Chapter 5
Department of Transportation and Infrastructure
Capital Maintenance of Highways

Contents

Department of Transportation and Infrastructure Capital Maintenance of Highways

Introduction

5.1 New Brunswick is a largely rural province where the roads and highways connect people to family, work, education, recreation, healthcare, and emergency services. They are vital to our communities and serve as essential transport corridors for industry.

5.2 Automobile use in New Brunswick accounts for the largest component of total transportation demand. Nearly 90% of all commuters travel to work by automobile and New Brunswick residents spend approximately 15% of their income on transportation[1]. The condition of the highway network impacts all New Brunswick residents.

5.3 The Department of Transportation and Infrastructure (Department) utilizes an Asset Management Business Framework to provide a more integrated and strategic approach to the long-term, sustainable investment planning and program management of its transportation infrastructure. In today's economic climate of tight fiscal control, the ability to optimally focus limited funding on highway infrastructure repairs that will best meet provincial needs in the most cost-effective manner is critical to taxpayers.

5.4 In this chapter, the term "capital maintenance" refers to repairs made to highway infrastructure to extend the service life of an asset. The Department uses the term "rehabilitation" to refer to these activities.

5.5 A glossary of terms used in this chapter can be found in Appendix I.

Why We Completed this Review

5.6 We reviewed the results of asset management in the Department for the following reasons:

- The condition of provincial roads is a significant issue for all New Brunswick citizens.

[1] New Brunswick Department of Transportation, "New Brunswick at the Centre: A Provincial Multimodal Transportation Strategy 2008-2018", (Province of New Brunswick), p.2.

- Our recent Public-Private Partnership (P3) chapter regarding school construction highlighted significant areas of risk to the Province as a result of deferring required capital maintenance. We are concerned the maintenance patterns we observed in this work may exist in other areas of government given the current fiscal environment. We have observed in our prior work deferred maintenance represents short-term expense relief while increasing long-term cost.
- In 2008, the then Department of Transportation (DOT) implemented a new Asset Management Business Framework to better manage the long-term investment requirements of the Province's aging highway infrastructure. We are interested in the results of this implementation both in terms of the impact on the highway infrastructure to date, and the possible benefits of utilizing asset management principles for other provincial infrastructure.

Objective

5.7 The objective of our review was:

To determine whether capital road repairs, identified as necessary by the Department of Transportation and Infrastructure, are made on a timely basis.

Conclusion

5.8 We have concluded that although the Department has the appropriate tools in place to identify and prioritize required capital highway maintenance projects, current funding levels do not allow the completion of optimal maintenance treatments on a timely basis. This will result in deferring required maintenance to future periods at greater overall cost to the Province.

Main Points

5.9 The Department is responsible for the maintenance and repair of designated provincial highways. Maintaining the New Brunswick highway network in an acceptable condition requires a significant taxpayer investment. In their *2008-2018 Multimodal*

Transportation Strategy, the Province states that annual expenditures to maintain roadways and bridges exceed $125 million.[2] Maintaining these assets is a challenge given the Province's current fiscal situation.

5.10 Due to an increasing proportion of mature or older roads, the Department determined it needed to use a radically different approach to manage the New Brunswick highway network since their traditional approach of "fix the worst first"[3] was considered unsustainable. The Department chose to develop a strategic framework based on the principles of asset management.

The Asset Management Methodology is Sound

5.11 The Department utilizes an Asset Management System (AMS) as part of a broader framework to meet the following objectives[4] (refer to Appendices II and III for more information on asset management):

- to look at assets over the long term with the goal of minimizing investment costs over the life of an asset (least life cycle cost);
- to predict how assets will change over time; and
- to select the treatment strategies that will minimize the cost of maintaining the asset at an acceptable standard.

The AMS is used to produce a 20-year strategic plan of optimal project choices on which 4-year tactical and annual operations plans are based.

5.12 In the first three years after adopting the Asset Management Business Framework with optimal funding in place, the Department noted positive results

[2] New Brunswick Department of Transportation, "New Brunswick at the Centre: A Provincial Multimodal Transportation Strategy 2008-2018", (Province of New Brunswick), p.5.
[3] Feunekes, U., J. MacNaughton, A. Feunekes, J. Cunningham, S. Palmer, K. Mathiesen. "Taking the Politics out of Paving, Achieving Transportation Asset Management Excellence through OR (Operations Research)", p.5-6.
[4] New Brunswick Department of Transportation, "Maintenance/Rehabilitation Requirements NBDOT Infrastructure (presentation)", October 27, 2011, Slide 33.

including[5]:

- "Government's funding commitment over the last 3 years has prevented over 1,200 kms of road from deteriorating to a poor condition"[sic][6] when compared to the traditional method of project selection; and
- Increased kilometers of capital maintenance on highways completed from 2008-09 through 2010-11 when compared to a similar period under traditional methods. The Department claims over 500 km more of asphalt surfaces and over 700 km more of chip seal surfaces were treated using asset management than were completed using the traditional methodology over a similar period.

Department projections of road condition for 2011-12 to 2014-15 though, based on reduced budgets from government, indicate increasing highway network deterioration.

Reduced Funding Leads to Deferred Maintenance and Deterioration of the Highway Network

5.13 The AMS is used to model an optimal capital maintenance plan over a 20 year strategic period. It uses cost data to project four year budget requirements in order to carry out the optimized strategy. When the model was adopted in 2008, one of the Department's objectives was to stabilize the number of kilometers of roads in poor condition.

5.14 Based on the information provided from the AMS, four year budget projections beginning in 2011-12 will result in an increase in the number of kilometers of poor roads from 1,730 kilometers in 2012 to 2,224 kilometers by 2015. As a result, the Department will not meet its objective of stabilizing the kilometers of poor roads.

5.15 When maintenance is not completed at key stages of the asset's life cycle, the highway network deteriorates and the cost of maintaining the highway

[5] New Brunswick Department of Transportation, "NBDOT Road Infrastructure Plan 2008-2011, Results and Benefits January 2010", (Province of New Brunswick), p.4-6.
[6] Ibid., p.7.

network increases. This deteriorating condition leads to ever increasing levels of infrastructure debt. Infrastructure debt is the result of deferring required maintenance to future years.

As Infrastructure Debt Grows, Sustainability of the Highway Network is at Risk

5.16 We are concerned that as the infrastructure debt grows, the Province will be in a situation where sustainability of the highway network cannot be maintained due to the higher cost of repairing greatly deteriorated roads with limited annual funds. At that point the Department may have to consider decommissioning an increasing number of assets if it hopes to maintain the remainder of the highway network in accordance with asset management objectives (paragraph 5.11).

5.17 We believe it is imperative the Department clearly and accurately communicate the impact of the growing infrastructure debt to government.

Significant Assets are not Included in the Asset Management Optimization Program

5.18 A key component of the AMS is the asset data stored in various system databases. This asset data is used to generate information on current condition and predict the future condition of the highway network. We found though that some significant assets such as ferries and large culverts are not modeled using the AMS optimization program.

5.19 By excluding these assets, the Department is not fully utilizing the system and may be making non-optimal maintenance decisions by following the traditional, more costly "fix the worst first" approach to capital maintenance project selection for these assets.

40% of the Capital Maintenance Projects Chosen for Completion are not Recommended Through the Asset Management Capital Planning Process

5.20 The AMS sets optimal targets for minor rehabilitation, major rehabilitation, and reconstruction to achieve a desired level of service at least lifecycle cost. It also produces a candidate list of potential projects. Departmental staff from different branches and the districts then complete a proposed project plan (Capital Program) that considers a number of other factors that are not included in the computer model. The Department identifies this as the Asset Management Capital Planning process. Departmental staff indicated they believe the proposed Capital Program meets the optimization criteria used within

the AMS. This program is submitted to the Department's Senior Management for approval.

5.21 In 2008, the Department set a target for the final approved Capital Program at 80 % based on the Asset Management Capital Planning process and 20% from other sources. Currently, the Department has achieved an approximate 60/40 ratio, meaning that 40% of the final projects approved by Senior Management for completion are not recommended through the Asset Management Capital Planning process.

5.22 We reviewed the 2011-12 and 2012-13 proposed project lists (resulting from the Asset Management Capital Planning process) and found there were a number of projects on the Capital Program that were not on the AMS project lists.

5.23 We asked the Department if the final Capital Program would have met the AMS optimization criteria and they indicated they do not verify that the non-AMS selected projects would meet system modeling criteria prior to completion.

5.24 Among the factors considered by the Department and included in projects chosen for completion (Capital Program) in the following construction season were:

- traffic demand;
- accident levels;
- Member of the Legislative Assembly (MLA) requests;
- district priorities; and
- administrative boundaries.

5.25 We believe there should be guidelines established to govern the inclusion of factors not currently modeled in the AMS but used for project selection, such as those noted above, to ensure that there is a clear link between projects chosen using these factors and the Department’s overall goals and objectives.

5.26 In addition, since the purpose of using the AMS is to identify optimal projects to minimize life cycle

cost, we believe the Department should clearly identify, document, and communicate to government the implications of completing projects that do not meet AMS optimization criteria. Such implications to be communicated should include the increased cost of capital maintenance when not selecting AMS optimal treatments for completion.

New Road Construction can Negatively Impact Sustainability of the Highway Network

5.27 New road construction, other than specific projects undertaken as Public-Private Partnerships, does not typically take into account future maintenance costs based on least lifecycle cost analysis when the decision to build the new road is made. This results in a lack of reserved or statutory funding to address future costs. Since current maintenance activities are experiencing a funding shortfall, new road construction can only worsen the situation.

5.28 In order to mitigate the impact of new construction on highway network sustainability, we believe the Department should complete full life cycle costing on all new highway infrastructure projects and request long term funding through statutory appropriation to ensure sustainability of these new assets. This would result in equitable funding treatment to that of Public-Private Partnership road kilometers.

Public Reporting of Performance Results and Highway Network Condition can be Improved

5.29 With the AMS in place, the Department has the data needed to measure its performance in completing projects and publicly report on the variances against its plans. However, this information is not presented in the annual report.

5.30 A key measure of highway network usefulness and sustainability used internally by the Department is road condition. We did not find evidence that the Department reports on the condition of the overall highway network by condition category (i.e. very good, good, fair, and poor).

5.31 We believe the Department should provide updated highway network condition information as part of their annual public reporting process. Annual changes in condition categories noting related road kilometers should be clearly communicated in the Department's annual report. This will provide greater transparency regarding the Department's assessment

of the status and sustainability of the highway network.

