Route 90 Improvements Benefit-Cost Analysis

Technical Report

Public Works & Economic Research · March 2024

Executive Summary

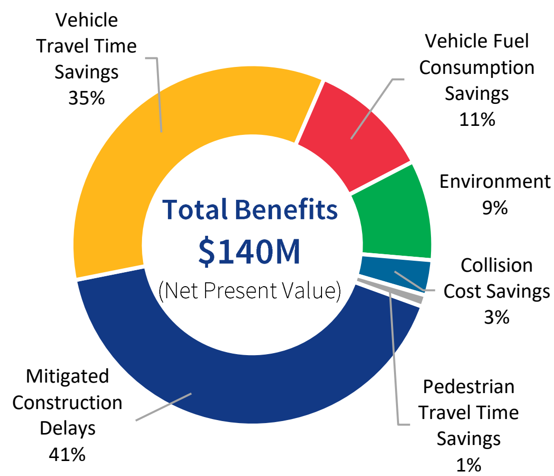
This report estimates the monetary value of the economic and social benefits associated with expanding Route 90 to three lanes in both directions in the study area. Only the incremental benefits and costs associated with the additional lanes are estimated as the other components of this project (reconstruction and drainage) will be necessary in the future regardless of if an additional lane is added.[1]

Overall, the findings indicate that the total incremental benefits are worth $140.0 million and incremental costs are $119.5 million[2], with a positive net present value of $20.5 million over the 2024-to-2054-time horizon**. This represents a benefit-cost ratio of 1.17 and an internal rate of return of 1.4%.**

For every dollar invested, one dollar and seventeen cents in benefits are returned to the public from this component of the project. Between 2024 and 2054 the economic value of benefits associated with widening Route 90 are as follows:

1. **Mitigated Construction Delays worth $57.8 million:** a third lane will enable Route 90 to be maintained at two lanes during rehabilitation. Without a third lane, Route 90 will need to be reduced to one lane in either direction for two construction seasons, costing the public 4.6 million hours of their time.
2. **Vehicle Travel Time Savings worth $48.5 million:** adding a third lane is estimated to provide 7.0 million hours of time savings over 25 years to the public.
3. **Vehicle Fuel Consumption Savings worth $15.2 million:** a more efficient design is estimated to save the public 21.9 million litres of fuel consumption over 25 years.
4. **Environmental benefits worth $12.6 million:** the reduction in fuel consumption is expected to result in a reduction in CO_2, CH_4, and N_2O emissions over 25 years.
5. **Safety Benefits worth $4.4 million:** a safer facility is expected to result in a net reduction of 450 collisions over 25 years despite inducing additional traffic to use the improved facility.
6. **Pedestrian Travel Time Savings worth $1.4 million:** the addition of signalized intersections is expected to reduce pedestrian travel times in the area by 250,000 hours over 25 years.
7. **Municipal Revenue:** there is no additional municipal revenue expected from this project.

Net Present Value of Benefits



It should be cautioned that a substantial portion (41%) of this project's benefits is driven by mitigated construction delays in 2028 and 2029. This is only a temporary benefit and if excluded, the benefit-cost ratio falls to **0.69**, indicating the long-term benefits are below total costs. This is explained by high construction costs and marginal time savings associated with the improved facility once it is operational. At minimum a 77% increase in average travel times in a three-lane scenario is required to increase the benefit-cost ratio to 1.00 if mitigated construction delay benefits are excluded from the analysis.

Economic benefit-cost analysis is most useful when using it to prioritize a list of capital projects competing for the same basket of limited funding, and it is only one of many methods that can be used to examine the value of a policy, program, or project. As this is the first and only major transportation investment to be analyzed by the public service, the metrics provided have limited use for comparing or prioritizing this project versus other infrastructure projects.

Within the City of Winnipeg's 2020 Infrastructure Plan, Route 90 Improvements – Taylor to Ness is priority 14 out of 45 ranked major capital projects, based on a Council approved multi-criteria prioritization model using a cost/benefit-points evaluation.

[1] Given the condition of the existing roadway and bridge structures and the city's obligation to replace combined sewers, it is assumed rehabilitation and drainage costs will be incurred in the future.

[2] Represents discounted construction costs of widening in 2023 dollars plus residual value, excluding administrative and contingency costs.

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1. Route 90 Improvements Overview

The 2011 Winnipeg Transportation Master Plan identified Route 90 from Taylor Avenue to Ness Avenue as a priority strategic road network improvement. The goal of the Route 90 improvement design is to provide safer and more efficient movement of people and goods, better connect residential areas on the east and west sides of Route 90, support social interaction, healthy lives, economic stability, and growth, while providing accessible connected transportation options for all ages and abilities.

The Route 90 improvements project has five main objectives:

1) Provide three through lanes in each direction to address current and forecasted traffic.
2) Rehabilitate and reconfigure the St. James Bridges to improve capacity and extend their life by 75 years.
3) Reconstruct the roadway to address road conditions and implement a consistent speed limit of 60 km/hr.
4) Provide connections for transit, pedestrians, and cyclists.
5) Separate combined sewers to decrease sewer overflows, reduce basement flooding, and improve water quality.

These objectives are achieved through three main project components:

I.) Widening the existing two-lane road to three lanes in both directions
II.) Bridge rehabilitation and road renewal
III.) Sewer upgrades which include the separation of combined sewer in the area

Route 90 is an important transportation and trade corridor that connects the north and south city limits. Current weekday traffic volumes are 79,000 per day on the St. James Bridges, and more than 40,000 per day on Route 90 between Taylor Avenue and Ness Avenue. With respect to goods movement, it is the busiest corridor in Winnipeg with up to 3,000 trucks per day helping move goods through the city. While it is three lanes in each direction both north and south of the improvement study area, it is only two lanes within the improvement study area which creates a bottleneck for traffic.

It is important to consider that regardless of whether Route 90 has an additional lane added in each direction in the improvement area, the pavement on the existing facility has deteriorated and is nearing the end of its life which will require reconstruction in the near future.

Further, the southbound bridge was completed in 1935 and is nearing the end of its life, while the northbound bridge was completed in 1962 and is also deteriorating. As such, the bridge structures also require rehabilitation to last another 75 years regardless of if Route 90 is widened to three lanes or not.

The benefit-cost analysis aims to provide a measurement of the incremental benefits and incremental costs associated with widening Route 90 from two to three lanes in the study area only. The other components of this project would be necessary to complete to maintain existing levels of service and are therefore excluded from the analysis.

2. Benefit-Cost Study Overview

The Purpose of Benefit-Cost Analysis (BCA)

A benefit-cost analysis (BCA) is a process that identifies and quantifies the expected benefits of an investment and compares it to the expected costs. Benefits aim to quantify the social and economic value of expected outcomes associated with the investment and can include the economic value of time savings, safety improvements, reduced emissions, and reduced operating costs for users resulting from the investment. The economic value of these benefits is contrasted to the financial costs associated with making the investment and include both capital and incremental operating expenditures.

The methodology followed in this report has been developed using guidance and resources publicly provided by various organizations including the U.S. Department of Transportation, the British Columbia Ministry of Transportation and Infrastructure, the California Department of Transportation, and the UK Department for Transport. Additional details on assumptions and calculations used in this benefit-cost study are provided in the sections below.

In general, benefit-cost analysis is most informative when it is used to rank projects that are competing for a limited quantity of funding. Typically project proposals with a higher benefit-cost ratio will receive priority over projects with lower benefit-cost ratios as higher benefit-cost ratios suggest more benefits are provided to users per dollar of expenditure and are therefore a more efficient use of the public's tax dollars.

Further, projects with a benefit-cost ratio below one indicates that the measurable benefits provided by the investment are less than the cost of the investment. However, many public programs and investments are made based on social rather than economic considerations, and so a BCA ratio of less than one isn't necessarily indicative that a project should not be completed. At a very high level, broadly investing in infrastructure can lead to productivity gains and economic growth but the ultimate effect a particular public investment may have will be more dependent on local variables such as the wider economic context of the region, the state regional transportation infrastructure, and the availability and productivity of local human capital.[3] Given this, it is important to note that:

- **Benefit-cost analysis is not an economic impact assessment (EIA):** Economic impact assessments provide estimates on the short-term economic impact that results from the physical construction of an infrastructure asset, and these assessments are provided by the public service outside of this report.
- **Benefit-cost analyses for infrastructure projects are inherently narrow in scope:** They seek to estimate the benefits primarily conferred to users of the asset. However, second-order benefits enjoyed by citizens more broadly are difficult to capture. This may include things like improved trip optionality, reliability, and providing capacity for future growth.
- **Benefit-cost analysis is not necessarily an authoritative tool:** While benefit-cost analysis can provide decision makers with valuable information on the relative efficiency of public spending opportunities, it may not be appropriate to used as the sole indicator of the worthiness a particular investment.

[3] For further discussion, please see Deng, Taotao. 2013. "Impacts of Transport Infrastructure on Productivity and Economic Growth: Recent Advances and Research Challenges." *Transport Reviews 33*(6), 686-699.

Route 90 Benefit-Cost Analysis in Context

The Route 90 improvements project has three major design and construction components between Taylor Avenue and Ness Avenue:

1. **Road Widening:** updated cost estimates indicate the road widening will make up **36%** of total project costs. Route 90 is three or more lanes in both directions north of Ness Avenue and south of Taylor Avenue, but the segment between Ness and Taylor is only two lanes. Therefore, this segment represents a significant bottleneck along this corridor with significant travel delays experienced by users during peak travel times on weekdays.
2. **Bridge Rehabilitation and Road Renewal:** updated cost estimates indicate bridge and road renewal are estimated to make up **42%** of total project costs. The pavement along this section of the corridor has deteriorated and is nearing the end of its life, while the bridge structures are also deteriorating and nearing the end of their life. Bridge rehabilitation is expected to extend their useful life by another 75 years, and improved capacity and safety will require reconfiguration.
3. **Sewer Upgrades and Combined Sewer Separation:** updated cost estimates indicate sewer upgrades and combined sewer separation are estimated to make up **22%** of total project costs. In 2013, the Province of Manitoba issued Environmental Act License No. 3042 to the City of Winnipeg with the aim to decrease the quantity and improve the quality of combined sewer overflows (CSOs) that are discharged to Winnipeg's rivers. In response, the City of Winnipeg's CSO Master Plan provides long-term goals for reducing the amount of CSOs entering local waterways. Therefore, replacing the combined sewers that currently exist along Route 90 is a component of the City's overall CSO Master Plan and in alignment with this Environmental Act License. This component of the project will reduce wastewater overflows into the river, basement flooding, and the burden placed on the City's wastewater treatment plants.

