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Item No. 15.1.4
Halifax Regional Council
January 23, 2024

TO: Mayor Savage and Members of Halifax Regional Council

SUBMITTED BY: Original Signed

Cathie O'Toole, Chief Administrative Officer

DATE: January 15, 2024

SUBJECT: **Level of Service HRM Streets, Sidewalks, and Curb Networks**

ORIGIN

This report originates from The Strategic Priorities Plan 2021-25 and The Transportation and Public Works 2021/22 Budget and Business Plan. Both documents state: Municipal staff will work with Regional Council to articulate what a "Well-Maintained Transportation Network" means for the municipality. This includes defining levels of service for transportation related assets (e.g., streets, sidewalks, walkways, etc.) and will help identify funding requirements to maintain assets at an acceptable level.

This report also originates from the January 25, 2022, Regional Council report "Recommendation on Level of Service (LOS) for the HRM Street Network", where Council approved the following recommendation: Approve a biennial reporting period, whereby staff will conduct similar analyses and report back to Council every two years with pavement condition, as described in the Discussion section of this report.

LEGISLATIVE AUTHORITY

Halifax Regional Municipality Charter, R.S.N.S. 2008, c. 39:

Purposes of Municipality
7A The purposes of the Municipality are to
(a) provide good government;
(b) provide services, facilities and other things that, in the opinion of the Council, are necessary or desirable for all or part of the Municipality; and
(c) develop and maintain safe and viable communities.

Municipal expenditures
79A (1) Subject to subsections (2) to (4), the Municipality may only spend money for municipal purposes if
(a) the expenditure is included in the Municipality's operating budget or capital budget or is otherwise authorized by the Municipality.

Interpretation
317 In this Part, "street" means a public street, highway, road, lane, sidewalk, thoroughfare, bridge, square and the curbs, gutters, culverts and retaining walls in connection therewith, but does not include bridges vested in the Halifax-Dartmouth Bridge Commission and streets vested in His Majesty in right of the Province.
Streets vested in Municipality

RECOMMENDATION ON PAGE 2

318 (1) All streets in the Municipality are vested absolutely in the Municipality.

(2) In so far as is consistent with their use by the public, the Council has full control over the streets in the Municipality.

Street related powers
322 (1) The Council may design, lay out, open, expand, construct, maintain, improve, alter, repair, light, water, clean, and clear streets in the Municipality.

RECOMMENDATION

It is recommended that Halifax Regional Council:

1) Approve decreasing the current 67% "Good" target Level of Service (LOS) for Halifax Regional Municipality's (HRM) street pavement network to achieve a minimum of 60% of the network in "Good" condition;

2) Approve the proposed Budget Based Funding Scenario for the street pavement network described in Table 6 of this report which would result in "60% Good" being the target funding level for the Street Recapitalization Account (CR200006) in future capital plans;

3) Adopt a Level of Service for the existing sidewalk network of less than 1% of the network in Poor Condition (greater than 40% of sidewalk panels defective in a block) and less than 5% of the network in fair condition (greater than 20% to less than 40% defective), which would, in turn, result in the approval of the proposed 10-Year funding scenario to the Sidewalk Renewal Account (CR200002) as described in Table 9; and

4) Adopt a Level of Service for the existing curb network of less than 0.5% in critical condition.

EXECUTIVE SUMMARY

Pavement Network

HRM's paved street network is continuing to deteriorate due to the impact of inflationary costs, network growth due to road transfer and development, environmental and traffic impacts, and reductions to Street Recapitalization funding. As a result, the "67% Good" target (LOS) approved by Regional Council in January 2022 is no longer financially realistic. Staff is recommending a new LOS target of "60% Good" for HRM's pavement street network which also results in growing the current "Poor" condition backlog from 15% to 20% over the next ten years.

Public Works staff will look to conduct additional trials and research to develop more cost-effective strategies on a project-by-project basis for HRM's specific traffic and environmental challenges. Staff will also continue to refine the modelling capabilities of its pavement management system, utilizing the biennial condition data that is collected to further improve the analytical capabilities of the system.

Sidewalk Network

In general, the existing sidewalk network backlog has been improving. Staff recommend adopting a LOS of <1% of the network in Poor Condition (>40% of panels defective in a block) and <5% of the network in fair condition (>20% to <40% defective). To achieve this there is no change to Years 1 to 4 of the current proposed Capital Budget as shown in Table 9.

Curb Network

The overall curb network condition appears to be stabilizing or improving; however, the ongoing presence of Alkali Silica Reactivity (ASR) throughout the curb network has left uncertainty around the ability for staff to assess the deterioration rates of concrete curb. For this reason, staff recommend a LOS for the existing curb network of less than 0.5% in critical condition (currently at 0.4%). Note, this change would not require additional funding for curb in addition to that already provided by the Street Recapilization Account (CR200006).

Staff will continue to track the potential progression of ASR in the curb and sidewalk network to determine if this is predictable, to provide a more detailed LOS relating to critical and poor curb in future updates.

BACKGROUND

Public Works (PW) is responsible for the maintenance and rehabilitation of HRM's transportation assets. It is comprised of approximately 4211 lane kilometers of arterial, collector and local roads, 989 kilometers of existing concrete and asphalt sidewalks, and 2250 kilometers of concrete and asphalt curb/gutter. Transportation infrastructure asset management has been a core function of PW, with an on-going pavement condition data collection program, as well as data collection on other roadway infrastructure assets including curbs, sidewalk, walkways, and multi-use pathways. This information is used to monitor condition, identify deficiencies, and develop annual/long term capital investment plans. While PW has had a Pavement Management System (PMS) in place for several years, historically the sidewalk and curb networks have not received the same long-term planning focus.

Pavement

In January 2022, Transportation Infrastructure Management (TIM) staff presented a report to Regional Council titled "Recommendation on Level of Service (LOS) for the HRM Street Network", summarizing the needs backlog of the existing road network, establishing Pavement Quality Index (PQI) condition category thresholds for each functional class as displayed in Table 1 below, as well as providing recommendations for a target LOS for HRM' s streets along with the associated ten-year funding requirements to meet the target LOS. The historical background of pavement management for HRM can be found in the report cited above. The report noted that based on a 2014 consultant report, there had been an estimated $83.8 million funding shortfall on pavement rehabilitation between 2015 and 2021. The report recommended that based on the current condition and trying to stabilize the backlog (infrastructure deficit), HRM should target a LOS to maintain 67% of the roads in good condition and proposed the funding scenario outlined in Table 3 to achieve this.

Table 1. PQI Condition Category Thresholds for Each Functional Class

Functional Class	Good	Fair	Poor
Arterial	≥ 75	60-75	≤60
Major Collector	≥ 70	55-70	≤55
Minor Collector	≥ 65	50-65	≤50
Local	≥ 60	45-60	≤45

Table 2. 2022 Proposed Street Recapitalization Account Funding Required to Achieve Target Pavement LOS

Year	Funds Attributed to Pavement (60/65%)	Street Recap Funding Proposed
2021	$21,905,720*	
2022	$24,600,000	$41,000,000
2023	$35,000,000	$53,846,154
2024	$40,000,000	$61,538,462
2025	$45,000,000	$69,230,769
2026	$45,000,000	$69,230,769
2027	$45,000,000	$69,230,769
2028	$50,000,000	$76,923,077
2029	$50,000,000	$76,923,077
2030	$55,000,000	$84,615,385

*Estimated funds spent on Pavement in 2021

Since the approval of the proposed LOS and funding scenario in January 2022, the Street Recapitalization Account (CR200006) funding has been reduced by $18 million in years 2023 to 2025 to help mitigate the tax burden. Along with record inflation, increased construction costs and the 2022 transfer of roads from the Province, which included 264 lane kilometers of paved roads, the outlook of HRM's road network has changed significantly. While funding for the Street Recapitalization Account (CR200006) has generally increased, so has the spending on elements required by the Complete Streets initiatives, which include traffic calming, curb upgrades, and drainage improvements. Including projected inflation there will be an additional $47 million dollar shortfall in funding, as summarized in Figure 1 below.

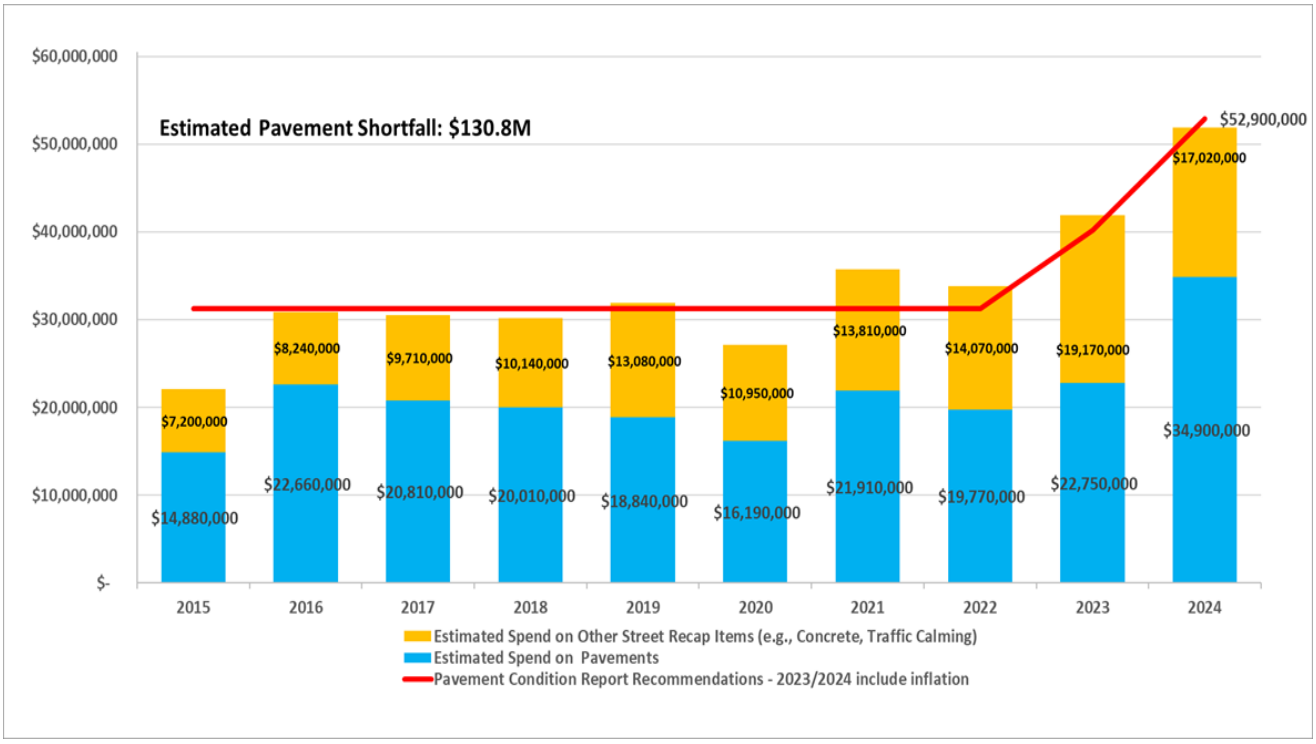

Figure 1. Spending Shortfall on Pavements

Sidewalk

Beginning in the late 1990's, curb and sidewalk condition data was collected manually by HRM staff on a three-year cycle. Approximately one third of the network was collected each year. Due to the increasing size of the network, as well as the scope of the assets collected, in 2013 HRM began contracting a consultant to complete the data collection of the non-pavement right-of-way assets. Ratings were completed by consultants in 2013, 2016, 2018 and 2021, with the entire network being collected in those years. The next data collection is scheduled for 2024.

The data collected for sidewalk includes the number of slabs, number of slabs showing distresses, and the types of distresses for each block of sidewalk. A total Percent Defective (%Def) and Sidewalk Deficiency Rating (SDR) is determined for each block. The Percent Defective is calculated by dividing the number of distressed slabs by the total number of slabs in each block segment. The SDR is like the Percent Defective, but minor defects receive less weight. In addition to the overall segment condition being assessed, any Priority 1 and Priority 2 hazards, as laid in the condition rating manual (most severe faults, cracks, and heaves), are noted and location and distress information are provided to the Infrastructure Maintenance and Operations (IMO) division to respond to according to their service standards.

For the purposes of the overall sidewalk network condition, each block is considered to be good, fair or poor based on the % Def, with 0 - 20%, 21 - 40% and 41 - 100% (of the entire block) being defined as good, fair, and poor respectively. Table 3 summarizes the sidewalk condition history.

Table 3. Historical Sidewalk Condition Data

Network wide by km	2013	2016	2018	2021
Good (0-20%)	66.3%	87.4%	83.8%	91.5%
Fair (21-40%)	25.6%	8.2%	11.0%	5.6%
Poor (>41%)	8.2%	4.4%	5.2%	2.9%

While the overall sidewalk network condition will be the focus for establishing a level of service from a capital planning perspective, the Priority 1 hazards are critical from a day-to-day accessibility and network functionality perspective and will need to continue to be addressed in a timely manner by IMO.

For sidewalks, the TIM Capital Program development procedures describe the sidewalk renewal selection criteria. Once the preliminary street capital program is developed, a list of the Percent Defective for any sidewalks on the street list is generated, and any sidewalks which have a rating above 40% defective are subsequently added to the Sidewalk Renewal Program. Based on available funding the highest Percent Defective sections are selected for consideration as stand-alone projects. If the available funding covers the estimated costs for the list of integrated projects, additional segments may be added based on the worst remaining sidewalk segments in the network. Once the Sidewalk Renewal program is developed further review and inspections are completed by TIM and Design and Construction staff, to refine the scope and estimates to the anticipated budget levels.

The Sidewalk Renewal capital budget is not the only funding expended to improve the overall sidewalk network condition. As mentioned above, IMO also plays a critical role in ensuring the most severe sidewalk defects are fixed, including ensuring permanent repairs meet current design standards and accessibility requirements where possible, including pedestrian ramps. Table 4 shows the budgeted concrete repair and replacement amounts since 2010. Note that the while the Sidewalk Renewal account comes from the capital budget, IMO uses funding from the Operations/State of Good Repair funding.

Table 4. Historical Sidewalk Repair/Renewal Spend

Budget Year	Sidewalk Renewal Capital Budget	IMO Concrete Sidewalk Repair Operations Budget	Total Concrete Sidewalk Repair/Renewal Budget
2010/2011	$1,495,000	$1,355,484	$2,850,484
2011/2012	$1,900,000	$1,499,077	$3,399,077
2012/2013	$2,000,000	$1,537,900	$3,537,900
2013/2014	$2,500,000	$1,523,700	$4,023,700
2014/2015	$2,500,000	$2,072,600	$4,572,600
2015/2016	$2,600,000	$2,230,200	$4,830,200
2016/2017	$3,000,000	$2,158,800	$5,158,800
2017/2018	$3,000,000	$2,186,100	$5,186,100
2018/2019	$2,750,000	$2,164,800	$4,914,800
2019/2020	$2,715,000	$2,091,400	$4,806,400
2020/2021	$2,500,000	$1,996,100	$4,496,100
2021/2022	$1,975,000	$2,417,200	$4,392,200
2022/2023	$2,000,000	$2,341,400	$4,341,400

As shown in Figure 2, during the mid-2010's funding toward sidewalk renewals and repairs peaked and the network condition gradually improved. These funding amounts have since decreased and with the recent inflation impacting construction costs (in the 30-50% range for concrete related items), new spending targets have been developed and are laid out in the Discussion section of this report.

