Communicating the Infrastructure Protection Plan for Saskatchewan Pavements

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ABSTRACT

Communicating the Infrastructure Protection Plan for Saskatchewan Pavements

This paper shares the Saskatchewan Ministry of Highways and Infrastructure (SMHI) experience with new tools for communicating pavement preservation needs to senior management.

New performance measures were created and put into practice for development of the 2016-20 pavement preservation strategy. These high level performance measures quantify what the investment strategy will mean for road users and for taxpayers. The long term risks of underinvestment are conveyed showing the drop in road user acceptance levels and the financial burden for taxpayers.

The performance measures and their application that are discussed in the paper include:

Financial Sustainability – this index compares historic investment to the needed investment given the existing condition of the road network and the future preservation treatment regime needed to sustain today's conditions. The index is best used to monitor investment overtime and understand if the current strategy is financially sustainable.

Bathtub Curve – this analysis informs decision makers of the cost to maintain current, improved or degraded pavement conditions. This gives guidance when selecting an investment strategy because it tells you how much it will cost to protect today's conditions and the cost of embarking on a strategy to improve conditions or letting them fall off. Depending on the roads it may be cheaper to spend money on them now because the future financial cost of keeping them there is more affordable than what we are spending today.

Road User Acceptability – measuring road user acceptance for different road conditions allows additional information to be presented when considering investment strategies. SMHI has designed a method to gather road user acceptability information. The data from these surveys is used to assess investment options as having high, low or no impact on road user acceptability in terms of the level of service provided.

Maintenance Crew Response – setting standards for response times to potholes, road failures, removing hazards, etc. a measure of the operational level of service delivered to the road user. In Saskatchewan pavement maintenance as an integral component of our pavement management system and tradeoffs for operational service delivery vs. preventative maintenance practices are balanced in the overall asset management plan.

INTRODUCTION

This paper is intended to share ideas and concepts being used in Saskatchewan for communicating preservation needs for our paved road networks. Presented here are a handful of ideas that the Ministry has been developing as communication tools to support our asset management program. Conveying information about pavement preservation needs in simple and understandable terms is a challenge. We are working to establish a set of information that can be quickly digested and provide the level of understanding and insight needed for Senior Management and Excecutive to confidently select the pavement preservation strategy.

FINANCIAL SUSTAINABILITY

The Financial Sustainability Index (FSI) compares the annual investment in pavement preservation treatments to the amount of funding required to sustain current conditions. The index compares the annual investment in pavement preservation treatments to the amount of funding required to sustain current surface conditions. Investment levels are considered financially sustainable when the amount and type of preservation treatments delivered can hold the existing road conditions; ie: no improvement or deterioration of the overall network condition.

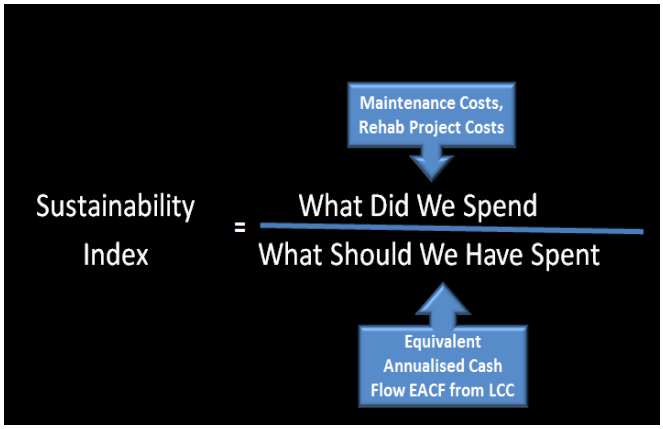


Figure 1 Financial Sustainability Index Calculation

This measure allows the Ministry to report on financial sustainability. The index is calculated annually at the end of the fiscal year when total annual expenditures are known. The index is backward looking; conveying the track record on how you have been doing.

The Ministry's overall strategic investment plan for Pavement Preservation may or may not be to achieve sustainability. In fact funding for our lower level network is typically much lower than sustainable levels (when FSI = 1.0) while the funding on our high level network is often at or above sustainable levels. When the strategy is to improve conditions to complement other components of the strategic plan such as investment in the National Highway System to support economic growth, then the FSI will be more than 1.0 as the amount spend is greater than what is needed to be sustainable .

