OFFICE OF THE
City Auditor

City Streets Audit

November 10, 2014

THE CITY OF Edmonton

The Office of the City Auditor conducted this project in accordance with the *International Standards for the Professional Practice of Internal Auditing*

City Streets Audit
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Executive Summary

The City's streets are the foundation of Edmonton's transportation system and the City's largest non-utility asset. Their replacement value is approximately $11.3 billion. In 2013, the City spent $26.3 million on routine and preventative maintenance (pothole filling, crack sealing, etc.) and $156.7 million on rehabilitation and reconstruction of City streets.

In recent years, the number of potholes on city streets has been steadily increasing. This has led to increased concern by citizens and Councillors about the overall condition and management of the City's streets. Therefore, the Office of the City Auditor included this audit in its *2014 Annual Work Plan.*

The objectives of this audit were to: 1) determine if the City is adequately protecting its roads as a capital asset and 2) assess the effectiveness and efficiency of the City's Pothole Repair Program.

Is the City adequately protecting its roads as a capital asset?

Due to the size and value of City streets, all the activities in the City's pavement management framework need to be working effectively to improve them. The pavement management framework activities in the City include governance, planning and programming of investments, design, construction, maintenance, periodic pavement evaluation, and research.

We found that the City is adequately protecting its roads as a capital asset. The pavement management framework helps ensure good decision-making regarding roadway maintenance. The current average condition of all roads (arterial and neighbourhood) is good (6.06 on a scale of 1 to 10).

We made four recommendations to enhance the effectiveness of the pavement management framework:

1. **Document strategies**
   The City has an overall Transportation Master Plan (*The Way We Move)* that includes high-level objectives and strategies for transportation asset management. The Transportation Operations Branch also has a strategy for neighbourhood renewal and a plan for arterial renewal. However, we found that they do not have these strategies and plans documented. They also do not have formally approved performance measures and targets to assess the effectiveness of the pavement management framework as a whole.

   Without documented guidance for staff, there is the potential risk that:
   - The work of Roadway Maintenance may not align with goals set out in the Transportation Master Plan.

- The knowledge of current processes and strategies will be lost when key employees leave the organization.
- The lack of performance measures may hinder management's ability to track progress toward its goals.

2. Document operating procedures

We found that the Transportation Operations Branch does not have the detailed planning and programming processes of the pavement management framework documented (i.e., the processes for identifying, analysing, and prioritizing roadway preservation, rehabilitation, and reconstruction projects). We also found that the process information on the City's website does not match the actual procedures.

Without documenting these processes, there is a risk that procedures may not be carried out consistently if different individuals do the work. Also, if existing staff leave the City, the knowledge could be lost.

3. Document reasons for selecting neighbourhood projects

The City does not have the resources or the industry capacity to renew all neighbourhoods in need of it over a short period of time. However, management asserts that they do have the resources and there is the industry capacity to renew all neighbourhoods in need over the long-term.

Our discussion with management confirmed that they use additional selection criteria and rationale to determine which neighbourhoods are scheduled for renewal each year. However, we found that management has not documented these additional criteria or the rationale for considering them when deciding which projects to complete. As well, they have not documented why they selected one project over another.

Neighbourhood renewal project selection ultimately rests with a limited number of City employees. Thus, to ensure effective succession planning, knowledge retention, and consistent application of criteria, management needs to document the project selection process.

4. Strengthen quality assurance process for city-built roads

The City's Roads Design and Construction Branch is responsible for the project management of city-built roads. The Engineering Services Section of the Transportation Operations Branch provides the quality assurance testing for these projects. We found instances were test results did not meet the requirements of the City's *Road Design Standards and Construction Specifications* and remedial action was not taken (i.e., contractors were not required to remove and replace an inferior product.)

We believe that by implementing these recommendations, the City will be able to continue to protect and improve the overall condition of its streets.

Is the Pothole Repair Program effective and efficient?

We concluded that the Transportation Operations Branch has been effective and efficient in managing the costs and time used for pothole repairs when compared to prior years. They have managed to keep material and labour costs and the average time to fill one pothole fairly consistent over the past five years, even with significant fluctuations in the number of potholes filled and the volume of pothole notifications.

We made one recommendation to further enhance the effectiveness and efficiency of the Pothole Repair Program. We recommended that the Transportation Operations Branch Manager ensure that the Training and Procedural Manual is updated to include:

1. A description of all operational activities related to the Pothole Repair Program.
2. Key performance indicators and targets for the Pothole Repair Program.
3. Procedures to ensure they are collecting the appropriate data in a timely manner.
4. Procedures to ensure that management is monitoring the effectiveness and efficiency of the Pothole Repair Program.

City Streets Audit

1. Introduction

The replacement value of Edmonton's streets is approximately $11.3 billion. The streets account for 48 percent of the replacement value of the City's non-utility assets. In recent years the growth in the number of potholes in city streets has led to increased concern by citizens and councillors as to the overall condition and management of the City's streets.

The Office of the City Auditor (OCA) included an audit of the processes and controls used to effectively manage the ongoing condition of City streets in its *2014 Annual Work Plan*. This value-for-money audit assessed whether the City is adequately protecting its roads as a capital asset as well as assessing the effectiveness and efficiency of the City's Pothole Repair Program.

There are many different terms relating to the management of pavement that we use in this report. We have included a glossary of the terms used in this report in Appendix A.

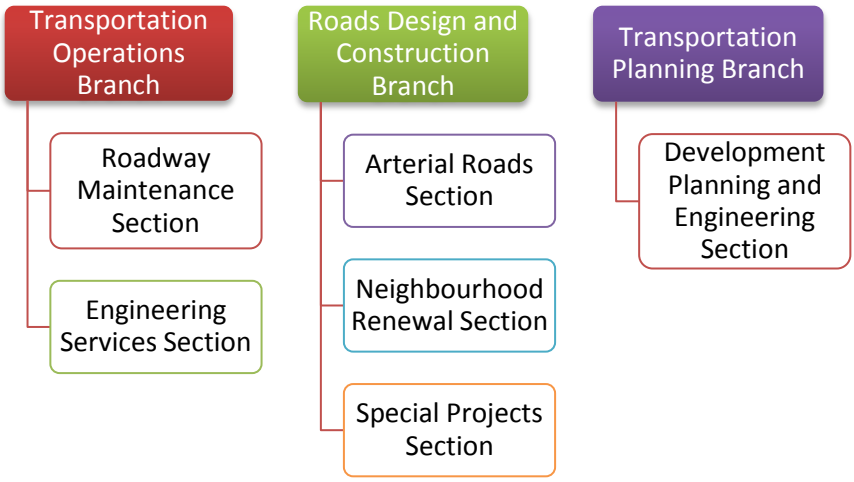
2. Background

2.1. Pavement Management in the City

Pavement management is the decision-making process that helps the City to make cost-effective decisions concerning the maintenance and rehabilitation of the City's pavement. The main responsibility for the management of City's streets lies with the Transportation Operations Branch of the Transportation Services Department. However, there are other Branches within the Transportation Services Department that also have a responsibility for certain aspects of pavement management.

Figure 1 on the next page shows the areas within the Transportation Services Department that have some responsibility for city streets.

Figure 1 – Transportation Services Department Areas with Responsibility for City Streets



The pavement management activities in the City relate to governance, planning and programming of investments, design, construction, maintenance, periodic pavement evaluation, and research. These activities come together to form the City's pavement management framework. Figure 2 depicts the City's pavement management framework.

