based on coefficients from Environment Canada (Environment Canada, 2006).
- Additional kilometres walked expressed as additional minutes of walking, based on the median elementary and middle school student walk speed of 4.3 kilometres per hour (McDonald, 2007).
- Additional kilometres cycled expressed as additional minutes of cycling based on the mean childhood cycling speed of 14.3 kilometres per hour (Thompson et al., 1997).

Data Source- Costs of STP implementation

The third data source required to complete the BCA relates to the costs associated with STP implementation. Each school's STP facilitator collected program costs for a 1-year implementation period. All facilitators were required to participate in a STP Training Webinar, which addressed the importance of recording all financial costs associated with program delivery. Using a standardized Excel template (Appendix C), costs were recorded and categorized under *planning*, *implementation*, and *monitoring* phases. Within each phase, the number of hours contributed by each stakeholder ('cost of people') and the materials invested for implementation were documented ('cost of materials').

For the 'cost of people,' average hourly rates for different professions were obtained and applied using official salary websites (Appendix D), specifically human resources and administrative costs special to the STP process. Many of the costs were in-kind or donated costs by existing staff and volunteers. Therefore, while schools and/or communities did not necessarily incur these as additional costs to their operating budgets, the value of this in-kind time was captured and included in analysis.

For the 'cost of materials', the facilitators were instructed to document costs under the following categories:

- Meeting facilities (e.g., school district, citytown, fire-hall $100)
- Catering (e.g., for AST events, meetings)
- STP committee documents (e.g., surveys, photocopying, printing)
- Incentives (e.g, for schools, students, teachers, parents)
- Promotional items (e.g., water bottles, helmets)
- Infrastructure projects (e.g, bike racks, pedestrian signage)
- Travel (e.g., facilitator travel fare)

Calculating benefit-cost ratio

As an indicator of cost effectiveness, the BCA is summarized as a ratio representing the amount of benefits returned for each dollar invested. The ratio is calculated by dividing present value benefits (car reduction benefits + walking benefits + cycling benefits) by present value costs (cost of people + cost of material). The benefit-cost ratio is calculated for the collective 13 STP project sample and for each community (n=2). Based on the 1-year results, further ratios are then projected for a hypothetical 3-and 5-year STP implementation period. In terms of benefits, the value is cumulative for a 3- and 5- year STP project given the annual benefits. That is,

the benefits are assumed to continue in a steady state annually when the following remain the same: i) percent mode shift in school travel behaviour ii) student population (i.e. the number of students annually leaving the school is replaced by an equal number of incoming students). The approach used in this time frame is conservative because it does not account for any further decreases in car travel, and increases in walking and cycling due to sustained implementation of STP and other associated STP initiatives. The time frame is also realistic as literature suggests that STP projects should be implemented at least over a period of two of 3 years (Mammen et al., 2013; Mammen et al., 2015).

Further, in terms of calculating projected STP benefits for a 3- and 5-year STP duration, a discount rate of 3% is applied to address the net present value of future benefits, recognizing that money available now is worth more than an equal amount in the future. The 3% discount rate is consistent with the recommendation of the U.S. Panel on Cost–Effectiveness in Health and Medicine, which sought to define a discount rate making all cost-effectiveness analyses comparable (Muennig, 2008). This discount rate is less conservative than the 5% typically utilized by the Government of Ontario, but over 5 years, impacts the net present value of benefits by less than 10%. Regarding the projected costs of STP over time, we assumed 50% of year 1 costs for on-going implementation and monitoring for years 2 and 3, and 25% of year 1 costs for implementation in years 4 and 5. These assumptions were collectively developed among STP practitioners who have had experience in delivering the program over multiple years.

RESULTS

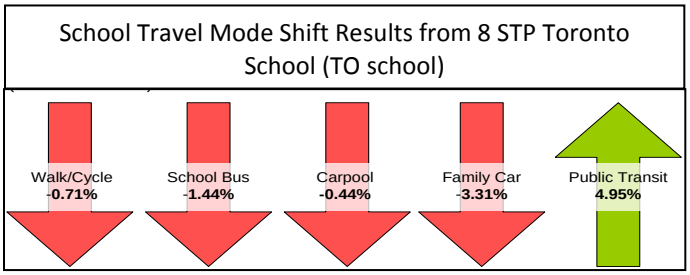
Which travel modes changed following 1 year of STP?

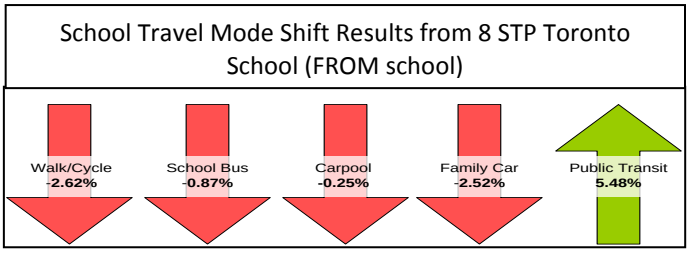
As noted, the basis for the BCA results is the student-reported classroom hands-up surveys conducted for each STP project. Table 5 displays the percentage shift in the various travel modes at the aggregate, community, and school levels.