The Financial Sustainability Index is not measuring the achievement of the Ministry strategy for preservation of our pavement network. However; it is a very valuable performance measure for taxpayers and road users to understand the ability of the Ministry to sustain the road conditions they see today into the future.

For the fiscal year ending 2013 the Financial Sustainability Index was calculated as follows:

Network	FSI
LOS 1	0.72
LOS 2	0.69
LOS 3	0.30
All Pavements	0.54

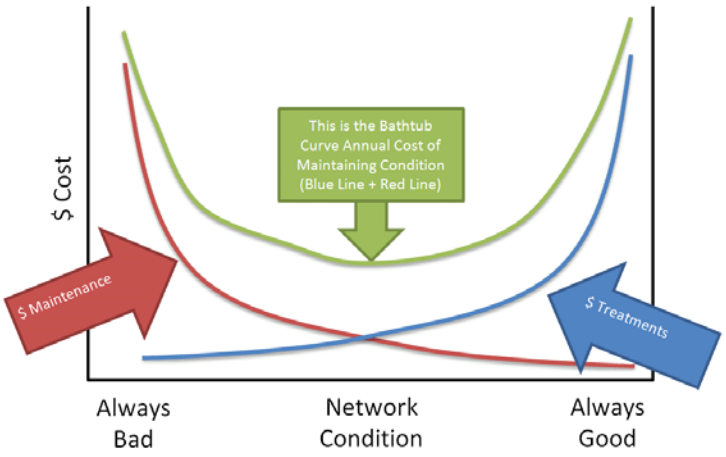
We are currently exploring the use of the FSI in a forward looking mode as a tool to evaluate new pavement preservation treatments. Would it make sense to adopt the use of Ultra-Thin Bonded Wearing Coarse such as a NovaChip treatment? A cheaper, longer lasting preservation technique would have a big impact on financial sustainability if a lot of your pavement network is a good fit for the treatment.

Particularly for preservation treatments that have a short window of opportunity ("right treatment at the right time") the returns on rapid progress to full scale implementation of a new treatment can be demonstrated by using the FSI analysis in a predictive or "future looking" mode. This is where this metric has the potential to really shine for us – putting the dollars and cents around the benefit of expanding and evolving the preservation toolbox beyond our conventional treatments.

BATHTUB CURVE

The bathtub curve illustrates the cost to maintain a pavement network over the full range of service levels. The Bathtub Curve Analysis provides information about where the road network currently sits and what the financial needs would be if the network conditions were improved or degraded. This gives the agency insight into how affordable a strategy will be to maintain in the long term.

A bathtub curve is the combination of the cost of routine maintenance repairs (potholes, crack sealing, localized failure repairs, etc.) for the network for each service level added to the cost of preservation treatment requirements (chip seal, microsurfacing, ultrathin bonded wearing coarse, resurfacing) to hold the network at each service level. Illustrated in Figure 2 these two curves are added together to produce the bathtub curve.



Senior management finds this information helpful when deliberating over investment strategies. What would we be in for if we let service level (conditions) fall? What about holding them? What about a strategy that brings everything up to a better service level – what's the cost of keeping it there once the goals of the investment strategy have been achieved ?

Note that the Bathtub Curve is not telling you anything about the investment needed to improve or degrade conditions; it is conveying what it will cost to maintain the new network conditions once you get it there.

Figure 3: 2013 Bathtub Curve for LOS 3 Pavement Network

In practice the calculation of the curve is limited to a window of the full curve that includes service levels (network condition improvement or drop) that are achievable in the near term.

Routine maintenance on a network in very poor condition is high while the maintenance cost of a brand new network is low or almost nothing. At the same time the cost of preservation treatments needed to keep a brand new road network always good is expensive because you need to repave it before any of it can become poor. When a network is in very poor condition there is no cost for repaving to keep it in very poor condition but the routine maintenance goes through the roof because of all of the localized potholes etc. that need to be fixed just to keep the road useable.

There is of course a balance point in the middle where the cost of treatments and maintenance is the same. This is the lowest cost service level for the network. Financially this may be the best situation to be in for taxpayers but is it the right service level for roads users? Probably not if the network includes the TransCanada Highway; but maybe it is just fine for the low volume networks. How to know what service level road users are looking for? This question lead us to work on the next question – how to capture information from road users about acceptable level of service.

