Collision Cost Study Update
FINAL Report

Prepared For:

CRISP
CAPITAL REGION INTERSECTION SAFETY PARTNERSHIP

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EXECUTIVE SUMMARY

ES-1 Background and Objectives

This report has been prepared for the Capital Region Intersection Safety Partnership (CRISP), with the objective to describe and quantify the costs that are associated with motor vehicle collisions within the Capital Region. This report is an update to a previous Collision Cost Study[1], which was completed in 2010. The 2010 study developed a collision cost model that was based on data from 2007 and as such, it was felt that an update was necessary to reflect changes to the model inputs, as well as the change in safety performance in the Region.

Collision costs are categorized into 3 types of costs including 1) direct costs, 2) human capital costs and 3) willingness to pay (WTP) costs. The major focus of the study was dedicated to direct collision costs, which are described in Chapter 3 but estimates for human capital (HC) costs and WTP costs were also provided, as detailed in Chapters 4 and 5 respectively.

ES-2 Baseline Collision Data

A fundamental input for the collision cost model is the historical data for the jurisdiction, which included 9 communities with the Capital Region (Devon, Edmonton, Fort Saskatchewan, Leduc, Morinville, Sherwood Park, Spruce Grove, St. Albert, and Stony Plain). This collision data is used to create an accurate depiction of the safety performance in the region, which will influence the total costs that are associated with collisions.

In comparing the collision data sets from 2007 and 2015, what is significant and notable is the marked improvement in the frequency of severe collisions (i.e., fatal and injury producing collisions). The data shows that fatal collisions have reduced by 17% and injury collisions have reduced 38% between 2007 and 2015. Although an improved level of safety has been observed in other jurisdictions, it is noted that the magnitude of this improvement for the Capital Region is very significant and could likely be linked to the dedication and efforts focused at road safety within the region.

[1] de Leur, P, Thue, L., and Ladd, B, Collision Cost Study Final Report, Prepared for CRISP Capital Region Intersection Safety Partnership (CRISP), February 2010.

ES-3 Collision Cost Results

A total of 28 different collision cost elements were considered in the generation of the estimates for collision costs, disaggregated over the three categories of collision costs (direct, human capital, and willingness to pay).

A summary of the results for the direct collision costs is provided in Table ES-1, which includes a reference to the report chapter that describes the each direct cost element.

Table ES-1: Summary of Estimated DIRECT Collision Costs: Updated Study 2017

DIRECT Collision Costs		Collision Costs (by Victim)				Collision Costs (by Collision)		
Report Chapter	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatal	Injury	PDO
3.1	**Property Damage**							
3.1.1	Vehicle Repairs	$29,853	$21,288	$18,020	$9,409	$32,412	$17,626	$9,130
3.1.2	Auto-Insurance Administration	$4,397	$2,157	$1,540	$423	$4,774	$1,751	$411
3.1.3	Out-of-Pocket Expenses	$1,346	$1,053	$972	$633	$1,462	$946	$614
3.1.4	Towing Services	$818	$661	$676	$508	$888	$735	$493
3.2	**Emergency Response Costs**							
3.2.1	Police Costs	$6,200	$1,925	$618	$188	$6,621	$741	$188
3.2.2	Fire / Rescue Costs	$3,023	$4,307	$1,168	$0	$3,282	$2,462	$0
3.2.3	Ambulance Costs	$914	$1,934	$621	$0	$992	$744	$0
3.2.4	Coroners Costs (Fatal Only)	$1,994	$0	$0	$0	$2,165	$0	$0
3.3	**Health Service Costs**							
3.3.1	Emergency Room Costs	$2,007	$341	$288	$0	$2,179	$502	$0
3.3.2	ICU Care Costs	$59,775	$40,443	$0	$0	$64,899	$5,908	$0
3.3.3	Acute Care Costs	$11,517	$8,611	$0	$0	$12,505	$1,258	$0
3.3.4	Rehabilitation Costs	$3,946	$2,209	$204	$0	$4,284	$643	$0
3.3.5	Continuing Care Costs	$23,280	$14,387	$832	$0	$25,276	$3,407	$0
3.4	**Legal Costs**							
3.4.1	Correctional Services	$1,294	$402	$13	$0	$1,405	$60	$0
3.4.2	Court Costs	$456	$142	$5	$0	$495	$21	$0
3.4.3	Legal Aid and Prosecution	$461	$143	$5	$0	$500	$21	$0
3.4.4	Funeral Costs (Fatal Only)	$10,109	$0	$0	$0	$10,975	$0	$0
3.5	**Travel Delay Costs**							
3.5.1	Delay Costs Caused by Collision	$20,511	$11,247	$6,142	$2,598	$20,511	$6,466	$2,598
3.5.2	Extra Fuel Consumption	$1,484	$814	$444	$188	$1,484	$468	$188
3.5.3	Environmental / Pollution Costs	$3,028	$1,660	$907	$384	$3,028	$954	$384
3.6	**Productivity / Disruption Costs**							
3.6.1	Short-Term Work-Place (Injury)	$18,654	$8,394	$1,531	$0	$20,253	$3,628	$0
3.6.2	Short-Term Work-Place (Fatal)	$4,761	$0	$0	$0	$5,169	$0	$0
3.6.3	Short-Term Work-Place (PDO)	$0	$0	$0	$59	$0	$0	$59
	TOTAL for DIRECT Costs:	**$209,828**	**$122,115**	**$33,987**	**$14,391**	**$225,558**	**$48,341**	**$14,065**

A summary of the results for the human capital costs is summarized in Table ES-2 and the results for the willingness to pay costs are summarized in Table ES-3. A combined cost that includes the direct costs is also included with the tables below.

Table ES-2: Summary of Estimated Human Capital Collision Costs: Updated Study 2017

HUMAN CAPITAL Costs		Collision Costs (by Victim)				Collision Costs (by Collision)		
Report Chapter	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatality	Injury	PDO
4.1	**Discount Future Earnings**							
4.1.1	Long-Term Income Loss (Fatal Collision Victim)	$1,855,990	$0	$0	$0	$1,873,520	$0	$0
4.1.2	Long-Term Income Loss (Disabled Injury Victim)	$132,083	$73,210	$7,044	$0	$143,405	$21,742	$0
4.1.3	House-Hold Productivity and Disruption Costs	$112,316	$59,331	$6,796	$0	$121,943	$19,326	$0
4.2	**Pain, Suffering and Grief**							
4.2	Pain, Suffering and Grief	$79,735	$122,115	$2,719	$0	$85,712	$48,341	$0
TOTAL for HUMAN CAPITAL Costs:		**$2,180,125**	**$254,656**	**$16,558**	**$0**	**$2,224,580**	**$89,408**	**$0**
TOTAL for HUMAN CAPITAL + DIRECT Costs:		**$2,389,953**	**$376,771**	**$50,546**	**$14,391**	**$2,450,139**	**$137,749**	**$14,065**

Table ES-3: Summary of Estimated Willingness to Pay Costs: Updated Study 2017

WILLINGNESS TO PAY Costs		Collision Cost (by Victim)				Collision Costs (by Collision)		
Report Chapter	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatality	Injury	PDO
5.1	**Value of Statistical Life**							
5.1	Valuation of Statistical Life (VoSL) (FATAL Only)	$6,177,710	$0	$0	$0	$6,707,228	$0	$0
5.2	**Valuation of Major Injuries**							
5.2	Valuation of Injures (MAJOR Injuries Only)	$0	$1,500,301	$0	$0	$0	$158,654	$0
TOTAL for WILLINGNESS TO PAY Costs:		**$6,177,710**	**$1,500,301**	$0	**$0**	**$6,707,228**	**$158,654**	**$0**
TOTAL: WILLINGNESS TO PAY + DIRECT Cost:		**$6,387,538**	**$1,622,416**	**$33,987**	**$14,391**	**$6,932,786**	**$206,994**	**$14,065**

ES-4 Comparison Between 2010 and 2017 Results

A comparison of the results from the 2010 study and this updated 2017 was completed to determine how the collision cost values have changed. The change for each collision cost element is shown in Section 6.4 of this report but in summary, it was determined that the direct collision costs increase by an average of 25%, while the indirect collision costs (human capital costs and willingness to pay costs) increase by an average of 18%. A summary of the total collision costs in 2010 (based on 2007 collision data) and the total collision costs in 2017 (based on 2015 collision data) is listed below.

	2017 Study	2010 Study
Direct Total Collisions Costs:	$807M	$905M
Human Capital Total Collision Cost	$2.1B	$3.0B
Willingness to Pay Collision Costs	$8.5B	$11.1B

1.0 INTRODUCTION

In 2015, there were 38 people killed, 4,300 people injured and over 39,000 property damage only collisions within the Capital Region. For those involved in these collisions, especially the fatal and serious injury collisions, the tragedy and human costs are very evident. However, for those fortunate enough not to be involved in a collision, the costs are less evident. As such, it is important to quantify the high costs of collisions in order to highlight the significance of the road safety problem.

The total economic costs associated with the motor vehicle collisions within the Capital Region is considerable and it is important to understand the economic cost of collision in order to appreciate and justify initiatives deployed to address the road safety problem. In support of this objective, the Capital Region Intersection Safety Partnership (CRISP) commissioned a study in 2010[2] to evaluate the cost of collisions. This report presented a set of collisions costs, reflecting the typical ways that collision costs are reported including:

Direct Costs: These are the largely tangible and clearly understood costs that can be directly linked to the collision, including property damage costs, emergency services, medical expenses, legal costs, travel delay costs and the costs associated with lost time from the workplace. Often, the data required to accurately determine the direct costs of collisions are readily available.

Human Capital Costs: These are costs that are associated with the future net production that is lost to a society as a result of a collision. A value for future net production is determined by subtracting a collision victim's future net consumption from their future net production. This value represents a measure of the 'value' of that person to the society.

Willingness To Pay Costs: These are costs that a society is willing to pay to prevent or reduce the risks associated with the occurrence of collisions, particularly collisions that involve injury and death. This method involves surveying a representative sample in order to understand the tradeoff between collision risk and economic resources available to the population.

[2] de Leur, P, Thue, L., and Ladd, B, Collision Cost Study Final Report, Prepared for CRISP Capital Region Intersection Safety Partnership (CRISP), February 2010.

1.1 Project Objective

Since it is reasonable to expect that the costs associated with collisions will change over time, it was felt that the results of the 2010 Collision Cost Study may be somewhat out of date and in need of updating. The 2010 study was based on data from 2007 and it was felt that an update was necessary to reflect changes to the model inputs used in the evaluation of collision cost of collision, as well as the change in safety performance in the Region. As will be presented later in this report, there has been a significant reduction in the frequency and severity of collisions within the Capital Region. As such, a follow-up study was commissioned to update the 2010 Collision Cost Study. The outcome from the updated study will be a new set of collision cost values that can be used within the Capital Region.

The methodology in this current report generally follows the methodological approach that was used in the 2010 study since the various elements of the collision-costing model have not changed (i.e., there are no new types of costs associated with collisions in 2017 as compared to 2010). The methodology follows an approach described in a Transport Canada report by Vodden et al[3] (2007), which is considered to be the most thorough and applicable approach for the Capital Region. Greater detail concerning the methodology and the applicability for the Capital Region can be found in the original 2010 study.

The focus of the update was to examine each input to the costing model, examine the suitability of the input, and make the necessary changes to reflect current costs and new or improved information. The success of the update is dependent upon the information available and provided and great care was taken to ensure that the most current and correct data was available for the study. This requirement lead to some delays in the project, but it was agreed that it would be better to wait to ensure that the data is most current rather than formulate collision cost estimates on data that was not the most current. In addition, some quality control reviews of the baseline collision frequency input data by the communities within the Capital Region lead to improved data quality as late as July 2017.

[3] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007.

1.2 Report Structure

This first chapter of the report has simply provided a brief introduction to the study, defined the objective of the current study, and provided the context for the study, including the methodology used and the focus of the study. Chapter 2 provides a general overview of the collision costing evaluation methods, which help to describe all of the various elements that are considered when evaluating the cost of collisions.

Chapter 3 of the report will discuss the different collision severity categories and how collisions are classified. This information was provided in the original study but is described again in this report, as it is important for the understanding and presentation of the collision cost model results. Also included in chapter 2 is the presentation of the baseline collision data, which provides the basis for the collision-costing model. This is important because it highlights the improved level of safety within the Capital Region, which shows a significant collision reduction from 2007 to 2015.

Chapter 4 of the report will focus on the direct costs associated with collisions and will provide information for any updates to the methodology used to calculate the collision cost values. Throughout this report, the results of this 2017 update will be compared to the results from the 2010 report, such that the reader can understand the magnitude of the change in collision costs. When the magnitude of the change is significant, some explanation for the difference is provided.

Chapter 5 of this report will present the results of the human capital cost values, which includes the examination of a collision victim's consumptions and production, as well as an estimate for a loss in the quality of life.

Chapter 6 of the report presents the results for the willingness to pay collision cost model. Methods to determine a willingness to pay are very involved and often involve surveys and sophisticated questionnaires, which was not part of the original study, or this update. However there are some techniques that can be used to generate an estimate for a willingness to pay for collision costs.

Chapter 7 provides the results for the update to the collision cost study, including a summary of the overall collision costs, the detailed collision costs estimates, and some potential limitations / caveats associated with the collision cost values.

2.0 COLLISION COST EVALUATION METHODS

As was briefly described in the introductory chapter, the costs associated with collisions are often grouped into three categories, including 1) direct costs, 2) human capital costs and 3) willingness to pay costs.

- Direct costs are those costs that are borne by the individuals involved in the collision and are typically costs that are more clearly understood (e.g., property damage, medical costs, etc.).
- Human capital costs refer to the lost productivity to a society due to the collision and are costs that are less understood (e.g., quantifying lost income).
- Willingness to pay cost, which is a highly intangible cost, is the value that a society is willing to pay to prevent or reduce the risks associated with a collision that involves injury and / or death.

Collision costs can also be categorized into two groups, namely internal costs and external costs. The internal costs are similar to the direct costs in that these costs represent the losses to individuals who are involved in the collision. The external costs represent the damages and losses that are NOT necessarily borne by the individual who is involved in the incident, but are costs that are borne by persons close to the individual (e.g., family members) and borne by the society as a whole.

Direct or internal collision costs are typically calculated from existing databases associated with the various components of cost. For example, emergency response agencies such as the police, fire and rescue, and ambulance normally maintain records of the time and costs associated with attending motor vehicle collisions. Similarly, healthcare service providers often maintain databases that can track emergency department and hospital costs associated with injury-causing motor vehicle collisions.

Since the collision costs associated with the direct / internal costs are typically generated from existing databases, the available literature concerning how these values were obtained is limited. More emphasis is generally placed on external costs, as it is often quite difficult to assign dollar values to intangible services that are borne by individuals and societies as a whole. As such, the external costs are the main focus of this section of the report. Values for internal / direct collision costs are provided in a subsequent section of this chapter.

The methods used to quantify external costs can be categorized into four categories:

- Loss of Productivity
- Lost Quality of Life
- Loss of utility and value of road injuries
- Pain and Suffering

Within each category, there are several techniques used to evaluate costs. A brief overview of these techniques is provided in this section of the report. It is noted however, that the main focus of this assignment for CRISP and the Capital Region was on the direct / internal costs, and the techniques listed in this section are generally beyond the scope of the assignment.

2.1 Loss of Productivity

Two methods are commonly used when trying to measure the loss of productivity associated with a collision, including, 1) the Human Capital Approach (HCA) and 2) the Friction Cost Method (FCM).

2.1.1 Human Capital Approach (HCA)

This approach involves estimating the value of earnings that the individual would have made had he/she not been involved in a collision. Authors Connelly and Supangan (2006) explained this by saying that from the point of view of the economy, an individual's lost productivity is irrecoverable after he/she has been in a collision. This method uses objective measures such as the number of lives that are saved and the disabilities that can be reduced (Marshall, 1930; Pigou, 1932). The main component is the calculation of the "discounted present value of the victim's future output forgone due to his/her death" (Dawson et al, 2007).

2.1.2 Friction Cost Method (FCM)

Some believe that the human capital approach overestimates the productivity losses to the economy (Connelly and Supangan, 2006). It is argued that the loss of productivity to society should only be computed until another worker is found to replace the disabled/injured employee. The assumption is that the labor supply within an economy is perfectly elastic, in the sense that any loss of labor due to collisions approaches zero if FCM is employed.

2.2 Pain, Suffering and Grief

Another component of the external costs that are associated with collisions is the pain, suffering and grief that are linked to either a severe injury collision or to a fatal collision. These costs can include the value of the pain, suffering and grief that is imposed on the individual who is involved in the collision, as well as the family and/or friends of the victim.