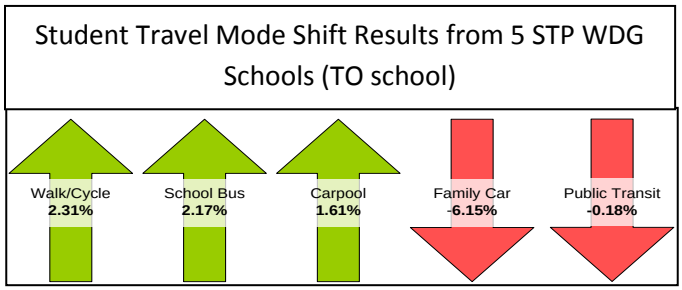
For the overall 13 schools, there was a slight decrease in walking but a 1.5% increase in part-way walking, 1% increase in cycling, 3.5% increase in public transit and a 3.5% decrease in driving for the school journey. When comparing communities (*n*=2), key findings show that:

- Walking increased in WDG (1%: up to 14%)
- Cycling increased in Toronto (1%: up to 6%)
- Public Transit increased in Toronto (5%: up to 15%)
- Driving decreased in Toronto (-3%: up to -8%) and WDG (-5.5%: up to -18%)

The following figures represent the detailed change in mode share for each community during the morning/afternoon periods.






Student Travel Mode Shift Results from 5 STP WDG Schools (TO school)
Walk/Cycle
2.31%
School Bus
2.17%
Carpool
1.61%
Family Car
-6.15%
Public Transit
-0.18%

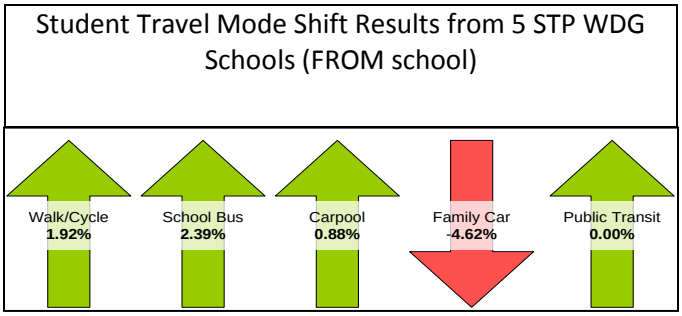

Student Travel Mode Shift Results from 5 STP WDG Schools (FROM school)
Walk/Cycle
1.92%
School Bus
2.39%
Carpool
0.88%
Family Car
-4.62%
Public Transit
0.00%

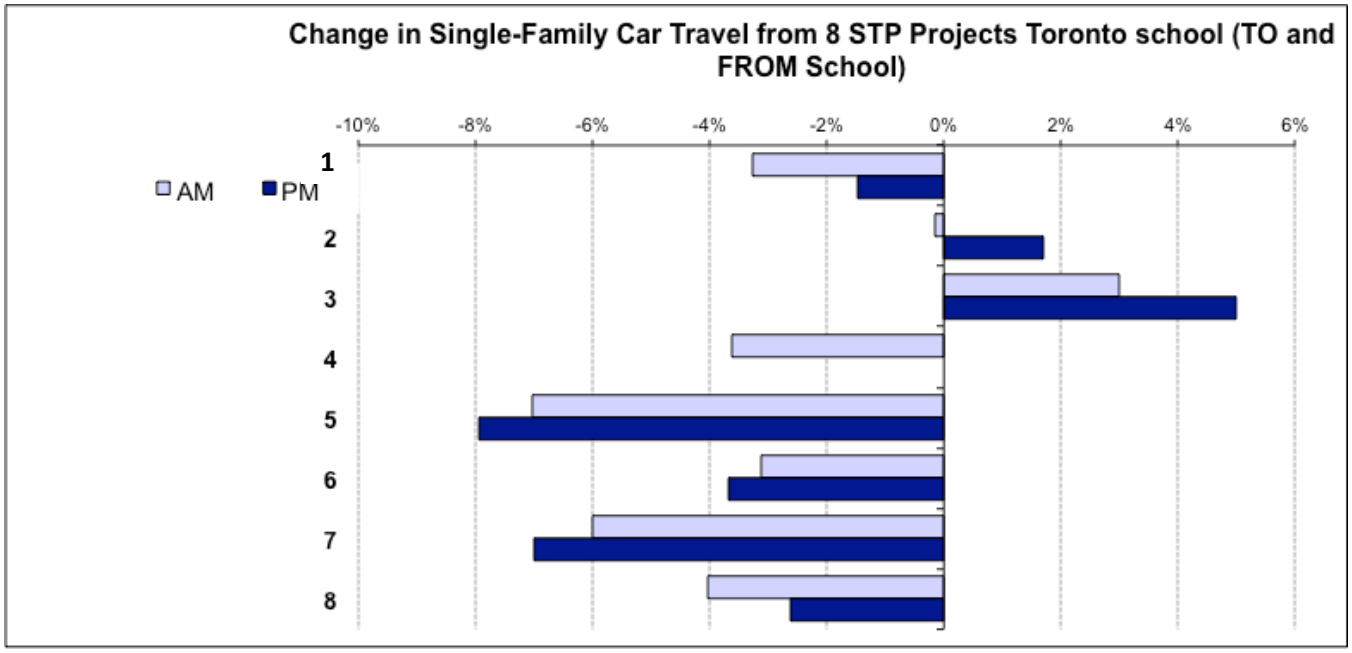
Table 5: Shift in school transportation mode