ROAD USER ACCEPTABILITY

What service level do road users want? Which things matter the most? To answer these questions we developed a survey for road user feedback. The survey method involved driving a group of people; one at a time, over the same route with designated stops along the way to collect feedback on short stretches of road (1 km) they had just travelled over.

We wanted to find out if they had a common opinion about the driving conditions along the route and how opinions change for different types of roads. Is the roughness of the road acceptable? How about the visual appearance? Wheel path ruts? Shoulder width? We could then see if those opinions correlate to known, very precisely measured, road conditions.

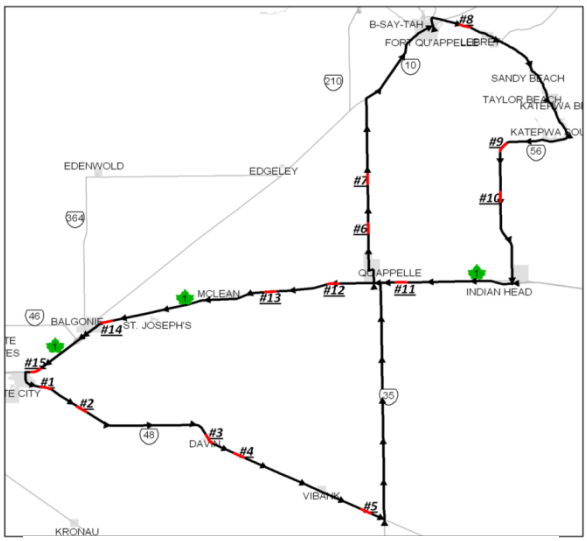


Figure 4: Road User Acceptability Survey Route

Finding a route for the study that provided a range of pavement types and conditions took some planning and we eventually selected a 186 km route near the City of Regina. The route included a range of highway geometrics, surface conditions, and traffic volumes.

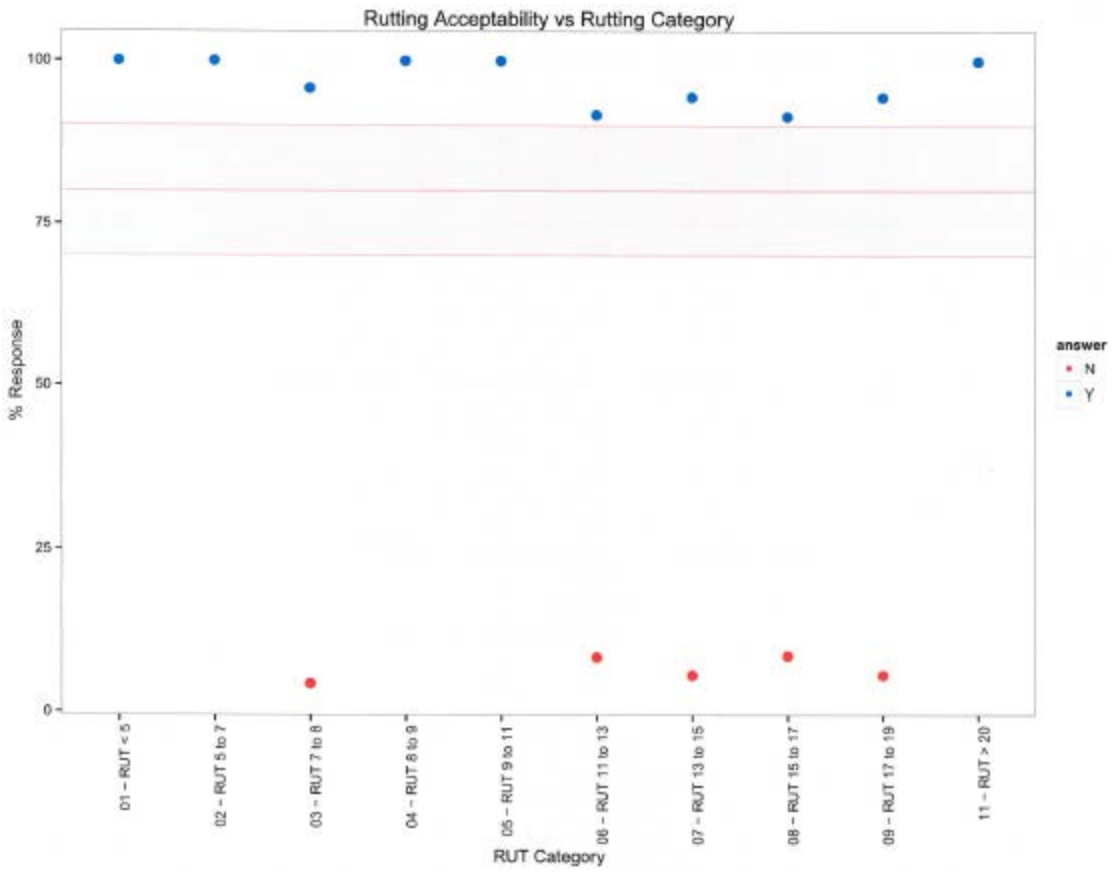
In the fall of 2015 we invited a group of Ministry staff to participate in the survey. The survey was conducted over 5 days using the same vehicle and driver and a common questionnaire that was filled out along the route at 15 different locations. 18 people participated in the study.

