Saskatchewan's Asset Management Cycle

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ABSTRACT:

Saskatchewan Highways and Transportation (DHT) manage an extensive provincial highway network that supports Saskatchewan's economic and social well being with exports generating approximately 67% of its GDP. New construction, preservation of the existing asset, safety, and other pressures compete for limited funds. To manage the preservation of the granular and paved highway system, the department employs an Asset Management system, developed by Vemax Management Inc., as a tool to facilitate network level, project level, and day to day decisions.

The purpose of this paper is to describe the annual Asset Management process used by DHT to manage the granular and paved networks. A high quality Asset Management system allows DHT to monitor and predict pavement performance and allow decision makers to make informed decisions on future funding decisions.

The paper will describe the steps required for a complete annual cycle, as described below:

1. Condition Data- DHT uses condition data in the modelling process. Processes must be in place to ensure data is reliable, repeatable, timely, and fit for purpose.
2. Model Development- To ensure reliable prediction models, standards and processes are required for maintenance work, treatment costs and model inputs.
3. Network Level Scenarios- Decision Makers require scenarios that take into consideration funding envelopes, network priorities and growth issues.
4. Funding Request and Executive Direction- DHT is required to submit its requirements to DHT Executive to seek funding.
5. Project Level Planning- Project-level scenarios are developed, reality checks are conducted, and final projects are scheduled to form a preservation program.
6. Maintenance Management System- Work from previous steps is incorporated into detailed work plans for over 90 section crews.
7. Performance Measures- Once the preservation program is completed, performance measures are in place to analyze planned work versus actual work. This analysis may also include recommendations on potential changes for the next asset management cycle.

The above seven steps are the key components of the annual process. This annual process incorporates asset management principles and DHT business practices, which enables the department to improve programming, planning, management and predicting performance.

Introduction

Saskatchewan Highways and Transportation (DHT) manage approximately 26 000 km of highways in the province of Saskatchewan. The highway network provides support for economic and social activity. As the Government of Saskatchewan tries to allocate funds and balance pressures in health care, education, and other program areas, DHT must be able to demonstrate to decision makers the importance of providing adequate funds to highway preservation.

In the past because of the extensive highway network, it was difficult to provide an objective assessment of the network conditions and predict the implications of funding decisions. As well, it was difficult to communicate the effect funding decisions would have on the highway network. DHT could intuitively predict that the network may improve or degrade but had no tool to systematically predict performance. In the mid-1990's, the department developed, with Vemax Management Inc. and other partners, an Asset Management system, as a tool to facilitate network level, project level, and day to day decisions. Asset Management optimizes maintenance treatments for a given funding level and provides a systematic evaluation and decision tool for the extensive highway network.

Over the years with organizational changes, personnel changes, and advances in technology, there have been changes to the asset management system in Saskatchewan; with these changes, there has been a lack of current supporting documentation. As a result, in 2004 DHT undertook a project to capture the current work, identify deficiencies and document the results in a manual that clearly outlines DHT practice. The purpose of this paper is to outline the annual process that has been developed to ensure DHT has an asset management process that clearly defines internal goals and objectives, outlines defendable processes, and meets the timelines and requirements of internal and external stakeholders.

In order to complete the annual cycle, the following steps are required and will be explained in further detail in the remainder of the paper:

1. Condition Data
2. Model Development
3. Network Level Scenarios
4. Funding Request and Executive Direction
5. Project Level Planning
6. Maintenance Management System
7. Performance Measures

1.0 Condition Data

Currently, DHT collects three surface distresses annually with in-house staff and equipment. The automated data collection vehicle (DCV) consists of a van containing an International Cybernetics Corporation (ICC) longitudinal profiler with Selcom lasers, INO transverse profiling device that detects and characterises pavement rutting and a downward imaging distresses system by Roadware Group Inc. that utilizes digital cameras to identify cracks. A photograph of the current DCV can be seen in Figure 1.

