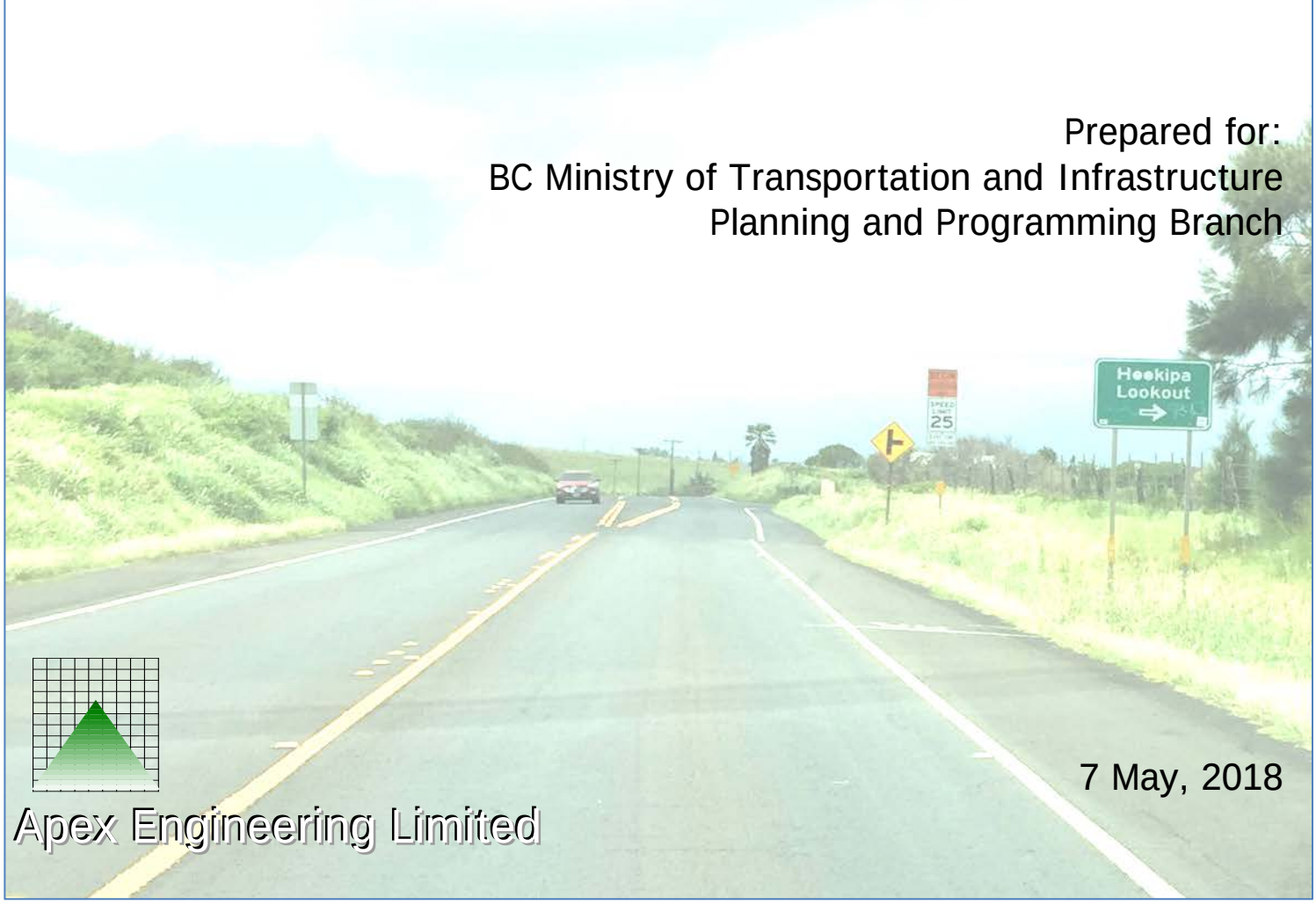
Default Values for Benefit Cost Analysis In British Columbia 2018

Prepared for:
BC Ministry of Transportation and Infrastructure
Planning and Programming Branch



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1 Background

This edition updates the default values used for benefit cost analysis in British Columbia from 2012 to 2018 values.

