New Brunswick Department of Transportation and Infrastructure's Strategic Multi-Criteria Analysis Model for Capital Infrastructure Investments

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ABSTRACT

This paper describes a multi-criteria analysis (MCA) model and methodology developed for the New Brunswick Department of Transportation and Infrastructure (NBDTI) for prioritizing new capital investments in its transportation infrastructure. The methodology and MCA model for transportation projects, including a user guide for its application, were developed by Opus International (Canada) Ltd. (Opus) in 2013. NBDTI has tested this MCA model & methodology and is currently considering utilizing it as a key component in its "Asset Management Decision Framework" to prioritize new capital transportation projects for its long-term strategic infrastructure plan. The department has recently initiated a continuous improvement project to extend the MCA model to prioritize other categories of infrastructure assets, specifically buildings.

NBDTI has a mature highway asset management program to determine the rehabilitation needs of its existing transportation assets. However, the department required a defendable, transparent methodology for prioritizing capital investments in new infrastructure that:

- Enabled the Department, and in turn the province, to strategically prioritize and plan capital infrastructure expenditures on a more efficient and effective basis;
- Supported the province's current commitment towards providing appropriate and affordable service to citizens on a sustainable basis;
- Aligned with the Government of New Brunswick's vision and strategy map; and
- Better positioned the Department, and in turn the Province, to seek future cost shared funding from the Federal government.

The paper describes the results of Opus's three step approach to develop the MCA methodology and model including:

1. A literature and current practice review of North American agencies;
2. Stakeholder Consultations and the resulting draft methodology and model; and
3. Testing and refining of the draft methodology and model.

The final model is presented along with examples of how it is being applied to:

- Assess the strategic value and expected performance of its planned capital infrastructure projects;
- Prioritize projects according to their strategic value; and
- Communicate the results.

The paper concludes with recommendations on how the MCA methodology and model can be improved, and extended to other government assets and decisions on asset divestiture or disposal.

1 INTRODUCTION AND BACKGROUND

This paper describes a multi-criteria analysis (MCA) model and methodology developed for the New Brunswick Department of Transportation and Infrastructure (NBDTI) for prioritizing capital investments in its transportation infrastructure. The methodology and MCA model for transportation projects, including a user guide for its application, were developed by Opus International (Canada) Ltd. (Opus) in 2013 [1]. NBDTI has tested this MCA model & methodology and is currently considering utilizing it as a key component in its "Asset Management Decision Framework" to prioritize new capital transportation projects for its long-term strategic infrastructure plan.

The MCA model was developed as part of NB DTI's continuous improvement initiative to plan and manage its infrastructure more strategically. The process started in 2007 with an asset management system for determining optimal rehabilitation schedules for roads. With a system in place for managing capital investments in existing assets (asset management rehabilitation) , the department required a defendable, transparent methodology for prioritizing capital investments in new infrastructure that:

- Enabled the Department, and in turn the province, to strategically prioritize and plan capital infrastructure expenditures on a more efficient and effective basis;
- Supported the province's current commitment towards providing appropriate and affordable service to citizens on a sustainable basis;
- Aligned with the Government of New Brunswick's vision and strategy map; and
- Better positioned the Department, and in turn the Province, to seek future cost shared funding from the Federal government.

The Government of New Brunswick's Strategy Map for 2012-2013, which highlighted the government's vision for the future and concisely outlined improvement priorities, was the basis of the new approach. The Strategy Map, shown in Figure 1, is part of the current government's performance excellence process for doing business that utilizes several best practice methodologies [2].

The MCA model was developed using a three step approach:

1. A literature and current practice review of North American agencies;
2. Stakeholder consultations and the resulting draft methodology and model; and
3. Testing and refining of the draft methodology and model.

- Section 2 describes the results of the literature and current practice review;
- A description of the stakeholder consultations and resulting draft model are presented in Section 3;
- The final MCA model is described in Section 4;
- Section 5 discusses the application of the model; and
- The paper concludes with Section 6 describing NB DTI's next steps for applying the model.

2 CURRENT PRACTICE AND LITERATURE REVIEW

2.1 Current Practice Review

The current practice review covered processes and models used by 16 agencies in North America to prioritize capital investments in transportation assets. The agencies were identified through a combination of study team experience, Opus's internal practice information network and library services, and a web-based review. A summary of the agencies reviewed and the method they use to prioritize planned projects is provided in Table 1.

Reviewing Table 1:

- Nine of the agencies use some form of multi-criteria analysis (MCA) to prioritize capital investments in infrastructure assets;
- The State of Washington Department of Transportation was the only agency reviewed that used benefit-cost analysis (BCA) solely to set priorities;
- The remaining six agencies use sophisticated models requiring extensive data to select projects that optimize system performance within budget constraints, similar to DTI's existing models for optimizing roadway rehabilitation projects.

NB DTI required a model that could be applied to a wide range of asset types using readily available data. Therefore, it was decided to use a multi-criteria analysis approach. Furthermore, it was found that agencies using MCA to prioritize a wide range of asset types, tended to base the model on the triple bottom line (or sustainable) measures of social, economic, and environmental impacts.

