

Winter Road Maintenance Activities and the Use of Road Salts in Canada:

A Compendium of Costs and Benefits Indicators.

Winter road maintenance activities present many benefits to the economy and the society in general. Road salts¹, used in aiding to achieve bare pavement quicker, adversely affect the environment on which life depend.

The available basic partial partial indicators of the costs and benefits of winter road maintenance associated with the use of road salts are presented in this document and can be used to extrapolate the benefits of winter maintenance and the costs resulting from the use of road salts for Canada and its provinces.

Table A: Breakdown of Costs and Benefits of Winter Maintenance, Using Road Salts as a De-icer.

Costs	Benefits
<p>Direct:</p> <ul style="list-style-type: none"> • Material Cost (salts) • Equipment cost • Labour Cost <p>Indirect:</p> <ul style="list-style-type: none"> • Cost to Infrastructures • Cost to motor Vehicles (on-road) • Cost to the Environment 	<p>Direct:</p> <ul style="list-style-type: none"> • Fuel savings • Travel time savings • Avoided Fatality, Injury and vehicle damage <p>Indirect:</p> <ul style="list-style-type: none"> • Reduction in liability claims to road authority (associated to hazardous driving conditions). • Maintain the economic activity (production, transportation, and earnings) • Maintain access to social activities.

The underlying components of the various costs and benefits reported in table A will be used to identify and classify the acquired economic partial indicators available to date. Partial indicators represented in this document by a dollar figure are expressed in term of Canadian dollar of 1998 (data is adjusted for inflation and exchange rate).

Section 1: Partial Indicators Associated With Salt Application To Roads

Based on our extensive research of the literature, including the Internet and other personal communications, this section presents the available partial indicators of costs and benefits of winter maintenance associated with the road application of salts - The partial indicators must be used only within proper context; Contact REAB Regulatory & Economic Analysis Branch) for information on how to adapt the partial indicators to specific cases.

Partial Indicators Of Costs Of Winter Maintenance With The Use Of Road Salts

Direct Costs

General partial indicators

Based on data received from one of the provinces that were contacted (not for Ontario), we estimated that:

- Winter maintenance direct cost per kilometre of highways to be around \$530/km²
- Winter maintenance direct cost per tonne of salt applied to highways, for that same province, is around \$320/tonne³

Material (Road salts)

- The price of salt in Canada vary from location to location and can range between \$20⁴ to \$80. The price is estimated to be on average \$50 per tonne for the country.

Salt application

- Equipment cost, for one of the provinces, is estimated to be on average \$30⁵ per hour-equipment (truck, snow plow, etc.).
- Labour cost is estimated to be between \$14-\$23⁶ per hour-worker for one of the provinces. According to the Transportation Research Board, this cost is estimated to be around \$38⁷ per hour-worker.

Indirect Costs

Infrastructures⁸

- Bridge: It is estimated that 1.5% of existing bridge surface need to be repaired every year due to salt contamination.
 - The cost to repair a bridge deck affected by salt is on average \$763⁹ per square metre per year.
 - Protection cost against salt contamination of a new constructed bridge deck is estimated to average \$76¹⁰ per square metre.
- Garage¹¹: on average, 1/10 of existing garages per year needs to be repaired during a 10 years period (1% per year).

Indicators

\$530/km

\$320/tonne

\$50 per tonne

**\$30/hour/vehicl.
\$14-\$23/hour-
worker. TRB
estimated it to
be \$38/hour-
worker**

**1.5% of bridges
per year**

\$763/m²/yr.