The information related to the pain, suffering and grief component of human capital costs is highly varied, which produces a wide range of results. Furthermore, the approach used to formulate the estimate for pain, suffering and grief appears to be largely abstract and highly subjective or arbitrarily derived. There appears to be no definitive or scientific way to accurately determine and quantify how much pain, suffering and grief is worth.

In settling claims for pain, suffering and grief, attorneys and insurance companies will often consult legal publications that report the results of other cases that have gone to trial and produced values for pain, suffering and grief. This, in combination with many other factors related to a specific claim (e.g., the effectiveness of medication at controlling pain, persons affected, time frame in which the pain, suffering and grief must be endured), helps to determine the value of pain and suffering.

A study prepared by the Transportation Research Laboratory (TRL) in the United Kingdom (Jacobs, G.D., 1995) proposed that pain, suffering and grief could be calculated based on a proportion of the direct / internal costs associated with collisions. The TRL study, which was cited in a report by the International Road Assessment Program (Dawson, et al, 2007), recommends that the value for the pain, suffering and grief should be 8% of the total direct collision costs for minor collisions and up to 100% of the total direct collision costs for serious, long-term permanent injuries.

Obviously, this represents a simple guideline or perhaps a range of values that can be used for the average economic value associated with pain, suffering and grief. However, it appears that a significant range exists when attempting to quantify the societal value for pain, suffering and grief.

2.3 Loss of Quality of Life

Lost quality of life as a result of an injury or disability is an important component of the external cost of collisions. This component is the main focus of the healthcare sector, specifically when making decisions about allocation of resources based on economic evaluations (Goebbels et al, 2008). Three methods are often used to determine lost quality of life, which are briefly described below.

2.3.1 Quality Adjusted Life-Year (QALY)

This method combines life expectancy and the quality of life in a single outcome measure (Goebbels et al, 2008). For this approach, one year of perfect health / life expectancy is worth a unit value (i.e., 1.0), whereas one year of less than perfect health / life expectancy is equal to a value of less than 1.0. In order to apply this approach, it is necessary to have information regarding the type of disability/injury that results from an individual's suffering (associated with a collision) and the value of a "less than perfect life expectancy" associated with that disability/injury. These values will provide an indication of benefits gained in terms of quality of life and survival.

2.3.2 Disability-Adjusted Life-Year (DALY)

This method includes calculating the burden that can be associated with an injury (in the case of motor vehicle collisions). There are 4 main concepts that constitute the DALY approach (Murray, 1994):

- Any health outcome which represents a net loss of "welfare" should be included in an indicator of a health status,
- The characteristics of individuals affected by a health outcome should be considered in calculating the burden of an injury, but it should be restricted to age and gender,
- All health outcomes should be treated alike, and
- The time (years) is the unit of measure of the burden of an injury.

In order to accurately evaluate the DALY, it is necessary to have information and data for various health outcomes, including the type of injuries caused as a result of the motor vehicle collision and the number of years that an individual needs to fully recuperate.

2.3.3 Health Years Equivalent (HYE)

Health Years Equivalent (HYE) represents the hypothetical number of years spent in good health, which is the equivalent to a health status. Gold (Gold et al, 1996) explained HYE as "the number of years of perfect health that has the same utility as the lifetime path of the state of health under consideration" (i.e., a "less than perfect" health status). The value of HYE is obtained by assigning values for each health outcome. Then, a weight for the expected value for each outcome is obtained by determining the probability of a specific path and the total across all paths. The assumptions required for the HYE method include determining a value for a healthy outcome and the health status attribute (Ried, 1998).

2.4 Value of Statistical Life (VoSL)

The overall value that a society associates with an unexpected death due to collisions is the main focus of most of the literature related to the external cost of collisions. Many economists believe that assigning monetary values to fatal collisions should reflect individual preferences (De Blaeij and Van Vuuren, 2003). This is often referred to in the literature as the value of statistical life (VoSL).

There are several methods that can be used to assess the value of statistical life, but the methods are generally based on two principle fundamental questions as listed below (Giles, 2003; Bellavance, 2007):

- Willingness to Pay (WTP): This is a measure of how much a society (or an individual) is willing to pay to avoid death due to a collision or to reduce the risk of death (Jones-Lee, 1974; Mishan, 1971; Schelling, 1968). This method involves a tradeoff between the level of risk and the economic resources available.
- Willingness to Accept (WTA): This is a measure of how much a society (or an individual) is willing to accept as compensation for a death as a result of a collision or the amount of financial compensation that an individual would need to receive before they are willing to accept a specific reduction in their life expectancy.

In general, two techniques are used to represent the value that an individual places on their own health (Connelly and Supangan, 2006), including 1) revealed preference and 2) stated preference, which are described below.

2.4.1 Revealed Preference

Revealed preference is a method that involves identifying various situations where people are asked to make a tradeoff between money and risk (Hiselius, 2003). It measures the "utility change in probability of a fatal collision by looking at the revealed behavior" (De Blaeij, D.J. van Vuuren, 2003). This method includes designing a survey aimed at determining tradeoffs. Road users are asked to make decisions between specific safety features and money; for example, one of the questions on the surveys could be: "how much are you willing to pay to have air-bags installed in your vehicle" (WTP) or "how much risk are you willing to accept to remove air-bags from your vehicle" (WTA). The revealed preference approach involves assessment of risk and willingness of individuals to choose resources in exchange for reducing risk to an acceptable level (Dawson et al, 2007).

2.4.2 Stated Preference

There are several methods that are used in order to determine the stated preference of road users but the WTP and WTA are still the fundamental basis of this approach. Stated preference is obtained by surveys that are designed to determine WTP and WTA values and this method is used when the revealed preference data is either unavailable or inconclusive. The estimates are obtained from hypothetical choices determined by questionnaires designed to address specific impacts. The approach facilitates the collection of detailed data on safety impacts that are of specific interest.

Respondents of stated preference questionnaires are expected to answer the questions based on the objective risk and not individual preference. In addition, it is assumed that the values obtained from the methods reflect those that occur in the real market. Respondents who complete the survey are assumed to be representative sample of the population.

There are a number of survey methods that can be used to obtain stated preferences related to the risks associated with collisions. Some of these techniques include contingent valuation methods (i.e., respondents state their WTP or WTA values), choice experiments, standard gamble, Firsch Method (Lhs et al, 2003), transfer price methods, and prospect theory. Greater detail on these techniques can be found in literature related to survey techniques.

2.5 Summary of Collision Cost Evaluation Methods

A graphical summary of the different collision cost elements for the internal (direct) costs and the external (human capital and willingness to pay) costs are provided in Figure 2.1 below.

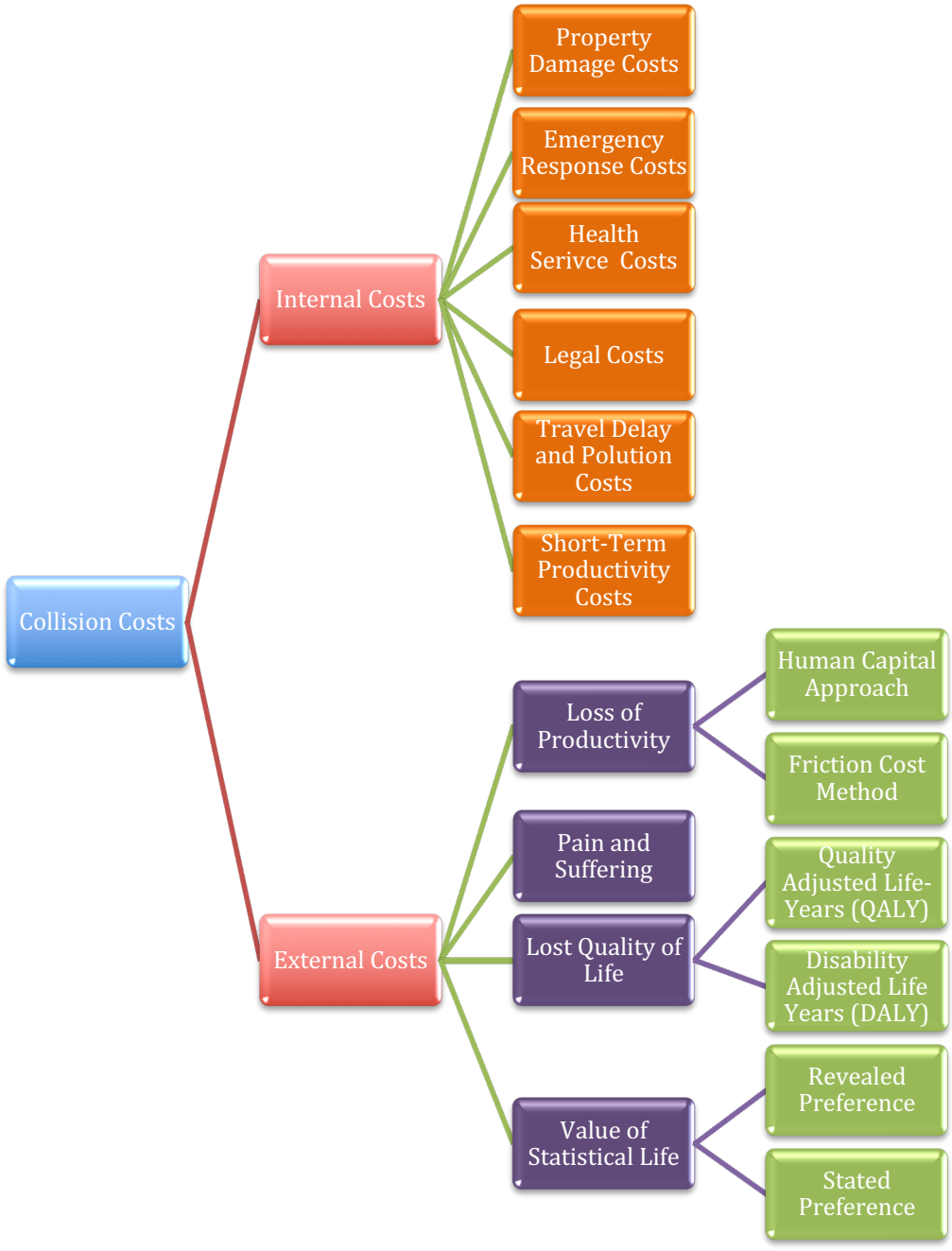

Figure 2.1: Summary of Collision Cost Evaluation Methods

3.0 BASELINE COLLISION DATA

The fundamental input for collision cost model is the historical data for the jurisdiction under review. This collision data is used to create an accurate depiction of the safety performance in the region, which will influence medical costs, property damage, traffic delay and all other costs associated with collisions. Baseline collision data is adjusted to account for problems that are typically associated with collision data. A description of the baseline collision data and the various adjustments are provided in this chapter.

3.1 RAW COLLISION DATA: 2015 Update

The historical collision data used in this update was made available from the Office of Traffic Safety for the Province of Alberta. Collision data for 2015 from the following communities were included in the raw data set for the collision cost model.

- Devon
- Edmonton
- Fort Saskatchewan
- Leduc
- Morinville
- Sherwood Park
- Spruce Grove
- St. Albert
- Stony Plain

The 2015 baseline collision data is shown on the following page in Table 3.1 and for comparative purposes, the baseline data from 2007 used in the original study is shown in Table 3.2. Included in Tables 3.1 and 3.2 are the collision frequency, disaggregated by community and collision severity level (i.e., fatal, injury and property damage only (PDO)). Also included in the tables are the collision frequencies by victim (i.e., fatalities, major injuries and minor injuries), also disaggregated by community. The difference between the two frequency types (i.e., collision versus victim) may be confusing and is best described by way of an example. Consider a severe collision involving two vehicles with 2 persons in one vehicle and 3 persons in the other vehicle (a total of 5 people). The outcome of the crash resulted in injuries to three people (one severe injury and 2 minor injuries), while the other two persons were not hurt. This incident only counts as one collision, but it counts as three victims (1 severe, 2 minor). A detailed description of this concept was provided in the original study and is provided again in Appendix 1.

In comparing the collision data sets from 2007 and 2015, what is significant and notable is the marked improvement in terms of a reduction in the frequency of severe collisions (i.e., fatal and injury producing collisions). The data shows that fatal collisions have reduced by 17% and injury collisions have reduced 38% between 2007 and 2015. Although an improved level of safety is consistent in other jurisdictions, it is noted that the magnitude of this improvement for the Capital Region is very significant and could likely be linked to the dedication and efforts that are focused at road safety within the region.

Table 3.1: 2015 Baseline Collision Data

Community	Collision Severity Class 1			Collision Severity Class 2 (Victim)		
	Fatal	Injury	PDO	Fatalities	Major Injuries	Minor Injuries
Devon	1	5	76	1	0	7
Edmonton	29	3,363	34,488	31	417	3,779
Ft. Saskatchewan	0	65	560	0	5	78
Leduc	2	110	662	3	16	124
Morinville	0	11	80	0	1	11
Sherwood Park	3	414	1,615	3	49	510
Spruce Grove	0	144	800	0	22	181
St Albert	0	127	741	0	13	170
Stony Plan	0	61	317	0	20	61
TOTAL	35	4,300	39,339	38	543	4,921

Table 3.2: 2007 Baseline Collision Data

Community	Collision Severity Class 1			Collision Severity Class 2 (Victim)		
	Fatal	Injury	PDO	Fatalities	Major Injuries	Minor Injuries
Devon	1	6	118	1	4	9
Edmonton	32	5,955	33,943	33	536	7,503
Ft. Saskatchewan	3	74	448	3	9	103
Leduc	1	111	917	1	17	128
Sherwood Park	2	375	1,534	2	33	473
Spruce Grove	1	70	667	1	14	84
St Albert	2	262	1,261	2	26	309
Stony Plan	0	29	396	0	7	30
TOTAL	42	6,882	39,284	43	646	8,639

3.2 Adjustments to Raw Collision Data: 2015 Update

There are a number of adjustments that must be made to the baseline collision data in order to correct for typical limitation and issues associated with collision data. The three main adjustments in include the following:

1) Additional fatal collisions:
   The number of police reported fatal collisions must be adjusted to reflect potential differences in the number of fatal collisions that can occur when the death happens later in hospital (i.e., not at the collision scene), but this information does not get updated on the collision report (i.e., it is still noted as an injury collision).
2) Additional injury collisions:
   The number of police reported injury collisions must be adjusted to resolve discrepancies between police reported PDO collisions and injuries reported from hospital admission records. These types of adjustments typically involve soft-tissue injuries (e.g., whiplash), which are reported by police as a PDO since injuries are not readily apparent at the scene. However, these crash victims will often visit an emergency department, hospital, or clinic, where the outcome of the incident is later denoted as a collision-related injury in a healthcare record.
3) Additional minor collisions:
   An adjustment is required to the number of minor collision to reflect the differences between the police reported collision data and the actual collision experience, recognizing that most police agencies do not attend all collisions or collect data for all collisions. This can be particularly problematic for lower severity incidents (e.g., minor injury), where police attendance and/or reporting can be low.

3.2.1 Adjustment 1: Additional Fatal Collisions

In order to account the difference between police reported fatal collisions and hospital reported deaths (due to traffic collisions) it is necessary to apply a multiplier of 1.017 to the number of reported fatal collisions. The multiplicative factor is based on the methodology described in a Transport Canada study[4] and was developed based on a large and updated data set from 2014.

[4] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007.

3.2.2 Adjustment 2: Additional Major Injury Collisions

Two sources of information are used to account for the potential misreporting of the frequency of injury collisions. A study conducted in Ontario[5] examined health department records that describe the injury outcome from motor vehicle collisions and compared this data with police reported injury collisions. This produced a ratio between police reported injury incidents and health department injury incidents. The second source of information came from analysis conducted by Chipman[6] based on a survey of health records that produced an estimate of the number of injuries resulting from motor vehicle collisions. The results determined that a multiplier of 1.48 should be applied to injury collisions to account for the misreporting collisions (i.e., collisions that were coded as PDO but were in fact an injury collision). These additional major injury collisions should be subtracted from the total PDO collisions.

3.2.3 Adjustment 3: Additional Minor Injury Collisions

The third adjustment to the raw collision data is required to address the under-reporting of minor collisions, which is common for minimal (i.e., it is much less likely for police to attend and report minor incidents). The Transport Canada study suggests a multiplier of 1.49 that can be applied to minor injury and PDO collisions to account for the level of under-reporting. However, a further adjustment is required to accommodate the collision severity categories in Alberta (i.e., there is no 'moderate' injury level in Alberta), and as such, the resultant multiplier is 1.76. These additional minor injury collisions should be subtracted from the total PDO collisions.

The under reporting and misreporting of collisions was examined using police reported collision data and the auto-insurance claims-based collision records, which is possible due to the public nature of the auto insurance in British Columbia. It became apparent that the multipliers vary considerably between jurisdictions, which suggests that the multipliers are location specific and dependent upon the priorities of the local policing agency. Since information to determine this multiplier is not available for the Capital Region, the multiplier of 1.76 for under-reporting should be used in this study.