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, 2012 and currently with the 2018 edition.

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 included:

- Gasoline prices 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

2018 edition – The table below highlights changes from the 2012 defaults:

- Default values for Microbencost were discontinued.
- Road maintenance and resurfacing costs have increased
- Injury costs have gone up as a result of switching to "made in Canada" collision costs and with inflation
- Gasoline prices increased 13% and diesel declined 4% since 2012
- Truck Driver time has increased
- Truck vehicle time cost ($/hr) has decreased due to greater truck utilization
- Truck vehicle distance cost ($/km) has increased

	2012	2018
Road Maintenance ($/Ln-km/yr)	$3,839	$5,099
Mill and Fill Overlay ($/Ln-km)	$65,000	$100,000
Value of Time ($/auto occupant)	$15.94	$18.49
Truck Driver Payroll Cost($/veh)	$29.16	$31.25
Cost/Collision		
Fatal	$6,385,999	$8,087,204
Injury	$135,577	$302,636
PDO	$11,367	$13,518
Fuel Price ($/L) excl. taxes		
Car	0.898	$1.014
Composite Truck	0.978	$0.942
Other Vehicle Costs		
Car ($/km)	$0.113	$0.135
Truck Time ($/hr)	$19.78	$14.65
Truck Distance ($/km)	$0.213	$0.257

Future editions – Potential improvements include:

- 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.
- Review of collision costs to confirm values used for analysis in Canada.

2 Auto Operating Costs

2.1 General Assumptions

In social benefit cost, normal practice is to include auto costs directly related to the distance driven (use related depreciation, tires, fuel and maintenance and repairs) and to exclude transfers or fixed costs. Transfer payments such as taxes, tolls or interest are excluded on the basis that they move resources from one sector of society to another but do not consume them.

Fixed costs are excluded on the basis that they are considered sunk costs under the current model of private car ownership and cannot be recovered by driving more or less distance. Fixed automobile costs include time related depreciation, insurance, licenses and registration. Time related depreciation is that portion of an automobiles market price that is attributable to age of the vehicle and independent of the kilometers on the vehicle.

2.2 Auto Use Related Depreciation

Depreciation in the value of an automobile is attributable to both time and distance. General practice is to use only the use (distance) related component in benefit cost analysis. The representative use related depreciation rate expressed as $/km was derived based on a regression of advertised price versus age and kilometers[1] for three representative model types below. The composite value reflects a weighted average of the assumed fleet mix.

% of Fleet	Category	Representative Vehicle	km/yr	$/yr	$/km
20%	Compact	Honda Civic	16,160	$634	$0.0433
40%	Mid Size	Toyota Camry	13,426	$918	$0.0409
40%	SUV	GMC Acadia	19,583	$1,885	$0.0615
		Weighted Avg	16,390	$1,248	$0.0496

[1] Autotrader.ca accessed April 2018

2.3 Tires

The following passenger vehicle tire prices were used to represent each vehicle category[2].

Veh. Category	Compact	Mid-Size	SUV	Composite Vehicle
% of Fleet	20%	40%	40%	100%
Brand	Pirelli	Pirelli	BFGoodrich	
Model	all season P175/65R14	all season P225/60R16	P265/70R17	
Qty	4	4	4	
Per Tire	$108	$146	$239	$176
Per Vehicle	$432	$584	$955	$702
Tire Life	100,000	100,000	100,000	
$/km	$0.0043	$0.0058	$0.0096	$0.0070

[2] Published Prices Canadian Tire April, 2018

2.4 Auto Maintenance and Repair

These costs are taken from the Canadian Automobile Association's 2018 Vehicle Operating Cost Calculator[3] using the input assumptions listed below. The average fleet age is now about 11 years in the United States[4] but the oldest model year available in the CAA model is 2010. The maintenance costs exclude tires.