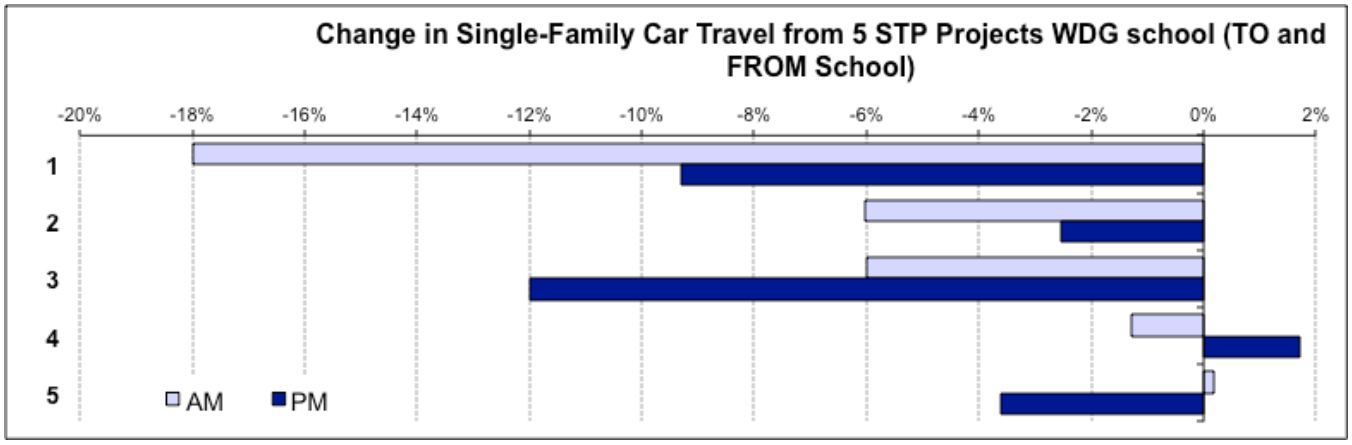
		Change (follow-up - baseline), TO school								Change (follow-up - baseline), FROM school							
Community	**School name**	**Walked**	**Walked part-way**	**Bicycle**	**School Bus**	**Public Transit**	**Carpool**	**Car**	**Other**	**Walked**	**Walked part-way**	**Bicycle**	**School Bus**	**Public Transit**	**Carpool**	**Car**	**Other**
Toronto	Rolph Road PS	-2%	1%	2%	0%	0%	0%	-3%	2%	-3%	1%	2%	0%	0%	0%	-1%	2%
Toronto	Northlea Public School	-4%	2%	3%	0%	0%	0%	0%	0%	-6%	2%	4%	0%	-1%	-1%	2%	0%
Toronto	Annunciation Catholic School	-4%	2%	2%	-3%	1%	-1%	3%	0%	-6%	-3%	2%	1%	1%	0%	5%	0%
Toronto	Cassandra Public School	1%	1%	6%	-2%	-1%	0%	-4%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toronto	Pierre Laporte Public School	-5%	2%	1%	-1%	9%	2%	-7%	0%	-3%	2%	0%	-1%	12%	-2%	-8%	0%
Toronto	St. Raphael Catholic School	3%	0%	0%	-1%	-1%	1%	-3%	0%	2%	-1%	0%	1%	1%	2%	-4%	0%
Toronto	Gateway Public School	2%	1%	1%	-2%	5%	0%	-6%	-1%	1%	1%	1%	-1%	5%	0%	-7%	0%
Toronto	Valley Park Public School	-12%	7%	0%	-2%	16%	-3%	-4%	-2%	-15%	5%	0%	-4%	17%	-1%	-3%	0%
Toronto Community (*n*= 8)		**-3%**	**2%**	**1%**	**-1%**	**5%**	**0%**	**-3%**	**0%**	**-5%**	**1%**	**1%**	**-1%**	**5%**	**0%**	**-3%**	**0%**
WDG	Glenbrook Elementary School	14%	1%	0%	0%	0%	1%	-18%	1%	7%	1%	0%	-1%	0%	2%	-9%	1%
WDG	J.D.Hogarth Public School	-5%	3%	1%	6%	0%	1%	-6%	0%	-5%	2%	1%	4%	0%	1%	-3%	-1%
WDG	Minto-Clifford Central PS	-1%	0%	0%	6%	0%	1%	-6%	0%	1%	0%	0%	12%	0%	0%	-12%	0%
WDG	Montgomery Village Public School	-5%	5%	-1%	3%	0%	3%	-1%	-4%	-4%	4%	-1%	3%	0%	2%	2%	-7%
WDG	Rickson Ridge Public School	2%	2%	2%	-6%	-1%	2%	0%	0%	7%	1%	1%	-6%	0%	0%	-4%	1%
WDG Community (*n*= 5)		**1%**	**2%**	**0%**	**2%**	**0%**	**2%**	**-6%**	**-1%**	**1%**	**2%**	**0%**	**2%**	**0%**	**1%**	**-5%**	**-1%**
Aggregate (n= 13)		**-2%**	**2%**	**1%**	**0%**	**3%**	**0%**	**-4%**	**0%**	**-3%**	**1%**	**1%**	**0%**	**4%**	**0%**	**-3%**	**0%**

Figure 2 displays the change in family car travel from baseline and follow up surveys for each of the 13 STP projects, demonstrating that car travel:

- decreased on the way To school in 10 of 13 STP projects;
- decreased From school in 9 of 13 STP projects;
- decreased by more than 5% in 6 of 13 STP projects (to and/or from school);

Figure 2: Change in car travel following STP





What monetary benefits accumulated from mode shift?