To maintain existing levels of service to citizens and businesses in the region, and to continue to meet Provincial environmental regulations, bridge and road renewal along with the sewer upgrade components of the Route 90 improvements project will need to be completed in the future. These project components and are not considered to be optional investments for the purposes of this study. To do so would be equivalent to considering the abandonment and decommissioning of this segment of Route 90 as a public route entirely, an alternative which is untenable. Thus, the benefits of the existing Route 90 configuration do not need to be quantified, it is only the incremental benefits offered by the proposed improvements that are estimated.

This study only considers the optional road widening component. Therefore, only the incremental costs of road widening, which is 36% of total project costs, is compared to the incremental benefits associated with a widened transportation facility.

Current Two-lane versus Improved Three-lane Facility

This benefit-cost analysis strictly compares the incremental cost and benefit of adding an additional lane in both directions to Route 90 from Taylor Avenue to Ness Avenue. The alternative scenario is to leave this facility in its current configuration at two lanes in both directions. Table 1 below summarizes the key statistics associated with both the "widening to three-lanes" and the current configuration "two-lane renewal" scenarios. Land drainage and combined sewer replacement costs are not included in the table below as their benefits and costs are not considered in this analysis.

Table 1: Route 90 Two Lane versus Three Lane Facility Statistics

Statistic and Year		Two-lanes	Three-lanes	Incremental Difference
Cost Estimates (2023 Dollars, millions)	Construction, Engineering & Property	$188.2	$352.0	$163.8
	Contingency & Administration[4]	$30.0	$56.0	$26.0
	Total Cost	**$218.1**	**$407.9**	**$189.8**
2030	Annual Traffic Counts (vehicles)	68,869,601	74,904,918	6,035,317
	Average Travel Time (minutes)	4.03	3.81	-0.22
2050	Annual Traffic Counts (vehicles)	79,725,522	94,111,818	14,386,295
	Average Travel Time (minutes)	5.06	4.88	-0.18

As summarized above, the incremental cost of adding the third lane is estimated to be $189.8 million, inclusive of administrative and contingency costs and $163.8 million excluding administrative and contingency costs.

The addition of a third lane is expected to reduce average travel times for facility users from 4.03 minutes to 3.81 minutes, or a 5.5% reduction, in 2030 when the improved facility is assumed to become operational. By 2050 the additional lane is expected to decrease average travel times from 5.06 minutes to 4.88 minutes, representing a 3.6% decrease. This indicates that the addition of a third lane in both directions will accommodate additional users *and* decrease average user travel times upon completion and 20 years into the future.

It should be noted that:

- Average Traffic Counts is the estimated total number of vehicles interacting with the project area, and is representative of all users of the facility, including through, turning, and cross traffic movements. The total number of vehicles using Route 90 per year makes up a component of this count.
- Similarly, Average Travel Time represents the average amount of time an average user interacts with the project area, including through, turning, and cross traffic movements. Average Travel Time reported here is **not** a measure of only the average time to travel along Route 90 from Taylor Avenue to Ness Avenue, but rather all users. As such, travel time benefits will be greater for users who traverse the entire length of the improved facility, versus users who only traverse a short segment of the facility or cross through it.

[4] Contingency and administrative costs are excluded in the primary benefit-cost analysis calculations.

Figure 1: Average Travel Times in Two Lane versus Three Lane Scenario by Hour of Day

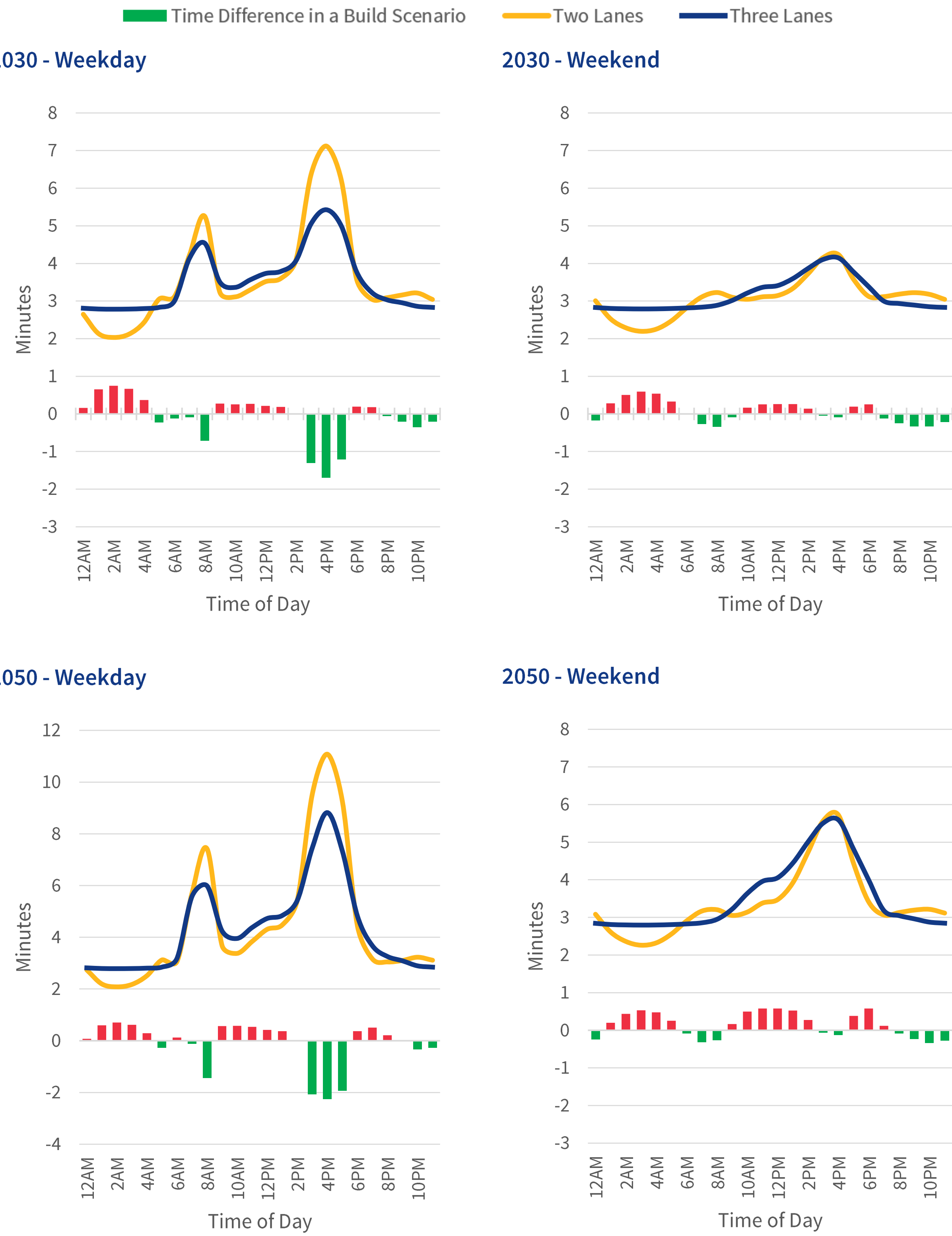

Figure 1 above shows the average travel time per vehicle (in minutes) across all hours of the day in 2030, 2050, on weekdays, and on weekends in the existing two-lane and improved three-lane scenarios. Red bars indicate that average travel times will go up in a three-lane scenario for that hour of the day and green bars indicate that average travel times will go down. Key observations from figure 1 are as follows:

i) On weekdays, a three-lane scenario mainly improves travel times during peak hours of the day (5AM to 9AM; 3PM to 6PM) since the corridor is currently very congested during these hours and a third lane will alleviate this. However, outside peak hours travel times will be marginally worse than the existing facility because the three-lane facility will add signalized intersections (currently 7 signalized intersections, while the proposed improvements require 10).

ii) On weekends, a three-lane scenario will have marginal improvements in average travel times during peak hours, but marginally worse travel times outside peak hours. Again, this is due to the third lane adding capacity which is needed during peak hours but also adding signalized intersections which may decrease travel times outside peak hours.

iii) By 2050, average travel times will significantly increase on the existing two-lane facility, potentially reaching just over 11 minutes for the average vehicle during the afternoon weekday peak-period. This is reduced to just under 9 minutes in a three-lane scenario despite an anticipated 18% increase in traffic counts from induced demand.

Induced Demand on an Improved Facility

Induced demand occurs from two primary sources: generated demand and latent demand. When any change to the transportation network is made, users adjust their use of that network, both in their decisions to make trips using the network, as well as selecting their path through the network itself.

- **Generated Demand:** this relates to users who are already using other routes within the transportation network to meet their origin and destination needs. By improving a particular segment of the network, the user costs associated with traveling through the network can be lowered by selecting the improved route. The effect is that existing traffic demand redistributes itself through the network, resulting in more traffic using the improved route, and reduced traffic on other routes.
- **Latent Demand:** this relates to users who are not currently using the transportation network to make a particular trip, but by improving the segment, a user's cost is reduced. The effect is that new trips are generated, resulting in more traffic on the improved route.

For the Route 90 improvements, most induced demand is generated demand. These users may be taking alternative routes and side streets nearby. Thus, an improved facility may be beneficial to travel times and safety for those living on nearby side streets or commuting on alternative routes, given that the proposed Route 90 improvements will relieve traffic from these areas. Unfortunately, these second-order benefits are difficult to quantify and are therefore excluded from this analysis.