Route Characteristics	Highway Function	Traffic Volume	Truck Traffic	Localized Rutting	Localized IRI	Localized Cracking	Lane Width	Shoulder Width	Posted Speed	Shoulder Condition
Range Along Route	TransCanada, Collector, Local, Tourist	AADT 331 to 6301	TAADT 35 to 920	3.08 to 21.8 mm	IRI 0.59 to 4.67	None to Severe	3.5 to 3.7 m	0.5 to 2.0 m	80 to 100km/hr	Good to Very Poor

The analysis of the survey results gave us the type of information about service levels that we were looking for:

- Responses to rutting questions had no correlation to actual field conditions
- Participants accepted rougher roads on lower networks
- Participants were less accepting of roughness on the high level network
- Participants were not accepting of higher roughness levels for longer periods of time
- Road roughness did not affect participants rating of comfort when driving at speed limit
- Visual appearance is important to the user's experience

An example of how the survey results were analyzed is illustrated here showing the results of the questions about rutting on the road. Even when ruts were relatively deep (21.8 mm) there was no consistent opinion about the impact on the experience of the participants in the study.



The one key metric examined in the survey that was tightly correlated to the functional class of the survey sites was participant acceptance of the roughness of the road. It was very clear that rougher roads were more acceptable when on local roads vs. the TransCanada Highway. The Ministry has reflected this difference in our standard for the intervention level for pavement resurfacing associated with International Roughness Index (IRI).

Network	IRI
LOS 1	≥ 2.25
LOS 2	≥ 3.0
LOS 3	≥ 3.5

The Ministry IRI standard has been adjusted to account for different expectations of service levels for the three different pavement networks. This change was brought into practice for the development of our 2016 through 2020 pavement preservation program. It is reflective of both the results of the road user survey and a scan of current practice in other Canadian jurisdictions. Prior to this change the standard was a threshold of IRI ≥ 2.5 regardless of the pavement network.

Building on the success of the study we are planning a full survey using Saskatchewan residents that volunteer to participate. Our intention is to validate the results of the first study with internal

Ministry staff. We may find some new metrics to add to our understanding of what factors constitute level of service for road users.

MAINTENANCE CREW RESPONSE

In Saskatchewan pavement maintenance is an integral component of our pavement management system and tradeoffs for operational service delivery vs. preventative maintenance practices are balanced in the overall asset management plan. Crack filling is one of the most effective preventative maintenance activities our crews do but the driving public notice no difference in the quality of their drive before or after crack filling has happened. On the other hand when a crew patches a pothole that many drivers have bounced their vehicle over the results are an immediate, visible improvement.

Early spring in Saskatchewan has always been the season for fixing potholes and getting out the spray wands to take care of cracks. But what would the tradeoffs be if crack filling work was shifted to the fall and those crews were reallocated to pothole repairs in the spring? Maybe you miss a few cracks because they are not opened up in the fall but would you have happier drivers? Or maybe not as many annoyed ones? Good questions to consider when working out the provincial maintenance budget allocation and the best way to prioritize work delivered by the crews. Some solid data on the operational demands for maintenance repairs and a standard for how quickly those repairs should be addressed would provide some guidance.

