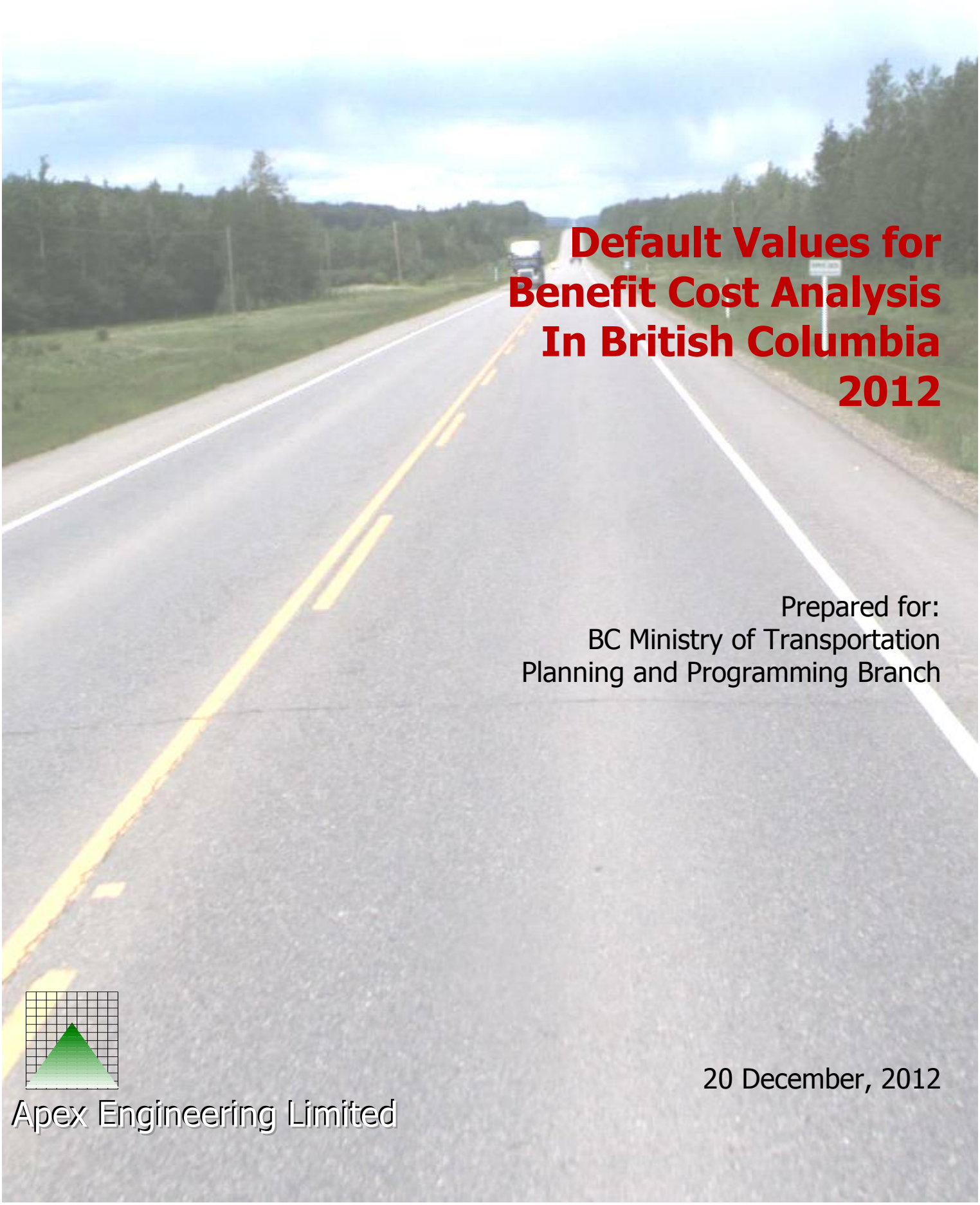


Default Values for Benefit Cost Analysis In British Columbia 2012

Prepared for:
BC Ministry of Transportation
Planning and Programming Branch

Apex Engineering Limited

20 December, 2012

Table of Contents

List of Exhibits

Page

Default Values for Benefit Cost Analysis
2012

1 Purpose

This report updates the 2007 default values used for benefit cost analysis in British Columbia to 2012 values. The default values presented here are structured to match inputs for the Microbencost model but can equally be used in any benefit cost model. The default data file BCDEF12.DD, has been prepared for use in MBC version 1.0 or version 2. This data set replaces the previous default data set BCDEF07.DD and is available from MoTI or Apex Engineering. .

The steps to implement the default data file for MBC are:

1. Copy the default data file BCDEF12.DD into the Microbencost directory.
2. Start MBC
3. Select CONFIGURE from the MBC Menu
4. Enter the new default data file name using the full path name
5. Save the default data setting.

The default data includes changes to:

- Vehicle Operating Costs
- Value of time
- Collision Costs
- Maintenance Costs
- Pavement Rehabilitation Costs

Historical – The original default economic data were developed by MoT Planning Services Branch in 1992 as part of their program to develop tools for economic analysis of highway improvements. These values were integrated into the UBCS (User Benefit Cost Spreadsheets) model developed concurrently by the Ministry. In 1997 the default values were updated and the Microbencost model was implemented to replace UBCS. The default values were subsequently updated in 2003, 2007 and again in 2012 with this edition of the default values.

2007 edition – Truck depreciation was segregated into time related and distance related components. The time related component was moved from the vehicle operating cost to the time cost default data so as to provide a more realistic estimate of time and vehicle operating cost (VOC) savings related to commercial traffic.

2012 edition – The most notable changes include:

- Gasoline prices have increased 19% and diesel 30% since 2007
- Default collision rates are adjusted to reflect more detailed Provincial collision data, disaggregated for signalized and unsignalized intersections. Previous data aggregated all intersections together.
- Better information for the collision cost estimates
- Value of time for auto and bus derived from median hourly household income

Future editions – Potential improvements include:

- Adopt a "made in BC" value for collisions. Historically, the cost of fatal collisions has been adopted from the US National Safety Council figures based on US statistics and exchange rates, leading to some arbitrary fluctuation in the BC values.
- Do further research into the inventory cost of goods in transit
- Do further research into allocation of the fixed costs of personal auto ownership. Current practice includes only the variable cost of personal vehicle use. Fixed costs are excluded from benefit cost analysis because they are considered sunk costs. Emerging models of vehicle ownership may change this.

2 Vehicle Operating Costs

2.1 Autos

Fuel – The average Provincial fuel price net of taxes[1] is used for social cost benefit analysis. In social cost benefit, taxes are considered to be a transfer not a resource cost. Gasoline and diesel are used as proxy for car and truck fuel.

$/Litre	Gasoline	Diesel
Fuel	$0.898	$0.978
Taxes	$0.389	$0.344
Total	$1.287	$1.323
Increase compared to 2007	19%	30%

Oil - $4.40 per litre

Tires - The following passenger vehicle tire prices were used to represent each vehicle category.

Category	Tire	Price ($/tire)	Tires /Veh	$/Veh
Small pass	PirelliP4 all season P175/65R14	$96	4	$384
Med/large pass	Pirelli P4 all season P225/60R16	$147	4	$588
Pickup/van	BF Goodrich P265/70R17 SUV	$241	4	$964
Bus	Bus	$400	8	$3,200

[1] "Fuel Focus," Natural Resources Canada, 2012
http://www.nrcan.gc.ca/energy/1374#allprices

Vehicle Price – The passenger vehicle types were drawn from the Canadian Automobile Association publication "Driving Costs 2012"[2]. Auto prices were drawn from Car Guide Canada[3].

Category	Description	Average
Small pass	2012 Honda Civic LX Auto (4 cylinder)	$20,535
Med/large pass	2012 Toyota Camry LE Auto 4 Dr(4 cylinder)	$25,365
SUV	2012 Chevrolet Equinox LT Auto 4 Dr	$30,820
Buses	Prevost Intercity Bus[4]	$400,000

Maintenance - The Canadian Automobile Association publishes typical maintenance and repair costs in their annual brochure "2012 Driving Costs." The baseline vehicles include a Honda Civic at $.0218/km, a Toyota Camry at $.046/km and a Chevrolet Equinox at $0.0255/km. These are assumed to reflect the "small", "medium" and "pickup/van" categories in Microbencost. The "Pickup/Van" would more correctly represent typical SUV's which are prevalent today. Maintenance costs for buses were assumed equal to a 5-axle truck.