Figure 2 – City of Edmonton's Pavement Management Framework

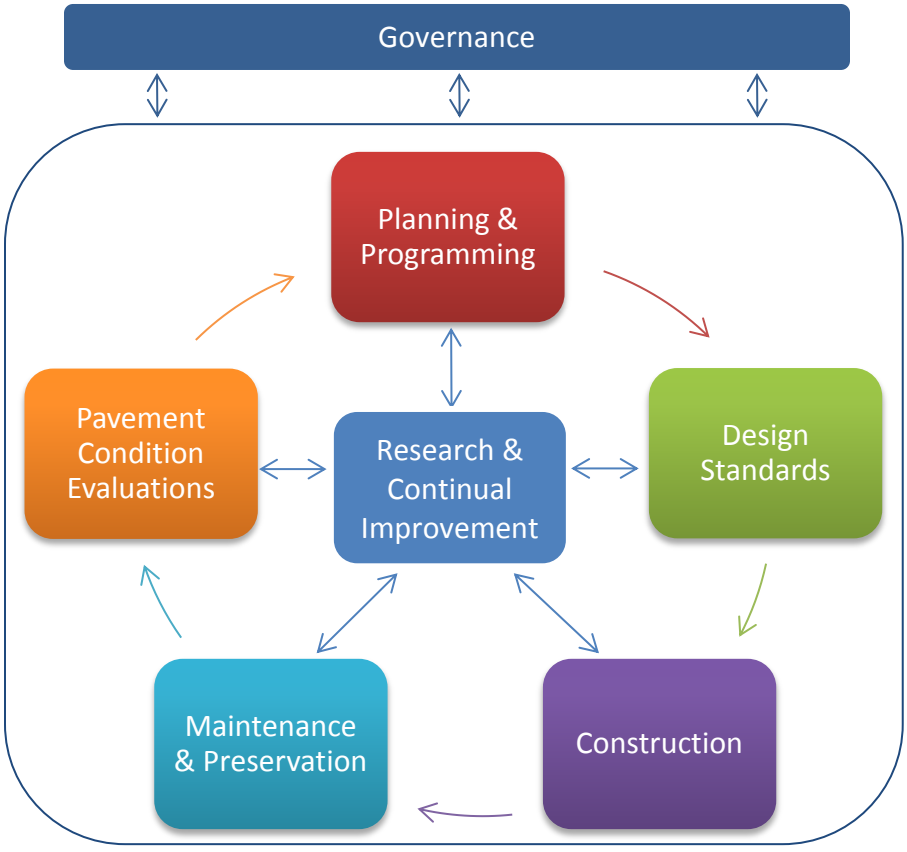


Table 1 describes the key activities of the City's pavement management framework and the areas responsible for them.

Table 1 – Key Activities of the Pavement Management Framework

Activity	Description	Primary Responsibility Area(s)
Governance	Setting policies, strategies, and the budget to guide the management of the City's roads.	City Council, Transportation Services Department, & Transportation Operations Branch
Planning and programming	Analyzing the pavement condition data, establishing priorities for rehabilitation, reconstruction, and maintenance, and scheduling projects.	Roadway Maintenance Section
Design standards	Setting the roadway design standards and construction specifications for the City.	Engineering Services Section & Development Planning and Engineering Section
Construction	Rehabilitation and reconstruction work done on existing roads as well as the construction of new roads.	Roads Design and Construction Branch & Development Planning and Engineering Section
Maintenance and preservation	Repairing potholes, crack sealing, spray patching and microsurfacing.	Roadway Maintenance Section
Pavement condition evaluations	Monitoring surface distress, roughness, and structural adequacy of the roads and determining the pavement quality index rating for all roads.	Roadway Maintenance Section
Research and continual improvement	Research is ongoing and affects each activity of the framework. It also incorporates learnings from previous experiences and projects to strengthen the roadway asset management framework.	Engineering Services Section & all other sections

2.2. Financial Resources

One of the purposes of the pavement management framework is to help the City make decisions that optimize the performance of the roads given the resources available to maintain them. There are four main ways that the City maintains its roads:

- Routine Maintenance – These are treatments to immediately address specific problems such as potholes that may compromise the safety of road users. The City funds these treatments through the operating budget.
- Preventative Maintenance – These are well-timed and executed activities to prevent premature pavement distress and to slow the rate of deterioration such as crack sealing, spray patching, and microsurfacing. The City also funds these treatments through the operating budget.
- Rehabilitation – These are structural enhancements that renew the service life of an existing road such as overlay and mill and overlay. The City funds rehabilitation through the capital budget.
- Reconstruction – This is when a road is completely reconstructed. The City also funds reconstruction through the capital budget.

Maintenance and preservation

Table 2 shows the operating expenses relating to routine and preventative maintenance of roads from 2009 to 2013.

Table 2 – Actual Routine and Preventative Maintenance Operating Expenses

(in thousands of dollars)

	2009	2010	2011	2012	2013
Labour	$7,746	$7,589	$8,763	$9,972	$13,091
Material and equipment	9,855	9,421	10,279	11,786	16,413
Contract services	8,316	4,694	5,936	4,449	4,959
Other	2	1	1	81	516*
Overhead	1,321	1,381	1,459	1,493	1,677
Reimbursement for neighbourhood paving**	(3,177)	(4,184)	(3,609)	(7,183)	(10,312)
Total Operating Expense	**$24,063**	**$18,902**	**$22,829**	**$20,598**	**$26,344**

* Includes $402,000 that was transferred to operating reserves for future microsurfacing needs.
** This is paving performed by the Roadway Maintenance Section as part of the Neighbourhood Renewal Program that is reimbursed from the neighbourhood renewal capital budget.

Rehabilitation and reconstruction

The City uses the capital budget to pay for roadway rehabilitation and reconstruction. The City introduced the Neighbourhood Renewal Program in 2009 to ensure funds are available to rehabilitate and reconstruct roads, sidewalks, and streetlights in existing neighbourhoods. It is a dedicated property tax levy of between 1.5 to 2 percent per year. The City also budgets for arterial road renewal work. Table 3 on the next page shows the actual amounts spent on arterial and neighbourhood renewal for capital projects from 2009 to 2013 as well as the 2014 budget.

Table 3 – Roadway Capital Investment 2009 to 2014
(in millions of dollars)

	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Budget
Arterial Renewal	$28.6	$42.4	$38.3	$21.3	$20.0	$48.3
Neighbourhood Renewal	48.0	72.2	113.0	134.3	136.7	139.3
Total Road Renewal	**$76.6**	**$114.6**	**$151.3**	**$155.6**	**$156.7**	**$187.6**

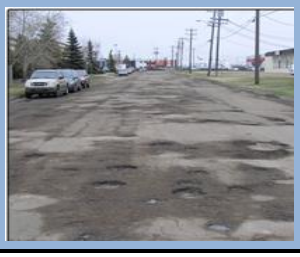
The increase in funding for neighbourhood renewal is due to the introduction of the Neighbourhood Renewal Program. Currently an arterial road renewal program does not exist. Therefore funding for arterial road renewal has been more reactive than planned over the past five years.

2.3. Current Condition of Roads

Roughness
(Ride Comfort)

Surface Distress
(Visual Condition)

Structural Capacity
(Structural Adequacy)



In order to know which roads are in need of rehabilitation or reconstruction, the City needs to assess the condition of the roads. Overall pavement condition information is important to assist the City in maintaining, preserving, rehabilitating, and reconstructing its roads in the most cost-effective manner and at the right time in the pavement life cycle.

To assess the condition, Roadway Maintenance has divided each road into sections and they measure the roughness, surface distress, and structural capacity (see appendix A for definitions) of each section on a regular basis. Roadway Maintenance rotates between assessing roughness and surface distress on arterials and collectors every other year and neighbourhood roads every four years[1]. They measure structural capacity approximately every six years.

Roadway Maintenance then uses sophisticated pavement management software called the Municipal Pavement Management Application to combine the roughness, surface distress, and structural capacity scores. The software combines these scores into an overall condition score called the Pavement Quality Index (PQI) for each road section. The PQI ranges between 0 and 10, with 10 meaning the road section is in very good condition and 0 meaning it is in very poor condition.

A typical road is built to last around 25 years. However, the life of the road can be extended through preservation, rehabilitation, and reconstruction. Roadway Maintenance prepared Figure 3 to depict the typical life cycle deterioration of a road

[1] Arterial roads are multi-lane thoroughfares in the City (e.g., Whitemud Drive, 97 Street). Neighbourhood roads include local, industrial, and collector roads.

from very good to very poor condition. It also shows the costs associated with "buying" (extending) additional years of service at the different condition levels.