The additional lane is expected to induce additional demand with total facility users increasing by 9% in 2030 when the improved facility opens. Induced demand is predicted to rise to 18% of total traffic by 2050. Consistent with the benefit-cost modelling approach used by many transportation agencies in North America including the United States Department of Transportation, the travel time benefits for the induced demand component of traffic volumes are assumed to be 50% of the travel time benefits enjoyed by existing users of the facility.[5]

[5] Source: United States Government, Department of Transportation. 2023. "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." Accessed December 12, 2023.

3. Data Sources and Assumptions

To complete a benefit-cost analysis, several inputs are required to estimate benefits and costs. Financial data is needed to estimate costs and the timing of cash outflows, traffic simulations are required to estimate changes in travel times for facility users, fuel consumption and emissions, safety information is needed to understand the impact an improved facility will have on the social cost of collisions, and various socioeconomic data is required to estimate aspects like the value of time and social cost of emissions.

The following sections provide greater detail on how this information was obtained, what values are assumed, and the rationale behind the assumptions.

Project Cost and Financial Data

Cost of Route 90 Widening

Table 2 below provides the most recent Route 90 Improvements class 3 cost estimate in 2023 dollars, before debt and finance charges. However, not every cost in this capital project is relevant to the benefit-cost analysis (BCA). This data has been obtained from the most recent basis of estimate with costing data provided by WSP.

As previously discussed, costs associated with the rehabilitation of the existing roadway and bridge structures, along with combined sewer upgrades, are excluded from the BCA. Further, contingency and administrative costs are excluded from the primary BCA but are included in sensitivity analysis. While contingency accounts for unforeseen costs, how much contingency will be used up is currently unknown and administrative charges represent internal costs to the City such as staff time and aren't applicable to BCA.

The cost of Route 90 widening, excluding contingency and administrative costs, is estimated to be $163.8 million (2023 dollars) or 31.4% of total project costs.

Table 2: Route 90 Road Widening Costs Considered in the Benefit-Cost Analysis (BCA)

Group	Expenditure	Cost (2023 Dollars, Millions)	% of Total Cost
Route 90 - Additional Lanes	Roadworks	$28.1	5.4%
	Structures	$81.0	15.5%
	Grading and Drainage	$3.6	0.7%
	Engineering, Planning, and Project Management	$13.6	2.6%
	Property	$37.6	7.2%
	Total Cost Included in BCA	**$163.8**	**31.4%**
Route 90 - Other Expenditures (excluded from BCA)	Existing Lanes and Bridge Rehabilitation	$188.2	36.1%
	Combined Sewer Upgrades	$98.1	18.8%
	Contingency and Administrative Charges	$71.5	13.7%
	Total Cost Excluded in BCA	**$357.8**	**68.6%**
Route 90 Improvements Total Cost		**$521.6**	**100.0%**

Debt and Finance Charges

The debt and finance service charges associated with this project are excluded from this analysis as the use of a discount rate renders the final debt and finance charges equal to the sum of principal payments of the project (i.e., the initial project cost).

The rationale is that debt and finance service charges are expressed in nominal dollars which are calculated based on a nominal interest rate that includes both real and inflationary components. Benefit-cost analysis expresses all costs and benefits in constant dollars, which requires converting the stream of nominal debt and finance service charges to real dollars, which is simply principal payments plus real interest payments. When principal payments plus real interest payments are converted to present dollars using the real discount rate, the real interest payments are cancelled out which only leaves the sum of principal payments that equates to the initial project cost. This eliminates the need to include debt and finance charges in the BCA calculations.[6]

Discount Rate

The discount rate for all non-environmental costs and benefits is 5.5% as per the City of Winnipeg's 2024 Q1 corporate-wide economic and demographic variables guidance document.[7]

For environmental benefits and/or costs, a 2.0% discount rate is used as this is the rate recommended by Environment and Climate Change Canada, which is consistent with the Federal Treasury Board Secretariat's guidance. This is due to the long intergenerational effects of climate change on society, and to enable more accurate representation of intertemporal trade-offs over longer time horizons.[8]

Discount rates are used in calculating costs and benefits because it is generally acknowledged that future costs and benefits are worth less today than costs and benefits occurring closer to the present. As such, the further into the future a cost or benefit occurs, the less it is valued in net present terms. However, analysis that have significant costs up front (e.g., detailed design and construction) that only enable benefits later (e.g., opening a transportation facility *after* construction is complete) are sensitive to the assumed discount rate. Therefore, the results of the BCA at 0% (undiscounted), 3%, and 7% are presented in the sensitivity analysis section of this report.

Facility Residual Value

The benefit-cost analysis focuses on the construction period and then a 25-year benefiting period with the assumption the improved facility is operational beginning in 2030. However, benefits and costs continue to accrue beyond 2054, and these are not captured in the analysis. Standard practice to resolve this issue is to add the residual (salvage) value of the facility as a benefit at the end of the 25-year benefiting period. To determine the facility's residual value in 2054, straight-line depreciation over the useful life of each component is used in accordance with guidance provided by the U.S. Department of Transportation.[9] While adding a third lane has an estimated cost of $163.8 million (2023 dollars, excluding

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[6] For additional information on this concept, please see the section titled "Initial Project Investment Costs" in the California High -Speed Rail Authority 2014 Business Plan Technical Supporting Document (pg. 22).
[7] Source: City of Winnipeg. 2024. "Economic and Demographic Variables – 2024 Q1". Accessed January 25, 2024.
[8] Source: Government of Canada, Environment and Climate Change Canada (ECCC). 2023. "Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance from the Government of Canada". Accessed January 25, 2024.
[9] Source: United States Government, Department of Transportation. 2023. "Benefit-Cost Analysis Guidance for Discretionary Grant Programs." Accessed December 12, 2023.

contingency and administrative costs), the calculated residual value in 2054 is $110.1 million (2023 dollars), though this future value will be discounted like all other benefits and costs.

Incremental Annual Operating Costs

Aside from the capital costs associated with adding an additional lane to Route 90, there are incremental operating costs to consider. These costs are mainly going to be incremental operating costs associated with snow clearing, beautification/street sweeping costs, and reactive maintenance. These costs are anticipated to be $7,553 per lane kilometer annually (2023 dollars), and an additional lane in either direction is expected to add 6 lane kilometers. Therefore, the total incremental annual operating cost in a three-lane scenario is approximately $45,320 annually (2023 dollars).

It is expected that pavement rehabilitation expenses on the additional lanes will only begin to accrue outside the 25-year benefiting period used in this analysis, and as such are not considered as a cost. Rather, the residual value of the improved facility reflects the overall depreciation of the facility expected over the 25-year benefiting period.

Facility and Traffic Simulation Data

Vehicle Travel Times and Fuel Consumption

To derive the net change in travel times, fuel consumption, and emissions for a two-lane versus three-lane scenario, the City of Winnipeg's Public Work's department developed several traffic simulation models using existing and projected vehicle counts at all segments along the Route 90 corridor in the study area.

A microsimulation traffic model was built to compare a two-lane vs three-lane scenario. The model was built in Synchro Studio using expected vehicle counts in 2030 and 2050, for both weekdays and weekends, with regional traffic patterns informed by travel demand model in VISUM and traffic generated from Naawi-Oodena development. The micro traffic simulations provide average travel time per vehicle and fuel consumption estimates for all hours of the day and these projections are further calibrated using traffic volume counts on the St. James Bridge.

Taken together, the simulation data allows for the comparison of average travel times and fuel consumption in a two-lane and three-lane scenario while accounting for increased volume in a three-lane scenario from induced demand. This information is used to estimate the value of travel time savings (VTTS) and net change in both fuel consumption and emissions resulting from an additional lane in the study area.

Mitigated Construction Delay Travel Times

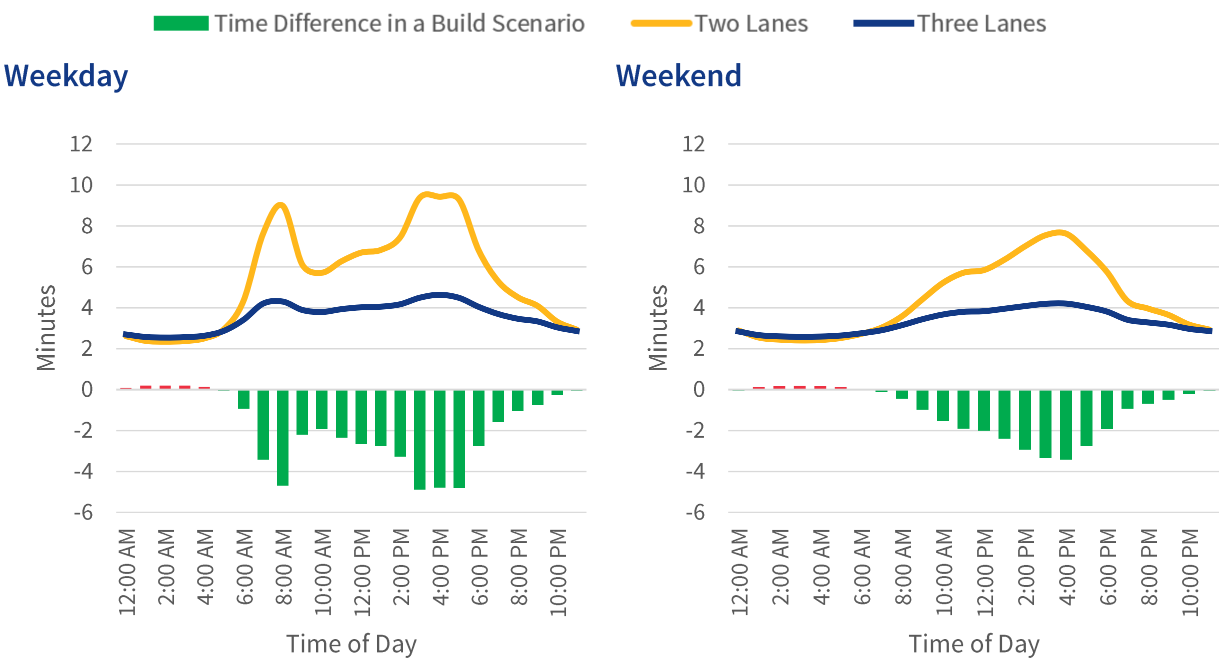
As previously described, the existing road and bridge structures in the study area will require renewal in the near future, regardless of whether a third lane is added. One advantage of a three-lane scenario is that the additional right-of-way for the improved facility can be used to stage construction such that two lanes remain operational in each direction while the improvements are being made. This means that for most of the construction period, traffic will experience travel times like that of the existing two-lane facility.