Recommendations

5.32 Our recommendations are found in Exhibit 5.1

Exhibit 5.1 – Summary of Recommendations

Recommendation	Department's Response	Target Date for Implementation
5.78 We recommend, in order to optimize decisions and reduce long term costs from asset management, the Department prioritize the addition of all significant asset categories not currently modeled in the system with timelines for their inclusion.	*The Department will develop a plan to incorporate other assets into the Asset Management System, prioritized based on value and risk.*	*September 2013*
5.83 We recommend the Department report on roads that are in very poor condition and develop optimization targets specific to that category of roads within the Asset Management System.	*The Department will assess the value of using very poor roads as a performance measure.*	*April 2013*
5.89 We recommend the Department further enhance the Asset Management System to incorporate non-road condition based factors such as traffic counts, safety indicators, and environmental concerns that significantly impact project selection.	*The Department will include these factors as part of its continuous improvement program in a phased approach.*	*2013-2015*
5.114 We recommend the Department establish guidelines to govern projects selected outside the Asset Management System and document the rationale and benefits of these projects against the Asset Management System optimization criteria.	*The Department will carry out a process review to establish guidelines as deemed necessary.*	*September 2013*
5.115 We recommend the Department, in its annual report, communicate the implications of selecting and completing projects that do not meet Asset Management System optimization criteria.	*The Department will review the Annual Report and communicate compliance with the asset management objectives.*	*2012-2013 Annual Report*

Exhibit 5.1 – Summary of Recommendations (continued)

Recommendation	Department's Response	Target Date for Implementation
5.118 We recommend the Department provide sufficient training for additional staff to be competent in utilizing the Asset Management System. Training should include, but not be limited to, knowledge of optimization process rules.	*The Department is pursuing training of additional staff.*	*April 2013*
5.126 We recommend the Department complete the Road Surface policy (a policy that will guide decisions regarding the most appropriate and economical road surface given particular circumstances (i.e. chip seal versus asphalt)). Once complete, we recommend the Department incorporate the road surface selection process into the Asset Management System optimization model.	*The Department has completed the Road Surface Policy and will be presenting it to government for approval.*	*April 2013*
5.130 In order to ensure sustainability of the Province's highway network at the most economical cost, we recommend the Department include total lifecycle costs in all new road construction decisions. We also recommend the Department obtain statutory funding when the decision is made to add new roads (similar to Public-Private Partnership highway projects).	*The Department is developing a 15-year Strategic Infrastructure Plan that will incorporate a framework for new infrastructure project decisions that includes long-term maintenance and rehabilitation lifecycle costs for future funding considerations.*	*December 2013*
5.179 We recommend the Department develop effective program performance measures for its stated goals and objectives that include specific, relevant targets against which performance can be measured.	*The Department has incorporated performance measures as part of our balanced scorecard and is committed to reviewing these measures on an annual basis.*	*2012-2013 Annual Report*

Exhibit 5.1 – Summary of Recommendations (continued)

Recommendation	Department's Response	Target Date for Implementation
5.180 We recommend the Department's annual report clearly state the overall highway network condition by kilometer in each condition category the Department uses, (currently very good, good, fair, and poor), with the intent of highlighting the short, medium, and long term impacts of not following Asset Management System projected funding recommendations. We further recommend the Department report the level of infrastructure debt caused by deferred capital maintenance in order to present a complete picture of the highway network status and the risk to safety and sustainability.	*The Department will enhance the annual report to include a comprehensive asset management overview.*	*2012-2013 Annual Report*

Background

5.33 The Department is responsible for the maintenance and repair of approximately 19,650 kilometers of designated provincial highways, 84% of which are paved surfaces with either Asphalt Concrete (Asphalt) (37%) or Aggregate Seal Coat (Chip Seal) (47%). Maintaining the New Brunswick (NB) highway network in an acceptable condition requires a significant taxpayer investment. This is a challenge given the Province's limited resources.

5.34 The NB highway network is divided into three primary categories: arterials, collectors and locals. The arterial highway system totals over 2,000 kilometers or 12% of all provincial highways but handles 70% of the total vehicle-kilometers driven on the system outside urban areas. Collectors feed traffic from the local highways into the arterial highway network.

Timely Maintenance Maximizes the Lifespan of the Highway Network

5.35 Timely maintenance maximizes the lifespan of highways and is essential if the taxpayers' investment is to be optimized (i.e. maintenance is done at a time when the dollars spent will have the greatest restorative impact on road condition). The Province is facing the challenge of maintaining both new and

existing infrastructure while addressing the replacement and rehabilitation requirements of its aging infrastructure.

5.36 Maintenance activities carried out by the Department can be categorized as ordinary and capital. Both are important components of highway preservation in New Brunswick.

5.37 Ordinary maintenance includes regular maintenance activities such as brush cutting and surface patching that is meant to maintain the road at current condition. Investment in ordinary maintenance can lower capital maintenance cost.

Capital Maintenance Extends the Service Life of Highway Assets

5.38 Capital maintenance includes larger scale resurfacing, rehabilitation, and reconstruction activities that are meant to significantly improve road condition and extend the service life of the asset. The Department generally defines this work as rehabilitation.

Example of Impacts of Poor Road Condition

5.39 In doing preliminary research for this review, we noted the following newspaper headline:

"$1M MRI unit damaged after truck hits pothole"

(CBC News, March 2012)

5.40 Road surface rutting and vehicle hydroplaning are among the many indicators of road deterioration and the damage to the MRI unit provides one example of the importance of adequately maintaining our roads.

5.41 Due to the damage sustained, the MRI unit in this article did not function correctly and resulted in the loss of services to people in the areas of Miramichi, Bathurst and Campbellton.

The Department's Traditional Approach to Repairing Roads was Unsustainable

5.42 Due to an increasing proportion of mature or older pavement, the Department determined in 2002 that it needed to use a radically different approach to manage NB roads since their traditional approach of repairing the worst roads first was unsustainable. The Department chose to develop a strategic framework based on the principles of asset management.

Asset Management

5.43 "Asset management is a comprehensive business strategy employing people, information and

technology to effectively and efficiently allocate available funds amongst valued and competing assets"

[Transportation Association of Canada, 1999]

5.44 The Department's Asset Management Business Framework was started in 2005 and fully implemented in 2008.

5.45 According to the Department's 2010 Asset Management Highway Infrastructure plan the purpose was to:

"provide a more strategic approach to long term, sustainable investment planning and program management. This will enable better decision-making by identifying the appropriate timing for the most effective and economical treatment based on long term, least life cycle costs taking into consideration the transportation infrastructure network to achieve optimal performance within annual budgets."[7]

5.46 In a 2011 presentation to government, the Department indicated that the objectives of asset management are:

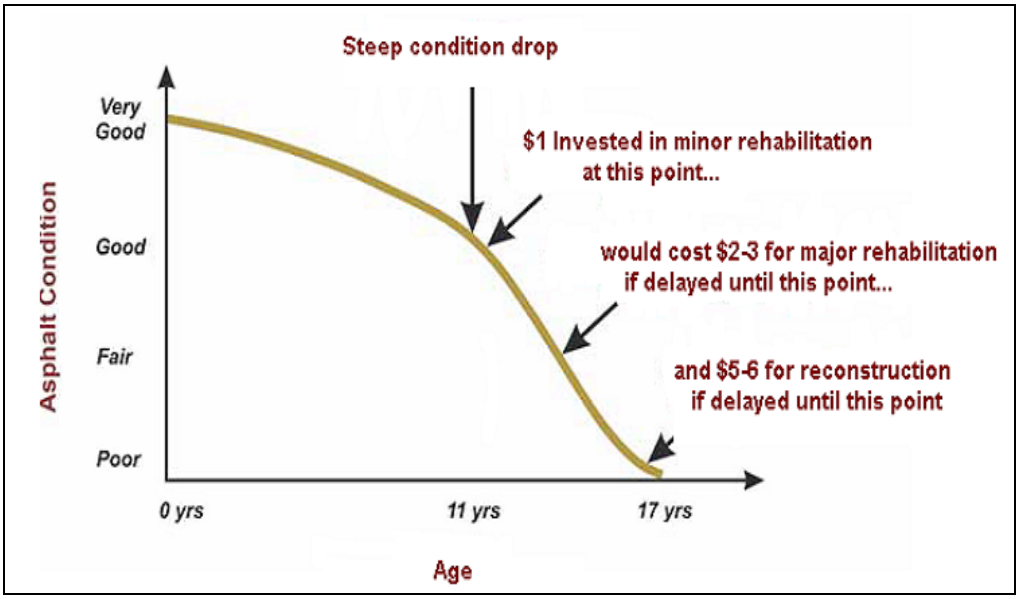
- to look at assets over the long term with the goal of minimizing investment costs over the life of an asset (least life cycle cost);
- to predict how assets will change over time; and
- to select best treatment strategies to use to minimize the cost of maintaining the asset at an acceptable standard.

5.47 For more information on Asset Management refer to Appendices II and III.

[7] New Brunswick Department of Transportation and Infrastructure, "Asset Management Highway Infrastructure Plan 2010-2014", (Province of New Brunswick), October 2010, page i.

Exhibit 5.2 – The Premise Behind Asset Management

EXHIBIT 5.2	THE PREMISE BEHIND ASSET MANAGEMENT



Source: Department of Transportation, "New Brunswick Road Infrastructure Plan (2008-2011) ", p.4 (unaudited).

The Increasing Cost of Deferred Capital Maintenance

5.48 Exhibit 5.2 shows the relationship between the age of a typical highway and its condition. It also shows the financial impact of deferring maintenance activities past the optimal point of completion.

5.49 As an asset ages the condition deteriorates at an accelerated rate, resulting in higher costs. The longer the delay in maintenance treatments, the higher the total cost.

5.50 In other words, as an asset ages there are key points in time where an intervention can affect its condition. The timing of the intervention affects the cost of the treatment. The further a treatment is delayed, the higher the cost to repair.

The Cost of Maintenance Can Increase Significantly Over a Short Timeframe

5.51 Treatments refer to maintenance activities completed on roads to address condition issues. The difference in treatment cost can grow significantly within a short time frame. As Exhibit 5.2 illustrates, spending $1 at the right time to keep a road in good condition can prevent spending $5-$6 a few years later to reconstruct it once it has fallen into poor condition.