Category	Compact	Mid-Size	SUV	Composite
% of Fleet	20%	40%	40%	100%
Make	Honda	Toyota	GMC	
Model	Civic	Camry	Acadia	
Province	BC	BC	BC	
Model Year	2010	2010	2010	
Odometer	100,000	100,000	100,000	
Highway/City	55%/45%	55%/45%	55%/45%	
Mtce. And Repair ($/yr)	$1,367	1867.39	1383.62	$1,574
Annual km	20,000	20,000	20,000	
Mtce. & Repair ($/km)	$0.0684	$0.0934	$0.0692	$0.0787

2.5 Summary of Auto Use Related Costs

These are the auto costs that vary with distance driven with the exception of fuel costs that are calculated separately. Use related cost have increased from $0.113 in the 2012 defaults to $0.135 in 2018.

	Compact	*Mid Size*	*SUV*	*Composite*
% of Fleet	20%	40%	40%	100%
Representative Vehicle	Honda	Toyota	GMC	Wt'd Avg.
Model	Civic	Camry	Acadia	
Distance Related Depreciation ($/km)	$0.0433	$0.0409	$0.0615	$0.0496
Maintenance and Repair	$0.0684	$0.0934	$0.0692	$0.0787
Tires	$0.0043	$0.0058	$0.0096	$0.0070
Total Use Related Cost ($/km)	$0.1159	$0.1401	$0.1402	$0.1353

[3] https://www.caa.ca/carcosts/, accessed April 16, 2018

[4] http://www.autonews.com/article/20161122/RETAIL05/161129973/average-age-of-vehicles-on-road-hits-11.6-years, accessed April 2018

2.6 Fuel Price

The fuel price net of taxes[5] 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. The prices below are the average of Vancouver and Victoria, the two urban centers in BC for which Statistics Canada reports prices.

2018 ($/liter)	Gasoline	Diesel
Fuel	$1.014	$0.942
Taxes	$0.312	$0.267
Total	$1.326	$1.208
Increase from 2012 defaults	3.1%	-8.6%

2.7 Fuel Consumption

Consumption is governed by a variety of vehicle, traffic and road related factors. For both auto and truck, the Shortben model accounts for:

- Average running speed including the effects of congestion but excluding stopped delay
- Stopped delay
- Vehicle type (car or truck) each of which is made up of a composite of several representative vehicle types.

Grade has a strong influence on fuel consumption but is not accounted for in the model on the basis that excess fuel consumption upgrade is largely offset by reduced fuel consumption downgrade.

[5] Statistics Canada. *Table 326-0009 - Average retail prices for gasoline and fuel oil, by urban centre, monthly (cents per liter), average from* March 2017 to Feb, 2018

3 Truck Operating Costs

3.1 General Assumptions

Trucks are generally operated on a commercial basis where both the fixed and variable costs of operation must be recovered through revenue. Social cost benefit however differs from financial analysis in that transfer payments such as interest on loans, tolls or taxes are excluded. The fixed costs which are allocated on a $/hr basis and include:

- Time related depreciation
- Registration and Permits
- Cargo time cost
- Administration and interest on working capital

Insurance is excluded from operating costs on the basis that it is already included in collision costs.

Variable costs are allocated on a $/km basis and include:

- Distance related depreciation
- Fuel
- Tires, maintenance and repairs

3.2 Truck Annual Utilization

This is the number of annual kilometers driven and the number of annual hours in use of a truck. The annual hours are necessary to allocate fixed costs to a cost per hour basis. Straight truck utilization will vary depending on the type of service. Urban applications have shorter haul distance and more stops while inter-urban service has longer hauls with fewer stops. Inter-urban service is assumed for straight trucks. Tractor trailers are more consistently used for longer hauls. The typical utilization is estimated below.