Based on the kilometres reduced from driving (i.e. single-family car) and increased from walking (including walked-part way), and cycling (Table 6), Table 7 displays the monetary benefits following 1-year of STP at the aggregate, community, and school levels and the associated benefits for a hypothetical 3- and 5-year STP project. Table 8 highlights additional environmental and health benefits from mode shift.

At the aggregate level (*n*= 13), key findings show that:

- As a result of decreased driving, there was an overall benefit value of $149,942 (avg: $11,534/school)
- As a result of increased walking, there was an overall benefit value of $20,091 (avg: $1,545/school)
- As a result of increased cycling, there was an overall benefit value of $16,337 (avg: $1,257/school)
- The total benefit value for the first year of STP was $186,370 (avg: $14,336/school)
- The total benefit value for a 3-year STP duration is projected to be $542,982 (avg: $41,768/school)
- The total benefit value for a 5-year STP duration is projected to be $879,123 (avg: $67,625/school)

When comparing communities (*n*= 2), key findings show that:

- Toronto ($85,066) gained greater benefits than WDG ($64,876) from reduced driving after year 1
- WDG ($14,125) gained greater benefits than Toronto ($5,966) from increased walking after year 1
- Toronto ($13,407) gained greater benefits than WDG ($2,930) from increased cycling after year 1
- The total benefit value was greater in Toronto ($104,439) than WDG ($81,931) after year 1

Table 6: Kilometres reduced from driving and increased from walking and cycling

Community	School	VKT Reduced (km)	Walking kilometres increased (km)	Cycling kilometres increased (km)
Toronto	Rolph Road PS	6,945	0	5,858
Toronto	Northlea Public School	0	0	17,240
Toronto	Annunciation Catholic School	0	0	4,528
Toronto	Cassandra Public School	3,549	625	5,386
Toronto	Pierre Laporte Public School	17,350	0	1,139
Toronto	St. Raphael Catholic School	10,386	3,928	0
Toronto	Gateway Public School	41,792	7,144	6,430
Toronto	Valley Park Public School	27,655	0	1,318
Toronto Community (*n*= 8)		**107,678**	**11,697**	**41,898**
WDG	Glenbrook Elementary School	40,494	19,120	999
WDG	J.D.Hogarth Public School	15,064	0	3,593
WDG	Minto-Clifford Central PS	22,563	0	0
WDG	Montgomery Village Public School	0	0	0
WDG	Rickson Ridge Public School	3,999	8,577	4,563
WDG Community (*n*= 5)		**82,121**	**27,697**	**9,155**
Aggregate (n= 13)		**189,799**	**39,394**	**51,053**

Table 7: Monetary Benefits of STP

		Monetary benefits first-year ($)				Monetary benefits 3-years ($)				Monetary benefits 5-years ($)			
Community	**School name**	VKT benefits	Walking benefits	Cycling benefits	Total annual benefits	VKT benefits	Walking benefits	Cycling benefits	3-year total benefits	VKT benefits	Walking benefits	Cycling benefits	5-year total benefits
Toronto	Rolph Road Public School	$5,486	$0	$1,875	$7,361	$15,985	$0	$5,462	$21,447	$25,880	$0	$8,843	$34,723
Toronto	Northlea Public School	$0	$0	$5,517	$5,517	$0	$0	$16,073	$16,073	$0	$0	$26,023	$26,023
Toronto	Annunciation Catholic School	$0	$0	$1,449	$1,449	$0	$0	$4,222	$4,222	$0	$0	$6,835	$6,835
Toronto	Cassandra Public School	$2,804	$319	$1,723	$4,846	$8,168	$928	$5,021	$14,118	$13,225	$1,503	$8,130	$22,858
Toronto	Pierre Laporte Public School	$13,707	$0	$364	$14,071	$39,934	$0	$1,062	$40,996	$64,656	$0	$1,719	$66,375
Toronto	St. Raphael Catholic School	$8,205	$2,004	$0	$10,209	$23,906	$5,837	$0	$29,743	$38,705	$9,451	$0	$48,156
Toronto	Gateway Public School	$33,016	$3,643	$2,057	$38,717	$96,191	$10,615	$5,994	$112,801	$155,740	$17,186	$9,705	$182,631
Toronto	Valley Park Public School	$21,848	$0	$422	$22,269	$63,652	$0	$1,228	$64,880	$103,057	$0	$1,989	$105,046
Toronto Community (total for 8 schools)		$85,066	$5,966	13,407	$104,439	$247,836	$17,381	$39,062	$304,279	$401,263	$28,140	$63,244	492,647
Toronto Community (average for 8 schools)		$10,633	$746	$1,676	$13,055	$30,980	$2,173	$4,883	$38,035	$50,158	$3,518	$7,905	$61,581
WDG	Glenbrook Elementary School	$31,991	$9,751	$320	$42,061	$93,204	$28,410	$931	$122,544	$150,903	$45,997	$1,508	$198,408
WDG	J.D.Hogarth Public School	$11,901	$0	$1,150	$13,051	$34,672	$0	$3,350	$38,022	$56,137	$0	$5,424	$61,561
WDG	Minto-Clifford Central Public School	$17,825	$0	$0	$17,825	$51,933	$0	$0	$51,933	$84,083	$0	$0	$84,083
WDG	Montgomery Village Public School	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
WDG	Rickson Ridge Public School	$3,160	$4,374	$1,460	$8,994	$9,205	$12,744	$4,254	$26,203	$14,904	$20,633	$6,887	$42,424
WDG Community (total for 5 schools)		$64,876	14,125	$2,930	$81,931	$189,014	$41,154	$8,535	$238,703	$306,026	$66,631	$13,819	$386,476
WDG Community (average for 5 schools)		$12,975	$2,825	$586	$16,386	$37,803	$8,231	$1,707	$47,741	$61,205	$13,326	$2,764	$77,295
Total for all 13 schools		$149,942	$20,091	$16,337	$186,370	436,850	58,535	47,497	542,982	707,289	94,771	77,063	879,123
Average for all 13 schools		$11,534	$1,545	$1,257	$14,336	$33,604	$4,503	$3,661	$41,768	$54,407	$7,290	$5,928	$67,625