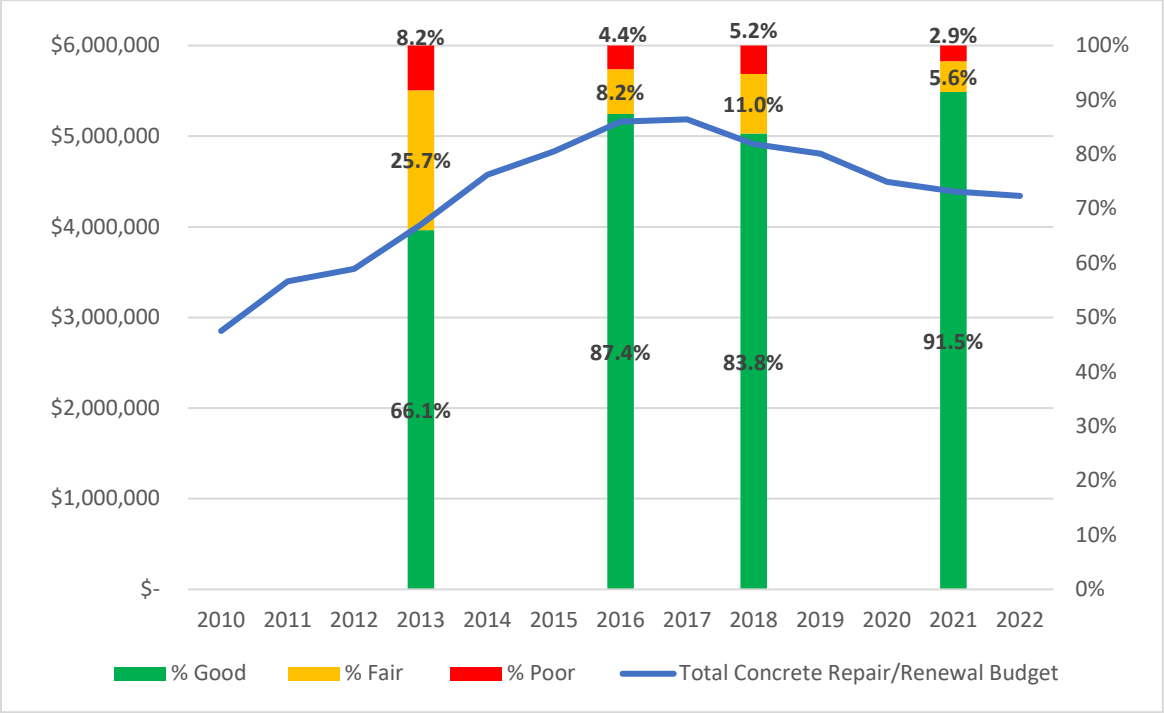

Figure 2. HRM Sidewalk Network vs Budget Spend

Curb

The collected data for the curb network includes an overall numerical rating. In 2013 and 2016, HRM used a 1, 2, 3 rating system (Poor/Fair/Good) and transitioned to a 1 to 5 rating system in 2018 and 2021 (Representing Critical to Very Good). Table 5 below summarizes the historical network condition of the curb network. Similar to the sidewalk rating process, the curb condition is rated manually. While every effort is made to ensure consistency during data collection, there is inherent subjectivity, and a certain amount of variation is expected from year to year due to changes in personnel and conditions.

Table 5. Historical Curb Condition Data

Year	Very Good	Good	Fair	Poor	Critical
2014	N/A	71.8%	20.3%	7.9%	N/A
2016	N/A	81.2%	13.7%	5.1%	N/A
2018	25.7%	40.9%	26.8%	4.6%	1.9%
2021	15.3%	61.0%	20.3%	3.0%	0.4%

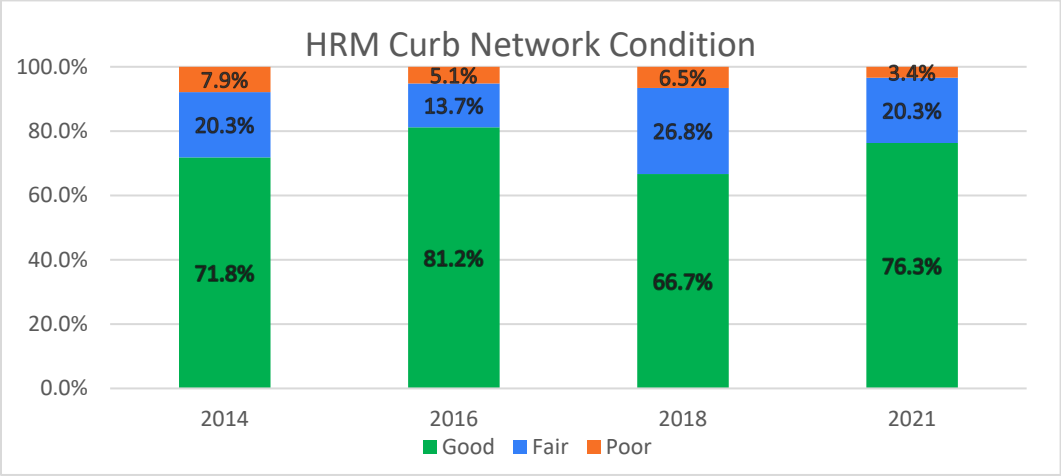

Figure 3. HRM Curb Network Condition

Alkali Aggregate Reaction

During the 2018 data collection process, TIM staff requested the consultant begin to note the presence of early or advanced-stage Alkali Aggregate Reaction (AAR). AAR happens when certain aggregates react with the alkalis in Portland Cement when in the presence of moisture. This reaction continues over time and can cause expansion of the concrete leading to premature cracking and deterioration. In Nova Scotia this reaction primarily occurs as Alkali Silica Reactivity (ASR) occurring in silicate minerals found in specific rock types, including types commonly found in quarried aggregate located in HRM. There are methodologies to help mitigate/reduce the extent of this reaction in concrete mixes. One methodology is to utilize supplementary cementing materials (e.g., flyash, Slag), which is a requirement in our current specifications. However, this was not always the case, as ASR was not as well understood in the past. As a result, large amounts of curb (and sidewalk to a lesser extent) are beginning to fail prematurely. Typically, the expected lifespan for concrete curb is 50-75 years; however, HRM is needing to replace concrete curb in some cases after 20-30 years due to the accelerated deterioration from ASR.

In 2021 parts of 477 km (out of 2250 km) of curb were observed to be showing some early signs of ASR and portions of 70 km were displaying signs of advanced stage ASR. Early-stage signs of ASR include fine cracking through the middle of the curb or gutter face with mild surface discoloration around the cracking from the silica gel reaction. Signs of advanced stage of ASR include cracks opening further and propagating throughout to appear as random "map cracking," and eventually fully eroding the concrete surface leading to chunks of concrete popping out. TIM staff is currently working to better understand the speed at which this progression occurs in our climate with typical local mixes and will begin conducting research into ways to delay the progression, if possible.

DISCUSSION

The key objectives of HRM's Transportation Asset Management Program continues to be to manage the assets to a level of service which meets the expectations of Regional Council and provides a safe and functional network, while applying cost effective solutions. The sidewalk LOS discussed in the following segment relates to the state of good repair around our existing sidewalks and is not directly connected to the "New Sidewalk Level of Service" Council Report dated on January 11, 2024 which discusses funding around high needs gaps for new sidewalk segments within the existing sidewalk network .

Pavement

In January 2022, HRM established a target LOS of "67% Good" for the street network. In summer 2022, new condition data was collected for the entire paved roadway network, including the 264 paved lane-km acquired from the provincial road transfer in June 2022. Staff updated the network condition charts to show the 2022 data along with the 2016, 2018 and 2020 condition data. Figure 4 below displays the 2022 projected PQI and % Good as represented in the 2022 LOS Report, in comparison to the projected PQI and % Good based on the draft 2024/25 Capital Budget for Street Recapitalization.

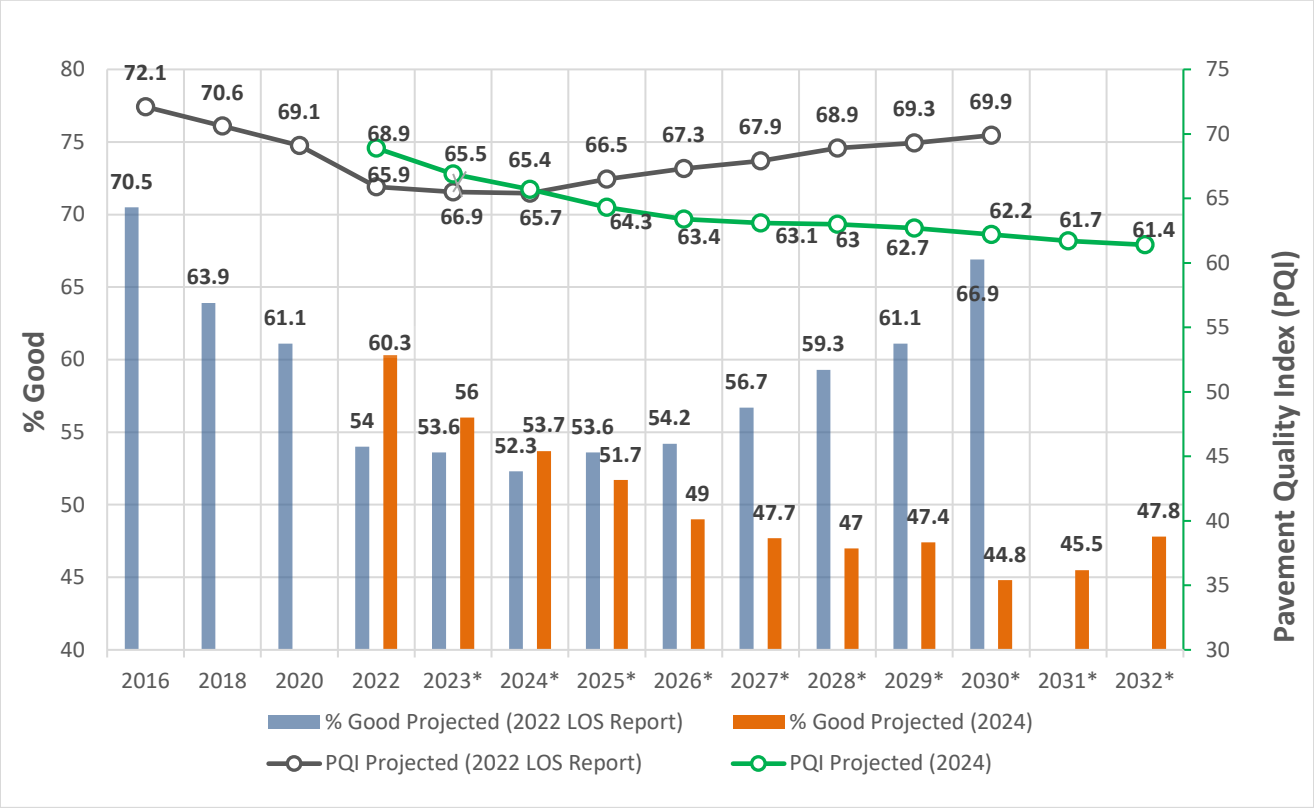

Figure 4. Pavement Network Condition Projection Based on Proposed 2024/25 Funding Program

The analysis utilizes the newly collected 2022 PQI data and updated rehabilitation unit costs based on the current years awarded work. Unit rates for rehabilitation costs for paving work have increased between 30 to 50%. Note, that the jump in PQI and % Good in 2022 is primarily due to the length and condition of arterial and collector roads acquired from the provincial road transfer. The 264 new lane-km of road represent an increase of 6.5% to the network length, which did not come with additional funding.

Given the updated data, and trends noted in Figure 4, staff performed an updated budget and performance LOS analysis utilizing the pavement management system to review the updated funding needs to achieve the approved LOS of 67% Good.

The following analysis parameters were used in the pavement management system:

- Programming and Economic Analysis Period: 10 years (base year is 2023)
- Inflation Rate: 0% (i.e., analysis based on present day costs)
- Discount Rate: 0% (i.e., constant dollars approach used for the Maintenance & Rehabilitation (M&R) analysis, therefore, the interest rate used to estimate the present worth of future costs and benefits is zero.)
- M&R costs provided by HRM (2023/24 Unit Rates)
- Engineering Factor of 1 (i.e., no increase in funding due to additional assets or engineering costs)

As shown in the analysis results displayed in Table 6, an average spend of approximately $61 million dollars annually including $116 million in year one would be required to achieve and maintain the approved 2022 LOS of 67% Good. Note that these are costs associated solely to pavement M&R. This is not feasible due to design and contractor limitations (e.g., resource capacity), as well as funding availability. However, the current proposed 2024/25 funding leads to the needs backlog (infrastructure deficit - $ to bring all assets above the poor threshold) doubling from 15% to nearly 30% over the next 10 years. Such a backlog could represent several risks to HRM, including:

- Further increased maintenance costs (for roads and vehicles).
- Greater public dissatisfaction.
- Missed opportunities to perform minor maintenance, leading to higher overall cost of repairs.
- More costly and disruptive future rehabilitations.
- Situations where network condition leads to health and safety issues for all modes of transportation.

Table 6. Pavement Network Backlog Based on Proposed 2024/25 Funding vs Spending Required to Meet Current LOS

Budget Scenario	Average Annual Budget Needs ($M)*	Year-1 Needs ($M)*	Needs Backlog at Year 10 (% Lane-Kms)	PQI at Year 10	Average % Good	% Good at Year 10
Base Level Funding	47	35	**29.7**	61.4	50	47.9
67% Good	61	**116**	15.2	67.4	67	65.7

*Funds are for Pavement M&R only

Given the potential risks associated with growing infrastructure deficit, it is important to attempt to reduce the backlog, or, at a minimum, maintain the current backlog. Industry standard recommends minimizing backlog to near 10%. Staff conducted a number of budget and performance LOS analyses to determine a feasible funding strategy which balances long-term network condition and funding considerations, as well as the ability for both internal and external stakeholders to deliver a proposed program.

The scenarios (including those considered above) included:

- Budget based scenario (base-level funding).

- Maintain current network average PQI (PQI = 68.9).
- Maintain the current network average PQI minus 3 (PQI = 66.1).
- Maintain a minimum of 67% of the network in good condition with PQI for each functional class greater or as shown in Table 2 for the Good category.
- Maintain a minimum of 64% of the network in good condition with PQI for each functional class greater or as shown in Table 2 for the Good category.
- Maintain a minimum of 60% of the network in good condition with PQI for each functional class greater or as shown in Table 2 for the Good category.
- Maintain a maximum of 10% of the network in poor condition with PQI for each functional class less or as shown in Table 2 for the Poor category.
- Maintain a maximum of 15% of the network in poor condition with PQI for each functional class less or as shown in Table 2 for the Poor category.
- Maintain a maximum of 20% of the network in poor condition with PQI for each functional class less or as shown in Table 2 for the Poor category.

Table 7. Summary of Budget and Performance LOS Analyses

Budget Scenario	Average Annual Budget Needs ($M)*	Year-1 Needs ($M)*	Needs Backlog at Year 10 (% Lane-Kms)	PQI at Year 10	Average % Good	% Good at Year 10
Base Level Funding	47	35	29.7	61.4	49	47.9
Maintain Current PQI (68.9)	65	86	16.7	68.9	64	68.4
Maintain Current PQI Minus 3	56	35	22.9	65.9	57	58.6
67% Good	61	116	15.2	67.4	67	65.7
64% Good	57	86	17.7	66.3	64	63.3
60% Good	52	51	21.3	64.9	60	59.6
10% Poor	62	90	10	68.7	59	61.8
15% Poor	53	30	15	66.2	54	57.7
20% Poor	48	35	19.9	64.3	50	52

*Funds are for Pavement M&R only

Based on the analyses results displayed in Table 7 above, the 67% Good scenario remains the optimal scenario since it stabilizes the backlog and maintains the largest percentage of streets in good condition. However, as mentioned above, this scenario is likely no longer achievable due to the funding requirements over the next ten years and the current budget pressures faced by HRM.