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[5] Ministry of Health and Long-Term Care, Operational Review of the Sudbury Regional Hospital, November 2002.

[6] Chipman, Mary L., Health Service Use Attributable to Injury in Traffic Crashes: Data from a Population Survey, 36th Annual Proceedings, Association for the Advancement of Automotive Medicine (AAAM), Portland Oregon, October 5-7, 1992.

3.2.4 Results of Adjustment to Raw Data: 2015 Update

The results from the adjustments for the 2015 raw collision data for the Capital Region are shown in Tables 3.3 and 3.4 below. Table 3.3 shows the raw collision data for the CRISP study area (based on the results that were provided in Table 3.1) and Table 3.4. shows the adjusted collision data, based on the three adjustments described.

Table 3.3: Raw Collision Data: 2015 Update

Collision Severity (Victim)	**Collision Severity (Collision)**			
	Fatal	**Injury**	**PDO**	**TOTAL**
Collisions	35	4,289	39,259	43,583
Fatalities	38			38
Injuries	91	5,361		5,452
Major Injury	37	505		542
Minor Injury	54	4,856		4,910

Table 3.4: Adjusted Collision Data: 2015 Update

Collision Severity (Victim)	**Collision Severity (Collision)**			
	Fatal	**Injury**	**PDO**	**TOTAL**
Collisions	36	5,505	38,041	43,583
Fatalities	39			39
Injuries	231	9,210		9,441
Major Injury	48	756		805
Minor Injury	183	8,453		8,636

4.0 DIRECT COLLISION COSTS

The direct cost elements that are associated with collisions and included in the costing model are presented in this chapter. A brief description of each collision cost element will be provided, as well as the assumptions that were used to generate the cost estimates. What is important in this update is to focus on the changes that have been made in relation to the original study and to explain any significant change that have been made. The direct collision-cost components of the overall collision cost model are listed below.

- Property Damage Costs
- Emergency Response Costs
- Health Service Costs
- Legal Costs
- Travel Delay Costs
- Productivity / Disruption Costs

4.1 PROPERTY DAMAGE COSTS

There are four components of property damage costs, including vehicle repair costs, the cost of auto-insurance administration, out-of pocket expenses, and towing services. Before these costs can be evaluated, it is necessary to determine the property damage costs is to estimate of the number of vehicles involved in collisions and the amount of vehicle damage. Unfortunately, due to the private nature of the auto insurance in Alberta, collision records and data that describe the level of vehicle damage are not available. As such, it was necessary to formulate method to estimate the level of vehicle damage based on the sample of collisions within the Capital Region.

Using the methodology described in the previously noted Transport Canada study (Vodden et al, 2007), an estimate for the number of vehicles damaged and the extent of the vehicle damage was obtained. Using data from the Insurance Bureau of Canada [7] and the Ontario Road Safety Annual Report 2014 [8], it was possible to obtain an estimate of the number of vehicles damaged and the level of damage, disaggregated by the different collision severity levels. The results are provided in Table 4.1.

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[7] Insurance Bureau of Canada, Fasts of the Property and Casualty Insurance Industry in Canada, 2017.

[8] 2014 Ontario Road Safety Annual Report, produced by the Road Safety Research Office, Ministry of Transportation, 2014

Table 4.1: Estimate of Vehicle Damage by Severity Level

Collision Type	Collision Severity Classification				
	Fatality	Major Injury	Minor Injury	PDO	TOTAL
Collisions (Adjusted)	39	806	8,656	34,173	43,674
Vehicles Damage					
Demolished	33	88	849	1,425	2,396
Severe Damage	11	179	1,725	6,714	8,630
Moderate Damage	11	222	2,141	22,859	25,233
Light Damage	8	208	2.001	35,399	37,616
No Damage	5	71	685	4,320	5,080

4.1.1 Vehicle Damage Costs

Using the estimate of the number of vehicles damaged and the corresponding damage levels from Table 4.1 above, an estimate for vehicle damage costs can be determined. Average collision repair costs were obtained from the Insurance Bureau of Canada[9], which are used in the calculation of the total vehicle damage costs. The average vehicle repair costs are based on 2014 costs and have been inflated to current values by using an inflation rate specific to Alberta. The average vehicle repair costs that are used in this study are provided in Table 4.2 below, together with the values used I the original study.

Table 4.2: Average Vehicle Damage Costs

Vehicle Damage Level	Vehicle Damage Costs ($)	
	Value Used for Update Study (2017)	Value Used in Original Study (2007)
Demolished Vehicle	$29,096	$21,772
Severe Damage	$15,593	$11,668
Moderate Damage	$6,618	$4,952
Light Damage	$1,443	$1,080

Using the values in Table 4.2, the total and average vehicle-repair costs are shown in Table 4.3 for collision severity classification 1 (collision) and Table 4.4 for collision severity classification 2 (victim).

[9] Insurance Bureau of Canada, Insurance Experience: Statistical Compilations and Annual Interpretations, 2004.

Table 4.3: Vehicle Repair Costs

Collision Severity Classification 1 (Collision)

Collision Type	Collision Severity Classification 1 (Collision)			
	Fatal	Injury	PDO	TOTAL
Collisions (Adjusted)	36	5,519	38,118	43,674
Vehicles Damage				
Demolished	$896,458	$27,270,135	$42,724,223	$70,890,816
Severe Damage	$160,538	$29,695,043	$107,896,355	$137,751,936
Moderate Damage	$66,622	$15,641,004	$155,906,920	$171,614,546
Light Damage	$10,785	$3,186,773	$52,642,649	$55,840,206
No Damage	$0	$0	$0	$0
TOTAL COST	$1,134,403	$75,792,954	$359,170,147	$436,097,504
AVERAGE COST	$32,412	$17,626	$9,130	$9,985

Table 4.4: Vehicle Repair Costs

Collision Severity Classification 2 (Victim)

Collision Type	Collision Severity Classification 2 (Victim)				
	Fatality	Major Injury	Minor Injury	PDO	TOTAL
Collisions (Adjusted)	39	806	8,656	34,173	43,674
Vehicles Damage					
Demolished	$896,458	$5,420,089	$24,560,091	$42,724,223	$73,600,860
Severe Damage	$160,538	$4,426,540	$40,116,024	$107,896,355	$152,599,457
Moderate Damage	$66,622	$1,554,368	$21,129,954	$155,906,920	$178,657,864
Light Damage	$10,785	$158,347	$2,870,079	$52,642,649	$55,681,859
No Damage	$0	$0	$0	$0	$0
TOTAL COST	$1,134,403	$11,559,343	$88,676,148	$359,170,147	$460,540,041
AVERAGE COST	$29,853	$21,288	$18,020	$9,409	$10,545

4.1.2 Auto-Insurance Administration Costs

The average auto insurance administration was estimated based on an assumed level of effort associated with the different vehicle damage levels. The range of auto insurance administration costs for used in the collision cost model is listed in Table 4.5, together with the values used in the original study. The values presented in Table 4.5 have also been adjusted by using an inflation rate specific to Alberta. The total and average auto insurance administration costs are shown in Table 4.6 for collision severity classification 1 (collision) and Table 4.7 for collision severity classification 2 (victim).

Table 4.5: Average Vehicle Damage Costs

Vehicle Damage Level	Auto-Insurance Administration Costs ($)	
	Value Used for Update Study (2017)	Value Used in Original Study (2007)
Demolished Vehicle	$2,473	$2,177
Severe Damage	$1,143	$875
Moderate Damage	$298	$248
Light Damage	$32	$27

4.1.3 Out-of-Pocket Expenses

Information concerning out of pocket expenses that a person may incur after a collision is very limited. Out of pocket expenses are expenses that are beyond what is normally covered by their auto insurance, including such things as the insurance deductible of the at-fault party, expenses not claimed under insurance and costs for un-insured drivers. Based on the 1993 General Social Survey by Statistics Canada and cited in the Transport Canada report[10], the average out-of-pocket expense was estimated to be $719, which was inflated to $1,210 to obtain these costs in current dollars. The amount of out-of-pocket expenses was linked to the level of vehicle damage, such that a demolished vehicle would have on average, more out-of-pocket expenses than a vehicle with minimal damage.

The total and average out-of-pocket costs are shown in Table 4.8 for collision severity classification 1 and Table 4.9 for collision severity classification 2 (victim).

[10] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007

Table 4.6: Auto Insurance Administration Costs

Collision Severity Classification 1 (Collision)

Collision Type	Collision Severity Classification 1 (Collision)			
	Fatal	Injury	PDO	TOTAL
Collisions (Adjusted)	36	5,519	38,118	43,674
Vehicles Damage				
Demolished	$53,787	$1,636,208	$2,563,453	$4,253,449
Severe Damage	$8,027	$1,484,752	$5,394,818	$6,887,597
Moderate Damage	$2,998	$703,845	$7,015,811	$7,722,655
Light Damage	$243	$71,702	$1,184,460	$1,256,405
Major Injury	$35,326	$551,103	N/A	$586,429
Minor Injury	$66,701	$3,081,373	N/A	$3,148,074
TOTAL COST	$167,082	$7,528,984	$16,158,542	$23,854,608
AVERAGE COST	$4,774	$1,751	$411	$546

Table 4.7: Auto Insurance Administration Costs

Collision Severity Classification 2 (Victim)

Collision Type	Collision Severity Classification 2 (Victim)				
	Fatality	Major Injury	Minor Injury	PDO	TOTAL
Collisions (Adjusted)	39	806	8,656	34,173	43,674
Vehicles Damage					
Demolished	$53,787	$325,205	$1,473,605	$2,563,453	$4,416,052
Severe Damage	$8,027	$221,327	$2,005,801	$5,394,818	$7,629,973
Moderate Damage	$2,998	$69,947	$950,848	$7,015,811	$8,039,604
Light Damage	$243	$3,563	$64,577	$1,184,460	$1,252,842
Major Injury	$35,326	$551,103	N/A	N/A	$586,429
Minor Injury	$66,701	N/A	$3,081,373	N/A	$3,148,074
TOTAL COST	$167,082	$1,171,145	$7,576,204	$16,158,542	$25,072,973
AVERAGE COST	$4,397	$2,157	$1,540	$423	$574

Table 4.8: Out-of-Pocket Expense Costs
Collision Severity Classification 1 (Collision)

Collision Type	Collision Severity Classification 1 (Collision)			
	Fatal	Injury	PDO	TOTAL
Collisions (Adjusted)	36	5,519	38,118	43,674
Vehicles Damage				
Demolished	$37,284	$1,134,172	$1,776,911	$2,948,367
Severe Damage	$8,347	$1,544,024	$5,610,179	$7,162,550
Moderate Damage	$4,020	$943,793	$9,407,569	$10,355,382
Light Damage	$1,510	$446,299	$7,372,465	$7,820,275
TOTAL COST	$51,162	$4,068,287	$24,167,125	$28,286,574
AVERAGE COST	$1,462	$946	$614	$648

Table 4.9: Out-of-Pocket Expense Costs
Collision Severity Classification 2 (Victim)

Collision Type	Collision Severity Classification 2 (Victim)				
	Fatality	Major Injury	Minor Injury	PDO	TOTAL
Collisions (Adjusted)	39	806	8,656	34,173	43,674
Vehicles Damage					
Demolished	$37,284	$225,423	$1,021,460	$1,776,911	$3,061,078
Severe Damage	$8,347	$230,162	$2,085,873	$5,610,179	$7,934,562
Moderate Damage	$4,020	$93,792	$1,275,001	$9,407,569	$10,780,382
Light Damage	$1,510	$22,176	$401,947	$7,372,465	$7,798,099
TOTAL COST	$51,162	$571,553	$4,784,282	$24,167,125	$29,574,121
AVERAGE COST	$1,346	$1,053	$972	$633	$677

4.1.4 Towing Expenses

The towing costs for the updated study have increased considerably from the original study. Information reported in a study from the Property Casualty Insurers Association of America (PCI) (2012)[11], indicate that the unit cost of a tow is more than 50% higher than used in the original study ($607 versus $400). The probability of a vehicle requiring a tow is linked to the severity of a collision, with more severe collisions having a higher probability of requiring a tow, as listed below and based on information provided in the previously noted report by Vodden et al for Transport Canada. The following tow rates were used together with the vehicle damage rates (Table 4.1) to generate an estimate of the tow costs. Total and average tow costs are shown in Table 4.10 for collision severity classification 1 and Table 4.11 for collision severity classification 2 (victim).

Fatal collision: Requires a tow 86% of the time

Injury collision: Requires a tow 63% of the time

PDO collision: Requires a tow 46% of the time

Table 4.10: Towing Costs - Collision Severity Classification 1 (Collision)

Collision Type	Collision Severity Classification 1 (Collision)			
	Fatal	Injury	PDO	TOTAL
Collisions (Adjusted)	36	5,519	38,118	43,674
Vehicle Needing a Tow	51	5,205	31,946	37,202
TOTAL COST	$31,079	$3,161,225	$19,402,046	$22,594,350
AVERAGE COST	$888	$735	$493	$517

Table 4.11: Towing Costs - Collision Severity Classification 2 (Victim)

Collision Type	Collision Severity Classification 2 (Victim)				
	Fatality	Major Injury	Minor Injury	PDO	TOTAL
Collisions (Adjusted)	39	806	8,656	34,173	43,674
Vehicle Needing a Tow	51	591	5,479	31,946	38,067
TOTAL COST	$31,079	$359,126	$3,327,417	$19,402,046	$23,119,668
AVERAGE COST	$818	$661	$676	$508	$529

[11] Property Casualty Insurers Association of America Special Report, Abusive Vehicle Towing And Storage Practices: A Half Billion-Dollar Problem, August 2012.

4.2 EMERGENCY RESPONSE COSTS

There are three components to the total cost for the emergency response associated with collisions. These include the police costs, fire and rescue costs, and ambulance costs. In addition, there are coroner costs then the collision results in a fatality. These four components are described below, including the assumptions that were made in generating the collision cost estimates.

4.2.1 Police Costs

Edmonton's Office of Traffic Safety (OTS) provided data for the various police efforts associated with collisions. The police data was disaggregated by collision severity (Fatal, Injury and Property Damage, as well as Hit and Run), which was easily accommodated by the collision cost model. This collision information was also categorized by information that was collected and obtained at the front counter, as well as collision information that were obtained from dispatched calls, where police attended incidents. Excellent and detailed information was provided that facilitated the assessment of the costs associated with police responses to crashes. The data allowed for an estimate of the amount of time dedicated to type of collision (i.e., fatal, injury of property damage only). The policing unit cost is lower in the updated results when compared to the original results, but this is offset by the amount of time dedicated to each event.

Using OTS police response data from August 2015, the following information for the effort related to collision response was determined.

- Officer hours per fatal collisions: 36.5 hours
- Officer hours per injury collision: 5.0 hours
- Officer hours per PDO collision: 1.5 hours
- Average staff cost for collisions: $87.96 (excluding benefits).

This data is supplemented by data from JURISTAT[12], which describes the effort required to justice spending for collisions (e.g., court preparation, legal aid, corrections, etc.).

- Preparation for fatal collisions: 59.0% of total collision response cost hours
- Preparation for injury collisions: 29.5% of total collision response cost hours
- Preparation for PDO collisions: 14.7% of total collision response cost hours

[12] JURISTAT: The Canadian Centre for Justice Statistics of Canada: Catalogue Number 85-002-XE, Volume 22, No. 11, 2009.

The total and average costs for police efforts necessary to respond to collision are shown in Table 4.12 for collision severity classification 1 and Table 4.13 for collision severity classification 2 (victim). It is noted that the methodology for the police costs have changed since the original study based on the data that was available, but the difference in the costs between the original study and the updated study is consistent with expectations.

Table 4.12: Police Costs - Collision Severity Classification 1 (Collision)

Collision Type	**Collision Severity Classification 1 (Collision)**		
	Fatal	**Injury**	**PDO**
Collisions (Adjusted)	36	5,519	38,118
Police Hours/Collision	36.5	5.0	1.5
Total Hours	1,297	27,690	55,785
TOTAL COST	$235,612	$4,088,449	$7,164,885
AVERAGE COST	$6,621	$741	$188

Table 4.13: Police Costs - Collision Severity Classification 2 (Victim)

Collision Type	**Collision Severity Classification 2 (Victim)**			
	Fatality	**Major Injury**	**Minor Injury**	**PDO**
Collisions (Adjusted)	39	806	8,656	34,173
Police Hours/Collision	36.5	5.0	1.5	N/A
Total Hours	1,297	7,078	20,612	55,785
TOTAL COST	$235,612	$1,045,067	$3,043,381	$7,164,885
AVERAGE COST	$6,200	$1,925	$618	$188

4.2.2 Fire and Rescue Costs

The costs associated with fire and rescue from the original collision cost study were determined to be considerably lower than expected, and much lower that that reported in other jurisdictions. For example, the cost for a call by a fire truck / rescue crew was $327 per incident. This is significantly lower than estimates from other sources that are in excess of 10 times higher. However, the data that was provided was used in the original study, recognizing that the costs were likely too low.