Figure 3 – Typical Road Service Life Behavior

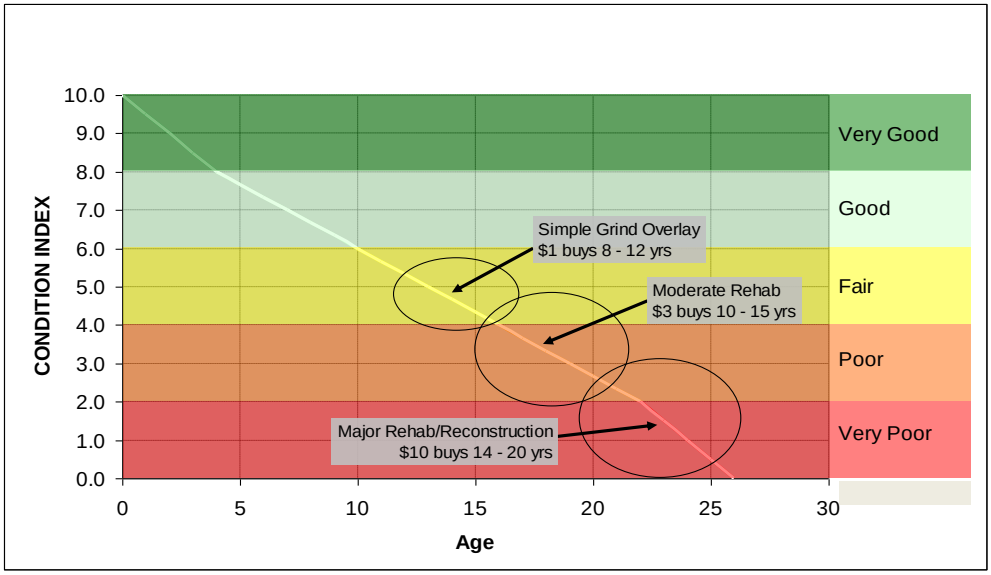
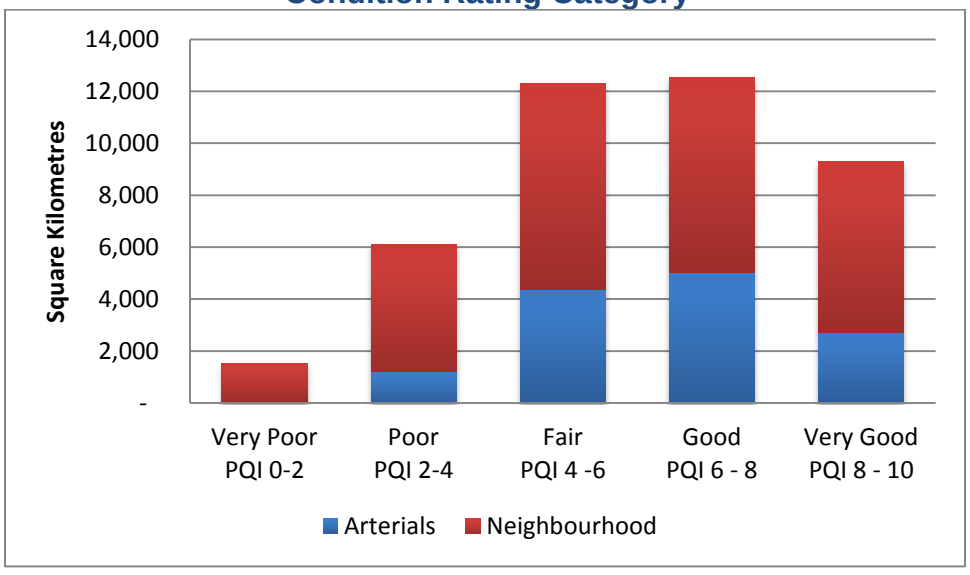


Figure 3 shows that spending $1 on rehabilitating a road in fair condition will "buy" the City an additional 8 to 12 years of service life from the road (i.e., the road will now last approximately 33 to 37 years). However waiting until the road reaches poor or very poor condition will cost 3 to 10 times more and the road will only last a few years longer than if they rehabilitated it when it was in fair condition (i.e., 35 to 45 years).

Figure 4 shows the distribution of the square kilometres of neighbourhood and arterial roads in each of the condition categories for 2013.

Figure 4 – 2013 Square Kilometres of Arterial and Neighbourhood Roads in Each Condition Rating Category

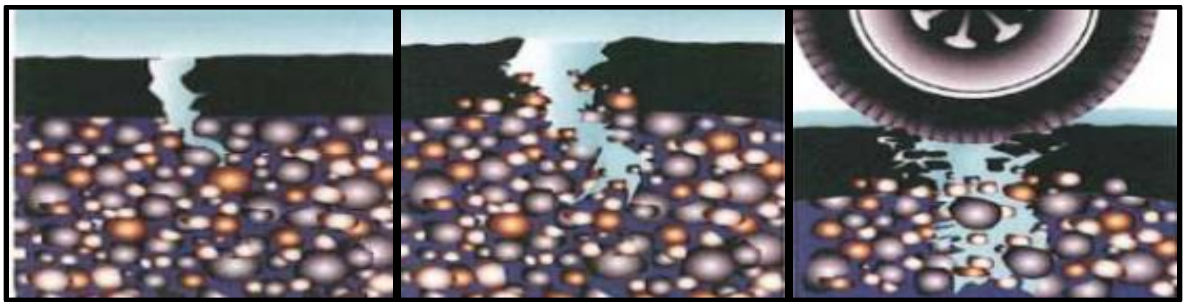


The overall average condition for all road segments in 2013 was 6.06 out of 10. As well, 82 percent of the City's roads are in fair or better condition. However, the remaining 18 percent of roads are in poor or very poor condition and need rehabilitation or reconstruction, which is relatively expensive.

Roadway Maintenance indicated that when roads are allowed to deteriorate beyond fair condition, the cost of restoration work increases exponentially, along with the frequency of pothole formation. By preventing roads from deteriorating beyond fair condition and repairing or rebuilding the ones in poor and very poor condition, the City can reduce the number of potholes in Edmonton's streets.

2.4. Potholes in Edmonton

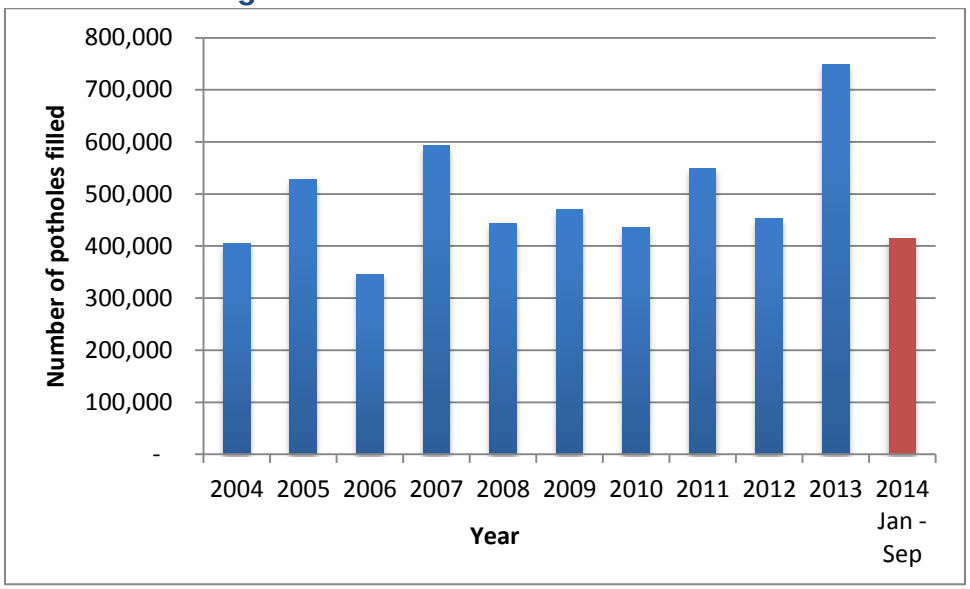
Potholes are more likely to form on roads where deterioration is already occurring. However, even roads in good condition can get potholes. Potholes are usually formed when water from melting snow and ice seeps into existing cracks in the asphalt. The water then freezes and expands, causing the surface to rise and making the crack bigger. Then the ice melts, leaving a gap beneath the road. Vehicle tires then push the surface into the gap, causing a pothole.



In 2013, the pothole repair crews filled over 700,000 potholes,[2] costing the city approximately $7.0 million. Figure 5 on the next page shows the number of potholes filled in Edmonton over the past ten years.

[2] Instead of maintaining a pothole count, the City calculates the number of potholes filled from the total weight of asphalt placed in potholes (approximately 15,000 tonnes in 2013) divided by the weight of asphalt required to fill a standard pothole (0.02 tonnes).

Figure 5 – Number of Potholes Filled



In 2013 and 2014 City Council allocated additional funding to roadways rehabilitation which has helped improve road conditions and reduce the number of potholes filled in 2014. From January to September of 2014, crews filled 415,300 potholes down significantly from the 664,400 filled from January to September in 2013.

3. Audit Objectives, Scope, and Methodology

The objectives of this audit were to determine if:

1. The City is adequately protecting its roads as a capital asset; and
2. The Pothole Repair Program is efficient and effective.

The scope of this audit covered all aspects of the current pavement management framework shown in Figure 2 except the Construction component. We did not look at the road construction process as the OCA audited the Roads Design and Construction Branch in 2011.[3] However, we did review the work performed by the Engineering Services Section of the Transportation Operations Branch and the Development Planning and Engineering Section of the Transportation Planning Branch to ensure roads are being built to the City's standards.

[3] Capital Construction Audit, Roads Design and Construction Branch, June 1, 2011.

4. Observations and Recommendations

4.1. Is the City Adequately Protecting its Roads?

We found that the City is adequately protecting its roads as a capital asset. The City has a strong pavement management framework in place. However, we did identify opportunities in the following areas of the pavement management framework to enhance its effectiveness.