The multi-criteria models used by the nine agencies listed in Table 1 were reviewed in detail to identify common practices. Key findings from the review include:

- The number of long-range goals or criteria used for the MCA varied from 5 to 10. The criteria were assessed using 1 to 6 indicators.
- Separate processes are often used to prioritize projects within funding categories and asset groups.
- Agencies work with regional stakeholders to develop and apply the prioritization process
- The results of the project prioritization process are reported in terms of priority categories rather than a ranking.
- Weighting of project prioritization criteria is often left to the discretion of each agency's decision makers.

2.2 Literature Review

A literature review of over 30 documents was conducted to identify best practices in multi-criteria analysis. The documents included manuals, consulting reports, journal articles, and

electronic reports as listed in the bibliography in Section 8. It was concluded from the review that a best practice multi-criteria analysis model should include the following:

- Preparation of a thorough description for each candidate project before it can be evaluated within the framework. This description should note the strategic relevance of the project in question and assure the reader that due diligence on costing (life cycle cost analysis, availability of funding in the capital budget and funding partners), the legislative context, and environmental issues has been completed;

- Choice of performance measures which are specific clear and concise. To the extent possible, particularly with cross-asset comparisons, measures should be results based. As well, data for the measurement should be currently available, or available in an efficient and repeatable fashion. It has been observed that some agencies tend to complicate the analysis by including too many measurements, choosing measurements which are not easy to measure and choosing desirable targets rather than those which are realistic and affordable;

- Grouping performance measures by the quadruple bottom line of economic, social, environmental and cultural impacts which will capture current New Brunswick Government policy statements;

- Involvement of stakeholders to achieve transparency and participative decision making. Stakeholders (both internal and external to government) should be consulted concerning appropriate performance measures and the relative weightings. It is noted that DTI has commenced a comprehensive stakeholder engagement process which includes collaboration and partnership levels of involvement;

- Scoring of anticipated performance may be accomplished with a number of techniques but the most commonly practiced approach is the choice of a non-monetary numerical rating scheme. It is desirable to establish definition of high, medium and low valuations to minimize scoring bias. Stakeholder involvement may be utilized both in weighting particular elements and in the scoring itself.

2.3 Recommendations for the NBDTI Model

Recommendation 1 – The prioritization model developed for NBDTI should be based on criteria that reflect the triple (or quadruple) bottom line if it is going to be applied across asset groups.

Agencies that prioritized projects for different asset groups, used criteria that reflect the triple bottom line of economic, social, and environmental impacts. Two of the agencies explicitly grouped criteria according to the triple bottom line. It was found in the literature review that a fourth category of criteria – culture – has become common changing the triple bottom line into a quadruple bottom line.

Recommendation 2 – The NBDTI model should have 5 to 10 long-range goals or criteria, and the criteria should be assessed using 1 to 6 indicators . An average of 2.5 criteria per element of the quadruple bottom line will result in a total of 10. Similarly, the maximum total number of indicators would be 20 to 30.

A key finding from the literature review was that MCA practitioners have a tendency to measure too much. The agencies reviewed used an average of 2 to 3 criteria for each component of the triple bottom line and similarly an average of 2 to 3 indicators for each criterion.

Recommendation 3 – NBDTI should start with separate prioritization processes for major funding programs within their department (e.g. capital rehabilitation of roads, capital rehabilitation of bridges, capital rehabilitation of buildings, new roads, new bridges, new buildings). MCA models used in each process should have common criteria.

Four of the nine agencies reviewed used MCA to prioritize projects within existing funding programs, rather than prioritizing projects as a single group. (Details on how the other four agencies applied the MCA across funding programs were not available in the documents reviewed.) For example, Missouri used separate prioritization processes for five programs (safety, taking care of the system, major projects, regional and emerging needs, and interstates) [3]. Alaska developed separate evaluation standards and scoring criteria for five programs as well (rural and urban streets, remote roads and trails, transit projects, marine highway system, and stand along trails and recreational access) [3]. The NAMS Optimised Decision Making Guidelines [4] refer to this approach as the basic approach (i.e. a number of processes are utilised within each asset area rather than a single process spanning all assets). NAMS recommends that common reporting standards be used for each process to allow progress with time towards a single MCA process spanning all assets.

Recommendation 4 – Include stakeholders in the prioritization process to increase transparency and build trust with the public.

Stakeholders can provide input at every stage of the prioritization process from developing the vision and associated performance measures for the MCA to scoring projects and reviewing the final results. Details on stakeholder involvement were not available for three of the agencies reviewed, but the remaining six all included stakeholders in the prioritization process.

Recommendation 5 – Report the results of the prioritization process in categories rather than a ranking.

Agencies tend to report the results of the prioritization process in terms of high, medium, and low priority projects rather than ranking them. As noted by a representative from the San Francisco planning agency [5], the goals of the assessment is to identify outliers – the projects that best and least support the agency's goals. This information is used to inform decision makers about the trade-offs of different projects. However, other factors besides the results of the MCA analysis will be considered when selecting projects.

Recommendation 6 – The MCA model be developed to allow sensitivity analysis of the weightings. However, the final project prioritization should be based on one set of weightings.

Selecting weights for the criteria is a politically sensitive process. In a peer review of Project Prioritization for Regional Long-Range Transportation Plans [6], it was recommended that the decision makers be given the discretion to select the final criteria weightings.

