Canadian Centre for Economic Analysis Toronto

Social Cost of Collisions in Ontario and Canada: Technical Documentation

July 2023

Canadian Centre for Economic Analysis

The Canadian Centre for Economic Analysis provides objective, independent and evidence-based analysis dedicated to a comprehensive and collaborative understanding of the short and long term risks and returns behind policy decisions and prosperity outcomes.

Contents

Executive Summary

Objectives

Traffic collisions are a significant source of largely preventable injuries and deaths across the country. In 2019, over 1,700 people died as a result of traffic collisions across Canada, with another 140,000 people suffering from an injury. These deaths and injuries, along with the impact of collisions in which no one is injured, result in a considerable cost to society. In order to quantify the social costs of collisions, an Excel-based model has been developed which combines detailed collision data for Ontario and Canada with the costs of the consequences of collisions to calculate the total social cost of collisions across Canada, and each of its provinces and territories.

The original Social Cost of Collisions model[1] was first developed in 2007. While many of the calculations in the model used data that was current at the time, the model was not structured in a manner to allow easy on-going maintenance. In addition, modern versions of Microsoft Excel have features that can improve the readability and maintainability of the spreadsheet model. Therefore, the objective of the current model iteration is threefold:

1. Update key data inputs in the model to use current data,
2. Restructure the model to provide an easy method to keep data up-to-date, and,
3. Ensure the model is clear and readable.

This document describes the details of the model calculations, the data sources used, and provides some basic instructions on how to use the model.

Implementation

The updated Excel-based model provides a flexible framework for using and maintaining the Social Cost of Collisions Model. The design clearly separates the raw data inputs from any calculations, and includes a Scenario feature to allow a consistent way to manage and adjust any model assumptions. While the previous model required separate data inputs for "submodels", the updated approach simplifies the concept of submodels. In the original implementation, the cost of collisions due to specific factors, such as impairment or speed, were calculated independently of the total costs of collisions and each other. In the new model, each collision has six factors that can be used to select a subset of collisions and their associated cost. These factors include:

- Large Truck Involvement
- Speed

[1] Vodden, K., et al., *Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario*, 2007

- Impaired
- Highway
- Pedestrian Involvement
- Multi-Vehicle

This approach ensures a consistent view of the social cost of collisions across each of the factors and regions.

Social Cost of Collisions in 2019

The updated estimates for the Social Costs of Collision are shown in the table below:

Quantity	Ontario ($2019 millions)	Canada ($2019 millions)
Fatalities	$5,932	$17,738
Injuries	$3,242	$9,879
Property Damage	$4,034	$12,590
Traffic Delays	$671	$2,218
Out-of-Pocket	$363	$1,133
First Responders	$310	$930
Health Care	$109	$371
Other Costs	$21	$79
Total	$14,682	$44,847

The largest component is the social cost associated with fatalities. With the increasing costs of property damage and the large number of property damage only collisions, property damage costs are the second largest factors followed by the social cost of injuries. Nationwide, the social costs amount to almost 2% of Canada's GDP while for Ontario, the cost is 1.5% of the province's GDP. Note that the updated model yields values which are slightly different from previous models. This is a result of using more current input data and a slightly different model structure. Section 1.3 conducts a comparison between the current model results and the previous values.

Chapter 1

1. Introduction

This document describes the data sources and calculations used to calculate the Social Cost of Collisions in Ontario and Canada. The model captures the economic and human costs of traffic collisions. While the approach is similar to the prior version of the model[1], the updated framework and more recent data mean that the results are not directly comparable with the previous model's output. This technical document is designed to complement the Excel dashboard, and is not intended to be a discussion of the social cost of collisions in Ontario or Canada.

1.1 Model Framework

The basic calculations to determine the social cost of collisions are straightforward if the number of collisions, and the appropriate costs associated with each class of collision are known. However, the available input data required is generally not in the ideal form to perform such calculations. Whether it is not available for the correct year, or that other calculations must be performed on it to transform it into the right shape, the input data generally needs to be transformed before being used. In order to ensure the model is maintainable as new data inputs are provided, it is important to keep the basic core model calculations separate from any data transformations. By doing so, the logic of the main model is kept distinct from any adjustments or transformations that may be required from the original input data.

Therefore, the Excel-based model is divided into three distinct components. The first component is the basic model structure which takes collision data, and the appropriate cost factors, to calculate the social cost of collisions. These can be found on the `Model Calculations` sheets. The details of the calculations can be found in Chapter 2. The second component consists of the transformation required to convert any input data into the form appropriate for the model calculations. These can be found on the `Transformation` sheets and are described in Chapter 4. Finally, the third component consists of source data inputs are provided in the `Inputs` sheets.

It is important to note that the model is designed to assess the current cost of collisions to society, not to evaluate what the economics of the regions would look like if collisions did not exist. For the former, it requires an accounting of where costs arise and money is spent. For the latter, it would involve examining the impact of where the costs and money spent as a result of collisions could otherwise be spent. In this case, one could include the marginal cost of public funds (MCPF) if the costs for collisions would not otherwise be spent by government, but instead invested in the private sector. However, if this is applied to cost factors such as police costs or fire department costs,

[1] Vodden, K., et al, *Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario*, 2007

the implicit assumption is that there would be fewer requirements for police and fire department staff.

1.2 Using the Model

1.2.1 Model Selection

As additional years of collision data are added to the model, the `Year` selection will automatically include all available years. (In the first year of use, only a single year will be shown.)

Collision Factors

The `Collision Factors` section of the Model Selection allows the user to select a subset of collisions which have the given characteristic. This replaces the concept of Sub-models which existed in the original version of the model. Rather than performing separate calculations for each factor, each collision is associated with one or more factors. Selecting `Impaired = True`, for example, is the equivalent to "Impaired Submodel" in the original model. However, by selecting both `Speed = True` and `Impaired = False`, the model can now show the cost of collisions associated with collisions which involved speeding, but did not involve impairment. The six collision factors included in the model are:

Large Truck Filter collisions by whether a large truck was involved
Speed Filter collisions by whether speed was a factor
Impaired Filter collisions by whether impairment (alcohol or drug) was a factor
Highway Filter collisions by whether collision occurred on a highway
Pedestrian Filter collisions by whether a pedestrian was involved
Multi-Vehicle Filter collisions by whether more than one vehicle was involved

Refer to Section 3.1.1 for a detailed description of each collision factor.

Geographic Regions

The model includes data and calculations for each province and territory in Canada. By selecting one or more regions, the cost of collisions for that geographic region can be calculated. When multiple regions are selected, the cost calculations are performed for each region, then summed (rather than summing the number of collisions first, then calculating the cost). This approach allows for region-specific data to be used regardless of regions selected.

Scenarios

The model has many configurable parameters to allow the user to adjust assumptions. These adjustments can be grouped into `Scenarios` to allow for a structured means to make model changes. There is a default scenario, which contains the assumed parameters to use if not otherwise specified. If a scenario other than the default is selected, any parameters values that differ from the default scenario are highlighted in the Current Scenario box on the left. Scenario values cannot be changed on the dashboard, but they must be set on the `Scenarios` sheet. See below for an overview on creating and updating scenarios.