5.52 Treatment costs vary considerably based on the surface type and the maintenance activity required. The Department estimates the cost of treatments to chip seal highways ranging from $33,000 to $76,000 per kilometer. [8]

5.53 The treatment cost for asphalt highways is highly dependent upon the type of activity required. The following are costs identified in a Technical Memorandum prepared for the Department by a consultant in 2007[9]:

- Minor rehabilitation is the 1st level of treatment. Costs range from approximately $50,000 to $200,000 per kilometer treated.
- Major rehabilitation is the 2nd level of treatment. Costs range from approximately $300,000 to $400,000 per kilometer treated.
- Reconstruction is the 3rd level of treatment. Costs range from approximately $350,000 to $500,000 per kilometer treated.

5.54 For more information on maintenance treatment categories see Appendix VI.

Exhibit 5.3 Examples of Road Categories

GOOD	FAIR	POOR

Source: Picture provided by the Department of Transportation and Infrastructure

[8] Department of Transportation and Infrastructure, "Asset Management Plan: Pavements", (Province of New Brunswick), April 2012, p.30.
[9] Ibid

The Condition of the NB Highway Network

5.55 The Department uses four general categories to describe overall road condition: very good, good, fair, and poor. Exhibit 5.3 shows examples of these conditions. Each of these categories corresponds to a range of values on three technical condition indices. For more information on condition categories and technical indices see Appendix V.

Scope & Methodology

5.56 Our work included a review of legislation, policy, and guidelines governing the capital maintenance programs. We also reviewed project, technical, and other Departmental documentation on capital maintenance, asset management, and performance reporting. We held discussions with Departmental staff and attended a demonstration of the Asset Management System. We performed other procedures as we determined necessary.

5.57 We contracted an expert in the field of infrastructure asset management to provide assurance the Asset Management System was credible and based on sound engineering science and modeling methodology.

5.58 This chapter focuses on capital maintenance of the New Brunswick highway network. Capital maintenance is work completed with the intent to extend the life of the highway network assets. Work completed with the intent to maintain the current condition of the asset is considered ordinary maintenance and was not included in this review.

5.59 Our work encompassed designated highway infrastructure that is part of the Asset Management System inventory and optimal project selection process. It did not include, for example, roads that are part of Public-Private Partnership highway agreements, provincially designated highways within municipalities, or other significant provincial assets such as bridges and buildings.

5.60 The Department has undergone a name change. Documentation used in this review often references the Department of Transportation. The current name for the Department is Transportation and Infrastructure.

Detailed Observations

5.61 To review this topic area, we developed three criteria to use as the basis for our work. We compared the evidence we obtained against the criteria to develop the observations, conclusions and recommendations presented in this chapter. Our criteria were:

1. The Department should identify current and future capital road repair requirements in accordance with its vision of a safe, sustainable transportation network;

2. The Department should make capital road repairs at the optimal time to minimize investment cost while preserving the assets at an acceptable standard; and

3. The Department should measure and report the effectiveness of its work for capital road repairs.

The criteria were reviewed with, and agreed upon by the Department.

Criterion 1: The Department Should Identify Repair Requirements

5.62 In its 2010 -11 annual report, the Department stated its vision is a "safe, sustainable transportation network to support the economic and social goals of the Province of New Brunswick."

5.63 The responsibility for roads is shared among governments. Outside municipal boundaries, the Province has full authority over matters related to road transportation. New Brunswick's transportation infrastructure is aging and, as a result, maintenance costs are increasing.

5.64 The *Highway Act* provides the Minister of Transportation and Infrastructure the authority to construct and maintain the designated highway infrastructure in New Brunswick.

The use of Asset Management Methodology

5.65 The Asset Management Business Framework is a broad framework to guide the Department's decision making processes at various levels. The Asset Management System (AMS) is the technical foundation of this framework. It is comprised of the systems and software used to manage and model the road condition data that identifies optimal maintenance project selections.

The Asset Management System (AMS) is a Good Strategic Tool.

5.66 The principles underlying the Department's AMS appear sound. They are based on solid mathematical and engineering principles, using advanced modeling tools to achieve the optimization of investments. The system was designed for the Department by Information Technology experts in the field and contains the necessary components to meet its intended objectives.

5.67 The AMS has flexibility in that it is adaptable to new circumstances. Assets can be added to the databases as required, variables used to determine the optimal project candidate list can be changed, and cost data used for projections can be updated. This allows the Department to adjust to a changing operational environment and expand the system by building in parameters such as traffic counts, environmental factors, and safety indicators.

5.68 The AMS provides a technology driven framework to optimize highway investments. The Department uses this system to prepare strategic (20 year), tactical (4 year) and operational (annual) plans for capital maintenance to roads.

5.69 The AMS optimization model completes an objective comparison of different investment decisions that can have different service lives, performance, and associated costs. By understanding a pavement's life cycle, the Department can perform the right treatment, at the right place, and at the right time.

The Asset Management System is Reliable for Predictive Modeling

5.70 We are satisfied from the work performed by the consultant that the predictive modeling capability of the system is reliable given the scope and context of this review. For a summary of the consultant's conclusions please refer to Appendix IV.

Concerns Regarding the Department's use of the Asset Management System

5.71 While we believe the AMS to be a reasonably accurate and reliable predictive modeling tool to identify optimal capital maintenance projects at the lowest cost, in the following paragraphs we have highlighted areas of concern that the Department should address to ensure that asset management is utilized at maximum potential. Below is a summarized

list of our concerns:

- significant assets are not included in the system;
- the AMS does not report on "very poor" roads;
- other factors in addition to road condition should be included in the AMS model;
- 40% of the projects selected for completion in the following construction season are not recommended through the Asset Management Capital Planning process;
- limited personnel have knowledge of AMS modeling in the Department;
- choice of road surface type (gravel, chip seal, asphalt) is not part of the AMS optimization model; and
- new road construction can negatively impact sustainability of the highway network.

Significant Assets Are Not Included in the Asset Management Optimization Program

5.72 A key component of the AMS is the asset data. The asset data is used to generate information on current condition and, through statistical analysis, predict the future condition of the highway network. However, not all assets are part of the optimization model.

5.73 Currently, the AMS models asphalt and chip seal surface designated highways only, and excludes provincially designated highways within municipalities as well as the highways built under Public-Private Partnership agreements.

5.74 The Department indicated that Public-Private Partnership constructed highways already have asset management strategies in place as these were required in the original construction contracts. These included future maintenance costs as part of their contracts with private sectors proponents.

5.75 The Department is not responsible for maintenance of roads within municipal boundaries with the exception of designated highways within municipalities. These are not currently included in the AMS due to additional infrastructure components such as curb and drainage systems that the AMS is not

programmed to model.

5.76 In addition to the provincially designated highways within municipalities, we noted the Department has not yet included other significant assets such as ferries and large culverts into the optimization process.

5.77 By not including and modeling assets of significant value in the AMS, the Department is not fully utilizing the system and may be making non-optimal and more costly "fix the worst first" maintenance decisions on these assets.

Recommendation

5.78 We recommend, in order to optimize decisions and reduce long term costs from asset management, the Department prioritize the addition of all significant asset categories not currently modeled in the system with timelines for their inclusion.

The AMS does not Report on "Very Poor" Roads

5.79 Level of service represents the Departmental targets for the condition of the overall highway network. In the AMS the level of service is linked to road condition only and this is expressed in terms of general condition levels as very good, good, fair, and poor.

5.80 Reporting road condition by general categories is consistent with other jurisdictions. Each of these four categories is defined against accepted technical indices such as the international roughness index. Please refer to Appendix V for more information.

5.81 The AMS has, within the "poor" roads classification a sub-category called "very poor" roads. This category of roads is not reported separately and is not well defined. Although an original goal of the AMS was to reduce the "very poor" roads across the highway network, the system was modeled to maintain, as a minimum, the status quo for "poor" roads.

5.82 We were informed by the Department that a long-term goal of the asset management plan was to eliminate all roads in very poor condition over a 12-year period but this timeline has shifted since 2008.

This goal is not properly described in the technical or policy documentation reviewed.

Recommendation

5.83 We recommend the Department report on roads that are in very poor condition and develop optimization targets specific to that category of roads within the Asset Management System.

Other Factors in Addition to Road Condition Should be Included in the AMS Model

5.84 In the AMS, the level of service target is based on road condition and is set to "non-declining", meaning that the system will model to maintain the status quo. In particular, the target level of service set in the AMS for paved roads in 2008 was to halt any increase in the percentage of roads in poor condition across the highway network.

5.85 The Department explained this is the minimum acceptable result set within the AMS optimal program and, although the target is set to maintain the kilometers of roads in poor condition, the intent is to gradually increase the overall condition of the entire highway network in the long term.

5.86 It is our understanding that prioritization criteria other than road condition are considered during the final project approval process that determines the Capital Program (capital maintenance plan) for the upcoming construction season. For example, highway safety, traffic volumes, economic development, and environmental concerns are all considered before the final capital maintenance plan is complete.

5.87 The Department confirmed that the AMS has the capacity to model on many of these other factors but at this time does not do so. The Department has identified these system enhancements as a continuous improvement project, but has set no target date for its completion.

5.88 To further refine the AMS modeling capability, we believe the Department needs to incorporate factors such as those noted above that impact project selection into the optimization program.

Recommendation

5.89 We recommend the Department further enhance the Asset Management System to incorporate non-road condition based factors such

as traffic counts, safety indicators, and environmental concerns that significantly impact project selection.

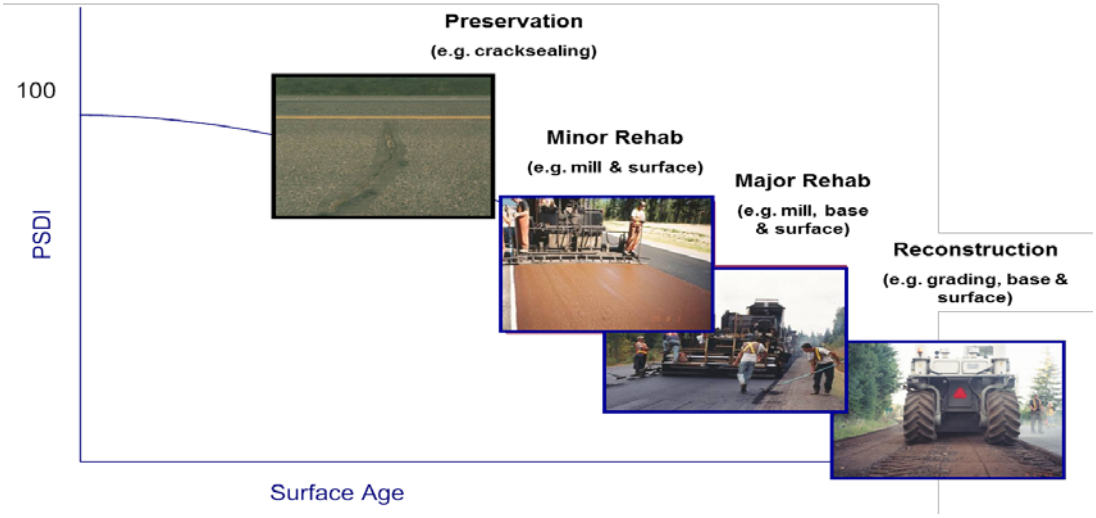
Process for Development of the Project Candidate List

5.90 As noted above, the desired level of service based on road condition is the primary factor considered in the selection of maintenance projects by the AMS.

