



City Auditor's Office

Roads Pothole Remediation Audit

April 28, 2020

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The City Auditor's Office conducted this audit in conformance with the *International Standards for the Professional Practice of Internal Auditing*.

Executive Summary

Repairing potholes is a part of The City of Calgary's Roads business unit (Roads) continual maintenance of Calgary's roadways. It is also an essential part of keeping traffic moving safely through the city and a top priority to citizens. Generally speaking, a pothole is a depression in a road surface, where a portion of asphalt has broken away, leaving a hole. Repairs take place throughout the year, with the majority of repairs occurring between April and September as one component of Roads' summer maintenance program. Every year Roads fills approximately 16,000 potholes on its paved streets and lanes, which is the main element of the asphalt repair activity. Although Roads does not track the cost of repairing potholes as a separate budget item, asphalt repair expenditures were approximately \$5.3M for 2019, with 40% of the costs covering material, equipment and supplies and 60% for labour.

The objective of this audit was to assess whether Roads has designed and implemented effective processes to support timely and quality pothole repairs. The audit focused on Roads' operational processes and practices and relevant data pertaining to activity occurring from January 1, 2019, to September 30, 2019, across Roads' five districts.

Our audit concluded that Roads utilizes varying prioritization and quality practices across each district and within individual depots which generally support effective processes. Given the importance of road maintenance to citizens and the likely increase in demand for pothole repairs, due to aging and expanding Roads infrastructure, we raised four recommendations that will improve the effectiveness and efficiency of current pothole processes. These recommendations, once implemented, will also establish processes which will continue to support timely and quality pothole repairs in future years.

Specifically, Roads should implement a framework of standardized prioritization processes and develop KPIs linked to prioritization, to effectively monitor timeliness of pothole repairs. Roads should also enhance efficiency of repairs by building resource capacity and agility and formalize quality expectations for repairs to reduce cost of rework.

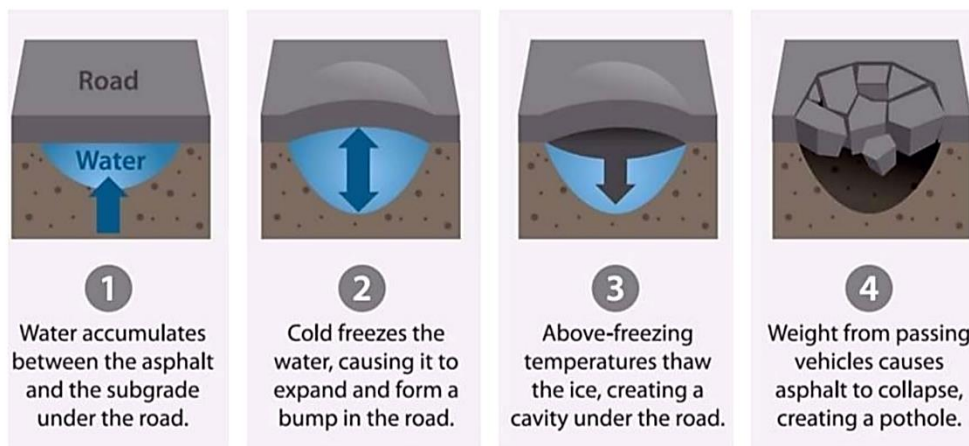
Roads has agreed to all recommendations and has committed to set action plan implementation dates no later than December 31, 2020. The City Auditor's Office will follow-up on all commitments as part of our ongoing recommendation follow-up process.

1.0 Background

The City of Calgary's citizen priority, A City That Moves, focuses on offering a variety of convenient, affordable, accessible and efficient transportation choices. Timely and quality pothole repairs directly support this priority by facilitating safe and efficient movement along City of Calgary roads.

Generally speaking, a pothole is a depression in a road surface, where a portion of asphalt has broken away, leaving a hole.¹ Potholes are a function of a number of causes including age and condition of the pavement, environmental conditions, traffic type and frequency, moisture sensitivity and construction defects. In Calgary, potholes are typically formed in the spring during freeze/thaw cycles when snow melts into cracks in the asphalt and then freezes, expanding in the cracks. Vehicles traveling over the weakened road then break off pieces of asphalt.

How a Typical Pothole is Formed



Source: <http://westcheshireyourstreets.co.uk/potholes/>

Roads maintains, rehabilitates, and reconstructs the city's current roadways and bridges, and manages traffic and parking infrastructure. Roads is divided into five districts and nine depots for efficient and effective implementation of maintenance programs. Repairing potholes is a major part of Roads' continual maintenance of Calgary's roadways, and an essential part of keeping traffic moving safely through the city. Every year Roads fills approximately 16,000 potholes on its paved streets and lanes.