Note that while Excel will allow the selection of multiple scenarios, selecting multiple scenarios at once will yield incorrect results.

1.2.2 Managing Scenarios

Scenarios are designed to allow the user to adjust various parameters in the model in a consistent and manageable manner. Rather than an ad-hoc approach of changing model inputs directly, which can easily be forgotten and difficult to track, the scenario framework allows the user to create their own custom model configuration without losing any of the original values. For a given scenario, one or more model parameters can be overridden to understand the sensitivity of the model output to the input parameters.

The steps for creating and using a scenario are:

1. Add a new row to the Scenario table in the `Scenarios` sheet.
2. In the first column of the table (Scenario column), enter the name of the new scenario. This is the label that will be shown in the *Scenario* selector on the dashboard.
3. In the second column of the table (Parameter column), enter the name of the parameter that is to be changed. For example, to alter the value of statistical life, enter "Value of Statistical Life" into the second column.
4. In the third column of the table (Value column), enter the value that you would like to use. Following the example above, enter 10 to set the value of statistical life to $10,000,000.
5. To enable the new scenario, click *Refresh All* under the Data menu. It is important to note that no changes will appear until the *Refresh All* button is clicked.
6. On the dashboard, the new scenario will be visible in the *Scenario* selector.

To change a second parameter for the same scenario, simply repeat the steps above for the second parameter using the same scenario name used before. To add a description to the scenario, use the special parameter *Description* and any text can be entered in the value columns. To delete a scenario, simply remove all of the associated rows in the Scenario table.

1.2.3 Data Updates

A key advantage of the clear separation of model, transformations, and inputs is that it provides a straightforward path to update and maintain the model. As new data becomes available, the data input sheets can simply be updated without any concern that any other calculations or Excel links will be broken. If the data format of any of the inputs changes over time, only the transformation routines need to be updated, and the core model remains unchanged.

1.3 Comparison with Previous Model

While similar in structure, the new model uses updated data and involves some structural changes due to differences in availability of data. The following table compares the key outcomes from the previous Transport Canada model results for Ontario[2] and Canada[3] with the current model

[2]Transport Canada, *Ontario: Social Cost of Collisions – Jurisdictional Factsheet, 2019 Statistics*, 2019
[3]Transport Canada, *Canada: Social Cost of Collisions*, 2019

outcomes, along with a description of the primary cause for changes. Note that the previous model presented values in 2010 dollars. They have been converted to 2019 dollars for comparison with the current model.

Ontario			
Quantity	Transport Canada Model ($2019 millions)	Current Model ($2019 millions)	% Difference
Fatalities	$6,090	$5,932	-2.6%
Injuries	$3,818	$3,242	-15.1%
Property Damage	$2,390	$4,034	+68.8%
Traffic Delays	$704	$671	-4.7%
Out-of-Pocket	$360	$363	+1.0%
First Responders	$285	$310	+8.7%
Health Care	$66	$109	+65.1%
Other Costs	$12	$21	+66.4%
Total	$13,725	$14,682	+7.0%

Canada			
Quantity	Transport Canada Model ($2019 millions)	Current Model ($2019 millions)	% Difference
Fatalities	$18,590	$17,738	-4.6%
Injuries	$16,863	$9,879	-41.4%
Property Damage	$6,610	$12,590	+90.5%
Traffic Delays	$1,971	$2,218	+7.9%
Out-of-Pocket	$935	$1,133	+21.2%
First Responders	$811	$930	+14.7%
Health Care	$244	$371	+52.1%
Other Costs	$37	$79	+114.3%
Total	$46,061	$44,847	-2.6%

The sources of the differences in both the Ontario and Canada tables are the same. The sections below provide a brief explanation of factors that give rise to the variation.

Fatalities

For the social cost of fatalities, the primary source of difference is simply from different assumptions about the Value of Statistical Life (VSL) and how it is transformed from the reference years to the current year.

Injuries

The difference in the social value of injuries arises from both the difference in the VSL value, as well as the distribution of injury severity and the fraction of a VSL assigned to each severity. The current distribution of reported injury severity is less severe on average than previously assumed in the older model, particularly on the national level where injury severity is not reported, which results in a lower social costs associated with injury. The fractions of VSL adopted align with Transport Canada research. It is important to note that in the previous model at the National level, injuries contributed almost 10% more total to the total cost of collisions than at the Ontario level. The updated model shows more consistency between the national and provincial-level data.

Property Damage

The average cost of property damage used in the current analysis is significantly larger than the previous model which used estimates from 2004. This results in a higher property damage cost than in the earlier version of the model.

Traffic Delays

The difference in the estimated cost of traffic delays arises from the different methodological approaches used. A different approach was required since data in the format that was used in the original report was not available.

Out-of-Pocket Expenses

The current and previous model show close agreement on out-of-pocket expenses estimates.

First Responders

In the updated models, first responders (police, fire, ambulance, and tow trucks) costs are slightly higher than in the previous model. This is primarily due to updated response costs, and a slightly different approach to estimating some of the components. The new approach is designed to be easily updated as new data is available.

Health Care

The primary factor driving the large percentage increase in health care costs are the higher costs of hospitalization compared to estimates used in the original model. While the percentage increase is relatively large, health care costs still only form a small part of the total cost of collisions.

Other Costs

Other costs are greater in the updated model simply due to the inclusion of more costs into that category. In the comparison models, the other costs consisted only of court costs. In the update, coroner costs and funeral expenses are also included.

Chapter 2

2. Model Structure

The Excel dashboard is designed so that the model structure can be described separately from the details of the input data. The calculations operate on data that has been converted into a standardized format and it is not concerned with the nature of the original source data. With this separation of responsibilities, the source data or reconciliation process could be completely replaced without affecting the primary model calculations. The transformation of input data into the standard format is described in Chapter 4.

The following sections describe the key calculations which generate the cost values from the collision and cost data. Values from the model calculations are summarized on the main Dashboard sheet. Where possible, tables used in calculations are named, rather than using cell ranges.

All collisions fall into one of three categories:

Fatality At least one individual in the collision died as a result of the event. Note that the death need not occur immediately at the scene of the collision, but could occur up to 30 days afterward, for example within a hospital, if attributable to the collision.

Injury At least one individual in the collision was injured, but no fatality occurred.

Property Damage Only No one was injured during the collision, but some property damage (such as a vehicle being damaged) did still occur.

For each collision, there can be one vehicle (a single vehicle collision) or more than one vehicle (a multi-vehicle collision) involved. Each vehicle in the collision may suffer a different amount of damage classified into one of five categories:

- No damage
- Light damage
- Moderate damage
- Severe damage
- Demolished

For each person involved in the collision, the level of injury they incur is classified into five categories:

- No injury
- Minimal injury
- Minor injury
- Major injury
- Fatality

These divisions are based on the Ontario Ministry of Transportation categories.