Annual Utilization	Tractor Trailer	Straight Truck
Annual km	160000	80000
Running Speed (km/hr)	80	60
Running Time (hr/yr)	2000	1333
Operating days/yr	280	250
km/day	571	320
Running Time (hr/trip)	7.50	3.33
Trip Length (km/trip)	600	200
Trips/yr	267	400
Wait, Load, Unload (hr/trip)	2.0	2.0
Wait, Load, Unload (hr/yr)	533	800
Total Annual Hours	2533	2133

3.3 Truck Use Related Depreciation

Depreciation in the value of a truck is related to both time and distance. The figures below are based on a regression of advertised prices of new and used equipment as a function of model year and kilometers[6]. The "composite" truck is a weighted average of 87% tractor trailers and 13% straight trucks[7]. The distance related component of depreciation makes up 35% of the "composite" truck depreciation.

Representative Vehicle	Highway Tractor	Dry Freight Trailer	Tractor Trailer Total	Straight Box Truck	Composite Truck
New Price	$120,054	$30,117	$150,171	$59,793	
% of Fleet			87%	13%	100%
Distance Related					
km/yr	160,000	n/a	160,000	80,000	
$/km	$0.0310	n/a	$0.0310	$0.0220	$0.0298
Total Annual Distance Related	$4,967		$4,967	$1,758	$4,537
Time Related					
Annual Utilization (hr/yr)	2533	800	n/a	2133	
$/hour	$3.09	$1.57	$4.66	$1.43	$4.23
Total Annual Time Related	$7,838	$1,253	$9,091	$3,052	$8,281.97
Total Annual Depreciation	$12,805	$1,253	$14,058	$4,810	$12,819

[6] Autotrader.ca, April 2018, Ryder Truck Sales 2018.
[7] Sample of 97 trucks observed Highway 1, Kamloops to Salmon Arm using the BC MoTI 2015 Photolog.

3.4 Truck Permits and Licenses

In BC fees include annual license fees plus commercial vehicle fees that vary according to gross vehicle weight. The costs used here for permits do not include oversize or overweight permits and fines.

% of Fleet	Configuration	Annual Cost	Annual Hours	$/hr
13%	2/3-Axle Straight Van	$1,062	2,133	$0.50
45%	5-Axle Van Semi	$2,293	2,533	$0.91
29%	6-Axle Van Semi	$2,578	2,533	$1.02
12%	8-Axle B-Train	$3,936	2,533	$1.55
100%	Composite Truck			$0.96

3.5 Truck Administration

For benefit cost purposes, administrative overhead excludes financing costs which are a transfer and insurance which is assumed to be part of collision costs. Cost of working capital and administrative overhead (marketing, management etc.) is estimated at 10% of operating revenue. Operating revenues in the 2016 US data were $165,000 USD/truck or $207,000 CAD/truck. The default cost is $20,700/truck per year.

Configuration	Straight Trucks	Tractor Trailer	Composite Truck
% of Fleet	13%	87%	100%
Operating Revenue ($/yr)			
USD	$69,865	$165,480	
Exchange	$1.25	$1.25	
CAD	$87,331	$206,851	$190,832
Admin Percent	12%	12%	
Annual	$10,480	$24,822	$22,900
Utilization (hr/yr)	2133	2533	
$/hr	**$4.91**	**$9.80**	**$9.14**

3.6 Cargo Time Cost

The value of cargo in transit is assumed to be the carrying cost of the inventory expressed as an hourly cost based on the social discount rate of 6%/year. The cargo time value proposed for analysis is presented below is based on some typical payload values and load factors.