\$76/m²

**1/10 of garages
/ yr.**

<ul style="list-style-type: none"> • The repair cost of a typical multi-level garage is on average \$143¹² per square metre. • It is estimated that the annual cost to repair a problem bridge to be \$300,000¹³. Assuming 50% of the repair needed is caused by Salt contamination, we estimate the cost to be around \$150,000 per year per garage (600 parking-garages per year need to be repaired in Canada) • The cost of additional protection for a new constructed garage is equal to 1%¹⁴ of the initial construction cost. • Underground utilities: <i>Corrosion cost to underground utilities: is estimated to be 5¹⁵ times greater than the cost per tonne to apply salt to road (5 * \$319/tonne = \$1595/tonne).</i> 	<p>\$143/ m²</p> <p>\$150,000/yr/gar.</p> <p>1% initial cost</p> <p><i>\$1595/tonne</i></p>
<p>Vehicles (on-road)</p>	<p>\$143/vehicle/yr</p>
<ul style="list-style-type: none"> • Vehicle depreciation cost due to road salt corrosion is estimated to be \$143¹⁶ per vehicle per year. • Vehicle protection cost to salt-related corrosion is estimated to be \$316¹⁷ per new vehicle. Considering advances in modern technology of automobile industry, this indicator can be considered as being over estimated. From our communication with car dealers in the Ottawa-Hull area, we estimated this cost to be around \$29¹⁸ per car per year. 	<p>\$316/vehicle</p> <p>\$29/yr/vehicle</p>
<p>Environment:</p>	<p>20% of water wells</p>
<p>Water</p>	<p>\$5,500 - \$16,000 per well per yr. (\$10,000/well/yr for Ontario)</p>
<ul style="list-style-type: none"> • Water wells: It is estimated that for one of the provinces, 20%¹⁹ of the water wells located close to heavily salted highways are contaminated by road salt. <ul style="list-style-type: none"> • Based on data from some of the provinces, we estimated the cost of well claims to range from \$5,500 to \$16,000 per well per year. • Surface Water: No data regarding the cost of salt contamination to surface water is available. 	<p>1.86 tree/ km/yr</p>
<p>Vegetation</p>	<p>\$886/ tree</p>
<ul style="list-style-type: none"> • Trees: It is estimated that, on the side of a highway, an average of 1.86 trees per km, is affected by salt and need to be replaced each year²⁰. It is estimated that in down town Ottawa, the average mortality rate of trees is 10%-15%²¹ per year (not essentially due to road salt). <ul style="list-style-type: none"> • According to the Transportation Research Board, the cost to replace one mature tree is estimated at \$886²². The city of Ottawa estimated that the total cost to replace a mature tree to be around \$300 (for one young tree and two years of maintenance). • Shrub: 0.6 salt contaminated shrub per km need to be 	<p>\$300/tree (City of Ottawa)</p> <p>\$115/0.6 shr/km \$25/Shr (City of Ottawa)</p>

<p>replaced at a cost of \$115²³ on average per year. The City of Ottawa estimate that the replacement cost per year of one shrub to be \$25.</p> <ul style="list-style-type: none"> Grass: repair cost of salt damaged grass is estimated to be on average \$378²⁴ per hectare per year. 	<p>\$378/ha</p>
<p>Soil</p> <ul style="list-style-type: none"> Soil contaminated by salt can be treated, using gypsum, at an estimated total cost of \$473²⁵ per hectare per year. 	<p>\$473/ha/yr</p>
<p>Biota</p> <ul style="list-style-type: none"> We have no partial indicators regarding the cost, due to the use of road salt, to wildlife (Deer, Mooses, Birds) and non salt-tolerant aquatic organisms that live in non salted water (Fish, micro-organism, and aquatic plant). 	

Partial Indicators Of Benefits Of Winter Maintenance With The Use Of Road Salt

Direct Benefits

Vehicles (on-road)

<ul style="list-style-type: none"> Fuel savings: Driving in bare road conditions allow savings in fuel of up to 33%²⁶ as compared to when roads are snowy or icy. 	<p>33% less fuel</p>
<ul style="list-style-type: none"> Fuel efficiency²⁷: fuel efficiency per 100 kilometers is approximated at 11 litres for autos and light trucks, and 17 litres for gas trucks. 	<p>11l/100kms 17l/100kms</p>
<ul style="list-style-type: none"> We estimated that the monetary value of fuel savings for autos and light trucks to be around \$1.88/100kms. [33%*((11l/100kms)*\$0.52/l)]. 	<p>\$1.88/100kms</p>
<ul style="list-style-type: none"> Transport Canada estimated that idling of cars results in 0.832 litres of fuel consumed per hour. 	
<ul style="list-style-type: none"> Travel time saving is on average \$11²⁸ per hour for auto travellers and \$9.73 per hour for bus travellers. 	<p>\$11/hr. for auto and \$9.73/hr. for bus</p>
<ul style="list-style-type: none"> Accident reduction rate: winter maintenance including the use of salt can reduce vehicle accident of up to 88.3%²⁹ 	<p>Acc. decr. Rate 88.3%</p>
<ul style="list-style-type: none"> Accident costs saving³⁰: Cost saving related to vehicle accident by type of accident are respectively \$1,594,412 per fatality³¹, \$28,618 per injury and \$5,724 per property damage. 	<p>\$1,594,412/fat. \$28,618/inj. \$5,724/dam.</p>

Indirect Benefits

Reduction in liability claims

- Decrease in claims and liabilities: Keeping road reasonably

safe can decrease the number of road-related vehicle accidents, thus the number of accident claims and liability to provinces, road authorities and insurance companies. This data is not available.