As a result, staff further explored two alternate scenarios to 67% Good which align closer to the current available funding proposed in the 2024/25 Capital Budget for Street Recapitalization, 60% Good and 20% Poor. In both scenarios, the needs backlog unfortunately increases from 15% to approximately 20% over the ten-year analysis period. The 60% Good scenario does maintain a higher percentage of streets in Good condition but does require slightly more funding over the ten years. Both scenarios align with the proposed 2024/25 Capital Budget for years 1 and 2 which should ensure that the design and construction groups have time to reach the capacity to meet the needs of the future work plan. Funding would gradually increase over the 10 years to achieve the proposed target LOS.

As mentioned above, the analyses conducted by the pavement management system only include pavement maintenance and rehabilitation costs (M&R), however the Street Recapitalization Account that funds pavement M&R also fund complete streets elements such as curb and traffic calming. As noted in the 2022 LOS report, only 60-70% of the Street Recapitalization Account Funding gets attributed directly to pavement M&R. The resulting Street Recapitalization funding scenarios for 60% Good and 20% Poor are laid out in Table 8 and are compared to the requirements for 67% Good. The estimated street recap costs include an estimated 30% of funds used to cover other elements of construction including curb, traffic calming and some storm infrastructure (does not include new storm systems). Additionally, due to processing limitations the initial analyses did not include any inflationary considerations, therefore the funding scenarios below incorporates an assumed annual growth rate of 3.59% which includes 3.09% estimated inflation and 0.5% network growth rate annually.

Table 8. Funding Scenarios for Pavements for 67 % Good, 60% Good, and 20% Poor

Year	2023/24 Approved Street Recap Funding (CR200006)	Required to Achieve and Maintain 67% Good	Required to Target 60% Good	Required to Target 20% Poor
		Street Recap Cost	Street Recap Cost	Street Recap Cost
2023	$42,830,000	$42,830,000	$42,830,000	$42,830,000
2024	$51,920,000*	$57,705,000**	$57,705,000**	$57,705,000**
2025	$58,920,000	$61,118,100***	$61,118,000***	$61,118,000***
2026	$64,205,000	$91,979,041	$76,649,000	$76,649,000
2027	$64,205,000	$103,221,179	$79,400,000	$79,400,000
2028	$71,350,000	$115,151,959	$98,701,000	$90,476,000
2029	$71,350,000	$127,806,337	$110,765,000	$93,724,000
2030	$78,490,000	$141,220,890	$123,568,000	$105,915,000
2031	$78,490,000	$155,433,890	$137,147,000	$109,718,000
2032	$78,490,000	$161,013,967	$142,071,000	$123,128,000
Average	$67,725,300	$106,869,844	$94,117,200	$85,188,100

*The total Workplan for 2024/25 is $68,923,000.
**Includes estimated Halifax Water Cost Share of $5,785,000
***Includes estimated inflationary costs

Due to recent funding cuts to Street Recapitalization, rising inflationary costs for paving and complete streets elements, network growth due to road transfer and development, and the current budget pressures faced by HRM due to rapid growth etc., the 2022 approved LOS of 67% Good is no longer financially realistic. As a result, staff explored two alternate scenarios (60% Good, 20% Poor) which unfortunately will lead to an increased infrastructure deficit or backlog over the ten-year analysis period (increase from 15% to 20%). Staff are now recommending a new target LOS of 60% Good which would be achieved by 2032. Figure 5 shows the predicted % Good for each of the proposed scenarios over the next 10 years.

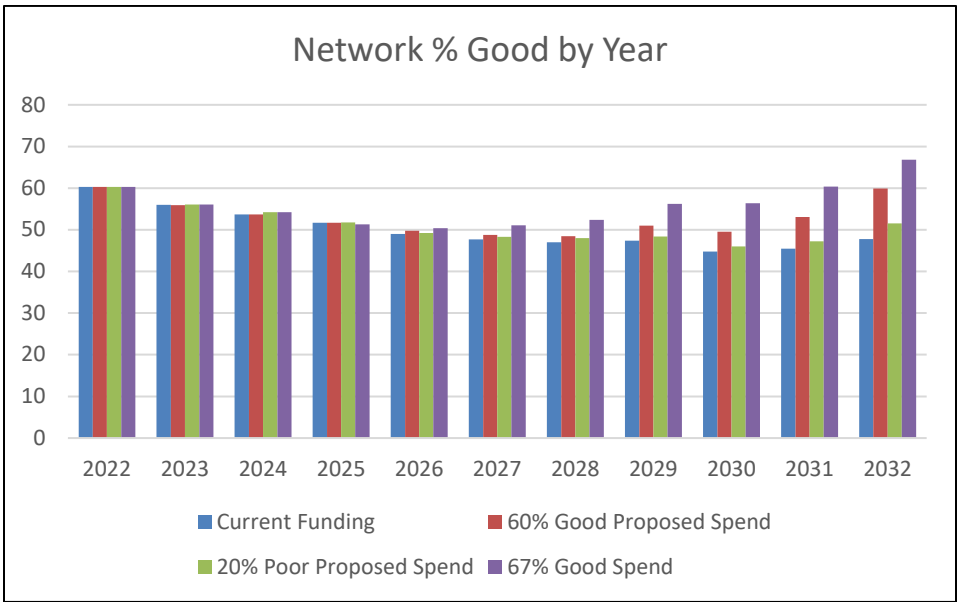

Figure 5. Annual % Good based on Required Funding Scenario

Sidewalk

Sidewalks play a crucial role in facilitating safe pedestrian movement and promoting active transportation. They serve as vital connectors within communities, enabling individuals to access various destinations, including residential areas, schools, businesses, and public spaces. The quality and condition of sidewalks significantly impact the level of service they provide to pedestrians. Understanding and evaluating sidewalk condition level of service is critical for enhancing pedestrian mobility, safety, and overall urban livability.

As with the street network level of service (LOS), part of the Strategic Priorities plan includes defining a LOS framework to encompass existing sidewalks. Based on the observations made during our assessments, staff are recommending that sidewalk segments (blocks) be classified using the following condition categories:

a. Good (% Def= 0% to 20%): Sidewalks in good condition exhibit minimal or no visible signs of distress. They have a smooth surface, minimal cracking or faults, and are free from obstructions or hazards that impede pedestrian movement.

b. Fair (% Def = 20% to 40%): Sidewalks in fair condition show noticeable signs of wear and tear but are still generally functional. They may have moderate cracking, slightly uneven surfaces or surface deterioration, or minor encroachments that may require attention and maintenance.

c. Poor (% Def = >40%) Sidewalks in poor condition exhibit significant deterioration and pose substantial hazards to pedestrians. They may have severe cracking, heaving, surface disintegration, inadequate width, or a high presence of obstacles that hinder safe and comfortable travel.

Sidewalks in poor condition have a profound impact on the mobility and accessibility of all pedestrians, particularly individuals who rely on wheelchairs for their daily transportation, as well as negatively impacting the walking experience, discouraging pedestrians from using sidewalks and potentially forcing them onto roadways, increasing the risk of accidents.

In 2022, staff worked with Stantec Consulting Ltd. (Stantec) to conduct jurisdictional scans as it relates to sidewalk condition assessment. The goal was to better understand industry standards in asset

management practices relating to sidewalks. The full memo can be found in Attachment 2, however an important takeaway from the analysis reads:

> *"Unlike primary infrastructure, such as roadways and bridges, sidewalks generally receive lower attention. However, lawsuits incurred from sidewalk hazards can be costly for jurisdictions and detrimental to public perception of safety and mobility.*
>
> *Many municipalities recognize the importance of maintaining sidewalk assets systematically from condition evaluation to treatment selection. However, limited resources for sidewalk assets, such as standards, reports, and research papers are available.*
>
> *HRM is among a few municipal agencies in Canada that have embarked on a strategic enterprise asset management journey and invested in developing sidewalk management tools and processes."*

To summarize the findings of the jurisdictional scan, there is not currently an industry standard relating to sidewalk asset management, levels of service or long-term investment strategies.

Given the minimal guidance from other jurisdictions, staff believe a good starting point for establishing a Sidewalk LOS for HRM is to stabilize or improve the current needs backlog. In general, the calculated needs backlog, as shown in Figure 6 below, has decreased for the existing sidewalk network. The variability from collection to collection can be attributed to the human element of collecting large amounts of data as described in the background section, however the overall trend indicates that existing funding has been effective in reducing the backlog. Staff will continue to collect and assess the asset data and monitor the effectiveness of the program. Though staff have not yet developed formal deterioration curves for sidewalks, to establish a funding scenario staff included all sidewalks with greater than 30% defective as needing full block replacement. The intent is that segments between 30% and 40% defective will continue to deteriorate and likely trigger rehabilitation over the ten-year analysis period.

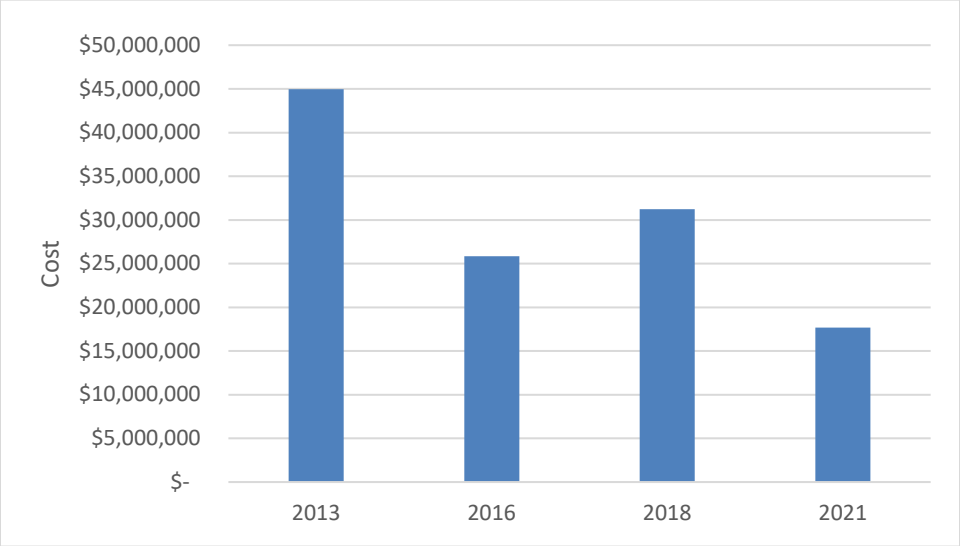

Figure 6. Sidewalk Rehabilitation Needs Backlog (Funds required to bring all sidewalk segments above "Poor" threshold)

Given the recent sidewalk condition data trends, general improvements to the network, and reductions to backlog, staff are recommending the following Level of Service (LOS) for the sidewalk network: Less than one percent of the network in Poor Condition (greater than 40% of sidewalk panels defective in a block)

and less than five percent of the network in fair condition (greater than 20% to less than 40% defective). While the elimination of all sidewalks in poor condition would be desirable, due to project integration timing and Complete Streets considerations, this is not achievable.

Based on the current and estimated future backlog (encompassing sidewalk segments that are currently greater than 30% defective), staff are proposing the ten-year funding scenario for the Sidewalk Renewals Capital Account (CR200002) displayed in Table 9 below,

Table 9. Ten-Year Funding Scenario to Achieve Target Sidewalk LOS

Year	Sidewalk Renewal (CR200001)
2024	$ 2,000,000
2025	$ 2,500,000
2026	$ 2,500,000
2027	$ 3,000,000
2028	$ 3,100,000
2029	$ 3,200,000
2030	$ 3,300,000
2031	$ 3,400,000
2032	$ 3,500,000
2033	$ 3,600,000

Aside from the overall sidewalk condition considerations, localized distresses and substandard pedestrian ramps also pose potential safety issues relating to accessibility. Localized hazards from distress, including faulting, heaving, and cracking, are brought forward during our asset condition assessment (currently rated every 3 years) and service requests submitted by the public. These hazards will at times be remedied when they are included in work associated with capital projects but in most cases are addressed by HRM's IMO Division as part of their State of Good Repair work. Appropriate resources should continue to be directed to IMO's operational funding to address these safety issues in a timely manner.

Pedestrian ramps are included in sidewalk condition data collection and renewal. At the end of 2022, HRM had over 10,000 pedestrian ramps, of which approximately 2,500 had been upgraded to recent standards and include tactile walking surface indicators. Current provincial government requirements for meeting accessibility standards are not well defined, however, it is staffs understanding that when assets are built or renewed, they are required to meet the current standards including tactile plates. Last year, 527 ramps were upgraded through capital construction projects and operational efforts. The total cost to upgrade all remaining pedestrian ramps is estimated to exceed $100 million.

Staff identified the potential to upgrade an additional 200-300 ramps per year in segments adjacent to projects included in our asphalt overlay contract work. This would include any substandard ramps, many of which are still in good or fair condition. The estimated cost to do this additional work is $2.5-$4 million dollars annually. Note this work requires significant design effort and different construction crews and may delay work relating to paving, which as discussed in the street network assessment, is already in a critical state. As a result, staff are not recommending introducing this additional funding at this time when also considering the current financial pressures and potential changes to the existing CSA standards. However, as part of the 2024 data collection and assessment, staff will explore the possibility of a stand-alone pedestrian ramp upgrade program that would target the least accessible ramps first. Staff will include this work when they provide the next LOS update in 2025.

Curb

Curbs play a key role in the overall transportation infrastructure, serving as both functional and aesthetic components of roadways. Curbs provide essential delineation and guidance for traffic, separating roadways from sidewalks, parking areas, and other spaces. Well-maintained curbs ensure the safety of pedestrians and drivers, preventing unintended incursions onto sidewalks and green spaces and help control stormwater runoff during major precipitation events, directing it to drainage systems and preventing erosion and flooding.

As discussed in the background section, 3.4% of the curb network was in poor or critical condition during the most recent data collection in 2021. This equates to approximately 66.5 km of curb in poor condition and 8.9 km in critical condition, resulting in an estimated backlog of more than $26 Million. Figure 7 shows a decrease in the backlog (funds required to bring all sidewalk segments above "Poor" threshold) from 2014 to 2021. The improvement of the network over this time is likely a result of the implementation of the "complete streets" focus and emphasis on curb renewal at the time of paving.