3 DRAFT MCA MODEL AND STAKEHOLDER CONSULTATIONS

A draft MCA model was created based on the Government of New Brunswick's Strategy Map and the results of the current practice and literature review. The model criteria were grouped into both the quadruple bottom line (QBL) and the key objectives from the strategy map as shown in the final version of the model in Figure 2. The criteria, and potential indicators to score the criteria, were selected considering best practices from the literature and agency reviews, and Opus's knowledge of NB DTI's information systems. The scoring method for the indicators and weightings for the criteria were not selected at this stage of the process.

Refinement of the MCA model was accomplished through extensive consultation with NB DTI personnel responsible for both the transportation and building assets. Input was also solicited from external stakeholders who were given the opportunity to provide feedback to a survey. Respondents highlighted which priorities they saw decision-making being best based upon.

Three workshops were held with NB DTI staff to finalize the criteria, indicators, scoring method and weightings for the MCA model.

- In the first workshop, the draft model was presented to NB DTI's Executive Team to get feedback and confirmation on the proposed approach. Overall, the executive input was positive and confirmed approval for the proposed MCA model.

- A second workshop was held with 21 NB DTI staff responsible for planning, designing, and operating transportation infrastructure assets. The participants provided input on the model's criteria and indicators, and on the content of data sheets describing projects to be prioritized. The model was revised to incorporate key outcomes from the second workshop and sample project data sheets were created for the third workshop.

- A third, and final workshop was held with the majority of the Workshop 2 participants to test the draft model using the sample projects and finalize the criteria, indicators, weightings, and scoring system. With the conclusion of the third workshop, the project team revised the model and scoring methodology, and compiled preliminary weightings prepared by DTI staff. The Workshop also provided excellent feedback on the project summary sheet requirements to ensure sufficient information is provided for evaluators. The final model is described in Section 4.

4 NB DTI'S MCA MODEL

The MCA model developed for NB DTI evaluates alternative projects on the basis of 16 indicators. The scores for the 16 indicators are then weighted and combined into three levels of criteria as shown in Figure 2.

The criteria in the first column represent the quadruple bottom line (QBL) which is often used by infrastructure managers to assess sustainability in terms of economic, environmental, social and cultural impacts. It is anticipated that these four criteria will not change over the long term and will eventually be applied to all government infrastructure assets.

The Government of New Brunswick's three strategic objectives of a *stronger economy*, *an enhanced quality of life*, and *living within our means* (from the Strategy Map in Figure 1) are listed in the second column. These will likely change in the medium term as government priorities change. The government's objectives have been aligned to the quadruple bottom line framework.

More detailed criteria are provided in the third column as measures of the QBL and government's strategic objectives. These criteria were selected to be applicable across asset types in the long term.

It is expected that the indicators and weights used for scoring the criteria will vary by asset type but the criteria in the first three columns of the model will remain the same for all government assets (e.g. transportation systems, buildings, water systems, etc.).

Proposed projects are evaluated by scoring them against the indicators in the model on a scale from minus 5.0 to plus 5.0 where:

- -5.0 is a very negative impact on the indicator;
- -3.0 is a moderately negative impact;
- 0.0 is no impact;
- +3.0 is a moderately positive impact on the indicator; and
- +5.0 is a very positive impact.

It should be noted that not all indicators have negative impacts. In these cases, projects are scored on a scale of 0.0 to +5.0.

Impacts should be evaluated from the provincial perspective when scoring projects. For example, traffic diverted from an existing service station because of a new bypass will likely stop at a service station at another more convenient location. In this situation, there would be no impact on jobs at the provincial level because they have been transferred from one location to another within the province.

A summary guide for scoring projects is provided in Table 2. A more detailed User Guide was developed for NB DTI as part of the project deliverables [1].

5 PROJECT PRIORITIZATION USING THE MODEL

The MCA model was developed to **prioritize projects for building new transportation assets or for divesting or eliminating existing assets. It does not apply to capital rehabilitation projects or projects to replace existing assets.** Capital rehabilitation or replacement projects should be identified and prioritized as part of asset management plans developed under NB DTI's existing asset management business framework.

Table 3 lists examples of projects that would be prioritized using the MCA model and examples of projects that would be identified and prioritized as part of asset management plans. As

shown in the table, the MCA model is used to prioritize projects that change the capacity of the transportation network and therefore have strategic level impacts such as reducing transportation costs through shorter trips, safer roads, or reduced congestion. Asset management plans are used to identify and prioritize projects for maintaining the network condition level of an existing asset without affecting capacity. They establish the acceptable condition levels for an existing asset and identify maintenance and rehabilitation options to preserve assets at the lowest life-cycle costs.

The MCA model was developed on the assumption that previous analysis had been completed to identify the best option for each project, and the portfolio of projects to be prioritized contains only one option per project. The evaluation team will require information on each project to apply the MCA model. A summary of the information requirements is provided in Table 4. The User Guide [1] contains examples of project summary sheets and MCA model scores for three fictitious projects. One of the examples is presented in Figure 3. Figure 4 shows examples of how the results from the MCA model can be compared to prioritize projects in NB DTI's long-term plan.

As noted above, it is expected that projects will be scored by an evaluation team to reinforce objectivity in scoring. In its trial application of the model, NB DTI created a team consisting of members with expertise in functional planning, environmental assessments, and safety analysis. The department also envisions consulting with other provincial departmental stakeholders and subject matter experts on project impacts when applying the model including Economic Development, Invest New Brunswick, Environment and Local Government, and the Aboriginal Affairs Secretariat.