[2] "Driving Costs 2012", Canadian Automobile Association, Ottawa ON. http://www.caa.ca/club-services/
[3] Carguide Canada.com, October 2012
[4] Volvo Group Annual Report 2011, - Prevost intercity bus costs an estimated $371,000

Exhibit 2-1 Unit Prices for Automobile Operating Costs 2012

Vehicle Description	Fuel	Oil	Tires	Depre-ciation	Maint & Repairs
			2012 Unit Costs		
Metric	$/L	$/L	$/veh	Price $/veh	$/1000 km
Small pass	$0.898	$4.40	$384	$20,535	$21.80
Med/large pass	$0.898	$4.40	$588	$25,365	$46.00
Pickup/van	$0.898	$4.40	$964	$30,820	$25.50
Buses	$0.978	$4.00	$3,200	$400,000	$538.40
US Units	$/us gal	$/Quart	$/veh	$/veh	$/1000 miles
Small pass	$3.40	$4.16	$384	$20,535	$35.10
Med/large pass	$3.40	$4.16	$588	$25,365	$74.06
Pickup/van	$3.40	$4.16	$964	$30,820	$41.06
Buses	$3.70	$3.79	$3,200	$400,000	$866.82

2.2 Trucks

Fuel - Excluding taxes, the current price for diesel fuel is $.978/L.

2012	Gasoline	Diesel
Fuel	$0.898	$0.978
Taxes	$0.389	$0.344
Total	$1.287	$1.323

Oil - $4.40/litre.

Tires – Size 11:00R24.5

Truck Configuration	Tires	Unit Cost[5]	Total
2-Axle Straight Van	6	$400	$2,400
3-Axle Straight Van	10	$400	$4,000
4-Axle Van Semi	14	$400	$5,600
5-Axle Van Semi	18	$400	$7,200
6-Axle Van Semi	22	$400	$8,800
8-Axle B-Train	30	$400	$12,000

[5] Greg Johnson "Tire Maintenance Effective in Preventing Blowouts", Transport Topics Newsletter Sept. 3, 2012

Value for Depreciation (Exhibit 2-2) – In Microbencost, the "Value for Depreciation" for trucks is intended to reflect "use-related depreciation", or the decline in value of the vehicle over its lifetime which can be attributed to distance driven. This is separate from the time related depreciation of a truck which reflects the loss in value due to age but not due to use.

Prior to 2007, default values used the full initial cost of the truck. This is fundamentally incorrect because depreciation is a function of both distance and time, not just distance. The portion of a truck's cost which is subject to use (distance) related depreciation ($/km) is about 28% of its initial cost[6]. The remaining 72% is a fixed cost of ownership which is a function of time, not distance and should be expressed in the model as a time cost. For example if a new 6-axle tractor trailer costs $173,063 then the portion subject to use related depreciation ($/km cost) is 28% or $47,978.

Starting with the 2007 edition of the default values, the distance and time related components of truck depreciation have been separated. There is no a change in the overall cost, just a more realistic means of allocating the cost. If for example, all the depreciation were allocated to distance traveled, there would be no cost to a truck sitting in traffic other than the driver's time and idle fuel consumption. If some of this depreciation cost is allocated to a time basis, this correctly reflects the opportunity cost of the truck asset. As applied to benefit cost, this will give greater value to congestion relief projects since trucks will have a higher time value. Time values are presented in Section 3. Values for distance related depreciation are presented in Exhibit 2-2 based on truck and trailer costs from Barton[7] .

[6] This is based on a regression analysis of 37 used truck listings giving the truck price, year and kilometers by Apex Engineering in 2003.

[7] "OPERATING COSTS OF TRUCKING AND SURFACE INTERMODAL TRANSPORTATION IN CANADA", prepared for Transport Canada by Ray Barton and Associates In association with Logistics Solution Builders Inc. and The Research and Traffic Group, March 11, 2011

Exhibit 2-2 Truck Values (2011) for Calculating Distance Related Depreciation

	Tractor	Trailer	Total Price	28% Portion Subject to Distance Related Depreciation
2-Axle Straight	$85,063	$0	$85,063	$23,582
5-Axle Semi	$112,815	$29,425	$142,240	$39,433
6-Axle Semi	$124,050	$36,380	$160,430	$44,476
8-Axle Train	$128,063	$45,000	$173,063	$47,978

The 2012 unit costs for truck vehicle operating costs in Microbencost are summarized in Exhibit 2-3. The same unit prices are used for urban or rural environments.

Exhibit 2-3 Unit Prices for Truck Operating Costs

Vehicle Description Imperial	Fuel -$/gal-	Oil -$/qrt (US)-	Tires -$/veh-	Value for Depreciation -$/veh-	Maintenance and Repairs -$/1000 miles-
2-Axle Single Unit	3.40	4.15	$2,400	$23,582	$867
3-Axle Single Unit	3.70	4.15	$4,000	$27,000	$867
4-Axle Semi	3.70	4.15	$5,600	$32,000	$649
5-Axle Semi	3.70	4.15	$7,200	$39,433	$649
6-Axle Semi	3.70	4.15	$8,800	$44,476	$792
A, B or C Train	3.70	4.15	$12,000	$47,978	$929
Vehicle Description Metric	Fuel -$/gal-	Oil -$/qrt (US)-	Tires -$/veh-	Value for Depreciation -$/veh-	Maintenance and Repairs -$/1000 miles-
2-Axle Single Unit	0.90	4.40	$2,400	$23,582	$538
3-Axle Single Unit	0.39	4.40	$4,000	$27,000	$538
4-Axle Semi	1.29	4.40	$5,600	$32,000	$403
5-Axle Semi	0.00	4.40	$7,200	$39,433	$403
6-Axle Semi	0.18	4.40	$8,800	$44,476	$792
A, B or C Train	0.21	4.40	$12,000	$47,978	$929

2.3 Rough Pavement Discomfort Costs

Microbencost includes a cost added on for rough pavement travel expressed in 1990 US$/mile and is applied to all vehicle types. The 2012 values were updated from the 1990 values using the consumer price index for British Columbia (92.4 in 1990 and 121.8 in 2012) and the exchange rate in 2012 at par ($1.00 CDN = $1.00 US).

Exhibit 2-4 Discomfort Costs Associated with Rough Pavement

	Pavement Condition Rating	1990 US$/mi	2012 CDN$/mi	2012 CDN$/km
Best	4.5 - 5.0	0.000	$0.000	$0.000
	4.0 - 4.5	0.000	$0.000	$0.000
	3.5 - 4.0	0.000	$0.000	$0.000
	3.0 - 3.5	0.000	$0.000	$0.000
	2.5 - 3.0	0.005	$0.007	$0.004
	2.0 - 2.5	0.011	$0.015	$0.009
	1.5 - 2.0	0.016	$0.021	$0.013
Worst	<1.5	0.020	$0.026	$0.016

The 1990 Microbencost values were derived in turn from a 1979 study in Kentucky[8]. This study used survey responses from of 164 DoT employees and 203 other licensed drivers as to their willingness to pay to travel on a newly paved surface compared to a road in poor condition.

[8] Zegeer, C. V., Agent, K.R. and Rizenbergs, R.L.,"The Use of Economic Analysis and Dynamic Programming in the Selection of Projects for Resurfacing", DOT Kentucky, 1979.

3 Value of Time

3.1 Auto and Bus Value of Time

History - The original values of time used by BC MoT for economic analysis were developed in 1994 by Waters[9] for use in the User Benefit Cost Spreadsheets (UBCS) model and were disaggregated by age group, driver, passenger, work/non-work and commercial/non-commercial. The weighted average of these values by user group was approximately $10/hr, which became the default 1997 value used in Microbencost for BC. Microbencost allows value of time inputs for urban or rural, commercial/non-commercial and vehicle type. The original value of time work was closely related to average Provincial wages. The average Provincial wage was $610.70/week in 1997, $682.00 in March 2003 and $743.18 in March 2007, an increase of 9% from 2003. This increase is used to calculate the 2007 value of time of $12.17/person-hour.

In 2012 BC MoT adopted a revised value of time for personal travel that is equal to 50 percent of the B.C. median hourly **Household** income. Household annual income is collected by the census every 5 years. The last available figure from the 2006 census is for 2005 data and is $52,709. The 2012 B.C. median household income is estimated to be $66,310 based on a projection of available 2005 to 2009 median **Family** income which is collected annually (from CANSIM Table 111-0009) and correlates closely to household income. The 2012 household income divided by 2,080 employment hours per year is $31.88/hr and the value of travel time is estimated in Exhibit 3-1 as 50% of the hourly income or **$15.94/hr** (in 2012 dollars).

50% of the wage rate is used as the value of non-work time. This is assumed to be the value of travel time savings for non-commercial vehicle occupants. The non-work value is used, based on the premise that travel time savings will generally be used for additional non-work activity rather than work activity.