The Ministry adopted a Maintenance Management System (MMS) in 1998 for provincial maintenance crews for the budgeting, planning, scheduling and recording of crew work. The system, however manages work at the asset level for an individual work crew. Individual repairs and problems are not currently managed in the MMS system. For example a crew supervisor will plan for an estimated amount of pothole patching for a season for the high volume roads in his/her section. As the work is completed it is recorded against a road segment; typically 1 to 8 km in length. When the potholes appeared and how long they were there before the crew made the repairs is not currently recorded in the MMS system.

To work out what makes sense for establishing standards for the response time for repairs the Ministry convened a group of practitioners. District Operations Managers and crew supervisors participated in a brainstorming session and came up with ideas and concepts for what the framework and standards for maintenance response times could look like. What things seem to bug drivers the most? What expectations are there for getting repairs done? How are expectations different for different types of roads? How can we capture information about when problems occur and how long it takes to address them? A small working group took the ideas generated from the brainstorming session and added in information gathered from a jurisdictional scan of best practice. The task group then recommended a draft set of standards for response times for three functional classes of roadway.

DRAFT - LOS Response Times	LOS 1	LOS 2	LOS 3
Inspection	twice weekly	weekly	biweekly
Pothole Patching (lanes) (shoulders)	5 days 30 days	14 days 60 days	60 days 90 days
Localized Problems (travel lanes) rutting (≥20mm deep & 300m long) failure (spot failure / extreme block cracks) rough ride (shoving / distortion)	45 days 15 days 30 days	before Sept 15 30 days 60 days	before Sept 15 45 days before Sept 15
Localized Problems (shoulders) failure (washout, drop offs) shoving (shoving / distortion)	60 days 60 days	before Sept 15 before Sept 15	before Sept 15 before Sept 15
Debris Removal (lanes) (shoulders)	3 hrs 24 hrs	3 hrs 24 hrs	3 hrs 24 hrs

Table 4: Level of Service (LOS) Draft Maintenance Response Times

With a starting point established the next steps are to measure response times in the field with real crews on roads representative of the three functional classifications. The Ministry has a project underway to capture this information during the summer of 2015. The project includes creating clear definitions of each type of road hazard, and a process map of the roles and responsibilities for recording information, crew notification, and reporting. One important consideration is defining when the clock starts ticking for responding to a problem; is it when the crew supervisor finds out about it or is it when the information is first called in to the maintenance office?

Establishing maintenance crew response time standards will allow the Ministry to annually report to the public how often crews were able to meet or beat the standard. It will be one of the key operational performance measures for Ministry Executive.

There are a lot of potential spin offs for adding response times to our current maintenance management system. Not only will we understand how long it takes to deliver repairs once they are identified but we will also begin to establish a repository of data that could be leveraged by our road information services and other parts of our asset management system including preservation treatment planning. Once we know the demand (frequency and effort) we can reevaluate the draft response time standards and look for opportunities to adjust crew operations through the season or adjust crew resources to optimize individual crew response times.

PUTTING IT TOGETHER

The Ministry now has a set of metrics that can be used to tell the story about pavement preservation needs in a way that connects to both the taxpayer and the road user. When alternative preservation strategies are presented to Senior Management and Executive we are able demonstrate the tradeoffs of one option relative to the other. Instead of showing the usual charts of IRI deterioration curves and life cycle costs we can use language that is more understandable (*note the following statements are hypothetical examples and may not reflect actual preservation options for the Ministry*):

- The overall roughness on the high level network exceeds what the road users find acceptable so we recommend shifting investment in repaving to the lower level network.
- Ramping up the chip sealing program will drop the amount of annual funding needed to stay financially sustainable on the high level network. We could be sustainable in as little as 3 years.
- The cost to maintain current conditions on the mid-level network is sitting right at the bottom of the bathtub curve so taxpayers will be happy. However, we know the conditions only satisfy 60% of the people who use those roads. Do you want to keep conditions where they are or should we look at improving them?

The metrics discussed here now make up part of the annual asset management plan for pavement maintenance and preservation. We have found that it takes time for everyone to get comfortable with using the new metrics. We have focused on introducing and refining one at a time getting feedback from Senior Management along the way. The Ministry will continue to use with these metrics and refine them over time.