Figure 1 DCV

The DCV travels the province collecting rutting, cracking and International Roughness Index (IRI) data on all asphalt concrete (AC) and granular highways. This process commences in middle of August every year and continues until the end of November, after which the condition data undergoes a quality assurance program to ensure that there is no data missing. The data is then post-processed where it can be utilized by the asset management modeling group. Each distress collected from the road is categorized as good or poor. The distresses for each road segment are then grouped together and labelled as condition state 1 through 8 as indicated in Table 1. Additionally, DHT uses an automated process as well as a field review to determine road segments. 50 m distress files containing rut, IRI and surface condition data are reviewed and when there is a defined change in distresses, a new segment is created. Segment lengths are restricted to a minimum of 1 km and a maximum of 8 km.

Condition State	Rutting	IRI	Cracking
1	Good	Good	Good
2	Good	Good	Poor
3	Good	Poor	Good
4	Good	Poor	Poor
5	Poor	Good	Good
6	Poor	Good	Poor
7	Poor	Poor	Good
8	Poor	Poor	Poor

Note: Rutting is Good if ≤ 10 mm
IRI is Good if ≤ 2.5 mm/m
Cracking is Good if ≤ 1200 m/km

Table 1 Condition State Table

2.0 Model Development

DHT uses network level and project level computer programs to predict network performance and optimize budgets. Performance Prediction Technology (PPT) Strategic is the computer program used to determine the network level optimal annual maintenance, rehabilitation program and budget. The program uses Markovian Transition probability methods to model the life cycle performance. DHT reviews the distribution of data for each of the three measured distresses and uses historic pavement performance to predict deterioration rates. Figure 2 illustrates the distribution of IRI data for a particular network. This data and historic pavement performance assist in the development of 5 or 10 year network targets.

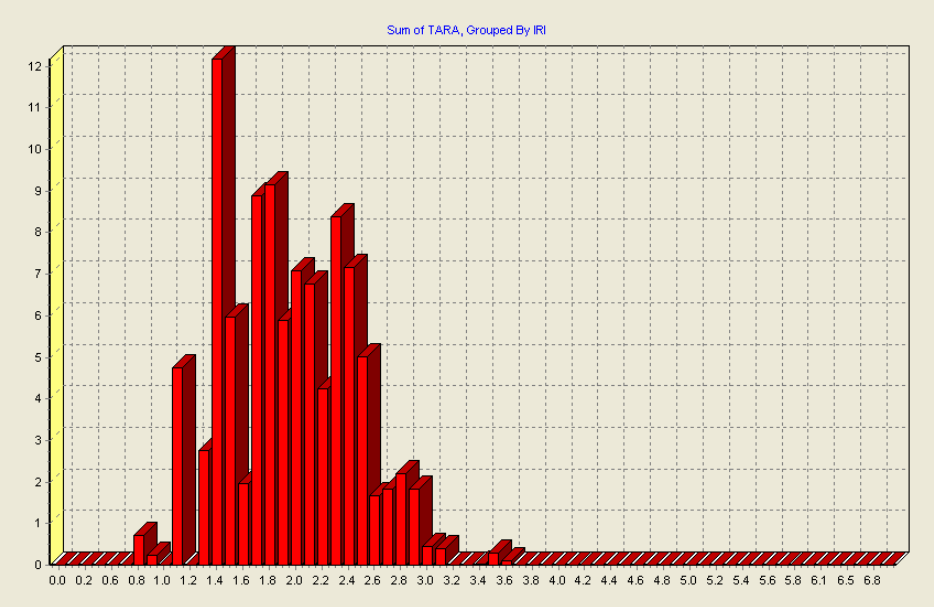

Figure 2 Area vs. IRI Distribution

For network level planning, DHT defines four work types: heavy, medium, light and routine. The costs for each work activity are calculated for each region and network. Table 2 outlines the targeted distress, road coverage, an example of activities, and approximate cost range. Examples of outputs will be shown in the next section. Once the models are completed for each region, they must pass a series of quality assurance tests and are then peer reviewed.

Definition	Targeted Distress	Road Coverage	Treatment	Cost (/m^2)
Heavy	All	Whole Segment	Asphalt Overlay	$15-$25
Medium	Rut	Whole Segment	Microsurfacing	$3-$5
Light	Cracking	Whole Segment	Graded Seal	$2-$4
Routine	All	Specific Area	spot seal, hand patch, etc.	<$1

Table 2 Network Level Categories

PPT Tactical is used for project level optimization by linking to the outputs of PPT Strategic. and are used to develop specific heavy, medium, and light projects. PPT Tactical uses linear programming optimization within a benefit/cost framework. Additionally, it uses survival curves, which are developed internally factoring in historic performance. Tactical model outputs provide projects for up to three years, which assists planning and design. As with PPT Strategic, PPT Tactical models are peer reviewed and tested to ensure they represent the highway network.