Repairs take place throughout the year, with the majority of repairs occurring from April to September as a component of Roads' summer maintenance program. Pothole repairs are reported by citizens through service requests (SRs) in 3-1-1, The City's government information and non-emergency services system. Foremen may also identify potholes when completing roadway inspections. Potholes are then prioritized according to severity and safety implications to citizens.

¹ <https://en.wikipedia.org/wiki/Pothole>

Pothole patching methods on paved streets include using hot asphalt or cold mix. Cold mix is used when weather conditions are not favorable, or in emergency situations. Hot asphalt is used during favourable weather conditions and may require removal of deteriorated pavement and loose material around the area to reconstruct the perimeter of the failed road. Hot asphalt repairs yield better overall results and last longer, but, take more time and utilize more resources resulting in greater cost in the short term. Although Roads does not track the cost of repairing potholes as a separate budget item, asphalt repair expenditures were approximately \$5.3M for 2019, with 40% of the costs covering material, equipment and supplies and 60% for labour².

2.0 Audit Objective, Scope and Approach

2.1 Audit Objective

The objective of this audit was to assess whether Roads has designed and implemented effective processes to support timely and quality pothole repairs.

2.2 Audit Scope

The audit assessed the effectiveness of processes set out below. Relevant pothole data pertaining to activity occurring from January 1, 2019 to September 30, 2019, across all five districts was analyzed. Technical quality of the fill was not tested, however, the audit examined the processes in place to ensure quality of the asphalt is maintained.

Risk	Inherent Risk (H,M,L)	Acceptable Business Risk (H,M,L)	Identified Process Steps
Potholes are not repaired in a timely manner.	H	M	Prioritization of potholes Resources/ scheduling
Pothole repair quality is poor.	H	M	Classification of potholes Training of staff Foreman inspections Quality validation of asphalt

2.3 Audit Approach

Our audit approach included the following:

- Interviews with five out of nine depots (one from each Roads district)
- Assess operations through analysis of 3-1-1 pothole SR data, resource and equipment scheduling, training records and foreman inspection and quality processes.

² Based on financial reporting provided by Roads

3.0 Results

The results focus on effective mitigation processes to address the risk that potholes are not repaired in a timely manner and/or pothole repair quality is poor. We also discuss the future risk outlook for pothole repairs based on Road's information provided in the 2019-2022 One Calgary Service Plans and Budgets.

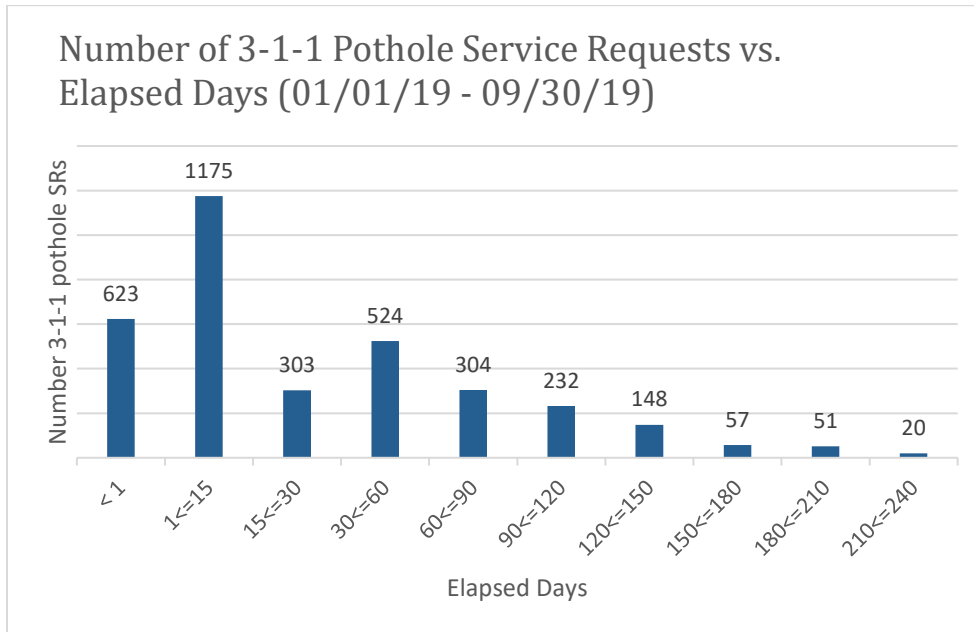
3.1 Processes to Address Timeliness of Repair

To assist in the evaluation of timeliness, Roads' foremen walked us through the process/criteria used to prioritize potholes, how fills are tracked, monitored and communicated to management, whether high priority potholes are filled first, and whether there are defined timeframes to close potholes including established key performance indicators (KPIs). We also discussed the adequacy of resources (staff and equipment) to fill potholes, how long and short-term resourcing gaps are addressed, whether pothole repairs were being effectively balanced with other roads maintenance activities (e.g. street cleaning), how resource scheduling occurs and if appropriate training is provided.