Several additional points are important to note regarding application of the MCA model:

- The weighting for each indicator should be determined through a collaborative approach amongst decision-makers and those who will be utilizing the model going forward. Weightings will obviously change as priorities change within government. The values shown in Figure 2 are preliminary weightings determined by NB DTI's Working Group for the study.

- Scoring methods and weightings should be reviewed and adjusted periodically, as appropriate, to reflect the current priorities of NB DTI and the government. For example, the Government of Brunswick and Department of Transportation and Infrastructure have updated their strategy maps since the model was developed last year.

- Consideration should be also given over time to involve stakeholders (local representatives, other Departments, external stakeholders) to develop weightings, and in particular to participate in project scoring.

6 NEXT STEPS FOR NEW BRUNSWICK

The Department has recently initiated two continuous improvement projects related to the MCA model. One is to extend the model to prioritize its building assets. The second is to develop a guide for estimating planning level benefit-cost impacts to be used in conjunction with the MCA

model. The benefit-cost analysis of capital investment projects will provide a measure of the return on investment, which will be particularly helpful to prioritize projects that are of a different scale. Figure 5 contains a sample plot demonstrating how projects can be compared using both the score from the MCA model and the benefit-cost ratio. Projects located in the top right quadrant of the plot, score high on both contribution to strategy and return on investment, and therefore should be given a higher priority than other projects.

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TABLE 1: Agency Prioritization Methods
MCA = Multicriteria Analysis, BCA = Benefit Cost Analysis

Agency	Prioritization Method	Agency	Prioritization Method
Missouri DOT	MCA & BCA	Washington DOT	BCA
Ohio DOT	MCA	Colorado DOT	Optimization to maximize few performance criteria and minimize costs
Vancouver Translink	MCA	New Jersey DOT	
Saskatchewan MHI	MCA[2]	North Carolina DOT	
Alaska DOT	MCA	Ohio	
San Francisco MPO[1]	MCA & BCA	Texas	
Wisconsin DOT	MCA	Utah	
Atlantic MPO	MCA & BCA		
Transport Canada Atlantic Gateway	MCA		

1. MPO = municipal planning organization
2. MCA used to prioritize road segments for strengthening program

TABLE 2: Scoring Guide Summary

Criteria	Indicator	-5	-3	0	+3	+5
Job creation	Jobs created after construction	Large decrease in non-construction related jobs More than 30 jobs	Moderate decrease in non-construction related jobs Less than 30 jobs	No impact on jobs after construction	Moderate number of new jobs created after construction Less than 30 jobs	High number of new jobs created after construction 30 or more jobs
	Regional unemployment rates.	not applicable	not applicable	Unemployment rate below provincial average	Average unemployment rate	Unemployment rate above provincial average
Foster Private Sector Business Growth	Impact on transportation costs to access markets	An increase in distances or travel times for 500 or more trucks per day.	An increase in distances or travel times for less than 500 trucks per day.	No impact on distances or travel times for trucks.	A decrease in distances or travel times for less than 500 trucks per day.	A decrease in distances or travel times for 500 or more trucks per day.
Supports Provincial Economic Development Plans	Level of support for initiatives in economic development plans	Large negative impact on a provincial economic development initiative e.g. Increasing the cost to market for a priority sector such as value-added wood because of a bridge closure	Slightly negative impact on a provincial economic development initiative e.g. increasing traffic and delays on a route serving a priority sector so level of service is reduced but is still acceptable	Does not impact initiatives identified in provincial economic development plans	Slightly positive impact on a provincial economic development initiative. e.g. Indirectly supports an initiative identified in a provincial economic development plan	Strongly supports a provincial economic development initiative. e.g. project identified as an initiative itself in a plan
Effective Service Delivery	Future level of service provided by asset.	<u>New Infrastructure Projects</u> Existing infrastructure provides an acceptable level of service now and 10 years in the future. Demand is expected to remain constant or decrease over the next 10 years and not exceed capacity. Project is being proposed for reasons	<u>New Infrastructure Projects</u> Existing infrastructure provides an acceptable level of service now. It is difficult to predict demand in 10 years due to factors that may divert traffic to or from the study area. Level of service may approach unacceptable limits within 10 years but demand is not	<u>New Infrastructure Projects</u> Level of service provided by existing infrastructure is expected to reach an unacceptable limit by the time the proposed project is completed. Demand is forecasted to increase over the next 10 years. The proposed project will provide an acceptable level of service in 10 years.	<u>New Infrastructure Projects</u> Level of service provided by existing infrastructure is now unacceptable and is expected to exceed capacity by the time the proposed project is completed. Demand is forecasted to increase over the next 10 years. The proposed project will	Demand exceeds capacity. <u>Asset Elimination Projects</u> Asset can be eliminated without building new infrastructure.