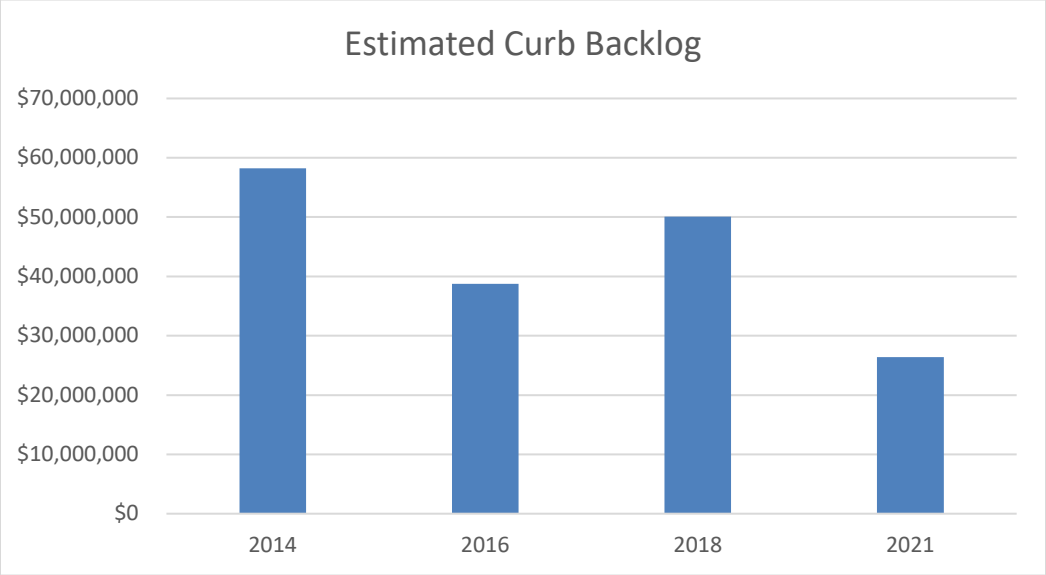

Figure 7. Curb Rehabilitation Needs Backlog

Curb renewal is currently funded by the Street Recapitalization Account (CR200006) and where the network pavement condition is projected to deteriorate significantly over the next 10 years, the curb network condition appears to be improving or stabilizing. While the amount of curb renewal varies year to year depending on projects, an additional $23 million dollars toward curb renewal has been funded since the data collection in 2021 (Table 10).

Table 10. Historical Curb Repair/Renewal Spend

Budget Year	Estimated Spend on Curb Renewal	Total Recap Budget	% of Total Recapitalization Budget (CR200006)
2022/2023	$6,511,710	$ 41,000,000	15.88%
2023/2024	$5,262,000	$ 42,830,000	12.29%
2024/2025	$11,287,140	$ 51,920,000	21.74%

Based on the current network condition and projected funding, staff are recommending the following LOS: Less than 0.5% of the existing curb network in critical condition (currently at 0.4%). Note, this change would not require additional funding proposed in the 2024/25 Capital Plan. While the elimination of all curbs in poor condition would be desirable, due to project integration, timing, and Complete Streets considerations, this is not achievable. Staff will continue to track the potential progression of Alkali Silica Reaction (ASR) in the curb and sidewalk network to determine if this is predictable in order to provide a more detailed LOS relating to critical and poor curb in future LOS updates.

FINANCIAL IMPLICATIONS

There is no change recommended to the draft 2024/25 Capital Budget. Depending on the level of service targets Regional Council wishes to support and the alternatives adopted, there are additions recommended to the capital plan for Street Recapitalization over the next three years and beyond. These implications are summarized in the table below:

Street Recapitalization #CR200006	2024/25	2025/26	2026/27	2027/28	Total 4Yr Plan
Approved 2023/24 Capital Plan	51,920,000	58,920,000	64,205,000	64,205,000	$ 239,250,000
Draft 2024/25 Capital Plan	57,705,000	58,920,000	64,205,000	64,205,000	$ 245,035,000
60% Good Target (Proposed Table 10)	57,705,000	61,118,000	76,649,000	79,400,000	$ 274,872,000
Additional Funding Required	**$ -**	**$ 2,198,000**	**$ 12,444,000**	**$ 15,195,000**	**$ 29,837,000**
67% Good Target (Alternative per Table 10)	57,705,000	61,118,100	91,979,041	103,221,179	$ 314,023,320
Additional Funding Required	**$ -**	**$ 2,198,100**	**$ 27,774,041**	**$ 39,016,179**	**$ 68,988,320**

How HRM has reached this point is the culmination of budget decisions of the past few years. In 2022/23, Regional Council approved increasing the annual capital-from-operating funding targets to support the 67% Good Level of Service targets. In the face of budget pressures in 2023/24 and 2024/25, Regional Council was provided options to reduce current year tax increases. For the capital budget, this meant reducing the capital-from-operating funding by $8 million in 2023/24 and a reduction of $30 million is proposed in the draft 2024/25 budget. Staff has had to reduce capital-from-operating funding intended to stabilize the Street Recapitalization budget. The Street Recapitalization budget is now funded by a combination of debt and the Canada Community Building Fund (CCBF). While the CCBF ten-year agreement with the federal government is due for renewal, it is believed that the funding source will continue to be predictable and stable.

Future increases beyond those currently included in the draft four-year capital plan will need to come from increases in capital from operating funding (increase to current year taxes) or increased debt policy levels (increase to future taxes plus debt servicing costs premium). A change of priorities in the Street Recapitalization program, as outlined in the Alternatives, could impact the percentage of the overall budget dedicated to maintaining/improving pavement condition.

Year	Additional Funding Required in Ten-Year Capital Plan to Support "60% Good" Target	Estimated Debt Payments for Additional Capital Budget	Estimated Tax Impact Based on 2023/24 Avg. Bill	
			If Cap-fr-Op Funded	If Debt Funded
2024/25	$ -		$ -	$ -
2025/26	$ 2,198,000		$ 7.75	$ -
2026/27	$ 12,444,000	$ -	$ 43.86	$ -
2027/28	$ 15,195,000	$ 154,000	$ 53.56	$ 0.54
2028/29	$ 27,351,000	$ 1,025,000	$ 96.40	$ 3.61
2029/30	$ 39,415,000	$ 2,089,000	$ 138.92	$ 7.36
2030/31	$ 45,078,000	$ 4,004,000	$ 158.88	$ 14.11
2031/32	$ 58,657,000	$ 6,763,000	$ 206.74	$ 23.84
2032/33	$ 63,581,000	$ 9,918,000	$ 224.10	$ 34.96

RISK CONSIDERATION

Research suggests that poorly maintained pavement, sidewalk and curb assets can result in:

- Increased operational reactive maintenance requirements (e.g., increased need for pothole repairs).
- Lower customer satisfaction.
- Increased vehicle maintenance costs (frames, suspensions, tires, etc.) of private as well as transit and commercial vehicles.
- Reduced network safety (friction and drainage issues) and reduced accessibility.
- Potential for increased claims and greater liability.
- Potential for health and safety impacts.
- Likelihood that missed opportunities to perform minor maintenance and rehabilitation will result in a greater volume of major rehabilitation needs along with higher cost repairs.
- Likelihood that more intrusive rehabilitation requirements increase road disruption.

Specific to the pavement network, further deterioration could result in risks associated with the items listed above. These risks could be related to service delivery, health and safety, reputation and legal. Additionally, the more the pavement condition backlog grow, the greater the cost will be to reduce it in the future.

Industry capacity to deliver continues to be a risk. While the proposed budget scenarios have allowed for gradual increase in projects, it is possible that industry is not able to grow to meet this demand.

There is a risk relating to the ASR observed in our concrete curb and sidewalk elements. While we know that it is occurring, we still do not have a clear sense about prediction modeling and the future impacts. Staff will continue to track the progression and attempt to develop models as more data is acquired.

COMMUNITY ENGAGEMENT

No direct community engagement was completed as part of this report. However, the 2022 Municipal Services Survey indicated that 65% of respondents were dissatisfied or very dissatisfied with street and road maintenance up from 45% in the 2021 Resident Survey. Street and road maintenance was also one of three services (out of 36) with a majority of respondents (58%) seeking to increase service levels. Relating to sidewalk maintenance 43% of respondents were dissatisfied or very dissatisfied up from 31% in 2021.

ENVIRONMENTAL IMPLICATIONS

Research suggests that poorly maintained pavements can result in:

- Environmental impacts such as increased fuel consumption, GHG emissions, and energy use.
- Increased noise which impacts short term welfare (e.g., sleep disturbance) and may also have long term health consequences (e.g., cardiovascular diseases).
- Increased resource consumption (construction materials); associated increased quarrying.

ALTERNATIVES

Regional Council could direct the Chief Administrative Officer to conduct additional analyses and provide further LOS recommendations and/or funding scenarios for consideration in a supplementary report. This direction could also include analyzing a reduction in the pace of investments in Complete Streets initiatives, (which include traffic calming, curb upgrades, and drainage improvements), in favour of stabilizing pavement condition sooner.

ATTACHMENTS

Attachment 1 – Recommendation on Level of Service (LOS) for the HRM Street Network – January 4, 2022

A copy of this report can be obtained online at halifax.ca or by contacting the Office of the Municipal Clerk at 902.490.4210.

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Item No. 15.1.5
Halifax Regional Council
January 25, 2022

TO: Mayor Savage and Members of Halifax Regional Council

SUBMITTED BY: Original Signed by
Jacques Dubé, Chief Administrative Officer

DATE: January 4, 2022

SUBJECT: Recommendation on Level of Service (LOS) for the HRM Street Network

ORIGIN

This report originates from The Strategic Priorities Plan 2021-25 and the Transportation and Public Works 2021/22 Budget and Business Plan. Both documents state: Municipal staff will work with Regional Council to articulate what a "Well-Maintained Transportation Network" means for the municipality. This includes defining levels of service for transportation related assets (e.g., streets, sidewalks, walkways, etc.) and will help identify funding requirements to maintain assets at an acceptable level.

LEGISLATIVE AUTHORITY

Halifax Regional Municipality Charter, R.S.N.S. 2008, c. 39:

Purposes of Municipality
7A The purposes of the Municipality are to
(a) provide good government;
(b) provide services, facilities, and other things that, in the opinion of the Council, are necessary or desirable for all or part of the Municipality; and
(c) develop and maintain safe and viable communities.

Municipal expenditures
79A (1) Subject to subsections (2) to (4), the Municipality may only spend money for municipal purposes if
(a) the expenditure is included in the Municipality's operating budget or capital budget or is otherwise authorized by the Municipality.

Street related powers
322 (1) The Council may design, lay out, open, expand, construct, maintain, improve, alter, repair, light, water, clean, and clear streets in the Municipality.

RECOMMENDAITONS ON PAGE 2

RECOMMENDATION

It is recommended that Halifax Regional Council:

1) Approve the Pavement Quality Index (PQI) Condition Categories as described in Table 4 of this report;

2) Approve a target Level of Service (LOS) for the HRM road pavement network as outlined in the Discussion section of this report to maintain a minimum of 67% of the network in "Good" condition with PQI for each functional class of road greater or equal to the number shown in Table 4 for the "Good" category";

3) Approve the proposed Budget Based Funding Scenario described in Table 10 of this report as the target funding level for the Street Recapitalization Account in future capital plans; and refer to the 2022/23 Budget process for the initial 22/23 funding level;

4) Approve the continued use of District allocation for Capital program selection as described in the Discussion section of this report; and

5) Approve a biennial reporting period, whereby staff will conduct similar analyses and report back to Council every two years with pavement condition, as described in the Discussion section of this report.

EXECUTIVE SUMMARY

Transportation and Public Works (TPW) manages the maintenance and rehabilitation of 3897 lane kilometers of roads throughout HRM. Pavement management has been a core function of TPW, with ongoing investments in pavement engineering, and management tools and processes. In 2020, staff acknowledged the importance of defining Council approved levels of service (LOS) for transportation infrastructure and included an initiative in both the Strategic Priorities Plan 2021-25 and the Transportation and Public Works 2021/22 Budget and Business Plan to work with Council on defining LOS. As part of this initiative, given that pavements are HRM's highest valued asset, the focus was to establish LOS for the road network first.

In 2021, HRM Staff worked with Stantec Consulting Ltd. (Stantec) to review and update many of the core data and parameters utilized in the pavement management software, assess network condition based on the 2016, 2018 and 2020 data collections, conduct jurisdictional scans, develop new PQI triggers and condition categories, and recommend a Level of Service (LOS) for the HRM roadway network as it relates to condition. Several budget and performance LOS analyses were completed to ultimately recommend an LOS for the network that helps stabilize the condition over the 10-year analysis period. The LOS recommended by both staff and Stantec is to maintain a minimum of 67% of the network in good condition with PQI for each functional class greater or equal to the number shown in Table 4 of this report for the "Good" category. However, due to the historical backlog, significant funding is required immediately to rapidly improve network condition. With potential concerns on the ability for HRM staff and the industry to deliver a more robust capital program, staff conducted a budget-based scenario, where funding would gradually increase over the 10-year analysis period. The proposed funding scenario, displayed in Table 7, would result in continued short-term decline in condition, but by year 2030 would align with the recommended LOS.

The Street Recapitalization Account funds street rehabilitation but also funds elements such as concrete curb and gutter, integrated traffic calming, accessibility improvements, staff resources, etc. As part of this report, staff assessed funding impacts of these elements. It was observed that on average roughly 40% of Street Recapitalization funding is currently attributed to other elements. One of the measures that can be

implemented to help maintain pavement condition but reduce potential Street Recapitalization costs is to implement more timely surface treatments and light rehabilitation activities without adding all complete streets elements (until a more aggressive rehabilitation treatment is required). Therefore, staff is recommending that not every street selected as part of the Capital Program be immediately considered for complete streets aspects. The decision to hold on rehabilitating or adding additional assets will continue to be discussed as part of the overall integration process with the Integration Committee. If the complete streets elements are not necessarily a priority, or require multiple years of planning, they will be added in a future year when the paving strategy is more intrusive. Like this, the costs of rehabilitating or adding adjacent assets can be distributed over many years, while pavement condition can potentially be stabilized.

Another aspect reviewed in this report was the selection criteria for the street rehabilitation program, including District allocation. Staff conducted an analysis where they compared optimization based on allocated funds and optimizing by District individually versus optimizing the entire network simultaneously. The analysis resulted in similar performance for both methodologies; therefore, staff are recommending that District allocation continue to be utilized at this time as part of program selection.

As part of the next steps, staff will continue to collect pavement condition data, conduct further refinement of the core data and parameters utilized in the pavement management software and conduct further budget and performance analyses as parameters are refined and adjust funding requirements as necessary. This will be completed biennially.

BACKGROUND

Transportation and Public Works (TPW) is responsible for the maintenance and rehabilitation of HRM's road network. It is comprised of 3897 lane kilometers of arterial, collector and local roads and is likely HRM's highest valued asset, valued over $1.6 billion. Pavement Management has been a core function of TPW, with both an on-going pavement condition data collection program and Pavement Management System (PMS). The information is used to monitor pavement condition, identify deficiencies, and develop annual/long term capital investment plans. Over time, HRM has continued to invest in the development of pavement engineering and management tools and processes.

Between 1996 and 2015, HRM collected pavement condition data for its road sections on a three-year cycle via visual windshield surveys performed by a field technician. The collected data was then uploaded into the PMS software Road Analytics, which was used primarily as the repository for pavement inventory and condition data, and had few analytical capabilities. The condition data uploaded to Road Analytics was used to compute the performance index reported at that time, the Surface Distress Index (SDI). The SDI was based on a scale from zero to 10, where 10 was best condition and zero worst condition.

In 2014 HRM engaged a third-party consultant to conduct an analysis of the current surface condition of the pavement network, assess current PMS processes, evaluate long term rehabilitation investment strategies based on alternative budget scenarios, and provide recommendations and next steps.

In 2016 HRM developed a Pavement Condition Rating Guide, procured a new PMS (Highway Pavement Management Application (HPMA)), and adopted a new pavement condition data collection methodology. The new data collection methodology involves collecting condition data biennially using a multi-function data collection vehicle. The vehicle includes a Laser Crack Measurement System (LCMS) for crack detection, laser profiler for rut and roughness measurements, a Distance Measuring Instrument (DMI), GPS and Right of Way (ROW) camera. Data collection is completed by a third-party consultant, and data for the entire network is captured over a two-month period. The intent of the new data collection methodology was to accelerate the collection period and to eliminate possible subjectivity involved with manual windshield surveys.