Alternatively, if a third lane is not added in both directions, Route 90 within the study area will go down to a single lane in either direction while it is being reconstructed, significantly increasing average travel times for existing users and causing some users to divert to alternative routes to avoid delays.

Micro traffic simulations were run on a generalized construction scenario whereby Route 90 in the study area is downgraded to a single lane in each direction during construction, and this is compared to existing average travel times for a two-lane per direction facility. These models suggest total time spent travelling on a one-lane facility during the construction period will increase by 54% and 35% on weekdays and weekends respectively.

The anticipated average travel times between the two scenarios is shown below for weekdays and weekends. The increase in travel time in a two-lane scenario (reduced to a single lane during construction) is significant for existing users on both weekdays and weekends.

Figure 2: Average Travel Times during Construction Season for Route 90 Rehabilitation



Reconstructing the existing facility is estimated to take two construction seasons to complete (assumed April 1 to October 31) with each direction being down to a single lane for the duration of construction. This would involve reconstructing both lanes in both directions along with major rehabilitation of the bridge structures.

It should be noted that while every effort is made to develop traffic models that accurately reflect changes in travel times during construction, there remains a high degree of uncertainty in the estimates produced by the model. Actual delays experienced during construction will strongly depend on the specifics of construction staging and sequencing which are not known until detailed design drawings are complete and tender documents are ready to be issued. Moreover, actual construction staging may differ from detailed design drawings as staging is done to reflect conditions on the ground in real time, with some changes unable to be captured in modelling and design. As such, caution should be used when interpreting these results.

Distribution of Vehicle Types

It is assumed that 96% of vehicle counts using the facility will be automobiles and the remaining 4% will be commercial trucks based on data from Public Works.

Pedestrian and Cyclist Travel Times

Analysis using existing pedestrian counts, design, and pedestrian travel times for the current two-lane facility is compared to the three-lane design. The net change in travel times for pedestrians is then calculated, with pedestrian travel times estimated to fall on net by a marginal amount, primarily through the introduction of additional signalized intersections in certain areas. Pedestrian counts are estimated to average from 40 to 165 per day in the study area, depending on the intersection.

No significant improvements to cyclist travel times are anticipated based on the improvements proposed in the three-lane design and the availability of alternative routes nearby that currently have nearly identical travel times.

Facility Safety

Analysis is performed on collision rate estimates for the existing two-lane facility and the proposed three-lane facility in 2030 and 2050. The analysis is based on five years of historical collision claims data from Manitoba Public Insurance (MPI) for the years 2012 to 2016, which matches the years used to design the project. Based on recent historical data, fatalities across all scenarios are assumed to be zero. The existing two-lane facility is assumed to experience the historical collision rate, whereas the three-lane facility is expected to experience a modified collision rate based on the application of Collision Modification Factors (CMFs) that account for some of the proposed design changes.

Figures 3A and 3B below show the estimated number of collisions by severity in 2030 and 2050 in both a two-lane (existing) and three-lane scenario. Overall, it is expected that the total number of annual collisions will fall in a three-lane scenario despite the increase in total traffic volume due to the safety improvements in the three-lane scenario.

Figure 3A: 2030 Collisions

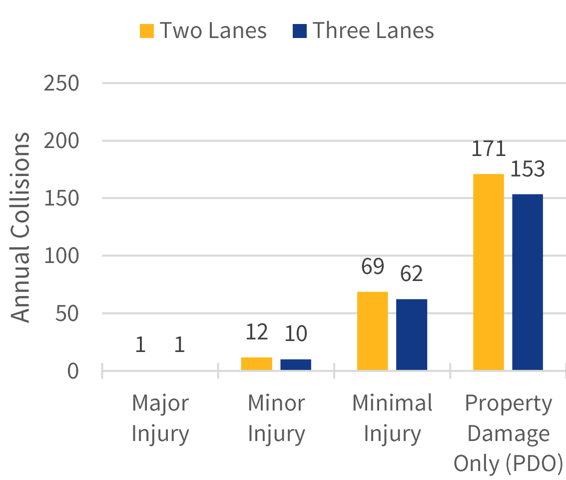
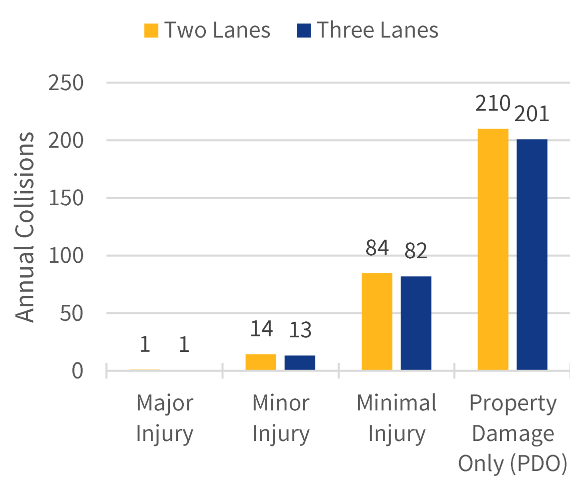


Figure 3B: 2050 Collisions



The proposed design includes several interventions expected to impact safety performance. This includes: modifications to right turn channels; modifications to left turn lanes that are expected to impact left turn signal phasing; widening from two to three lanes in both directions; installation of new multi-use paths and bicycle crossings; changing the speed limit from 50 km/h to 60 km/h; reconfiguration of the St James Bridge that involves the removal of several weaving conflicts as well as alignment improvements; new full and half signal intersections; and some median closures.

Some of these interventions are expected to improve safety performance while others may see certain collision types increase. For example, installing cycling infrastructure could result in an increase in cycling collisions as exposure would increase, whereas improvements to right turn channels should decrease right turn related conflicts.

Estimating the safety performance of design changes requires the use of Collision Modification Factors (CMFs) and accurate CMFs are not available for all design changes. Therefore, this analysis does not estimate the safety performance impact of every design change.

The analysis uses available CMFs that best reflect the proposed design and that could be applied within reason to the collision data in its present form. The safety analysis estimates the impact of changing the speed limit from 50 km/h to 60 km/h, adding an additional lane, and completing bridge improvements.

- The CMF for changing the speed limit is based on a modification to Nilsson's Power Model that accounts for urban conditions.[10] Nilsson's Power Model estimates the effect of the change in average speed on the number of injury collisions. This analysis assumes that the current average operating speed on Route 90 with a 50 km/h speed limit is 48 km/h. It also assumes that the average operating speed for a 60 km/h speed limit would be 55 km/h, which is based on the average operating speeds on other 6-lane divided arterial streets in Winnipeg. Based on these assumptions, the CMF for increasing the speed limit from 50 km/h to 60 km/h is 1.23 for major injury collisions and 1.15 for minor injury collisions. These CMFs reflect 23 percent and 15 percent increases in major injury and minor injury collisions, respectively.
- The CMF for adding an additional lane per direction was sourced from research completed on other urban arterials.[11] The CMF for changing a four-lane roadway to a six-lane roadway is 0.85 for total collisions, which reflects a 15 percent reduction in total collisions.
- For the St James Bridge, a CMF was assumed based on judgement and therefore there is lower confidence in the appropriateness and accuracy of the bridge safety performance assessment. The CMF was assumed to be 0.65 for total collisions, reflecting a 45 percent reduction in total collisions.

[10] Source: Institute for Road Safety Research (SWOV). (2012). "SWOV Fact Sheet: The Relation between Speed and Crashes". Accessed February 8, 2024. Available at: https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa1304/Resources3/08%20-%20The%20Relation%20Between%20Speed%20and%20Crashes.pdf

[11] Source: Park, J., M. Abdel-Aty, J. Wang, and C. Lee. (2015). "Assessment of safety effects for widening urban roadways in developing crash modification functions using nonlinearizing link functions", *Accident Analysis and Prevention, Vol. 79*, 80-87. Accessed February 8, 2024. Available at: https://www.cmfclearinghouse.org/study_detail.php?stid=438

Further assumptions used in the safety analysis are as follows:

- The analysis estimates the safety performance of Route 90 with and without widening. It does not estimate the safety performance on other streets that are impacted by Route 90 widening.
- The analysis assumes the historical collision rate continues into future study horizon years. CMFs are applied to collision frequencies developed using the historical collision rate and forecasted volumes.
- The collision rate is based on historical data and does not account for regression to the mean bias. Collision rate assumes a linear relationship between volume and collision frequency. This assumption is known to be untrue - as collision frequency tends to taper out at higher volumes.
- The analysis considers collisions that occur at existing major signalized intersections as well as those on the St. James Bridge. It should be noted that location information for collisions that occur on bridges and overpasses are often inaccurate and get excluded from the source data set. Therefore, the analysis performed likely underestimates the safety performance of the St. James Bridge in both the two-lane and three-lane scenarios. The analysis does not include minor-street intersections or road segments.
- The analysis does not include the Ness Avenue and Century Street intersection as the CMF's selected do not apply to the changes proposed at this intersection.
- There are many methodologies for combining multiple CMFs. This analysis uses Method 5.1 found in Gross and Hamidi's "Investigation of Existing and Alternative Methods for Combining Multiple CMFs".[12]

[12] Source: Gross, F. and Hamidi A. (2011). "Investigation of Existing and Alternative Methods for Combining Multiple CMFs", *Task A.9, T-06-013, Highway Safety Improvement Program Technical Support prepared by Vanasse Hangen Brustlin, Inc.* Accessed February 8, 2024. Available at: https://www.cmfclearinghouse.org/collateral/Combining_Multiple_CMFs_Final.pdf

Socio-economic Data

Value of Travel Time Savings (VTTS)

One of the largest benefits, and therefore justifications for improved transportation infrastructure is a reduction in user travel times. The general assumption is that a reduction in travel times for users means more time for users to engage in one of three activities: engaging in economic production (e.g., transportation of goods or business travel) engaging in personal recreation or leisure activity, or avoiding personal negative experiences associated with travel such as fatigue or stress.