The Ministry recommends updating the value of time:

- Upon Statistics Canada's release of B.C. median household income figures from each Census (scheduled to occur in August 2013 for 2011 Census data); and
- One time between each Census update, preferably two or three years after the Census update.

[9] Waters W.G. et al, "The Value of Travel Time in British Columbia" prepared for the BC Ministry of Transportation and Highways, Planning Services Branch November 1994.

Exhibit 3-1 Value of Travel Time Estimate

	Median Total Income, All Families, BC
2005 2006 2007 2008 2009	$58,500 $62,600 $65,780 $67,890 $66,700
Increase from 2005 to 2009	14.02%
Annual Compound growth	3.33%
2005 Household Income	$52,709
Estimated 2012 household income = 2005 household income x $(1.0333)^7$	= $66,310/yr
/ Full time hrs/yr	2080
= Income/hr	$31.88
x non-work/work value of time	50%
= Value of Travel Time	**$15.94/hr/person**

3.2 Truck Value of Time

Starting in 2007 and continuing with the 2012 data, the default values recommended for Microbencost included values of time for truck and cargo in addition to the driver's value of time. For the purpose of Microbencost, these values are all summed and entered as the driver's hourly wage because there are no separate inputs for truck and cargo time.

3.2.1 Truck Time

The time based costs for the truck only, include fixed costs such as licenses, administration, insurance and time related depreciation.

Industry practice is to combine time and distance depreciation. This amounts to 79% of the value of the original value of a tractor unit depreciated over 5 years (15.8%/yr) and 100% of the trailer over 8 years or about 12%/yr.

Section 2.2 presented the concept of separate time and distance related components of depreciation, identifying 72% of the initial price of the truck as subject to time related depreciation. This is applied in Exhibit 3-2 to the industry standard depreciation to derive the time based depreciation costs for combination and straight trucks. The combination truck assumes a 5 axle tractor trailer.

Exhibit 3-2 Time Related Depreciation

	Combination Truck	Straight Truck
Initial Cost		
Tractor Unit	$112,815	$85,063
Trailer	$29,425	$0
Total	$142,240	$85,063
Annual Depreciation Industry Standard		
Tractor	15.8%	15.8%
Trailer	12.0%	n/a
Portion of depreciation related to time	72%	72%
Annual Time Related Depreciation		
Tractor	$12,883	$9,714
Trailer	$2,552	n/a
Annual Hours		
Tractor	2600	2000
Trailer	1600	n/a
Time Related Depreciation ($/hr)		
Tractor	$4.96	$4.86
Trailer	$1.60	n/a
Total	$6.55	$4.86

In addition to time related depreciation, the other fixed costs of ownership including licenses, administration and insurance fees, are also considered a time based expense. They are allocated to hourly charges assuming the annual hours of utilization presented in Exhibit 3-2.

Finance charges and profits are excluded in social cost benefit analysis since they are a transfer, not a resource cost. If this were a financial analysis from a company perspective then they would be included.

For social cost benefit analysis, the total time based cost for trucks (excluding driver and cargo) is estimated in Exhibit 3-3.

Exhibit 3-3 Time Value of Truck

Combination Truck	$/hr
License & Registration	$3.23
Depreciation	$6.55
Admin	$10.78
Insurance	$3.23
Total	**$23.80**
Straight Truck	$/hr
license & Misc.	$1.07
Depreciation	$4.86
Admin	$10.66
Insurance	$3.20
Total	**$19.78**

3.2.2 Truck Cargo Time

Most logistics analyses today recognise the cost impact of supply chain interruptions on inventory and production. Generally these costs refer to large scale, unexpected delays such as air or marine port shutdowns or rail stoppages. These delays impose large macro scale costs which do not apply in the context of the shorter delays encountered in highway transport which typically includes delays due to congestion or short term highway closures.

This issue warrants further research in future editions of the benefit cost default values. In the interim, the value of cargo in transit is assumed to be the carrying cost of the inventory expressed as an hourly cost and using the social discount rate of 6%. The cargo time value proposed for analysis is presented in Exhibit 3-4 based on some typical payload values and load factors.

Exhibit 3-4 Time Value of Cargo

2012	Straight Truck	Combination
Payload Value	$5,000	$75,000
Load Factor	40%	65%
Average Payload Value	$2,000	$48,750
Discount Rate	6%	6%
Annual Inventory Cost	$120	$2,925
Hours/yr	8760	8760
Time Cost ($/hr)	**$0.01**	**$0.33**

The smaller payload value assumed for straight trucks reflects both the smaller payload and the lower unit value (many straight trucks carry low value construction material).

3.2.3 Truck Driver Time

History - The 1997 MBC default values of time for heavy trucks included the driver's wages plus a 25% wage burden yielding a total $25/hr for straight trucks and $28/hr for combination trucks. The comparable figures in the 2005 Trimac Report[10] were $25.42 for combination trucks for wage plus payroll burden and no figure was given for Straight Trucks. The 1997 wage was overstated, reflecting an error in the 1997 Trimac report used to define wages.

The figures for 2012 are taken from2011 estimates prepared by Barton[11] and adjusted to 2012 based on median income estimates.

Exhibit 3-5 Time Value of Driver

	Truck	Wage ($/hr)	Payroll Cost ($/hr)
Combination Trucks			
Bulk Commodity	5-Axle 6-Axle 7/8-Axle	$21.25 $22.75 $24.25	$26.56 $28.44 $30.31
General Commodity	5-Axle 6-Axle 7/8-Axle	$21.50 $23.00 $24.50	$26.88 $28.75 $30.63
Average 2010		$22.88	$28.59
Estimated Combination Truck 2012		$23.33	**$29.16**
Straight Trucks			**$26.25**

The payroll cost for straight trucks is assumed to be 90% of the payroll cost for combination vehicles or $26.25/hr for 2012.

10 "Operating Costs of Trucks in Canada - 2005" Prepared by Trimac Logistics Ltd., Calgary, AB. for Transport Canada, Economic Analysis Directorate, Ottawa, ON.
11 "OPERATING COSTS OF TRUCKING AND SURFACE INTERMODAL TRANSPORTATION IN CANADA", prepared for Transport Canada by Ray Barton and Associates In association with Logistics Solution Builders Inc. and The Research and Traffic Group, March 11, 2011

3.3 Summary of Time Values

Exhibit 3-6 summarizes the default values of time for use in Microbencost. The Microbencost model has no provision for separate driver, truck or cargo time values. The values must be added together and entered as the driver's value of time. The values in bold print in Exhibit 3-6 can be used. The only proviso is that, **vehicle occupancy for trucks must be left at the default value of 1.0** in order to avoid double counting the time based vehicle or cargo costs. This is the normal default value in any case so the analyst does not have to make any changes to the default values.

The same values are assumed for urban and rural (Microbencost inputs require both). In economic analysis the main difference between urban and rural trucking is accounted for in the percentage of straight and combination trucks rather than any difference in their operating costs.

Exhibit 3-6 Default Values of Time for Microbencost

	2012
Auto	$/person-hr
Urban	**$15.94**
Rural	**$15.94**
2/3 axle Straight Truck	$/Truck-hr
Driver	$26.25
Truck Time	$19.78
Cargo	$0.01
Total	**$46.03**
Combination Truck	$/Truck-hr
Driver	$29.16
Truck Time	$23.80
Cargo	$0.33
Total	**$53.30**

4 Safety

4.1 Collision Costs

History - Collision costs used for economic analysis in BC were originally developed in 1992 by Ted Miller of the Urban Institute for BC MoTH[12]. These were adjusted downward by one standard deviation for fatal collisions by MoTH Highway Safety Branch and then rounded off for use in economic analysis. The 1997 values were generated by taking the 1992 Miller values at a 4% discount rate and factoring them up using the CPI (1992 to 1997) of 1.09. In this case, the unit cost for fatal collisions was not adjusted downward as the Highway Safety Branch had done in 1992.

Exhibit 4-1 Historical Collision Costs

	Miller for MoTH 1992		Highway Safety Branch 1992	1997	2003	2007
	8% discount rate	4% discount rate				
Fatal	$3,870,324	$3,824,738	$2,900,000	$4,170,000	$5,693,954	$6,063,419
Injury	$101,695	$89,061	$100,000	$97,000	$128,580	$134,824
PDO	$5,974	$5,516	$6,000	$6,000	$7,342	$7,759

The 2003 values are based on collision costs derived by the US National Safety Council[13] in 2002 and converted to Canadian values using the Canadian Dollar equivalent of the time of $1.37 CDN=$1.00 US. In hindsight, this exchange likely overestimates the collision costs used in BC. The 2007 default values were derived from the latest (2005) National Safety Council figures[14] and converted to Canadian dollars using a 30 year (1977 to 2007) average exchange rate of $1.30 CDN = $1.00 US.