5.91 At the strategic level, the system determines the required maintenance treatment for a section of highway and when it should be applied. It considers highway condition factors such as age and deterioration to identify a specific window of time that any treatment must be applied before it will require a more costly treatment (as highlighted previously in Exhibit 5.2). The AMS uses industry standard rules for defining what interventions are best within these windows of opportunity to optimize investments.

Exhibit 5.4 – Windows of Opportunity for Timely Capital Maintenance

EXHIBIT 5.4	**WINDOWS OF OPPORTUNITY FOR TIMELY CAPITAL MAINTENANCE**



Notes

PSDI is the percentile measure of the Surface Distress Index (see Appendix V for more information on Surface Distress Index)

Rehab means rehabilitation

Source: New Brunswick Department of Transportation, "Maintenance/Rehabilitation Requirements NBDOT Infrastructure (presentation)", October 27, 2011, Slide 33 (unaudited).

5.92 Exhibit 5.4 illustrates the concept of opportunity windows. As an asset ages and deteriorates, the maintenance required to return the asset to a specified quality level will increase, as will the cost of the

treatment. As Exhibit 5.4 shows, as an asset ages it slides down the condition curve and into more costly maintenance windows.

5.93 The AMS selects projects for maintenance treatments at a specific point within the opportunity window to minimize the total cost. To that end, it creates a candidate list of possible capital maintenance projects that are optimal for cost minimization over a 20-year period.

5.94 The Department indicated that the list generated by the AMS does not include all possible candidate projects that meet the optimization criteria. The program stops once its quota of optimal candidate projects is reached but it could produce significantly more. The Department told us that they cannot address the projects currently produced due to resource constraints so producing a longer list has little value.

5.95 Since this list of candidates is used for selecting projects, it is possible some projects will be missed.

40% of the Maintenance Projects Chosen for Completion are not Recommended Through the Asset Management Capital Planning Process

5.96 Once the modeling program has identified the optimal projects, a list of these candidates is generated from the system. This candidate list is used as the foundation for the development of the four year plan and the annual Capital Program (capital maintenance projects to be completed).

5.97 Department staff from district offices and the Construction, Planning, and Design branches assess the list of candidate projects while considering other factors that are not part of the AMS modeling program. The result of this annual Asset Management Capital Planning process is a proposed Capital Program for the upcoming construction season.

5.98 Among the factors considered in the development and approval of the Capital Program:

- traffic demand;
- condition rating;
- costs;
- accidents;
- district priorities;
- administrative boundaries;

- operational logistics;
- investment targets; and
- Member of the Legislative Assembly (MLA) requests

5.99 Upon completion of the Asset Management Capital Planning process the proposed Capital Program is forwarded to the Design branch for executive review and approval. The result of that review determines the final Capital Program to be carried out on roads and highways in the Province. This final approval process may be further influenced by some or all of the same factors considered in the development of the proposed program.

5.100 In 2008, the Department set a target for the final approved Capital Program at 80 % based on the Asset Management Capital Planning process recommendations and 20% from other sources. Currently, the Department has achieved an approximate 60/40 ratio, meaning that 40% of the final projects approved by Senior Management for completion are not recommended through the Asset Management Capital Planning process.

5.101 Although most of the factors highlighted above relate to budgetary, technical, or safety concerns and require attention, we believe that during the final approval phase of the Capital Program there is a risk that non-optimal considerations may influence the choice of capital maintenance projects as well.

5.102 When considering such factors as district priorities and MLA requests the Department may be influenced by non-condition related variables such as economic and social development, industry considerations, and political activism. While economic, social, and industry considerations could be expected to impact project choice, the Department clearly believed that asset management would “take the politics out of

paving"[10].

5.103 A 2010 paper co-authored by key Departmental staff involved in the AMS implementation stated, "Because the consequences of deviating from the optimized path can be easily quantified and communicated to stakeholders, politics has largely been removed from the decision-making process."[11]

5.104 However, we were told it is a long standing practice for Members of the Legislative Assembly to make requests to the Department for capital maintenance and repair projects.

5.105 We asked for and received from the Department a document of government priorities that impacted project selection in 2011-12 and will likely influence project selection in 2012-13. The document contained 48 MLA requests for work on asphalt roads and 31 MLA requests for work on chip seal roads.

5.106 Although we could not specifically identify which of the MLA requests have been completed, we confirmed with the Department that at least some of these had been included in the 2011-12 Capital Program. Some are also on the 2012-13 proposed project list.

5.107 We reviewed the final project plans for both 2011-12 and 2012-13 with Department staff for two programs:

- Permanent Highways; and
- Rural Road Initiative.

When these lists were compared with the recommendations from the Asset Management Capital Planning process we identified a number of projects on the approved project plan that were not on the project recommendation lists.

[10] Op. cit., Feunekes, p. 23
[11] Ibid., p. 23

5.108 For these two programs we found that 18 of 27 (66%) projects approved in 2011-12 were based on recommendations from the Asset Management Capital Planning process, while 9 of 27 (33%) were not.

5.109 When we reviewed a list of proposed projects for 2012-13 in the same programs, we found that 24 of 39 (62%) were in agreement with the recommended project list while 15 of the 39 (38%) were not.

5.110 In speaking with the Department we learned that the original goal of selecting 80% of all projects from the list of projects recommended through the Asset Management Capital Planning process has now slipped to actual results of approximately 60%.

5.111 We asked the Department if the projects selected outside of the AMS optimal project candidate list would have met the AMS optimization criteria and they indicated that they do not verify that the non-system selected projects are optimal prior to completion.

5.112 We believe there should be guidelines established to govern the inclusion of non-road condition based factors, such as those noted above, to ensure there is a clear link between these projects and the Department's overall goals and objectives.

5.113 In addition, since the purpose of using the AMS is to identify optimal projects to minimize life cycle cost, we believe the Department should clearly identify, document, and communicate to government the implications of completing projects that do not meet AMS optimization criteria.

Recommendations

5.114 We recommend the Department establish guidelines to govern projects selected outside the Asset Management System and document the rationale and benefits of these projects against the Asset Management System optimization criteria.

5.115 We recommend the Department, in its annual report, communicate the implications of selecting and completing projects that do not meet Asset Management System optimization criteria.

Limited Personnel Have Knowledge of AMS Modeling in the Department

5.116 The AMS system is complex. The linear programming model is updated on a three year cycle but the system is used regularly in the project planning processes and for budgeting purposes.

5.117 A single individual within the Department is most knowledgeable about the AMS. We believe this presents a high risk to the Department since the loss of that person would create a void difficult to fill in the short and possibly medium terms.

Recommendation

5.118 We recommend the Department provide sufficient training for additional staff to be competent in utilizing the Asset Management System. Training should include, but not be limited to, knowledge of optimization process rules.

Choice of Road Surface Type (gravel, chip seal, asphalt) is not Part of the AMS Optimization Model

5.119 The level of service selected aims to maintain the physical condition of categories of roads in the highway network at certain levels of quality. We understand there are sometimes pressures to change the type of roadway surface, for example from unpaved (gravel) to surface treated or from surface treated to asphalt pavement.

5.120 Consultants contracted by the Department completed a technical report in June of 2011 to support the Department's development of a "road resurfacing policy" that would guide the Department in road surfacing decisions.

5.121 The report looked at the processes used in other jurisdictions for deciding what surface is optimal for a roadway in order to develop the screening criteria the Department would use in their policy.

5.122 Some significant findings from the consultant's report included[12]:

- The greatest potential cost savings of the proposed road surfacing policy are most likely to result from

[12] Department of Transportation and Infrastructure, "New Brunswick Road Surfacing Policy – Background Technical Document", June 30, 2011, p.36.

the conversion of existing asphalt roads to a treated (i.e. chipseal) surface.

- The proposed policy would reduce NBDoT's [New Brunswick Department of Transportation's] pavement rehabilitation costs by an estimated $92 million over the next 20 years, or $4.6 million annually (undiscounted 2011 dollars).

5.123 The Department has a draft policy that reflects the process outlined in the consultant's report.

5.124 We believe if the Department intends to finalize this policy for decision-making on project work, it should be incorporated into the AMS model.

5.125 Changing the road surface from one type to another and calculating the associated costs and benefits is not a function currently included in the AMS optimal modeling program. This would require the inclusion of non-road condition based criteria such as traffic counts, operation and maintenance costs, and economic impacts.

Recommendation

5.126 We recommend the Department complete the Road Surface policy (a policy that will guide decisions regarding the most appropriate and economical road surface given particular circumstances (i.e. chip seal versus asphalt)). Once complete, we recommend the Department incorporate the road surface selection process into the Asset Management System optimization model.

New Road Construction can Negatively Impact Sustainability of the Highway Network

5.127 The Asset Management Business Framework is a strategy that focuses on the Department's goal of maintaining a sustainable NB highway network. We believe this goal is negatively impacted by new highway infrastructure development that does not take into account the future costs of capital maintenance through the application of the least lifecycle costing methodology.

5.128 New road construction, other than specific projects undertaken as Public-Private Partnerships, does not typically take into account future capital maintenance costs based on least lifecycle cost analysis when funding is appropriated. This results in a lack of reserved or statutory funding to address future costs.

Since current maintenance activities are experiencing a funding shortfall, new road construction can only worsen the situation.

5.129 In order to mitigate the impact of new road development on highway network sustainability, we believe the Department should complete full life cycle costing on new infrastructure projects and request funding at appropriate levels to ensure sustainability of these new assets.

Recommendation

5.130 In order to ensure sustainability of the Province's highway network at the most economical cost, we recommend the Department include total lifecycle costs in all new road construction decisions. We also recommend the Department obtain statutory funding when the decision is made to add new roads (similar to Public-Private Partnership highway projects).

Criterion 2: The Department Should Optimize the Timing of Capital Road Repairs

5.131 The goal of asset management is the timely completion of capital maintenance and repairs in order to minimize cost while preserving assets at an acceptable level of service.