With the routine funding output from PPT Strategic, DHT uses a maintenance management system (MMS) to help the crews plan, schedule and deliver work. Routine funds are used to preserve the highway network. One of the outputs from the asset management project was the development of guidelines for types of maintenance treatments recommended for each condition state. This has allowed DHT to become more comfortable with long-term predictions of network performance since all crews will be following a similar strategy. Historically, maintenance activities were at the discretion of local managers and no direction was given to crews.

3.0 Network Level Scenarios

Annually, DHT receives preliminary funding targets for preservation of its asphalt concrete and granular networks, as shown in Table 3. Each network is modelled separately because each network has a different level of service and serves different functions. The province is divided into three geographic regions with each region having a portion of the three networks.

Network	Surface Type	km
RR Class 1	Asphalt Concrete	5031
RR Class 2	Asphalt Concrete	4176
RR Class 2	Aggregate Seal	4587

Table 3 Modeled Network

PPT Strategic is used to generate numerous combinations of funding alternatives for 5 or 10 years based on a DHT strategy. For each network, the existing condition of the three distresses is summarized, as shown in Figure 3, and is used as the basis for developing strategies.

	Rut % Good	IRI % Good	Cracking % Good
Region 1	92	80	60
Region 2	90	72	75
Region 3	90	90	81
Provincial Average	90	82	75

Legend	
	Above Provincial Average
	≈ Provincial Average
	Below Provincial Average

Figure 3 Example of Current Condition of Network

Numerous 5 or 10 year scenarios are developed and summarized in a table, similar to Table 4. The table shows fictitious annual values required to meet a 5 year target for a particular network. The mix of scenarios are combined and presented to the Executive to review and provide direction.

	Region 1	Region 2	Region 3
Each Region Maintain Average	$ 3,283,270	$ 6,112,528	$ 3,160,684
Target Provincial Average	$ 5,059,294	$ 5,441,286	$ 2,109,963
Target 1% below Provincial Average	$ 4,933,707	$ 5,212,447	$ 1,999,758
Target 3% below Provincial Average	$ 4,682,735	$ 4,755,638	$ 1,789,091
Target 1% above Provincial Average	$ 5,184,948	$ 5,670,200	$ 2,222,254
Target 3% above Provincial Average	$ 5,443,885	$ 6,142,710	$ 2,447,089
Target 5% above for Crack and maintain Prov Aver. for Rutt and IRI	$ 5,107,309	$ 5,511,209	$ 2,144,830

Table 4 Example of Scenarios for Specific Network

When scenarios are developed, DHT reviews the treatment type for the analysis period. Figure 4 illustrates the mix of routine, light, medium and heavy work for a 10 year analysis period and the annual cost.