[12] Miller T.R. "Crash Costs for British Columbia, Contract034535" Letter from Ted Miller to Ross Harris, Planning Service Branch, BC MoTH, Victoria BC, 19 Feb, 1992.
[13] Mei-Li Lin, et al.,"Injury Facts" annual report prepared by the US National Safety Council, Itasca Il., 2002
[14] Mei-Li Lin, et al., "Injury Facts 2007 Edition", annual report prepared by the US National Safety Council, Itasca Il., 2007

The 2012 default values continue to use the 2012 edition of the US National Safety Council figures for economic and comprehensive collision costs[15] for fatal and injury collisions (Exhibit 4-2). The NSC values are well supported in the US but the conversion to Canadian values is somewhat arbitrary depending on exchange rates. The approach has been to use a 20 year average exchange rate. The values have been modified slightly to account for different severity data from BC Provincial collision statistics. It is recommended that we adopt a "made in BC" value for collision costs.

The average cost of a fatal or injury collision in 2012 is only modestly higher than 2007 due to the impact of declining 20 year average exchange rate differential (2007 = $1.30 and 2012 = $1.24). The value estimated for injury collisions in 2012 is $135,577 but the value used for the Microbencost model remains $99,999 since this is the largest number the model allows for an injury collision.

The 2012 PDO collision cost is 46% greater than the 2007 value. The 2007 value was CPI adjusted from the original 1992 claims based cost of PDO collisions. The current figure is derived from work by DeLeur in Alberta which looked extensively at the direct costs of crashes including other factors beyond simply the insurance claim cost.

[15] "Injury Facts 2012 Edition" US National Safety Council, Itasca, Illinois, 2012

Exhibit 4-2 2012 Collision Cost Calculations

2012		NSC Unit Cost (2010 US $)	CPI Adjusted Cost (2012 US $)	Unit Cost (CDN$) $1.24/US$	2012 Number /Crash	Cost	Used for Economic Analysis*
Fatal Crash							
Economic Cost		$1,150,000	$1,202,318	$1,495,435			
Quality of Life		$3,210,000	$3,356,034	$4,174,214			
Comprehensive Fatal Cost		$4,360,000	$4,558,352	$5,669,648	1.11	$6,273,261	
incapacitating injury in a fatality crash		$220,300	$230,322	$286,473	0.39	$112,738	
Total cost/fatal crash						$6,385,999	**$6,385,999**
Non-fatal injury crash	Assumed %						
Incapacitating Injury	11%	$220,300	$230,322				
Non-incapacitating evident injury	70%	$56,200	$58,757				
Possible injury	19%	$26,700	$27,915				
Weighted Average		$69,507	$72,669	$90,385	1.50	$135,577	**$135,577**
Property damage only crash				$11,367	1	$11,367	**$11,367**

The 2010 US figures were adjusted to 2012 Canada using the CPI and the 20 year average exchange rate ($1 USD = $1.24 CDN). The number of injuries and deaths per crash were derived from 2012 ICBC data[16] and used to convert cost per victim to cost per crash. The National Safety Council injury costs are segregated into 3 injury categories and allocated to the 2 ICBC categories "serious" and "minor" injury. "Serious" is assumed to equate to the NSC "incapacitating injury" and the ICBC "minor" injuries are allocated to the NSC "non-incapacitating" and "possible" injury categories. The unit cost for PDO crashes is derived from work by Deleur in Alberta which looked extensively at the direct costs of collisions.

** In Microbencost, the maximum value that can be input for Injury collisions is $99,999 so it will understate collision costs somewhat.*

[16] "Quick Statistics" ICBC Business Information Warehouse, August 2012

4.2 Collision Rates and Severity

The default collision rates and severity are based on Provincial data prepared by MoTI for 2006 to 2010. These are collated separately for highway sections and signalized intersections and non-signalized intersections. Highway sections collision data are further disaggregated according to their operational class (RAU2, RAU4 etc).

The Provincial collision rates for all RFD4 and UFD4 and most UED4, RED4, and RAD4 roadways are calculated using separate AADT (Average Annual Daily Traffic) for each direction of travel. Theses have been adjusted here to reflect 2-way traffic consistent with Microbencost inputs.

Section and intersection collision rates are presented here as a function of AADT and were smoothed to remove some inconsistencies due to the natural variation in observed Provincial data. This also makes it possible to translate the BC data, expressed in 5,000 AADT increments, into the different increments used in Microbencost.

4.2.1 Highway Sections

For highway sections, the smoothed Provincial collision rates follow a negative exponential curve as AADT increases, approximated as:

$$AR_{AADT} = AVG \times \left(A + B \times e^{C \times AADT/10{,}000}\right)$$

Where:

AR_{AADT} =	The section collision rate (a/mvk) for a given service class and AADT.			
AADT =	Average 2-way annual daily traffic of the highway section (including freeways)			
AVG =	The average section collision rate (a/mvk) for a given service class.			
e =	2.718282			
	A	B	C	AVG
UAU2	0.17	2.10	-1.20	0.18
UAU4	0.90	5.00	-3.00	0.10
UAD4	0.95	5.00	-3.00	0.05
UED4	0.60	4.00	-0.50	0.10
UFD4	0.95	0.80	-0.30	0.29
RAU2	0.15	1.25	-1.10	0.31
RAU4	0.60	3.80	-1.60	0.12
RAD4	0.60	2.00	-0.50	0.12
RFD4	0.75	1.30	-0.80	0.27

The section collision rate (excluding intersections) on an RAU2 highway with 5,000 AADT for example, would be:

$$AR_{5,000} = .31 \times \left(.15 + 1.25 \times e^{-1.1 \times 5{,}000/10{,}000}\right) = .27 acc/mvk$$

The smoothed urban and rural collision rates are presented graphically in Exhibit 4-3 and Exhibit 4-4 layered on the Provincial data.