Cargo Time Cost 2018	Straight Trucks	Tractor Trailer	Composite Truck
% of Fleet	13%	87%	
Payload Value	$5,000	$75,000	$65,619
Load Factor	50%	70%	
Average Payload Value	$2,500	$52,500	$45,799
Discount Rate	6%	6%	
Annual Inventory Cost	$150	$3,150	$2,748
Hours/yr	8760	8760	
Time Cost ($/hr)	**$0.017**	**$0.360**	**$0.314**

The payload value assumed for straight trucks reflects both the smaller payload and the lower unit value. Values range widely from zero for excavated construction material to high value consumer goods.

3.7 Truck Tires

Typical tire costs are $563/tire and $313 per retread with a typical 2.5 retreads per tire. The combined life varies depending on the service cycle. The default values assume 300,000 km for Straight trucks and 550,000 for tractor trailers. The composite cost is the weighted average over the fleet distribution[8].

% of Fleet	Truck Configuration	New Tire	Retread Tire	Retreads /tire	($/tire)	No. Tires	Total Cost	Total Life (km)	Cost ($/km)
7%	2 Axle	$563	$313	2.5	$1,344	6	$8,063	300,000	$0.03
6%	3 Axle	$563	$313	2.5	$1,344	10	$13,438	300,000	$0.04
45%	5 Axle Semi	$563	$313	2.5	$1,344	18	$24,188	550,000	$0.04
29%	6 Axle Semi	$563	$313	2.5	$1,344	22	$29,563	550,000	$0.05
12%	8 Axle B-Train	$563	$313	2.5	$1,344	30	$40,313	550,000	$0.07
100 %	Composite Truck								$0.049

[8] Fleet distribution was based on a sample of 97 trucks taken from the Ministry's 2015 photolog Kamloops to Salmon Arm.

3.8 Truck Maintenance and Repair

The most recent research efforts in this area were in 2011 in Canada[9] and 2017 in the US[10]. The US data was adjusted for exchange and CPI and then the average $0.178/km of the Canadian and US data was used for the 2018 default value.

US 2016 Data

US 2016 Data Repair and Mtce	Straight Trucks	Tractor Trailer	Composite Truck
% of Fleet	13%	87%	
Miles/yr	25,511	103,945	
USD/mi	$0.310	$0.157	
USD/yr	$7,908	$16,319	
Exchange Rate	$1.25	$1.25	
CAD/yr	$9,886	$20,399	
km/yr	41,073	167,351	
CAD/km	$0.241	$0.122	$0.138

Canada 2011 Data

% of Fleet	Configuration	Annual Cost	km/yr	Repairs & Mtce
13%	2-Axle Straight Van	$13,460	80,000	$0.168
45%	5-Axle Van Semi	$28,032	160,000	$0.175
29%	6-Axle Van Semi	$34,224	160,000	$0.214
12%	8-Axle B-Train	$40,144	160,000	$0.251
100%	Composite Truck			$0.195
	2011 CPI			118.3
	2018 CPI			132.6
	2018 Repair &Mtce			$0.218

[9] "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

[10] Hooper, A., Murray, D., "An Analysis of the Operational Costs of Trucking: 2017 Update" American Transportation Research Institute, Atlanta, Georgia, October, 2017

3.9 Summary of Truck Costs

For social benefit cost purposes, the composite truck cost is $14.65/hr plus $0.257/km. This excludes fuel and driver time which are calculated separately. It also excludes financing costs, tolls or truck payments which are transfers and insurance which is included in collision costs.

	Straight Truck	Tractor/Trailer	Composite Truck
% of Fleet	13%	87%	100%
Time Related Costs ($/hr):			
Time Related Depreciation	$1.43	$4.66	$4.23
Permits and Licenses	$0.50	$1.04	$0.96
Cargo	$0.017	$0.360	$0.314
Administration	$4.912	$9.798	$9.14
Total ($/hr)	$6.86	$15.85	$14.65
Distance Related Costs ($/km):			
Distance Related Depreciation	$0.0220	$0.0310	$0.0298
Maintenance and Repairs	$0.24	$0.12	$0.178
Tires	$0.035	$0.051	$0.049
Total ($/km)	$0.298	$0.204	$0.257

4 Value of Time

4.1 Auto Occupant Value of Time

History - The original values of time used by BC MoT for economic analysis were developed in 1994 by Waters[11] 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 allowed 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 of $15.94/hr which is equal to 50 percent of the B.C. median hourly **Household** income.

