Appendix 4

Option Evaluation Guidelines for MoT Business Cases

including

Multiple Account Evaluation

Prepared By:

Planning and Programming Branch
Infrastructure Department
BC Ministry of Transportation and Infrastructure

Updated December, 2014

1.1 Introduction

Multiple account evaluation (MAE) is a multi-criteria decision matrix tool designed to:

- provide a balanced view to decision makers
- understand any necessary compromises (trade-offs)
- compare options within a project
- draw comparisons with other projects
- facilitate comparison with other program needs (such as health, education and social services)

1.2 Relationship to Option Development and Problem Identification & Definition

Option evaluation is the fourth step in the business case development process and directly references the third step, option development. The improvement options relate directly to the first two steps, problem identification and problem definition. Therefore the option evaluation step examines the costs, benefits and impacts associated with addressing one or more specific performance problems.

1.3 MAE Accounts

The ministry (MoT) uses five accounts in MAE (see Exhibit 1.1):

- Financial
- Customer Service
- Social/Community
- Environmental
- Economic

Benefit-cost analysis is the foundation for comparing road user benefits to project costs. See MoTI's Benefit Cost Analysis Guidebook available at:
http://www.th.gov.bc.ca/publications/planning/index.htm

MicroBENCOST has been MoT's preferred tool in past years but it has not been kept up to date by its USA source and so it is no longer used. The Ministry has developed 2 tools: "ShortBEN" is a high level benefit-cost tool for preliminary project evaluation, and Safety-BenCost is a tool specifically for assessing the safety benefits of highway improvements. They are available at:
http://www.th.gov.bc.ca/publications/planning/index.htm

Other benefit-cost tools are generally acceptable as long as the ministry's standard default values are used. Refer to:
http://www.th.gov.bc.ca/publications/planning/Guidelines/Business%20Case%20Guidelines/DefaultValues-BenefitCostAnalysis.pdf

Exhibit 1.1

Typical Multiple Account Evaluation

OPTION / ACCOUNT	Base Case	1 Passing Lanes then 4 lanes	2 Pass.Ln. converted to 4 lanes	3 Staged 4 Lane Sections	4 Bypass Option: Existing Route	4 Bypass Option: Bypass Route
FINANCIAL (millions $)			millions $1997			
Capital Cost (PV)	$1	$120	$130	$125	$1	$200
Annual Maintenance	$0	$1	$1	$1	$0	$1
Resurfacing (PV)	$5	$7	$7	$8	$5	$6
Life Cycle Cost (PV)	$9	$132	$142	$138	$223	
Incremental Cost		$123	$133	$129	$214	
CUSTOMER SERVICE			millions $1997			
Time (PV)	$273	$218	$218	$218	$100	$119
Accident (PV)	$146	$102	$102	$102	$38	$64
Vehicle Operating (PV)	$730	$715	$715	$723	$276	$319
Total	$1,149	$1,036	$1,036	$1,043	$917	
Incremental Benefit	$0	$113	$113	$106	$232	
Annual Closures (hrs)	80	80	80	60	60	20
NPV		($10)	($20)	($23)	$18	
B/C Ratio		0.9	0.8	0.8	1.1	
SOCIAL/COMMUNITY						
Average Daily Traffic (noise, pollution)	8000	8000	8000	8000	3000	5000
Residences Impacted	166	166	166	166	166	5
Business/institutional	71	71	71	71	71	0
Business Takings	0	1	1	l	0	0
Residential Takings	0	6	6	7	0	2
Commmunity Severance	⊙	●	●	●	❍	❍
Community Plans	⊙	❍	❍	❍	●	●
Business Impact (equity)	⊙	❍	❍	❍	●	⊙
Visual Impact	⊙	⊙	⊙	⊙	⊙	●
ECONOMIC DEVELOPMENT						
Provincial Output		($9)	($18)	($21)	$16	
Jobs		-11	-21	-25	19	
ENVIRONMENTAL						
Land Requirements	0.0	5.0	7.0	7.0	0.0	20
Fuel (million litres)	1,825	1,900	1,900	2,000	800	1,000
CO (million kg)	456	475	475	500	200	250
Site Rehabilitation	❍	❍	❍	❍	❍	❍
Wildlife	❍	⊙	⊙	⊙	❍	●
Water Pollution	❍	⊙	⊙	⊙	❍	●
Special Areas	none	none	none	none	none	historic site

KEY

❍ Good

⊙ Fair

● Poor

PV=Present Value

NPV = Net Present Value

1.4 Financial Account:

This is the cost to the infrastructure provider(s) of each option. It is expressed as a life cycle cost which is the present value of capital cost estimates (less salvage), periodic rehabilitation costs and annual operating/maintenance costs discounted at 6% over a 25 year planning period to the current year. Financial costs do not differentiate between who pays. Cost shared amounts with other agencies for example should not generally be excluded from the project cost.