5.132 Under the pre-AMS "fix the worst first" methodology the highway network condition was rapidly deteriorating.

5.133 The AMS is designed to provide a list of capital maintenance projects to be addressed over a 20 year span per the least life cycle cost methodology. Although this appears to be a sound process, unless the Department can complete the capital maintenance as prescribed by the AMS, optimal results cannot be achieved.

Factors Affecting Highway Condition

5.134 Completing required capital maintenance is essential to preserve the condition of the highway network, minimize safety risk to users, and protect the public investment.

5.135 Age, weather, moisture, traffic volume, and vehicle weight are among the factors that affect the deterioration rate of roadways. These factors, combined with poorly timed maintenance activities, ultimately lead to more expensive maintenance

treatments such as rehabilitation and reconstruction.

5.136 New assets have a relatively slow rate of deterioration but without proper preventative maintenance the deterioration rate accelerates. As shown in Exhibit 5.2, as an asset deteriorates the cost of treatments to rehabilitate increase significantly, to the point where the only option is reconstruction.

5.137 The Department decided that the best way to address these risks was to invest in asset management. This decision led to an initial three year request for a substantial funding increase in 2008.

The Initial Investment in Asset Management met the Department's Objective

5.138 An initial long-term objective of the Department in 2008, through the use of the AMS optimal model, was to reduce the number of "very poor" roads in the highway network. The AMS 20-year strategic plan created the list of optimal projects that would accomplish this and the projected funding required.

Exhibit 5.5 – DTI Program Funding (Actual and Budgeted - $ Millions)

EXHIBIT 5.5	**DTI PROGRAM FUNDING (ACTUAL AND BUDGETED - $ MILLIONS)**							
	Actual Expenditures						**Budget**	
Program	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Permanent Highways	57.2	61.6	56.9	134.2	143.4	142.2	62.0	66.4
Rural Road Initiative	40.1	40.1	25.7	44.7	49.2	51.9	41.0	38.0
Totals	97.3	101.7	82.6	178.9	192.6	194.1	103.0	104.4

Sources:

Actual Expenditures are from Government of New Brunswick *Public Accounts*.

Budget represents forecasted budget supplied by the Department of Transportation and Infrastructure (DTI) (unaudited).

5.139 As illustrated in Exhibit 5.5, the actual expenditures for 2008-09 through 2010-11 were significantly higher than those of previous years. This was possible due to increased funding during those years approved by government. The Permanent Highways and Rural Road Initiative programs provide the majority of the funding for capital maintenance of assets treated under asset management.

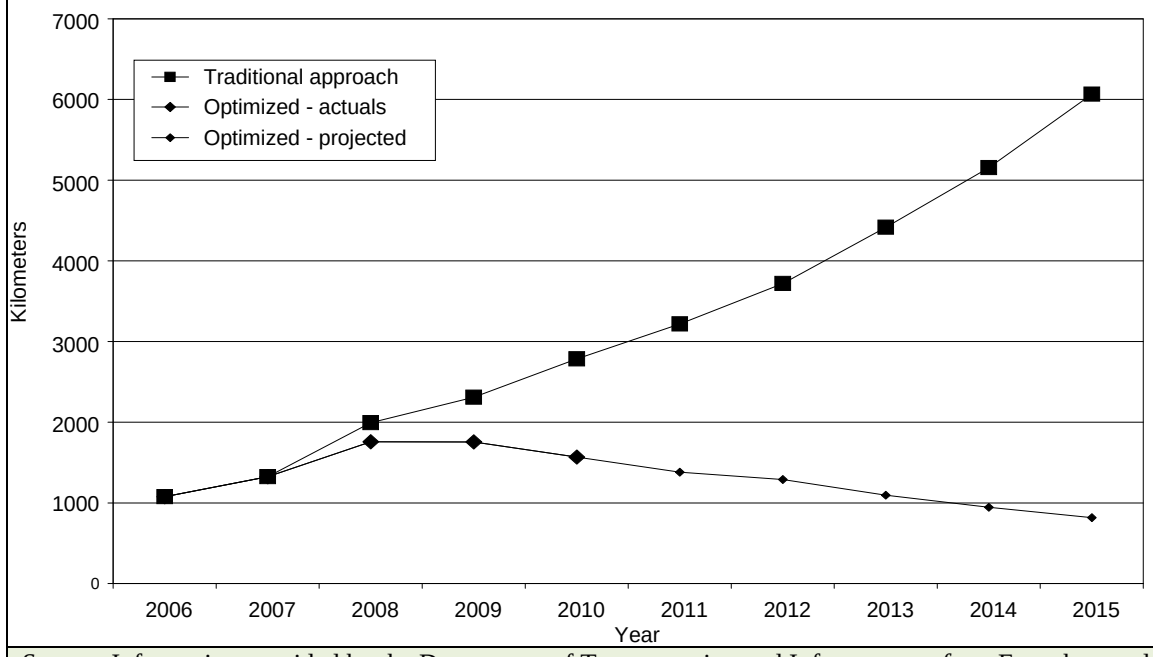
5.140 The Department received this increased three year budget commitment from government based on the

required budget projected by the AMS to meet the Asset Management plan for 2008-09, 2009-10, and 2010-11. The 2008-09 Permanent Highways program funding level represented an approximate 155% increase over the 2007-08 budget for capital maintenance. The Rural Road Initiative funding increased by approximately 120% over that same period.

5.141 By receiving this funding increase, the Department had an opportunity to demonstrate the value of using the AMS for optimal project selection. By comparing the highway network condition after 2010-11with the highway network condition in 2008-09, they were able to highlight the strengths of the AMS.

Exhibit 5.6 – Poor Roads – Original (2008) AMS Optimal Plan Versus Traditional Approach

EXHIBIT 5.6 **POOR ROADS – ORIGINAL (2008) AMS OPTIMAL PLAN VERSUS TRADITIONAL APPROACH**



Source: Information provided by the Department of Transportation and Infrastructure *from* Feunekes et al., "Taking the Politics out of Paving, Achieving Transportation Asset Management Excellence through OR (Operations Research)", p. 21 (unaudited).

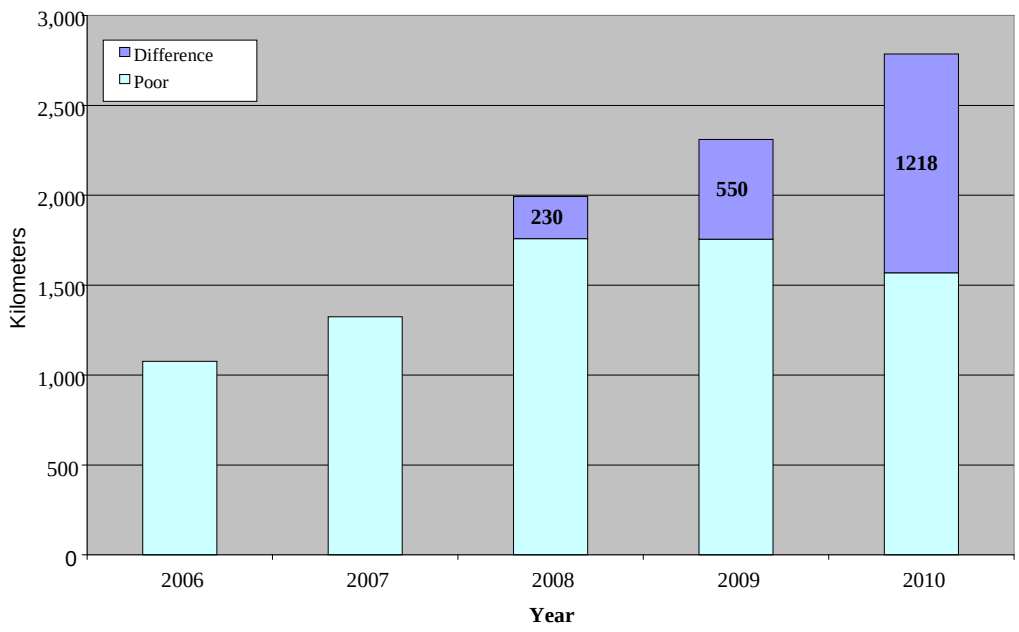
5.142 The graph in Exhibit 5.6 highlights the success of following the asset management recommendations from 2008 to 2010. The graph compares the number of kilometers of poor roads in each year under the AMS optimal approach and the traditional approach.

The actual results using AMS optimal recommendations with the increased funding are shown on the lower line between 2008 and 2010.

5.143 The lower, downward sloping line (from 2010 to 2015) represented the projected kilometers of poor roads using the original 2008 asset management recommendations with optimal funding levels maintained. These projections have changed since 2008 but the overall trend when compared to the traditional methodology highlights the potential benefit of using asset management at optimal funding levels. The upward sloping line represents the projected kilometers of poor roads under the traditional approach.

Exhibit 5.7 – Kilometers of poor roads declined over three year period

EXHIBIT 5.7 KILOMETERS OF POOR ROADS DECLINED OVER THREE YEAR PERIOD



Source: New Brunswick Department of Transportation, "NBDOT Road Infrastructure Plan 2008-2011 – Results and Benefits", January 2010, p.7 (unaudited).

5.144 Exhibit 5.7 shows the kilometers of poor roads that would have been added to the highway network (the numbered sections) in 2008, 2009, and 2010 had the Department followed the "fix the worst first" methodology of previous years and not been provided

with additional funding. The Department indicated that more than 1,200 km of roads were prevented from falling into the poor category by using asset management in contrast to the "fix the worst first" approach.

Exhibit 5.8 – Increase in KM of Asphalt Roads Treated Under AMS

EXHIBIT 5.8	**INCREASE IN KM OF ASPHALT ROADS TREATED UNDER AMS**		
Age of road (years)	**Pre-AMS (2005/06 – 2007/08)**	**Asset Management (2008/09 – 2010/11)**	**Net Difference**
9 – 16 (Good to Fair)	154	592	+ 438
17 – 24 (Fair to Poor)	178	206	+ 28
25 + (Very Poor)	93	158	+ 65
Total	425	956	+ 530
Source: New Brunswick Department of Transportation, "NBDOT Road Infrastructure Plan 2008-2011 – Results and Benefits", January 2010, p.6 (unaudited).			

5.145 Exhibit 5.8 shows that the kilometers of asphalt surfaced roads treated from 2008-09 through 2010-11 was 530 kilometers greater than those completed in the three years prior to asset management.