Like Road Analytics, HPMA serves as a repository for pavement inventory and condition data, and computes the performance indices; however, the software also has many analytical capabilities including the tools to evaluate various funding or condition-based constraints to help in decision making as it relates to the management of the road network. The software can also predict long term performance using deterioration models to predict condition over time.

As part of the new PMS implementation, HRM also adopted new performance indices related to roadway condition: The Pavement Condition Index (PCI), Ride Condition Index (RCI), and Pavement Quality Index (PQI). Unlike the SDI, the PCI, RCI, and PQI range from zero (worst condition) to 100 (best condition). The PCI is based on pavement surface distresses that include, alligator cracking, edge cracking, longitudinal / transverse cracking, bleeding, potholes, patching and utility cut patching and rutting. As part of the new data collection methodology and PMS, HRM started collecting roughness, which is a measure of the pavement longitudinal profile. It is used to describe the ride quality of a road, and is defined in HPMA as the RCI. The PQI is a composite performance index composed of both surface distresses and roughness, and is therefore based on the PCI and RCI. Given that roughness was an added parameter, it was decided that HRM would begin using PCI as the performance index until staff were able to review roughness datasets, with the intent to eventually transition to PQI as the overall index.
Since 2016, HRM staff have also worked to refine the PMS to align with HRM's requirements, capture and review condition data and conduct analyses using the PMS software. Table 1 summarizes HRM's pavement asset management activities since 2014.

Table 1. HRM Pavement Asset Management Activities Since 2014

Timeline	Pavement Asset Management Activities
2014	• Pavement Condition Report (current network condition, investment strategies, recommendations, and next steps)
2016	• Pavement Condition Rating Guide Development (New Data Collection Methodology) • Linear Referencing System Standards Development • Completed High Speed Pavement Condition Data Collection (Surface Distress and Roughness) • Procured New Pavement Management System – Highway Pavement Management Application (HPMA)
2017	• Completed Initial Implementation of HPMA
2018	• Completed High Speed Pavement Condition Data Collection (Surface Distress and Roughness)
2019	• Capital Budgeting and Programming Analysis Using HPMA • Pavement Condition Data Update
2019 – 2020	• Pavement Condition Indices and Performance Prediction Models Review/Update
2020	• HPMA Construction History Update • HPMA Traffic Data Update • Capital Budgeting and Programming Analysis Using Updates and Enhanced HPMA Models • Completed High Speed Pavement Condition Data Collection (Surface Distress and Roughness)

2021	• HPMA Construction History and Pavement Condition Data Update • HPMA Models and Decision Trees Review/Update • RCI Equation Update • Transition to PQI as Performance Index Related to Pavement Condition • Maintenance & Rehabilitation (M&R) Treatments Service Lives Update • Updated M&R Treatments List • Unit Costs Update – Based on 2020 Unit Rates • PQI Triggers and Performance Targets/Level of Service (LOS) Review

The 2014 Pavement Condition Report provided a budget scenario for maintaining the current network average condition at that time. The recommendation indicated a funding need for pavements of $313M between 2015 and 2024. As shown in Figure 1, the funding attributed solely to pavements between 2015 and 2021 indicates a shortfall of approximately $83.8M over those seven years.

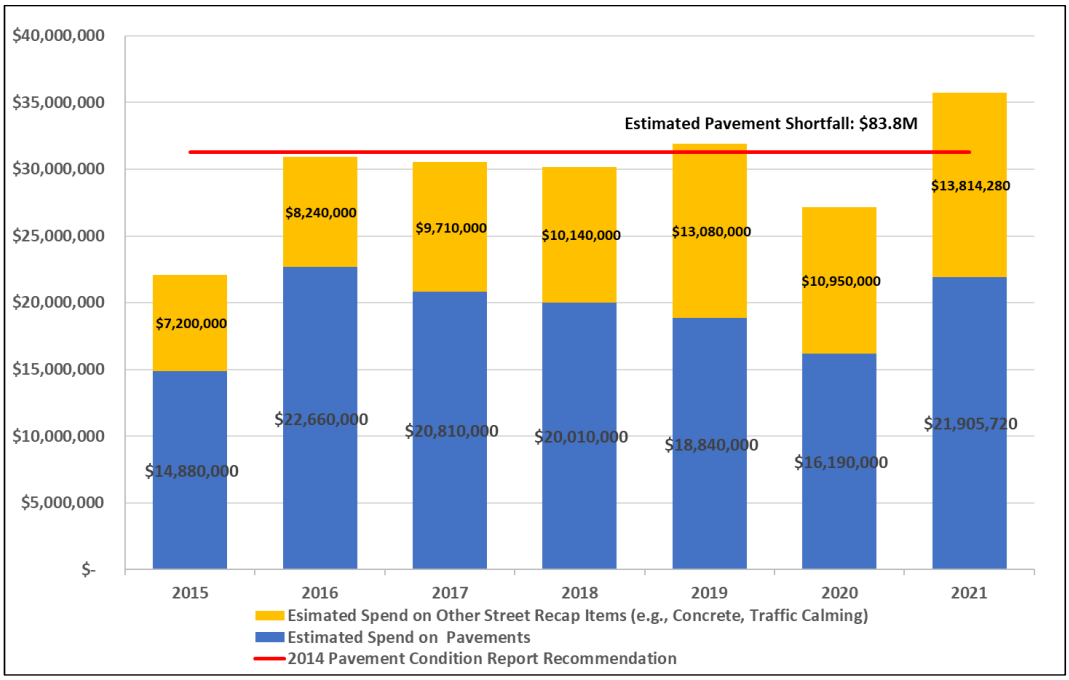

Figure 1. Estimated Versus 2014 Recommended Budget Spend on Pavements

As noted in Table 1, pavement condition data collection was completed in 2016, 2018 and 2020. As shown in Figure 2, the Pavement Condition Index (PCI) for the network and across all functional classes has steadily decreased.

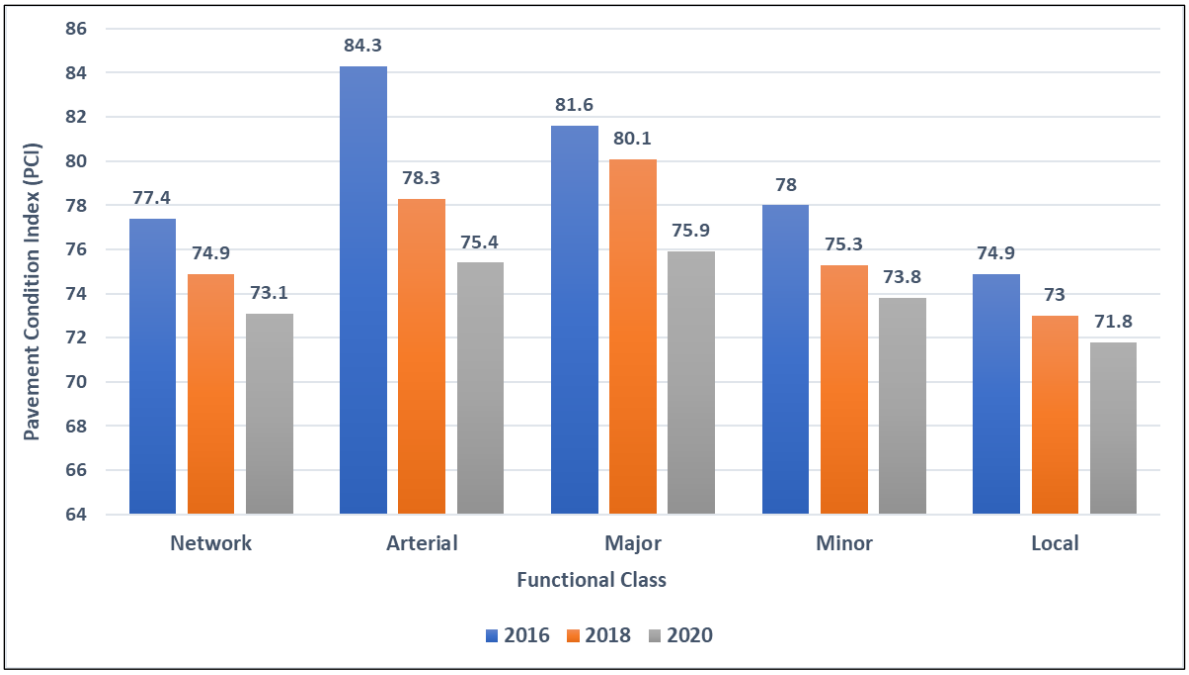

Figure 2. Pavement Condition Index (PCI) for Network and by Functional Class Since 2016

Given the estimated shortfall in pavement spending, the average network condition has decreased, and the rehabilitation backlog has increased. Historically staff have presented to Council the rehabilitation backlog required to bring all streets above a PCI of 75 (or SDI of 7.5). As shown in Figure 3, backlog has increased significantly between 2015 and 2018. Note that backlog was not computed with the 2020 condition data using this methodology. Needs backlog is further discussed in the Discussion section of the report, and includes the 2020 data.

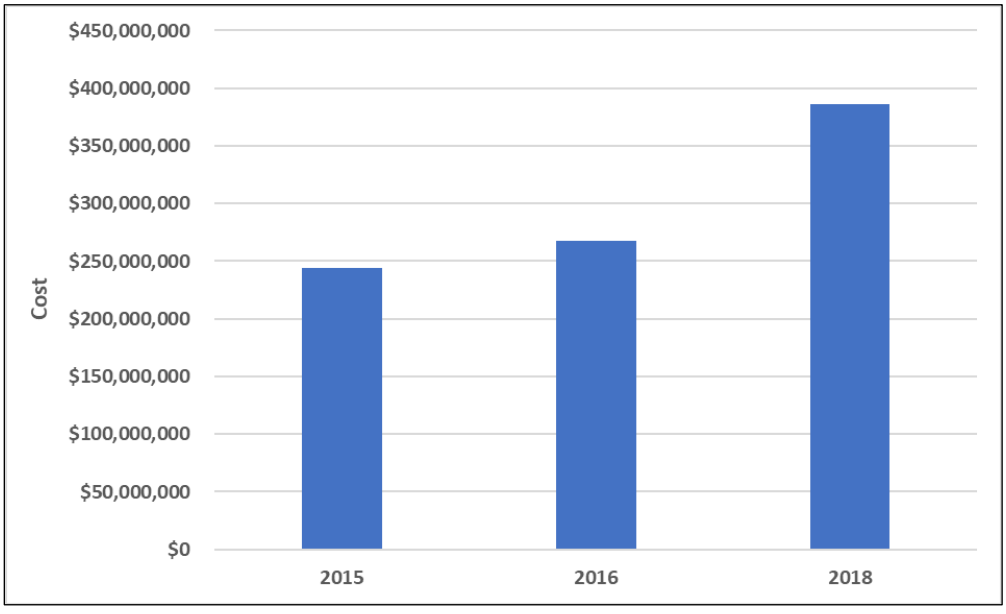

Figure 3. Rehabilitation Backlog Between 2015 and 2018

Historically, the development of HRM's annual street rehabilitation capital program has been largely based on the following criteria:

- SDI/PCI/PQI (street condition rating).
- Street classification (e.g., arterial, collector, local).
- Type of existing street surface material.
- Synergies, conflicts, and integration with both internal and external stakeholders (Integration Committee) (i.e., engage in integration opportunities with utilities such as Halifax Water or with internal stakeholders such as Active Transportation or Transit; avoid conflicts with large development projects).
- Rehabilitation backlog in each District (i.e., funding is allocated by District based on the percentage of the overall backlog in each District. Therefore, a District with a higher percentage of rehabilitation backlog receives a higher percentage of funding allocation to help reduce the backlog).
- Budget levels.

DISCUSSION

Like HRM, annual investments in transportation infrastructure throughout many agencies in North America continue to fall short of needs, resulting in a persistent and growing backlog of maintenance and rehabilitation (also referred to as infrastructure deficit). This has become a critical challenge for agencies as they struggle with constrained budgets and increased demands for infrastructure use. As a result, agencies are increasingly completing data-driven analysis and adopting performance-based management and decision-making approaches to help develop and prioritize investments and policies.

In a recent Transportation Association of Canada (TAC) study on performance-based decision making conducted by Montufar, Regehr and Haas[1], several agencies were surveyed on the level of impact that various performance objectives have on their asset management decisions and on the optimization techniques that the respondents use for managing assets. The performance objective that was identified by respondents as having the highest level of impact was asset condition, followed by safety and then financial resources. The survey identified engineering judgement as the most used optimization technique for asset management, followed by level of service targets and risk exposure analysis.

In 2021, HRM staff worked with Stantec Consulting Ltd. (Stantec) to review and update many of the core data and parameters utilized in HPMA to better refine the analytical capabilities of the software. In addition, HRM reviewed and updated many of the models utilized in HPMA, and transitioned to the Pavement Quality Index (PQI) to measure the functional performance of the pavement assets related to the condition (i.e., Performance Index). In 2021, Stantec was also retained to conduct jurisdictional scans, work with HRM staff to develop new PQI triggers and condition categories, and recommend a Level of Service (LOS) for the HRM roadway network as it relates to condition.

One of the key objectives of HRM's pavement management program is to manage the assets to the level of service (LOS) that meets the expectations of customers (i.e., public users), and to provide a safe and functional road network, while applying cost-effective solutions. LOS targets are used by some agencies to set an annual maintenance and rehabilitation standard that aligns with the public's expectations and available funding. For some agencies, the LOS may be striving to maintain the current network average condition. For others, they may wish to maintain a targeted percentage of the network in good or poor condition, where good and/or poor is defined by the overall asset condition. This is often characterized by indices, such as the PQI. The jurisdictional scans conducted by Stantec suggested that some municipalities strive to maintain a particular network average condition; however, there are larger jurisdictions such as provincial/state level agencies in Canada and the United States and larger municipalities/cities that use

[1] Montufar, J., Regehr, J., Chapman, S. and Haas, R. 2021. Performance-Based Decision Making for Asset Management: Lessons Learned and Practitioner Toolkit. Ottawa, ON: Transportation Association of Canada.

overall percent good or percent poor as targets for their network. In general, the LOS selected by an agency may relate to the level of sophistication regarding their pavement management processes.

With HRM's roadway network condition steadily declining and the rehabilitation backlog (infrastructure deficit) continuing to increase, HRM staff believe it is now imperative to establish a Council approved Level of Service (LOS) that stabilizes the network condition while determining funding requirements over the next ten years that align with the newly established LOS. With the optimizations made to HPMA, staff now have a greater comfort level with the analytical capabilities of the software.

Establishing PQI Triggers and Condition Categories

HPMA uses pavement condition data and analysis models to forecast maintenance and rehabilitation needs across the road network, and can develop maintenance program budgets and priorities. HPMA uses cost-effectiveness and marginal cost-effectiveness approaches to select an optimized program. In other words, performing the right fix at the right time. Rehabilitation needs generally increase when roads are not maintained or rehabilitated within a timeframe when the work would be effective (i.e., missed opportunities to resurface a road may result in more costly rehabilitation work, including partial or full reconstruction being required much earlier in the overall life of the pavement).

The optimization function provides a methodology for determining feasible maintenance and rehabilitation (M&R) strategies for each street section (cost-effectiveness), and can perform network optimization of the strategies based on performance and/or funding constraints (marginal cost-effectiveness). Performance constraints can be used to determine funding requirements while funding constraints can be used to develop a work program or determine resulting network performance.