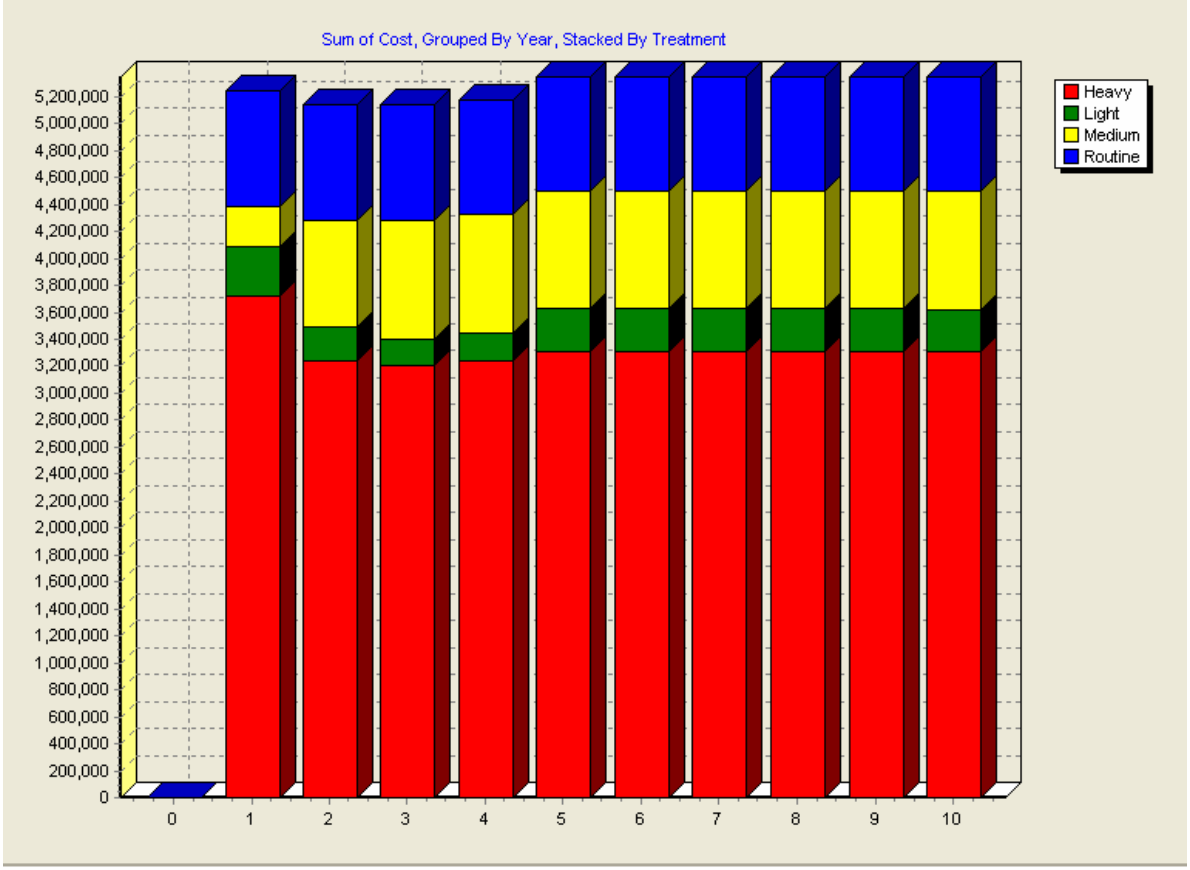

Figure 5 Summary of Type of Work by Year

As indicated previously, DHT uses condition states for planning and analysis. Figure 6 illustrates the type of work based on condition state. This type of graph is used to quality assure models and ensure that each condition state has an appropriate treatment. For example, a light treatment is a generally a good treatment in condition state 2 since DHT treats surface condition with aggregate seals.