1. Governance;
2. Planning and programming; and
3. Construction.

4.1.1. Document operational strategies

City streets governance includes the policies, processes, and structures used by management and staff to direct and control pavement management activities in order to achieve the objectives of the City. In general, we found that the City has strong governance over the pavement management framework. We did find that the Transportation Operations Branch needs to document its operational strategies to ensure they effectively integrate into the goals and objectives set out by the City.

Overall transportation strategy

The goals and objectives of the City are included in *The Way We Move* (the Transportation Master Plan), which is the City's over-arching policy document that relates to pavement management. The Plan includes a strategic objective to fully utilize asset management best practices to achieve a safe, enjoyable and well-maintained transportation system. The Plan defines asset management as:

> … an integrated approach involving planning, engineering and finance to effectively manage existing and new municipal infrastructure to maximize benefits, reduce risk and provide satisfactory levels of service to local users and citizens. This approach emphasizes careful planning, identification of maintenance and repair requirements and optimizes investment through a mix of preventative maintenance, renewal, and reconstruction.

The City has also published an Implementation Plan and Progress Report for *The Way We Move*. They include two performance indicators that relate to the condition of arterial and neighbourhood roads. [4]

For strategic purposes, Roadway Maintenance management has divided the roadway network into two groups: Neighbourhoods (includes local, industrial, and collector roads) and Arterials (includes multi-lane roadways such as Whitemud Drive and 97 Street).

[4] The percent of arterial roadways and the percent of neighbourhood roadways in Edmonton in need of rehabilitation (PQI less than 4.5) in order to maintain good condition. (In 2012, 18 percent of arterial roads and 37 percent of neighbourhood roads had a PQI of less than 4.5.)

Neighbourhood road strategy

As discussed earlier, the City has the Neighbourhood Renewal Program in place for neighbourhood roads. It is the City's strategy for the long-term funding of investments in preventative maintenance, rehabilitation, and reconstruction of Edmonton's neighbourhood roads and sidewalks. It is proving to be a cost-effective strategy that will ensure the City's neighbourhoods are sustainably maintained. Figure 6 shows the impact of this strategy on the average condition of neighbourhood roads.

Figure 6 – Impact of Neighbourhood Renewal Program (NRP) on Average Condition of Neighbourhood Roads

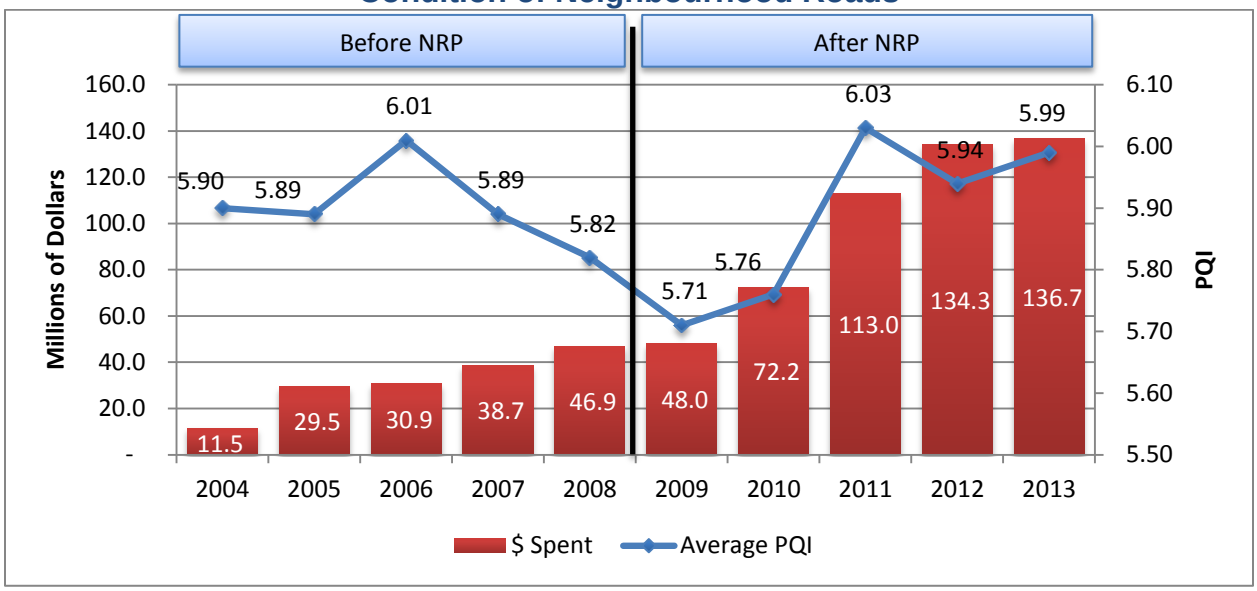


Figure 6 shows that since this programs inception in 2009, the City has spent $504 million on neighbourhood renewal, increasing the average PQI for neighbourhood roads from 5.71 to 5.99. A PQI of 6 or greater would put the roads in the "good" category. In the 5 years prior to 2009, the City spent $158 million and the PQI fell from 5.90 in 2004 to 5.71 in 2009.

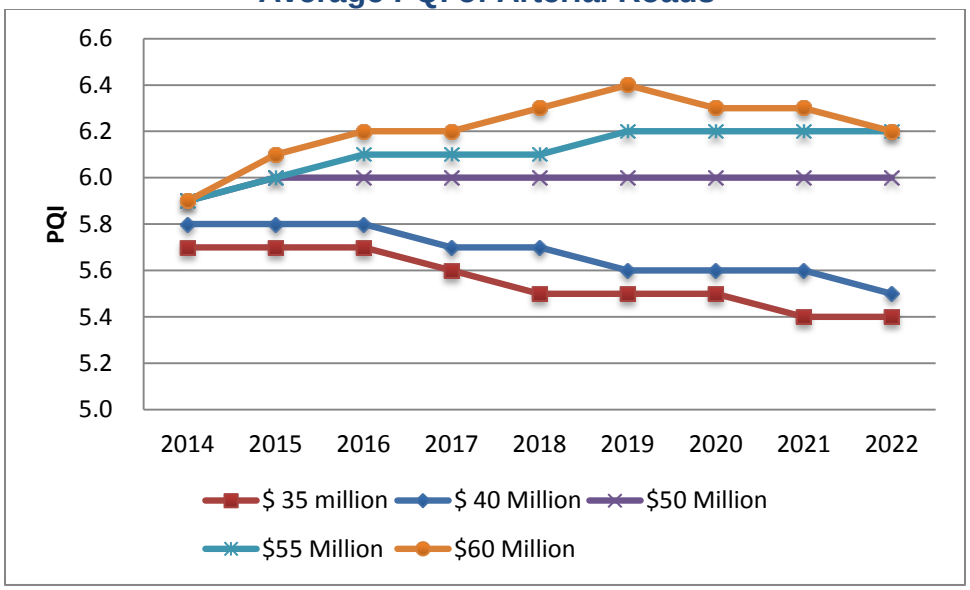
Arterial road strategy

Roadway Maintenance does not have a formal Council-approved strategy for arterial renewal similar to the Neighbourhood Renewal Strategy. They currently use a strategy that optimizes investment in arterial roads through a mix of preventive maintenance, rehabilitation, and reconstruction. The amount of work they can complete each year is determined by the funding they receive for that year. In 2013, the average PQI of all arterial roads was 6.36. This is the highest it has been in the past 20 years. However, if they have to defer capital investments in arterial roadway renewal, the condition of the roads will deteriorate and will increase the need for future maintenance work.

Roadway Maintenance is currently developing an investment strategy similar to the Neighbourhood Renewal Plan to ensure they can sustainably maintain arterial roads.

Figure 7 shows the predicted average PQI for arterial roads from 2014 to 2022 based on five different levels of funding.

Figure 7 – Impact of Different Capital Funding Scenarios on the Long-term Average PQI of Arterial Roads



The City's average spending on arterial road rehabilitation and reconstruction from 2010 to 2014 has been around $34 million. If the City maintains this spending level the model predicts that the average PQI for arterials will decrease to around 5.4 over the next eight years. The model suggests that in order to maintain the average PQI at or above the "good" level (PQI = 6 or greater) the City must spend a minimum of $50 million per year over the next eight years.

Documentation of operational strategies

The descriptions and the two measures included in *The Way We Move* and its *Implementation Plan* are high-level only. They do not include specific information on the processes and procedures that Roadway Maintenance uses to achieve the objectives of the *Way We Move* (i.e., the Neighbourhood Renewal Program). As well, the two measures alone do not provide management with enough information to assess the effectiveness of the pavement management framework.

Currently, Roadway Maintenance is using Council reports, budget documents and presentations, and the City's website to inform Council and citizens of its strategies, investment decisions, progress, and processes regarding the Neighbourhood Renewal Program and arterial road pavement management. They do not have a holistic document that includes specific operational strategies, investment decisions, and processes, as well as a set of performance indicators to assess the effectiveness of their decisions to achieve the goals and objectives set out in the Transportation Master Plan.