The M&R strategy analysis process is based on user-defined decision trees that vary by functional class and pavement type. The decision trees define the feasible strategies under various conditions. Each treatment alternative selected, based on the decision tree, is analyzed in terms of life-cycle costs and performance (performance index and/or individual distresses predicted). The decision trees utilized in HPMA were defined by HRM staff in consultation with Stantec, and align with typical HRM construction practices.

The cost-effectiveness analysis and evaluation methodology is extensively used in pavement management. The study conducted by Montufar, Regehr and Haas[1] suggests that the methodology provides a relatively simple calculation where costs and benefits are clearly outlined, is successful in evaluating the cost-effectiveness of individual system interventions, and is perceived to be a reliable, objective, and consistent technique for prioritizing investments. However, while the analysis has the ability to select a cost-effective program, it does not have the ability to assess intangible factors such as disruption/congestion, integration opportunities / conflicts with other stakeholders, or issues such as environmental impacts (i.e., street flooding/icing problems) which are also key factors in developing a comprehensive rehabilitation program. Another factor is the implementation of complete streets. In certain instances, the inclusion of complete streets elements requires the paving strategy to be more intrusive than required in terms of pavement cost-effectiveness, or can result in delays to the rehabilitation year due to planning requirements. This results in a sub-optimal treatment selection and influences overall budget. However, the benefits of applying the complete streets elements in some instances may outweigh the cost-effectiveness of the pavement treatment selection/timing when assessing the entire roadway corridor. As a result, engineering judgement is also important in the overall development of the program.

As mentioned in the Background section, historical backlogs were calculated using a PCI of 75 (or SDI of 7.5), and represented the funds required to bring all streets above this value. In this scenario, the intent was to eliminate all potential rehabilitation needs for the network. With HPMA, the software has the capability to set differing rehabilitation triggers based on functional class. Rehabilitation triggers are commonly used by agencies to aid in rehabilitation needs analysis. They represent the condition level where an asset requires needs or intervention by means of maintenance or rehabilitation, and generally differ by

road functional class (i.e., Arterial, Collector, Local). In many cases throughout the industry, the condition rehabilitation triggers represent the condition level where the asset would be considered in poor condition. It can also be considered the critical value you would not want a particular asset to fall below. For HRM, the condition triggers are based on PQI.

The needs analysis performed using HPMA utilizes M&R optimization analysis described above and ultimately calculates the cost required to bring all streets above the trigger values for each functional class. Need is defined as the level where a street segment falls below the trigger, and therefore the objective of the M&R analysis is to identify the feasible M&R treatments (i.e.,, microsurfacing, overlay, mill and overlay, reconstruction, etc.) for each section in need based on the current PQI during the analysis period. The costs identified are for pavement M&R only, and do not include any additional assets. The year in which a street's PQI falls below the defined PQI trigger is the pavement need year.

During the initial implementation of HPMA, HRM staff selected PQI triggers which they considered were aligned with industry standards. However, as part of the analyses performed by HRM staff and Stantec in 2021, Stantec conducted jurisdictional scans of comparable agencies to confirm if HRM's triggers aligned with industry. In addition, Stantec conducted an analysis to evaluate the existing PQI triggers and assess the need for establishing new PQI triggers. The analysis involved conducting a needs sensitivity analysis using the following scenarios:

- Initial PQI Triggers (established during initial implementation of HPMA)
- Initial PQI Triggers Minus Five PQI Points
- Initial PQI Triggers Plus Five PQI Points
- Initial PQI Triggers for Arterial and Major Collector and Minus Five PQI Points for Minor Collector and Local

The first sensitivity analysis that was performed included the plus and minus five PQI points scenarios. The plus/minus five PQI points were somewhat arbitrary selections, but still aligned with industry standards, and provided enough differentiation in PQI to observe the needs impacts from altering the trigger values. Once this analysis was completed, HRM staff decided to add a fourth scenario which would maintain the initial values for arterials and major collectors but reduce the thresholds for minor collectors and locals. The intent of this decision was to keep higher traffic volume streets (i.e., arterials and major collectors) in better condition but reduce overall funding needs by reducing the threshold on lower traffic volume streets (i.e., minor collectors and locals). PQI trigger values corresponding to each scenario are shown in Table 2. Based on the jurisdictional scans, all scenarios align with the ranges identified from other jurisdictions.

Table 2. PQI Trigger Scenarios

Functional Class	PQI Trigger Scan Ranges	Initial PQI Triggers	Initial PQI Minus 5	Initial PQI Plus 5	Initial PQI Minus 5 (Minor and Local Only)
Arterial	50 to 70	60	55	65	60
Major Collector	40 to 65	55	50	60	55
Minor Collector	40 to 65	55	50	60	50
Local	40 to 55	50	45	55	45

Using the various triggers identified above, Stantec performed an M&R optimization analysis using HPMA for all roads in the network. Ten years was selected as the analysis period. The results of the needs analysis for each trigger scenario are displayed in Table 3

Table 3. Results of Need Budget Scenarios Related to PQI Triggers

Budget Scenario	Average Annual Needs ($M)	Year-1 Needs ($M)
Initial PQI Triggers	$53 M	$192 M
Initial PQI Minus 5	$52 M	$152 M
Initial PQI Plus 5	$60 M	$235 M
Initial PQI Minus 5 (Minor and Local Only)	$50 M	$163 M

Reviewing the results, the "Initial PQI Triggers for Arterial and Major Collector and Minus Five PQI Points for Minor Collector and Local" scenario has the lowest average annual needs among all other scenarios with the second lowest Year-1 needs. As a result, Stantec recommended reducing the existing PQI triggers for minor collectors and locals to align with this scenario. Given the current financial pressures faced by HRM, HRM staff agreed with the recommendation and lowered the PQI triggers for minor collectors and locals given that they are still within the ranges identified in the jurisdictional scans. These PQI triggers were then used for the LOS analysis described in the next section of the report. As a note, the needs identified in Table 3 would be the funds required to bring all streets above poor condition. It does not represent the funds required to eliminate all M&R requirements.

In addition to the PQI triggers used in the needs analysis described above, the PQI of a road section can then be classified as Good, Fair, or Poor, where the Good/Fair/Poor thresholds would also vary by functional class. HRM staff, through consultation with Stantec and review of the jurisdictional scans, established new condition categories for each functional class as part of the work completed in 2021. Three condition categories (Good/Fair/Poor) were selected for each functional class as outlined in Table 4. Similar to the PQI triggers, the condition categories have higher thresholds depending on functional class, i.e., higher traffic volume streets have higher thresholds. It should be noted that three to five condition states are typical throughout the industry.

Table 4. PQI Condition Category Thresholds for Each Functional Class

Functional Class	Good	Fair	Poor
Arterial	≥ 75	60-75	≤60
Major Collector	≥ 70	55-70	≤55
Minor Collector	≥ 65	50-65	≤50
Local	≥ 60	45-60	≤45

Once the transition to PQI was completed and the new PQI triggers and condition categories were established, HRM staff assessed network condition using the 2016, 2018 and 2020 condition data. Figure 4 displays the PQI for the network and for each individual functional class. Figure 5 indicates the needs backlog or cost required to bring all streets above the newly established trigger values. Figure 6 shows the distribution of Good/Fair/Poor. Like the PCI trend and backlog identified in the Background section of the report, the condition analyses conducted in 2021 show significant deterioration over the three most recent

data collections and further reinforce the pavement funding shortfall estimated since 2015. In addition, the percentage of the network considered in good condition dropped significantly from 2016 to 2020, and the backlog nearly doubled.

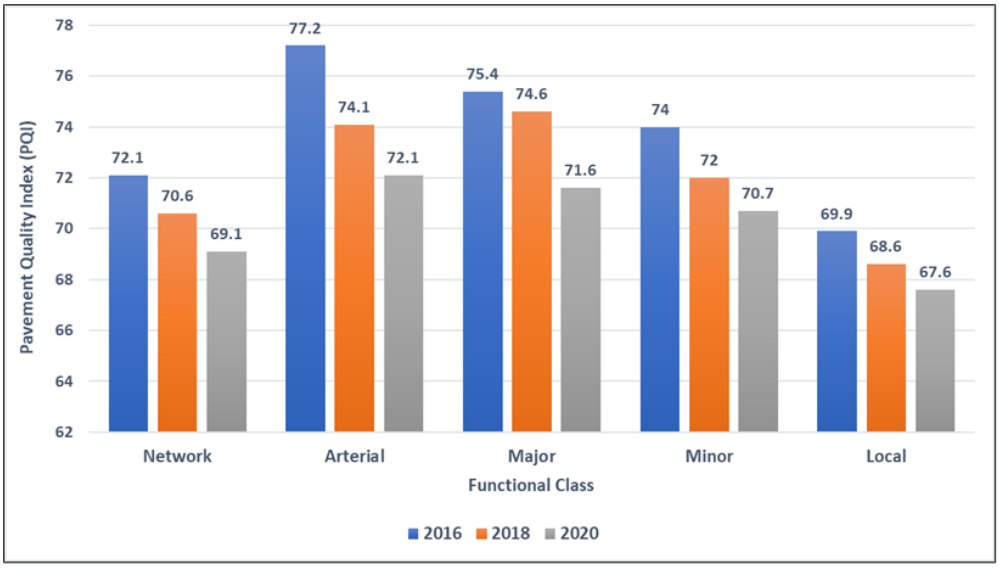

Figure 4. Pavement Quality Index (PQI) for Network and by Functional Class Since 2016

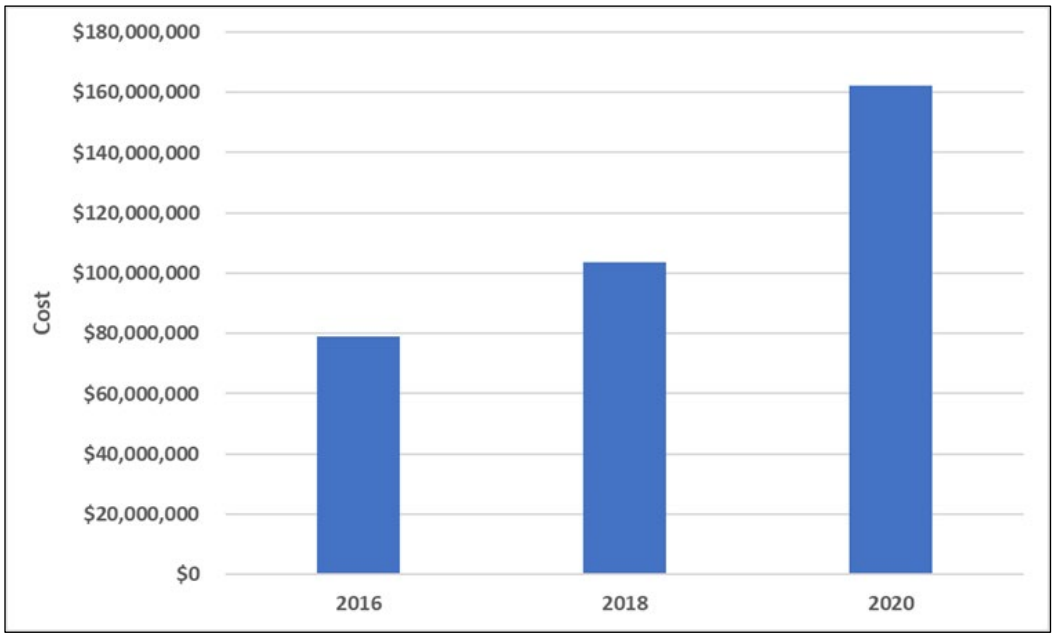

Figure 5. Rehabilitation Needs Backlog (Funds Required to Bring all Streets Above Poor Threshold)

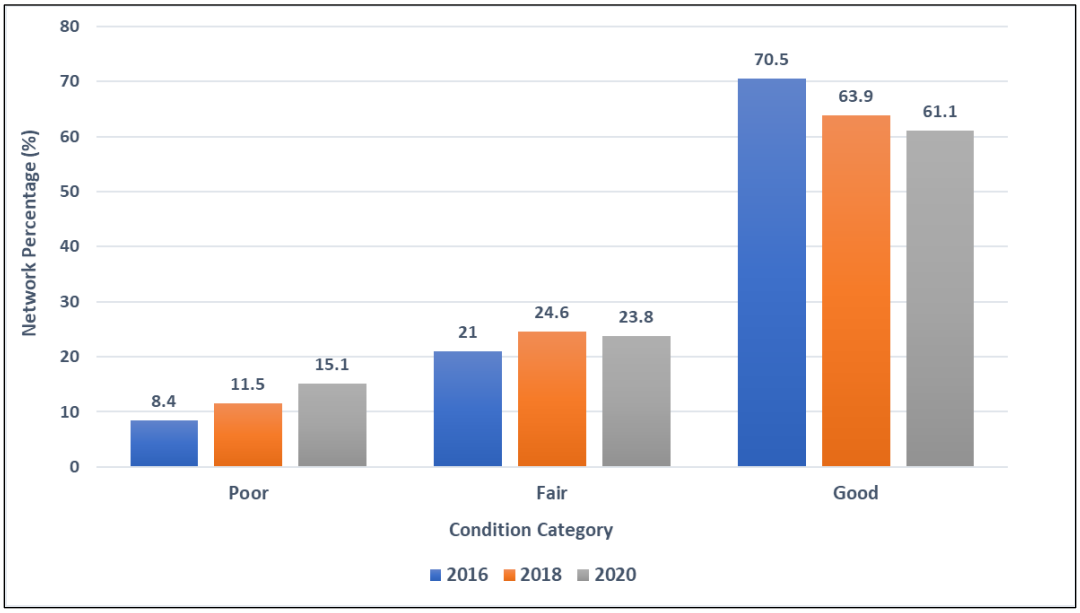

Figure 6. Network Condition in Terms of Good / Fair / Poor Distribution

Budget and Performance Analysis

In general, jurisdictions should strive to have manageable needs backlogs and should try to avoid growing the needs backlog as future attempts to stabilize the network condition will be even more cost prohibitive. In addition, delaying necessary state of good repair work also increases road rehabilitation backlogs which generally relate to the following risks:

- Increased operational reactive maintenance requirements (i.e., increased need for pothole repairs).
- Lower customer satisfaction.
- Increased vehicle maintenance costs (frames, suspensions, tires, etc.) of private as well as transit and commercial vehicles.
- Reduced network safety (friction and drainage issues) and reduced accessibility.
- Potential for increased claims and greater liability.
- Potential for health and safety impacts.
- Likelihood that missed opportunities to perform minor maintenance and rehabilitation will result in a greater volume of major rehabilitation needs along with higher cost repairs.
- Likelihood that more intrusive rehabilitation requirements increase road disruption.

With historical backlogs continuing to increase and Year-1 needs already unfeasible to address, HRM Staff believe the newly selected LOS should help stabilize the network over the 10-year analysis period (i.e., funding requirements should maintain the network average PQI and needs backlog near the 2020 condition levels (i.e., network average PQI = 69.1, needs backlog 15.1% of network lane-kilometers). In addition, increasing the percentage of streets in good condition should also be considered a target.