Criteria	Indicator	-5	-3	0	+3	+5
		other than increasing capacity. <u>Asset Elimination Projects</u> Not applicable	expected to exceed capacity. Uncertain if additional capacity will be required in the long term. <u>Asset Elimination Projects</u> Not applicable	Project has been planned to open just as the level of service reaches unacceptable limits and demand is expected to grow. <u>Asset Elimination Projects</u> Not applicable	provide an acceptable level of service during this time. Project should be in place now to provide acceptable levels of service and demand is expected to grow. <u>Asset Elimination Projects</u> Asset can be eliminated but new infrastructure is required to maintain land access.	
	Impact on network operating, maintenance and rehabilitation costs	Large increase in size of asset network to be operated, maintained, and rehabilitated OMR costs increase by more than $1 million over 20 years	Small increase in size of asset network to be operated, maintained, and rehabilitated OMR costs increase by $1 million or less over 20 years	No change in size of asset network to be operated, maintained and rehabilitated No change in OMR costs	Small decrease in size of asset network to be operated, maintained, and rehabilitated. OMR costs decrease by $1 million or less over 20 years	Large decrease in size of asset network to be operated, maintained, and rehabilitated. OMR costs decrease by more than $1 million over 20 years
Leveraging Opportunities	Potential for sharing infrastructure costs with another jurisdiction / agency	not applicable	not applicable	No potential for sharing life cycle costs, i.e. capital, operating, maintenance, or rehabilitation costs	Potential for sharing project life-cycle costs is less than 50 percent. Potential = probability x %costs paid by other agency	Potential for sharing project life-cycle costs is 50 percent or more. Potential = probability x %costs paid by other agency
Mitigate risks of climate change	Resiliency to respond to severe climate events	Large increase in risk of asset to climate change e.g. New alignment constructed in a flood plain	Moderate increase in risk of asset to climate change, e.g. increases width of a roadway in a flood plain	No impact on risk of asset to climate change	Moderate decrease in risk of asset to climate change, e.g. additional culverts to handle increased water flow	Large decrease in risk of asset to climate change, e.g. relocate a segment of highway currently in a flood plain

Criteria	Indicator	-5	-3	0	+3	+5
Environmental Impacts	GHG emissions	GHG emissions are increased by more than 15%	GHG emissions are increased by less than 15%	no impact on GHG emission	GHG emissions are reduced by less than 15%	GHG emissions are reduced by more than 15%
	Other environmental impacts	Large negative environmental impact e.g. Extensive mitigation required to achieve	Moderate negative environmental impact. e.g. Mitigation required in addition to standard methods.	Not significant environmental impact e.g. No mitigation required in addition to standard methods	Moderate positive environmental impact e.g. Project mitigation addresses existing environmental impact	Large positive environmental impact, e.g. Project includes restoration of a polluted waterway
Health and Safety	Impact on risk of a casualty collision (i.e. injury or fatal collision)	Large increase in collision risk e.g. 50% or higher increase in expected casualty rate	Moderate increase in collision risk e.g. less than a 50% increase in expected casualty rate	No impact on collision risk	Moderate decrease in collision risk e.g. less than a 50% decrease in the expected casualty rate	Large decrease in collision risk e.g. Expected casualty rate decreased by 50% or more
Access to services that meet primary needs	Impact on access to emergency services	Large increase in response times	Moderate increase in response times	No impact on access to emergency services	Moderate decrease in response time	Large decrease in response time
	Impact on access to services that meet primary needs (i.e. work, shelter, food, education, health, etc.)	Vehicle hours travelled (VHT) are increased by an average of 500 hours or more per day VHT = AADT x time savings	Vehicle hours travelled (VHT) are increased by an average of less than 500 hours per day VHT = AADT x time savings	No change in travel times to access services.	Vehicle hours travelled (VHT) are reduced by an average of less than 500 hours per day VHT = AADT x time savings	Vehicle hours travelled (VHT) are reduced by an average of 500 hours or more per day VHT = AADT x time savings
Alignment with Community Plans	Level of local community support for project	Community strongly opposes the project.	Moderate community opposition to the project. e.g. DTI project may limit a community initiative from being fully implemented or increase the cost of a local project (a new road may limit planned trail development).	Does not impact projects identified in community plans	Moderate community support for the project. e.g. DTI project supports an initiative identified in the plan (a new bridge may improve access to an area zoned for future development).	Strong community support for the project. e.g. project is identified as a priority project in a local community plan.
Impact on First Nations	Impact on First Nations lands,	Project has a large negative impact on	Project has a moderate negative impact on	Project has no impacts on First Nations	Project has a moderate positive impact on First	Project has a large positive impact on First

Criteria	Indicator	-5	-3	0	+3	+5
	culture, or community	First Nations communities (in addition to impacts on other communities). e.g. archeological site that would have to be excavated; project location may be subject to a land claim; project requires land on a First Nations Community	First Nations communities (in addition to impacts on other communities). e.g. project may cause an increase in traffic volumes in a First Nations community; an existing road or corridor crossing the First Nations community may need to be widened	communities in addition to impacts on other communities	Nations communities (in addition to impacts on other communities). e.g. Delays at intersections to the community or traffic volumes within the community may be reduced.	Nations communities (in addition to impacts on adjacent communities)> e.g. New road may divert through traffic from the community improving safety and reducing congestion; access may be provided to land allowing more development
Preserves or enhances heritage resources	Impact on heritage resources	Heritage resource must be removed for project to proceed	Project decreases value or demand for heritage resource. e.g. New limited access road makes heritage resource less accessible	No impact	Project enhances a heritage resource. e.g. Access is improved to a heritage site	Project preserves a heritage resource. e.g. Traffic is diverted from a covered bridge to a new bridge