2018 Value of Time - Household annual income is collected by the census every 5 years. The last available figure from the 2016 census was for 2015 data and is $69,995 for BC. The 2018 BC median household income was estimated to be $76,923 based on a projection of available 2011 to 2015 median **Family** income which is collected annually (from CANSIM Table 111-0009) and correlates closely to household income. The 2018 household income divided by 2,080 employment hours per year is $36.98/hr and the value of travel time is estimated next page as 50% of the hourly income or **$18.49/hr** (in 2018 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 are generally used for additional non-work activity rather than work activity.

[11] 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.

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 2021 for 2020 Census data); and
- One time between each Census update, preferably two or three years after the Census update.

Value of Travel Time Auto Occupants

Year	Median Total Income, All Families, BC
2011	$69,150
2012	$71,660
2013	$74,150
2014	$76,770
2015	$79,750
Annual Increase ($/yr) last 5 years	$2,631
Estimated 2018	$87,643
Ratio 2018/2015	1.099
Tax Year	Median Household Income
2015	$69,995
2018 est'd	$76,923
full time hrs/yr	2080
Income/hr	$36.98
non-work/work value of time	50%
Value of Travel Time	**$18.49**

4.2 Truck Driver Value of Time

History - The 1997 MicroBencost 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[12] 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 from 2011 estimates prepared by Barton[13] and adjusted to 2012 based on median income estimates.

2018 Truck Driver Value of Time - The average wage for truck drivers in BC is $25/hr[14]. The payroll expense of 25% accounts for benefits packages, the costs of producing payroll and other payroll burden expenses. The total cost including payroll expenses is used for benefit cost.

Truck Driver	$/hr
2018 Average Wage BC	$25.00
25% Payroll Expenses	$6.25
Total Payroll Cost	**$31.25**

[12] "Operating Costs of Trucks in Canada - 2005" Prepared by Trimac Logistics Ltd., Calgary, AB. for Transport Canada, Economic Analysis Directorate, Ottawa, ON.
[13] "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
[14] Federal Department of Employment and Social Development Canada - - Median Wage - BC, 2018

5 Safety

5.1 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[15]. 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.

Historical Collision Costs

Fatal	Injury	PDO	Notes
$3,870,324	$101,695	$5,974	Miller for BC MoTH 1992, 8% discount rate
$3,824,738	$89,061	$5,516	Miller for BC MoTH 1992, 4% discount rate
$2,900,000	$100,000	$6,000	Highway Safety Branch 1992
$4,170,000	$97,000	$6,000	1997
$5,693,954	$128,580	$7,342	2003
$6,063,419	$134,824	$7,759	2007
$6,385,999	$135,577	$11,367	2012

The 2003 values are based on collision costs derived by the US National Safety Council[16] in 2002 and converted to Canadian values using the Canadian Dollar equivalent of the time of $1.37 CDN=$1.00 US. This exchange was at the high end of historical rates and likely overestimated the collision costs used in 2003 for BC. The 2007 default values were

[15] 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.
[16] Mei-Li Lin, et al.,"Injury Facts" annual report prepared by the US National Safety Council, Itasca Il., 2002

derived from the latest (2005) National Safety Council figures[17] and converted to Canadian dollars using a 30 year (1977 to 2007) average exchange rate of $1.30 CDN = $1.00 US.