While there is extensive literature on how to apply a monetary value to an individual's time along with debate and variance on the metrics to use, the method employed in this study is consistent with the U.S. Department of Transportation's guidance on the subject, which is to value time savings at 50% of individual average hourly income for non-work related trips, 100% of individual average hourly income plus employer overhead for work related trips, and the average hourly earnings plus employer overhead in the transportation industry for goods movement.[13] Table 3 summarizes these values.

Table 3: Value of Travel Time Savings (VTTS)

Vehicle Type	Trip Type	Share of Traffic	Hourly Value of Time (2023 Dollars) [14]
Automobile	Business Travel	4.4%[15]	$36.43
	Personal Travel	91.6%	$14.01
Commercial Truck	Goods Movement	4.0%	$36.83
Composite Hourly Value of Time Savings:			**$15.98**

Hourly wages are derived from Statistics Canada's Survey of Employment, Payrolls and Hours using Manitoba data for 2023. The above composite hourly value is applied to any time savings (or travel time increases) for vehicle occupants, while all pedestrian and cyclist travel times are considered to be personal travel.

For additional discussion on approaches to valuing travel time savings, "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Update)" publication produced by the United States Department of Transportation may act as a good resource.

Occupants per Vehicle

To calculate the value of vehicle travel time savings across all facility users, both the expected number of vehicles and occupants per vehicle is required. The number of occupants per automobile vehicle is

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[13] Source: United States Government, Department of Transportation. 2016. "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Update)". Accessed December 12, 2023.

[14] Data Source: Statistics Canada, Table 14-10-0206-01, Average hourly earnings for employees paid by the hour, by industry, annual. Note: industrial aggregate excluding unclassified businesses (including overtime) in Manitoba is used for overall wage rates, and Truck Transportation (NAICS 484) is used for goods movement. Both business travel and goods movement hourly value of time include a 30% increase over the average hourly rate to account for employer overhead.

[15] In the absence of local data, the distribution of business versus automobile trips for automobiles is derived from the United States 2001 National Household Travel Survey (NHTS) as recommended by the United States Department of Transportation.

assumed to average 1.25 people per vehicle and 1 person per vehicle for commercial trucks. This information is derived from 2007 Winnipeg Area Travel Survey.

Fuel Costs

An improved transportation facility may become more efficient for fuel consumption as a result of less idle time and/or more efficient travel speeds resulting from the improvement. Fuel prices tend to be volatile, but as the BCA is anchored to 2023 prices, the 2023 average price for retail gasoline in Winnipeg is used.

This value is $1.55 per litre for regular unleaded gasoline.[16] As there is no distinction between gasoline and diesel consumption in the Synchro Studio SimTraffic output and automobile traffic represents 96% of all traffic, all fuel consumption statistics calculated in the models are assumed to represent unleaded gasoline.

It should be noted that the electrification of Manitoba's automobile fleet is not considered in this analysis, though it is anticipated this effect would be marginal on overall fuel savings. Statistics from 2022 indicate that electric/hybrid/plug-in hybrid/other fuel type vehicles make up 1.3% of Manitoba's overall motor vehicle registrations.[17] While this may rise over time, the impact on changes in fuel consumption specific to the Route 90 improvements study area would be minimal.

[16] Source: Statistics Canada, Table 18-10-0001-01, Monthly average retail prices for gasoline and fuel oil, by geography (Winnipeg CSD; 2023 average)

[17] Source: Statistics Canada, Table 23-10-0308-01, Vehicle registrations, by type of vehicle and fuel type (Manitoba)

Socio-economic Cost of Collisions

Safety evaluation requires assigning a monetary value to human life and safety. While this may be controversial to some, individuals and public agencies often make decisions that require trade-offs between incremental changes in safety and other benefits and costs. For example, motorists may need to decide whether to pay extra for an optional safety feature when purchasing a vehicle, and a transportation agency must decide whether to allow higher traffic speeds or implement roadway design changes that affect crash rates. Applying monetized values enables different projects or policies to be compared, enhancing decision makers' ability to prioritize the most efficient use of the public's tax dollars.

The socio-economic impact that an increase or decrease in safety on a transportation facility resulting from a change in design can be calculated using assumptions about how safety may change on an improved facility and figures on the value of statistical life (VSL) and social costs of collisions. Table 4 below summarizes the socio-economic cost of different collision types assumed in this BCA.

Table 4: Socioeconomic Costs of Collisions

Collision Type	Severity	Socio-economic Cost (2023 Dollars)
Fatality[18]		$9,158,296
Injury[19]	Major	$1,137,460
	Minor	$42,128
	Minimal	$10,990
Property Damage Only (PDO)[20]		$17,959

Socio-economic Cost of Greenhouse Gas (GHG) Emissions

The socio-economic impact that an increase or decrease in average fuel consumption on an improved transportation facility may be estimated by translating fuel consumption to greenhouse gas (GHG) emissions and emissions to their social cost estimated by Environment and Climate Change Canada. The net change in average fuel consumption per vehicle is provided by the Simtraffic model outputs. Greenhouse gas (GHG) emissions are then estimated by translating fuel consumption to carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) using the ratios presented in table 5 below.

Total emissions in a two-lane and three-lane scenario are compared, on the assumption that induced users are seeing decreases in emissions equivalent to half (50%) of those observed among existing users, like the VTTS calculations. The net change in carbon dioxide, methane, and nitrous oxide as a result in a

[18] Source: Government of Canada, Treasury Board of Canada Secretariat. 2023. "Canada's Cost-Benefit Analysis Guide for Regulatory Proposals". Accessed December 4, 2023. Note that the TBS assumes the value of statistical life (VSL) in Canada is assumed to be $6.5 million in 2007 dollars and is to be inflated to the current year based on Statistics Canada Consumer price index. Value has been adjusted to 2023 dollars via Canada CPI inflation.

[19] Source: Government of Canada, Transport Canada. 2020. "2020 statistics on the social costs of collisions in Canada." Accessed December 4, 2023. Value has been adjusted to 2023 dollars via Canada CPI inflation.

[20] Source: De Leur Consulting Ltd. 2018. "Collision Cost Study Update Final Report, prepared for: Capital Region Intersection Safety Partnership". Accessed December 5, 2023. Value has been adjusted to 2023 dollars via Canada CPI inflation.

change in total fuel consumption in a three-lane scenario is monetized using values provided by Environment and Climate Change Canada.[21]

This analysis does not include the effects of emissions caused by construction of the proposed improvements from sources such as construction material extraction, refinement, and transportation, as well as the manufacture, maintenance, and operation of construction equipment to accomplish the work.

Table 5: Emissions Factors for Refined Petroleum Products[22]

Greenhouse Gas	g of GHG/L Fuel
Carbon Dioxide (CO_2)	2,307.000
Methane (CH_4),	0.100
Nitrous Oxide (N_2O)	0.020

Greenhouse Gas (GHG) Emissions Originating from Construction of the Asset

While an improvement in a transportation facility may increase or decrease fuel consumption and therefore affect the total emissions resulting from motorists, physically constructing the improved transportation facility will have an impact on the environment. The production of construction materials such as concrete and steel, and fuel consumed by the equipment used to construct the improvement will all produce emissions during the construction process.

Using data from Statistics Canada's Infrastructure Economic Accounts (Environmental Perspective) it is estimated that 0.2492 tonnes of greenhouse gasses are emitted for every $1,000 invested in highway and road structures in Manitoba.[23] Assuming $112 million in hard construction costs for the three-lane scenario in the Route 90 study area, it is estimated that constructing the third lane in both directions will generate **28,067 tonnes** of greenhouse gases.[24]

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[21] Source: Government of Canada, Environment and Climate Change Canada. 2022. "Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance for the Government of Canada". Values derived from "Table 1: Updated SC-GHG estimates (C$2021, $/tonne of respective GHG)". Accessed December 13, 2023.

[22] Source: Government of Canada, Environment and Climate Change Canada. 2023. "Emissions Factors and Reference Values". Accessed December 5, 2023.

[23] Source: Statistics Canada, Table 36-10-0655-01, Infrastructure Economic Accounts, Environmental Perspective. Data represents highway and road structures and networks in Manitoba for 2022.

[24] Hard construction costs are costs related to roadworks, structures, grading, and drainage. Costs excluded from this figure are those related to engineering/planning/project management, property acquisition, contingency, and administrative costs.

4. Methodology

This section describes the methods used to calculate the benefits and costs associated with Route 90 widening. Generalized mathematical formulas are provided in the appendix.

Benefits

Net Present Value: Benefits are calculated on an annual basis and expressed as a series of positive cashflows accruing to the public and/or municipality, depending on the type of benefit. All cashflows are discounted to net present dollars using the prescribed discount rate.

Vehicle Travel Time Savings: Vehicle travel time savings (VTTS) are calculated at an annual level, based on average time savings accruing to all users in a three-lane scenario using hourly difference in travel times. Calculations are made based on modelled data in 2030 and 2050 and interpolated between and after these two modeling years.

Vehicle Fuel Consumption Savings: Vehicle fuel consumption savings is calculated at an annual level, based on comparing average fuel consumption per vehicle in a two-lane and three-lane scenario. Calculations are made based on modelled data in 2030 and 2050 and interpolated between and after these two model years.

Pedestrian and Cyclist Travel Time Savings: Pedestrian and cyclist travel time savings are calculated by estimating the existing pedestrian/cyclist counts and projecting reductions and/or increases in travel time from new intersection crossings and updated facility layout.