Table 8: Environmental and Health Benefits of STP

	Vehicle Trips Avoided Each Day	GHG Reduced Each Year (Tonnes)	CAC Reduced Each Year (Tonnes)	Additional Mins. of Walking Each Year	Additional Mins. of Cycling Each Year
Toronto Schools (n=8)	315	23.38	0.94	163,762	314,235
WDG Schools (n=5)	240	17.83	0.71	387,754	68,661

What were the costs associated with STP?

Table 9 displays the costs associated with STP implementation at the aggregate, community, and school levels. At the aggregate level, key findings show that:

- The one time planning phase cost in total $31,666
- Year 1 implementation/monitoring cost in total $45,283
- 1-year STP duration cost in total $76,950
- 3-year STP duration cost in total $119,494
- 5-year STP duration cost in total $139,546

When examining the costs more depth as it relates to the costs of people and materials (Table 10), key findings show that:

- For the one-time planning phase, the costs of people was $27,978 and costs of materials was $3,688
- For year 1 implementation/monitoring, the costs of people was $36,522 and costs of materials was $8,761

Table 9: Costs associated with STP

Community	School name	Planning	Implementation and Monitoring Year 1	Implementation and Monitoring Years 2-5	Total Cost [1-year project duration]	Total Cost [3-year project duration]	Total Cost [5-year project duration]
Toronto	Rolph Road Public School	$3,531	$5,769	$1,653	$9,300	$12,463	$13,954
Toronto	Northlea Public School	$2,493	$3,213	$1,555	$5,706	$8,680	$10,082
Toronto	Annunciation Catholic School	$2,562	$4,478	$2,255	$7,040	$11,355	$13,389
Toronto	Cassandra Public School	$2,690	$4,864	$2,540	$7,554	$12,415	$14,705
Toronto	Pierre Laporte Public School	$2,554	$1,887	$1,066	$4,442	$6,483	$7,444
Toronto	St. Raphael Catholic School	$2,696	$4,398	$2,145	$7,094	$11,198	$13,132
Toronto	Gateway Public School	$3,074	$4,723	$2,445	$7,798	$12,477	$14,682
Toronto	Valley Park Public School	$2,920	$4,860	$2,117	$7,780	$11,831	$13,741
Toronto Community (total for 8 schools)		$22,520	$34,193	$15,777	$56,713	$86,902	$101,131
Toronto Community (average for 8 schools)		$2,815	$4,274	$1,972	$7,089	$10,863	$12,641
WDG	Glenbrook Elementary School	$1,570	$2,470	$1,375	$4,041	$6,671	$7,911
WDG	J.D.Hogarth Public School	$2,166	$2,418	$1,377	$4,584	$7,218	$8,460
WDG	Minto-Clifford Central Public School	$1,943	$2,561	$1,422	$4,504	$7,225	$8,507
WDG	Montgomery Village Public School	$1,783	$1,912	$1,083	$3,696	$5,768	$6,745
WDG	Rickson Ridge Public School	$1,683	$1,729	$1,201	$3,413	$5,710	$6,793
WDG Community (total for 5 schools)		$9,146	$11,090	$6,457	$20,237	$32,592	$38,415
WDG Community (average for 5 schools)		$1,829	$2,218	$1,291	$4,047	$6,518	$7,683
Total for all 13 schools		31,666	$45,283	$22,234	$76,950	$119,494	$139,646
Average for all 13 schools		$2,436	$3,483	$1,710	$5,919	$9,192	$10,734