The 2012 default values were derived from work by DeLeur[18] in Alberta which produced "made in Canada" values for collisions. The report looked extensively at the direct costs of crashes including other factors beyond simply the insurance claim cost and reviewed the literature on Statistical and Human Capital estimates for value of life and injury. This overcomes the issue of using US National Safety Council figures for economic and comprehensive collision costs[19] and then applying a somewhat arbitrary exchange rates to convert to Canadian Dollars.

[17] Mei-Li Lin, et al., "Injury Facts 2007 Edition", annual report prepared by the US National Safety Council, Itasca Il., 2007
[18] DeLeur, P., "Collision Cost Study", prepared for the Capital Region Intersection Safety Partnership, Edmonton, Alberta, 2010
[19] "Injury Facts 2012 Edition" US National Safety Council, Itasca, Illinois, 2012

2018 Collision Costs - The 2018 default costs are presented below and are based on the work by DeLeur, factored up to 2018 using the National CPI. The costs agree closely with the 2009 report[20] from the Federal Government on mortality costs used for benefit cost.

2018 Collision Cost Calculations

Per Victim	Direct Costs	Willingness-to-Pay	Total
	2007 dollars		
Fatality	$178,499	$5,237,750	$5,416,249
Major Injury	$113,624	$1,272,025	$1,385,649
Minor Injury	$30,581	$0	$30,581
Property Damage	$11,367	$0	$11,367

Victims Per Crash	Fatal	Injury	PDO
	2016 BC Data		
Fatalities	1.05	0.00	0.0
Major Injuries	0.78	0.15	0.0
Minor Injuries	0.00	1.20	0.0
Property Damage	1.0	1.0	1.0

Per Crash	Direct Costs	Willingness-to-Pay	Total	CPI Adjusted from 2007 to 2018 dollars
	2007 dollars			
Fatal	$287,834	$6,512,493	$6,800,327	**$8,087,204**
Injury	$65,116	$189,363	$254,479	**$302,636**
PDO	$11,367	$0	$11,367	**$13,518**

The 2007 figures from DeLeur were adjusted to 2018 Canada using the National CPI. The number of injuries and deaths per crash were derived from 2016 ICBC data[21] and used to convert cost per victim to cost per crash.

[20] Chestnut, Lauraine G. and De Civita, Paul, "Economic Valuation of Mortality Risk Reduction: Review and Recommendations for Policy and Regulatory Analysis", Prepared for the Government of Canada, Policy Research Initiative, March 2009.
[21] "Quick Statistics" ICBC Business Information Warehouse, August 2012

5.2 Collision Rates and Severity

Safety benefits generally make up the majority of benefits of a project and are worth some extra effort. A business case should consider:

- The historical safety performance
- Future safety performance if a proposed project does not proceed
- Future safety performance with the proposed project in place.

The tools available for this can be downloaded at:
http://www.th.gov.bc.ca/publications/planning
and include:

Safety Bencost	This is the Provincial safety prediction model used to estimate future safety performance. The model can combine historical data with internal prediction models to improve the estimated base case safety performance of an existing road particularly in cases where there is limited or no historical collision data. It can also predict the performance of improvements to an existing road or of a new road of a different service class.
Collision Modification Factors (CMF's)	Safety Bencost predicts a baseline safety performance for a "typical" service class and then uses CMF's to adjust performance when non-typical geometric or other features are added (or absent) from the facility. The "Collision Prediction Models and Collision Modification Factors" document is available at the URL above.
Default Collision Rates and Severity	These are based on Provincial data prepared by BC MoTI for 2009 to 2013 and updated periodically. They are collected from Provincial data for highway sections, signalized intersections, non-signalized intersections and five AADT ranges. Highway sections collision data are further disaggregated according to their operational class (RAU2, RAU4 etc). This data is already embedded in the Safety Bencost model but is still useful to refer to separately at times.

6 Financial

6.1 Capital Costs

There are no default values. For benefit cost purposes the relevant capital cost is the total project cost which includes all Ministry costs associated with a project as well as property, project management, planning, engineering and construction. Costs are generally developed using the standard costing models and previous contract data available from the Ministry. Typically as the design progresses, more detailed cost estimates are prepared based on design drawings.