It is important to note that in Ontario collisions in which no one is injured and the property damage is below $2,000 are not required to be reported. As a result, these collisions are not included in the analysis. In practice, their exclusion would have a minimal impact on the results since, by definition, the financial burden is minimal and no one is injured.

2.1 Number of Events

A primary set of outputs of the model are the number of collisions, the number of vehicles involved, and the number of people injured. These event counts then drive the subsequent cost calculations. The various event count views are generated from the Collision Input sheet (see section ?? for details on the data input).

2.1.1 Total Number of Collisions

This short table summarize the year of interest and the total number of collisions for the selected geography. This is a pivot of the main collision table.

Pivot Parameter	Values
Source Table	`Tbl_Collision`
Output Table	`ModelCalculations!B2`
Values	Number of Collisions (nCollisions)

2.1.2 Number of Collisions

The next output on the `ModelCalculations` sheet summarize the total number of collisions by province and territory, and by severity of collision. This is a pivot of the main collision table.

Pivot Parameter	Values
Source Table	`Tbl_Collision`
Output Table	`ModelCalculations!B8`
Values	Number of Collisions (nCollisions)

2.1.3 Number of Vehicles

For each collision, there may be more than one vehicle involved. In addition, each vehicle in the collision may suffer a different level of damage ranging from none to being demolished. This is a pivot of the main collision table.

Pivot Parameter	Values
Source Table	Tbl_Collision
Output Table	`ModelCalculations!B19`
Values	Number of Vehicles: Demolished (nDemolished) Number of Vehicles: Severe (nSevere) Number of Vehicles: Moderate (nModerate) Number of Vehicles: Light (nLight) Number of Vehicles: None (nNone)

2.1.4 Number of People

Finally, for each collision there may also be multiple people involved. Each person may suffer a varying degree of injury, ranging from no injury to a fatality. This is a pivot of the main collision table.

Pivot Parameter	Values
Source Table	`Tbl_Collision`
Output Table	`ModelCalculations!B43`
Values	Number of People: Fatality (nFatality) Number of People: Injury - Major (nInjury - Major) Number of People: Injury - Minor (nInjury - Minor) Number of People: Injury - Minimal (nInjury - Minimal) Number of People: No Injury (nNo Injury)

2.2 Direct Medical Costs

Direct medical costs are those that arise from the outcomes of the collision including initial emergency department care, and longer term hospitalization where required.

2.2.1 Hospitalization Costs

The hospitalization costs associated with collisions are based on the cost of a "standard hospitalization" stay, and assumed to scale with the severity of injury. The relative length of stay in hospital is governed by the hospital stay factor parameters .

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B3`
Calculation Location	`ModelCalculations!B78`

Parameters	`Hospital Stay Factor - Fatality`
	`Hospital Stay Factor - Major Injury`
	`Hospital Stay Factor - Minor Injury`
	`Hospital Stay Factor - Minimal Injury`

These parameters account for the longer duration of hospitalization depending upon the severity of the injuries. Refer to 5 for the additional parameter details and default values.

The total hospitalization cost is calculated using:

$$\text{Cost} = \sum_{\text{severity}} N_{\text{severity}} \times F_{\text{severity}} \times C_{\text{hospitalization}}$$

where N_{severity} is the number of people involved in the collision of the given severity, F_{severity} is the hospital stay factor based on severity, and $C_{\text{hospitalization}}$ is the cost of a standard hospitalization.

2.2.2 Emergency Department Costs

The emergency department cost scales with the number of people with minor injuries or worse. The total cost is the number of people affected times the average ED cost.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B51`
Calculation Location	`ModelCalculations!B100`

The total emergency department cost is calculated using:

$$\text{Cost} = \sum_{\text{injury}>\text{minimal}} N_{\text{injury}} \times C_{\text{ed}}$$

where N_{injury} is the number of people involved in collisions with the given injury severity, and C_{ed} is the cost of a standard hospitalization.

2.3 First Responders Costs

First responder costs include the costs associated with the initial response to the accident. These include police, ambulance, and fire department responders, as well as tow truck operators. These costs are driven by the number of collisions, type of vehicles involved, and the severity of each collision. Depending upon the jurisdiction, a portion of these costs may be the responsibility of those involved in collision.

2.3.1 Ambulance

For those people who suffer injuries (major or worse), they are assumed to be transported to hospital via ambulance. Note that this also includes all fatalities. The ambulance cost is the number of people affected times the average cost of an ambulance. The total cost is used, though the full amount may be shared between the government and the patient.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B300`
Calculation Location	`ModelCalculations!B145`

The total ambulance costs are calculated using:

$$\text{Cost} = \sum_{\text{injury}>\text{minor}} N_{\text{injury}} \times C_{\text{ambulance}}$$

where N_{injury} is the number of people involved in collisions with the given injury severity, and $C_{\text{ambulance}}$ is the cost of a standard ambulance.

2.3.2 Police

For most collisions, it is required that police attend. The number of hours required depends upon the severity of the collision and number of vehicles involved. The average wages of a police officer are divided by the annual hours worked (configurable in the `annual police hours` parameter) and multiplied by the average number of hours required to respond to the incident. Fatalities are assumed to take more time than non-fatal collisions.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B150`
Calculation Location	`ModelCalculations!B117`

Parameters	`Annual Police Hours`
	`Police Hours Response per Vehicle`
	`Police Hours Response per Fatality`

The total police costs are calculated using:

$$\text{Cost} = \sum_{\text{severity}} V_{\text{severity}} \times W_{\text{police}} \times H_{\text{severity}}$$

where V_{severity} is the number of vehicles involved in collisions with the given severity, W_{police} is the average hourly cost of police services, and H_{severity} is the number of hours per response depending upon the severity of the collision.

2.3.3 Fire Department

The costs associated with the fire department is modeled in a similar manner to the police costs. The average annual wage of a person in the fire department is divided by the average annual hours worked, and multiplied by the average number of hours to respond to a collision.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B200`
Calculation Location	`ModelCalculations!B168`
Parameters	`Annual Fire Department Hours` `Fire Department Hours Response per Vehicle`

The total fire department costs are calculated using:

$$\text{Cost} = \sum_{\text{severity}} V_{\text{severity}} \times W_{\text{fire}} \times H_{\text{severity}}$$

where V_{severity} is the number of vehicles involved in collisions with the given severity, W_{fire} is the average hourly cost of fire department services, and H_{severity} is the number of hours per response depending upon the severity of the collision.