One of the principal differences is that the total cost of providing fire/rescue services should be considered and not just the time used in responding to a call (i.e., fire departments costs are accumulating with or without responding to an incident). The methodology provided in this update study has included a more comprehensive cost model for fire and rescue services, including an average unit cost of $3,292 per collision incident[13] call rather than the $327 per call used previously. In determining the total and average cost for fire and rescue, it is assumed that all fatal and major injury collisions will be attended by fire and rescue, whereas minor collisions will only be attended 50% of the time.

The total and average costs for the fire and rescue efforts that are necessary to respond to collision are shown in Table 4.14 for collision severity classification 1 and Table 4.15 for collision severity classification 2 (victim).

Table 4.14: Fire and Rescue Costs - Collision Severity Classification 1 (Collision)

Collision Type	**Collision Severity Classification 1 (Collision)**		
	Fatal	**Injury**	**PDO**
Collisions (Adjusted)	36	5,519	38,118
Attendance Rate	100%	75%	N/A
TOTAL COST	$116,790	$13,584,556	N/A
AVERAGE COST	$3,282	$2,462	N/A

Table 4.15: Fire and Rescue Costs - Collision Severity Classification 2 (Victim)

Collision Type	**Collision Severity Classification 2 (Victim)**			
	Fatality	**Major Injury**	**Minor Injury**	**PDO**
Collisions (Adjusted)	39	806	8,656	34,173
Attendance Rate	100%	100%	50%	N/A
TOTAL COST	$116,790	$3,472,411	$10,112,145	N/A
AVERAGE COST	$3,023	$4,307	$1,168	N/A

[13] Data from the Ontario Fire Marshalls Office, based on 447,181 total responses and $1.118B in total cost in 2003, as reported by Vodden et al., 2007. The 2017 values are adjusted by Alberta inflation rates.

4.2.3 Ambulance Costs

A similar assessment used that was used for Fire / Rescue is applied to ambulance services. However, the discrepancy is not as great as that determined for Fire / Rescue. In the original study, the unit cost for an ambulance was set at $358 per call for a collision incident. Again, this unit cost seemed to be low given the effort and resources used to attend to a collision. The revised unit cost for an ambulance in the update is $992 per call, which is based on data from 166,000 transported patients by Emergency Medical Services in 2005 within the City of Toronto. It was determined that the average cost per call is $783 and with an adjustment for Alberta specific inflation, the 2017 average cost per ambulance call is $992 per call. The attendance rates by collision severity level are assumed to be similar to fire and rescue services.

The total and average costs for ambulance services to respond to collisions are shown in Table 4.16 for collision severity classification 1 and Table 4.17 for collision severity classification 2 (victim).

Table 4.16: Ambulance Costs - Collision Severity Classification 1 (Collision)

Collision Type	**Collision Severity Classification 1 (Collision)**		
	Fatal	**Injury**	**PDO**
Collisions (Adjusted)	36	5,519	38,118
Attendance Rate	100%	75%	N/A
TOTAL COST	$35,312	$4,107,362	N/A
AVERAGE COST	$992	$744	N/A

Table 4.17: Ambulance Costs - Collision Severity Classification 2 (Victim)

Collision Type	**Collision Severity Classification 2 (Victim)**			
	Fatality	**Major Injury**	**Minor Injury**	**PDO**
Collisions (Adjusted)	39	806	8,656	34,173
Attendance Rate	100%	100%	50%	N/A
TOTAL COST	$35,312	$1,049,902	$3,057,460	N/A
AVERAGE COST	$914	$1,934	$621	N/A

4.2.4 Coroner Costs

The methodology to determine the costs associated with coroner services for fatal collisions are similar to the original study, with costs adjusted to reflect Alberta-specific inflation rates. This cost element only pertains to collisions involving fatalities and is based on a series of assumptions including the following:

- 100% attendance rate for collisions involving fatalities
- Total coroner resources per incident: 24 person-hours per incident
- Hourly coroner cost: $61.97 (excluding benefits)
- Benefits are assumed to be 1.34 times the base hourly unit cost

The total and average costs for coroner services to respond to the fatal collisions are shown in Table 4.18 for collision severity classification 1 (collision) and for collision severity classification 2 (victim).

Table 4.18: Coroner Costs

Collision Type	Collision Severity Classification 1 (Collision)		Collision Severity Classification 2 (Victim)
	Fatal		Fatality
Collisions (Adjusted)	36		39
Attendance Rate	100%		100%
Resources (Hrs./Incident)	24		24
Unit Cost ($/hr)	$1,994		$1,994
TOTAL COST	$77,055		$77,055
AVERAGE COST	$2,165		$1,994

4.3 HEALTH SERVICE COSTS

A considerable proportion of the overall direct costs associated with collisions are health service costs. Health service costs are separated into 5 categories, including Emergency Room Costs, ICU Care Costs, Acute Care Costs, Rehabilitation Care Costs and Long-term Care Costs. Health service costs are only associated with fatal and injury collisions and as such, there will not be any health service costs for PDO collisions. Each of these components of the health service costs will be presented below, including the assumptions and values used in generating the estimate associated with collisions.

4.3.1 Emergency Department Costs

Some additional information concerning the likelihood of an emergency room visit per collision (by severity level) was incorporated into the update to the collision cost model. The average cost per emergency department visit was noted as $335 as per information provided by Public Health Surveillance and Infrastructure, Population, Public and Indigenous Health. This represents an increase of approximately 50% over the unit cost from the original study ($231 per emergency department visit).

The following assumptions were used to estimate the number of visits to an emergency department resulting from a collision. It should be noted that the following assumptions are similar to the original study and based on input from Alberta Health Services:

- 50% of fatal collisions visit an emergency department, noting that not all fatal collisions result in someone dying at the site. Some victims die later, either at the emergency department or after admission to an intensive care unit;
- 100% of major injury collisions require a trip to the emergency department;
- 75% of minor injury collisions require a trip to the emergency department.

As noted above, the average cost of an emergency room visit was estimated to be $335. This is the current per diem or per-visit amount used by the Alberta Health Care Insurance Plan for billing out-of-province or un-entitled patients in the Edmonton area[14]. The estimate for the emergency room visit reflects the basic costs of processing a person visiting the ER, and would apply across the injury severity spectrum. The total and average costs of emergency department visits are summarized in Table 4.19.

Table 4.19: Emergency Department Costs

Emergency Department Costs:	**Collision Severity Classification 1**		**Collision Severity Classification 2**		
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
Collisions / Victims:	36	5,519	39	806	8,656
Percent requiring ED Visit:	50%	100%	50%	100%	75%
Unit Cost For Emergency:	$335	$335	$335	$335	$335
TOTAL COST:	$77,539	$2,769,413	$77,539	$274,620	$2,494,794
AVERAGE COST:	$2,179	$502	$2,007	$341	$288

[14] Values provided by Public Health Surveillance and Infrastructure Population, calculated from values provided by AHS Business Advisory Services and EMS Accounts Receivable, 2016.

4.3.2 Intensive Care Unit (ICU) Costs

An updated estimate for ICU costs for collisions comes from results that examined the number of days spent in ICU following a collision, disaggregated by fatal collisions and major injury collisions. The results show that 2.4 days of ICU are associated with a fatal collision and 9.1 days of ICU are associated with a major collision. The daily cost has also been updated to $4,729 per day on an ICU ward ($4,049 in the 2010 Study).

The ICU Care costs were estimated in a similar manner as the emergency department costs. The following assumptions were used to estimate the ICU costs resulting from a collision.

- 50% of fatal collision victims will be transferred to ICU from emergency;
- Average time spent in an ICU for a fatal collision victim is 2.4 days;
- 100% of major injury collisions victims will be transferred to an ICU from the emergency department;
- Average time spent in an ICU for a major injury collision victim is 9.1 days;
- Minor injury collisions are assumed to not require any time in an ICU.

As noted above, the average cost of an intensive care unit is estimated to be $4729 per day. This per diem amount for intensive care is used by the Alberta Health Care Insurance Plan for billing out-of-province or un-entitled patients[15]. The total and average costs of the ICU are summarized in Table 4.20.

Table 4.20: ICU Care Costs

Intensive Care Unit (ICU) Costs:	**Collision Severity Classification**				
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
Collisions / Victims:	36	5,519	39	806	8,656
Percent requiring ICU:	50%	100%	50%	100%	0%
Time Spent in ICU (days):	2.4	9.1	2.4	9.1	0
Unit Cost For Emergency:	$4,729	$4,729	$4,729	$4,729	$4,729
TOTAL COST:	$2,309,432	$32,605,347	$2,309,432	$32,605,347	$0
AVERAGE COST:	$64,899	$5,908	$59,776	$40,443	$0

[15] Values provided by Public Health Surveillance and Infrastructure Population, calculated from values provided by AHS Business Advisory Services and EMS Accounts Receivable, 2016.

4.3.3 Acute Care Hospital Costs

The average cost per day for a patient in acute care has been updated from $1,261 in the 2010 Study to $1,560 per day in this 2017 Update Study. These average daily rates are based on a sample of hospitals locations within the Capital Region.

Acute care costs were estimated using several assumptions on the proportion of injury victims requiring acute care and the time required for recovery. The following assumptions were used to estimate the acute care costs, noting that the following assumptions are based on input or information from Alberta Health Services.

- 0% of fatal collision casualties will spend time in acute care, although major injuries linked to fatal collisions will spent time in acute care;
- 100% of the major injury collision casualties will spend time in acute care;
- Time that a major injury collision victim spends in acute care is assumed to be an average of 5.87 days;
- Minor injury collision casualties do not require any time in an acute care.

As noted in the update above, the average cost of acute care is estimated to be $1,261 per day. This per diem amount for intensive care used by the Alberta Health Care Insurance Plan for billing out-of-province or un-entitled patients [16]. This information is based on a survey of costs from of Capital Region hospitals that provide acute care. The total and average costs of the acute care are summarized in Table 4.21.

Table 4.21: Acute Care Hospital Costs

Acute Care Hospital Costs:	**Collision Severity Classification**				
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
Collisions / Victims:	36	5,519	39	806	8,656
Percent requiring Acute Care:	0%	100%	0%	100%	0%
Time Spent in Acute Care (days): (Major Injuries linked to a fatal)	5.87	5.87	0	5.87	0
Unit Cost For Emergency:	$1,560	$1,560	$1,560	$1,560	$1,560
TOTAL COST:	$444,979	$6,941,948	$444,979	$6,941,948	$0
AVERAGE COST:	$12,505	$1,258	$11,517	$8,611	$0

[16] Values provided by Public Health Surveillance and Infrastructure Population, calculated from values provided by AHS Business Advisory Services and EMS Accounts Receivable, 2016.

4.3.4 Rehabilitation Costs

The medical costs associated with rehabilitation costs are based on estimates of the level of disability resulting from collisions, with disability is broken down into two categories, 1) total disability and 2) partial disability. Research on the level of disability following a collision is used to estimate the amount to time that a crash victim will receive rehabilitation care.

The cost associated with a day in rehabilitation care has not increased too significantly since the original study, with the costs rising from $972/day in 2010 to $1,085 in 2017. This rate of increase is considerably less than some of the other health service categories.

The costs associated with rehabilitation are estimated based on the number of persons that are either totally or partially disabled as a result of a motor vehicle collision. The estimate for the level of disability is based on the work of Ted Miller, which is described further in the Data-book on Non-Fatal Injury Incidence Costs and Consequences [17]. The probability of total and partial disability, by collision severity level is estimated as follows:

	Incidence of Permanent Disability	
Injury Level	TOTAL	PARTIAL
- Major Injury	0.0162	0.1493
- Minor Injury	0.0009	0.0173

Using this information, an estimate of the number of persons that will become permanently disabled, either totally or partially can be determined[18]. Table 4.22 on the following page presents the expected number of permanent disability victims based on the collision severity level.

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17 Miller, T., Pindus, N, Gouglas, J, and Rossman, S, Data-book on Non-Fatal Injury Incidence Costs and Consequences, Urban Institute, 1995.

18 It is noted that the likelihood of a total or partial permanent disability resulting from a minor collision is unlikely, given the definition of minor injury in Alberta. The proportion of disabilities for minor injuries could be combined with major injury, however, it was decided that the approach should be consistent with the reference cited. Ultimately, the calculated collision costs for permanent disabilities resulting from minor injuries is relatively small.

Table 4.22: Estimate of Permanent Disabilities (Total and Partial)

Disability by Injury Level	Collision Severity Level		
	Fatal	Injury	Total
Injury Level (Raw Data)			
Major	48	758	806
Minor	183	8,472	8,656
TOTAL	231	9,230	9,462
TOTAL Disability			
Major	0.79	12.27	13.06
Minor	0.16	7.63	7.79
TOTAL	0.95	19.90	20.85
PARTIAL Disability			
Major	7.25	113.12	120.37
Minor	3.17	146.57	149.74
TOTAL	10.42	259.69	270.11

To generate the estimate for rehabilitation costs, several assumptions are made concerning the number of rehabilitation visits required per year and the cost per day for rehabilitation. The assumptions are listed below, including an estimate of the number of visits per year and the extent of the rehabilitation service required.

- Totally disabled (permanent) collision injury victims are assumed to require 12 rehabilitation visits per year;
- Partially disabled (permanent) collision injury victims are assumed to require 4 rehabilitation visits per year;
- Average time for rehabilitation is estimated to be 5 years for an injury victim with total disability;
- Average time for rehabilitation is estimated to be 2 years for an injury victim with a partial disability.

As noted previously, the average daily cost of rehabilitation treatment is estimated to be $1,085 per day, up slightly from $972 in the original study. This estimate of daily rehabilitation costs was obtained from the previously noted information from Alberta Health Services[19]. The total and average costs of rehabilitation care are summarized in Table 4.23.

[19] Values provided by Public Health Surveillance and Infrastructure Population, calculated from values provided by AHS Business Advisory Services and EMS Accounts Receivable, 2016.

Table 4.23: Rehabilitation Costs

Rehabilitation Care Costs:	Collision Severity Classification				
	Fatal	Injury	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	39	806	8,656
Totally Disabled:	0.95	19.90	0.95	12.27	7.63
Partially Disabled:	10.42	259.69	10.42	113.11	146.57
Unit Cost /day For Rehabilitation:	$1,085	$1,085	$1,085	$1,085	$1,085
TOTAL COST:	$152,437	$3,549,478	$152,437	$1,780,853	$1,768,625
AVERAGE COST:	$4,284	$643	$3,946	$2,209	$204

4.3.5 Continuing Care Costs

The final component included in the health service costs is long-term care costs, which include collision victims that are permanently disabled, where long term care is necessary for their entire life. The estimate involves an examination of actuarial tables to determine the average life spans and the probabilities associated with permanent disability. Due to the long timeframe associated with long-term care costs, a discount rate is applied to obtain a net present value cost for long-term care.

Similar to Rehabilitation Care Costs, the cost associated with a day in long-term care has not increased too significantly since the original study. Long-term care costs in the original study was $343 per day (2010) and has only risen to $368 per day in 2017. This rate of increase is considerably less than some of the other health service categories.

The assumptions used in generating the estimate of continuing care costs are as follows:

- Continuing care includes any continuing care that is provided either within a health facility or outside such as assisted living group homes, homecare, etc.;
- Totally disabled (permanent) collision injury victims will require continuing care 365 days per year;
- Partially disabled (permanent) injury victims do not require continuing care;
- Average life expectancy at time of collision is 29.1 years (this is described further in a subsequent section on lost productivity);
- A net present value factor of 0.242 is used for long-term costs, based on a discount rate of 5% and 29.1 years (i.e., i=6% and n=28.8).

As noted previously, the average daily cost for continuing care is estimated to be $368 per day, up slightly from $343, as used in the original study. This estimate of continuing care costs was obtained from the previously noted information from Alberta Health Services[20]. The estimate generated for continuing care costs as a result of motor vehicle collisions is provided in Table 4.24.