Exhibit 5.9 – Increase in KM of Chip Seal Roads Treated Under AMS

EXHIBIT 5.9	**INCREASE IN KM OF CHIP SEAL ROADS TREATED UNDER AMS**		
Treatment	Pre-AMS (2005/06 – 2007/08)	Asset Management (2008/09 – 2010/11)	Net Difference
Reseal	1490	2020	+ 530
Double seal	150	380	+ 230
Total	1640	2400	+ 760
Source: New Brunswick Department of Transportation, "NBDOT Road Infrastructure Plan 2008-2011 – Results and Benefits", January 2010, p.6 (unaudited).			

5.146 Exhibit 5.9 shows the total kilometers of chip seal roads treated was 760 kilometers greater under asset management than the preceding three years. Chip seal roads that require the more expensive double seal treatment are deteriorated to a greater degree than those that are resealed at less cost.

5.147 The Department indicated that employing asset management principles with optimal funding resulted in more kilometers of roads being treated than would have occurred under the traditional approach. The Department modeled these projects in the AMS under the traditional "fix the worst first", non-optimal

methodology to substantiate this conclusion.

Current Funding does not Support the AMS Objectives

5.148 The Department presented their capital budget requirements to government for approval based on AMS projections for a four-year period, 2011-12 through 2014-15. The commitment from government was significantly less than what the Department requested.

5.149 Significant reductions in current funding threaten to reverse the Department's achievements under the Asset Management Business Framework. As shown in Exhibit 5.10, Departmental projections indicate increasing deterioration of the highway network should funding remain at this level.

Exhibit 5.10 – Forecasted Capital Maintenance Budget Over Four Years (millions)

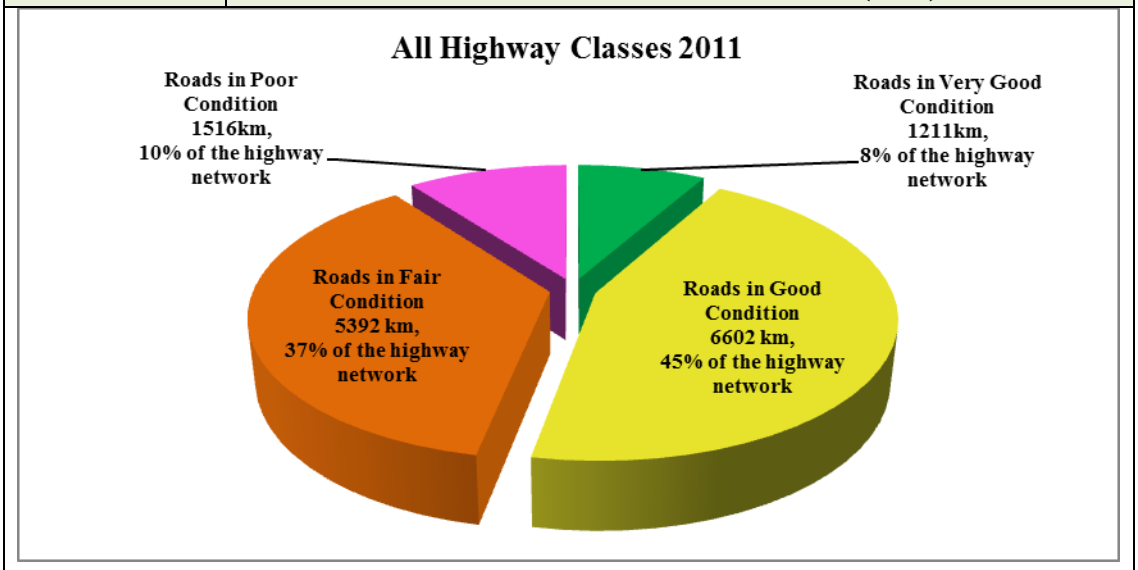
EXHIBIT 5.10	**FORECASTED CAPITAL MAINTENANCE BUDGET OVER FOUR YEARS (MILLIONS)**			
	2011-12	**2012-13**	**2013-14**	**2014-15**
Paving Arterials	$ 10.0	$ 9.0	$ 8.1	$ 9.8
Paving Collectors	6.0	9.0	8.0	8.0
Chip Seal	26.0	23.0	25.0	27.0
Surface Rehab Locals	10.0	10.0	10.0	10.0
Totals	$ 52.0	$ 51.0	$ 51.1	$ 54.8
Source: Table created by Office of the Auditor General of New Brunswick with budget information provided by the Department of Transportation and Infrastructure (unaudited).				

5.150 Exhibit 5.10 highlights the 2011-12 budget and the Department's budget forecast over the entire four-year period under applicable sections of the Permanent Highways and Rural Road Initiative programs. These funding levels are similar to those that existed prior to asset management, a period during which the condition of provincial roads was progressively deteriorating.

5.151 This reduction will make it difficult for the Department to continue implementing asset management recommendations and will result in significantly worsened highway conditions and future long-term increased costs.

Exhibit 5.11 – Condition of the Highway Network (2011)

EXHIBIT 5.11 CONDITION OF THE HIGHWAY NETWORK (2011)



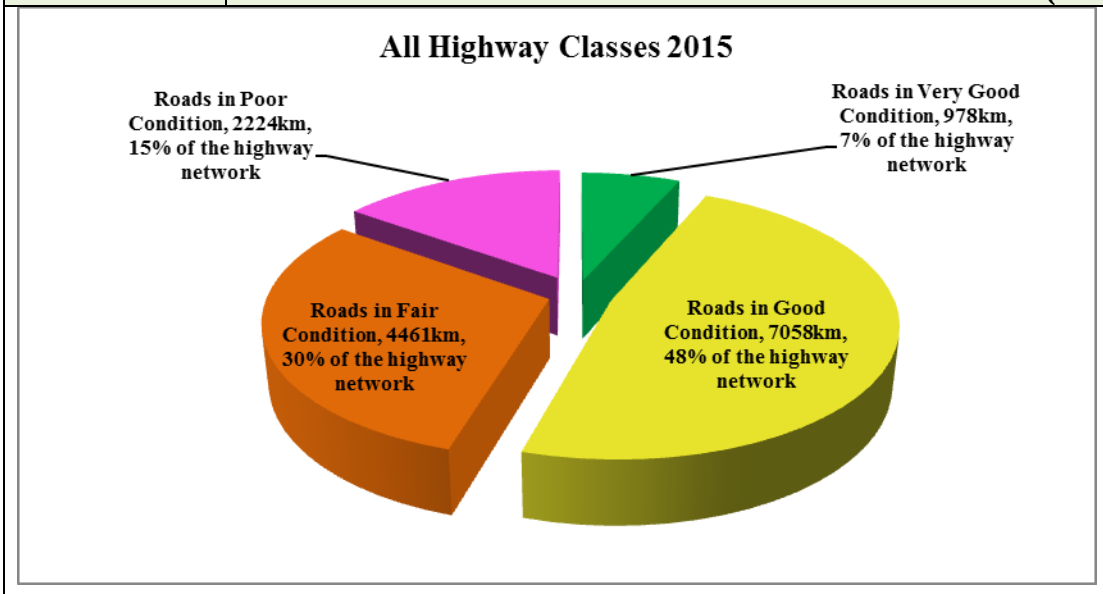
Source: Graphics, information, and data provided by Transportation & Infrastructure (created September 2012 using the Department's Asset Management System) (unaudited).

5.152 Exhibit 5.11 highlights the condition of the highway network as projected by the AMS after the three years of increased funding. The estimated number of kilometers of roads in poor condition as projected by the AMS had decreased to approximately 1,516 km or 10% of the overall highway network.

5.153 Exhibit 5.12 below shows the 2015 AMS projected condition of the highway network after the AMS optimal maintenance treatments have been applied under the forecasted funding highlighted in Exhibit 5.10.

Exhibit 5.12 – Projected Condition of the Highway Network (2015)

EXHIBIT 5.12 PROJECTED CONDITION OF THE HIGHWAY NETWORK (2015)



	Four Year Forecasted Capital Budget Period				Net Four Year Change	
Condition	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**kilometer**	**%**
Very Good	1,005 km	947 km	909 km	978 km	-26	-3%
Good	6,747 km	6,986 km	7,127 km	7,058 km	311	5%
Fair	5,240 km	4,684 km	4,458 km	4,461 km	-779	-15%
Poor	**1,730 km**	**2,103 km**	**2,228 km**	**2,224 km**	**495**	**29%**
Total	14,721 km	14,721 km	14,721 km	14,721 km		

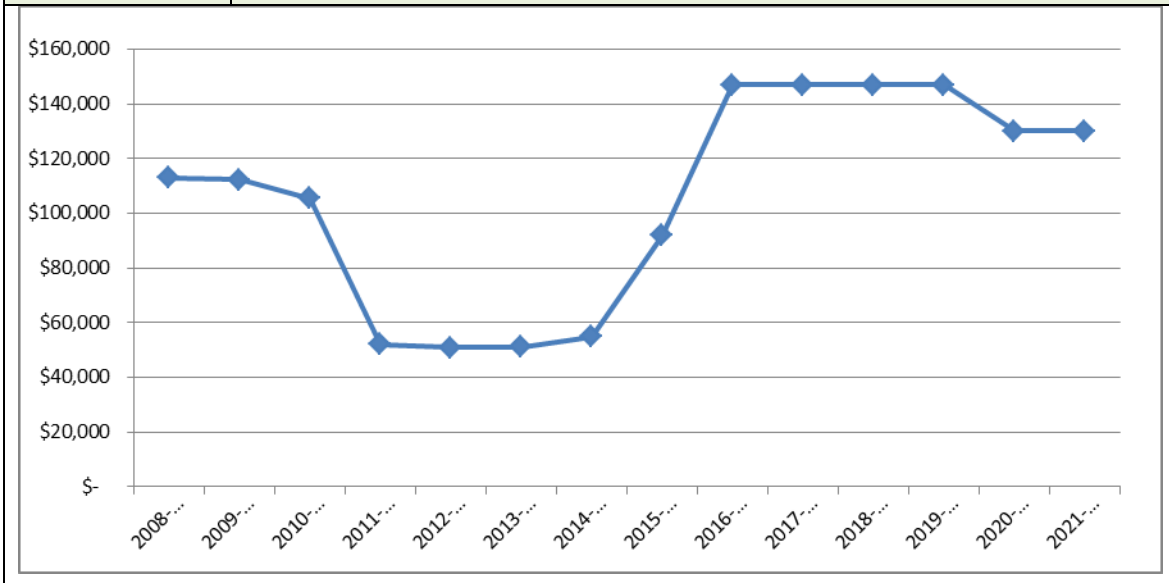
Source: Graphics, information, and data provided by the Department of Transportation & Infrastructure (created September 2012 using the Department's Asset Management System) (unaudited).