2.3.4 Tow Truck Costs

Collisions in which vehicles are damaged may require the service of tow truck operators. For minor collisions which result in only minimal damage, tow truck operations may not be required. For collisions which involve a large truck, an additional cost is applied due to the higher towing costs and greater length of time required to clear the collision. For property damage only collisions, it is assumed that not all collisions will require a tow truck as the damage may be sufficiently minor. Both of these factors are adjustable via scenario parameters.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B250`
Calculation Location	`ModelCalculations!B196`
Parameters	`Heavy Towing Cost Factor` `PDO Towing Factor`

The total towing costs are calculated using:

$$\text{Cost} = \sum_{\text{severity}} \left(V_{\text{severity,heavy}} \times C_{\text{heavy}} + V_{\text{severity,not-heavy}} \times C_{\text{not-heavy}} \right)$$

where $V_{\text{severity,weight}}$ is the number of vehicles involved in collisions with the given severity and weight (large trucks), and C_{weight} is the average cost per tow. Refer to the 3 for details on the classification of large trucks.

2.4 Other Costs

In addition to the direct health costs and first responders, there are additional direct costs that may be incurred.

2.4.1 Property Damage

In most collisions, vehicles suffer some degree of damage. This cost is borne either directly by the owner, or through insurance. The greater the severity of vehicle damage, the larger the property damage is likely to be. Note that in many jurisdictions, including Ontario, there is a threshold of property damage value, below which reporting of a collision is not required if no injuries occured. All collisions with property damage above the threshold, or any injury, are required to be reported to the police. As a result, there are unreported collisions, with low property damage and no injury, which cannot be included in the total cost of collisions analysis. However, as these omitted collisions have, by definition, a small cost, they are unlikely to significantly affect the aggregate totals. However, as the severity of the collision increases, the amount of property damage will also increase.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B350`
Calculation Location	`ModelCalculations!B196`

Parameters	`Property Damage Factor - Demolished`
	`Property Damage Factor - Severe`
	`Property Damage Factor - Moderate`
	`Property Damage Factor - Light`

The total property damage costs are calculated using:

$$\text{Cost} = \sum_{\text{damage}} V_{\text{damage}} \times F_{\text{damage}} \times C_{\text{average}}$$

where V_{damage} is the number of vehicles involved in collisions with the given damage, C_{average} is the average property damage value per vehicle in a collision, and and F_{damage} is the parameter to adjust the value of property damage for collision severity.

The default values for the parameters were based upon the relative property damage costs in the original model.

2.4.2 Out of Pocket Expenses

People involved in a collision may also be required to pay out of pocket expenses. This may arise from insurance deductibles or other fines and fees. In general, the more severe the vehicle damages, the greater the out of pocket expenses are likely to be. Therefore the total out of pocket expenses are assumed to scale with the severity of the collision in the same way in which overall property damage scales.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B400`
Calculation Location	`ModelCalculations!B280`

Parameters	`Property Damage Factor - Demolished`
	`Property Damage Factor - Severe`
	`Property Damage Factor - Moderate`
	`Property Damage Factor - Light`

The total out-of-pocket costs are calculated using:

$$\text{Cost} = \sum_{\text{damage}} V_{\text{damage}} \times F_{\text{damage}} \times C_{\text{average}}$$

where V_{damage} is the number of vehicles involved in collisions with the given damage, C_{average} is the average out-of-pocket cost per vehicle in a collision, and and F_{severity} is the parameter to adjust the value of expenses for collision severity.

2.4.3 Funeral Costs

For each fatality, there is an associated funeral cost. The total costs due to funerals is simply the number of fatalities multiplied by the average cost per funeral.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B100`
Calculation Location	`ModelCalculations!B229`

The total funeral costs are calculated using:

$$\text{Cost} = N_{\text{fatality}} \times C_{\text{average}}$$

where N_{fatality} is the number of fatalities, and C_{average} is the average funeral cost.

2.4.4 Court Costs

Traffic collisions, particularly those involving impaired drivers, can add to the case load facing courts. In contrast, many collisions involving non-impaired driver do not end up in court. Therefore, the court costs are estimated based upon whether the collision involved any impairment or not.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B500`
Calculation Location	`ModelCalculations!B307`
Parameters	`Impaired Court Cost Factor` `Non-impaired Court Cost Factor`

The total court costs are calculated using:

$$\text{Cost} = N_{\text{impaired}} \times C_{\text{average}} \times F_{\text{impaired}} + N_{\text{non-impaired}} \times C_{\text{average}} \times F_{\text{non-impaired}}$$

where N is the number of collisions, C_{average} is the average court case cost, and F is the relative costs of impaired and non-impaired court cases compared to the average court case cost.

2.4.5 Coroner Costs

For a subset of fatalities, coroners are required to attend after the person's death. The total cost is the number of fatalities, times the fraction of fatalities requiring a coroner, times the average coroner cost. The fraction of fatalities requiring a coroner is set to the value from the original social cost of collision model, but can be updated via the Coroner Fraction parameter.

Pivot Parameter	Values
Source Table	`Transformation-YearAlignment:B550`
Calculation Location	`ModelCalculations!B346`
Parameters	`Coroner Fraction`

The total coroner costs are calculated using:

$$\text{Cost} = N_{\text{fatality}} \times C_{\text{average}} \times F_{\text{coroner}}$$

where N_{fatality} is the number of fatalities, C_{average} is the average coroner cost per fatality, and F_{coroner} is the fraction of fatalities which require coroner services.

2.5 Congestion Costs

In addition to the people directly involved in, and responding to, the collision, there are other indirect impacts. In particular, if the collision occurs in a region with a high volume of traffic, or is a major collision, it can significantly affect the flow of traffic in the region. This congestion can result in significant lost productivity for travellers.

In the previous analysis, congestion data provided by the Ontario Ministry of Transportation was used to quantify the impact of a traffic collision. However, comparable data is no longer available so an alternative approach is required. Fortunately, literature[1] has shown how the average delay from initial collision to clearing the road varies depending upon the severity of the collision. In particular, the analysis estimates the following delays:

Severity	Delay (minutes)	Model Parameter
Fatality	245	`Delay - Fatality`
Injury	48	`Delay - Injury`
No Injury	22	`Delay - No injury`

If more contemporary or local data becomes available, these are adjustable via scenario parameters.

The economic value of the lost productivity due to congestion can be estimated as the additional hours spent in traffic times the average hourly wage that people would earn. Given the delays from literature, the additional factor required is the number of vehicles that are impacted. While there are several ways to estimate this value. One possibility is to examine the average annual daily traffic data (AADT) for major roads in Ontario[2]. A second approach is to simply calibrate the value against the existing model results. Using this approach, an estimate of 250 cars on average is obtained in line with the earlier MTO analysis, which is adopted as the default parameters value. By exposing this value as a parameter, the user of the model can investigate the sensitivity of the total social cost of collisions on this estimate.

Pivot Parameter	Values
Calculation Location	`ModelCalculations!B369`

Parameters	`Delay - Fatality`
	`Delay - Injury`
	`Delay - No Injury`
	`Delay - Number of Vehicles`

[1] Wang et al, 2008. Quantifying Incident-Induced Travel Delays on Freeways Using Traffic Sensor Data
[2] MTO ICorridor Historical Provincial Highways Traffic Volumes

The cost associated with congestion is:

$$\text{Cost} = \sum_{\text{severity}} N_{\text{severity}} \times V_{\text{average}} \times T_{\text{severity}} \times W_{\text{severity}}$$

where N_{severity} is the number of collisions of given severity, V_{average} is the average number of vehicles impacted, T_{severity} is the number of hours traffic is delayed, and W_{severity} is the average hourly wage.