Table 10: Breakdown of costs

Community	School	Planning costs (one-time)			Impl. & Monitoring (year 1)			Impl. & Monitoring (years 2-5)		
		Cost of people	Cost of materials	Total	Cost of people	Cost of materials	Total	Cost of people	Cost of materials	Total
Toronto	Rolph Road Public School	$2,711	$820	$3,531	$3,410	$2,358	$5,769	$1,395	$258	$1,653
Toronto	Northlea Public School	$1,860	$632	$2,493	$3,001	$212	$3,213	$1,091	$464	$1,555
Toronto	Annunciation Catholic School	$2,319	$243	$2,562	$3,789	$690	$4,478	$1,894	$361	$2,255
Toronto	Cassandra Public School	$2,382	$307	$2,690	$4,358	$506	$4,864	$2,179	$361	$2,540
Toronto	Pierre Laporte Public School	$2,307	$248	$2,554	$1,411	$477	$1,887	$705	$361	$1,066
Toronto	St. Raphael Catholic School	$2,388	$308	$2,696	$3,568	$830	$4,398	$1,784	$361	$2,145
Toronto	Gateway Public School	$2,842	$232	$3,074	$4,169	$554	$4,723	$2,084	$361	$2,445
Toronto	Valley Park Public School	$2,679	$241	$2,920	$3,512	$1,347	$4,860	$1,756	$361	$2,117
WDG	Glenbrook Elementary School	$1,420	$150	$1,570	$2,027	$443	$2,470	$1,014	$361	$1,375
WDG	J.D.Hogarth Public School	$2,087	$79	$2,166	$2,032	$386	$2,418	$1,016	$361	$1,377
WDG	Minto-Clifford Central Public School	$1,741	$202	$1,943	$2,122	$439	$2,561	$1,061	$361	$1,422
WDG	Montgomery Village Public School	$1,624	$159	$1,783	$1,444	$468	$1,912	$722	$361	$1,083
WDG	Rickson Ridge Public School	$1,617	$66	$1,683	$1,679	$50	$1,729	$840	$361	$1,201
	TOTALS	$27,978	$3,688	$31,667	$36,522	$8,761	$45,283	$17,542	$4,692	22,234

Cost benefit ratios

Based on the mode shift and its associated monetary benefits, along with STP program costs, the following figures detail how the benefit-cost ratios at the aggregate and community levels were produced. Table 11 provides an overview of the benefit-cost ratios at the school level and for the projected 3-and 5-year STP projects. Overall, results show a benefit-cost ratio of 2.4 across schools following a 1-year STP project. The Toronto and WDG-based schools showed a respective 1.8 and 4.0 ratio after one year. After a 5-year STP duration, projected benefit-cost ratios for each level were 6.3 (Aggregate), 4.9 (Toronto), and 10.1 (WDG).

Figure 3: Benefit-cost ratio for all 13 STP projects (1-year)

Benefit-Cost Ratio =	Total Present Value Benefits / Total Costs	=	$186,369 / $76,950		=	**2.4**

Figure 4: Benefit-cost ratio for 8 Toronto schools (1-year)

Present Value Benefits =	$85,066 Car Reduction Benefits	+	$5,966 Walking Benefits	+	$13,407 Cycling Benefits	=	**$104,439**
Total Costs =	$46,707 Cost of people	+	$10,006 Cost of materials			=	**$56,713**
Total Costs =	$22,520 Planning costs (one-time)	+	$34,193 Implementation and Monitoring (year 1)			=	**$56,713**
Benefit-Cost Ratio =	Total Present Value Benefits / Total Costs	=	$104,439 / $56,713			=	**1.8**

Figure 5: Benefit-cost ratio for 5 WDG schools (1-year)

Present Value Benefits =	$64,876 Car Reduction Benefits	+	$14,125 Walking Benefits	+	$2,930 Cycling Benefits	=	**$81,931**
Total Costs =	$17,793 Cost of people	+	$2,443 Cost of materials			=	**$20,237**
Total Costs =	$9,146 Planning costs (one-time)	+	$11,090 Implementation and Monitoring (year 1)			=	**$20,237**
Benefit-Cost Ratio =	Total Present Value Benefits / Total Costs	=	$81,931 / $20,237			=	**4.0**

Table 11: Cost benefit ratios across years for each school and community

Community	School name	Benefit-cost ratios		
		1-year project duration	3-year project duration	5-year project duration
Toronto	Rolph Road Public School	0.8	1.7	2.5
Toronto	Northlea Public School	1.0	1.9	2.6
Toronto	Annunciation Catholic School	0.2	0.4	0.5
Toronto	Cassandra Public School	0.6	1.1	1.6
Toronto	Pierre Laporte Public School	3.2	6.3	8.9
Toronto	St. Raphael Catholic School	1.4	2.7	3.7
Toronto	Gateway Public School	5.0	9.0	12.4
Toronto	Valley Park Public School	2.9	5.5	7.6
Toronto Community (8 schools combined)		**1.8**	**3.5**	**4.9**
WDG	Glenbrook Elementary School	10.4	18.4	25.1
WDG	J.D.Hogarth Public School	2.8	5.3	7.3
WDG	Minto-Clifford Central Public School	4.0	7.2	9.9
WDG	Montgomery Village Public School	0.0	0.0	0.0
WDG	Rickson Ridge Public School	2.6	4.6	6.2
WDG Community (5 schools combined)		**4.0**	**7.3**	**10.1**
All 13 schools combined		**2.4**	**4.5**	**6.3**

DISCUSSION

This study examined STP's cost-effectiveness in 13 Ontario elementary schools between 2013-2014. Overall, the benefit-cost ratio was 2.4, supporting STP as a cost-effective intervention following the initial year of implementation. When projected for a hypothetical 3- and 5-year STP implementation period by using year one data (i.e., mode share and STP costs), the benefit-cost ratios were 4.5 and 6.3, respectively.