Without a document to guide staff on the achievement of the goals in the Transportation Master Plan, there is the potential risk that:

- The work of Roadway Maintenance may not align with goals set out in the Transportation Master Plan.
- The knowledge of current processes and strategies is lost when key employees leave the organization.
- There is no established course of action for achieving goals.

A guiding document specific to the work performed by Roadway Maintenance will help provide direction and focus for all employees. It should point to specific results that they want to achieve and establish a course of action and funding levels for achieving them. The document should have well-defined goals and objectives. The document should also contain an action plan detailing the steps the City will take in order to fully implement the strategies and tactics defined in the document.

Recommendation 1 – Document strategies

We recommend that the Transportation Operations Branch Manager develop a strategic document that includes operational strategies for achieving the goals and objectives in *The Way We Move.* This document should also include performance indicators to assess the effectiveness of the Pavement Management System and tie investment levels to the desired performance levels.

Management Response and Action Plan

Accepted

Action Plan:
Transportation Operations will prepare an overall Roads Strategy document that will encompass the ongoing strategy for arterial road renewal, neighbourhood renewal and bridge investment, and will link these programs to the objectives in The Way We Move. This document will identify the investment models to be used for program investment and condition evaluation, desired outcomes and goals of these programs and will define progress measures to allow the Branch to assess the effectiveness of the programs and provide progress reporting to Council.

Planned Implementation Date: December 2015

Responsible Party: Branch Manager, Transportation Operations

4.1.2. Effectiveness of project planning and programming

The City's Roadways Maintenance Section is responsible for the planning and programming of roadway preservation, rehabilitation, and reconstruction projects. The objective of this process is to balance the type and timing of work in order to optimize the use of budget dollars to increase or maintain the condition of roads.

Planning and programming process

Roadway Maintenance uses the pavement condition data contained in the pavement management system (the Municipal Pavement Management Application) to plan and program arterial and neighbourhood road projects. They also use sidewalk condition data to help prioritize neighbourhoods for renewal.

For arterial roads they use the system to prioritize the projects based on the funding available. The system uses a number of technical factors such as sectional pavement attributes, performance indices, user defined deterioration curves, and decision trees to make its determination. Depending on how much money is available, the system will determine which arterial roads should get which treatments in a given year in order to reach and maintain a predetermined condition for all arterial roads.

For neighbourhoods Roadway Maintenance use the pavement and sidewalk condition data from the system to determine which neighbourhoods require rehabilitation or reconstruction. Currently there are over 150 neighbourhoods that require renewal. Of these, over 100 need to be reconstructed. According to management, the City has the resources to renew all neighbourhoods in need over the long-term and industry currently has the capacity to meet this ongoing demand. However, there are neither the resources nor the industry capacity to renew all neighbourhoods in need of it over a short period of time. Therefore, they can only conduct renewal work in 13 to 15 neighbourhoods each year.

Roadway Maintenance management therefore uses additional criteria to determine which neighbourhoods the City will renew each year including:

- Available funding;
- Coordination with utility work and other major capital projects;
- Location efficiencies; and
- Minimizing traffic impacts.

Effectiveness of the planning and programming process

To assess the effectiveness of the planning and programming function, we chose to use a comparison over time of the following measures:

1. Average pavement quality index; and
2. Percent of roads in each condition category.

If the planning and programming function has been effective, there should be an increase in the average PQI. If effective planning and programming is occurring, the percent of roads in very poor or poor condition should be decreasing.

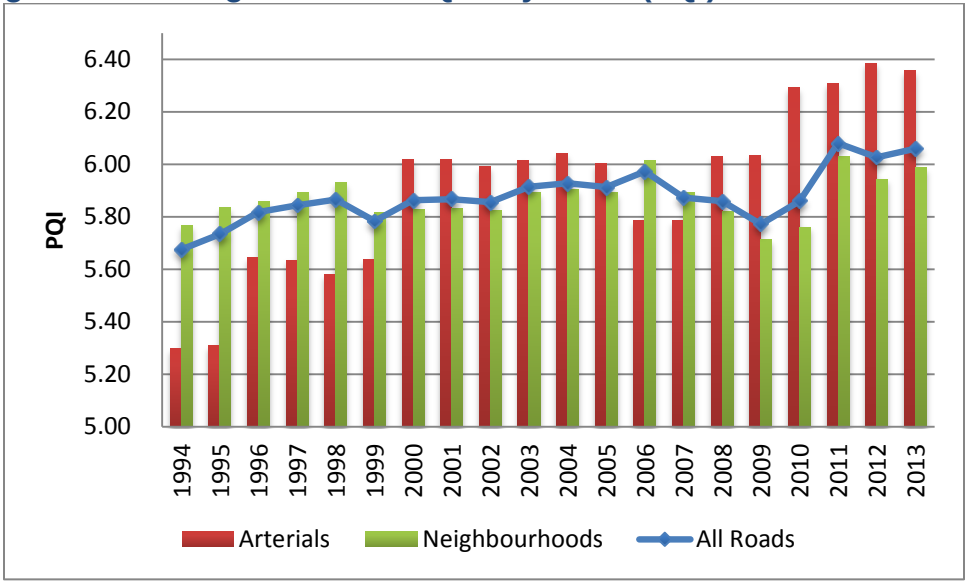
The effectiveness of the planning and programming function is also significantly affected by the available funds. However, increasing the budget alone is not necessarily going to change the overall condition of roads. The appropriate mix of prevention, rehabilitation, and reconstruction is what will drive a change in the condition of the roads. For example, using the available budget to fix the worst roads first may not be optimal since

this will lead to other roads deteriorating faster and being more costly to repair in the future.

Average Pavement Quality Index

Figure 8 shows that the average Pavement Quality Index for neighbourhood and arterial roads has been generally increasing over the past 20 years.

Figure 8 – Average Pavement Quality Index (PQI) from 1994 to 2013



Percent of roads in each condition category

Figure 9 shows the percent of arterial roads in each condition category and Figure 10 shows the percent of neighbourhood roads in each condition category.

Figure 9 – Percent of Arterial Roads in Each Pavement Condition Category

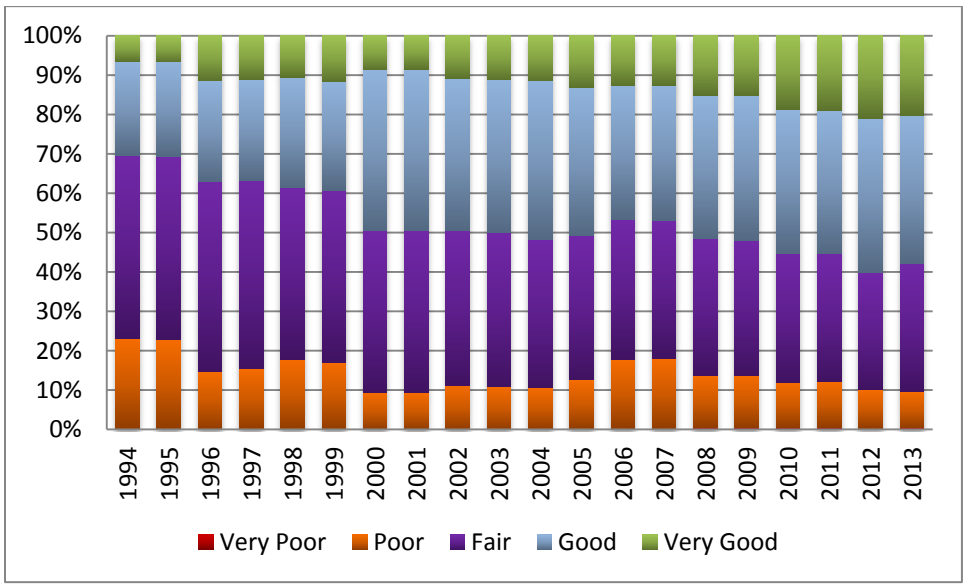


Figure 9 shows that Roadway Maintenance has been effective in decreasing the percent of arterial roads in poor and very poor condition.