Exhibit 4-3 Collision Rates on Urban Sections

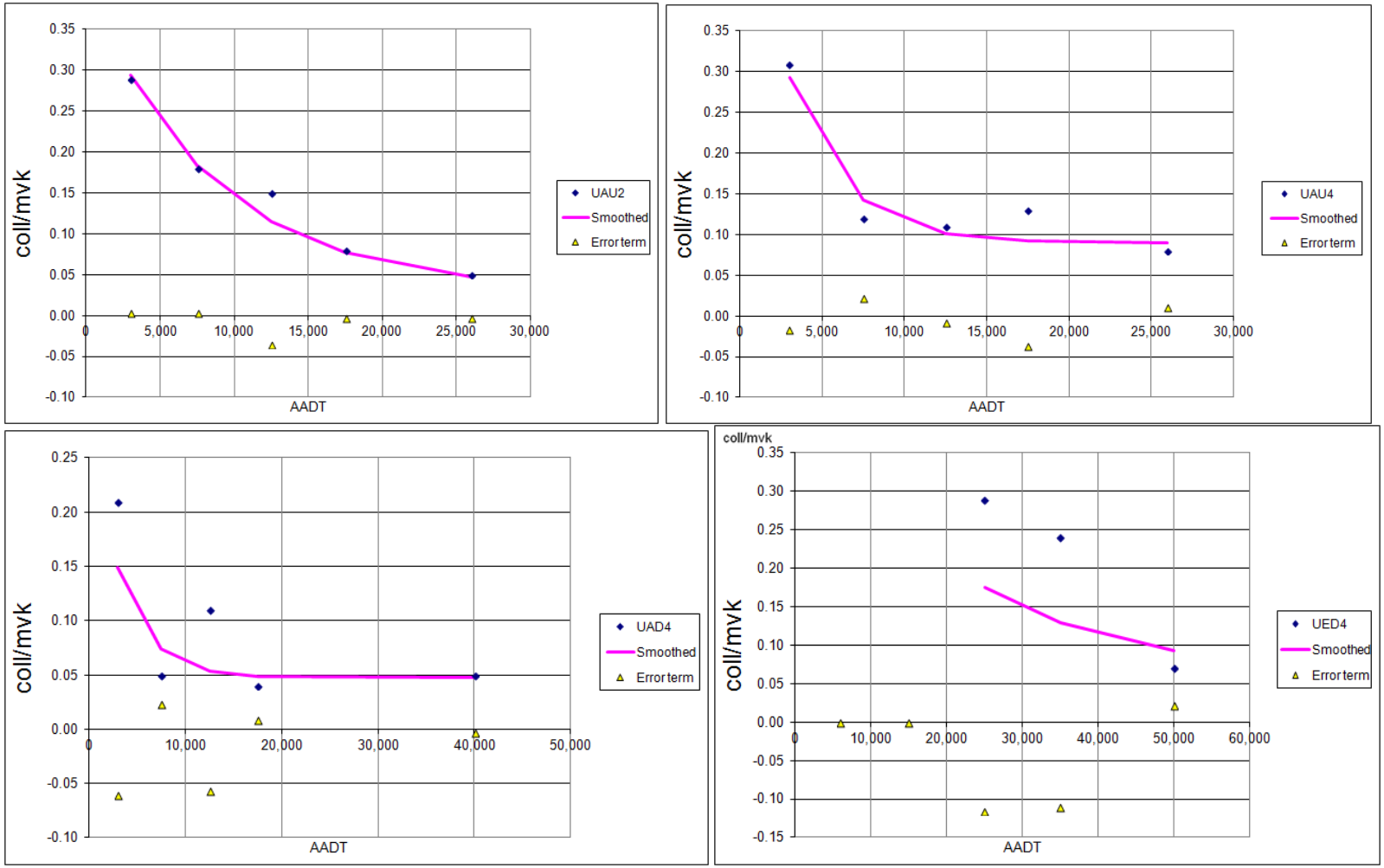
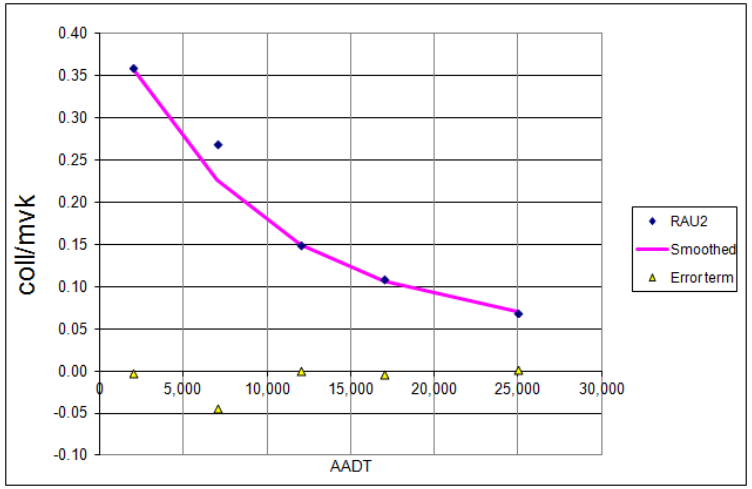
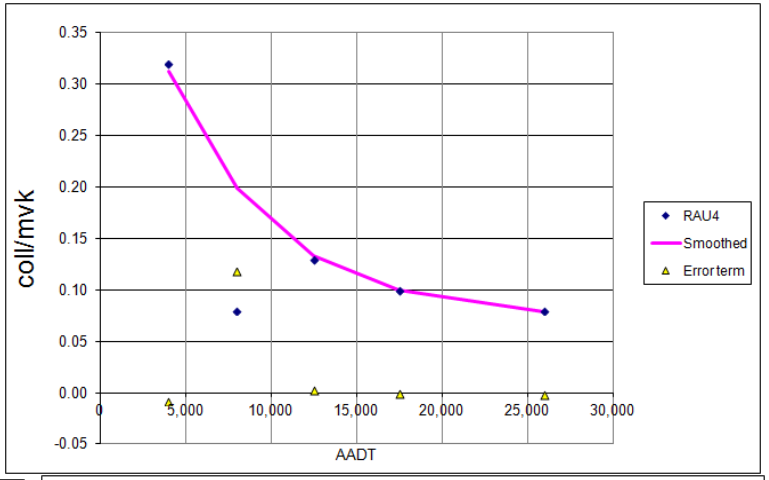
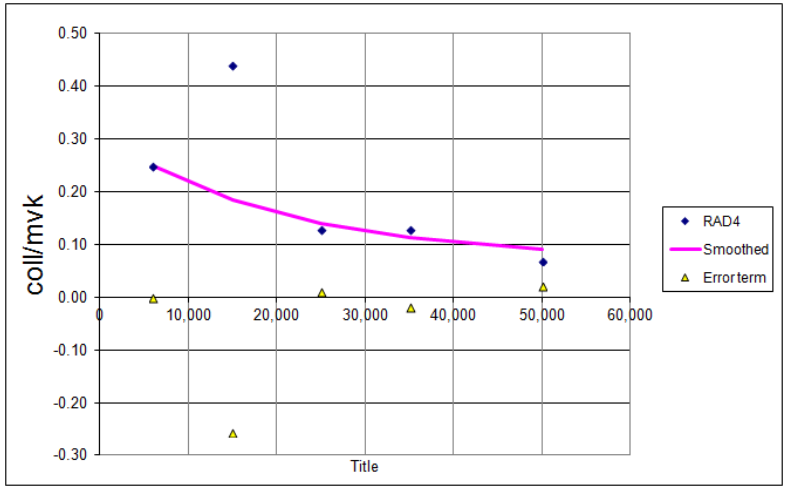
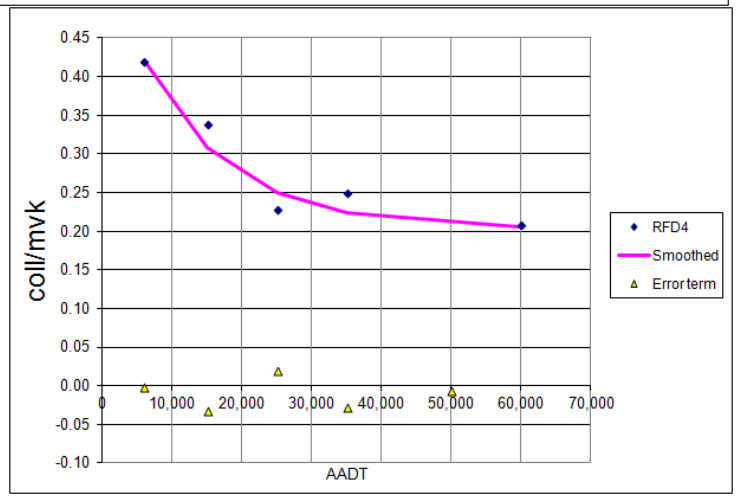


Exhibit 4-4 Collision Rates on Rural Sections









4.2.2 Highway Intersections

The collision rates for **Highway Intersections** derived from Provincial Data 2006-2010, is disaggregated by highway type, stop or signal and urban or rural. The inputs for Microbencost do not distinguish between highway types and so the data is aggregated only with respect to stop/signal and urban/rural as shown below.

The collision rate at **stop controlled intersections** is modeled as:

$$AR_{AADT} = A \times AADT^2 + B \times AADT + C$$

Where:

	Urban Stop	Rural Stop
A	1.10E-09	6.00E-10
B	-3.60E-05	-2.20E-05
C	0.45	0.45

And for **signalized intersections** is modeled as:

$$AR_{AADT} = A + B \times e^{C \times AADT/10{,}000}$$

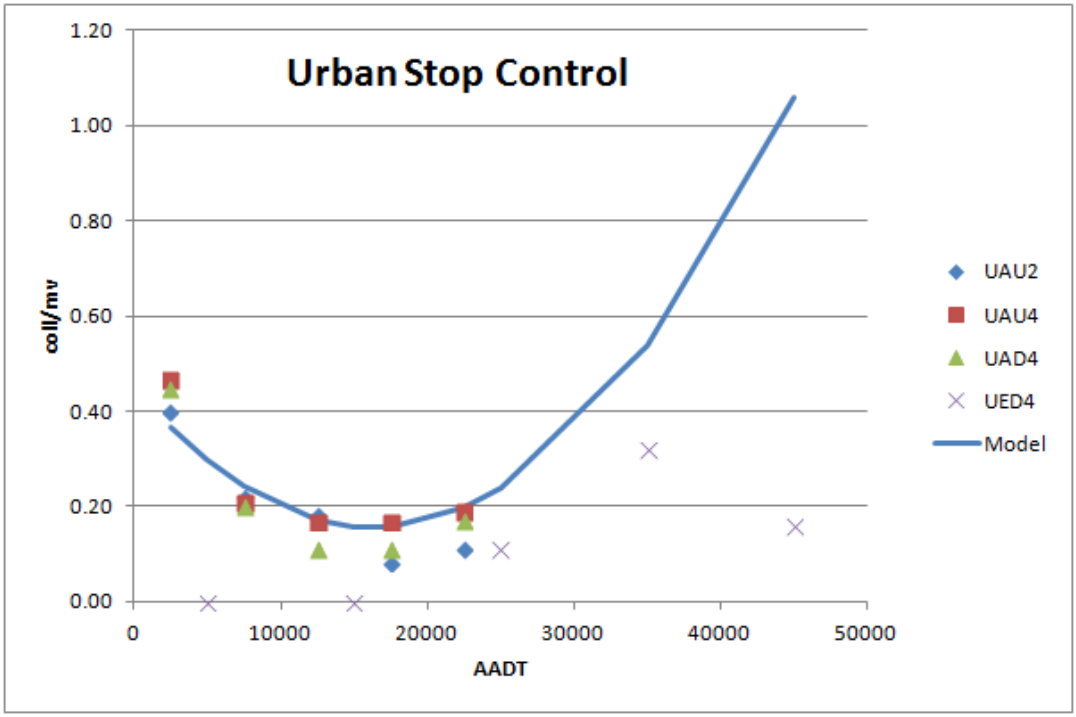
Where:

	Urban Signal	Rural Signal
A	3.60E-01	4.00E-01
B	9.00E-01	4.00E-01
C	-2.7	-1.5

Similar to the section rates, the intersection collision rates are presented as a function of AADT so as to translate the BC data, expressed in 5,000 AADT increments, into the different increments used in Microbencost.