Ideally, pavement rehabilitation (resurfacing) costs should be based on local experience. Otherwise refer to Section 5.2 of the previously referenced 2012 Ministry default values guide, which provides typical values for BC arranged by treatment type for low-high-average values.

Assume resurfacing is required every 15 years.

Pavements resurfaced near the end of the planning period are assigned a salvage value equal to:

$$\text{Salvage value of resurfacing} = \text{Resurfacing cost} \times (1-N/10)$$

where N is the number of years remaining to the end of the planning period. For example, N=2 for a highway resurfaced in 2020 and a planning period ending in 2022.

For maintenance costs, refer to Section 5.1 of the 2012 Ministry default values guide.

See section 1.9 of this appendix for a discussion of capital, rehabilitation and maintenance issues as they relate to the Financial account.

1.5 Customer Service Account

This is the cost to highway users for each option and includes dollar values for:

- Time
- Collisions
- Vehicle operating costs

The business case must clearly show safety and mobility performance before the improvement, and what it is expected to be after the improvement, using the performance measures listed in Appendix 1, Problem Identification.

Highway closures due to avalanche conditions, landslides, traffic accidents or other causes may be a regular occurrence. If reliability is to be a distinguishing feature between options, then the customer service account should show this as a separate item. The dollar cost of closures is difficult to estimate since it varies depending on the decision to wait, divert or postpone a trip which in turn depends on the duration and location of the closure. Where Ministry staff are able to provide relevant data, the business case should identify the annual duration of closures, their causes, and their impacts.

Travel Demand

Travel demand forecasts (short/medium/long term) have a big influence on business cases. Demand varies over time and is a function of demographic, economic, spatial and other variables including current and future consumer preferences, industrial structure, global supply chains and technological change. Business cases need to clearly state all assumptions, methodologies, data sources and proxies used in generating travel demand forecasts.

If a static four step urban travel demand model is used (e.g. Emme/2, TransCAD), the business case will document its assumptions about key issues such as future land use patterns, transit demand, trip internalization, and transportation demand management (TDM) strategies. The business case needs to show that the model replicates existing conditions through appropriate calibration and validation, and that it produces reasonable forecasts.

Urban capacity upgrades can result in new trips (not made before), can divert trips from other routes, and can lead to more travel due to the changes in destinations of trips. This can significantly impact future performance and reduce customer service benefits on the improved route. However, the improvement may lead to improved speeds on other routes. If so, these are treated as a project benefit. When a static urban travel demand model is used, the project's NPV and B/C ratio are influenced by the change in travel speeds and mode shift across the network.

Travel demand models like Emme/2 do not account for any new trips (induced trips) made as a result of capacity upgrades, but they do account for increased travel throughout the network due to changes to trip destinations and route changes. It is important to understand that this increased travel in the proposed case must be accounted for using the principles of "consumer surplus" which will lead to it contributing to an increase in project benefits rather than an increase in proposed case user costs (and a decrease in project benefits).

Within a model, an appropriate sub-area should be identified for 2 reasons:

- If the analysis area is too large in comparison to the scope of the improvement, the inherent variation in model-produced travel speed outputs across the network may exceed the travel speed benefits created by the improvement.
- The other routes (referred to above) experiencing better service will normally be routes in the vicinity of the improved route.

Dynamic urban traffic models increasingly are being used to supplement or replace static models. They may be "mesoscopic" models (e.g. Dynameq) or "microsimulation" models (e.g. Synchro, Paramics, Vissim). Regardless of the type of model, the objective is to quantify appropriate network benefits as opposed to examining only the improved route. Appropriate input data, calibration and validation are essential, as is related documentation, because the model output is used to estimate user costs for both the base case and proposed case.

Future conditions can seldom be predicted with absolute accuracy. Assumptions about the key issues, referenced in the 2nd paragraph above, may significantly differ from reality.

Therefore travel demand may turn out to be different than anticipated. The Customer Service account should therefore discuss:

- the option's flexibility: its ability to perform (or to be modified) should unforeseen events occur (e.g. travel demand exceeding the forecast values), and
- risk and uncertainty (see Appendix 5 of the Business Case Development Guidelines) which can affect both the estimated costs and the benefits of a project.

1.6 Social/Community Account

This documents external effects of highway projects on the communities and social values.

Noise, Visual and Pollution Impacts:

- Exposure - The number of residences and number of businesses adjacent to the highway quantifies how many will be directly influenced by noise, visual impact and pollution. This can be done with a drive-by survey.
- Magnitude - Changes in AADT indicate the magnitude and direction of the impacts for each option.