Maintaining economic activities

- Reduction in production losses: Enterprises can suffer from losses in productivity due to the following factors: lateness and/or absenteeism by employees to the workplace, unavailability of inputs to production. No data is readily available.
- Reduction of losses in good shipments: Non-bare road or lack of safe travel conditions can delay shipments of goods to delivery points, which affect sales. There are no estimates for such losses.
- Cost to trucking activities during severe storms is not available.
- Reduction in wage losses:
 - Wage loss due to lateness to work is estimated to be on average \$27³² per hour per paid-by-the-hour worker
 - Wage loss due to absenteeism to work can be negligible, in part, because of teleworking opportunity (in the service sector). Due to modern ways of conducting winter maintenance, it is unlikely that the economic activity of an entire province will be completely shut down.

\$27/hr/ worker

Access to social activities

- Emergency response time: Although acknowledge as being an important factor in term of life saved on workplace accident and household accident, for example, there exist no economic valuation of such benefit.
- Social activities: No study had attempted to economically determine the benefit derived from ability to participate in social activities during a winter storm due to better road travel conditions.

Concluding remark: To our knowledge, the partial indicators presented in this document are the ones that are presently available for use. They can be further improved as better information become available. The partial indicators will be used with complementary data so the costs and benefits of winter maintenance can be computed for a specific province or for the country.

Unfortunately, most of the partial indicators for the indirect benefit of winter maintenance could not be gathered or estimated. Thus, a methodology need to be

developped or further research need to be done in order to come up with some estimates of these benefits.

While we acknowledge the uncertainties associated with the estimates, we are confident that they are the best partial indicators that are available.

¹ The term "Road salts" refers to Sodium Chloride.

² Personal communication. Province of Saskatchewan - Ref: 29

³ Ibid.

⁴ Socio-Economic Background and Options Study on the Canadian Salt Industry, 1999, Cheminfo Service Inc.

⁵ Personal communication. Province of Saskatchewan - Ref: 29

⁶ Personal communication. Province of Saskatchewan - Ref: 29

⁷ Life Cycle Cost-Benefit Model for Road Weather Information System, Transportation research record 1627, # 98-0882, pgs: 41-48.

⁸ It is estimated that road salt does not affect asphalt, thus salt has no effects on road surface per se. Source: Environmental Impact of Road Salting, Jones et al., 1986.

⁹ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹⁰ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹¹ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹² Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹³ IRC and partners identifying rebar corrosion solutions, Robert Bullis, 1998.

[Www.nrc.ca.irc/fulltext/prac/visi92.html](http://www.nrc.ca.irc/fulltext/prac/visi92.html)

¹⁴ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹⁵ Corrosion and Alternate Deicers, R.L. McGrum, in Chemical Deicers and the Environment, F.M. D'Itri, Lewis Publishers, 1992. Dollar value is based on saskatchewan data.

¹⁶ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

¹⁷ Ibid.

¹⁸ Telephone interview with car dealers in the Ottawa-Hull area.

¹⁹ "The GPI water quality account", Sara Justine, July 2000. Province of Nova Scotia.

²⁰ Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

²¹ Personal communication, Ctiy of Ottawa

²² Highway Deicing: Comparing Salt and Calcium Magnesium Acetate (1991), Special report 235, TRB-NRC.

²³ Ibid.

²⁴ Ibid.

²⁵ Ibid.

²⁶ Salt Institute, Internet web site: <http://www.saltinstitute.org/30.html>

²⁷ "GHG reduction benefits of intelligent transportation system - Final report, Transport Canada, June 1999

²⁸ Guide to Benefit-Cost analysis in Transport Canada, Transport Canada, 1994.

²⁹ Salt Institute, Internet web site: <http://www.saltinstitute.org/30.html>

³⁰ Guide to Benefit-Cost analysis in Transport Canada, Transport Canada, 1994.

³¹ Environment Canada estimated that the value of human statistical life is \$5,485,049.

³² Source: Average hourly earnings, serie L76126, CANSIM (StatsCan). This number is the average

rate-hour of salaried worker. We estimated that this number is representative of the loss that a paid-by-the-hour worker will suffer if he is one hour late to the workplace.