Table 4.24: Continuing Care Costs

Long-Term Costs:	Collision Severity Classification				
	Fatal	Injury	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	39	806	8,656
Totally Disabled:	0.95	19.90	0.95	12.27	7.63
Life Expectancy (years):	29.1	29.1	29.1	29.1	29.1
Long-term care days / year:	365	365	365	365	365
Net Present Value factor:	0.242	0.242	0.242	0.242	0.242
Unit Cost /day For Long-term care:	$368	$368	$368	$368	$368
TOTAL COST:	$899,444	$18,804,181	$899,444	$11,598,547	$7,205,635
AVERAGE COST:	$25,276	$3,407	$23,280	$14,387	$832

4.4 LEGAL COSTS

There are several legal costs that need to be considered when evaluating the total cost of collisions. The components that are Included in the collision cost model are costs associated with correctional services, court costs, legal costs, and funeral costs (for fatal collisions only). Each collision cost element is discussed in this section, including the assumptions and data used to generate the cost estimate.

4.4.1 Cost of Corrections

Correction costs includes operating expenditures for federal and provincial correctional facilities and related costs such as probation services that are related to the justice issues associated with the occurrence of a motor vehicle collision. The costs of corrections are based on information from Statistics Canada[21] that provides a proportion of corrections costs relative to the cost of policing as shown in Table 4.25.

[20] Values provided by Public Health Surveillance and Infrastructure Population, calculated from values provided by AHS Business Advisory Services and EMS Accounts Receivable, 2016.

[21] JURISTAT: Canadian Centre for Justice Statistics of Canada, Catalogue No. 85-002-XE, Volume 19, No. 12.

Table 4.25: Justice Spending in Canada

Justice Spending	Percent of Total Spending	Percent of Total Police Spending
Police	59%	N/A
Corrections	25%	25 / 59 = 41.7%
Courts	9%	9 / 59 = 14.7%
Legal Aid	6%	6 / 59 = 10.4%
Prosecution	3%	3 / 59 = 4.5%

The proportions for the justice spending s a proportion of police spending that is shown above in Table 4.25 has been updated since the original 2010 study, using more current data. However, the proportions have only changed slightly (i.e., less than 5%). Using the proportions of justice expenditures shown in Table 4.25 and using the estimated police costs determined in Section 4.2.1, an estimate for corrections costs is determined using the following assumptions:

- 50% of fatal incidents and major injury incidents will require corrections;
- 15% of injury collisions will require corrections;
- 5% of minor injury collisions will require corrections
- 0% of PDO collisions will require corrections.

The total and average costs associated with correctional services for motor vehicle collisions are summarized in Table 4.26.

Table 4.26: Correctional Services Costs

Correctional Services Costs	Collision Severity Classification					
	Fatal	Injury	PDO	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	38,118	39	806	8,656
% Requiring Corrections:	50%	15%	0%	50%	50%	5%
Police Costs (Table 4.2.1):	$235,612	$4,088,449	$7,164,885	$235,612	$1,045,067	$3,043,381
Justice Costs (% of Police):	41.7%	41.7%	41.7%	41.7%	41.7%	41.7%
TOTAL COST:	$49,167	$255,952	$0	$49,167	$218,083	$63,509
AVERAGE COST:	$1,405	$60	$0	$1,294	$402	$13

4.4.2 Court Costs

Court costs include the operating costs for the court system, such salaries and benefits for judges and support staff as well as the overall operation of the courts system. The court costs are determined in a similar manner as the cost of corrections by using a proportion of the policing costs. For this updated study, the court costs represent 14.7% of the total policing costs and the following assumptions are applied.

- 50% of fatal incidents and major injury incidents will incur court costs;
- 15% of injury collisions will incur court costs;
- 5% of minor injury collisions will incur court costs
- 0% of PDO collisions will incur court costs.

The results that were generated to produce an estimate of court costs related to collisions are summarized in Table 4.27.

Table 4.27: Court Costs

Court Costs	Collision Severity Classification					
	Fatal	Injury	PDO	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	38,118	39	806	8,656
% Requiring Court:	50%	15%	0%	50%	50%	5%
Police Costs (Table 4.2.1):	$235,612	$4,088,449	$7,164,885	$235,612	$1,045,067	$3,043,381
Justice Costs (% of Police):	14.7%	14.7%	14.7%	14.7%	14.7%	14.7%
TOTAL COST:	$17,336	$90,245	$0	$17,336	$76,893	$22,392
AVERAGE COST:	$495	$21	$0	$456	$142	$5

4.4.3 Legal Aid and Prosecution Costs

Legal aid includes payments to private law firms and legal aid staff for the provision of legal advice and representation in criminal matters associated with motor vehicle collisions. Legal aid and prosecution costs are determined in a similar manner as the correctional and court costs, by using a proportion of the policing costs. The legal aid and prosecution costs represent 14.9% of the total policing costs, and again it is assumed that the same proportion of incidents as listed above will require legal aid and prosecution costs (i.e., 50% for fatal and major injury, 15% for injury collisions, 5% for minor injury and 0% for PDO collisions).

The results that were obtained to produce an estimate of the cost of legal aid and prosecution are summarized in Table 4.28.

Table 4.28: Legal Aid and Prosecution Costs

Legal Aid and Prosecution Costs	Collision Severity Classification					
	Fatal	Injury	PDO	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	38,118	39	806	8,656
% Legal Aid + Prosecution:	50%	15%	0%	50%	50%	5%
Police Costs (Table 3.2.1):	$235,612	$4,078,049	$7,150,419	$235,612	$1,042,785	$3,035,264
Justice Costs (% of Police):	14.9%	14.9%	14.9%	14.9%	14.9%	14.9%
TOTAL COST:	$17,515	$91,177	$0	$17,515	$77,687	$22,624
AVERAGE COST:	$500	$21	$0	$461	$143	$5

4.4.4 Funeral Costs

The final cost element that is considered in this section of the report is the cost of funerals, which will only apply to fatal collisions. The same methodology and cost elements that were used in the original study are used again for the updated study, since the cost elements for a funeral would not have changed. The only update required is to adjust the costs using a multiplier to reflect the change in inflation between the time of the original study and this study.

The methodology assumes that 75% of persons dying from a fatal collision will have a traditional funeral, while the other 25% of fatal collision victims will choose to be cremated, reducing the costs when compared to a traditional funeral. There are several funeral costs, including professional services, casket, plot, monument, music, services, flowers, among others miscellaneous costs.

The estimated average cost for a traditional funeral was $11,025 in the 2010 study, which if inflated to current dollars would be $12,431. The cost of cremation is still assumed to be 25% of the cost of a traditional funeral, or $3,108. Using these values and the frequency of fatal collisions and fatalities, the total funeral costs is estimated to be $390,545 and the average cost per fatal collision is $10,975 and the average cost per fatality is $10,109.

4.5 TRAVEL DELAY COSTS

Although it may not be readily apparent when considering the cost of collisions, the real and direct costs associated by increased travel delay are considerable. Factors that are considered in the calculation of costs due to traffic delays from collisions include the cost of lost time, extra fuel consumption and the costs associated with an increase in air pollution. The collision cost model requires a series of inputs and assumptions to generate the three travel delay costs, as described in the following sections.

There have been several updates included in the travel delay costs from the original 2010 study. The updates will be described in further detail in the subsequent section, but include changes to the overall delay times to better reflect improved management at crash scenes, increased value of a person's time due to delay for both work trips and non-work trips, changes to the emission rates to better reflect more current information, and changes in fuel costs from 2010 to 2017.

4.5.1 Traffic Delay Costs

It is necessary to formulate a set of reasonable assumptions for the average delay per vehicle that is caused by the different types of collision (i.e., fatal, injury, PDO, etc.). The delay per incident type can be highly variable, especially for the higher severity incidents, where the procedures for attendance by emergency response staff and collision investigation staff can be considerable.

Obtaining specific information concerning the average delays caused by collisions is difficult as this is type of delay is non reoccurring congestion, which makes it very difficult to assess without automated traffic monitoring systems. Travel delay information for collisions specific for the Capital Region was not available for the original study nor was it available for this update. However, an adjustment to the average delays was made for this update analysis to better reflect improved management at crash scenes, which generally have improved in recent years. These improved crash scene management protocol have developed in response to criticism concerning the excessive time to clear severe collisions, with delays sometimes exceeding many hours. The average traffic delays per collision severity category are shown in Table 4.29, which includes the average delay vales used in the original study and the delay values used in this update.

Table 4.29: Delay by Collision Type

Collision Type	Average Delay (Hours)	
	Value Used for Update Study (2017)	Value Used in Original Study (2010)
Fatal collision	1.50	1.67
Major injury collision	0.82	0.88
Minor injury collision	0.45	0.46
Injury collision	0.47	0.49
PDO collision	0.19	0.19

With the average delay per collision type, it is then necessary to estimate the number of vehicles that would be affected in the event of a collision, which was estimated based on the time of day and the roadway classification (local, collector, arterial, etc.). This traffic related information was available from the Institute of transportation Engineers (ITE), Traffic Engineering Handbook [22], providing an hourly distribution of traffic for typical urban environments, showing the expected traffic peaks in the morning and afternoon time periods. The handbook also provided a theoretical capacity of the different types of roadways, which was used as a guideline for estimating the amount of traffic affected. The following traffic volume capacity levels for the differing roadway classifications were used in the analysis.

- Local road = 1200 vehicles per hour
- Collector Road = 2200 vehicles per hour
- Arterial Roadway = 4000 vehicles per hour
- Expressway Road: = 6000 vehicles per hour

Information on the hourly distribution of the collisions (by collision severity category) within the Capital Region was available from the Office of Traffic Safety. Using this information with the average delay and the estimated traffic distribution, it was possible to calculate the amount of delay (in hours) by hour of the day and by collision severity level. The calculated delays caused by collisions ranged from 1.50 hours for a fatal collision during rush hour, to virtually zero delay caused by a PDO collision that occurs in the early hours of a morning when there is very little traffic.

[22] Traffic Engineering Handbook, 4th Edition, Institute of Transportation Engineers, Prentice-Hall, ISBN 0-13-926791-3, 1992

Since the amount of cost of delay is associated with the loss of time, it is necessary to determine how many persons are impacted rather than the number of vehicle impacted. A vehicle occupant multiplier was formulated based on the time of day, which ranged from 1.10 during morning commuter traffic to 1.40 during off-peak travel periods. This suggests that the number of persons in a vehicle would be lower as people go to work and the number of persons in a vehicle would be higher during out-of work time periods, as the likelihood of additional passengers would increase.

The percent of work trips and non-work trips were also estimated based on the time of day in which travel is occurring. For example, more work trips occur during the morning and afternoon rush hours than compared to midday traffic. This is a necessary distinction because there are different economic values associated with work trips versus non-work trips.

It is reasonable to place a value on time, which can be especially apparent during times of unexpected delay, such as the traffic congestion that is caused by a collision. Data from Statistics Canada[23] was obtained to determine the average hourly wage for persons older than 15 years within the province of Alberta, which was determined to be $30.58 per hour. The value of a work trip is estimated to be 100% of the average hourly wage ($30.58/hour) and the value of a non-work trip is estimated to be 50% of the value of a work-trip ($15.29/hour).

Combining the information described above, it is possible to produce an estimate for cost associated with traffic delays caused by the different collision severity categories. The results are listed below.

- Fatal Collisions: $20,511
- Injury Collisions: $6,466
- PDO Collisions: $2,598
- Major Injury Collisions: $11,247
- Minor Injury Collisions: $6,142

[23] Statistics Canada, Average Hourly Wages of Employees by selected characteristics and occupation by province, https://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/labr69j-eng.htm.

4.5.2 Extra Fuel Consumption Costs

Another real and direct cost that is associated with the delays caused by collisions is the extra fuel consumption used during the traffic delay. The methodology to determine the extra fuel consumption costs is based on the amount of traffic delay, which was presented in the preceding section (Section 4.5.1).

An update was necessary from the original study to better reflect the change in vehicle fleet and the corresponding change in average fuel consumption levels. In the original study, the fuel consumption rate was 3.25 litres per hour, which is based on information from Vodden et al in the Ontario Study[24]. Also used in the estimate of fuel consumption is the average cost of fuel, which was assumed to be $0.85 / liter in the 2010 Study. These values are very time dependent and as such, are important updates fro the collision cost model.

For this update, the estimated fuel consumption rate was estimated to be 2.246 litres per hour based on recent information from the Office of Energy Efficiency and Renewable Energy[25]. This current information is considered superior to the data in the original data, which was dated, The average cost of fuel in 2017 is $0.98 / litre, based on historical fuel process posted by GasBuddy Alberta[26].

Combining the information described above, it is possible to produce an estimate for extra fuel consumption cost associated with traffic delays associated with the different collision severity categories. The results are listed below.

- Fatal Collisions: $1,484
- Injury Collisions: $468
- PDO Collisions: $188
- Major Injury Collisions: $814
- Minor Injury Collisions: $444

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[24] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007.

[25] Fact Sheet #861: February 23, 2015, Idle Fuel Consumption for Selected Gasoline and Diesel Vehicle Types, United States Office of Energy Efficiency and Renewable Energy, 2015, https://energy.gov/eere/vehicles/fact-861-february-23-2015-idle-fuel-consumption-selected-gasoline-and-diesel-vehicles.

[26] Historical fuel prices in Alberta from available from the website GasBuddy, providing information on the price of fuel. See https://www.gasbuddy.com/GasPrices/Alberta.

4.5.3 Extra Air Pollution Costs

Another important component of traffic delay costs is the environmental impact caused by an increase in vehicle emissions and pollution. Public awareness of this real and important issue has become more tangible in recent years and it is important to consider the economic costs associated with increased vehicle emissions. The additional pollution caused by traffic delay comes from several sources, with the greatest share of vehicle emissions made by carbon dioxide (CO_2). The other motor vehicle pollutants that cost society include hydro carbons (HC), carbon monoxide (CO) and nitrous oxides (NO_x).

With the change in vehicle fleet over time, it is necessary to update the collision cost model for vehicle emissions. There is considerable information available to quantify the level of vehicle emissions, but perhaps the most comprehensive information is available through the US Environmental Protection Agency (EPA)[27]. Updates on the average vehicle emission levels were obtained, which indicated that 26.7 kg of vehicle emissions were created per hour of travel and that this value should be doubled when a vehicle is idling (53.4 kg of emissions per hour of idling). These rates are significantly lower than the values used in the previous study based on the Transport Canada report by Vodden et al[28], which assumed a pollution rate of 245 kg per hour per vehicle.

The cost associated with the costs of vehicle emission has also been updated in this study. Information published by the Government of Canada [29] reports that the cost of emission is costs a total of $84 per tonne ($0.084/kg), including adjustments for inflation, which is higher than the values used in the original study ($70 per tonne).

The costs associated with increased pollution as a result of collisions are listed below.

- Fatal Collisions: $3,028
- Injury Collisions: $954
- PDO Collisions: $384
- Major Injury Collisions: $1,660
- Minor Injury Collisions: $907

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27 Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks Emission Facts, https://nepis.epa.gov.

28 Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007

29 Government of Canada Publication available online (refer to the link below): Technical update to Environment and Climate Change: Canada's social cost of greenhouse gas estimate, published 2016. See http://publications.gc.ca/site/eng/9.629765/publication.html

4.6 LOST PRODUCTIVITY COSTS

Short-term loss of workplace productivity due to time missed as a result of the collision is the final element that is included in the category of the direct cost of collisions. This category of collision costs does not include the long-term loss of productivity and the disruption that is caused by permanent disability (partial or total disability). These long term lost productivity costs are considered in the estimates associated with in-direct collision costs (i.e., Chapter 4: Human Capital Costs).

4.6.1 Lost Productivity Due to Injury Collisions

Short-term productivity costs are estimated by examining the number of workdays that are lost before the full recovery and return to work of a person involved in an injury collision. To obtain the number of workdays lost, the number of permanently disabled injury victims is subtracted from the total number of persons injured. The data concerning the number of permanent disabilities (as presented earlier with the health service costs) is provided again in Table 4.30, together with the estimate of the number of injured with no permanent disability.

Table 4.30: Estimate of Injured Persons (NO Disability)

Disability by Injury Level	Collision Severity Level		
	Fatal	Injury	Total
Injury Level (Raw Data)			
Major	49	758	806
Minor	183	8,472	8,656
TOTAL	232	9,230	9,462
TOTAL Disability			
Major	0.79	12.27	13.06
Minor	0.16	7.63	7.79
TOTAL	0.95	19.90	20.85
PARTIAL Disability			
Major	7.25	113.11	120.37
Minor	3.17	146.57	149.74
TOTAL	10.42	259.69	270.11
INJURED but NO Permanent Disability (Non-Permanent Disability)			
Major	41	632	673
Minor	180	8,318	8,498
TOTAL	221	8,950	9,171

The next step to calculate lost productivity is to estimate the number of workdays that would be lost as a result of the injuries that are sustained in a collision. The model inputs that were used in the original study were determined to be still applicable and thus, these were used again in this updated study with very minor modifications. The number of days lost by collision severity category was based on information from the Ontario study by Vodden et al[30], which provided the following estimate for the number of days lost due to injury collisions with no permanent disabilities.