When focusing on the first year, there was a range in benefit-cost ratios across schools (0-10.4). This suggests that the economic efficiency of STP can substantially vary from one project to the next. Though this study did not analyze how or why some projects observed a higher ratio than others, the STP literature helps explain by showing wide-variability in mode shift between schools (Hinckson et al., 2011; Mammen et al., 2013; Mammen et al., 2014; Mammen et al., 2015; Mammen et al., 2016). These studies have suggested that STP can lead to greater AST shifts in certain schools, dependent on a variety of 'school specific' contextual (e.g., school location, socioeconomic status) and program-related factors (e.g., Principal and parent commitment, student involvement). Depending on the array of factors, STP costs between schools will then differ, as the individual STP interventions will be delivered with varying degrees of resources.

Overall, however, the benefit-cost ratio of 2.4 in this study is higher than the 1.8 reported in the first BCA (Metrolinx, 2014). This is promising when considering this study applied key lessons learned from the first BCA to provide a more conservative and accurate representation of STP benefits and costs. First, the 2.4 ratio was a result of a 1-year STP implementation period while the 1.8 ratio was a projected result of an 11-year STP project. In this type of analyses, any additional hypothetical year is a year to include in the overall benefit values within the BCA. For example, if comparing a hypothetical 7-year STP project versus a 6-year STP project, the benefit-cost ratio will be higher in the former given the extra year of 'benefits' that would be included in analysis. Hence, the cost benefit ratio of 2.4 after 1-year of STP should be interpreted quite positively.

Second, compared to the original BCA report data collection procedure, the current study's project costs were recorded on an on-going basis and not through a retrospective-recall approach. This lesson learned from the first BCA study enabled a more precise and complete documentation of STP program costs whereas several costs may have been overlooked when attempting to recall the finite items (e.g. photocopying) involved in STP delivery. Thus, the overall costs are likely to be higher in the current study, which represents a more stringent value to use in the BCA that would produce more conservative cost benefit ratios. Third, the current study also took into account the mode change in cycling behaviors. Including this was important to not only capture benefits aside from walking, but to highlight some of the variation in STP effectiveness across communities.

Beyond the aggregate level, this study provides detailed results for STP benefits and costs at the community level. Eight Toronto schools showed a cost benefit ratio of 1.8 and five WDG schools yielded a 4.0 ratio, with a considerable range between schools. In grouping the results by community, this study provides new knowledge to the STP literature. For instance, the peer-review literature has indicated STP to facilitate greater AST shifts in urban-like environments where built environments (e.g., street density and connectivity) are more conducive to walking and cycling (Hinckson et al., 2011; Mammen et al., 2013; Mammen et al., 2014). This study shows that STP can also help increase AST behaviours in rural environments, for example within the WDG area.

More specifically, this study highlights which specific AST behaviours are likely to change in communities with varying geographies. Though both communities observed the greatest changes in kilometres driven, the Toronto schools showed greater shifts in cycling and public transit while the WDG schools showed greater shifts in walking. This has practical implications for STP facilitators by emphasizing specific AST behaviours to strategize towards based on the school's geographical setting. It is also important to highlight that although public transit was not taken into account in providing monetary benefits in this study, recent studies reveal that this travel mode is increasingly considered active travel given its role in contributing to daily physical activity (Owen et al., 2012; Pabayo et al., 2012; Voss et al., 2015). Future studies should then consider carefully monitoring public transit changes and including them in analysis to further provide a more holistic picture of STP's economical impact.

Aside from including public transit in a BCA, future studies should also address the key limitations of this study in being an observational based study. Stronger research designs such as quasi-experiments or randomly controlled trials that use control schools can better help infer causation and if STP is solely responsible for the mode shifts. Furthermore, multi-year evaluation periods are needed to help determine the program's sustainability and how the program's costs fluctuate across years.

Conclusion

Overall the benefit-cost ratio of 2.4 supports STP as a cost-effective intervention. The study has demonstrated that STP can contribute toward significant school travel behaviour change, and provide substantial economic, health and environmental benefits. More specifically, this study highlights the importance of examining the costs and benefits of STP at the community level in order to help differentiate the program's impact in different contexts. A more refined methodology to conduct the BCA was also provided that can be used as a model and further refined in future work.

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Appendix A- Classroom Hands-up Survey

Please complete this survey, using hands-up, for the week of: < Day/Month to Day/Month of Year >

Grade: _____ Room/Class #: _____ # Students: _____

Teacher:_____ Dates: Mon. _____ to Fri. _____

Ask students: "How did you travel <u>to</u> school this morning?"

	Weather	Walked	Walked part-way*	Bicycle	School Bus	Public Transit	Carpool (2 or more families)	Car (Just my family)	Other?	Total
Mon	Example: Rainy/6C									
Tues										
Wed										
Thurs										
Fri										
Total										
Daily Avg=Total/5										

*Walked at least one entire block.

Ask students: "How will you travel <u>from</u> school today?"

	Weather	Walked	Walked part-way*	Bicycle	School Bus	Public Transit	Carpool (2 or more families)	Car (Just my family)	Other?	Total
Mon	Example: Sunny/25C									
Tues										
Wed										
Thurs										
Fri										
Total										
Daily Avg=Total/5										

*Walked at least one entire block.