Mitigated Construction Delay: The time savings associated with a three-lane scenario, which avoids significant construction delay during the rehabilitation phase of the existing roads and bridge structures, is calculated by taking the difference in total daily travel times during the construction season in a two-lane reduced to one lane scenario and comparing it to the existing two lane scenario which is maintained if a third lane is added.

Emissions and Environmental Benefits: An improved facility may result in reduced average emissions per vehicle if the improvements result in more efficient travel speeds and/or reduced idle time which reduce fuel consumption.

While an improved facility may induce additional traffic, this additional traffic would likely be traveling to and from the same origin and destination, just using alternative routes that are presumably less efficient than the improved facility to varying degrees. Therefore, despite increased users in a three-lane scenario from induced demand, those induced users are also enjoying a proportion of the improved travel speeds and reduced emissions via reduced fuel consumption. Like the travel time calculations, it is assumed that the average induced user enjoys half (50%) of the benefits of an existing user to account for uncertainty about what their current travel behaviour looks like in the absence of the improved facility.

Any benefit associated with reduced emissions is calculated using average fuel consumption per vehicle data that is derived from the Synchro Studio SimTraffic output. The change in average fuel consumption is then applied to the emissions factors, which is then translated to social costs per unit of reduced pollutant. Pollution in a two-lane versus three-lane scenario is compared, with an increase in pollution being considered a cost and a decrease in pollution being considered a benefit.

Facility Safety and Social Cost of Collisions: Using the collision by scenario data produced in the safety analysis and the socioeconomic costs of collisions in section 3, the costs or benefits associated with the net change in collisions can be calculated over the benefiting period.

Municipal Revenue: Currently there are no known land development or intensification projects that are entirely contingent on adding a third lane to Route 90 in the study area. As such, there is no additional municipal revenue associated with this project.

Costs

Costs are calculated on an annual basis and expressed as a series of negative cashflows accruing to the public and/or municipality, depending on the type of cost. All cashflows are discounted to net present dollars using the same formula used for benefits.

Capital Expenditures

The capital costs associated with a three-lane scenario, as summarized in table 2 are converted to annual cash outflows incurred by the municipality.

The timing of these cash outflows is shown in table 6 where it is assumed the first costs representing 9% of total expenditures will be incurred in 2024, and all costs related to widening will be incurred by 2031. These values are obtained from the latest basis of estimate for this project.

It is expected that based on this schedule the benefits associated with road widening would begin to accrue in 2030.

Table 6: Distribution of Route 90 Road Widening Expenditures by Year

Year	% Expenditure	Cumulative Expenditure
2024	9%	9%
2025	23%	32%
2026	17%	49%
2027	14%	63%
2028	17%	79%
2029	8%	87%
2030	7%	94%
2031	6%	100%

Incremental Operating Expenditures

As described in section 3, incremental operating expenditures associated with a widening facility within a 25-year benefiting period is the city-wide cost of snow clearing, street sweeping, and reactive maintenance on a per-kilometer basis for regional roads, multiplied by the length of road added in the three-lane scenario which is approximately six lane kilometers.

Facility Residual Values

The residual value of the facility at the end of the 25-year benefiting period is calculated based on various expenditure components within the three-lane scenario and their associated useful life. Residual values aim to reflect the remaining value of the asset at the end of the benefiting period. This is because the benefiting period is limited to 25 years, but the useful life of the asset continues beyond this time. As such, the residual value of the asset is treated as a positive "benefit" in the final year of the analysis, representing some proportion of the benefits users would receive from the asset in year 26 and on.

Table 7 below summarizes the assumed useful life, initial cost, and residual value for the incremental costs associated with widening Route 90. Residual values for each expenditure group are determined using straight-line depreciation rates over the course of their useful life.

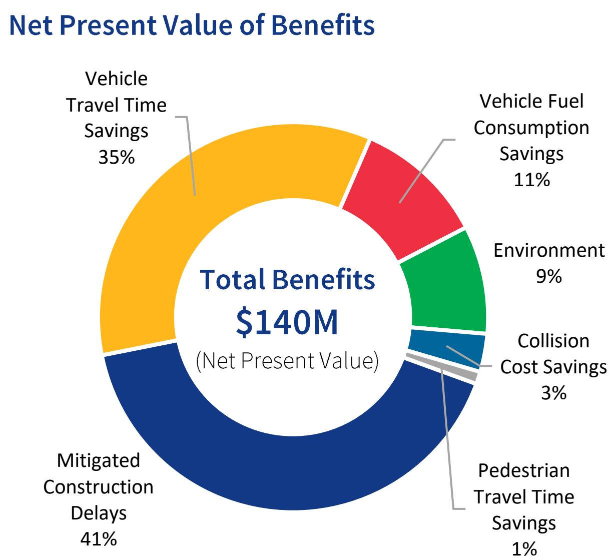
Table 7: Route 90 Road Widening Residual Values

Expenditure Group	Useful Life[25]	Initial Cost (2023 Dollars, Millions)	Residual Value (2023 Dollars, Millions)
Roadworks	50	$28.1	$16.8
Structures	80	$81.0	$60.7
Grading and Drainage	60	$3.6	$2.4
Engineering, Planning, and Project Management	0	$13.6	$0.0
Property	100	$37.6	$30.1
Total		**$163.8**	**$110.1**

[25] Useful life by expenditure type is, in part, derived from the parameters used by the B.C. Ministry of Transportation and Infrastructure.

5. Results

Benefit-Cost Analysis Results



Benefit-cost analysis for widening Route 90 to three lanes in both directions shows a **positive benefit-cost ratio of 1.17**. In other words, for every dollar invested in the project, one dollar and seventeen cents-worth of benefits in total are returned to the public over the duration of construction and 25 years afterwards. The total net present value of costs is $119.5 million and net present value of benefits is $140.0 million, resulting in a positive net present value of $20.5 million.

However, it should be noted that over 41% of all benefits for this project are from mitigated construction delays, which are only assumed to occur in during the 2028 and 2029 construction seasons. As previously discussed, this benefit has a high degree of uncertainty due to difficulties accurately predicting the impacts of construction on travel time. If this temporary and short-term benefit is excluded, the benefit-cost ratio falls to 0.69 with an IRR of -1.9%, which indicates the long-term benefits are less than the cost. This and other scenarios are explored further in appendix B.

Table 8: Route 90 Road Widening Benefits (Net Present Values)

Benefit	Net Present Value ($ Millions)	Description
Mitigated Construction Delays	$57.8	Economic value of 4.6 million person-hours saved over 2 construction seasons
Vehicle Travel Time Savings	$48.5	Economic value of 7.0 million person-hours saved over 25 years
Vehicle Fuel Consumption Savings	$15.2	Economic value of 21.9 million liters of fuel saved over 25 years
Environment	$12.6	Socioeconomic value of a net reduction in 50,537 tonnes of CO_2, 2 tonnes of CH_4, and 0.4 tonnes of N_2O over 25 years
Collision Cost Savings	$4.4	Socioeconomic value of a net reduction in 450 collisions over 25 years
Pedestrian Travel Time Savings	$1.4	Economic value of 250,000 person-hours saved over 25 years
Municipal Revenue	$0.0	N/A
Total Discounted Benefits		**$140.0 million**
Total Discounted Costs		**$119.5 million**
Net Present Value		**$20.5 million**
Benefit-Cost Ratio		**1.17**
Internal Rate of Return (IRR)		**1.4%**

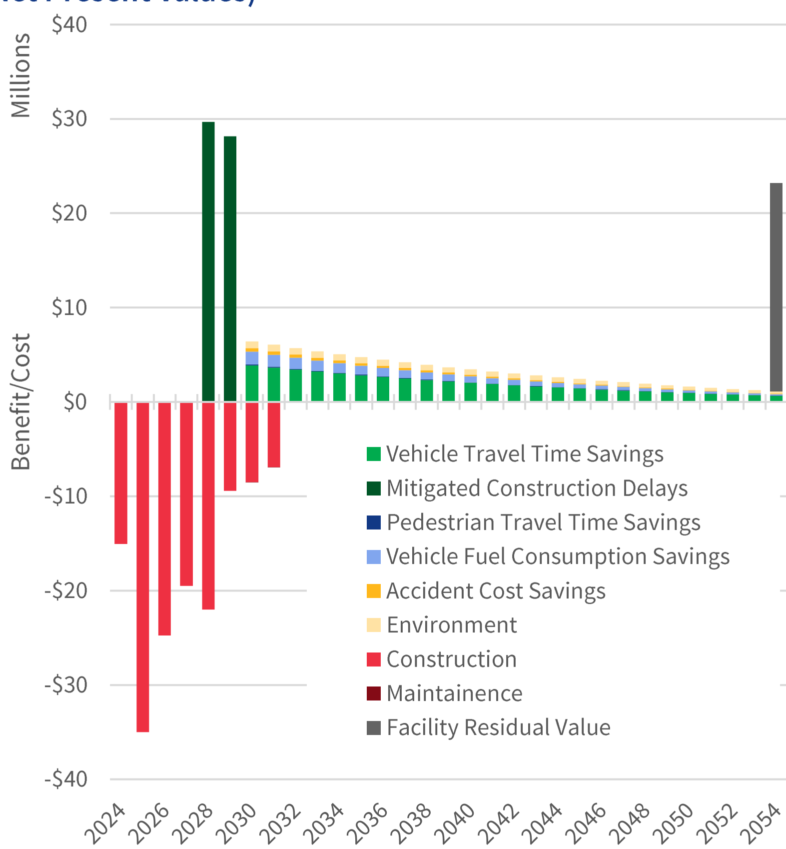
Conclusion

This report quantifies the incremental benefits and costs associated with expanding Route 90 to three lanes in both directions in the study area, relative to maintaining the existing configuration of roads and bridges that will eventually require renewal.

Overall, the findings indicate that the total incremental benefits are worth $140.0 million and incremental costs are $119.5 million, with a positive net present value of $20.5 million over the 2024-to-2054-time horizon. This represents a benefit-cost ratio of 1.17 and an internal rate of return of 1.4%. For every dollar invested, one dollar and seventeen cents in benefits are returned to the public from this project.