Figure 10 – Percent of Neighbourhood Roads in Each Condition Category

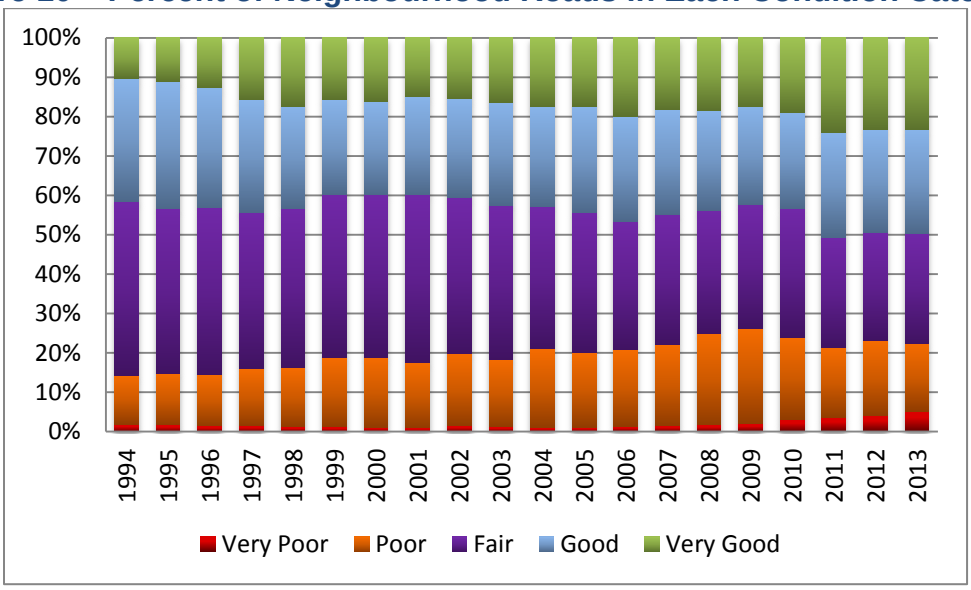


Figure 10 shows that Roadway Maintenance has been effective in increasing the total percent of neighbourhood roads in good and very good condition. However, the percent of neighbourhood roads in poor and very poor condition has also increased. This can be attributed to the lower levels of funding prior to the introduction of the Neighbourhood Renewal Program. After the program was established in 2009, the percent of roads in poor and very poor condition started to decline.

Overall, we conclude that Roadway Maintenance is doing an effective job of planning and programming roadway maintenance and renewal in order to optimize investments in road maintenance and provide adequate service levels. However, we found two opportunities to improve the planning and programming process and thus increase program effectiveness.

1. **Document operational procedures**
   Roadway Maintenance does not have the planning and programming processes documented to guide management and staff at an operational level.

   There are a number of documents on the City's website informing the public on how the City determines which roads are fixed first. However, these are at a very general level. We also found that this information may not exactly match the process that management is using. For example, the City's website indicates that Roadway Maintenance uses the condition of the road to determine the type of renewal required, including preventative maintenance. However, in practice, preventative maintenance is normally performed 2 years after an arterial road is reconstructed or 10 years after a neighbourhood road is reconstructed. Therefore, it is not based solely on the condition of the road.

Currently, only a small of number people know how to use the pavement management system. Management has not documented its operating procedures (i.e., the constraints that are entered and the process of converting the data to a readable format) for using this software system. Therefore, there is a risk that procedures may not be consistent if different individual perform the work. If existing staff leave the City, the knowledge would also leave.

Recommendation 2 - Document operating procedures

We recommend that the Transportation Operations Branch Manager ensure that the detailed operating procedures and processes of the planning and programming function are documented (i.e., identification, analysis, and prioritization of roadway preservation, rehabilitation, and reconstruction projects). This documentation will also indicate which information is presented publically (i.e., on the website and in Council reports.)

Management Response and Action Plan

Accepted

Action Plan:
Transportation Operations will prepare a document outlining the process for planning and programming of the Neighbourhood Renewal Program and the Arterial Renewal Program. This process will outline identification of locations, analysis of renewal type and prioritization of locations. This document will also define the renewal categories for both the neighbourhood and arterial programs and outline the selection criteria for each renewal type.

Planned Implementation Date: December 2015

Responsible Party: Branch Manager, Transportation Operations

2. Document reasons for selecting neighbourhood projects

As discussed earlier, the City does not have the resources or the industry capacity to complete every neighbourhood in need of renewal over a short period of time. Our discussion with management confirmed that they use additional selection criteria to determine which neighbourhoods they schedule for renewal each year. We found that management has not documented these criteria or the importance of considering them when deciding which projects to complete. As well, they have not documented why they selected one eligible project over another.

The selection of projects ultimately rests with a limited number of City employees. Thus for succession planning, to retain knowledge, and ensuring consistent application of the criteria being used, management should document the project selection process.

As an example, in 2013 the City reconstructed one neighbourhood and overlayed two others even though the neighbourhoods did not meet the minimum condition criteria for overlay or reconstruction. In order for a neighbourhood to be considered for reconstruction the roads must have a condition rating of less than 5 out of 10 and the sidewalks must have a condition rating of less than 3.5 out of 5. However, upon further discussion with management they were able to explain why these neighbourhoods were chosen for reconstruction or overlay. However, these reasons were based on the memory of staff as they had not been formally documented.

Recommendation 3 – Document reasons for selecting neighbourhood projects

We recommend that the Transportation Operations Branch Manager ensure that all decisions regarding neighbourhood roadway renewal projects are properly documented, including justification for selecting one project over another.

Management Response and Action Plan

Accepted

Action Plan:
As part of the prioritization and selection of neighbourhood renewal projects, the justification for selection will be documented for each neighbourhood reconstruction project and for each neighbourhood overlay project. This justification document will be contained in the Project Charter and will be incorporated into the outlined procedure in Recommendation 2.

Planned Implementation Date: December 2015

Responsible Party: Branch Manager, Transportation Operations

4.1.3. Quality assurance

Roads constructed in the City are generally built by contractors hired by the City or by developers. Regardless of who builds the road, they all must follow the City's Design and Construction Standards.

These Standards set out the minimum requirements to be satisfied during planning, design and construction of municipal improvements (roadways, drainage, landscaping, etc.). The Standards relating to roadways (Roadways Standards) are aligned with the Transportation Association of Canada *Pavement Asset Design and Management Guide 2013* (the Guide).

The Guide is an up-to-date consolidation of Canadian pavement design and management practices for practitioners in various sectors. The Guide is not a comprehensive design manual. Therefore, the City can ensure that its Roadways Standards are in line with the guide, but also make appropriate enhancements to ensure that roads built in Edmonton will meet the City's life-cycle expectations.

The City expects that roads built in accordance with these Standards are designed to achieve a 60 year life-cycle given appropriate rehabilitation interventions performed at the right times during this time period.

All roads built in the City, including those built by developers, eventually become the responsibility of the Roadway Maintenance Section to maintain. Therefore, it is important that the City and developers build the roads in accordance with the Roadways Standards. This ensures they meet performance expectations and the City does not incur earlier than expected maintenance and/or rehabilitation costs. The City has a variety of practices to ensure the City and developers build roads in accordance with the Standards. We found that there are opportunities for improvement in both areas.

City-managed road building

The Roads Design and Construction Branch provides design and construction project management services for road projects. This Branch manages contracts, controls the capital budget for client Department projects, and determines project delivery options.

The Branch uses the services of the Engineering Services Section of the Transportation Operations Branch for all of their quality assurance testing requirements. During construction, the assigned Project Manager provides the necessary oversight to ensure that the contractor is building the roads in conformance with specifications. When the Project Manager requires a quality assurance test, it is scheduled for the following day. The results of the test sample and its analysis are typically provided to the Project Manager within 24 hours for interpretation and subsequent corrective action if required.

In order to assess the outcome from the quality assurance process, we reviewed a sample of reconstruction projects built between 2009 to 2013. Out of the eight major reconstruction projects, we chose the following three as our sample:

- 118th Avenue: from 87th Street to 92nd Street;
- 99th Street: from 81st Avenue to Saskatchewan Drive; and
- 118th Avenue: from 93rd Street to 97th Street.

For each section of road, we compared the quality assurance test results to what was specified in the Roadway Standards. In each project we reviewed, there were instances where test results did not meet the requirements of the Standards. Specifically, where testing results were not within the parameters specified in the Standards (in some cases even after additional testing was performed) contractors were not required to remove and replace an inferior product.

The potential causes for these process failures include:

1. The Project Manager could have overlooked the results of the test. We found that the design layout of the test reports does not easily allow the Project Manager to quickly focus on results.
2. The Project Manager may have applied professional engineering judgment based on the specific site conditions or pressures to open the road, however did not record the rational for the decisions. In this case, a refresher training course may be required for the City's quality assurance staff and Project Managers to ensure consistency in decision making.

Recommendation 4 – Strengthen quality assurance documentation

We recommend that the Roads Design and Construction Branch Manager works with the Engineering Services Section to strengthen quality assurance documentation including:

- Improving the test report layout.
- Ensuring that all decisions based on the review of test results are documented.

Management Response and Action Plan

Accepted

Action Plan:
Roads Design and Construction will revise the design layout of the test reports to clearly identify where test results do not meet the requirements of the Standards as well as requiring the Project Manager to document all decisions to clarify the go forward action plan when test specifications are not met; this will strengthen the existing process. Training for all staff involved prior to the start-up of the construction 2015 program.