TABLE 3: Examples of Projects Prioritized using the MCA Model and Asset Management Plans

MCA Model	Asset Management Plan
• New bypass • New bridge (that does not replace an existing bridge) • Additional lanes on a road segment or at an intersection that increase capacity • Removing an existing bridge without replacing it • A new interchange • Decommissioning an existing road • Strengthening a road to support heavier loads	• Repaving an existing road without adding additional lanes • Rehabilitating an existing bridge without adding additional lanes • Replacing an existing bridge with a new bridge that has the same number of lanes

TABLE 4: Summary of Project Information Required for the MCA Model

• Project type, i.e. new asset, elimination • Project rationale • Description of network impacted by project • Project scope in terms of major components, e.g. right-of-way, structures, new roadway • Asset features with and without the project • Project life-cycle costs in terms of right-of-way, planning and engineering, construction or removal/decommissioning, operations and maintenance, and rehabilitation over 20 years • Potential for sharing life-cycle costs with another agency • Impacts on businesses / industry	• Regional and provincial unemployment rates in the project location • Traffic volumes, route lengths, and travel times with and without the project • Casualty (injury and fatal) collision rates with and without the project • Impact of project on emergency response • GHG emissions with and without the project • Project impact on risk of damage from more severe weather events (i.e. climate change). • Other environmental impacts • Cultural impacts on First Nations communities, heritage resources • Level of local community support for the project

FIGURE 1: Government of New Brunswick Strategy Map for 2012-2013

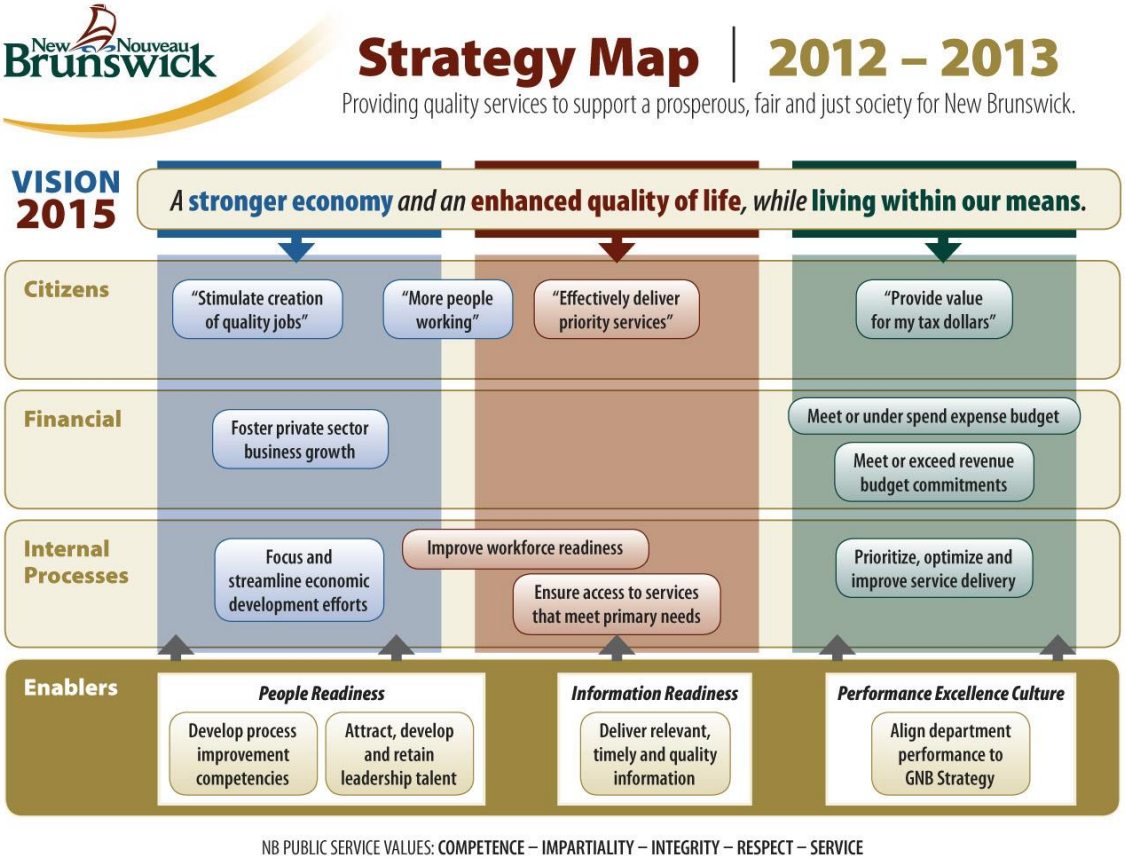


FIGURE 2: Final Multi-Criteria Assessment Model for the New Brunswick Department of Transportation and Infrastructure