However, as shown in figure 5, a substantial portion (42%) of this project's benefits is driven by mitigated construction delays in 2028 and 2029. This represents the value of keeping Route 90 open to two lanes during pavement reconstruction and bridge rehabilitation, which can only occur under the Route 90 widening scenario. Otherwise, Route 90 being reduced to a single lane per direction during rehabilitation incurs a substantial cost to the public's time. If this benefit is ignored, the BCA ratio for this project becomes less than one.

Figure 5: In-Year Benefits and Costs (Net Present Values)



This indicates that the long-term benefits (mainly ongoing time savings) are relatively smaller than the cost of construction. This is driven by two main factors:

1. **Ongoing time savings are marginal:** estimated reductions in average travel times for users once the improved facility is operational means minor time savings benefits which are generally the primary driver behind transportation improvements. If the benefits of mitigated construction delay are excluded, the BCA ratio falls to 0.69. **Average travel time savings per user would need to rise by 77% to justify the investment and bring the ratio to at least 1 if the benefits of mitigated construction delays are ignored.**
2. **Construction inflation versus wage growth:** growth in construction costs has outpaced wage growth (i.e., the value of the public's time) by a modest amount in recent years. Over time, this may cause costs to rise faster than benefits for public projects of this scope.

Report Appendices

Appendix A: Summary of BCA Assumptions

Summary of BCA Assumptions

Category	Assumption	Value	Unit	Source
Facility Information	Facility Length in Study Area	3.00	KM	1
	2030 Total Daily Weekday Traffic Counts - No Build (2 Lane)	202,480	vehicles	1
	2030 Total Daily Weekday Traffic Counts - Build (3 Lane)	219,968	vehicles	1
	2050 Total Daily Weekday Traffic Counts - No Build (2 Lane)	233,028	vehicles	1
	2050 Total Daily Weekday Traffic Counts - Build (3 Lane)	275,849	vehicles	1
	2030 Average Travel Time - No Build (2 Lane)	4.29	minutes	1
	2030 Average Travel Time - Build (3 Lane)	3.96	minutes	1
	2050 Average Travel Time - No Build (2 Lane)	5.55	minutes	1
	2050 Average Travel Time - Build (3 Lane)	5.20	minutes	1
	2030 Average Fuel Consumption - No Build (2 Lane)	0.19	litres	1
	2030 Average Fuel Consumption - Build (3 Lane)	0.18	litres	1
	2050 Average Fuel Consumption - No Build (2 Lane)	0.20	litres	1
	2050 Average Fuel Consumption - Build (3 Lane)	0.19	litres	1
	Rehabilitation Period Total Daily Travel Time - No Build (2 Lane)	19,531	hours (weekdays)	1
	Rehabilitation Period Total Daily Travel Time - Build (3 Lane)	12,656	hours (weekdays)	1
	Incremental Operating Costs (2023 dollars)	$7,533	Per lane KM	1
Share of Total Traffic Counts	Automobile - Personal Travel	91.6%	% of total	2
	Automobile - Business Travel	4.4%	% of total	2
	Truck Transportation - Goods Movement	4.0%	% of total	1
Value of Time	Average Hourly Wage - All Industries	$28.02	$/hr	3
	Average Hourly Wage - Truck Transportation	$28.33	$/hr	3
	Employer Overhead Multiplier	1.30	number	4
	Personal Travel Multiplier	0.50	number	2
	Value of Time - All Traffic	$15.98	$/hr	N/A - calculated
	Value of Time - Pedestrian/Cyclist	$14.01	$/hr	3
Fuel Consumption and Emissions	Average Fuel Price	$1.55	$/l	5
	Carbon Dioxide (CO2) Emissions per Litre of Fuel Consumed	2,307.00	grams/l	6
	Methane (CH4) Emissions per Litre of Fuel Consumed	0.10	grams/l	6
	Nitrous Oxide (N2O) Emissions per Litre of Fuel Consumed	0.02	grams/l	6
	Social Cost of Emissions	N/A - see source		7
Social Cost of Collisions	Fatality	$9,158,296	$ per life	8
	Major Injury	$1,137,460	$ per incident	9

	Minor Injury	$42,128	$ per incident	9
	Minimal Injury	$10,990	$ per incident	9
	Property Damage Only (PDO)	$17,595	$ per incident	10
Other Assumptions	Discount Rate	5.50%	%	11
	Annual Week Days	261	days	N/A - calculated
	Annual Weekend Days	104	days	N/A - calculated

Source List

Source Number	Source
1	City of Winnipeg Public Works Department
2	United States Government, Department of Transportation. 2016. “The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Update)”
3	Statistics Canada, Table 14-10-0206-01, Average hourly earnings for employees paid by the hour, by industry, annual (Manitoba data used)
4	Intuit Quickbooks, 2022. "How to Calculate the True Cost of a New Employee"
5	Statistics Canada, Table 18-10-0001-01, Monthly average retail prices for gasoline and fuel oil, by geography (Winnipeg CSD 2023 average data used)
6	Government of Canada, Environment and Climate Change Canada. 2023. “Emissions Factors and Reference Values"
7	Government of Canada, Environment and Climate Change Canada. 2022. “Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance for the Government of Canada"
8	Government of Canada, Treasury Board of Canada Secretariat. 2023. “Canada’s Cost-Benefit Analysis Guide for Regulatory Proposals”
9	Government of Canada, Transport Canada. 2020. “2020 statistics on the social costs of collisions in Canada”
10	De Leur Consulting Ltd. 2018. “Collision Cost Study Update Final Report, prepared for: Capital Region Intersection Safety Partnership”
11	City of Winnipeg Corporate Finance Department

Appendix B: Benefit-Cost Model Equations

Benefits

Net Present Value:

$$PV_t = \frac{FV_t}{(1+i)^t}$$

Where: PV = present discounted value of future payment (cashflow) from year "t"
FV = Future value of payment in real dollars in year "t"
i = Discount rate
t = Years in the future for payment, assuming base year t = 0

Vehicle Travel Time Savings:

$$VTTS_t = \left(\sum_{h=1}^{24} \left(\left(ATT_{h,t,3\ Lane} - ATT_{h,2\ Lane} \right) \times \left(Exisiting\ Users_{h,t,2\ Lane} \right) \right) + \left((0.5) \times \left(ATT_{h,t,3\ Lane} - ATT_{h,t,2\ Lane} \right) \times \left(Induced\ Users_{h,t,3\ Lane} \right) \right) \right) \times (VT_v)$$

Where: VTTS = value of travel time savings in year t
h = hour of day (weekday or weekend)
ATT = average travel time for users in each hour of the day h in year t in a 3 or 2 lane facility scenario
Existing Users = total amount of users on the facility in each hour of the day h in year t in a two-lane facility scenario
Induced Users = total of users on the facility in each hour of the day h in year t in a three-lane facility scenario
VT = value of time for vehicle traffic

Vehicle Fuel Consumption Savings:

$$NCFC_t = \left(\left(AFC_{t,3\ Lane} - AFC_{t,2\ Lane} \right) \times \left(Exisiting\ Users_{t,2\ Lane} \right) \right) + \left((0.5) \times \left(AFC_{t,3\ Lane} - AFC_{t,2\ Lane} \right) \times \left(Induced\ Users_{t,3\ Lane} \right) \right)$$

Where: NCFC = Net change in fuel consumption in year t
AFC = average fuel consumption per vehicle on the facility for users in year t in a 3 or 2 lane facility scenario
Existing Users = total amount of users on the facility in year t in a two-lane facility scenario
Induced Users = total of users on the facility in year t in a three-lane facility scenario

$$FCS_t = (NCFC_t) \times (Fuel\ Price)$$

Where: FCS = Value of fuel consumption savings in year t
NCFC = Net change in fuel consumption in year t
Fuel Price = Assumed price of unleaded gasoline (dollars/litre)

Pedestrian and Cyclist Travel Time Savings:

$$VPTS_t = (APTT_{3\ Lane} - APTT_{2\ Lane}) \times (Users_{2\ Lane}) \times (VT_p)$$

Where: VPTS = value of pedestrian travel time savings in year t
APTT = average pedestrian travel time for users in a 3 or 2 lane facility scenario
Users = total annual pedestrians/cyclist users, based on data observed from the existing two-lane scenario
VT = value of time for pedestrian/cyclist traffic

Mitigated Construction Delay:

$$VMCD = (TDT_{2\ Lane,Current} - TDT_{2\ Lane,Construction}) \times (VT_v) \times (Construction\ Days) \times (Construction\ Seasons)$$

Where: VMCD = value of mitigated construction delays in year t
TDT = total daily travel times for the two-lane facility, based on current conditions and conditions during construction
Construction days = total days in a year that construction is expected to take place (approx. 213/year)
Construction seasons = total construction seasons required to rehabilitate existing facility (approx. 2 years)

Emissions and Environmental Benefits:

$$TSCE_{p,t} = (NCFC_t) \times (EF_p) \times (SCE_{p,t})$$

Where: TSCE = total social cost (or benefit) of emissions from pollutant type p in year t
NCFC = Net change in fuel consumption in year t
EF = emissions factor (emissions per litre of fuel) for pollutant type p
SCE = social cost of emissions from pollutant type p in year t per unit of fuel consumption, as defined by Environment and Climate Change Canada.

Facility Safety and Social Cost of Collisions:

$$TSCC_{s,t} = \left((Collisions_{s,t,3\ lane}) - (Collisions_{c,t,2\ lane})\right) \times (SC_s)$$

Where: TSCC = Total social cost (or benefit) of collisions for severity type s in year t
Collisions = Total estimated collisions on the facility for severity type s in year t in a 3 or 2 lane scenario
SC = Social cost of a collision for severity type s

Municipal Revenue: N/A

Costs

Capital Expenditures

$$CAPEX_t = (TC) \times (\%\ Expenditure_t)$$

Where: CAPEX = total capital expenditure in year t
TC = total capital expenditures related to the three-lane scenario
% Expenditure = percent of total project expenses incurred in year t

Incremental Operating Expenditures

$$OPEX_t = (TO) \times (Length)$$

Where: OPEX = total operating expenditure in year t
TO = total operating expenditures per lane KM of regional road, including snow clearing, street sweeping, beautification, and reactive maintenance
Length = incremental length of lane kms added to the city's regional road inventory in a three-lane scenario.