Given the rapidly evolving profile of vehicles on the road, it is difficult to estimate metrics such as fuel consumption or excess emissions. Many modern cars minimize consumption through shutting off the engine when stopped, and electric vehicles have no fuel consumption (in the traditional sense). Therefore, the congestion costs are limited to the lost productivity of people.

2.6 Human Costs

In addition to the economic costs resulting from a collision, there is also a human cost associated with a loss of life or injury. The standard adopted by the Government of Canada[3][4][5] is to use what is known as the Value of Statistical Life (VSL).

The concept behind the VSL is not to put a value on any individual life but it is the sum across many people of their individual willingness to pay for a small reduction in mortality risk. While there is considerable variability in estimates of the VSL across different studies, the recommended value to use for analysis covered by Regulatory Impact Analysis Statements is $6.5 million in 2007 Canadian dollars. However, the Social Cost of Collisions analysis does not fall under that analysis so alternative values can be used. Transport Canada conducted an analysis in 2014 which recommended using a value of $7.8 million in 2007 dollars[6]. To convert VSL from 2007 dollars to the present day, both the rate of inflation (CPI), and the change in real wages (W) can be used. From Bergeron (2014), the value for the elasticity of real wages (ϵ) of 0.6 was recommended.

$$\text{VSL}_{t_2} = \text{VSL}_{t_1} \frac{\text{CPI}_{t_2}}{\text{CPI}_{t_1}} \left(\frac{\text{W}_{t_2}}{\text{W}_{t_1}} \right)^{\epsilon}$$

The table below summarizes some potential values for the VSL. The default value in the model in the 2019 estimates of the Transport Canada values.

Estimate	$2007 dollars	$2019 dollars
Treasury Board	$6.50 M	$8.34 M
Transport Canada	$7.80 M	$10.01 M

From 2007 to 2019, the CPI growth[7] is 1.24 and the real wage growth[8] is 1.06.

[3] Treasury Board of Canada Secretariat, Policy on Cost-Benefit Analysis, 2018
[4] Government of Canada, Canada's Cost-Benefit Analysis Guide for Regulatory Proposals, 2018
[5] Transport Canada. 2014a. The Value of a Statistical Life: Estimates used in Transport Canada's Social Cost of Collision Model
[6] Bergeron, N., *The Value of a Statistical Life: Estimates used in Transport Canada's Social Cost of Collision Model*, 2014
[7] Statistics Canada, Table 18-10-0005
[8] Statistics Canada, Table 14-10-0255

2.6.1 Value of Statistical Life for Fatalities

The value of statistical life is subject to considerable uncertainty depending upon the literature examined. Therefore, it is adjustable via the Value of Statistical Life parameter. The VSL due to fatalities is the number of fatalities times the VSL.

Pivot Parameter	Values
Source Table	`ModelCalculations!B41`
Calculation Location	`ModelCalculations!B65`

2.6.2 Value of Statistical Life for Injuries

The calculation of the VSL for injuries is performed in the same manner as the calculation for fatalities, with the only difference being the VSL is scaled according to the level of injury severity. The scaling factors are adjustable via the scenario parameters, and the default values are consistent with previous reports by MTO and Transport Canada[9].

Pivot Parameter	Values
Source Table	`ModelCalculations!B41`
Calculation Location	`ModelCalculations!B65`

Parameters	`Human Cost of Major Injury`
	`Human Cost of Minor Injury`
	`Human Cost of Minimal Injury`

2.7 Dashboard Summary

The `Dashboard` sheet summarizes the key results from the Model calculations. No new calculations, other than basic summations, are performed on the dashboard.

[9] Miller, T.R. and B.A. Lawrence. 2015. Fractions of Value of Statistical Life Lost to Injury by Severity, Final Report, Contract T8080-1 40190, Motor Vehicle Safety Directorate, Transport Canada

Chapter 3

3. Data Sources

This section describes the data sources used in the analysis. The model is designed so that the data sources can be updated regularly without having to make any changes to the model. Where possible, links to the data sources are provided, both in this document and the model spreadsheet, to allow for easy access to update most data sources.

3.1 Collisions

Collision data are the data directly related to the number and severity of collisions. It includes information on the number of collisions, the number of and type of vehicles involved and the number people injured (by severity). In addition, it contains information on the factors related to the collision such type of vehicles involved and whether alcohol or drug impairment was a factor.

Unlike other data sources which are directly input into the model, this dataset is generated from the merging injury-level data and collision-level data from MTO, in conjunction with the Transport Canada National Collision Database. Due to the large size of the injury-level data and relative complexity of aligning the data into a form appropriate for the Excel-based model, a standalone Python script was used to transform data in the appropriate format. This script, with documentation, is publicly available for future use.

3.1.1 Provincial-Level Collision Dataset Script

While the Canadian-level data from the National Collision Database contains many of the required fields for the model, it does not include provincial-level data, or the same level of resolution of injury, vehicle damage, or contributing factors. Therefore, the script performs two key operations:

1. Summarize the injury-level data from MTO into the format suitable for the model
2. Expand the NCDB data to include provincial-level estimates and align with the model format

The inputs to the script include:

- Ontario Ministry of Transportation individual-level CSV collision dataset
- National Collision Database
- Canadian motor vehicle traffic collision statistics

The final result is a dataset where each row in the aligned input data set includes several discrete values describing the characteristics of the collision, as well as several numeric values describing the outcomes. In particular, the columns consist of:

Year Year of the collision

Geography Province or Territory

Collision Severity Fatality, Injury, or Property Damage Only
Large Truck True/False if a large truck is involved
Speed True/False if speed was a factor
Impaired True/False if impairment was a factor
Highway True/False if collision occurred on a highway
Pedestrian True/False if a pedestrian was involved
Multi-Vehicle True/False if more than one vehicle was involved
Number of Collisions Number of Collisions
Number of Vehicles: None Number of vehicles with no damage
Number of Vehicles: Light Number of vehicles with light damage
Number of Vehicles: Moderate Number of vehicles with moderate damage
Number of Vehicles: Severe Number of vehicles with severe damage
Number of Vehicles: Demolished Number of vehicles demolished
Number of People: No Injury Number of people with no injury
Number of People: Injury - Minimal Number of people with minimal injury
Number of People: Injury - Minor Number of people with minor injury
Number of People: Injury - Major Number of people with major injury
Number of People: Fatality Number of people with fatal injuries

The process to summarize the Ontario data consisted of classifying each collision, number of vehicles, and number of people according the discrete characteristics of Collision Severity, Large Truck, Speed, Impaired, Highway, Pedestrian, and Multi-Vehicle. For each of these discrete characteristics, the classification was based on criteria in the MTO injury-level datasets.