QBL	Provincial Objectives	Criteria	Indicator Weight*	Indicators
Economic (Wt = 50)	Stronger Economy (Wt = 26)	Job Creation	7	Jobs created after construction
			5	Regional unemployment rates
		Foster Private Sector Business Growth	8	Impact on transportation costs to input and output markets (i.e. labour, supplier, and customer markets).
		Supports Economic Development Plans	6	Level of support for initiatives in provincial economic development plans
	Living Within Our Means (Wt = 24)	Effective Service Delivery	8	Infrastructure provides the required capacity to meet present and future needs at acceptable levels of service
			8	Impact on network operating, maintenance, and rehabilitation costs
		Maximizes Leveraging Opportunities	8	Potential for sharing infrastructure costs with a public or private sector partner
Environment (Wt = 15)		Mitigate risks of climate change	7	Resilience to severe climate events
		Environmental Impacts	4	Impact on GHG emissions
			4	Other environmental impacts
Social (Wt = 25)	Enhanced Quality of Life (Wt = 50)	Health and Safety Impacts	10	Impact on risk of a casualty collision (i.e. injury or fatal collision)
		Access to services that meet primary needs	6	Impact on access to emergency services
			6	Impact on access to non-emergency services (i.e. work, shelter, food, education, health, etc.)
		Supported by community plans	3	Level of local community support
Cultural (Wt = 10)		First Nations	5	Impact on First Nations lands, culture, or community
		Preserves or Enhances Heritage Resources	5	Impact on heritage resources

* Preliminary weights developed by DTI Project Teams. Weights should be reviewed periodically.

FIGURE 3 – Project Summary Sheet and MCA Scoring Example

New Ramps at Blue Lake Interchange on Route 99

Project Description

This project involves the construction of two diamond ramps at the existing Route 99 interchange to Route 444 near the resort town of Blue Lake. Southbound traffic on Route 99 currently uses an interchange located 1.4 km to the north of the project location and travels via a 2 km route at 50 km/h to access the town of Blue Lake. It is expected that 1,250 vehicles per day will divert to the new ramps which will:

- Provide a shorter route on a controlled access highway;
- Improve travel times; and
- Reduce the risk of a collision.

Key features of the transportation network with and without the project are summarized in Table 1. Project costs are presented in Table 2.

TABLE 1: Network Features with and without the Project

Feature	Without Project	With Project
Trip length for vehicles that would use the new ramps	2.0 km @ 50 km/h	1.4 km @ 100 km/h
Number of lanes	2 lane, local road	4-lane, controlled access highway
Traffic volumes	2,000 AADT	11,000 AADT
Collision rates	0.3 casualty collisions per mvk	0.10 casualty collisions per mvk

TABLE 2. Summary of Project Costs (2013 – 2034)

Component	Years	Current Cost	Discounted Cost
Preliminary engineering and ROW costs	2013	$120,000	$120,000
Construction	2014	$850,000	$773,000
OMR costs	2015 – 2034	$598,000	$136,800
Life-cycle costs	2013 – 2034	1,568,000	1,030,000

Route 99 is part of the National Highway System so there is an 80% chance that the construction costs can be shared 50-50 with the federal government. The Town of Blue Lake is also willing to plow the ramps which represents $60,000 of the OMR costs.

The potential for sharing costs (probability x %costs paid by another agency) is therefore:

$$0.80 \times 425/1{,}568 + 1.0 \times 60/1{,}568 = 0.26$$

Economic and Business Impacts

» The Town of Blue Lake is expecting a 10 percent increase in traffic for their local businesses including restaurants, hotels, a golf course, eco-tourism for hikes around the undeveloped areas of the lake, and visitation to the local interpretive centre
» The regional unemployment rate is 9% compared to the provincial average of 10.5%.

» 10 new seasonal jobs are expected to be created in the tourism sector as a result of the increased traffic.

Traffic Volumes and Operations

» A total of 1,250 vehicles per day including 300 trucks are expected to use the new ramps. This volume is expected to increase by 2% per year.

TABLE 3: Operational Impacts

Operations	Without Project	With Project	Impact
Distance Travelled	2 km	1.4 km	0.6 km shorter
Travel Time	2 km @ 50 km/h = 2.4 min	1.4 km @ 100 km/h = 0.8 min	1.5 min savings
Casualty Collisions	7 casualty collisions over 20 years	2 casualty collisions over 20 years	decrease of 5 casualty collisions over 20 years
% Change in collisions	(7 – 2) / 7 = 71% decrease		

» The diverted traffic does not impact levels of service on Route 99. Levels of service on Route 444 are expected to improve from LOS D to LOS C.

» Emergency response will improve due to the more direct access

Potential Environmental Issues

» Estimate GHG emissions based on veh-km travelled as shown below.

TABLE 4: Project Impact on GHG Emissions

Measure	Without Project	With Project
Vehicle-distance-travelled over 20 years	22,171,350 veh-km	15,519,945 veh-km
Emissions (0.19 kg/veh-km)	4,213 tonnes	2,949 tonnes
% change	(4,213-2,949) / 4,213 = 30% decrease	

» The ramps decrease the risk of climate change impacting the network because they divert traffic from a section of Route 444 which is located in the flood plain for the lake.

» The project will have a minimal impact on the environment because it will be constructed within the existing right-of-way for the highway and standard mitigation will be used to protect the environment from erosion, runoff into the lake.

Social and Cultural Impacts

» The project will have no impact on First Nations communities or heritage assets.
» The community fully supports the project.