Projected Highway Network Condition Will Deteriorate by 2015

5.154 Exhibit 5.12 predicts over the four year period (2012 through 2015) poor roads in the Province will increase by approximately 495 kilometers or 29%.

Exhibit 5.13 – Paving and Chip Seal Budgets (Actual & Projected $'000)

EXHIBIT 5.13	PAVING AND CHIP SEAL BUDGETS (ACTUAL & PROJECTED $'000)



Source: Graph created by the Office of the Auditor General of New Brunswick with data and information provided by the Department of Transportation and Infrastructure (unaudited).

5.155 Exhibit 5.13 graphically represents the initial expenditures under the AMS (2008-09 through 2010-11), the budget for 2011-12, and the estimated budgets for 2012-13 through 2014-15. The years following 2014-15 presume that the budget will return to AMS optimal levels.

5.156 Exhibit 5.13 shows that to recover from the funding shortfall (2011-12 through 2014-15), an increase of 68% ($37.2 million) will be needed in 2015-16 with an additional increase of 60% ($55 million) in 2016-17. The budget would remain at this level until 2020-21 and then stabilize at $130 million for the remainder of the forecast timeline. At this time, there is no commitment from the Province to provide this level of funding from 2015-16 onwards.

5.157 Based on the information provided from the AMS, current budget projections will result in an increase in the number of kilometers of poor roads from 1,730 kilometers in 2012 to 2,224 kilometers by 2015. This amounts to a projected increase in poor road kilometers across the highway network of approximately 47% over 2010-11 levels (Exhibit

5.11). As a result, the Department will not meet its objective of non-declining condition and road safety may suffer.

Reduced Funding Will Result in an Increasing Infrastructure Debt

5.158 As the condition of the highway network deteriorates, the cost of maintaining the roads increases. The impact of this decreasing road condition is infrastructure debt. Infrastructure debt is the result of deferring required maintenance to future years.

5.159 The Department uses a four year planning period to allow government to pursue a target despite single year setbacks due to unexpected budget shortfalls.

Exhibit 5.14 – Four Year Infrastructure Debt Forecast (millions)

EXHIBIT 5.14	**FOUR YEAR INFRASTRUCTURE DEBT FORECAST (MILLIONS)**				
Annual Funding	**2011-12 Actual**	**2012-13 Budget**	**2013-14 Budget**	**2014-15 Budget**	**Totals**
AMS requirement[1]	$ 102.0	$ 102.0	$ 102.0	$ 102.0	$ 408.0
Forecasted budgets[2]	52.0	51.0	51.1	54.8	208.9
Infrastructure Debt	**$ 50.0**	**$ 51.0**	**$ 50.9**	**$ 47.2**	**$ 199.1**

Notes:

1. **AMS requirement** is the projected optimal funding required to meet the target level of service ("non-declining" kilometers of poor roads).
2. **Forecasted budgets** are the expected budgetary funding from Department information (unaudited) with the exception of 2011-12 where the funding level was known.

Source: Table created by Office of the Auditor General with information and data provided by the Department of Transportation and Infrastructure (unaudited).

5.160 The Department estimates that in just four years infrastructure debt for roads currently modeled in the AMS will climb to $199 million. Exhibit 5.14 illustrates how the projected funding shortfall will result in this accumulated infrastructure debt.

5.161 As noted earlier, there are significant assets currently not included in the AMS optimization process. This means that the Department does not model these assets and the projected infrastructure debt is actually greater than currently projected by the AMS.

5.162 We are concerned if the infrastructure debt continues to grow, the Province will be in a situation where sustainability of the highway network will be at risk. At

that point the Department may have to consider decommissioning assets if it hopes to maintain the remainder of the highway network at acceptable standards.

5.163 We believe regardless of the method used by the Department, it is imperative the Department clearly and accurately communicate to government the impact of the growing infrastructure debt.

Criterion 3: Reporting Performance

5.164 Effective public reporting of performance is an important component of good governance and accountability. It provides a measure of government accountability to the public, allows government to monitor programs and services effectively, and promotes better decision making.

The Department's Annual Report has Performance Measures

5.165 The Department produces an annual report as a primary mechanism of communicating performance achievements publicly. We reviewed the Department's 2010 -11 annual report to determine how the Department reports publicly on the effectiveness of its maintenance programs.

5.166 The Department identifies the following four goals as measures of success in one of its core business areas – "Safe, sustainable highway network". They are:

1. to improve highway safety;
2. to maintain long-term sustainability of the highway network;
3. to develop strategic highway corridors; and
4. to be environmentally responsible.

We only considered the first two directly applicable for the purposes of our review.

5.167 For each goal the Department reported objectives, performance measures, targets (if any), and results.

5.168 Some of the performance measures relevant to our review included:

- to decrease casualty rates per 10,000 motor vehicles. (safety);
- highway and bridge maintenance and repair activities will be carried out on a prioritized basis

(sustainability);

- various grading, paving and structures projects will be undertake on a prioritized basis (sustainability);
- various chipseal, county projects and local collector paving projects will be undertaken on a prioritized basis (sustainability); and
- progress towards implementation of Asset Management Business Framework (sustainability).

The Department does not Have Targets for all Performance Measures

5.169 With reference to the goals in paragraph 5.166 above, there were:

- Three performance measures for goal #1; and
- Eight performance measures for goal #2.

Of the eleven performance measures noted in the annual report, only six had associated targets identified.

5.170 Performance measures require preset targets against which actual results can be compared. The absence of targets for performance measures in the Department's annual report means readers cannot determine how successful the Department was in reaching its stated goals.

Reporting on Capital Maintenance Project Results is Limited

5.171 When we reviewed the annual report, we noted only summary results of kilometers of completed maintenance were provided.

5.172 With the AMS in place, the Department has the data needed to measure its performance in completing the projects and report on the variances against its plans. This information is not provided in its annual report.

5.173 The benefits of asset management and the optimization process appear to be readily measured and documented internally. By reporting the results of the optimal program publicly on an annual basis the Department can highlight to government areas of risk such as deteriorating highway condition. Government can then develop plans to mitigate the impact of these risks.

Annual Reporting of the Highway Network Condition is Poor

5.174 In order to communicate the value of following the AMS program, the Department needs to effectively communicate the risks and associated impacts of completing non-optimal capital maintenance projects to

government.

5.175 We did not find evidence the Department publicly reports on the condition of the overall highway network by condition category (i.e. very good, good, fair, and poor). However, it is a key measure used for internal purposes.

5.176 For example, the "% of kilometers" assessed as poor, a common measure of highway condition used internally in the Department was not reported in the annual report.

5.177 In order to clearly communicate the impact of government funding decisions, we believe the Department should provide updated highway network condition information as part of their annual public reporting process.

5.178 The Department is currently implementing a balanced scorecard approach to performance reporting internally. It may provide a basis for improved public reporting in the future.

Recommendations

5.179 We recommend the Department develop effective program performance measures for its stated goals and objectives that include specific, relevant targets against which performance can be measured.

5.180 We recommend the Department's annual report clearly state the overall highway network condition by kilometer in each condition category the Department uses, (currently very good, good, fair, and poor), with the intent of highlighting the short, medium, and long term impacts of not following Asset Management System projected funding recommendations. We further recommend the Department report the level of infrastructure debt caused by deferred capital maintenance in order to present a complete picture of the highway network status and the risk to safety and sustainability.

APPENDIX I: Glossary of Terms

Arterial Highways	Major paved, high volume highway in New Brunswick for long distance intra and inter provincial travel – Route numbers 1 to 99
Asphalt	Refers to Asphalt Concrete, a primary road surfacing material comprised of pre-mixed asphalt binder and aggregate. It is the surface material for arterials and most collectors.
Asset Management	*"The combination of management, financial, economic, engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost effective manner."* Department of Transportation Asset Management Plan (2008)
Asset Management Business Framework	*"A Department initiative to provide a more strategic approach to the long term, sustainable investment planning and program management of its transportation infrastructure."* Department of Transportation Asset Management Plan (2008)
Asset Management System	*"A combination of processes, data and software applied to provide the essential outputs for effective asset management."* Department of Transportation Asset Management Plan (2008)
Capital Maintenance	Capital Maintenance refers to maintenance and repair activities undertaken to extend the service life of an asset. (see rehabilitation)
Chip Seal	A road surface comprised of asphalt and fine aggregate applied separately to the roadway bed and rolled (compressed) to form the final surface. Chip Seal roads are typically low volume.
Collector (road)	Moderate to low volume roads that connect local and rural New Brunswick roads to major surfaced routes (primarily intra provincial travel) – Route number 100 to 199.
Deterioration	*"The reduction in an asset's utility and / or useful life resulting from impairment in physical condition that can be caused by factors such as age, wear and tear, defects, climatic conditions, etc."* Department of Transportation Asset Management Plan (2008)
Infrastructure Debt	Infrastructure debt is the result (expressed in dollars) of ongoing road deterioration caused by deferring required maintenance activities to future periods. Deferring maintenance to the future results in increased costs of repair as the road condition requires more work to be returned to a satisfactory condition state.
Least Life Cycle Cost Analysis	*"A technique of economic evaluation that sums over a given study period all costs over the useful life of an asset, usually discounted to present value. Components of the life cycle costs include, without limitation: initial costs, rehabilitation costs, maintenance costs, and salvage value."* Department of Transportation Asset Management Plan (2008)
Level of Service	*"Levels of Service describe the quality of services to be provided by the pavement infrastructure for the benefit of road users. They are underpinned by performance indicators that are measured and evaluated according to physical condition, management and demand criteria."* Cunningham, J, J. MacNaughton, S. Landers, "Managing the Risk of Aging Pavement Infrastructure in New Brunswick Through Innovative Decision Making", p.5
Local (road)	Low volume roads comprised of Local numbered routes (Route numbers 200 and up) and Local unnumbered routes.
Ordinary Maintenance	Ordinary Maintenance refers to maintenance activities carried out to maintain the current condition of a road.
Provincial designated highway	*"A highway that the Minister of Transportation* [and Infrastructure] *intends to maintain through the expenditure of ordinary and/or capital funds.…per section 15 of the Highway Act."* Department of Transportation Asset Management Plan (2008)
Rehabilitation	The Department of Transportation and Infrastructure defines rehabilitation as lifecycle altering treatments. (See Appendix VI for specific examples).

APPENDIX II : Asset Management Model

Exhibit 5.15 – Asset Management Hierarchical Planning Process

EXHIBIT 5.15: ASSET MANAGEMENT HIERARCHICAL PLANNING PROCESS

Source: Department of Transportation and Infrastructure, "Asset Management Highway Infrastructure Plan (2010-2014)", p.2.