- Collision severity was derived from field `B13 Classification of Accident` with 1=Fatality, 2=Injury, and 3=Property Damage Only
- Speed was considered a factor if field `D15 Driver Action` was 03=Speed Exceeded Limit or 04=Speed Too Fast For Condition. If multiple vehicles were involved in a collision, only one vehicle needs to be classified with Speed as a factor for the collision to have the Speed status associated with it.
- Based on the MTO vehicle classification in field *D29 - Vehicle Type*, large trucks are considered to be:
  - 07 to 13 and 98 - Trucks (open, closed, tank, dump, car carrier, tractor, other)

  If multiple vehicles were involved in a collision, only one vehicle needs to be classified as a large truck for the collision to have the Large Truck status associated with it.
- Impaired was considered a factor based on `D16 - Driver Condition` having a value of 02=Had Been Drinking, 03=Ability Impaired Alcohol (over .08), 04=Ability Impaired Alcohol, and 05=Ability Impaired Drugs. If multiple drivers were involved in a collision, only one driver needs to be impaired for the collision to have the Impaired status associated with it.
- Highway status is set if field `B12 - Road Jurisdiction` has a value of 2=Provincial Highway.
- The Pedestrian flag for the collision is set if any person involved in the collision has a value of 9=Pedestrian for `I06 - Position in Vehicle`.
- A collision was considered multi-vehicle if `B09 - Total Driver Vehicle` was greater than 1.

The second state consisted of using the national data, in conjunction with the detailed Ontario data, to generate estimates for the rest of the country[1] While the national dataset includes some of the collision factors including collision severity, multi-vehicle, pedestrian involvement, or heavy-vehicle involvement, it does not contain data in impairment, speeding, or highway status. In addition, it excludes property-damage only collisions, and has a fewer categories of injury and vehicle damage. To account for these differences, the script uses the Ontario data to impute the missing data. The basic steps consist of:

1. Removing the Ontario aggregate data from the National totals
2. Using the provincial and territorial per-capita rates of fatalities and injury reported by Transport Canada to distribute the remaining fatal and injury collisions across the other provinces and territories.
3. Using the ratios of Ontario collision factors for impairment, highway status, and speed to estimate their contribution to other provinces and territories
4. Using Ontario splits of vehicle damage, injury level, and property damage only collisions align the national data with the Ontario data.

The result of the script is a provincial and territorial level dataset consistent both with the national aggregate data and the Ontario injury-level data.

Additional information:

- Excel Sheet: `Inputs-Collision`
- Geographic coverage: Provinces and Territories
- Online source: Preprocessing Script

3.1.2 Vital Statistics - Death Database

While the collision data does include information about whether a collision resulted in a fatality, it is important to check that the the total number reported aligns with Statistics Canada's Vital Statistics database.

Statistics Canada Vital Statistics database contains the cause, classified by ICD-10, of all deaths in Canada by age and sex. Included in these categories are "External causes of morbidity and mortality" which includes those associated with transport accidents. The specific ICD-10 categories included in the model include:

V02-V09 Pedestrian injured in collision with vehicle excluding pedal cycle

V12-V19 Pedal cyclist injured in a collision with vehicle excluding pedestrians and other cyclists

V20-V29 Motorcycle collisions

V30-V39 Occupant of three-wheeled motor vehicle

V40-V49 Car occupant injured

V50-V59 Occupant of pick-up truck or van injured

V60-V69 Occupant of heavy transport vehicle injured

V70-V79 Bus occupant injured

V87,V89 Unclassified

[1] If other provinces were to provide detailed data in a similar for to Ontario, it is straightforward to update the script appropriately.

Note that while the ICD categories refer to injuries, the dataset includes the number of deaths. In addition, for each category of person injured, the other type of vehicle involved in the collision, such as a heavy transport vehicle, another car, or fixed/stationary object. Transport accidents between non-motorized vehicles and pedestrians are not included.
Additional information:

- Excel Sheet: `Inputs-VS-Fatalities`
- Geographic coverage: Canada
- Online source: Statistics Canada Table 13-10-0156

3.2 First Responders

First responders refer to those who attend to the scene of a collision. This includes:

- police,
- ambulance,
- fire department, and
- tow truck operators .

Data in this section includes inputs to estimate both the number of resources required, and the typical cost of responding. Some are paid by government (police, fire, ambulance), some by individuals (tows, ambulance fee).

3.2.1 Towing Costs

Ontario has published standardized towing rates for major highways around Toronto. The value for a medium-duty truck is used as a proxy for towing costs. . Ontario data is used as a proxy, however the input is designed to accept provincial values if available. The Ontario data is also used to estimate the cost factor between collisions which involve large trucks and those which do not. That ratio is configurable via the Heavy Towing Cost Factor.
Additional information:

- Excel Sheet: `Inputs-Tow Costs`

3.2.2 Fire Department Wages

Fire department wages refer to the average annual wages received by a fire department officer. This is used to estimate the cost of the fire department attending the scene of a collision. Fire department wages are from the 2021 census, based on the 2021 National Occupation Codes (occupation code 42101). Costs were deflated to 2019 values for the model input using the provincial CPI values. For the detailed 5-digit NOC resolution, only Canada-wage averages were available. However, the data inputs are structured to allow provincial-level updates when available.
Additional information:

- Excel Sheet: `Inputs-FireDeptWages`
- Geographic coverage: Provinces and Territories
- Online source: Statistics Canada Table 98-10-0412

3.2.3 Police Department Wages

Police department wages refer to the average annual wages received by a police officer. This is used to estimate the cost of a police officer attending the scene of a collision. Police wages are from the 2021 census, based on the 2021 National Occupation Codes (occupation code 42100). Costs were deflated to 2019 values for the model input the provincial CPI values. For the detailed 5-digit NOC resolution, only Canada-wage averages were available. However, the data inputs are structured to allow provincial-level updates when available.
Additional information:

- Excel Sheet: `Inputs-PoliceDeptWages`
- Geographic coverage: Provinces and Territories
- Online source: Statistics Canada Table 98-10-0412

3.2.4 Ambulance Costs

The ambulance costs are used to calculate the cost associated with transporting an injured individual from the site of collision to a hospital. The ambulance costs are based on rates published by the Ontario Ministry of Health and Long-Term Care. The data currently uses the same rate for other regions in the country, but the input table is structured to allow province-specific data if required.
Additional information:

- Excel Sheet: `Inputs-AmbulanceCosts`
- Online source: Ontario: Ambulance Services Billing

3.3 Medical Care

While not all people involved in collisions require medical care, hospitalization and emergency department visits are often required. These data sources are used to calculate the short and long term medical costs associated with collisions.