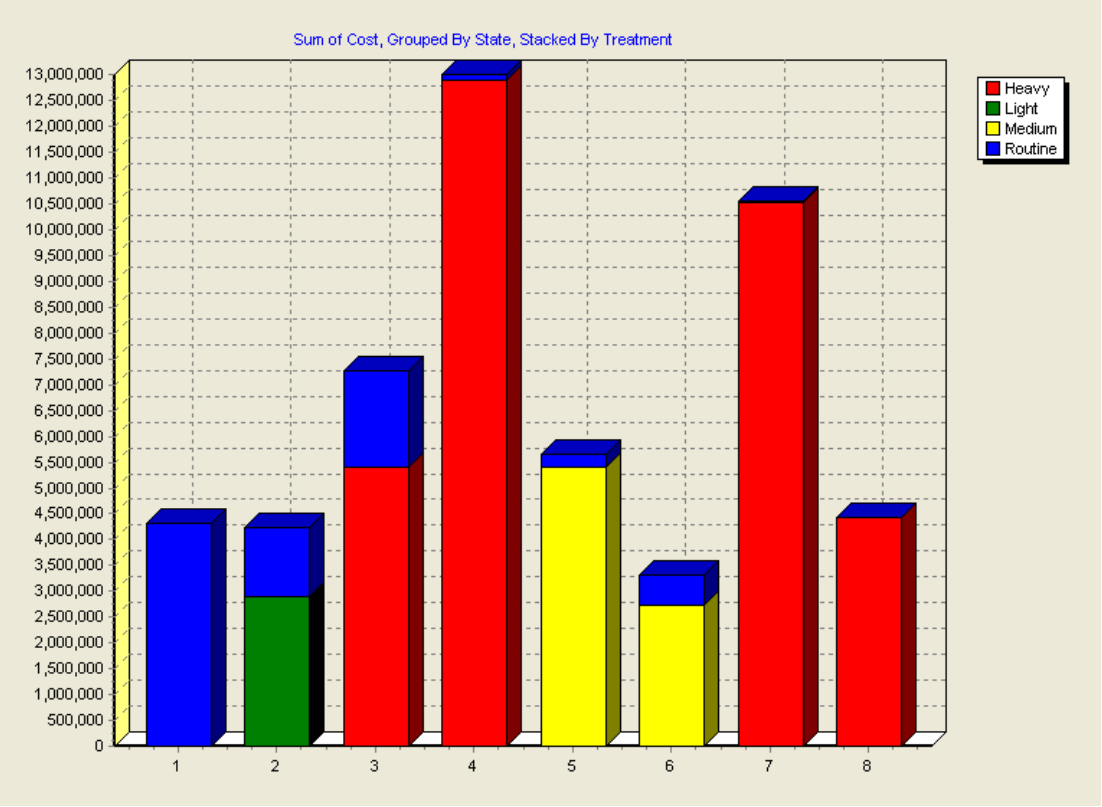

Figure 6 Type of Work by Condition State

4.0 Funding Request and Executive Direction

Once scenarios have been developed for each region and each of the three networks, a summary is taken to the Executive. The Executive uses the asset management information with DHT goals and objectives, future trends and existing pressures to choose the best mix of scenarios for each network. The information can also be used as an illustrative tool to other departments as a communication tool.

5.0 Project level Planning

Once Executive has chosen the strategies for the networks, DHT utilizes the PPT Tactical models to finalize projects. When developing the models, PPT Strategic and Tactical are calibrated so both models calculate similar mixtures of work. PPT Tactical outputs heavy, medium, and light projects. Because most of the heavy (rehabilitations), medium (microsurfacing), and light (aggregate seal treatment) projects are contracted, lists are required for advertising. An example of a typical output is shown in Figure 7.

Year	CS	Segment Name	From	To	Seg Area	Total Cost	Length	Unit Cost	Trt Effectiveness
Trt Applied : Full Seal (Light)									
1	2	0021100MUANN0207	14.95	15.88	6975	10462.5	930	1.5	2030105.798
1	4	0031500MUANN0202	5.85	8.75	21460	32190	2900	1.5	6107037.898
1	4	0031500MUANN0207	29.25	36.75	55500	83250	7500	1.5	17385284.34
1	8	0031500MUANN0210	45.2	48.35	23310	34965	3150	1.5	7399784.502
1	2	0041200MUANN0203	4.6	7.1	18750	28125	2500	1.5	5837305.562
1	2	0050400MUANN0202	1.2	3.85	19345	29017.5	2650	1.5	6139283.124
Trt Applied : Micro-Surface (Medium)									
1	5	0041100MUANN0205	16.7	17.65	7220	30685	950	4.25	5750296.8
1	7	0091300MUANN0205	18.9	20.25	9720	41310	1350	4.25	7741396.8
1	7	0130600MUANN0201	2.53	10.5	60572	257431	7970	4.25	48241963.68
1	7	0131200MUANN0205	20.75	23.9	23625	100406.25	3150	4.25	18815895
1	8	0150300MUANN0201	0	1.35	10260	43605	1350	4.25	8171474.4
Trt Applied : Structural (Heavy)									
1	7	0131200MUANN0204	16.45	20.75	32250	645000	4300	20	135982083.8
1	7	0260200MUANN0202	4.15	6.3	15910	318200	2150	20	61434879.9
1	8	0320200MUANN0207	27.25	33.64	47925	958500	6390	20	213450056.6
1	7	0420200MUANN0204	16.55	18.05	14100	282000	1500	20	55224906
1	7	0420300MUANN0208	34.85	38.68	27959	559180	3830	20	117716875.4
1	7	0440500MUANN0201	0	1.85	14800	296000	1850	20	55995783.86

Figure 7 Project List Example

The project list is developed for three years and requires scrutiny from regional staff before finalizing the project lists. Because segment lengths range from 500 m to 8.0 km, short segments in close proximity may be identified in different years so adjustments must be made so projects are reasonable in size for constructability and cost. Although PPT Tactical is currently run annually, the three year project list provides a reasonable estimate of future year projects.