Benefit – Cost Information (suggested as a future continuous improvement)

» Benefits = $4.098 million (discounted $$)
» Costs = $1.030 million (discounted $$)
» Benefit Cost Ratio = 4.0

MCA Scoring for Interchange Improvement Example

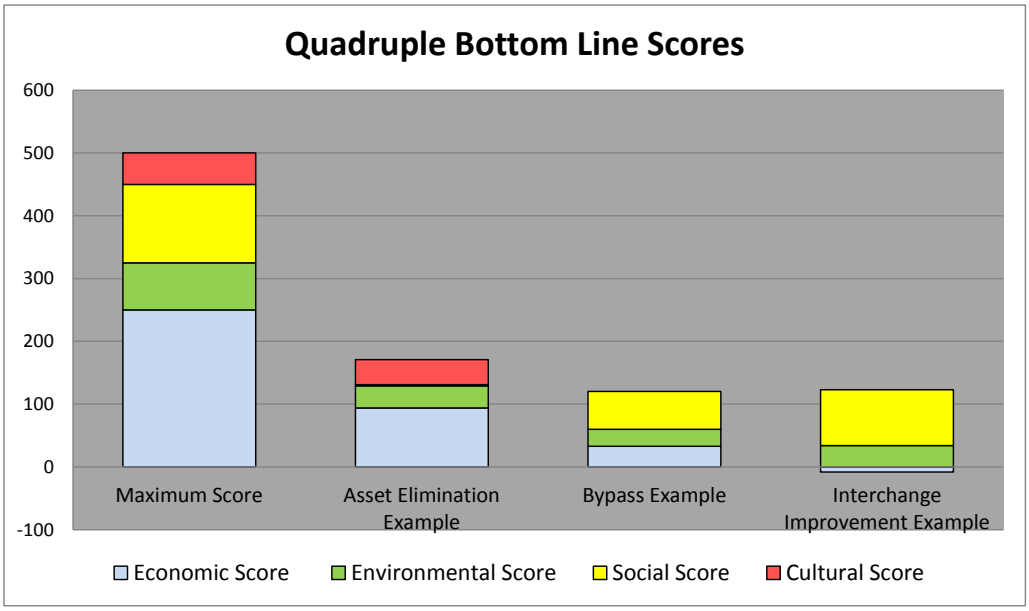
NBDTI - Multi-Criteria Analysis of Transportation Infrastructure Strategic Value							
Interchange Improvement Example							
QBL	Provincial Objectives	Criteria	Weight	Indicators	Score	Comment	Weighted Score
Economic 50	Stronger Economy 26	Job Creation	7	Jobs created after construction	1	10 seasonal jobs which would be equivalent to 3 full-time jobs	7
			5	Regional unemployment rate	-5	unemployment rate below provincial average	-25
		Foster Private Sector Business Growth	8	Impact on transportation costs to market	2	300 trucks will save time and travel a shorter distance to access Blue Lake.	16
		Supports Economic Development Plans	6	Level of support in provincial economic development plans	3	Improved access benefits tourism sector, a traditional industry.	18
	Living within Our Means 24	Effective Service Delivery	8	Present and future levels of service provided by the asset	-4	Current LOS is acceptable at D. Demand is expected to increase over 10 years but LOS is not expected to drop to LOS E.	-32
			8	Impact on network operating, maintenance, and rehabilitation costs	-1	OMR costs over 20 yrs = $600,000	-8
		Maximizes Leveraging Opportunities	8	Potential for sharing infrastructure costs with a public or private sector partner	2	Potential = 0.26 (see summary sheet)	16
Environment 15	Enhanced Quality of Life 50	Mitigate Risks of Climate Change	7	Mitigate risks of climate change	2	Diverts traffic from existing road in a flood plain	14
		Environmental Impacts	4	Greenhouse gas emissions	5	GHG emissions are reduced by 30%	20
			4	Other environmental impacts	0	negligible increase in roadway footprint, environmental impacts can be mitigated with standard methods	0
Social 25		Health and Safety Impacts	10	Impact on risk of a casualty collision (injury or fatal collision)	5	71% decrease in casualty collisions	50
		Access to Services that Meet Primary Needs	6	Impact on access to emergency services	3	moderate decrease in response times	18
			6	Impact on access to non-emergency services	1	VHT = 1250 AADT x 1.5 min = 31 veh-hr per day	6
		Supported by Community Plans	3	Level of local community support	5	strong community support	15
Cultural 10		First Nations	5	Impacts on First Nations	0	no impact on First Nations	0
		Preserves or Enhances Heritage Resources	5	Impacts on Heritage Resources	0	no impact on heritage resources	0
			100.00				115.00

FIGURE 4 – Project Comparison Examples

Project Ranking Summary

MCA Score Summary

Quadruple Bottom Line Scores	Maximum Score	Asset Elimination Example	Bypass Example	Interchange Improvement Example
Economic Score	250	94	33	-8
Environmental Score	75	35	27	34
Social Score	125	2	60	89
Cultural Score	50	40	0	0
Total MCA Score	500	171	120	115



Summary of Information for Capital Plans

Project	Construction Cost	Construction Period	Strategic Score	Benefit-Cost Ratio
Asset Elimination	$6.75 million	2015 – 2016	171	1.0
Bypass	$30 million	2014-2018	120	0.3
Interchange Improvement	$0.85 million	2014	115	4.0

FIGURE 5 – Example of a Plot Comparing Projects using the Strategic Score and Benefit-Cost Ratio