- Between 2004 and 2009 the Department directed $2 million toward consulting, software development, and software purchases to develop an Asset Management System (AMS). This system is a key component of the Asset Management Business Framework.
- As highlighted in Exhibit 5.15 above, the AMS utilizes a hierarchical approach to planning. Government and Departmental goals and objectives are used to create strategic, tactical and operational plans.
- The Exhibit 5.15 symbolizes the flow of inputs on the left to produce the capital maintenance 20-year strategic investment plan (upper triangle), the four-year tactical plan (middle section), and the annual operating plan (bottom section), resulting in the outputs on the right.
- Levels of service (such as the targeted condition for a road), deterioration curves based on age and other factors, and treatment options (possible maintenance activities) are determined for Departmental infrastructure assets that have been entered into the Department's databases. At the strategic level of the model these variables are used to mathematically determine an optimal selection of projects called a candidate list.
- Decision making within the AMS is based upon least lifecycle cost analysis

(LLCA) methodology, whereby feasible alternatives strategies are compared and the one with the lowest cost over time is selected.

- LLCA compares the total discounted cost of alternative maintenance treatments to determine the optimal projects for completion with given resources and constraints. In this manner the total cost to maintain the asset is minimized over its lifecycle.
- LLCA provides an objective comparison of different treatments as investment decisions that can have different service lives, performance and associated costs. In other words, by understanding an asset's life cycle, optimal rehabilitation can be achieved by doing the right treatment, at the right place and at the right time.
- The required investment (in dollars) is determined by the level of service desired from the asset. For example, the current desired level of service for New Brunswick roads is defined as: kilometers of poor roads are "non-increasing" or in other words "status quo". This means that the Department's target is to maintain the kilometers of poor roads at current levels.
- The tactical planning period is set to achieve the desired level of service by using a 4-year target rather than more volatile annual targets. This provides some flexibility for any single year budgetary or operational situations that result from unforeseen circumstances. It is critical that these targets are reached in terms of dollars invested to ensure that the projects are completed within the overall strategic timeframe.
- Accurate costs of interventions (e.g., repairs, rehabilitation or reconstruction) are needed to generate budgets or evaluate impacts. The Department uses the following steps to establish costs:
  1. identify treatments which are acceptable to the design branch and characterized by their cost and intensity;
  2. group treatments into families;
  3. examine past expenditures on similar contracts;
  4. comparison to the current asphalt prices;
  5. apply appropriate discount and inflation factors;
  6. update the model;
  7. apply specific adjustments at the project level.
- The cost data within the AMS is updated as conditions change. The data is used to create the four-year tactical plan and the associated capital maintenance funding requirements.

Source:

1. Department of Transportation and Infrastructure, "Asset Management Highway Infrastructure Plan (2010-2014)"

2. Interviews with Department staff

APPENDIX III : Key Aspects of Asset Management

In general, asset management asks the following questions (2012 – Executive Brief, Advancing a Transportation Asset Management Approach, US Federal Highway Administration)

1. What is the state of my assets?

a. What do I own?
b. Where is it?
c. What condition is it in?
d. What is its remaining useful life?
e. What is its remaining economic value?

2. What is my required level of service?

a. What is the demand for services by stakeholders?
b. Are there regulatory requirements I must meet?
c. What is my actual performance?

3. Which assets are critical to sustained performance?

a. How can it fail? How does it fail?
b. What is the likelihood of failure?
c. What does it cost to repair?
d. What are the consequences of failure?
e. How can I mitigate these failures?

4. What are my best "Operations and Maintenance" and "Capital Improvement" investment strategies?

a. What alternative management options exist?
b. Which are the most feasible for my organization?

5. What is my best long-term funding strategy?

a. What revenues will I have?
b. What is my investment gap or surplus to meet asset condition goals?
c. What is my revenue gap to keep my asset within my risk tolerance level?
d. What would be my optimum mix of:
    i. Preservation and Preventive Maintenance
    ii. Reactive Maintenance
    iii. Rehabilitation
    iv. Replacement
e. If I cannot afford my optimum mix, what is the best mix of fixes I can afford?

Answering these questions require data. The context (legal framework, government objectives, public health and safety, sustainability, etc.) plays a critical role in the decision making process.

APPENDIX IV: Summarized Conclusions from Consultant's Report

The following are excerpts from the consultant's report and summarizes his response to our Office regarding the reliability of the Department's Asset Management System.

Assessment of the Asset Management System

1) Completeness and accuracy of the current condition of the road kilometres in the New Brunswick Asset Management System

The AMS and associated processes in place provide a completely and reasonably accurate state of the current condition of the road network (paved and surface treated) that **are included in the system** (see notes below) and that are under the jurisdiction of the DTI.

Notes:

The AMS does not include Public-Private Partnership (P3) roads. These roads will be incorporated into the DTI AMS at the time they are transferred to the Province.

There is a different process used for choosing priorities and funding provincially owned roads in municipalities. The Department has the desire to include those roads into the AMS and to develop five-year priority plans for them.

2) Accuracy of short and long term projections of capital funding requirements to maintain the current condition given the Department's goals over a twenty year planning horizon.

The AMS and associated processes in place provide **reasonably accurate** projections of funding requirements to maintain the Department's paved and surface treated roads in the condition **defined by the levels of service established**.

Notes:

The levels of service adopted by the Department in 2008 refer to the physical condition of the roads. Other non-condition based levels of service are used outside the AMS process at the project selection stage.

Improvements to the road network in the AMS projections are defined in terms of a reduction of the number of kilometres in the "poor" category. The initial 2008

projections of funding needs and resulting three-year budget did achieve the goal of improving the road network, i.e., reducing the percentage of roads in poor condition.

3) Economy of the application of capital budget dollars by the AMS to achieve the least cost life cycle approach (LCLCA).

The Department has set a goal of achieving 80% of the projects selected will meet the AMS LCLCA and levels of service criteria. This target has not been reached.

It can be concluded that the capital budget **dollars invested in projects that are recommended by or meet the criteria set by the AMS** are applied in the most economical way to achieve the least cost life-cycle approach and meet the established levels of service.

It was not possible to assess, based on the information at hand, if the other projects selected contribute to achieving the least cost life-cycle objectives or the levels of service targets.

4) Accuracy and reliability of the AMS to project the deterioration of overall physical condition of road kilometres for valuing the related infrastructure deficit

An in-depth analysis of the formulation and rules in the AM system was beyond the scope of this evaluation. However, the documentation reviewed and a detailed presentation by DTI Asset Management staff points to a reliable and reasonably accurate forecast of current and future road network conditions.

Valuing the “infrastructure deficit” requires the following parameters: the current (or future) condition of the road; the actual/expected service life of the road; and the level of service.

Based on the **AMS road condition assessment, asset service lives and adopted levels of service,** the “infrastructure deficit” that is calculated is reliable and reasonably accurate. A key recommendation stemming from this assessment, however, is to revise the levels of service to include other non-condition parameters which in fact may change the value of the “deficit” (up or down).

5) Evaluation of the AMS

a) As a decision-making tool;

Overall, based on the historical records of road conditions and cost avoidances, the AMS has enabled better decision-making. As it evolves, matures and is refined, the AMS will prove to be an even more valuable decision-making support tool.

b) To predict the most cost effective and economical timing and treatment of infrastructure;

The AMS, based on the level of service criteria currently in place predicts the most cost effective and economical timing and treatment of the road infrastructure considered.

c) To accurately assess future dollar impact of deferring capital repairs.

The AMS, based on the current level of service criteria, is reasonably accurate in assessing future dollar impacts of deferring capital repairs.

Since the AMS generates medium to long term scenarios, the prediction of the impacts of deferring capital repairs is highly dependent on the estimate of future budget allocations. Overly optimistic budget allocations beyond the current 3-year budget plans do not present an accurate portrait of the impacts of these budget reductions.

APPENDIX V: Condition Category Description

This table, taken from the Department's 2012 Asset Management Plan, provides a general description of the different condition categories used by the Department. It also references technical condition measures (IRI, SDI, and VIR) commonly used by the Department to show where the different condition categories would fall within the technical scales.

Condition	**Description**	**Asphalt Surfaces**			**Chipseal Surfaces**	
		Class	IRI	SDI	Class	VIR
Very Good	Asset is very close to new condition with very little deterioration	Arterial Collector Local	0 - 1.5 0 - 1.5 0 - 1.5	10 - 8.5	Local Roads	10 - 9
Good	Asset has some minor deterioration but is still functioning at a very high level of performance – some preservation activities can be considered	Arterial Collector Local	1.5 - 1.8 1.5– 2.7 1.5– 2.7	8.5 - 7	Local Roads	< 9 - 6
Fair	Asset has deteriorated to the point where rehabilitation or replacement would be considered – functional performance is still acceptable	Arterial Collector Local	1.9 - 2.7 2.7 - 3.5 2.7 - 3.5	7 - 5	Local Roads	< 6 - 3
Poor	Asset has deteriorated to the point where either a major rehabilitation is required or complete replacement – functional performance is below acceptable levels	Arterial Collector Local	> 2.8 > 3.5 > 3.5	5-0	Local Roads	< 3

IRI (International Roughness Index) is a standard scale for Asphalt surface roughness of a single wheel track measured in meters / kilometer of suspension travel. The lower values represent the smoothest surfaces.

SDI (Surface Distress Index) is a mathematical model that incorporates severity and density ratings for seven surface distress types into a single score from 10 to 0 with 10 being least distressed.

VIR (Visual Inspection Rating) measures the coarseness of chip seal surface condition on a scale of 10-0, with a score of 10 representing the highest rating.

APPENDIX VI: Capital Maintenance Treatment Life spans

This table, taken from the Department's 2012 Asset Management Plan, provides information on the types of treatments in different treatment categories by road surface type and the associated average service life of those treatments.

Surface Type	Strategic Rehabilitation Category	Example Treatments	Average Service Life (yrs)
Asphalt	Preservation	Micro-surfacing	5 – 8
	Minor Rehabilitation	Mill-Seal Spot Pad- Seal	8 – 12
	Major Rehabilitation	Mill-Base-Seal Spot Pad-Base-Seal Full Pad-Base-Seal	12 - 15
	Reconstruction	Pulverize-Base-Seal Expanded Asphalt-Seal Expanded Asphalt-Base-Seal	15 – 20
Chipseal	Minor Rehabilitation	Single Seal–Minimal Leveling	8 – 10
	Major Rehabilitation	Pulverize-Double Seal	8 – 12