Facility Residual Values

$$RV_e = \left(\frac{U_e - Y}{U_e}\right) \times (TC_e)$$

Where: RV = residual value of expenditure group e
U = useful life (in years) for expenditure group e
Y = years of analysis for the benefiting period (25 years)
TC = total capital cost of expenditure group e

Appendix C: BCA Results Using Alternative Assumptions

Benefit-cost analysis requires relying on a variety of assumptions that will affect the calculation of benefits and/or costs. The table below provides BCA results under assumptions different from those used in the main analysis for stress-testing purposes.

Route 90 Widening Benefit-Cost Analysis Results Using Different Assumptions ($ millions)

Criteria	0% Discount Rate	3% Discount Rate	7% Discount Rate	Inclusion of Admin. and Contingency Costs	Exclusion of Mitigated Construction Delay Benefits
Total Discounted User Benefits	$246.1	$176.4	$124.0	$140.0	$82.2
Total Discounted Agency Cost	$54.9	$106.0	$121.9	$142.0	$119.5
Net Present Value	$191.2	$70.3	$2.1	-$1.9	-$37.4
Gross Benefit-Cost Ratio	4.48	1.66	1.02	0.99	0.69
Internal Rate of Return (%)	6.5%	3.6%	0.2%	-0.1%	-1.9%

The table above shows that the final benefit-cost ratio is sensitive to the assumptions used in this report. If the analysis assumes a 0% discount rate (i.e., future benefits and expenditures are not discounted and worth just as much tomorrow as they are today), the result is significantly more positive with the BCA ratio of 4.48. However, if discount rates of 7% or higher are used, the ratio begins to approach 1.

Further, including administrative and contingency costs in the primary scenario results in a BCA ratio below 1 and as discussed in previous sections, excluding the benefits of mitigated construction delay also results in a BCA ratio below 1.

Appendix D: Comparison to 2012 MMM Study

In 2012 MMM Group (now a part of WSP Global) conducted a benefit-cost analysis of the proposed Route 90 improvements using MicroBENCOST software developed by the Texas Transportation Institute for the Highway Research Program.

Assuming a 6% discount rate, the MMM study found that the Route 90 improvements had a net present value of $58.0 million in 2012 and a gross benefit-cost ratio of 1.87 suggesting the public receives $1.87 in benefits for every $1.00 of investment. These findings are significantly more positive than the findings produced in this report, where the benefit-cost ratio is 1.17 including mitigated construction delays and 0.69 excluding them.

The table below compares the MMM study to the current study using a 6% discount rate and excluding any benefits related to mitigated construction delays since these benefits were not included in the MMM report.

Route 90 Improvements: Comparison to MMM Study (6% discount rate for current study)

Criteria	MMM Study (2012 Dollars, millions)	Current Study (2023 Dollars, millions)
Total Discounted User Benefits	$125.0	$77.6
Discounted Construction Cost	$90.5	$139.4
Discounted Salvage Value	$23.7	$19.2
Discounted Increase in Operating Costs	$0.3	$0.4
Discounted Total Agency Cost	$67.1	$120.7
Net Present Value	$58.0	-$43.0
Gross Benefit-Cost Ratio	1.87	0.64
Internal Rate of Return (%)	10.96%	-2.33%

The equivalent comparison suggests significant differences in the calculation of costs and benefits. The primary reasons for the different findings between the two studies are as follows:

1. **Differences in traffic modelling:** the MicroBENCOST software used in the MMM study calculates user travel time from general assumptions about lane capacity utilization under approximately free-flow conditions, which may have over-estimated the predicted travel time improvements. The present analysis uses more sophisticated microsimulations using Synchro software to determine aggregate user travel time, which is more representative of proposed traffic conditions.
2. **Differences in value of time**: the MMM study assumes that the value of time is equal to 100% of hourly wages, regardless of type or mode of travel which is in contravention of current best practices and guidance from the U.S. Department of Transportation. The present study assumes it to be 50% of hourly wages for automobile personal travel and pedestrian travel. If the present study makes the same assumption as the MMM study on the value of time, the benefit-cost ratio rises to 0.96.
3. **Differences in the safety performance analysis:** the MMM study assumed an overall 10% reduction in total collisions. The present analysis uses a more evidenced-based approach, which selects available Collision Modification Factors (CMFs) that reflect some of the proposed design elements and that can be applied within reason to the collision data. The historical collision rate is applied to

variable (and increasing) traffic volumes to determine the total number of collisions, which are then factored appropriately using the CMFs and monetized as a cost.

4. **Shorter construction period**: the MMM study assumed the improvements would take 2 years to complete. The present study follows a 7-year timeframe. As such, benefits only begin accruing after 7 years (instead of 2) and are therefore moderately discounted by year 7.
5. **Construction inflation versus wage growth:** the MMM study assumes undiscounted capital costs of $111 million while the present study assumes $164 million, representing an increase of 47%. However, over the same time, average wages in Manitoba have grown 44% indicating that the value of time has not risen as quickly as construction costs.

Appendix E: Analysis Limitations

In general, benefit-cost analysis (BCA) is most useful when being used to do the following:

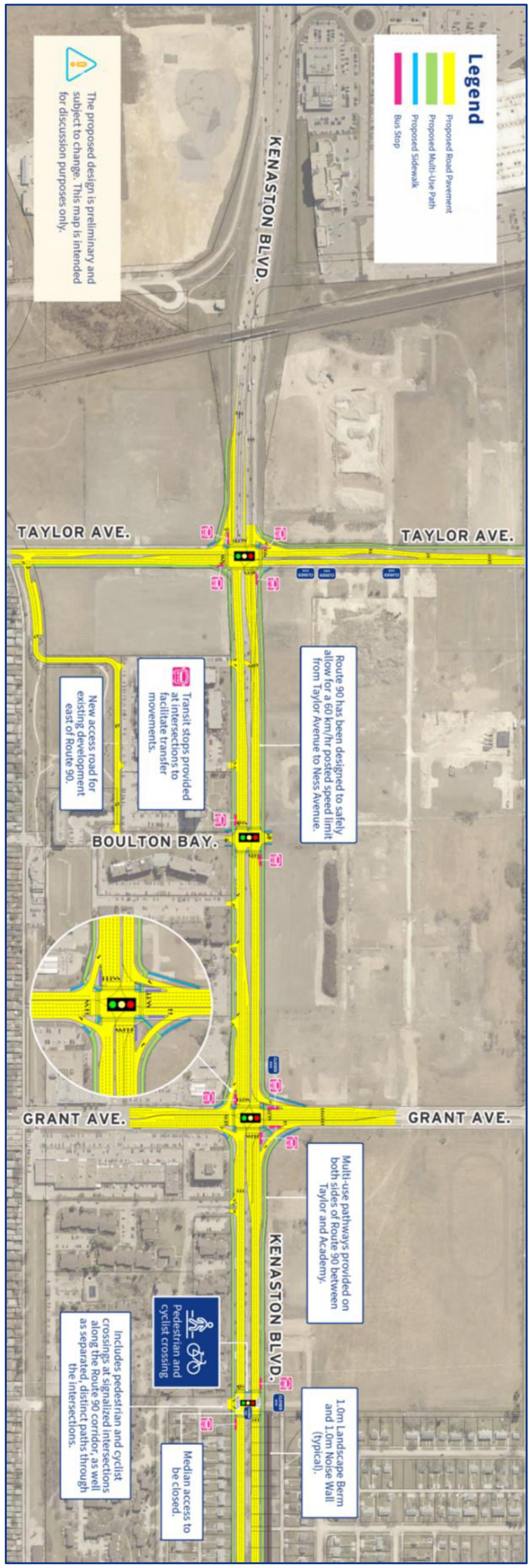
1. **Compare different configurations or design options for a single project:** BCA can be used to analyze the ratio of benefits to costs for multiple design options for a single project. This can help provide clarity in selecting the optimal design for a single project that will provide the greatest ratio of benefits to expenditures that can then be ranked against other capital projects.
2. **Compare and prioritize multiple different capital projects:** BCA can be used to analyze many different capital projects all competing for limited funding. If there are multiple options for investing a fixed amount of capital, projects that yield the highest benefit-cost ratios are generally prioritized over those with lower ratios to maximize the return on infrastructure investments to the public.

For the current study, only one configuration, the current preliminary design, was studied.

Further, BCA calculations have not been conducted on any other major transportation projects being considered by the City of Winnipeg at this time. Therefore, there may be projects or proposals that yield better results, but the outcomes of those projects are currently unknown. This limits the usefulness of benefit-cost analysis.

Finally, this analysis attempts to quantify the economic and socioeconomic benefits and costs associated with this transportation project which requires relying on a wide variety of assumptions and traffic models. The actual benefits and costs are unknown until they are realized. Readers should familiarize themselves with the assumptions used in the modelling and calculations for this report as any deviation from these assumptions could result in outcomes different from those projected.

Appendix F: Route 90 Proposed Design




2.0m High Noise Wall (typical).
CORYDON AVE.
Pedestrian and cyclist crossing
LOCKSTON AVE.
Improved street-level crossing at Lockston Avenue.
TUXEDO AVE.
Pedestrian and cyclist crossing
WILLOW AVE.
Median opening to be closed.
Access changes between Willow Ave. and Academy Rd.
Lockwood connection to be closed.
ACADEMY RD.
Existing ramps to be removed.
Academy connection will be closed.
Pedestrian and cyclist connections to Wellington, Wolseley and Portage.
Existing northbound bridge to be rehabilitated to include widened sidewalk.
Existing southbound bridge to be used for ramps and multi-use path.
New southbound bridge.
New westbound to southbound left turn on Portage at new signal. Existing loop ramp to be closed.
PORTAGE AVE.
Legend
Proposed Road Pavement
Proposed Multi-Use Path
Proposed Sidewalk
Bus Stop
NESS AVE.
N

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