Interviews indicated that at the start of each season, Roads Maintenance develops a program plan to determine resource requirements. Staff then bid for shifts based on seniority. Once shifts are set, Maintenance identifies and addresses training gaps with staff. Filling potholes starts with the foreman pre-inspecting each pothole SR to determine its priority and the method of fill required. Foremen prioritize potholes based on location, type of road, severity and safety risk to citizens. Potholes are then filled on a best effort, dependent on resource availability. In instances where resources may not be sufficient, there are strong relationships amongst depots that allow the borrowing of staff and/or equipment if available. Interviews indicated that day crews typically have adequate resources. Further resource improvements are planned to the 2020 spring schedule which will overlap crews on Tuesdays, Wednesdays, and Thursdays. This will more effectively balance pothole repairs with street cleaning by ensuring there are resources available to care for both maintenance activities.

Although potholes are being prioritized based on location, type of road, severity and safety risk to citizens, practices vary across depots. There are also varying record keeping and data collection practices. We recommended that Roads should develop procedures and practices that are applied consistently across the business unit and are supported by training (recommendation 1).

We judgmentally selected six days per shift type (day/night) to determine whether a potholes crews and equipment were deployed for that day. Our results indicated that a potholes crew was deployed for 46/60 (76%) of the days sampled. We also analyzed 3-1-1 SR data and calculated the mean, median and range of time to resolve potholes to determine whether pothole repairs were being addressed in a timely manner. The median was 12.9 days, the mean was 36.8 days and the range was from the day reported to 270 days after notification.



Although our analysis could be indicative of effective service delivery, without intentional key performance measures and ongoing monitoring we could not conclude if these met service expectations. Roads needs to develop a definition of timeliness, establish KPIs linked to prioritization and collect appropriate data to monitor KPIs (recommendation 2).

Testing of shift coverage, indicated that 74% of our sample did not have either backup for key positions (i.e. someone trained on hotbox, rollers, rake or tar kettle) or adequate resources. Testing of resource availability, noted that 15% of the days sampled did not deploy a potholes crew due to skilled operator absences, resource sharing or equipment repairs. Going forward, Roads should review resource agility to support ongoing timeliness of response to the highest priority repairs (recommendation 3).

3.2 Processes to Address Quality

Assessment of quality included, whether foreman inspections are occurring at defined frequencies, if criteria is used to complete inspections, whether materials are monitored to determine their effectiveness, how daily spot checks of potholes are completed and filled, and ensuring staff are appropriately trained. We also met with the asphalt group to determine the processes used to ensure the quality of the asphalt.

Our interviews indicated that hot asphalt is always the preferred method of fill, but this is weather, location and resource dependent. If a fill is urgent (i.e. can cause harm/damage) cold mix is used. The method of fill is determined by the foreman or crew lead-hand. If a foreman 4 position is available, he is responsible for ensuring the quality of the fill, however, district foremen may visually identify issues when driving to inspect incoming SRs or completing right-of-way inspections. Foremen indicated in interviews that there is open dialogue with staff regarding issues as they arrive including identifying opportunities for improvement. Foremen also indicated that citizens can escalate SRs through the City's 3-1-1 system.

The hot asphalt used by crews is obtained from the City's asphalt plant. Our review of the asphalt plant indicated that there are appropriate quality processes, including adequate quality testing of asphalt completed. Staff noted that fails on asphalt quality tests are not common.

We selected a random sample of 10 employees who completed pothole fills across each pothole position during 2019 and obtained documented evidence to support role-related training. Based on our testing, we concluded that employees have received required training at defined frequencies. However, there is no definition of a quality fill either when using cold mix or hot asphalt. Depots interviewed indicated that best practice pothole repair techniques are infrequently being utilized. Roads Maintenance should formalize and standardize quality expectations for repairs supported by training and define measures to track and report on quality repairs (recommendation 4).