Community Displacement

This is measured as the number of property takings associated with each option. These are typically assessed in the planning stages of a project and can be quantified for example:

Business takings	4
Residential takings	42
Partial takings	27
Special Purpose takings	Golf course

Community Severance Effect

Constructing a new transportation right of way through an existing community can limit access to pedestrian or local vehicle traffic to major generators and attractors in the community. Qualitatively, a bypass reduces community severance by reducing through traffic volume. Improving the existing route through town generally increases the barrier effect of the route. This can be summarized on an MAE chart as:

- good - reduces barrier effects
- fair - little or no change
- poor - increases barrier effects

Consistency with Community Plans

This is rated by comparing options to Official Community Plans and Major Street Network Plans where they exist. Consistency is evaluated qualitatively, based on the location, role, and impact of proposed transportation works relative to where they were envisioned in the plans. This can be summarized on an MAE chart as:

- good - project agrees with community plans
- fair - project is not addressed in the community plan
- poor - project is not consistent with community plans

Equity

This highlights changes which benefit one group at the expense of another. A bypass for example benefits residents of the bypassed community and through traffic, possibly at the expense of local businesses who depend on through traffic for business. If the issue is to be addressed in the economic development account, then it should not be repeated here. The MAE chart can summarize this by identifying the major impact group(s) and whether the impact is:

- good - positive impact
- fair - neutral
- poor - negative impact

Visual Impacts

This may include for example:

Obstruction	Desirable views are blocked by structures with no aesthetic value.
Intrusion	This is a broader concept than visual obstruction. It relates to the perceived loss of amenity by people located close to a road and its traffic. It includes loss of privacy, night time glare from street and vehicle lights and the changed character of the landscape (i.e. from natural to modified).
Overshadowing	A structure, such as an embankment or overhead bridge, reduces the amount of direct sunlight on an occupied property.

For presentation in the MAE chart, impacts may be given as:

- good - improves visual qualities (i.e. by removing undesirable structures)
- fair - little or no change
- poor - visual impact is negative

1.7 Economic Development Account

This is not a straightforward account. The Highway Planning & Programming Branch's Manager, Economic Analysis must be contacted if the economic development account is thought to apply to any project under consideration. Refer to Appendix 1 for the appropriate MoT contact person.

This account does not apply to a project unless it results in B.C. being a beneficiary in terms of:

1) a net increase in employment
2) a positive impact on private sector investment
3) a positive impact on productivity
4) a positive impact on GDP and tax revenues
5) a positive impact on trade

The business case must explain how the project will result in these positive net benefits. Quantitative analysis is preferred but if this is not possible, a qualitative analysis is necessary.

All costs, benefits and externalities (positive and negative impacts in addition to the project's costs and benefits) should be identified. Construction expenditures do not necessarily provide net benefits if resources must be diverted from employment in other sectors. Private sector investment may not generate a net increase in employment if it comes at a cost of employment in another region (a transfer).

Assessment of employment, income and output implications of the investment proposal should be expressed as a difference from a base case scenario. The base case scenario should represent, as closely as possible, the most efficient and productive use of existing assets, even if expenditures are required to achieve a stated goal. The base case should include any costs that would be incurred in the event all other options are rejected. Comparing the net benefit stream to the base case will answer the question "what would happen if this project does not go ahead?" In most cases there would be no impact on the provincial economy.

Input-output multipliers should not be used unless the analysis has been reviewed by the Manager, Economic Analysis. In the past, the wrong values often have been used, and more seriously, that have been used as an indicator of macroeconomic benefits (which they are not) rather than what they are – a way to describe the effect of a project on various industry sectors.

An example of a project which had positive economic development benefits was the Coquihalla Highway project, because it had a pronounced impact on capital investment and employment activity in the Thompson-Okanagan region.

1.8 Environmental Account

This account documents the nature, degree and mitigation of environmental impacts. Evaluation work must be scoped within the project management constraints (i.e. available budget and schedule). Data availability and processing effort will be major factors. Where non-dollar measures are used, description of environmental impacts should be along the following lines:

Impact	Measure
Land Requirements	The requirements are quantified in hectares by land use, to the extent that different land uses can be defined. For example: • Wetland, Agricultural, Forest, Park/Protected Area • Developed land • Total
Noise	This is already included in the Social/Community Account as traffic volume and number of residences/businesses impacted.
Impact	**Measure**
Energy Consumption	Estimates of fuel consumption.
Emissions	The following vehicle emissions impacts are required and shall be quantified in the units noted over the analysis period, all in accordance with the online MoT document: *Guidelines for Quantifying Vehicle Emissions within the Ministry's Multiple Account Evaluation Framework*. *1. Criteria Air Contaminants (CO, NO_x, VOC, PM_{10}, $PM_{2.5}$, and SO_2)* *In tonnes or kilo-tonnes* *2. Greenhouse Gases (CO_2, CH_4 ,N_2O) in kilo-tonnes of CO_{2eq}* *(including estimates of both direct and indirect GHG emissions)* GHG emissions should also be presented in terms of the equivalent number of passenger vehicles that would have to be taken off the road annually to achieve the same benefit (or the equivalent number added if emissions increase relative to the base case).
Visual	Included in the Social/Community Account
Site Rehabilitation	Cleanup of contaminated sites prior to construction.
Wildlife	Wildlife impacts include roadkill of migratory animals and habitat fragmentation related to new roads. In general, animals grow accustomed to transportation routes and tend to stay away from them. However, new routes are notorious for initial high rates of roadkill.
Water Pollution	Water quality impacts can be measured quantitatively after the fact using accepted quantity, chemical and observation techniques. Predicting the impact prior to implementing a project is harder. The impact measure is likely to be the degree of avoidance and mitigation measures required in advance.
Special Areas	The MAE should report special areas, their importance and whether the impact is positive, negative or neutral. Special areas may include sites of cultural, spiritual, historic, aesthetic, archaeological, special ecological, botanical, geological, scientific or recreational importance. The importance of special sites is specific to each case and can only be evaluated by people who have experience and knowledge of it. If they have not been previously identified, special sites are often identified through public consultation.

For the purpose of summarizing complex environmental impacts on a one page MAE table, a simple presentation is needed. For example:

Good	Low impact due to direct effects. Mitigation of impacts feasible and cost effective
Fair	Medium impacts due to direct effects. Mitigation of impacts is possible and should be considered
Poor	High impacts due to direct effects. Mitigation opportunities are limited

1.9 Capital, Rehabilitation and Maintenance

Although the tendency has been to consider highway improvement options largely in terms of new capital work, this may be neither the most cost-effective improvement strategy nor the one likely to make best use of limited funding resources. The Financial account should document the issues surrounding the tradeoffs and inter-dependencies between the mixture and timing of capital, rehabilitation and maintenance actions. This is important not only because agencies are looking for the best technical and value-for-money strategy, but because there is a need to forecast and co-ordinate the funding requirements for programs which may not be funded from the same administrative budgets. There is also a need to ensure that agencies avoid wasteful or repetitious work undertaken by different business units which may be trying to deal with the same basic sets of problems, but without full knowledge of what others may be attempting to do.

Examples of tradeoffs include:

- New capital work may result in increased or decreased rehabilitation and maintenance needs in future, depending upon the specific circumstances. E.g. new capacity will mean an increase in the size of the highway asset to be maintained and eventually rehabilitated, and therefore an increase in the cost to the agency responsible. A capital project which improves a highway asset but does not significantly change its size, and which possibly improves its “maintainability”, may actually reduce rehabilitation and/or maintenance costs in the short to medium term.

- Increased rehabilitation and maintenance may delay the need for new capital improvements, but at increased costs in these areas until such time as a capital option is implemented.

- In the absence of a capital improvement, there may be an optimum mix and timing of actions limited to only rehabilitation and maintenance.

Evaluation and presentation of tradeoffs and inter-dependencies may be done in a tabular format which shows the years of analysis (1 to 25) at the left side of the table along the y-axis, and options at the top of the table along the x-axis. Each option should have columns indicating the activity and the estimated cost for any given year. The total cost, salvage value, and NPV can be summarized at the bottom.

2.0 Presenting the MAE Results

The results of an MAE should be presented in a clear and concise manner along with adequate supporting information to allow for an independent review of what has been done.

1. Provide a concise summary of the results

Present the MAE results in a summary table similar to Exhibit 1.1 shown earlier in this section.

For the preferred option, determine the optimal year(s) of construction and present the optimal results (optimal year(s), B/C and NPV). Provide a note if the optimal year has passed.

Present the results of the sensitivity analysis in a simple table that identifies the sensitivity and the corresponding NPV and B/C ratio.

2. Provide supporting information for the benefit cost analysis

Provide adequate supporting information for the benefit cost analysis including:

- Agency costs (capital less salvage, rehabilitation, and maintenance)
- Traffic information
- Collision information
- Travel time information
- Vehicle Operating Cost information

Describe any significant assumptions, and highlight the significant differences between the base case and the proposed case.

3. Provide supporting information for the evaluation under the Environmental and Social/Community Accounts

Provide adequate supporting information for the evaluation of qualitative and quantitative measures under these accounts.

4. Provide a brief interpretation of the results

Confirm that the benefit cost results for travel time savings, safety savings, and vehicle operating cost savings are consistent with expectations. Highlight the key differences between the base case and each option that are generating the resulting benefits.

2014-04-16