3.3.1 Hospitalization Costs

For people with injuries, hospitalization care may be required. The Canadian Institute for Health Information (CIHI) regularly published the cost of an average hospitalization across the country. These costs of a standard hospitalization stay by province from CIHI are used as the basis for the hospitalization costs. Cost of a standard hospitalization in 2019 range from a low of $5,784 in New Brunswick to a high of $13,134 in the territories. Note that the model adjusts these values based on the severity of injury with more severe injuries requiring higher than average costs, and less severe injuries requiring less than average costs. These adjustments are tunable using model parameters.
Additional information:

- Excel Sheet: `Inputs-Hosp_Cost`
- Geographic coverage: Provinces and Territories
- Online source: CIHI Cost of a Standard Hospital Stay

3.3.2 Emergency Department Costs

For people with injuries, a trip to the emergency department may be required. The Canadian Institute for Health Information (CIHI) published a report examining the average cost per emergency department visit from CIHI which it found to be $304 per visit. While provincial-level data was not available, this value was used as a proxy across the country. The input is structured such that if regional values are available, the inputs can be easily updated. Costs include an estimate of the overhead, such as hospital administration, in addition to the direct medical care provided, but exclude any transportation to the emergency department.

Additional information:

- Excel Sheet: `Inputs-ED_Costs`
- Geographic coverage: Canada
- Online source: CIHI Average ED Costs

3.4 Other Costs

In addition the first responders, and medical costs, there can be other costs arising as a consequence of a collision. This section describes the sources used for these factors.

3.4.1 Funeral Costs

There is no set price for funerals in Canada as the cost can vary depending upon the wishes of the family. A review of Canadian articles on the topic shows the average price across the country is typically $9,000. As cost can vary considerably based on individual preference, typically reported values are used. In recent years, there has been an increasing shift toward cremation instead of burial which may act to reduce the costs in the future.

Additional information:

- Excel Sheet: `Inputs-Funeral_Cost`
- Geographic coverage: Provinces and Territories
- Online source: Policy Advisor Website

3.4.2 Property Damage Costs

Insurance claim data provides insight into the amount of property damage as a result of collisions. The Insurance Bureau of Canada publishes average claims from automotive insurance policies. It reports that the average claim as a result of collisions is $11,112 per vehicle. Note that the values reported here are considerably lower than in the previous model.

Additional information:

- Excel Sheet: `Inputs-PropertyDamage`
- Online source: Insurance Bureau of Canada

3.4.3 Adult criminal courts, number of cases

While the model requires the average cost of a court case, that value is not directly reportable from Statistics Canada or other sources. Therefore, it must be calculated based on other available data. This data input includes the total number of cases, as well as the number of cases related to traffic charges.

Additional information:

- Excel Sheet: `Inputs-CourtCases`
- Geographic coverage: Provinces and Territories
- Online source: Statistics Canada Table 35-10-0027

3.4.4 Law Courts Expenditures

As mentioned in the previous section, the model required the average cost of a court case which is not directly available. In order to calculate it, the total law court expenditures from Canadian classification of functions of government by province are included in this input.

Additional information:

- Excel Sheet: `Inputs-CourtCosts`
- Geographic coverage: Provinces and Territories
- Online source: Statistics Canada Table 10-10-0024

3.4.5 Coroner Costs

There are a variety of factors that contribute to the overall cost of coroners. The primary one, based on Ontario data, is a minimum flat fee of $420. Depending upon the distance required to travel, additional mileage rates can apply. In addition, if other services or suppliers are required, or attendants are required to wait, additional fees can be incurred. Therefore, an estimate of $600 is used for the typical fee incurred.

Additional information:

- Excel Sheet: `Inputs-CoronerCosts`
- Geographic coverage: Provinces and Territories
- Online source: Ontario Government Regulations, Coroner's Act: Fees, Allowances, and Forms

3.5 Price Indexes

The model is designed to accommodate data inputs that are not all aligned to the same year. When the cost data is not available for the year being analyzed, consumer price indices are used to align costs to the year of interest. Note that results are most reliable if the actual costs of inputs for the year of interest are included in the model, but new releases of inputs may lag behind the release of collision data.

3.5.1 Consumer Price Indexes

In addition to the aggregate consumer price index, Statistics Canada produces product-specific price indices. In particular, product-group indices are used to both bring historical cost data up to the current year, as well as extrapolate price increases going forward if required. In order to avoid unnecessary CPI extrapolation, keeping the CPI data current in the model is recommended.

Note that Nunavut is not included in the product-specific Statistics Canada dataset.

Additional information:

- Excel Sheet: `Inputs-CPI`
- Geographic coverage: Provinces and Territories
- Online source: Statistics Canada Table 18-10-0005

Chapter 4

4. Data Transformations

The raw input data comes in a variety of different formats, and different sources may provide inconsistent data. This section describes the transformations to align the input data into the format and year that the primary model requires. If the shape of the input data changes, updating the transformations to align the new data to the standard form prevents having to make any changes to the core model calculations.

4.1 Year Alignment Transformation

The primary data transformation is one that ensures all data are aligned with the current year of interest. As the same transformation is repeated for most data inputs, it is described once here.

The basic idea behind the year alignment transformation is to use the most recently available data with as little adjustment as possible. This ensures that as the model is updated over time, assumptions about inflation rates, for example, will not cause the estimated costs to diverge from the actual ones.

The process of aligning the year first compares the available years of data to the year of interest in the analysis. If that year of data exists, it is used directly. If the year of data does not exist, a price index is used to estimate the price in the required year using the most recent data available. Depending upon the price being adjusted, either a general or sector-specific price index will be used. Also note that the adjustment is done at the provincial level so that if one province has current data it can be used, while other regions may still be estimated. For health-related costs, the health-services specific price index is used. For all others, the general CPI index is used.

The `Transformation-CPI_Estimates` sheet provides the CPI factors used to align the costs to the year of interest. If it happens that the CPI data does not have the year of interest, it will be estimated based on historical trends. When extrapolating a future price based on CPI data, the parameter `CPI Lookback Years` is used to specify how many years to historical price changes to use to project the future rate. As year-over-year fluctuations can be noisy, using a multiple year lookback period provides a more reliable means to estimate the future prices. However, it is important to note that this estimate is intended to be a fallback measure, and that is best to keep the CPI data in the model up to date.

The year alignment process is applied to the following data inputs.

Item	Transformation Location	Input Table
Hospitalization Costs	`Transformation-YearAlignment!B3`	`Tbl_Hosp_Cost`
Emergency Costs	`Transformation-YearAlignment!B51`	`Tbl_ED_Cost`
Funeral Costs	`Transformation-YearAlignment!B100`	`Tbl_FuneralCosts`
Police Department Wages	`Transformation-YearAlignment!B150`	`Tbl_PoliceDeptWages`
Fire Department Wages	`Transformation-YearAlignment!B200`	`Tbl_FireDeptWages`
Tow Costs	`Transformation-YearAlignment!B250`	`Tbl_Tow Costs`
Ambulance Costs	`Transformation-YearAlignment!B300`	`Tbl_AmbulanceCosts`
Property Damage Costs	`Transformation-YearAlignment!B350`	`Tbl_ProperyDamage`
Out-of-Pocket Costs	`Transformation-YearAlignment!B400`	`Tbl_OutOfPocket`
Court Costs	`Transformation-YearAlignment!B500`	`Tbl_AvgCourtCost`
Coroner Costs	`Transformation-YearAlignment!B550`	`Tbl_OutOfPocket`

Due to the structure of the algorithm the alignment will fail if the current year is prior to any years in the dataset. It is designed to do only forward-looking projections.