Planned Implementation Date: April 2015

Responsible Party: Branch Manager, Roads Design and Construction

Developer-built roads

Developers build a large portion of the City's road inventory. In 2013, the City capitalized $74 million dollars in transportation assets (i.e., roads, sidewalks, etc.). These roads are now the City's responsibility to maintain.

During construction of a road, the developer's Road Engineer is required to provide the necessary oversight to ensure that the developer's road construction contractor is building the road in conformance to the Roadway Standards. Quality control and quality assurance requirements also remain with the developer through its Road Engineer. The developer also secures the services of a private laboratory to provide testing which the Road Engineer reviews to ensure that the road construction is in conformance with the City's standards.

As well, the City has a process in place to review road designs, monitor road construction, and review test results prior to accepting the asset. This process is carried out by the Development Planning and Engineering Section within the Transportation Planning Branch.

During our audit we noticed some areas of risk within this process that may affect its effectiveness. We are not making any recommendation in this audit as the Transportation Planning Branch asked the Office of the City Auditor to include an audit of this process in its *2014 Annual Work Plan*. This audit is currently underway and the results are expected to be discussed at the February 2015 Audit Committee meeting.

4.2. Is the Pothole Repair Program Efficient and Effective?

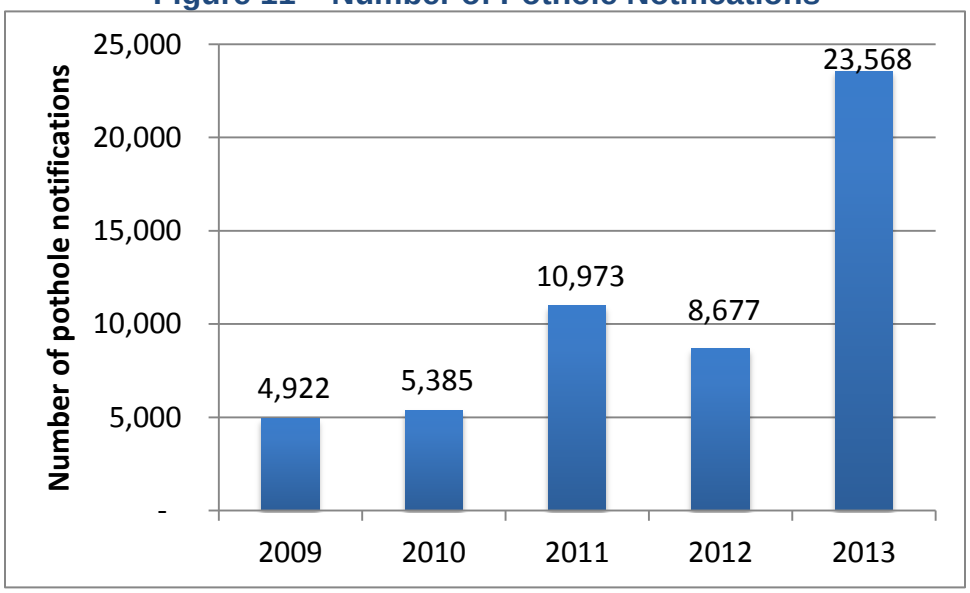
Even though the number of potholes filled over the past five years has fluctuated significantly, we found that Roadway Maintenance has been effective and efficient in managing the costs and time used for pothole repairs. However, our review found some areas to improve the effectiveness and efficiency of the Pothole Repair Program.

4.2.1. Pothole notification, inspection, and repair process

The Roadway Maintenance Section is responsible for the inspection and repair of potholes. Roadway Maintenances staff are notified of potholes through complaints made by the public. The public can report a pothole via email, phone, in-person, or mobile phone application.

In 2013, the City received 23,568 pothole notifications from citizens. This was up significantly from previous years. Figure 11 shows the number of pothole notifications from 2009 to 2013.

Figure 11 – Number of Pothole Notifications



As mentioned earlier, the City increased funding for road repair work in 2013 and 2014 which has led to the improved condition of city streets and a decrease in the number of potholes. There has also been a decrease in the number of pothole notifications from 2013 to 2014. From January to July in 2014, the number of notifications was only 8,981.

The City is divided into five roadway maintenance districts. Pothole notifications are sent to the appropriate district. Once the notification is received, an Inspector checks the pothole to determine the priority of the repair. Road classification, scheduled servicing, pothole size, depth, location, and claims information will determine the priority of the repair. For example, a large pothole or a pothole in a busier location is given higher priority as they have more impact on traffic safety. Inspectors then enter the inspection date and the priority assessment into the system.

Based on the priority assessment and the location of the potholes, the inspectors determine the most efficient and effective routing and repair methods for the pothole repair crews. Inspectors then assign the work to a crew to repair the pothole along with others in the surrounding area.

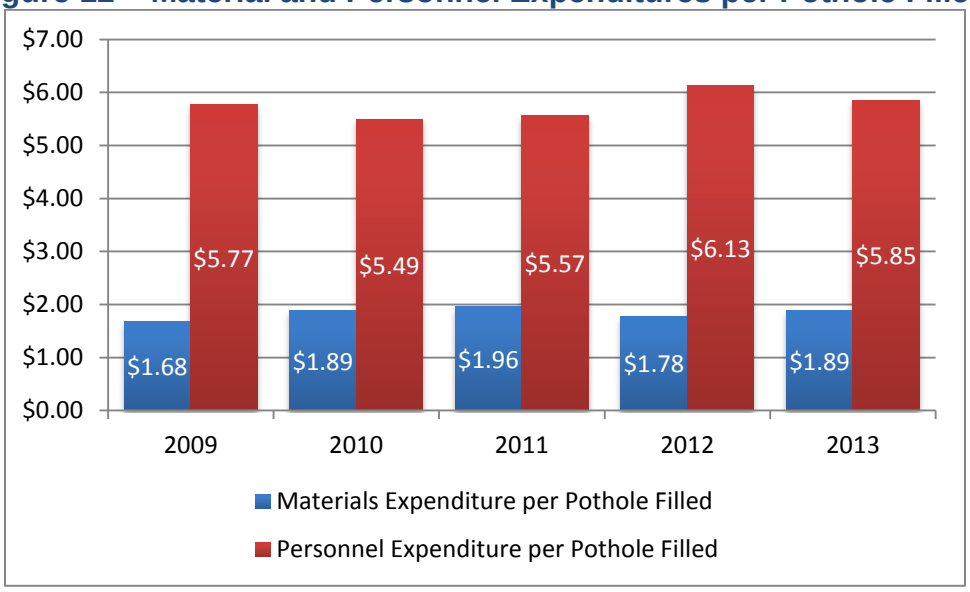
4.2.2. Effectiveness and efficiency of the Pothole Repair Program

In order to assess the effectiveness and efficiency of the Pothole Repair Program, we calculated the material and personnel expenditures per pothole filled and the average time to fill one pothole over the past five years.

Cost-per-pothole measures relate the costs to the work accomplished. They allow management to evaluate costs in terms of outputs and can help identify roadways that need additional attention. By using these types of measures, management can see the effects of any changes made to the process. Using this measure at the District-level allows management to compare and assess techniques employed in each District and assess needs for additional training.

Figure 12 on the next page shows the material and personnel expenditures per pothole filled over the past five years.

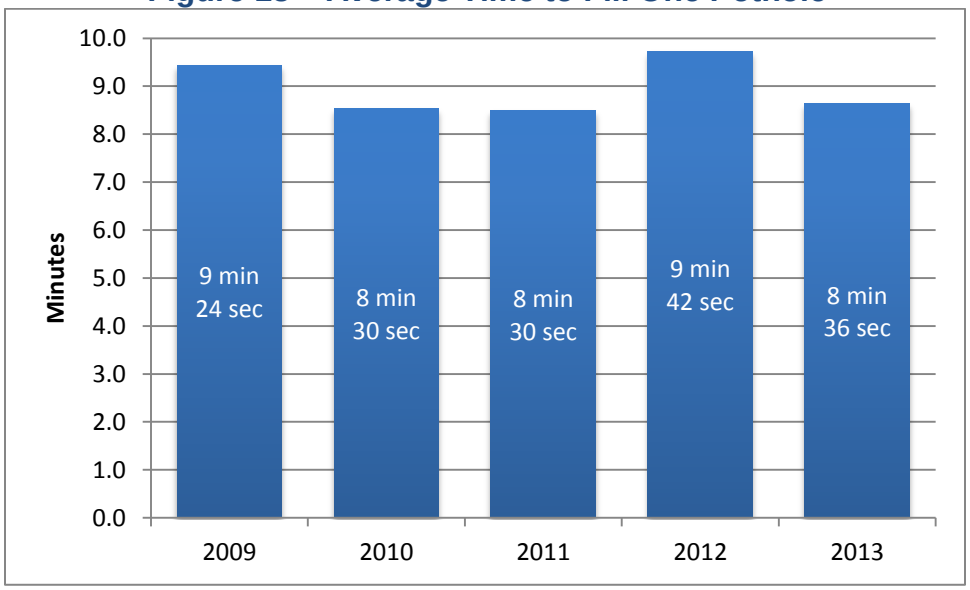
Figure 12 – Material and Personnel Expenditures per Pothole Filled[5]



Material and personnel expenditures per pothole filled have remained fairly consistent over the past five years.