- Major Injuries: 45.0 days lost
- Minor Injuries: 6.7 days lost

The proportion of the population that was in the workforce and the proportion of the population that was not in the workforce are also required to generate the estimate. The workforce breakdown was available from statistics from the Government of Alberta[31], which indicated the following information concerning the national workforce:

- 72.5% of the population is engaged in the workforce
- 27.5% of the population is not in workforce (students, retirees, etc.)

The economic value of lost workdays is determined by applying an average wage for those in the workplace over an 8-hour day. The average wage is based on the information from Statistics Canada[32] concerning the 2016 average hourly wage in Alberta, which indicated that the average hourly rate was $30.58. It is also noted that workplace benefits are associated with workdays, which are 34.1% of the hourly rate. The average daily economic value for a workday is listed below.

- Average economic daily value for a workday: = $328.06 / day

The number of workdays that are lost due to injuries sustained in a motor vehicle collision is shown in Table 4.31, together with the total cost associated with these lost workdays. Then, the results from Table 4.31 are used to establish the average costs and total costs for the different collision severity classifications used for this report, with the results provided in Table 4.32.

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30 Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007.

31 Government of Alberta, 2016 Labour Market Highlights. See https://work.alberta.ca/labour/2016-monthly-labour-force-statistics.html

32 Statistics Canada, Average Hourly Wages of Employees by selected characteristics and occupation by province, https://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/labr69j-eng.htm

Table 4.31: Estimate of Lost Productivity for Injury Collisions

Lost Productivity: Injuries	Collision Severity Level		
	Fatal	Injury	Total
INJURED but NO Permanent Disability (Non-Permanent Disability)			
Major	41	632	673
Minor	180	8,318	8,498
TOTAL	221	8,950	9,171
WORK Days Lost			
Major Injury:	1322	20,627	21,949
Minor Injury:	875	40,405	41,280
TOTAL	2,197	61,032	63,229
COST of Lost WORK Days			
Major Injury:	$433,761	$6,766,948	$7,200,710
Minor Injury:	$286,934	$13,255,405	$13,542,339
TOTAL	$720,695	$20,022,354	$20,743,049

Table 4.32: Average Lost Productivity for Injury Collisions

Lost Productivity Due to: Injury Collisions	Collision Severity Classification				
	Fatal	Injury	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	39	806	8,656
TOTAL COST:	$720,695	$20,022,354	$720,695	6,766,948	$13,255,405
AVERAGE COST:	$20,253	$3,628	$18,654	$8,394	$1,531

4.6.2 Lost Productivity Due to Fatal Collisions

There will also be some lost productivity in the workplace as a result of persons who are killed in motor vehicle collisions. The following assumptions were used to determine the lost productivity for fatal collisions, many of which are similar to the assumptions used for lost productivity due to injury collisions:

- 72.5% of the population is engaged in the workforce; 27.5% not in workforce
- Average daily value for a workday = $328.06
- Number of work days lost due to a fatality = 20 days

Using the information above, the average lost productivity cost per fatal collision is $5,169 and the average lost productivity cost per fatality is calculated to be $4,761.

4.6.3 Lost Productivity Due to PDO Collisions

Some very minor work place productivity is also lost due as a result of a PDO collision, primarily due to the delay caused by the incident. The following assumptions were used to determine the lost productivity for PDO collisions, noting that some of the assumptions are similar to the assumptions used for lost productivity due to injury and fatal collisions:

- 72.5% of the population is engaged in the workforce; 27.5% not in workforce
- Average daily value for a workday = $328.06
- Number of work days lost due to a PDO collision = 0.25 days (2 hours)

The average lost productivity cost per PDO collision is estimated to be $59.

4.7 SUMMARY OF DIRECT COLLISION COSTS

This chapter of the updated collision cost report has quantified the direct costs that are associated with motor vehicle collisions. A total of six different categories of collision costs were considered, with 23 specific collision costs evaluated. The results for the direct costs of collisions are summarized in Table 4.33 on the following page and the total costs, by collision severity category, are listed below.

DIRECT Collision Costs (by Collision):

FATAL Collision:	$225,558
INJURY Collision:	$48,341
PDO Collision:	$14,065

DIRECT Collision Costs (by Victim):

FATALITY:	$209,828
MAJOR injury:	$122,115
MINOR Injury:	$33,987
PDO Collision:	$14,391

A comparison of the results from the original 2010 study and this updated study are provided in Table 4.34 for collision severity classification 1 (collision) and in Table 4.35 for collision severity classification 2 (victim).

Table 4.33: Summary of Estimated DIRECT Collision Costs: Updated Study 2017

DIRECT Collision Costs		Collision Severity Categories (by Victim)				Collision Severity Categories (by Collision)		
		Fatality	Major Injury	Minor Injury	Property Damage	Fatal	Injury	PDO
1	**Property Damage (Vehicle and Non-Vehicle related)**							
	Vehicle Repairs	$29,853	$21,288	$18,020	$9,409	$32,412	$17,626	$9,130
	Auto-Insurance Administration	$4,397	$2,157	$1,540	$423	$4,774	$1,751	$411
	Out-of-Pocket Expenses (Not covered by insurance)	$1,346	$1,053	$972	$633	$1,462	$946	$614
	Towing Services	$818	$661	$676	$508	$888	$735	$493
2	**Emergency Response Costs**							
	Police Costs	$6,200	$1,925	$618	$188	$6,621	$741	$188
	Fire Department Costs	$3,023	$4,307	$1,168	$-	$3,282	$2,462	$-
	Ambulance Costs	$914	$1,934	$621	$-	$992	$744	$-
	Coroners Costs (Fatal Only)	$1,994	$-	$-	$-	$2,165	$-	$-
3	**Health Service Costs**							
	Emergency Room Costs	$2,007	$341	$288	$-	$2,179	$502	$-
	ICU Care Costs	$59,775	$40,443	$-	$-	$64,899	$5,908	$-
	Acute Care Costs	$11,517	$8,611	$-	$-	$12,505	$1,258	$-
	Rehabilitation Costs	$3,946	$2,209	$204	$-	$4,284	$643	$-
	Long-Term Care Costs	$23,280	$14,387	$832	$-	$25,276	$3,407	$-
4	**Legal Costs**							
	Correctional Services	$1,294	$402	$13	$-	$1,405	$60	$-
	Court Costs	$456	$142	$5	$-	$495	$21	$-
	Legal Aid and prosecution	$461	$143	$5	$-	$500	$21	$-
	Funeral Costs (Fatal Only)	$10,109	$-	$-	$-	$10,975	$-	$-
5	**Travel Delay Costs**							
	Delay Costs Caused by Collision	$20,511	$11,247	$6,142	$2,598	$20,511	$6,466	$2,598
	Extra Fuel Consumption	$1,484	$814	$444	$188	$1,484	$468	$188
	Environmental / Pollution Costs	$3,028	$1,660	$907	$384	$3,028	$954	$384
6	**Productivity / Disruption Costs**							
	Short-Term Work-Place Productivity Costs (Injuries)	$18,654	$8,394	$1,531	$-	$20,253	$3,628	$-
	Short-Term Work-Place Productivity Costs (Fatalities)	$4,761	$-	$-	$-	$5,169	$-	$-
	Short-Term Work-Place Productivity Costs (PDO)	$-	$-	$-	$59	$-	$-	$59
	TOTAL for DIRECT Costs:	**$209,828**	**$122,115**	**$33,987**	**$14,391**	**$225,558**	**$48,341**	**$14,065**

Table 4.34: Comparison of Estimated DIRECT Collision Costs: 2017 Updated Study versus 2010 Original Study
Collision Severity Category 1 (COLLISION)

		2017 Updated Study Results			2010 Original Study Results		
DIRECT Collision Costs		**Collision Severity Category 1 (by Collision)**			**Collision Severity Category 1 (by Collision)**		
		Fatal	**Injury**	**PDO**	**Fatal**	**Injury**	**PDO**
1	**Property Damage (Vehicle and Non-Vehicle related)**						
	Vehicle Repairs	$32,412	$17,626	$9,130	$26,456	$16,092	$6,272
	Auto-Insurance Administration	$4,774	$1,751	$411	$3,312	$1,180	$120
	Out-of-Pocket Expenses (Not covered by insurance)	$1,462	$946	$614	$1,323	$898	$403
	Towing Services	$888	$735	$493	$602	$586	$311
2	**Emergency Response Costs**						
	Police Costs	$6,621	$741	$188	$5,884	$541	$169
	Fire / Rescue Costs	$3,282	$2,462	$-	$628	$278	$-
	Ambulance Costs	$992	$744	$-	$548	$222	$-
	Coroners Costs (Fatal Only)	$2,165	$-	$-	$1,770	$-	$-
3	**Health Service Costs**						
	Emergency Room Costs	$2,179	$502	$-	$1,064	$348	$-
	ICU Care Costs	$64,899	$5,908	$-	$46,970	$2,489	$-
	Acute Care Costs	$12,505	$1,258	$-	$9,374	$775	$-
	Rehabilitation Costs	$4,284	$643	$-	$3,924	$616	$-
	Long-Term Care Costs	$25,276	$3,407	$-	$19,100	$2,525	$-
4	**Legal Costs**						
	Correctional Services	$1,405	$60	$-	$1,061	$29	$-
	Court Costs	$495	$21	$-	$434	$12	$-
	Legal Aid and prosecution	$500	$21	$-	$386	$11	$-
	Funeral Costs (Fatal Only)	$10,975	$-	$-	$8,741	$-	$-
5	**Travel Delay Costs**						
	Delay Costs Caused by Collision	$20,511	$6,466	$2,598	$16,903	$4,926	$1,927
	Extra Fuel Consumption	$1,484	$468	$188	$2,069	$603	$236
	Environmental / Pollution Costs	$3,028	$954	$384	$12,843	$3,743	$1,464
6	**Productivity / Disruption Costs**						
	Short-Term Work-Place Productivity Costs (Injuries)	$20,253	$3,628	$-	$15,300	$3,165	$-
	Short-Term Work-Place Productivity Costs (Fatalities)	$5,169	$-	$-	$3,975	$-	$-
	Short-Term Work-Place Productivity Costs (PDO)	$-	$-	$59	$-	$-	$48
	TOTAL for DIRECT Costs:	**$225,558**	**$48,341**	**$14,065**	**$182,663**	**$39,039**	**$10,949**

Table 4.35: Comparison of Estimated DIRECT Collision Costs: 2017 Updated versus 2010 Original: Collision Severity Category 2 (VICTIM)

		2017 Updated Study Results				2010 Original Study Results			
DIRECT Collision Costs		Collision Severity Category 2 (by Victim)				Collision Severity Category 2 (by Victim)			
		Fatality	**Major Injury**	**Minor Injury**	**Property Damage**	**Fatality**	**Major Injury**	**Minor Injury**	**Property Damage**
1	**Property Damage (Vehicle and Non-Vehicle related)**								
	Vehicle Repairs	$29,853	$21,288	$18,020	$9,409	$25,841	$18,308	$15,509	$6,681
	Auto-Insurance Administration	$4,397	$2,157	$1,540	$423	$3,235	$1,537	$920	$127
	Out-of-Pocket Expenses (Not covered by insurance)	$1,346	$1,053	$972	$633	$1,292	$975	$871	$429
	Towing Services	$818	$661	$676	$508	$588	$512	$504	$333
2	**Emergency Response Costs**								
	Police Costs	$6,200	$1,925	$618	$188	$5,884	$2,322	$441	$169
	Fire / Rescue Costs	$3,023	$4,307	$1,168	$-	$628	$3,281	$81	$-
	Ambulance Costs	$914	$1,934	$621	$-	$548	$3,775	$27	$-
	Coroners Costs (Fatal Only)	$1,994	$-	$-	$-	$1,812	$-	$-	$-
3	**Health Service Costs**								
	Emergency Room Costs	$2,007	$341	$288	$-	$1,039	$318	$254	$-
	ICU Care Costs	$59,775	$40,443	$-	$-	$45,878	$26,517	$-	$-
	Acute Care Costs	$11,517	$8,611	$-	$-	$9,156	$8,258	$-	$-
	Rehabilitation Costs	$3,946	$2,209	$204	$-	$3,832	$2,903	$274	$-
	Long-Term Care Costs	$23,280	$14,387	$832	$-	$18,656	$15,035	$887	$-
4	**Legal Costs**								
	Correctional Services	$1,294	$402	$13	$-	$1,061	$419	$8	$-
	Court Costs	$456	$142	$5	$-	$434	$171	$3	$-
	Legal Aid and prosecution	$461	$143	$5	$-	$386	$152	$3	$-
	Funeral Costs (Fatal Only)	$10,109	$-	$-	$-	$8,887	$-	$-	$-
5	**Travel Delay Costs**								
	Delay Costs Caused by Collision	$20,511	$11,247	$6,142	$2,598	$16,903	$8,874	$4,648	$1,927
	Extra Fuel Consumption	$1,484	$814	$444	$188	$2,069	$1,086	$569	$236
	Environmental / Pollution Costs	$3,028	$1,660	$907	$384	$12,843	$6,742	$3,532	$1,464
6	**Productivity / Disruption Costs**								
	Short-Term Work-Place Productivity Costs (Injuries)	$18,654	$8,394	$1,531	$-	$14,944	$10,606	$1,802	$-
	Short-Term Work-Place Productivity Costs (Fatalities)	$4,761	$-	$-	$-	$3,882	$-	$-	$-
	Short-Term Work-Place Productivity Costs (PDO)	$-	$-	$-	$59	$-	$-	$-	$48
	TOTAL for DIRECT Costs:	**$209,828**	**$122,115**	**$33,987**	**$14,391**	**$179,795**	**$111,792**	**$30,332**	**$11,414**

5.0 INDIRECT COLLISION COSTS: HUMAN CAPITAL COSTS

The next category of collision costs examined for this updated collision cost study is human capital costs, which are considered indirect collision costs. The detailed examination of indirect collision costs was beyond the scope of the original collision cost study and this updated study, but an estimate for is provided for completeness.

Human capital costs are separated into two categories, including the discounted future earnings of the persons affected by the collision and the pain, suffering and grief for the individuals affected by an injury or fatal collision. The human capital approach does not explicitly account for the value and enjoyment of a life that is lost or compromised as a result of permanent injuries sustained in a collision. Because of this, it is sometimes suggested that the human capital approach under-estimates the comprehensive cost of collisions. To account for this potential limitation, a pain, suffering and grief component is used to represent the "human costs".

5.1 Discounted Future Earnings

Discounted future earnings involve estimating the present value of earnings that the individual would have made had he/she not been involved in a collision. These are the long-term earnings that a victim would have received if the collision did not occur, as opposed to the short-term productivity losses as described in Section 4.6. The three components considered to estimate the total discounted future earnings include:

1) The long-term income loss for the person who is involved in a fatal incident;
2) The long-term income loss for persons with a permanently disabling injury;
3) The household productivity and disruption costs for the family or caregiver of the person involved in an injury of fatal collision.

5.1.1 Long-Term Income Loss for Fatal Collision Victims

To calculate the long-term income loss for a fatal collision victim, it is necessary to actuarial tables to determine the life expectancy. Since life expectancy changes over time, a current life expectancy table was obtained[33] for this updated study, showing the number of years of life remaining by gender and age. This life expectancy information is used to estimate the lost income of a victim of a fatal collision. It is assumed that meaningful incomes are earned by persons between the ages of 16 and 65.

[33] Actuarial Publications, 2015 Average Life Expectancy Table, Refer to website: www.ssa.gov/OACT

Workforce utilization varies by age and as such a workforce adjustment factor is required based on the age and gender. This adjustment accounts for the likelihood that not all age and gender groups would be fully engaged in the workforce between 16 and 65. For example, persons between 16 and 25 are quite likely to be attending school / university and as such, may not be in the workforce. Another example would be females between the ages of 20 and 40, who may be less engaged in the workforce as they may be on maternity leave or at home to attend to child care needs.

The average income is required to calculate the total loss of income over the lifetime remaining. Average income levels by age and gender have been updated from the original 2010 study using information from Statistics Canada[34] for the province of Alberta and are provided in Table 5.1. The average incomes in Table 5.1 were also adjusted for inflation (to 2017).

Table 5.1: Average Income by Age and Gender in Alberta

Age Group	Average Income ($/Year)(2017)	
	Male	Female
Under 20:	$38,862	$36,919
20 to 24:	$48,855	$42,504
25 to 34:	$70,137	$52,603
35 to 44:	$87,902	$58,016
45 to 54:	$89,013	$58,748
55 to 64:	$88,272	$62,673
Over 65:	$82,166	$66,554

Using the information described above, the future discount earnings were calculated using the distribution of fatal collisions by age and by gender, as well as the fatal collision involvement rate for males and females. It is also noted that the future earnings are discounted using a rate of 4%.