6.0 Maintenance Management System (MMS)

DHT uses a MMS to plan, organize, schedule, track and review day to day maintenance tasks, as shown in Figure 8. DHT relies on maintenance crews for timely preventative maintenance because heavy, medium, and light treatments constitute a relatively minor percent of work on the network. Routine funding from PPT Strategic is split based on network level optimization to the 90 maintenance crews across the province for program development. Note that routine funding is provided to the maintenance crews by condition state.

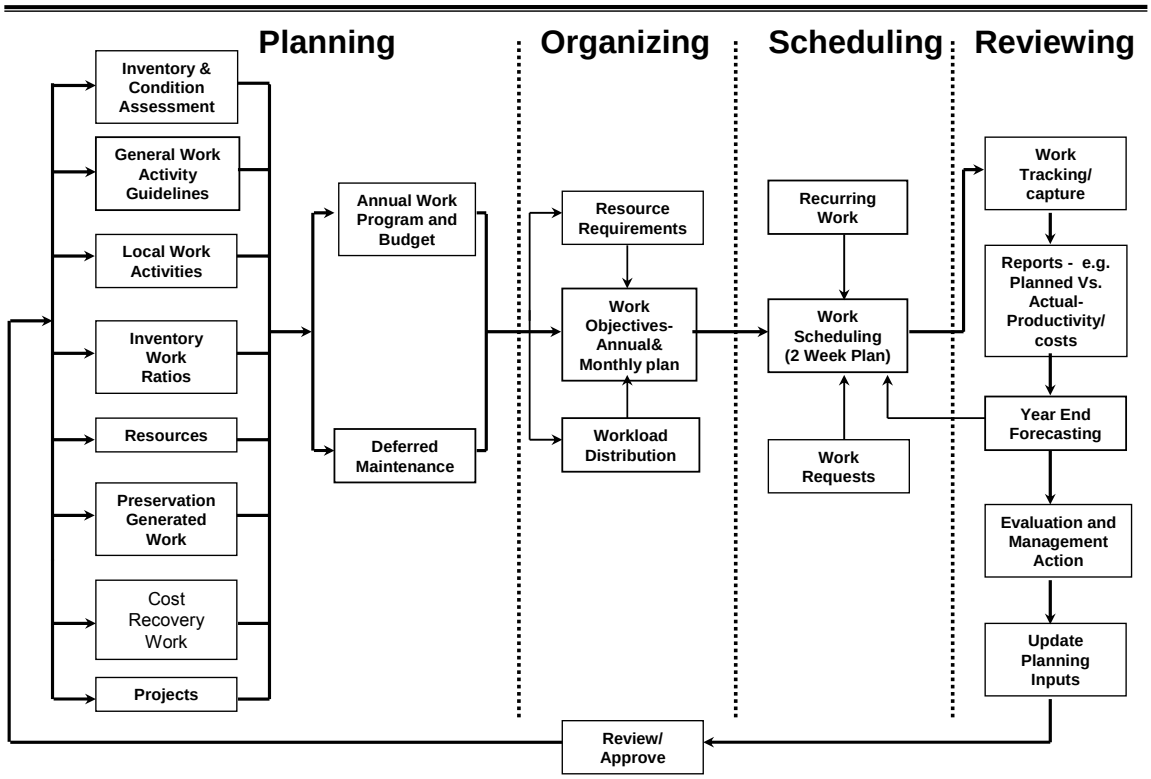

Figure 8 MMS Flowchart

To assist in the development of workplans and have confidence in the prediction of long-term models, maintenance guidelines were developed for the maintenance crews. An example of the guidelines is shown in Figure 9. The guidelines are flexible since it is difficult to limit work activities when only three surface distresses are measured.