Using the newly established PQI triggers and condition categories, Stantec then completed budget and performance LOS analyses using a variety of scenarios. The following analysis parameters were used:

- Programming and Economic Analysis Period: 10 years (base year is 2021)
- Inflation Rate: 0% (i.e., analysis based on present day costs)
- Discount Rate: 0% (i.e., constant dollars approach used for the M&R analysis, therefore, the

interest rate used to estimate the present worth of future costs and benefits is zero.)
- M&R costs provided by HRM (2020/21 Unit Rates)
- Engineering Factor of 1 (i.e., no increase in funding due to additional assets or engineering costs)

The scenarios considered in the study included the following:

- Budget based scenario (base-level funding).
- Maintain current network average PQI (PQI = 69.1).
- Maintain the current network average PQI plus 3 (PQI = 72.1).
- Maintain the current network average PQI minus 3 (PQI = 66.1).
- Maintain a minimum of 67% of the network in good condition with PQI for each functional class greater or equal to the number shown in Table 4 for the Good category.
- Maintain a minimum of 64% of the network in good condition with PQI for each functional class greater or equal to the number shown in Table 4 for the Good category.
- Maintain a minimum of 70% of the network in good condition with PQI for each functional class greater or equal to the number shown in Table 4 for the Good category.
- Maintain a maximum of 5% of the network in poor condition with PQI for each functional class less or equal to the number shown in Table 4 for the Poor category.
- Maintain a maximum of 10% of the network in poor condition with PQI for each functional class less or equal to the number shown in Table 4 for the Poor category.
- Maintain a maximum of 15% of the network in poor condition with PQI for each functional class less or equal to the number shown in Table 4 for the Poor category.

The base-level funding budget scenario utilized the funding parameters identified in Table 5 (see below). These values were the base levels provided for the Street Recapitalization Account in the 2022/23 Draft four-year budget and conveyed to 2030 as a baseline. As shown in Table 5, the funds attributed to pavement M&R are 60% of the total spend, given that 40% of the funds are spent on other items such as curb, traffic calming etc. (as noted above and discussed later in this report). Funding displayed for 2021 is the actual pavement spend given that the construction season is nearly completed.

Table 5. Budget Based Scenario (Base-Level Funding)

Year	Street Recap Funding Proposed	Funds Attributed to Pavement (60%)
2021		$21,905,720*
2022	$32,000,000	$19,200,000
2023	$33,000,000	$19,800,000
2024	$33,000,000	$19,800,000
2025	$33,000,000	$19,800,000
2026	$33,000,000	$19,800,000
2027	$33,000,000	$19,800,000
2028	$33,000,000	$19,800,000
2029	$33,000,000	$19,800,000
2030	$33,000,000	$19,800,000

*Estimated funds spent on Pavement in 2021

The Maintain current PQI scenario was selected considering some municipal agencies as identified in the jurisdictional scans select this as their LOS. From there, it was decided to select plus/minus three as a sensitivity analysis to determine the impacts of raising and lowering the network average. As opposed to the sensitivity analysis performed for the PQI triggers where plus/minus five was selected, plus/minus three

was selected for reviewing impacts to the overall network average. In the case of the network average, a three percent change in condition can significantly impact funding requirements and seemed reasonable as a starting point for the sensitivity analysis.

The Maintain % Good scenarios were established based on the jurisdictional reviews. Some agencies strive to maintain two thirds or 67% of their network in good condition. Therefore 67% was selected as a starting point and plus/minus three was selected for sensitivity analysis. For the % Poor scenarios, the intent was to determine the effect of maintaining minimal backlog throughout the network. It is important to note that maintaining a percentage of the network in good condition does not control the LOS percentage for the other two condition categories (i.e., fair and poor), and similarly maintaining a percentage of the network in poor condition does not control the fair and good categories.

Table 6 and Figure 7 summarize the results of all 10 budget scenarios. As mentioned above, note the following for comparison purposes:

- Network average PQI in 2020 was 69.1.
- Needs backlog in 2020 was estimated at 15.1% of the network lane-kilometers (i.e., the PQI of approximately 588 lane-kilometers (15.1% of 3897) of street were below the PQI triggers).
- 61% of the network was in good condition in 2020 (70% in 2016).

Table 6. LOS Scenarios Results Comparisons

Budget Scenario	Average Annual Budget Needs ($M)*	Year-1 Needs ($M)*	Needs Backlog at Year 10 (% Lane-Kms)	PQI at Year 10	Average % Good	% Good at Year 10
Base Level Funding	20	22	40	56.0	-	-
Maintain Current PQI	42	61	16	69.1	-	-
Maintain Current PQI Minus 3	36	-**	22	66.1	-	-
Maintain Current PQI Plus 3	48	103	11	72.1	-	-
67% Good	38	69	15	67.5	67	65.4
64% Good	36	51	18	66.6	64	62.7
70% Good	41	90	13	68.7	70	67.4
5% Poor	45	114	5	71.4	65	66.9
10% Poor	39	57	10	69.1	60	62.9
15% Poor	34	20	15	66.7	55	58.4

*Funds are for Pavement M&R only
**Year-1 funds not required as PQI below actual value

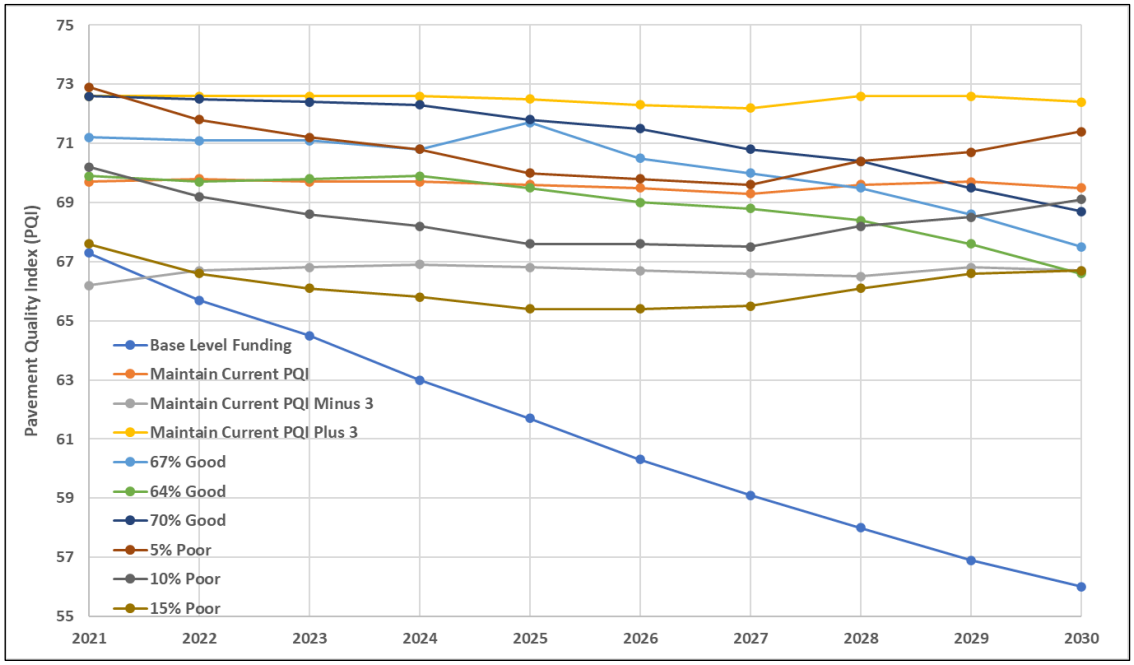

Figure 7. LOS Scenarios PQI Summary Comparisons

As shown in the results comparisons, the base level funding scenario results in a significant decline to the network average PQI (69.1 in 2020 to 56 in 2030) and significant increase to the needs backlog (15.1% in 2020 to 40% in 2030) over the 10-year analysis period. As a result, HRM staff would not recommend the current baseline funding scenario.

Two of the proposed LOS scenarios that maintain or reduce the needs backlog, maintain the network average PQI near the 2020 level, maintain a larger percentage of the network in good condition, and have both Year-1 and average funding needs that appear reasonable include:

- Maintain current network average PQI (69.1).
- Maintain 67% of the network in good condition.

As mentioned earlier, these LOS scenarios align with LOS used by other jurisdictions. However, selecting an LOS based on performance of the various functional classes (e.g., % Good or % Poor) allows for maintaining differing conditions for the various functional classes. As a result, streets such as arterials with higher traffic volumes can be maintained at a higher threshold than lower volume locals. A budget scenario based on maintaining a network average PQI does not allow for the differentiation by functional class.

Based on Stantec's observations and discussions with HRM staff, they provided the following key recommendations regarding LOS:

- Reduce the PQI Triggers as outlined in Table 2.
- Use 67% Good as an annual LOS target for M&R analysis.
- Invest a minimum of $40M annually on pavement rehabilitation as soon as feasible.
- Detailed constrained funding and cash flow analysis should be performed in the future to practically align the new LOS target against HRM budget, resources, and other organizational constraints, and recommend changes to existing business processes and recommend new business processes.

- Long term investment planning effects of different funding constraints needs to be analyzed using a 25-year analysis period.

HRM Staff LOS Recommendation and Proposed Funding Scenario

HRM staff agree with Stantec's recommendation that maintaining 67% Good as an annual LOS target for M&R analysis will help stabilize the network long term.

However, due to the historical backlog, the resulting Year-1 needs for all LOS scenarios including 67% Good, are significantly higher than the actual HRM budget spending for pavements in 2021 and the proposed spending for 2022. It is also important to note that the proposed Year-1 needs are significantly more than what HRM staff could currently design, tender and manage in a given year, and that the construction industry would likely be required to prepare in advance to construct such a program. HRM would have to increase staffing resources to plan, design and deliver such a large program. The construction industry would also likely have to increase resources or would be required to prepare in advance. In addition, with many other budget pressures, HRM Finance will require time to potentially align available funding to the proposed LOS need.

As a result, HRM staff performed a second Budget Based Scenario with the actual 2021 budget spend on pavement, proposed 2022 Workplan, and future budgets that allow both HRM and the construction industry to gradually increase resources, plan funding strategies, and over the course of the 10-year period aligns with the recommended LOS. In accordance with the other scenarios described previously, the funding requirements proposed below are for Pavement M&R only, and do not include inflation. They are based on present day costs. The funding scenario is displayed in Table 7 with results provided in Table 8 and Figure 8. Figure 8 also includes the measured values for 2016, 2018 and 2020 for comparison with the predicted outer year values. Note that the results for the funding scenario are also based on the condition categories described in Table 4.

Table 7. Proposed Budget Based Scenario

Year	Funds Attributed to Pavement M&R
2021	$21,905,720*
2022	$22,770,000**
2023	$35,000,000
2024	$40,000,000
2025	$45,000,000
2026	$45,000,000
2027	$45,000,000
2028	$50,000,000
2029	$50,000,000
2030	$55,000,000

*Estimated funds spent on Pavement in 2021
**Estimated funds to be spent on Pavement in 2022 based on current workplan

Table 8. Recommended Proposed Funding Scenario Performance Results

Budget Scenario	Average Annual Budget Needs ($M)*	Year-1 Needs ($M)*	Needs Backlog at Year 10 (% Lane-Kms)	PQI at Year 10	Average % Good	% Good at Year 10
Recommended Funding	41	22 (Current)	15.4	69.9	56.9	66.9

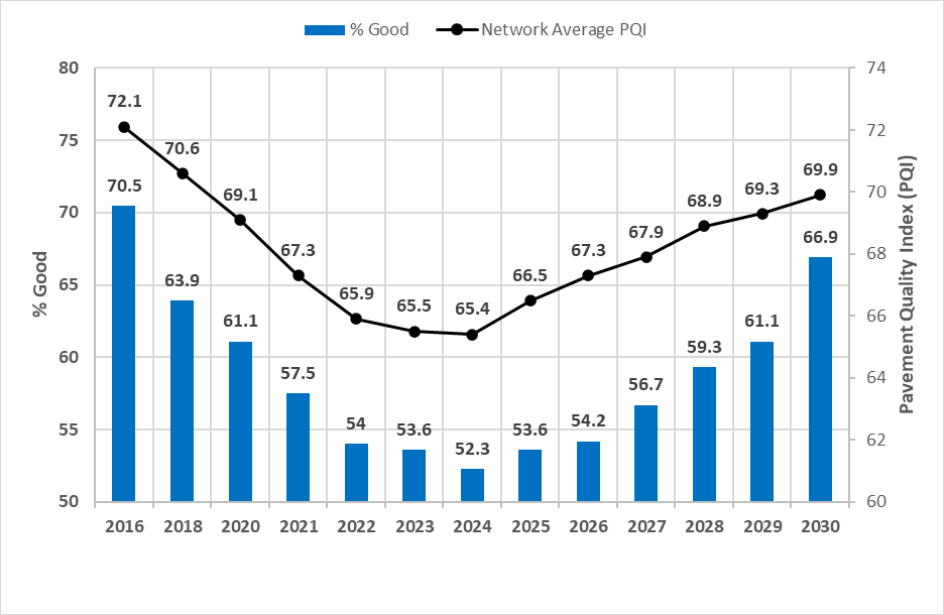

Figure 8. % Good and PQI Trend for Proposed Funding Scenario
Based on this scenario, due to the historical backlog and under funding in 2021 and 2022, the PQI continues to decrease, and backlog increases in the short term, however as funding ramps up in future years, the PQI returns to 2020 levels and the backlog also decreases to 2020 levels by 2030.

Therefore, HRM staff recommend the selection of maintain a minimum of 67% of the network in good condition with PQI for each functional class greater or equal to the number shown in Table 4 for the Good category as an LOS, with understanding that due to historical backlog, this may not be achieved until 2030. At that time, HRM may wish to alter the LOS. In the interim, the pavement funding scenario outlined in Table 7 will potentially achieve the LOS by 2030. It is important to note that due to the continued short-term decline in network condition, the need for operational reactive maintenance may also increase in the short term.

Historically, HRM's pavement management strategy included trying to prevent good and fair streets from declining into the poor category, while also selecting poor streets (blended strategy), especially as part of integration projects with partners such as Halifax Water. In line with the new proposed LOS (67% Good), it is likely that the focus will be on improving the number of good streets in the network. Therefore, similar to historical practice, project selection may include addressing more fair and good streets and maintaining them or bringing them into the good category using lower cost rehabilitation treatments, while reconstructing some poor streets, particularly where there is an opportunity for integration. For example, there are roads in poor condition that may require reconstruction, however, in the interim, they will continue to deteriorate and be maintained through reactive activities such as critical interim repairs, localized pothole filling, crack sealing and patching.

As discussed above, the optimization analysis conducted using HPMA develops a cost-effective rehabilitation program, however it does not have the ability to assess intangible factors such as disruption/congestion, integration opportunities/conflicts, flooding/icing problems, potential complete streets impacts or as mentioned in the Background, funding allocation based on District backlog. In terms of rehabilitation program selection, given that engineering judgement is still considered one of the most used optimization techniques, HRM staff believe that utilizing HPMA as a tool to establish a baseline optimized program, followed by the implementation of engineering judgement to refine the program based on additional factors is the best approach. It will allow for HRM staff to integrate with both internal and external stakeholders which produces many intangible benefits and can result in multi-asset optimization. HRM staff are planning to work with Stantec on developing a manual intervention module in HPMA to incorporate ground truth and engineering judgement to the HPMA recommended capital program to align and coordinate it with multi-asset multi-year capital programs. As part of this work, HRM staff are also looking to conduct a comprehensive budget and performance LOS analysis for comparing the impacts of program selection including intangible factors versus not including them. This analysis will be completed over the next two years.