The smoothed Stop and Signal controlled collision rates are presented graphically in Exhibit 4-5 and Exhibit 4-6 layered on the Provincial data.
. Collision rates and severity proposed for the Microbencost defaults are presented in Appendix A.

Exhibit 4-5 Stop Controlled Intersections



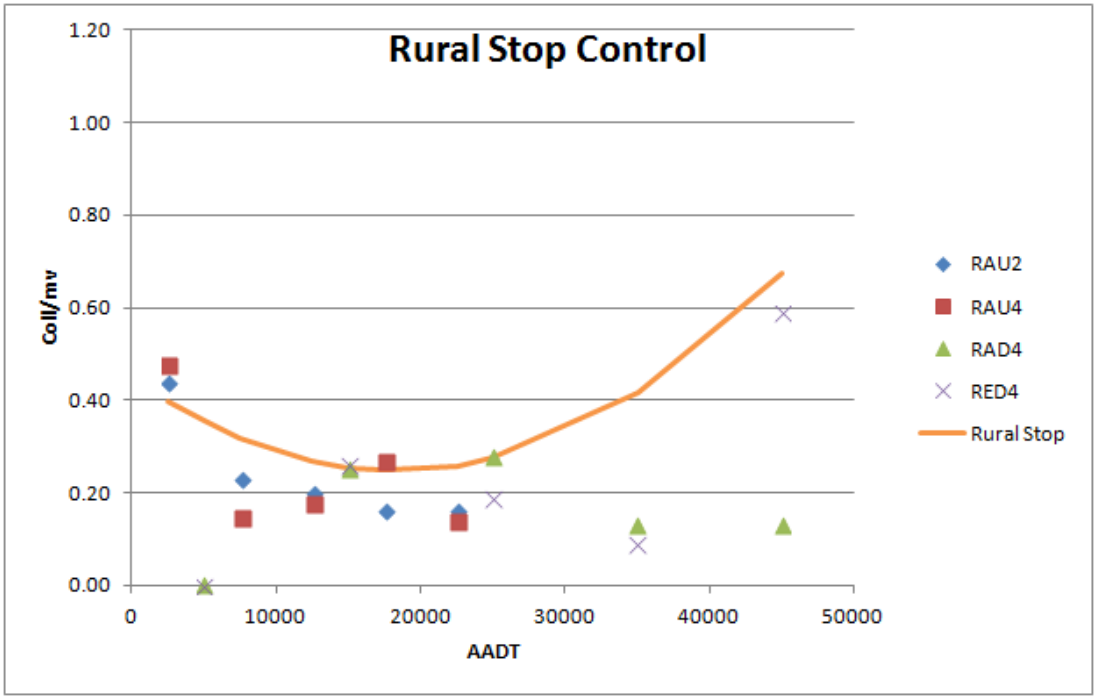
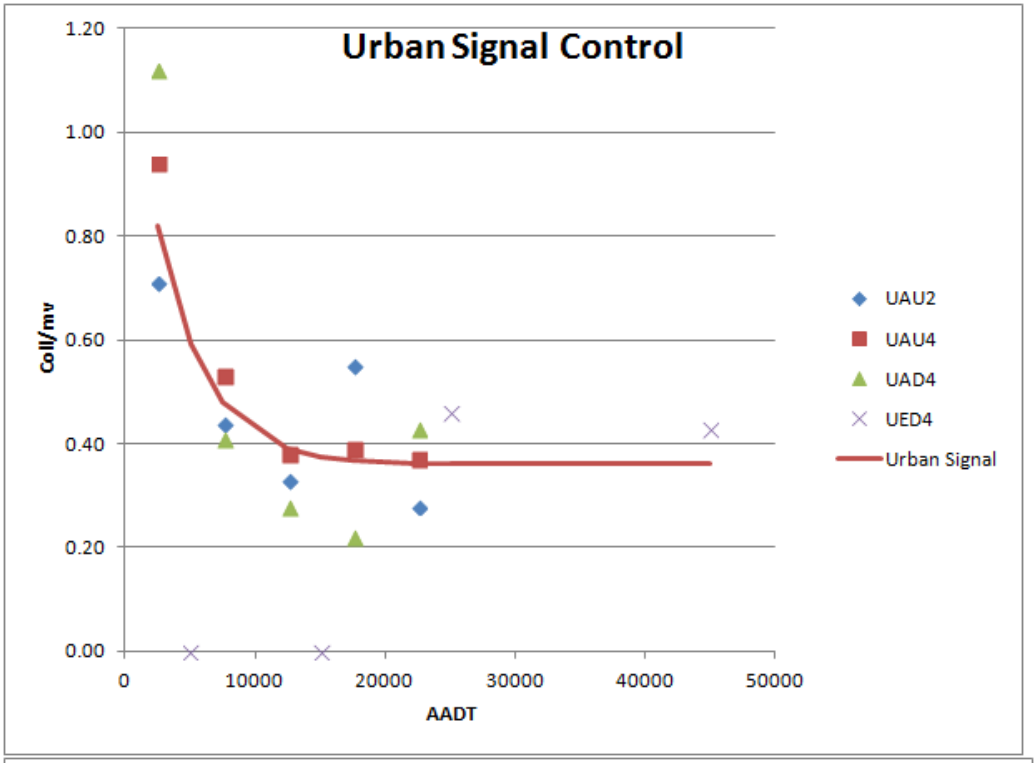
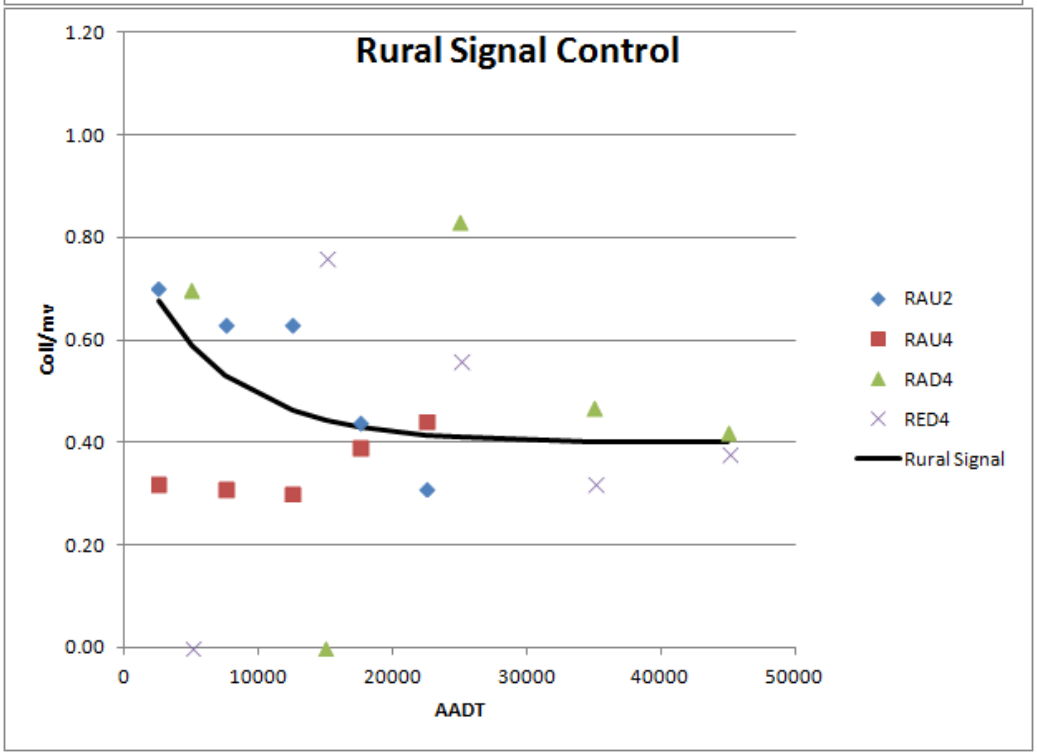