The results for the lost discounted future earning for fatal collisions is as follows:

- Lost Earnings per Fatal collision: $1,873,520
- Lost Earnings per Fatality: $1,855,990

[34] Statistics Canada Annual Incomes in Canada 2013, https://www.statcan.gc.ca/tables-tableaux

5.1.2 Long-Term Income Loss for Permanently Disabled Victims

To estimate the lost future earning potential for collision victims with permanent disabilities, it is necessary recall the estimate of permanent disabilities (total and partial disability), which was presented in Table 4.22 and is shown again below in Table 5.2.

Table 5.2: Estimate of Permanent Disabilities (Total and Partial)

Disability by Injury Level	Collision Severity Level		
	Fatal	Injury	Total
TOTAL Disability			
Major	0.79	12.27	13.06
Minor	0.16	7.63	7.79
TOTAL	0.95	19.90	20.85
PARTIAL Disability			
Major	7.25	113.12	120.37
Minor	3.17	146.57	149.74
TOTAL	10.42	259.69	270.11

The collision costing methodology assumes that a totally disabled collision victim cannot return to work and therefore, has the same loss of earning potential as a person that dies as a result of a collision. In contrast, a person that only suffers a partial, permanent disability is expected to have 17.2% of the earning potential loss compared to someone who is totally disabled or dies as a result of a collision[35].

The results for the loss of potential future discounted earnings for persons who suffer permanent disabling injuries are provided in Table 5.3.

Table 5.3: Lost Discount Future Earnings for Permanent Disabilities

Lost Future Earning Due to: Permanent Disabilities	Collision Severity Classification				
	Fatal	Injury	Fatalities	Major Injuries	Minor Injuries
Collisions / Victims:	36	5,519	39	806	8,656
TOTAL Future Earnings:	$5,103,052	$119,990,123	$5,103,052	$59,021,886	$60,968,237
AVERAGE COST:	$143,405	$21,742	$132,083	$73,210	$7,044

[35] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007, page 140.

5.1.3 Long-Term Household Productivity Loss

Motor vehicle collisions that result in disabling injuries can produce some long-term household productivity losses. Often a spouse or another family member may either quit their job or reduce their employment level to attend to a loved one that has become permanently disabled from a collision.

The loss of future earnings for a caregiver is computed using similar assumptions and values as those used for long term income loss for permanently disabled victims, as presented in the preceding section (Section 4.1.2). It is noted that the lost future earnings for caregivers is less than that for the victim since more males are the victims in serious collisions and thus, it is likely that caregivers are women, who typically earn less than males.

The results for the loss of potential future earnings for the household caregivers of persons who suffer permanent disabling injuries are provided in Table 5.4.

Table 5.4: Lost Discount Future Earnings for Caregivers

Lost Future Earning For Caregivers	**Collision Severity Classification**				
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
Collisions / Victims:	36	5,519	39	806	8,656
TOTAL Future Earnings:	$4,339,348	$106,654,209	$4,339,348	$47,832,499	$58,821,709
AVERAGE COST:	$121,943	$19,326	$112,316	$59,331	$6,796

5.2 Pain, Suffering and Grief

The information contained in the collision costing literature on the pain, suffering and grief component of human capital costs is highly varied, which produces a wide range of results. Furthermore, the approach used to formulate the estimate for pain, suffering and grief appears to be largely abstract and highly subjective or arbitrary, even as this "cost" element is often the most important one to those directly involved in, or bearing the consequences of, motor vehicle collisions. As such, all dollar estimates of this cost element should be interpreted with great caution, since the impacts of concern are fundamentally, qualitatively different from commodities such as labour, towing services, and pharmaceuticals.

To obtain an estimate for pain, suffering and grief, a study by the Transportation Research Laboratory (TRL) from the United Kingdom was used. The TRL study [36], which was cited in a report by the International Road Assessment Program (referred to as iRAP)[37], recommends the following values for the pain, suffering and grief components of human capital costs. The results for the cost of the pain, suffering and grief component of human costs is provided in Table 5.5.

- 38% of the total cost of the direct costs for fatal collisions
- 28% of the total cost of the direct costs for injury collisions
- 100% of the total cost of the direct costs for major injury collisions
- 8% of the total cost of the direct costs for minor injury collisions

Table 5.5: Pain, Suffering and Grief

Pain, Suffering and Grief:	**Collision Severity Classification**				
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
TOTAL for Direct Costs:	$225,558	$48,341	$209,828	$122,115	$33,987
% For Pain and Suffering:	38%	28%	38%	100%	8%
AVERAGE COST:	$85,712	$48,341	$79,735	$122,115	$2,719

5.3 Summary of Human Capital Costs

This chapter has presented the human capital costs associated with fatal and injury collisions. The overall results are summarized in Table 5.6, showing the average costs by collision severity level.

Table 5.6: Summary of Human Capital Costs

Total Human Capital Costs	**Collision Severity Classification**				
	Fatal	**Injury**	**Fatalities**	**Major Injuries**	**Minor Injuries**
Collisions / Victims:	36	5,519	39	806	8,656
TOTAL Human Capital Costs:	$2,224,580	$89,408	$2,180,125	$254,656	$16,558

[36] Overseas Road Note 10: Costing Road Accidents in Developing Countries, TRL Transportation Research Laboratory, Dr. G. D. Jacobs, Berkshire, United Kingdom, 1995.

[37] McMahon, K., and Dahdah, S., The True Cost of Road Crashes: Valuing Life and the Cost of Serious Injuries, International Road Assessment Program (iRAP), 2007.

6.0 INDIRECT COLLISION COSTS: WILLINGNESS TO PAY COSTS

Willingness to pay is another technique that is used to quantify the indirect costs associated with collisions, which applies primarily to fatal and major injury collisions. As stated earlier, the detailed examination of indirect collision costs was beyond the scope of the original collision cost study and this updated study, but an estimate for willingness to pay indirect costs is provided for completeness.

Estimating the willingness to pay (WTP) costs associated with a fatal or serious injury collision is very involved. The evaluation of the WTP normally involves obtaining estimates from persons within a population to assess their trade-offs between wealth and the potential for physical risk and harm. Often, analysts use complex questionnaires to ascertain how much money an individual would be willing to forfeit in order to obtain a small reduction in their own (or another person's) risk. The design, distribution, compilation and analysis of these sophisticated questionnaires and surveys to quantify willingness to pay are far beyond the scope of this assignment for CRISP.

The methodological approach used in this updated study was similar to the approach that was used in the original study. The WTP costs from fatal and injury collisions were evaluated in two ways including:

1) Using results from a series of studies from developed countries that examined and quantified the value of statistical life (VoSL), and,
2) Using results from regression analysis of willingness to pay studies and economic indicators for a region.

6.1 Value of Statistical Life (Fatal Collisions)

A vast amount of research has been conducted over the years on the value for statistical life (VoSL). An excellent summary of reported VoSL values was produced by Miller[38], which included a robust critical review of the VoSL values and included approximately 70 studies, disaggregated by country. A report from the Canadian Research Chair in Risk Management[39] also provided a range of values for the VoSL within a Canadian context. These VoSL results are summarized in Table 6.1, reported in 2017 dollars.

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38 Miller, T., Variations between Countries in the Values of Statistical Life, Journal of Transport Economics and Policy, ISSN 0022 55258, Volume 34, Part 2, May 2010.

39 Bellavance, F, Dionne, G, ad Lebeau, M, The Value of a Statistical Life: A meta-Analysis with Mixed Effects Regression Model, Canada Research Chair in Risk Management, Working Paper 06-12, Montreal, Canada, January 7, 2007.

Table 6.1: Summary of Values for the Value of Statistical Life (VoSL)

International Studies (From Miller[40])		
Country	**Number of VoSL Values**	**Mean Value for VoSL (2017 $)**
Australia	1	$3,444,120
Austria	2	$5,269,860
Canada	5	$5,699,160
Denmark	1	$6,097,680
France	1	$5,564,700
Japan	1	$13,413,600
New Zealand	3	$2,632,500
Sweden	4	$5,031,720
Switzerland	1	$12,190,500
United Kingdom	7	$3,695,220
United States	39	$5,624,640
	AVERAGE:	$6,242,155
Canadian Studies		
Author	**Number of VoSL Values**	**Mean Value for VoSL (2017 $)**
Cousineau et al	1	$4,981,000
Martinello and Meng	1	$7,524,200
Meng	1	$5,019,930
Meng and Smith	1	$6,703,560
Vodden et al (1993)	1	$5,871,600
Vodden et al (2007)	1	$7,128,200
	AVERAGE:	$6,204,748
	OVERALL AVERAGE	$6,228,952

The values determined for the VoSL sin Table 6.1 shows considerable consistency although some variability is noted. The consistency is likely due to the critical review by Miller. For this study, a simple average of the 2017 values for the VoSL is used to estimate for the willingness to pay for fatal collisions, as noted below

- WTP to prevent a Fatal Collision: $6,768,243
- WTP to prevent a Fatality: $6,228,952

40 Miller, T., Variations between Countries in the Values of Statistical Life, Journal of Transport Economics and Policy, ISSN 0022 55258, Volume 34, Part 2, May 2010.

6.2 Regression Analysis

Another approach that that can be used to determine the willingness to pay values to avoid a fatal collision is based on regression analysis of different studies that have reported WTP estimates. The approach is described by Miller[41], which attempts to link the WTP estimates with various economic indicators from the corresponding jurisdiction. The methodology was used again in a more current report produced by the International Road Assessment Program (iRAP)[42]. Valid regression models were developed to link the VoSL to a country's gross domestic product (GDP) per capita.

The regression models from the iRAP study produced the following relationships for the willingness to pay value of a fatality and for a serious injury. The constants in the model have been modified slightly from the original study to better reflect current and local conditions, but it is noted that the constants are still within the sensitivity range that are recommended by iRAP.

- WTP to prevent a Fatality = 79.1*GDP/Capita
- WTP to prevent a Serious Injury = 19.2*GDP/Capita

Using information available from Statistics Canada[43] the GDP/capita for Alberta such that the WTP values could be determined. The results indicated that the GDP/capita for the province of Alberta was $78,100 in 2016.

Using the regression models and the GDP data, the value for the WTP for a fatality and a serious injury were determined and the computed values are listed below.

- WTP to prevent a Fatal Collision: $6,707,228
- WTP to prevent a Fatality: $6,177,710
- WTP to prevent a Major Injury Collision: $1,596,470
- WTP to prevent a Major Injuries: $1,500,301

The WTP estimates for fatal collision values between the two approaches are very similar (e.g., $6.768M vs. $6.707M), and either value could be reported. However, it was decided that the values produced by the iRAP approach be used for this report.

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41 Miller, T., Variations between Countries in the Values of Statistical Life, Journal of Transport Economics and Policy, ISSN 0022 55258, Volume 34, Part 2, May 2010

42 McMahon, Kate and Daddah, Said, The True Cost of Road Crashes: Valuing Life and the Cost of Serious Injury, prepared for the International Road Assessment Program (iRAP), 2007.

43 Statistic Canada, *Canada, Government of Canada, Statistics.* "CANSIM - 384-0038 - Gross domestic product, expenditure-based, provincial and territorial". *www5.statcan.gc.ca*, 2016.

6.3 Summary of Willingness to Pay Costs

This chapter has presented the willingness to pay costs associated with fatal and injury collisions. The overall results are summarized in Table 6.2, showing the willingness to pay costs by collision severity level.

Table 6.2: Summary of Willingness to Pay Cost Estimates

Willingness to Pay Cost Estimates	**Collision Severity Classification**			
	Fatal	**Injury**	**Fatalities**	**Major Injuries**
Collisions / Victims:	36	5,519	39	806
Willingness to Pay Cost Estimates:	$6,707,228	$158,654	$6,177,710	$1,500,301

7.0 SUMMARY

7.1 Background and Objectives

This report has been prepared for the Capital Region Intersection Safety Partnership (CRISP), with the objective to describe and quantify the costs that are associated with motor vehicle collisions within the Capital Region. This report is an update to a previous study[44] that was completed in 2010 and based on data from 2007 and as such, it was felt that an update was necessary to reflect changes to the model inputs used in the evaluation of collision cost of collision, as well as the change in safety performance in the Region. An accurate and current set of collision cost values is important to understand the economic cost of collision in order to appreciate and justify initiatives deployed to address the road safety problem.

Collision costs were categorized into 3 types of costs including: 1) Direct Costs, 2) Human Capital Costs (HC) and 3) Willingness to Pay (WTP) costs, as described throughout this report. The major focus of the report was dedicated to direct collision costs, but estimates for human capital costs and WTP costs were also provided.

[44] de Leur, P, Thue, L., and Ladd, B, Collision Cost Study Final Report, Prepared for CRISP Capital Region Intersection Safety Partnership (CRISP), February 2010.

The methodology in this current report generally follows the methodological approach that was used in the 2010 study since the various elements of the collision-costing model have not changed (i.e., there are no new types of costs associated with collisions in 2017 as compared to 2010). The methodology follows an approach described in a Transport Canada report by Vodden et al[45] (2007), which is considered to be the most thorough and applicable approach for the Capital Region.

The focus of the update was to examine each input to the costing model, examine the suitability of the input, and make the necessary changes to reflect current costs and new or improved information. The success of the update was dependent upon the information available and provided and great care was taken to ensure that the most current and correct data was available for the study.

7.2 Baseline Collision Data

The fundamental input for collision cost model is the historical data for the jurisdiction under review, which included 8 communities with the Capital Region. This collision data is used to create an accurate depiction of the safety performance in the region, which will influence medical costs, property damage, traffic delay and all other costs associated with collisions.

In comparing the collision data sets from 2007 and 2015, what is significant and notable is the marked improvement in terms of a reduction in the frequency of severe collisions (i.e., fatal and injury producing collisions). The data shows that fatal collisions have reduced by 17% and injury collisions have reduced 38% between 2007 and 2015. Although an improved level of safety is consistent in other jurisdictions, it is noted that the magnitude of this improvement for the Capital Region is very significant and could likely be linked to the dedication and efforts focused at road safety within the region.

Several adjustments were made to the historical collision data to account for the under and misreporting of collisions. These adjustments are required to obtain a better representation of the true collision experience and the true costs of collisions. The adjustment process for the raw collision data was described in chapter 2.

[45] Vodden, K, Smith, D, Eaton, F and Mayhew, D., Analysis and Estimation of the Social Cost of Motor Vehicle Collisions in Ontario, Transport Canada, August 2007.

7.3 Collision Cost Results

A total of 28 different collision cost elements were considered in the generation of the estimates for collision costs, disaggregated over the three categories of collision costs (direct, human capital, and willingness to pay). The details concerning the elements associated with direct collision costs, human capital costs and willingness to pay costs were provided in Chapters 3, 4, and 5 respectively.

A summary of the results for the direct collision costs is summarized in Table 7.1 below. Included in the table is a reference to the chapter of the report that describes the each direct cost element.

Table 7.1: Summary of Estimated DIRECT Collision Costs: Updated Study 2017

DIRECT Collision Costs		Collision Costs (by Victim)				Collision Costs (by Collision)		
Report Chapter	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatal	Injury	PDO
3.1	**Property Damage**							
3.1.1	Vehicle Repairs	$29,853	$21,288	$18,020	$9,409	$32,412	$17,626	$9,130
3.1.2	Auto-Insurance Administration	$4,397	$2,157	$1,540	$423	$4,774	$1,751	$411
3.1.3	Out-of-Pocket Expenses	$1,346	$1,053	$972	$633	$1,462	$946	$614
3.2.4	Towing Services	$818	$661	$676	$508	$888	$735	$493
3.2	**Emergency Response Costs**							
3.2.1	Police Costs	$6,200	$1,925	$618	$188	$6,621	$741	$188
3.2.2	Fire / Rescue Costs	$3,023	$4,307	$1,168	$0	$3,282	$2,462	$0
3.2.3	Ambulance Costs	$914	$1,934	$621	$0	$992	$744	$0
3.2.4	Coroners Costs (Fatal Only)	$1,994	$0	$0	$0	$2,165	$0	$0
3.3	**Health Service Costs**							
3.3.1	Emergency Room Costs	$2,007	$341	$288	$0	$2,179	$502	$0
3.3.2	ICU Care Costs	$59,775	$40,443	$0	$0	$64,899	$5,908	$0
3.3.3	Acute Care Costs	$11,517	$8,611	$0	$0	$12,505	$1,258	$0
3.3.4	Rehabilitation Costs	$3,946	$2,209	$204	$0	$4,284	$643	$0
3.3.5	Continuing Care Costs	$23,280	$14,387	$832	$0	$25,276	$3,407	$0
3.4	**Legal Costs**							
3.4.1	Correctional Services	$1,294	$402	$13	$0	$1,405	$60	$0
3.4.2	Court Costs	$456	$142	$5	$0	$495	$21	$0
3.4.3	Legal Aid and Prosecution	$461	$143	$5	$0	$500	$21	$0
3.4.4	Funeral Costs (Fatal Only)	$10,109	$0	$0	$0	$10,975	$0	$0
3.5	**Travel Delay Costs**							
3.5.1	Delay Costs Caused by Collision	$20,511	$11,247	$6,142	$2,598	$20,511	$6,466	$2,598
3.5.2	Extra Fuel Consumption	$1,484	$814	$444	$188	$1,484	$468	$188
3.5.3	Environmental / Pollution Costs	$3,028	$1,660	$907	$384	$3,028	$954	$384
3.6	**Productivity / Disruption Costs**							
3.6.1	Short-Term Work-Place (Injury)	$18,654	$8,394	$1,531	$0	$20,253	$3,628	$0
3.6.2	Short-Term Work-Place (Fatal)	$4,761	$0	$0	$0	$5,169	$0	$0
3.6.3	Short-Term Work-Place (PDO)	$0	$0	$0	$59	$0	$0	$59
	TOTAL for DIRECT Costs:	**$209,828**	**$122,115**	**$33,987**	**$14,391**	**$225,558**	**$48,341**	**$14,065**

A summary of the results for the human capital costs is summarized in Table 7.2 below. Included in the table is a reference to the chapter of the report that describes the human capital cost element. A combined cost that includes the human capital cost and the direct costs is also shown below.