3.3 Future Outlook

In the 2019-2022 One Calgary Service Plans and Budgets, Calgary's 2019 citizen satisfaction survey consistently shows infrastructure, traffic and roads at the top of citizens' issue agenda. Citizens rated the following activities with high importance, low satisfaction and a high willingness to invest: traffic flow management, road maintenance including pothole repairs, transportation planning, and snow removal. Specifically, the Roads annual survey showed low satisfaction for pothole repair (45%). The 2019-2022 One Calgary Service Plans and Budgets also indicated that pavement represents a replacement value of over \$9.8 billion. Roads stated that lifecycle funding from 2015-2018 was not sufficient to maintain overall pavement condition, and during this period citizen satisfaction with road condition dropped from 79% in 2016 to 68% in 2018 for main roads; and from 89% to 81% for neighborhood roads. The report forecasted that reduction in lifecycle funding through 2019-2022 One Calgary Service Plans and Budgets will result in accelerated deterioration and a heavier burden on maintenance activities, such as pothole repairs.

Given the importance of road maintenance to citizens and the likely increase in demand for pothole repairs, due to aging and expanding Roads infrastructure, Roads should implement a framework of standardized prioritization and quality processes supported by KPIs and targets, to continue to deliver timely and quality pothole repairs in an increasingly challenging environment.

We would like to thank Roads staff for their assistance and support throughout this audit.

4.0 Observations and Recommendations

4.1 Standardize Prioritization Practices

Roads does not use consistent practices to prioritize pothole repairs. Established prioritization procedures support consistency of repairs across depots and the collection of reliable data to track whether the highest priority potholes are repaired on a timely basis.

Potholes are prioritized by foremen based on an inspection following a SR. We interviewed foremen from five depots who indicated that potholes are prioritized based on location, type of road, severity and safety risk to citizen. A 1-5 priority rating (5 being the most severe) is being used by two of the five depots interviewed. Prioritization of potholes is addressed in foremen training, however, foremen indicated in interviews that training is not sufficiently detailed.

There are also inconsistent record keeping and data collection practices being utilized. For example, some foremen track potholes through 3-1-1 and others utilize manual tracking systems. There is no uniform recording of pothole priority. There are also varying practices in how potholes are recorded, including how the number of potholes is recorded and tracked and tracking potholes versus other Roads defects such as sinkholes, and sunken utility cuts.

Recommendation 1

The Manager of Roads Maintenance develop prioritization procedures and practices that are applied consistently across Roads and are supported by training.

Management Response

Agreed.

Action Plan	Responsibility
<p>a) We will formalize our current prioritization into a framework that standardizes:</p> <ul style="list-style-type: none"> • The language we use; • The parameters of a pothole vs. other defects that might be repaired using hot asphalt; and • The rating system for assessing pothole priority, including the key aspects to be addressed (e.g. address public safety based on pothole size/depth, traffic volume/route classification, and potential disruption to driver behavior). <p>This prioritization framework will be included in our pothole repair manual and in foreman training program.</p>	<p><u>Lead</u>: Manager, Roads Maintenance</p> <p><u>Support</u>: Leader, Planning and Projects</p> <p><u>Commitment Date</u>:</p> <p>a) October 31, 2020 b) December 31, 2020</p>

Action Plan	Responsibility
<p>b) Pothole repairs are currently identified through 3-1-1 service requests and through routine inspections by Roads Maintenance. We will investigate the feasibility of using the Street Light Outage Map as a tool for managing pothole processes and capturing consistent repair information. This would include a map to facilitate location capture of potholes for inspection; prioritization of work and generation of work orders; and communication of completed repairs.</p>	

4.2 Establish KPIs Linked to Prioritization

Roads Maintenance does not have a described measure of timeliness or appropriate KPIs and associated targets to effectively measure timeliness of the highest priority pothole repairs. Establishing KPIs will support roads maintenance in monitoring their progress and determine if they are being successful in closing potholes within defined timeframes.

Potholes are prioritized by foremen and filled on a best effort based on resource availability. Pothole SRs from citizens are captured in 3-1-1 along with other maintenance SRs. 3-1-1 dashboards are available to Roads management, but they do not contain data on pothole priorities or set uniform targets based on these priorities. The overdue SR target utilized in Roads dashboards is 370 days from the date the SR is opened, however, this does not consider the priority of the pothole repair.

Recommendation 2

The Manager of Roads Maintenance develop a definition of timeliness, establish KPIs linked to prioritization and collect appropriate data to monitor KPIs.

Management Response

Agreed.