Exhibit 4-6 Signal Controlled Intersections





5 Financial

5.1 Annual Maintenance Costs

The 2002/2003 maintenance contract costs were $334.9 million for 84,415 lane-km of highway, equivalent to $3,967/lane-km. 2006 data was $300.5 million for 84,415 lane-km or $3,560 per lane-km. The 2012 default annual maintenance cost is **$3,839/Lane-km** ($5,910/Lane-mile) for roads and **$19.87/sq.m.** for bridges based on the Provincial statistics below:

Road Mtce Estimate	$336,200,000	$/yr
Lane km in Provincial jurisdiction	91,575	Lane-km
Road Maintenance Cost	$3,671	$/Ln-km
Est. Annual Line Painting cost	$168	$/Ln-km
Total Road Maintenance Cost	**$3,839**	$/Ln-km
Annual Bridge Maintenance	$33,800,000	$/yr
Total Bridge Deck	1,701,004	m2
Bridge Maintenance Cost	**$19.87**	$/m2/yr

New in the 2012 figures is the allowance for line painting.

5.2 Resurfacing Costs

Typical Values for BC are shown below. The low range represents of areas in Region 2 and around Prince George. The high range reflects projects in the Lower Mainland where night time work is required. The default value is $70,000/Ln-km ($112,700/Ln-mi).

	Resurfacing Cost ($/Lane-km)			
Treatment	Low	High	Average	Life (years)
Mill and fill/Overlay	$110,000	$150,000	$130,000	15+
Hot In Place	$50,000	$65,000	$57,500	9 to 11
Seal Coat	$20,000	$25,000	$22,500	3 to 7

Bridge Deck Resurfacing is estimated at using a default value of $500/m2 every 30 years.

5.3 Project Cost Categories

The default project cost categories were not changed. Given a total cost, MBC applies a default breakdown of total cost for 5 cost categories, 7 different project types and urban or rural areas. Service life and residual value is calculated separately for each category.

If a cost estimate is available for a project which has the costs broken down, then this can be used, otherwise the defaults are a good estimate of cost breakdown.

Appendix A

Default BC Provincial Section Collision Rate for Microbencost

BC MoT Classification	
	RAU2
MBC Classification	
Area Type	Rural
Access Control	N/A
Lanes	<4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	1.10	32.39	2.27	35.75
4,000	0.91	26.82	1.88	29.61
8,000	0.64	18.77	1.31	20.72
16,000	0.35	10.25	0.72	11.32
24,000	0.23	6.72	0.47	7.42
36,000	0.17	4.88	0.34	5.39
58,000	0.14	4.27	0.30	4.72
75,000	0.14	4.22	0.30	4.66
75,000	0.14	4.22	0.30	4.66

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.76	52.14	3.65	57.55
4,000	1.46	43.18	3.02	47.67
8,000	1.02	30.23	2.11	33.36
16,000	0.56	16.51	1.15	18.22
24,000	0.37	10.82	0.76	11.94
36,000	0.27	7.86	0.55	8.68
58,000	0.23	6.88	0.48	7.59
75,000	0.23	6.80	0.48	7.50
75,000	0.23	6.80	0.48	7.50

BC MoT Classification	
	RFD4
MBC Classification	
Area Type	Rural
Access Control	Full
Lanes	>=4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.712	20.68	28.77	50.16
4,000	0.649	18.85	26.24	45.74
8,000	0.550	15.98	22.23	38.76
16,000	0.426	12.37	17.21	30.01
24,000	0.360	10.47	14.57	25.40
36,000	0.315	9.16	12.75	22.22
58,000	0.292	8.49	11.81	20.59
75,000	0.289	8.38	11.67	20.34
75,000	0.289	8.38	11.67	20.34

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.15	33.29	46.33	80.76
4,000	1.04	30.35	42.24	73.64
8,000	0.89	25.72	35.79	62.40
16,000	0.69	19.91	27.71	48.31
24,000	0.58	16.85	23.45	40.89
36,000	0.51	14.75	20.52	35.77
58,000	0.47	13.66	19.01	33.15
75,000	0.46	13.50	18.78	32.74
75,000	0.46	13.50	18.78	32.74

BC MoT Classification	RAD4
MBC Classification	
Area Type	Rural
Access Control	Partial
Lanes	>=4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.546	10.76	17.61	28.92
4,000	0.507	9.99	16.35	26.85
8,000	0.440	8.67	14.18	23.29
16,000	0.340	6.69	10.95	17.98
24,000	0.273	5.37	8.79	14.43
36,000	0.211	4.16	6.80	11.17
58,000	0.161	3.17	5.19	8.52
75,000	0.147	2.89	4.73	7.76
75,000	0.147	2.89	4.73	7.76

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	0.88	17.32	28.35	46.55
4,000	0.82	16.08	26.33	43.23
8,000	0.71	13.95	22.83	37.49
16,000	0.55	10.77	17.63	28.95
24,000	0.44	8.64	14.15	23.23
36,000	0.34	6.69	10.95	17.98
58,000	0.26	5.10	8.35	13.72
75,000	0.24	4.65	7.61	12.50
75,000	0.24	4.65	7.61	12.50

BC MoT Classification	
	RAD4
MBC Classification	
Area Type	Rural
Access Control	None
Lanes	>=4
Median	>0

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.546	10.76	17.61	28.92
4,000	0.507	9.99	16.35	26.85
8,000	0.440	8.67	14.18	23.29
16,000	0.340	6.69	10.95	17.98
24,000	0.273	5.37	8.79	14.43
36,000	0.211	4.16	6.80	11.17
58,000	0.161	3.17	5.19	8.52
75,000	0.147	2.89	4.73	7.76
75,000	0.147	2.89	4.73	7.76

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	0.88	17.32	28.35	46.55
4,000	0.82	16.08	26.33	43.23
8,000	0.71	13.95	22.83	37.49
16,000	0.55	10.77	17.63	28.95
24,000	0.44	8.64	14.15	23.23
36,000	0.34	6.69	10.95	17.98
58,000	0.26	5.10	8.35	13.72
75,000	0.24	4.65	7.61	12.50
75,000	0.24	4.65	7.61	12.50

BC MoT Classification	RAU4
MBC Classification	
Area Type	Rural
Access Control	None
Lanes	>=4
Median	=0

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	2.094	16.01	22.21	40.31
4,000	1.623	12.41	17.22	31.24
8,000	1.033	7.89	10.95	19.88
16,000	0.557	4.26	5.91	10.73
24,000	0.425	3.25	4.51	8.18
36,000	0.381	2.92	4.05	7.34
58,000	0.374	2.86	3.97	7.20
75,000	0.374	2.86	3.97	7.20
75,000	0.374	2.86	3.97	7.20

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	3.37	25.77	35.76	64.90
4,000	2.61	19.97	27.72	50.30
8,000	1.66	12.71	17.64	32.00
16,000	0.90	6.86	9.51	17.27
24,000	0.68	5.23	7.26	13.17
36,000	0.61	4.69	6.51	11.82
58,000	0.60	4.61	6.39	11.60
75,000	0.60	4.60	6.39	11.59
75,000	0.60	4.60	6.39	11.59

BC MoT Classification	
	UAU2
MBC Classification	
Area Type	Urban
Access Control	N/A
Lanes	<4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.662	12.57	19.56	32.79
4,000	0.534	10.14	15.78	26.45
8,000	0.354	6.72	10.46	17.53
16,000	0.174	3.30	5.13	8.60
24,000	0.105	1.99	3.09	5.18
36,000	0.072	1.37	2.13	3.56
58,000	0.062	1.19	1.85	3.10
75,000	0.062	1.17	1.83	3.06
75,000	0.062	1.17	1.83	3.06

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.07	20.24	31.49	52.80
4,000	0.86	16.32	25.40	42.58
8,000	0.57	10.82	16.84	28.23
16,000	0.28	5.31	8.26	13.85
24,000	0.17	3.20	4.98	8.34
36,000	0.12	2.20	3.42	5.74
58,000	0.10	1.91	2.97	4.98
75,000	0.10	1.89	2.94	4.93
75,000	0.10	1.89	2.94	4.93