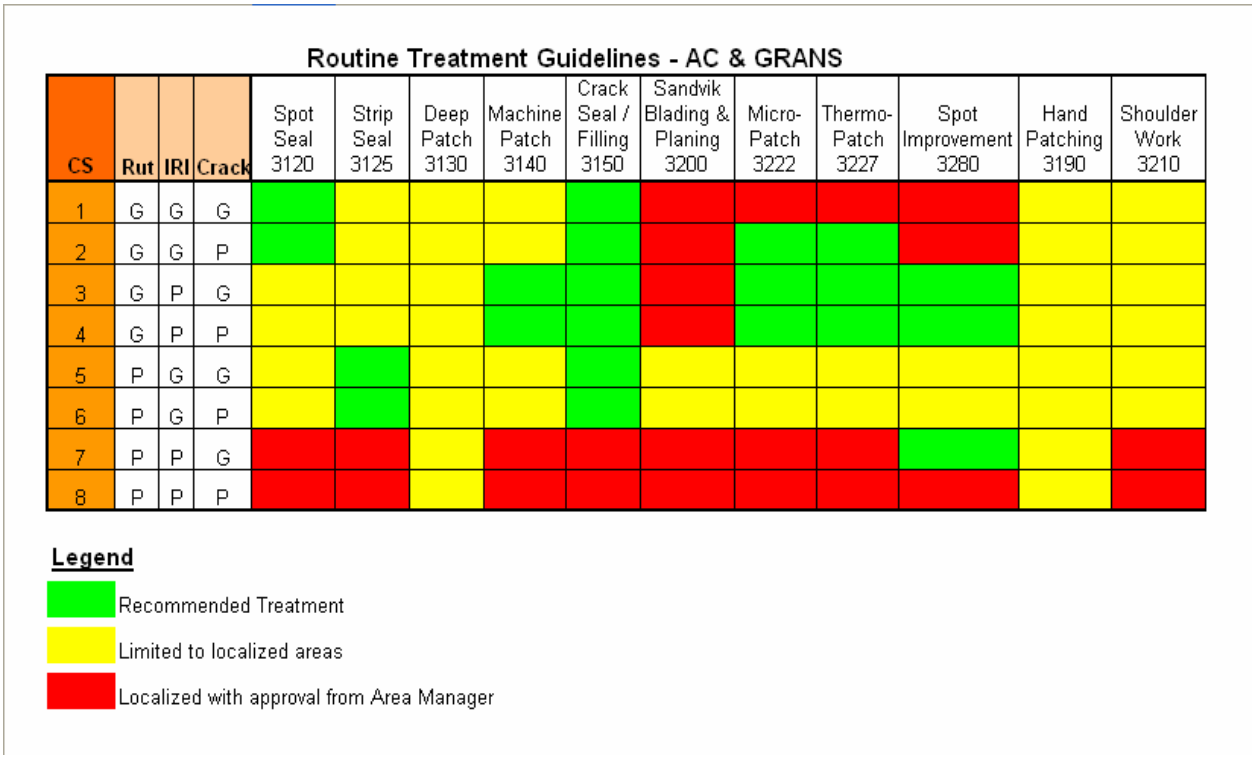

Figure 9 Maintenance Guidelines for Asphalt Concrete and Granular Highways

Once maintenance sections begin working in the spring, equipment, materials, and labour are tracked through the MMS. Managers and supervisors can use this detailed information to update budgets and accomplishments. MMS is a tool that helps DHT preserve the highway network.

7.0 Performance Measures

An important part of an asset management system is the ability to review and measure work accomplishments. Tracking work accomplished versus work planned allows DHT to evaluate progress with respect to the asset management goals. Recently, DHT moved to a SQL version of MMS which makes it easier to summarize and review data. Evaluating performance in this manner allows DHT to continually improve business practices.

Collected distress data is also compared with previous year's data to improve prediction models and measure treatment performance. This data is also used to evaluate new treatments and/or technologies (i.e. in-place recycling) and measure performance.

Conclusion

DHT use an asset management system as a tool to assist in the optimization of treatments and predict performance based on specific budget levels. Historically, it has been difficult to communicate to decision makers the consequences or improvements a budget will have on the highway networks; however, the asset management system provides a systematic process to assist in the delivery of a preservation program. DHT has seen benefits at the treasury board/ finance level from asset management due to their ability to show what is produced for the funding level received.