6.2 Annual Maintenance Costs

Road maintenance is contracted for each of 28 service areas for 10 year periods. The 2017 total cost (ministry + contract) is divided by the total lane-kilometers of road under Provincial jurisdiction[22] to get the average cost/Ln-km of $5,099/Ln-km/yr. Bridge maintenance costs are included in road maintenance. Periodic bridge resurfacing costs are in shown separately in section 6.3.

Maintenance Costs	2017 ($mill/yr)
Road and Bridge	$400.5
Pavement Marking	$11.5
Electrical	$11.0
Total	$423.0

Estimated Lane Kilometers	
Road km in Prov. jurisdiction	46,401
Lane Kilometers	89,281
Unmaintained Road km	4,927
Maintained Road km	41,474
Maintained Lane-km	84,354

Maintenance Cost/Lane-km/yr	
2017	$5,015
2018 est'd	$5,099

[22] "Quick Facts Book", BC Ministry of Transportation and Infrastructure, Sept., 2017

6.3 Resurfacing Costs

Typical values for BC are shown below and total project costs including the value of the contract plus the associated Ministry costs.

Treatment	Unit Cost	Units	Life (years)
Mill and fill/Overlay	$100,000	$/Ln-km	15
Hot In Place Recycling	$65,000	$/Ln-km	8-10
Bridge Deck Resurfacing	$1,500	$/m2	30

6.4 Residual Values

Residual values reflect the value of the asset continuing in its current use beyond the end of the analysis period. Benefit cost incorporates residual values as a recoverable in the last year of the analysis period. The analysis period is the construction period plus the benefit period. The residual values depend on the service life of the asset:

Category	Service Life (yrs)
Engineering and Project Management	0
Property	100
Major Structures	80
Grading and Drainage	60
Base & Sub-base	50
Surface	40

The approach used in the Shortben Model is similar to the MicroBencost model[23]. Consider the structure portion of a bridge project completed in 2021 followed by a 25 year benefit period. The planning period is 28 years and if the bridge is designed for 80 years and costs $100 million, then the residual value RV of the structure at the end of the planning period (year 28) is for example:

$$RV = IC \times (1+i)^{(Y_H - Y_C)} \times (PWF_{i,SL} - PWF_{i,N})/(PWF_{i,SL})$$
$$= \$100m \times (1+.06)^{(2046 - 2021)} \times (16.51 - 12.78)/(16.51)$$
$$= \$96.9 \text{ million}$$

[23] "Microcomputer Evaluation of Highway User Benefits", prepared for the US National Cooperative Highway Research Program, Project 7-12, October, 1993, Appendix pg A38.

Where:

RV = Residual value in the horizon year (horizon year = base year + analysis period). This value would be discounted back to the base year to get the present value of the recoverable.

IC = Initial cost of the asset $100 million

i = Discount rate 6%

Y_C = Year the asset is finished. 2021 in this case.

Y_{SL} = Service Life Year. This is the last year of the service life of the asset. For example if a the structure is completed in 2021 and has an 80 year service life then the service life year is 2021+80 = 2101.

Y_H = Horizon year (base year + analysis period) = 2018 + 28 = 2046

PWF_{SL} = Uniform series present worth factor for discount rate i=.06 and the number of periods equal to the service life of the asset (80 yrs). Then PWF_{SL} = 16.51

PWF_N = Uniform series present worth factor for discount rate i = .06 and the number of years equal to (Horizon Year - Construction Complete Year) = 2046 - 2021 = 25 yrs. Then PWF_N = 12.78

The structure portion has a residual value of $96.9 million in 2046. The present value in the 2018 base year is $96.9 mill /(1+.06)^(2046-2018) = $18.9 million which is a recoverable in the base year.