BC MoT Classification	
	UFD4
MBC Classification	
Area Type	Urban
Access Control	Full
Lanes	4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.208	16.66	32.53	49.40
4,000	0.202	16.23	31.69	48.13
8,000	0.192	15.45	30.16	45.80
16,000	0.176	14.14	27.59	41.91
24,000	0.163	13.10	25.58	38.84
36,000	0.149	11.95	23.33	35.43
58,000	0.133	10.67	20.82	31.62
75,000	0.126	10.12	19.75	30.00
75,000	0.126	10.12	19.75	30.00

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	0.33	26.83	52.37	79.53
4,000	0.33	26.14	51.02	77.48
8,000	0.31	24.87	48.55	73.74
16,000	0.28	22.76	44.43	67.47
24,000	0.26	21.10	41.18	62.54
36,000	0.24	19.24	37.56	57.04
58,000	0.21	17.17	33.52	50.91
75,000	0.20	16.29	31.80	48.29
75,000	0.20	16.29	31.80	48.29

BC MoT Classification	
	UFD4
MBC Classification	
Area Type	Urban
Access Control	Full
Lanes	>4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.208	16.66	32.53	49.40
4,000	0.202	16.23	31.69	48.13
8,000	0.192	15.45	30.16	45.80
16,000	0.176	14.14	27.59	41.91
24,000	0.163	13.10	25.58	38.84
36,000	0.149	11.95	23.33	35.43
58,000	0.133	10.67	20.82	31.62
75,000	0.126	10.12	19.75	30.00
75,000	0.126	10.12	19.75	30.00

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	0.33	26.83	52.37	79.53
4,000	0.33	26.14	51.02	77.48
8,000	0.31	24.87	48.55	73.74
16,000	0.28	22.76	44.43	67.47
24,000	0.26	21.10	41.18	62.54
36,000	0.24	19.24	37.56	57.04
58,000	0.21	17.17	33.52	50.91
75,000	0.20	16.29	31.80	48.29
75,000	0.20	16.29	31.80	48.29

BC MoT Classification	
	UED4
MBC Classification	
Area Type	Urban
Access Control	Partial
Lanes	4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.866	15.10	26.23	42.19
4,000	0.795	13.86	24.09	38.75
8,000	0.674	11.74	20.40	32.81
16,000	0.492	8.58	14.90	23.97
24,000	0.370	6.46	11.22	18.05
36,000	0.259	4.51	7.84	12.61
58,000	0.168	2.93	5.10	8.20
75,000	0.142	2.48	4.32	6.94
75,000	0.142	2.48	4.32	6.94

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.39	24.30	42.23	67.93
4,000	1.28	22.32	38.79	62.39
8,000	1.08	18.90	32.84	52.83
16,000	0.79	13.81	24.00	38.60
24,000	0.60	10.40	18.06	29.06
36,000	0.42	7.26	12.62	20.31
58,000	0.27	4.72	8.21	13.20
75,000	0.23	4.00	6.95	11.17
75,000	0.23	4.00	6.95	11.17

BC MoT Classification	
	UED4
MBC Classification	
Area Type	Urban
Access Control	Partial
Lanes	>4
Median	N/A

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.866	15.10	26.23	42.19
4,000	0.795	13.86	24.09	38.75
8,000	0.674	11.74	20.40	32.81
16,000	0.492	8.58	14.90	23.97
24,000	0.370	6.46	11.22	18.05
36,000	0.259	4.51	7.84	12.61
58,000	0.168	2.93	5.10	8.20
75,000	0.142	2.48	4.32	6.94
75,000	0.142	2.48	4.32	6.94

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.39	24.30	42.23	67.93
4,000	1.28	22.32	38.79	62.39
8,000	1.08	18.90	32.84	52.83
16,000	0.79	13.81	24.00	38.60
24,000	0.60	10.40	18.06	29.06
36,000	0.42	7.26	12.62	20.31
58,000	0.27	4.72	8.21	13.20
75,000	0.23	4.00	6.95	11.17
75,000	0.23	4.00	6.95	11.17

BC MoT Classification	
	UAD4
MBC Classification	
Area Type	Urban
Access Control	None
Lanes	>=4
Median	>0

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.637	7.43	10.40	18.47
4,000	0.423	4.94	6.92	12.28
8,000	0.242	2.82	3.95	7.02
16,000	0.171	1.99	2.79	4.96
24,000	0.164	1.92	2.69	4.77
36,000	0.164	1.91	2.68	4.75
58,000	0.164	1.91	2.68	4.75
75,000	0.164	1.91	2.68	4.75
75,000	0.164	1.91	2.68	4.75

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.03	11.96	16.75	29.74
4,000	0.68	7.95	11.14	19.77
8,000	0.39	4.55	6.36	11.30
16,000	0.28	3.21	4.49	7.98
24,000	0.26	3.09	4.32	7.68
36,000	0.26	3.08	4.31	7.65
58,000	0.26	3.08	4.31	7.65
75,000	0.26	3.08	4.31	7.65
75,000	0.26	3.08	4.31	7.65

BC MoT Classification	
	UAU4
MBC Classification	
Area Type	Urban
Access Control	None
Lanes	>=4
Median	=0

AADT	Fat	Inj	PDO	All
		acc/100mvk		
2,000	0.656	12.93	22.86	36.44
4,000	0.433	8.54	15.09	24.06
8,000	0.244	4.80	8.49	13.54
16,000	0.169	3.34	5.90	9.41
24,000	0.163	3.21	5.67	9.04
36,000	0.162	3.19	5.65	9.00
58,000	0.162	3.19	5.65	9.00
75,000	0.162	3.19	5.65	9.00
75,000	0.162	3.19	5.65	9.00

AADT	Fat	Inj	PDO	All
		acc/100mvm		
2,000	1.06	20.81	36.80	58.67
4,000	0.70	13.74	24.30	38.74
8,000	0.39	7.73	13.67	21.79
16,000	0.27	5.38	9.50	15.15
24,000	0.26	5.16	9.13	14.55
36,000	0.26	5.14	9.09	14.49
58,000	0.26	5.14	9.09	14.49
75,000	0.26	5.14	9.09	14.49
75,000	0.26	5.14	9.09	14.49

Appendix B

Default Signalized and Stop Controlled Intersection Collision Rates for Microbencost

Urban
Stop Control
coll/100mv

AADT Range	Fat	Inj	PDO	All
0-1,999	0.63	15.47	33.7	41.5
2,000-3,999	0.51	13.26	28.4	35.2
4,000-7,999	0.36	10.47	21.9	27.4
8,000-15,999	0.19	6.96	13.9	17.6
16,000-23,999	0.13	6.98	13.2	17.0
24,000-35,999	0.13	15.51	27.1	36.0
36,000-57,999	0.43	51.16	89.52	118.8
58,000-75,999	1.07	128.17	224.26	297.6
80,000+	2.20	263.59	461.20	612.0

Urban
Signal
coll/100mv

AADT Range	Fat	Inj	PDO	All
0-1,999	1.64	37.07	66.0	104.7
2,000-3,999	1.24	27.68	47.2	76.0
4,000-7,999	0.93	20.39	32.6	53.8
8,000-15,999	0.75	16.17	22.8	39.5
16,000-23,999	0.78	16.35	19.5	36.4
24,000-35,999	0.88	17.98	17.5	36.0
36,000-57,999	1.06	21.02	14.4	36.0
58,000-75,999	1.28	24.62	10.8	36.0
80,000+	1.53	28.76	6.7	36.0

Rural
Stop Control
coll/100mv

AADT Range	Fat	Inj	PDO	All
0-1,999	1.04	17.56	24.3	42.9
2,000-3,999	0.93	16.03	22.0	38.9
4,000-7,999	0.79	14.08	19.1	34.0
8,000-15,999	0.60	11.46	15.1	27.2
16,000-23,999	0.51	10.72	13.7	25.0
24,000-35,999	0.61	14.48	17.8	33.0
36,000-57,999	1.12	33.79	38.9	74.1
58,000-75,999	1.85	79.41	84.6	166.9
80,000+	2.16	166.07	161.8	333.0

Rural
Signal
coll/100mv

AADT Range	Fat	Inj	PDO	All
0-1,999	0.69	35.73	38.0	74.4
2,000-3,999	0.61	31.38	33.5	65.5
4,000-7,999	0.53	26.87	28.9	56.3
8,000-15,999	0.44	22.12	24.1	46.6
16,000-23,999	0.41	19.76	21.8	42.0
24,000-35,999	0.40	18.83	21.2	40.4
36,000-57,999	0.41	18.30	21.4	40.0
58,000-75,999	0.43	17.88	21.7	40.0
80,000+	0.44	17.42	22.2	40.0