4.2 Court Cost Transformation

While the year alignment process accounts for most of the transformation required in the analysis, one additional transformation is required in the model to calculate the average court costs. The average cost of a court case is not directly provided in the input data. Instead, the annual cost of all court cases, as well as the number of cases processed are available as inputs from Statistics Canada data. These values must be transformed into the average cost of a court case that is required by the model input.

The transformation is simply:

$$C_{\text{average}} = \frac{E_{\text{total}}}{N_{\text{total}}}$$

where C_{average} is the average cost per court cases, E_{total} are the total court expenditures, and N_{total} are the total number of court cases.

Chapter 5

5. Model Parameters

While as much of the analysis as possible is based on available data, there are some variables which the user may which to adjust to understand the sensitivity of the results. The adjustable parameters used in the model are listed below. These can be changed for the default model, or new scenarios can be created to test different circumstances. The *Scenarios* sheet in the Excel model contains instructions on how to update existing scenarios, or create new ones.

Value of Statistical Life Value of Statistical Life ($M). The default value is based on the Bergeron (2014) in 2007 dollars
Default value: $7.8

Year of Value of Statistical Life The year for which the VSL is given.
Default value: 2007

Human Cost of Major Injury Fraction of VSL for a major injury. The default is the value used in existing Transport Canada analysis.
Default value: 0.1242

Human Cost of Minor Injury Fraction of VSL for a minor injury. The default is the value used in existing Transport Canada analysis.
Default value: 0.0046

Human Cost of Minimal Injury Fraction of VSL for a minimal injury. The default is the value used in existing Transport Canada analysis.
Default value: 0.0012

Hospital Stay Factor - Fatality Relative to the standard hospital stay for people who have fatal injuries. Fatalities in the collision dataset include those who die as a result of the collision within 30 days of the event.
Default value: 4

Hospital Stay Factor - Major Injury Relative to the standard hospital stay for people with major injuries
Default value: 2

Hospital Stay Factor - Minor Injury Relative to the standard hospital stay for people with minor injuries
Default value: 0.5

Hospital Stay Factor - Minimal Injury Relative to the standard hospital stay for people with minimal injuries. A value of zero implies that minimal injuries do not require hospitalization.
Default value: 0

CPI Lookback Years In the case that the price indexes in the model do not extend to the

current model year, the average price increases over the last several years will be used to estimate the current price level. The number of years used is specified in this parameter.
Default value: 5

Future Consumer Price Index Future assumption of CPI if actual data is not available, in percent. Note that this is only a fallback measure if CPI data is not updated.
Default value: 2

Heavy Towing Cost Factor For collisions which involve a large truck, an additional towing cost factor can be applied. Based on Ontario's Tow Zone pilot program, heavy-duty wreckers can cost 2.6 times more per hour. In addition, the time taken to clear the collision is likely longer. This parameter can account for those factors.
Default value: 3

Property Damage Only Towing Cost Factor For collisions which involve property damage only, all vehicles may not require towing. This parameter specifies the fraction of property damage only vehicles which require towing.
Default value: 3

Annual Police Hours The average number of hours worked per year by a police officer.
Default value: 2000

Police Hours Response per Fatality For collisions which involve a fatality, this parameter specifies the extra police hours are required. This includes hours not on the scene of the collision.
Default value: 10

Police Hours Response per Vehicle The average hours spent responding to a collision per vehicle. This includes hours not on the scene of the collision.
Default value: 2

Annual Fire Department Hours The average number of hours worked per year by a fire department officer.
Default value: 2000

Fire Department Response per Fatality For collisions which involve a fatality, this parameter specifies the extra fire department hours are required. This includes hours not on the scene of the collision.
Default value: 4

Fire Department Response per Vehicle The average hours spent responding to a collision per vehicle. This includes hours not on the scene of the collision.
Default value: 2

Property Damage Factor - Demolished The property damage cost for a demolished vehicle, relative to the average value of property damage. The default value is chosen to maintain the relative costs between levels of vehicle damage from the original model.
Default value: 4.41

Property Damage Factor - Severe The property damage cost for a severely damaged vehicle, relative to the average value of property damage. The default value is chosen to maintain the relative costs between levels of vehicle damage from the original model.
Default value: 2.36

Property Damage Factor - Moderate The property damage cost for a moderately damaged vehicle, relative to the average value of property damage. The default value is chosen to

maintain the relative costs between levels of vehicle damage from the original model.
Default value: 1

Property Damage Factor - Light The property damage cost for a lightly damaged vehicle, relative to the average value of property damage. The default value is chosen to maintain the relative costs between levels of vehicle damage from the original model.
Default value: 0.22

Coroner Fraction The fraction of fatalities which require the service of a coroner. The default value is based on the original model.
Default value: 0.52

Delay - Fatality Collision (minutes) The average number of minutes vehicles are delayed due to a fatal collision. Refer to Section 2.5 for details.
Default value: 245

Delay - Injury Collision (minutes) The average number of minutes vehicles are delayed due to an injury collision. Refer to Section 2.5 for details.
Default value: 48

Delay - Non-Injury Collision (minutes) The average number of minutes vehicles are delayed due to a non-injury collision. Refer to Section 2.5 for details.
Default value: 22

Delay - Average Vehicles Affected The average number of vehicles affected by a collision. The default value aligns the results with the earlier model. Refer to Section 2.5 for details.
Default value: 250

Appendix A

A. Updating the Model

The Model is designed to be easily updated with new data while maintaining existing results. This allows comparison between years in a model that is guaranteed to be consistent over time. The use of Scenarios allows the sensitivity of the output to various model parameters to be explored without disrupting the base case.

When updating the model, only tables on the `Input` sheets need to be changed. No updates to any calculations or transformations is required. There are three basic steps to updating the model:

- **Generate Updated Collision Data:** While most data is available in the required format, the collision data is too complex and large to transform direct in Excel. Therefore, a standalone script is used. The first step in updating the model is to run the script to generate the summaized data set. For example,

```
python3 ./align_data.py -y 2019 -ontario-collisions BDFile2019.csv
-ontario-injury FatalitiesAndInjuries2019.csv -national 2019DatasetEn.csv
-casualty ProvincialCasualtyRatesTransportCanada.csv
```

- **Update Data Inputs:** The data sources for each of the input sheets is listed at the top of each sheet and in the model documentation. In general, to update any of the data on the `Input` sheets, one simply retrieves the new year of data from the identified sources and appends it to the Excel tables. In some cases were
- **Refresh Excel:** In Excel, after tables are updated, the internal data caches need to be updated in order for any changes to be visible. To do this, simply select `Refresh All` under the `Data` menu.

Concepts Index

Excel Sheet Index

This index list all of the Excel sheets in the calculation spreadsheet.