The average time to fill one pothole provides another indication of how efficiently crews are completing their work. Using this indicator at the district level will allow management to compare times across districts to assess the need for additional training. Figure 13 shows the average time to fill one pothole over the past five years.

Figure 13 – Average Time to Fill One Pothole



[5] This does not represent the total cost of filling one pothole. There are other costs relating to equipment, overhead, and contracted services that make up the total cost to fill a pothole.

The average time to fill one pothole has been fairly consistent over the past five years.

Based on the results of the above measures, we conclude that Roadway Maintenance has been effective and efficient in managing the costs and time used for pothole repairs when compared to prior years. Roadway Maintenance has managed to keep material and labour costs and the average time to fill one pothole fairly consistent over the past five years, even with the fluctuations in the number of potholes filled and the volume of pothole notifications.

However, we found the following three areas where Roadway Maintenance can improve the effectiveness and efficiency of the program:

1. Use of performance indicators

Roadway Maintenance management does not use a set of performance indicators to monitor the effectiveness and efficiency of the Pothole Repair Program.

Without performance indicators, there is a risk that management is not able to:

a) Continuously monitor and assess the results of the Programs as well as the economy and efficiency of its management;
b) Make informed decisions and take appropriate, timely action with respect to the Program;
c) Provide effective and relevant reporting on the Program; and
d) Ensure staff members are collecting credible and reliable performance data to effectively support evaluation.

(See Recommendation #5)

2. Collecting appropriate data

Roadway Maintenance is recording inspection and repair data that includes the inspection date, the priority of the pothole, the repair date, the amount of material used, and the amount of time spent on repairs. However, as mentioned previously, management could use this data more effectively to review and monitor the Pothole Repair Program.

We found that Roadway Maintenance has a good process for entering and reviewing the repair data, as well as using it to prepare a monthly summary of the number of potholes filled. However, we found the inspection data to be inconsistent and untimely.

To determine the accuracy of inspection data, we examined the inspection records of a statistical sample of notifications in the system. By using a statistical sample, we can apply the results of the testing to the entire population of notifications. We found that:

- 8 percent of the time Inspectors did not enter an inspection date; and
- 66 percent of the time they did not enter a priority assessment.

Without this information, management is unable to assess the number of notifications addressed, the amount of time it is taking to inspect potholes, and the amount of time it is taking to address high priority potholes, etc.

As management has not been using pothole inspection data to monitor the effectiveness or efficiency of the inspection process, there has been little emphasis on entering all inspection data into the system consistently and in a timely manner.

By not being able to calculate these measures, management is unable to quantifiably determine the effectiveness and efficiency of the inspection and pothole repair crew activities. Also, management cannot ensure all citizens' notifications - especially high priority potholes - are addressed in a timely manner which can lead to unsatisfied citizens and increased liability for the City.
(See Recommendation #5)

3. Update procedures manual

Roadway Maintenance crews perform multiple roadway maintenance functions such as snow plowing, street cleaning, pothole repairs, and graffiti removal. This allows, Roadway Maintenance to adjust staffing according to weather conditions and other factors to increase the efficiencies and effectiveness of all its operations. For example, when there is no snow to clear in the winter, more crews can be scheduled for pothole repairs. Consequently, most staff members receive pothole repair training.

Roadway Maintenance has a Training and Procedural Manual that provides guidance on the methods and procedures used for pothole repairs and related information such as City policies and bylaws. However, it developed this manual in 1998 and has not updated it to include changes to policies and procedures. As well, the Manual does not include the guidelines and procedures for inspections following pothole notifications.

Once management has determined which indicators they will be using to assess the effectiveness and efficiency of the Pothole Repair Program, they will need to ensure that these indicators are included in the Manual and communicated to all pothole repair staff. This will help ensure that staff members are recording the required information consistently and in a timely manner.

By updating the Manual and including specific procedures for the collection of inspection and other required information, management can ensure they are collecting appropriate data to monitor the effectiveness and efficiency of the Pothole Repair Program. Management can also ensure staff members have access to an updated current resource when they are unclear of policies, bylaws, or procedures. As well, they can ensure consistency in terms of the inspection, prioritization, and decisions on repair methods for potholes.

Recommendation 5 – Update training and procedural manual

We recommend that the Transportation Operations Branch Manager ensure that the Training and Procedural Manual is updated and reviewed regularly. The updated Manual should include:

1. A description of all operational activities related to the Pothole Repair Program.
2. Key performance indicators and targets for the Pothole Repair Program.
3. Procedures to ensure they are collecting the appropriate data in a timely manner.
4. Procedures to ensure management is monitoring the effectiveness and efficiency of the Pothole Repair Program.

Management Response and Action Plan

Accepted

Action Plan:
Transportation Operations will update the Pothole Repair Training Manual and will expand this Manual to include the performance metrics for efficiency and effectiveness of the overall program along with identified performance targets for specific program activities; expected timelines for inspection of pothole notifications and requirements for recording of inspections.

Planned Implementation Date: June 2015

Responsible Party: Branch Manager, Transportation Operations

5. Conclusion

Overall, we found that the City is adequately protecting its roads as a capital asset. It has an effective pavement management framework to help ensure the City gets the best value from available funds. However, we made four recommendations to strengthen internal controls to ensure it continues to protect the roads as a capital asset.

We recommended that Roadway Maintenance document its operational strategies to clearly define how they support the goals and objectives set out by the City. We also recommended that they document the operational procedures and decisions made during the planning and programming stage of the pavement management framework. Our fourth recommendation was for the Roads Design and Construction Branch to strengthen quality assurance documentation for road building that they are managing.

The second objective of this audit was to assess the effectiveness and efficiency of the Pothole Repair Program. We concluded that Roadway Maintenance is effective and efficient in managing the costs and time used for pothole repairs. However, we recommended that the Training and Procedural Manual be updated and include:

- Descriptions of all operational activities related to pothole repair;
- A set of key performance indicators and targets;
- Procedures to ensure they are collecting the appropriate data in a timely manner; and
- Procedures to ensure that management is monitoring the effectiveness and efficiency of the Pothole Repair Program.

We thank all of the management and staff of the Transportation Services Department who helped us during this audit for their cooperation and assistance.

Appendix A – Glossary of Terms

Routine Maintenance:

Pothole repair – Filling a hole in the pavement.

Preventative Maintenance:

Crack sealing – Filling a crack in the pavement to reduce moisture infiltration into the pavement's base layers from snowmelt or rain. This action reduces the rate of deterioration of the pavement prolonging its service life.

Spray patching – A method of pothole repair. This method is typically a one-person operation which involves the use of a high-pressure nozzle to clear a hole of debris, inject the repair material, and dust the surface with stone to prevent vehicle tires from pulling the repair material out of the hole.

Microsurfacing – A thin seal coat of small stone and asphalt emulsion designed to restore the resilience of the pavement surface to sunlight and thereby extend the service life of the pavement. It is normally applied to the entire pavement surface ten years after resurfacing or reconstruction of a neighbourhood road.

Rehabilitation:

Overlay – The resurfacing of a pavement through the direct application of hot-mix asphalt to the existing surface.

Mill and overlay – The resurfacing of a pavement by removing the existing pavement to a depth of five centimeters or more and then applying new hot-mix asphalt to replace the removed material. On roads that have a structural deficiency, the thickness of new material will be greater than the thickness removed.

Reconstruction:

Reconstruction – The complete restoration of all pavement layers. This work also typically involves the removal and replacement of adjacent curbs, sidewalks, and sometimes street lights.

Level of Service – The ability of an asset to perform its intended function. A target or desired level of service is typically set for infrastructure assets by agencies in response to public expectations and/or available funds.

Quality Control – Testing done during construction to ensure a quality product is being provided.

Quality Assurance – Testing done to ensure all quality control tests were completed properly.

Pavement Quality Index (PQI) Components:

Pavement roughness (Ride Comfort Index) – The deviation from a smooth surface with characteristics that affect vehicle dynamics and ride quality.

Pavement surface distress (Visual Condition Index) – Involves the inspection and rating of all observable irregularities, imperfections, and flaws on the pavement surface.

Pavement structural capacity (Structural Adequacy Index) – Evaluation of structural or load-carrying capacity of a pavement.