In regard to District allocation, HRM staff conducted an M&R analysis where they utilized proposed District allocated funds, set budget constraints for each district, and ran optimization scenarios for each district individually. The results from each District were then summed to determine percent good and percent poor for the overall network. These results were then compared to the analysis conducted for the budget-based scenario described above, where the optimization analysis was conducted by allocating funds on the overall network and not by individual District. The results provided in Figure 9 indicate that optimizing by District with allocated funds provides similar results to optimizing the entire network when comparing %Good and %Poor for years 2021 and 2022. The District allocated analysis results in slightly lower %Good, but also slightly lower %Poor.

Therefore, staff recommend Council approve the use of District allocation based on District backlog as part of the rehabilitation program selection procedure at this time. As additional data is collected, staff will monitor measured versus predicted performance, conduct further analysis on the use of manual intervention and reassess optimization techniques over the next two years.

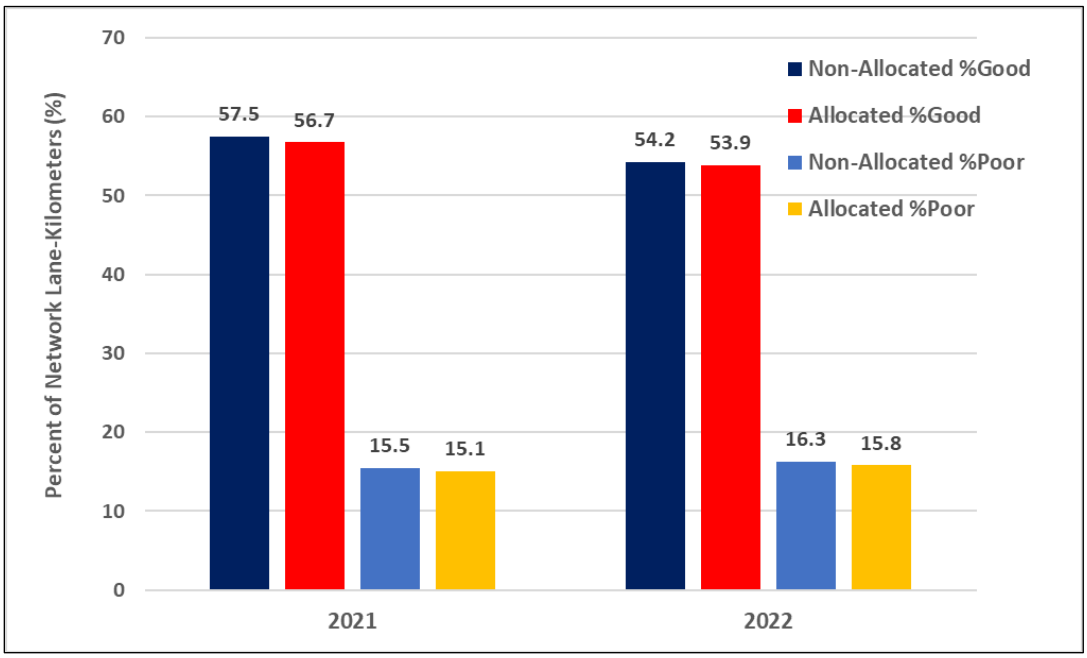

Figure 9. %Good / %Poor Comparison for Full Network vs Individual District Optimization

Additional Funding Impacts on the Street Recapitalization Account

The Street Recapitalization Account is the account that funds HRM capital street rehabilitation projects. In addition to street rehabilitation, the account also funds complete streets elements such as curb, integrated traffic calming measures (bump outs or speed humps/tables), sidewalk spot repairs, pedestrian ramps, tactile plates, landscaping elements, etc. The account also funds preventative maintenance initiatives such as crack sealing and street planer patching along with items such as staff resources tied to capital, studies, designs, investigations, surveys, and pavement condition data collection.

HRM staff reviewed the Street Recapitalization Account in detail for 2014/2015 (pre-IMP) and for 2019/2020 (post-IMP), and calculated the percentage of funds not attributed directly to pavement rehabilitation activities. The average percentage from 2014/2015 was determined to be approximately 32% and increased to an average of 41% for 2019/2020. Based on initial review of the 2022 proposed Capital Program, this value may increase to 44%.

As described above, the analyses performed using HPMA are based solely on associated pavement needs, and do not include any additional assets or items described above. The associated costs in HPMA are for pavement maintenance and rehabilitation (M&R) only. Pavement M&R treatments currently utilized in HPMA include surface treatments (e.g., microsurfacing, thin overlay), overlay, mill and overlay, partial depth recycling, full depth recycling and partial/full depth reconstruction. Crack sealing and street planer patching are critical preventative maintenance initiatives but are currently not included in the HPMA decision trees; however, all deterioration models within HPMA have been refined using street condition data where these activities have generally occurred. Note that operational maintenance requirements such as reactive pothole repair and surface patching are not funded by the Street Recapitalization Account.

The HPMA analyses and network funding requirements reviewed above are therefore based solely on pavement M&R costs for treatments incorporated in the decision trees and do not reflect all other items currently covered by the Street Recapitalization Account.

One of the measures that can be implemented to help maintain pavement condition but reduce potential Street Recapitalization costs is to implement more surface treatments and light rehabilitation activities without adding all complete streets elements (holding strategy). For example, in certain instances, a street may receive a microsurfacing or mill and overlay, but no curb renewal if flooding is not a concern. The curb renewal would be implemented at a later date when the pavement is receiving a more intrusive rehabilitation strategy (e.g., partial reconstruction). As a result, more lane kilometers of pavement can be rehabilitated at a lower cost. Based on this, the intent would be to perform more surface treatments and light rehabilitations without renewing adjacent assets in certain cases, which could potentially reduce the impact from the 41% or more currently observed. As part of the engineering judgement optimization and work with stakeholders, the decision to hold on rehabilitating or adding additional assets will continue to be discussed as part of the overall integration process with the Integration Committee. If additional assets are considered a priority, they will be added to the program even when the paving strategy is minimal. However, if the complete streets elements are not necessarily a priority, or require multiple years of planning, they will be added in a future year when the paving strategy is more intrusive. Like this, the costs of rehabilitating or adding adjacent assets can be distributed over many years, while pavement condition can potentially be stabilized.

For financial planning purposes, Table 9 and 10 below outline the potential Street Recapitalization Account Funding required based on the recommended LOS funding scenario for pavement rehabilitation and impacts due to the additional items outlined above. For years 2021 and 2022, the funds are based on estimated pavement spend for actual projects. For years 2023 to 2030, Table 9 utilizes an impact of 41% while Table 10 displays the impacts for 30% spending on additional assets. 30% was selected as this aligns closely to historical impacts. Like Table 7, these values are based on present day costs. Based on the recommended funding for pavement M&R, the yearly investment in Street Recapitalization can be reduced by $10 to 15 million by reducing impacts of adjacent assets.

Table 9. Potential Street Recapitalization Account Funding Required to Achieve Pavement LOS with 41% Funds Attributed to Other Assets

Year	Funds Attributed to Pavement (59%)	Street Recap Funding Proposed
2021	$21,905,720*	
2022	$22,770,000**	
2023	$35,000,000	$59,322,034
2024	$40,000,000	$67,796,610
2025	$45,000,000	$76,271,186
2026	$45,000,000	$76,271,186
2027	$45,000,000	$76,271,186
2028	$50,000,000	$84,745,763
2029	$50,000,000	$84,745,763
2030	$55,000,000	$93,220,339

*Estimated funds spent on Pavement in 2021
**Estimated funds to be spent on Pavement in 2022 based on current workplan

Table 10. Potential Street Recapitalization Account Funding Required to Achieve Pavement LOS with 30% Funds Attributed to Other Assets

Year	Funds Attributed to Pavement (70%)	Street Recap Funding Proposed
2021	$21,905,720*	
2022	$22,770,000**	
2023	$35,000,000	$50,000,000
2024	$40,000,000	$57,142,857
2025	$45,000,000	$64,285,714
2026	$45,000,000	$64,285,714
2027	$45,000,000	$64,285,714
2028	$50,000,000	$71,428,571
2029	$50,000,000	$71,428,571
2030	$55,000,000	$78,571,429

*Estimated funds spent on Pavement in 2021
**Estimated funds to be spent on Pavement in 2022 based on current workplan

2022 Road Transfer and Development

It is important to note that the analyses completed in 2021 do not include the proposed increase in roadway network size due to the 2022 Road Transfer or new developments. At this time, the roads/streets in HPMA are only considered to be HRM owned. The 2022 high speed pavement condition data collection will include streets transferred as part of the Road Transfer. Once these streets, along with their condition are included in HPMA, further analyses will be required to determine needs for the larger network. Currently, the estimated increase in network size as part of the Road Transfer is eight percent. In addition, HRM typically

accepts 10 to 20 lane-kilometers of new streets on average yearly through development. One key difference between roads obtained through development as opposed to Road Transfer, is that the newly developed streets should be designed to the latest edition of the Municipal Design Guidelines. Therefore, many or all complete streets elements should already be in place. In the case of Road Transfer streets, funds will be required to maintain the pavement, but near-term investments will likely also be required to include some complete streets elements.

Next Steps

HRM staff are continuously working to improve HRM's pavement management processes. Some of the next steps required to continue this improvement and monitor LOS include:

- Develop cash flow analysis to align with the proposed LOS and apply reasonable inflation rates to the various analyses.
- Should Council decide to increase funding allocation for Street Recapitalization, an assessment on staff resourcing will have to be completed with requirements to potentially increase TPW staff for planning, design, and construction.
- Work with industry partners to ensure industry has the capacity to construct more robust capital programs.
- Revisit the analysis once the 2022 Road Transfer is complete and include a 25-year analysis period.
- Continue to work with integration partners both internal and external to find synergies and optimizations with competing programs.
- Look to define LOS targets for other assets such as curb, sidewalk, etc. This will also help establish overall funding requirements for Street Recapitalization.
- Work with industry partners and conduct more research and development to look for innovative methodologies that could help extend pavement life at a minimal cost increase.
- Develop a manual intervention module in HPMA to incorporate ground truth and engineering judgement to the HPMA recommended capital program to align and coordinate it with multi-asset multi-year capital programs and conduct a comprehensive budget and performance LOS analysis for comparing the impacts of program selection.
- Continue to collect pavement condition data and as more data is collected, conduct further refinement of the core data and parameters utilized in HPMA to better refine the analytical capabilities of the software. This will be completed biennially.
- Conduct further budget and performance analyses as parameters are refined, and adjust funding requirements as necessary. This will be completed biennially.
- Where feasible align pavement management planning with climate change mitigation approaches.

FINANCIAL IMPLICATIONS

The financial implications associated with the recommended level of service for maintaining an average of 67% of HRM roads at "good" condition impacts not only the Street Recapitalization capital project account, but also staff compensation for estimated increased program delivery capacity, and a short-term increase likely to be experienced in the road operating repairs and maintenance budget while the network further deteriorates before stabilizing as per Figure 8. An accurate estimate for the required staffing complement increase will be assessed once Regional Council sets the level of service direction and will be incorporated into the 2023/24 operating budget recommendation. The roads state of good repair, which is budgeted at approximately $3M (cost centres R715, R719, R735, R743) in Transportation & Public Works operating budget for 2022/23, will be assessed as part of the annual business planning process as street condition is only one driver.

The recommended level of service to stabilize the road condition and continue to implement complete streets at a slower progress to minimize cost escalation will require an estimated additional $72,428,571 over the next four years, as reflected in the table below.

Street Recapitalization #CR200006	2022/23	2023/24	2024/25	2025/26	Total 4Yr
Current 2022/23 Capital Plan	32,000,000	33,000,000	33,000,000	33,000,000	131,000,000
Proposed Capital Plan (Table 10)	32,000,000	50,000,000	57,142,857	64,285,714	203,428,571
Additional Funding Required	**$ -**	**$ 17,000,000**	**$ 24,142,857**	**$ 31,285,714**	**$ 72,428,571**

The $72.4M increase is not currently funded in the 2022/23 multi-year capital plan which was approved December 17, 2021. The November 28, 2021 Budget Committee Fiscal Framework report indicated that there is $11.5M capital from operating funds presently unallocated to capital projects in anticipation of additional priorities being raised throughout the budget deliberations, including this report. Attributing $9M annually from those funds would cover half of the $72.4M variance required. These funds are contingent on Council approving the recommended 5.9% tax increase.

Possible funding options for the first four years of the ten-year stabilization plan include higher capital from operating, increased federal funding from the Canada Community-Building Fund (previously Gas Tax) or other cost sharing, reprioritizing projects within the capital plan, additional debt funding or additional tax increases in 2023/24 and future years.

It is noted that the projected annual budget required for the Street Recapitalization project account in Table 10 is stated in present-day dollars and therefore does not reflect inflationary increases, which is additionally volatile and unpredictable right now due to the pandemic. There is also risk due to the 2022/23 Road Transfer from the Province since the condition data for these roads was not available for this analysis. These two potentially large factors will be assessed and updated biennially to iteratively reflect the accurate investment required to reach the condition target within the ten-year plan.

RISK CONSIDERATION

Research suggests that poorly maintained pavements can result in:

- Increased operational reactive maintenance requirements (e.g., increased need for pothole repairs).
- Lower customer satisfaction.
- Increased vehicle maintenance costs (frames, suspensions, tires, etc.) of private as well as transit and commercial vehicles.
- Reduced network safety (friction and drainage issues) and reduced accessibility.
- Potential for increased claims and greater liability.
- Potential for health and safety impacts.
- Likelihood that missed opportunities to perform minor maintenance and rehabilitation will result in a greater volume of major rehabilitation needs along with higher cost repairs.
- Likelihood that more intrusive rehabilitation requirements increase road disruption.

As a result, further deterioration of the pavement network could result in risks associated with the items listed above. These risks could be related to service delivery, health and safety, reputation and legal.

Another risk that has been identified is industry capacity. The industry is currently experiencing labor shortages in many jurisdictions nationwide. As a result, even with the ability to gradually ramp up resources, the market may have difficulty delivering such a robust program.

COMMUNITY ENGAGEMENT

No direct community engagement has been completed as part of this report. However, historical along with the latest citizen survey results indicate some dissatisfaction with the current condition of the HRM roadway network.

ENVIRONMENTAL IMPLICATIONS

Research suggests that poorly maintained pavements can result in:

- Environmental impacts such as increased fuel consumption, GHG emissions, and energy use.
- Increased noise which impacts short term welfare (e.g., sleep disturbance) and may also have long term health consequences (e.g., cardiovascular diseases).
- Increased resource consumption (construction materials); associated increased quarrying.

ALTERNATIVES

Regional Council could select one of the other budget and performance LOS scenarios identified in this report as a recommended LOS for the HRM street network or could direct the Chief Administrative Officer to conduct additional analyses and provide further LOS recommendations and funding scenarios, including changes to the proposed condition categories.

In regard to program selection, Council could elect to remove District allocation based on District backlog as a selection criterion. This is not recommended at this time as initial analysis suggests that optimizing by individual district has little influence on performance. Further analyses will be conducted to assess the influence of manual intervention on program selection.
Council could elect that staff include complete streets elements for all streets, no matter what rehabilitation strategy is required. However, this is not recommended as this will likely lead to increased budget pressures and further deterioration of the network condition.

At present, Staff are looking to provide updates to Regional Council biennially (every two years) to align with the current data collection frequency. Council could elect to increase or reduce the frequency of updates. Increasing the frequency is not recommended as it would not provide Staff sufficient time to review collected data and perform the necessary analyses.

ATTACHMENTS

No attachments.

A copy of this report can be obtained online at halifax.ca or by contacting the Office of the Municipal Clerk at 902.490.4210.

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