Table 7.2: Summary of Estimated Human Capital Collision Costs: Updated Study 2017

HUMAN CAPITAL Costs		Collision Costs (by Victim)				Collision Costs (by Collision)		
Report Chapter	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatality	Injury	PDO
4.1	**Discount Future Earnings**							
4.1.1	Long-Term Income Loss (Fatal Collision Victim)	$1,855,990	$0	$0	$0	$1,873,520	$0	$0
4.1.2	Long-Term Income Loss (Disabled Injury Victim)	$132,083	$73,210	$7,044	$0	$143,405	$21,742	$0
4.1.3	House-Hold Productivity and Disruption Costs	$112,316	$59,331	$6,796	$0	$121,943	$19,326	$0
4.2	**Pain, Suffering and Grief**							
4.2	Pain, Suffering and Grief	$79,735	$122,115	$2,719	$0	$85,712	$48,341	$0
TOTAL for HUMAN CAPITAL Costs:		**$2,180,125**	**$254,656**	**$16,558**	**$0**	**$2,224,580**	**$89,408**	**$0**
TOTAL for HUMAN CAPITAL + DIRECT Costs:		**$2,389,953**	**$376,771**	**$50,546**	**$14,391**	**$2,450,139**	**$137,749**	**$14,065**

A summary of the results for the willingness to pay costs is summarized in Table 7.3 below. Included in the table is a reference to the chapter of the report that describes the human capital cost element. A combined cost that includes the willingness to pay cost and the direct costs is also shown below.

Table 7.3: Summary of Estimated Willingness to Pay Costs: Updated Study 2017

WILLINGNESS TO PAY Costs		Collision Cost (by Victim)				Collision Costs (by Collision)		
Rpt.	Cost Category	Fatality	Major Injury	Minor Injury	Property Damage	Fatality	Injury	PDO
5.1	**Value of Statistical Life**							
5.1	Valuation of Statistical Life (VoSL) (FATAL Only)	$6,177,710	$0	$0	$0	$6,707,228	$0	$0
5.2	**Valuation of Major Injuries**							
5.2	Valuation of Injures (MAJOR Injuries Only)	$0	$1,500,301	$0	$0	$0	$158,654	$0
TOTAL for WILLINGNESS TO PAY Costs:		**$6,177,710**	**$1,500,301**	$0	**$0**	**$6,707,228**	**$158,654**	**$0**
TOTAL: WILLINGNESS TO PAY + DIRECT Cost:		**$6,387,538**	**$1,622,416**	**$33,987**	**$14,391**	**$6,932,786**	**$206,994**	**$14,065**

7.4 Comparison Between 2010 and 2017 Results

A comparison of the results from the original 2010 study and this updated 2017 study are provided in a series of tables as follows:

Table 7.4 Direct Costs for Collision Severity Classification 1 (COLLISION)
Table 7.5 Human Capital Costs for Collision Severity Classification 1 (COLLISION)
Table 7.6 Willingness to Pay Costs for Collision Severity Classification 1 (COLLISION)

Table 7.7 Direct Costs for Collision Severity Classification 2 (VICTIM)
Table 7.8 Human Capital Costs for Collision Severity Classification 2 (VICTIM)
Table 7.9 Willingness to Pay Costs for Collision Severity Classification 2 (VICTIM)

Table 7.4: Comparison of 2017 and 2010 Direct Costs
Collision Severity Classification 1 (COLLISION)

		2017 Updated Study Results				2010 Original Study Results		
DIRECT Collision Costs		**Collision Severity Category 1 (by Collision)**				**Collision Severity Category 1 (by Collision)**		
		Fatal	**Injury**	**PDO**		**Fatal**	**Injury**	**PDO**
1	**Property Damage**							
	Vehicle Repairs	$32,412	$17,626	$9,130		$26,456	$16,092	$6,272
	Auto-Insurance Admin.	$4,774	$1,751	$411		$3,312	$1,180	$120
	Out-of-Pocket Expenses	$1,462	$946	$614		$1,323	$898	$403
	Towing Services	$888	$735	$493		$602	$586	$311
2	**Emergency Response Costs**							
	Police Costs	$6,621	$741	$188		$5,884	$541	$169
	Fire / Rescue Costs	$3,282	$2,462	$0		$628	$278	$0
	Ambulance Costs	$992	$744	$0		$548	$222	$0
	Coroners Costs (Fatal Only)	$2,165	$0	$0		$1,770	$0	$0
3	**Health Service Costs**							
	Emergency Room Costs	$2,179	$502	$0		$1,064	$348	$0
	ICU Care Costs	$64,899	$5,908	$0		$46,970	$2,489	$0
	Acute Care Costs	$12,505	$1,258	$0		$9,374	$775	$0
	Rehabilitation Costs	$4,284	$643	$0		$3,924	$616	$0
	Long-Term Care Costs	$25,276	$3,407	$0		$19,100	$2,525	$0
4	**Legal Costs**							
	Correctional Services	$1,405	$60	$0		$1,061	$29	$0
	Court Costs	$495	$21	$0		$434	$12	$0
	Legal Aid and prosecution	$500	$21	$0		$386	$11	$0
	Funeral Costs (Fatal Only)	$10,975	$0	$0		$8,741	$0	$0
5	**Travel Delay Costs**							
	Delay Costs Due to Collision	$20,511	$6,466	$2,598		$16,903	$4,926	$1,927
	Extra Fuel Consumption	$1,484	$468	$188		$2,069	$603	$236
	Environment/Pollution Cost	$3,028	$954	$384		$12,843	$3,743	$1,464
6	**Productivity / Disruption Costs**							
	Short-Term Work-Place Productivity Costs (Injuries)	$20,253	$3,628	$0		$15,300	$3,165	$0
	Short-Term Work-Place Productivity Cost (Fatalities)	$5,169	$0	$0		$3,975	$0	$0
	Short-Term Work-Place Productivity Costs (PDO)	$0	$0	$59		$0	$0	$48
	TOTAL for DIRECT Costs:	**$225,558**	**$48,341**	**$14,065**		**$182,663**	**$39,039**	**$10,949**

Table 7.5 Comparison of 2017 and 2010 Human Capital Costs
Collision Severity Classification 1 (COLLISION)

		2017 Updated Study Results				2010 Original Study Results		
HUMAN CAPITAL Costs		**Collision Severity Category 1 (by Collision)**				**Collision Severity Category 1 (by Collision)**		
		Fatal	**Injury**	**PDO**		**Fatal**	**Injury**	**PDO**
1	**Discount Future Earnings**							
	Long-Term Income Loss (Fatal Collision Victim)	$1,873,520	$0	$0		$1,414,927	$0	$0
	Long-Term Income Loss (Disabled Injury Victim)	$143,405	$21,742	$0		$108,513	$17,314	$0
	House-Hold Productivity and Disruption Costs	$121,943	$19,326	$0		$76,741	$13,154	$0
2	**Pain, Suffering and Grief**							
	Pain, Suffering and Grief	$85,712	$48,341	$0		$67,902	$39,039	$0
	TOTAL for HUMAN CAPITAL Costs:	**$2,224,580**	**$89,408**	**$0**		**$1,668,083**	**$69,507**	**$0**

Table 7.6 Comparison of 2017 and 2010 Willingness to Pay Costs
Collision Severity Classification 1 (COLLISION)

		2017 Updated Study Results				2010 Original Study Results		
WILLINGNESS TO PAY Costs		**Collision Severity Category 1 (by Collision)**				**Collision Severity Category 1 (by Collision)**		
		Fatal	**Injury**	**PDO**		**Fatal**	**Injury**	**PDO**
1	**Value of Statistical Life**							
	Valuation of Statistical Life (VoSL) (FATAL Only)	$6,707,228	$0	$0		$5,362,458	$0	$0
2	**Valuation of Major Injuries**							
	Valuation of Injures (MAJOR Injuries Only)	$0	$158,654	$0		$0	$95,032	$0
	TOTAL for WILLINGNESS TO PAY Costs:	**$6,707,228**	**$158,654**	**$0**		**$5,362,458**	**$95,032**	**$0**

Table 7.7 Comparison of 2017 and 2010 Direct Costs
Collision Severity Classification 2 (VICTIM)

		2017 Updated Study Results				2010 Original Study Results			
DIRECT Collision Costs		**Collision Severity Category 2 (by Victim)**				**Collision Severity Category 2 (by Victim)**			
		Fatality	**Major Injury**	**Minor Injury**	**Property Damage**	**Fatality**	**Major Injury**	**Minor Injury**	**Property Damage**
1	**Property Damage**								
	Vehicle Repairs	$29,853	$21,288	$18,020	$9,409	$25,841	$18,308	$15,509	$6,681
	Auto-Insurance Admin.	$4,397	$2,157	$1,540	$423	$3,235	$1,537	$920	$127
	Out-of-Pocket Expenses	$1,346	$1,053	$972	$633	$1,292	$975	$871	$429
	Towing Services	$818	$661	$676	$508	$588	$512	$504	$333
2	**Emergency Response Costs**								
	Police Costs	$6,200	$1,925	$618	$188	$5,884	$2,322	$441	$169
	Fire / Rescue Costs	$3,023	$4,307	$1,168	$0	$628	$3,281	$81	$0
	Ambulance Costs	$914	$1,934	$621	$0	$548	$3,775	$27	$0
	Coroners Costs (Fatal Only)	$1,994	$0	$0	$0	$1,812	$0	$0	$0
3	**Health Service Costs**								
	Emergency Room Costs	$2,007	$341	$288	$0	$1,039	$318	$254	$0
	ICU Care Costs	$59,775	$40,443	$0	$0	$45,878	$26,517	$0	$0
	Acute Care Costs	$11,517	$8,611	$0	$0	$9,156	$8,258	$0	$0
	Rehabilitation Costs	$3,946	$2,209	$204	$0	$3,832	$2,903	$274	$0
	Long-Term Care Costs	$23,280	$14,387	$832	$0	$18,656	$15,035	$887	$0
4	**Legal Costs**								
	Correctional Services	$1,294	$402	$13	$0	$1,061	$419	$8	$0
	Court Costs	$456	$142	$5	$0	$434	$171	$3	$0
	Legal Aid and prosecution	$461	$143	$5	$0	$386	$152	$3	$0
	Funeral Costs (Fatal Only)	$10,109	$0	$0	$0	$8,887	$0	$0	$0
5	**Travel Delay Costs**								
	Delay Costs Due to Collision	$20,511	$11,247	$6,142	$2,598	$16,903	$8,874	$4,648	$1,927
	Extra Fuel Consumption	$1,484	$814	$444	$188	$2,069	$1,086	$569	$236
	Environment/Pollution Cost	$3,028	$1,660	$907	$384	$12,843	$6,742	$3,532	$1,464
6	**Productivity / Disruption Costs**								
	Short-Term Work-Place Productivity Costs (Injuries)	$18,654	$8,394	$1,531	$0	$14,944	$10,606	$1,802	$0
	Short-Term Work-Place Productivity Cost (Fatalities)	$4,761	$0	$0	$0	$3,882	$0	$0	$0
	Short-Term Work-Place Productivity Costs (PDO)	$0	$0	$0	$59	$0	$0	$0	$48
	TOTAL for DIRECT Costs:	**$209,828**	**$122,115**	**$33,987**	**$14,391**	**$179,795**	**$111,792**	**$30,332**	**$11,414**

Table 7.8 Comparison of 2017 and 2010 Human Capital Costs
Collision Severity Classification 2 (VICTIM)

		2017 Updated Study Results				2010 Original Study Results			
HUMAN CAPITAL Costs		**Collision Severity Category 2 (by Victim)**				**Collision Severity Category 2 (by Victim)**			
		Fatality	**Major Injury**	**Minor Injury**	**Property Damage**	**Fatality**	**Major Injury**	**Minor Injury**	**Property Damage**
1	**Discount Future Earnings**								
	Long-Term Income Loss (Fatal Collision Victim)	$1,855,990	$0	$0	$0	$1,392,531	$0	$0	$0
	Long-Term Income Loss (Disabled Injury Victim)	$132,083	$73,210	$7,044	$0	$105,990	$79,785	$7,827	$0
	House-Hold Productivity and Disruption Costs	$112,316	$59,331	$6,796	$0	$74,957	$54,700	$6,388	$0
2	**Pain, Suffering and Grief**								
	Pain, Suffering and Grief	$79,735	$122,115	$2,719	$0	$5,884	$2,322	$441	$169
	TOTAL for HUMAN CAPITAL Costs:	**$2,180,125**	**$254,656**	**$16,558**	**$0**	**$1,640,324**	**$246,277**	**$16,641**	**$0**

Table 7.9 Comparison of 2017 and 2010 Willingness to Pay Costs

Collision Severity Classification 2 (VICTIM)

WILLINGNESS TO PAY Costs		Collision Severity Category 2 (by Victim)					Collision Severity Category 2 (by Victim)			
		Fatality	Major Injury	Minor Injury	Property Damage		Fatality	Major Injury	Minor Injury	Property Damage
1	**Value of Statistical Life**									
	Valuation of Statistical Life (VoSL) (FATAL Only)	$6,177,710	$0	$0	$0		$5,362,458	$0	$0	$0
2	**Valuation of Major Injuries**									
	Valuation of Injures (MAJOR Injuries Only)	$0	$1,500,301	$0	$0		$0	$1,272,025	$0	$0
TOTAL for WILLINGNESS TO PAY Costs:		**$6,177,710**	**$1,500,301**	**$0**	**$0**		**$5,237,750**	**$1,272,025**	**$0**	**$0**

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APPENDIX 1: Classification and Description of Collisions

In Alberta, collisions are categorized by the traditional collision severity classifications of fatal, injury and PDO. However, Alberta also provides information related to the victims (i.e., the number of fatalities and injuries per incident), including the disaggregation of injury collisions into two categories: major injury and minor injury. For example, although counted as one fatal collision, a very severe fatal collision could actually involve two fatalities, two major injuries, three minor injuries and PDO. This information must be captured in the collision cost model.

Two collision severity categorization schemes were used for this study. The first approach slots each collision into one of 3 collision severity levels: fatal, injury, or PDO. The second approach, which is based on the number of victims, has 4 collision severity levels: fatalities, major injuries, minor injuries, and PDO. These two classifications are used in the present study for consistency with the classifications used in Alberta.

The definitions for the different collision severity levels used in this study are provided below.

<u>Collision Severity Classification 1 (Collision):</u>

Fatal:	A collision that results in at least one death as a result of the collision, and which has occurred either at the scene or within 30 days from the date of the collision.
Injury:	A collision that results in at least one readily apparent injury, or vehicle damages that would support the claim of an injury from an involved individual.
PDO:	A collision that only involves property damage to vehicles and/or other property in excess of $1000, with no apparent injuries or deaths.

Collision Severity Classification 2 (Victim):

Fatalities:	A collision that results in one or more deaths, with the deaths occurring either at the scene or within 30 days from the date of the collision.
Major Injury:	A collision that results in an injury that requires the injured individual to be transported in an ambulance to a hospital by emergency response personnel.
Minor Injury:	A collision that involves a readily apparent injury or a claim of an injury but does not require that the injured individual be transported by an ambulance to a hospital.
PDO:	(As Above): A collision that only involves property damage to vehicles or other property in excess of $1000 and no apparent injuries or deaths is associated with the collision.