APPENDIX B

BENEFITS DEFINITIONS FROM VICTORIA TRANSPORT POLICY INSTITUTE

Benefits of VKT Reduction	Monetary Benefit per VKT Reduced	Definition
Congestion Reduction	$0.04	Reduced traffic congestion from automo- bile travel on congested roadways.
Pollution Reduction	$0.03	Economic and environmental benefits from reduced air, noise, and water pollu- tion
Parking Cost Savings*	$0.16	Reduced parking problems and facility cost savings
Vehicle Cost Savings	$0.14	Consumers savings from reduced vehicle ownership and use
Energy Conservation	$0.02	Economic and environmental benefits from reduced energy consumption
Reduced Barrier Effect	$0.01	Improved non-motorized travel condi- tions due to reduced traffic speeds and volumes
Roadway Cost Savings	$0.03	Roadway construction, maintenance and operating costs
Avoided Chauffeuring Driver's Time	$0.36	Reduced chauffeuring responsibility due to improved travel options
Total	**$0.79**	
Benefits of Walking	**Monetary Benefit per Additional Km. Walked**	**Definition**
Health Benefit	$0.31	Improved fitness and health
User Benefits	$0.16	Increased user convenience, comfort, safety, accessibility and enjoyment
Options Value	$0.02	Benefits of having mobility options available in case they are ever needed
Equity Objectives	$0.02	Benefits to economically, socially, or physically disadvantaged people

Total	**$0.51**	

*Please note: All benefit values are consistent with the “Overall Average” values found in Tables 16-18 in VPTI’s Evaluating Active Transport Benefits and Costs report (after conversion from $/mile to $/kilometre), except for Parking Cost Savings, which is reduced from $0.22/VKT to $0.16/VKT in recognition that student trips require less parking than commuting trips, and generally require only temporary parking solutions for the purposes of student travel.

APPENDIX C

Excel Tool used to document STP costs

Cost of People (hours)		Planning	Implementation & Monitoring Year 1	Implementation & Monitoring Year 2-5
Facilitator				
Police Official				
School Staff Representative	Principal			
	Vice Principal			
	Teacher			
	Office staff			
	Custodial staff			
School District/Board Representative	School board trustee			
	Facilities, Curriculum, Environment, etc.			
Public Health Officials	Public Health Nurse			
	Other Public Health officials (other staff that are not nurses, e.g., project managers)			
Other municipal departments	Parks & Recreation			
City/Town Representatives	Councillor			
	Other			
Non Government Organization Representatives	Environmental groups			
	Transportation groups			
Municipal Transportation Planning Department	Transportation Engineer			
	Municipal planner			
By-law officer	Those enforce 'stationary' violation (i.e., parking and stopping issues)			
Volunteers	Parents			
	Local resident groups, community association			
	Other			
Other	(specific professional title)			
	(specific professional title)			
	(specific professional title)			
	(specific professional title)			
Total monetary value		**$0.00**	**$0.00**	**$0.00**

Cost of Materials ($)	Planning	Implementation & Monitoring Year 1	Implementation & Monitoring Year 2-5
Meeting facilities (i.e, school district, city/town, fire-hall $100)			
Catering			
Incentives (i.e., for schools, students, for teachers, for parents)	N/A		
Promotional items (i.e. water bottles, helmets, etc.)	N/A		
Infrastructure projects under $7500 (e.g. bike racks, signage, pavement painting)	N/A		
Infrastructure projects over $7500 (e.g. sidewalk, speed bumps)	N/A		
STP Committee documents (e.g. photocopying, printing)			
Travel (TTC)			
Documents for baseline data collection			
Documents for follow-up data collection	N/A		

Total monetary value (excluding projects over $7500)	**$0**	**$0**	**$0**

APPENDIX D

Hourly Rates for STP Committee Members

Average hourly rate for different roles		Hourly rate	
Facilitator		$28	*According to Director, GCC Walks*
Police Official		$36	http://www.torontopolice.on.ca/careers/uni_benefits.php
School Staff Representative	Principal	$49	http://swz.salary.com/SalaryWizard/School-Principal-Hourly-Salary-Details-Ontario-CA.aspx
	Vice Principal	$40	http://swz.salary.com/SalaryWizard/Assistant-School-Principal-Hourly-Salary-Details-Ontario-CA.aspx
	Teacher	$31	http://www.livingin-canada.com/wages-for-social-education-jobs-canada.html
	Office staff	$20	http://www.livingin-canada.com/salaries-for-administrative-officers-canada.html
	Custodial staff	$16	http://www.livingin-canada.com/salaries-for-janitors-and-caretakers-canada.html
School District/Board Representative	School board trustee	$26	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=0011
	Facilities, Curriculum, Environment, etc.	$21	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=1221
Public Health Officials	Public Health Nurse	$36	http://www.ona.org/faqs.html#f15
	Other Public Health officials (other staff that are not nurses, e.g., project managers)	$31	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=0711
Other municipal departments	Parks & Recreation	$16	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=8612
City/Town Representatives	Councillor	$53	http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=29032704635c0410VgnVCM10000071d60f89RCRD
	Other	$16	
Non Government Organization Representatives	Environmental groups	$0	
	Transportation groups	$0	*Note: must be in a paid capacity*
Municipal Transportation Planning Department	Transportation Engineer	$35	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=2131
	Municipal planner	$34	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=2153
By-law officer	Those enforce 'stationary' violation (i.e., parking and	$29	http://www.jobbank.gc.ca/report-eng.do?area=9219&lang=eng&noc=6463

	stopping issues)		
Volunteers	Parents	$15	
	Local resident groups, community association	$15	
	Other	$15	
Other	(specific professional title)	$28	
	(specific professional title)	$28	
	(specific professional title)	$28	
	(specific professional title)	$28	