Action Plan	Responsibility
<p>Roads receives nearly 90,000 service requests each year, and 4,000-6,000 of these are for pothole repairs. Over the past two years Roads has been reviewing and updating the processes for all our service request types, which has yielded substantial savings in staff time. The 11 maintenance service request types, which include the pothole repair service request, are the last set to be updated and are identified in our 2020 work plan. These process reviews include a review of timeliness targets and are scheduled to be completed by September 30, 2020. We will implement new service level targets for each rating identified in the prioritization framework being developed as part of recommendation 1 above. Once this implementation is complete, the Manager of Maintenance and Director of Roads will review monthly timeliness reports. Repair progress will be posted to The City’s website for citizens to view, similar to our snow and ice control and spring clean-up progress mapping.</p>	<p><u>Lead:</u> Manager, Roads Maintenance</p> <p><u>Support:</u> Leader, Planning and Projects and Strategic Services</p> <p><u>Commitment Date:</u> October 31, 2020</p>

4.3 Availability of Trained Resources and Required Equipment

Roads complete pothole repairs on a best efforts basis, when trained resources and equipment are available. Roads are not currently tracking whether availability is sufficient to support maintenance crews in repairing the highest priority potholes in a timely manner when weather conditions permit.

Foremen from all depots interviewed indicated that there have been constraints that impacted availability of trained resources and equipment during the 2019 summer maintenance program. These included not having adequate resources on the nights crew; not having backup for key positions e.g. if an asphalt carrier operator is absent (shift and season dependent); the reliability of asphalt carriers (equipment) and their fit for purpose; and availability of skilled rakers to support high quality repairs.

We also tested shift coverage and judgmentally picked one shift per season (winter, spring summer) to evaluate if the depots in our sample had appropriate resources to run a potholes crew. Out of the 39 shifts we sampled 74% did not have either backup for key positions or adequate resources (someone trained on hotbox, rollers, rake or tar kettle). When we tested resource availability, we also noted that a potholes crew was not deployed for 15% of the days sampled due to skilled operator absences, resource sharing or equipment repairs.

The Manager of Roads Maintenance stated that he is aware of the constraints experienced by depots during 2019. He is anticipating that changes to resource scheduling (overlapping of shifts on Tuesday/ Wednesday/ Thursday) and equipment (troubleshooting of asphalt carrier reliability by Fleet Services) will improve availability to support repairs during the 2020 summer maintenance program. Monitoring of availability on a sample basis will support Roads management in determining if availability is improving, and whether availability is sufficient to support best efforts repairs in a timely manner.

Recommendation 3

The Manager of Roads Maintenance:

- a) Review availability of trained resources and required equipment on a sample basis during the 2020 summer maintenance program, and conduct analysis to determine whether further action is required to support the agility of crews to respond to high priority potholes.
- b) Continue to work directly with Fleet to resolve reliability and fit for purpose issues associated with the asphalt carriers.

Management Response

Agreed.

Action Plan	Responsibility
<p>a) Over the past several years Roads has been running spring maintenance a shift on each day of the week with no overlapping shifts. This was done to accelerate the completion of spring clean-up. We are reviewing shift schedule for the 2020 spring season to include overlapping crews on Tuesdays, Wednesdays, and Thursdays. In addition, we are reviewing our spring clean-up schedule to accommodate more concurrent pothole maintenance and make it less susceptible to staff absenteeism.</p>	<p><u>Lead:</u> Manager, Roads Maintenance</p> <p><u>Support:</u></p> <ul style="list-style-type: none"> a) Business Services b) Fleet <p><u>Commitment Date:</u></p> <ul style="list-style-type: none"> a) December 15, 2020 b) December 15, 2020

Action Plan	Responsibility
<p>Roads will continue to work with Local 37 to enhance our letter of understanding to reduce staffing adjustments and at the same time allow for training based on shift selection.</p> <p>After the summer maintenance season is complete we will perform an assessment to determine whether resource availability has improved as a result of our process changes. The Manager of Maintenance and Director of Roads will review this assessment, and if required develop an action plan to address further adjustments to processes.</p> <p>b) Roads and Fleet have worked together to resolve several technical and training issues that arose through use of the asphalt carriers through all seasons. We will continue to work together to ensure that any issues affecting the serviceability and operation of the asphalt carriers are addressed.</p> <p>We will also continue to work with our staff to ensure that they are proficient in using the equipment.</p> <p>After the summer maintenance season is complete we will perform an equipment assessment to determine whether resource availability has improved as a result of our process changes. Roads and Fleet will review this assessment and develop an action plan to address further adjustments to processes as required.</p>	

4.4 Formalize Quality Expectations

Roads have not established expectations regarding what constitutes a quality pothole repair. There is an opportunity to enhance consistency of expectations to support “right first time” repairs and efficiency of operations. If potholes repairs are not completed to a quality standard, further repairs may be required which could result in additional costs or waste to The City.

Foremen pre-inspect potholes to prioritize them and determine the best method of fill. However, there is no definition of a quality fill either when using cold mix (in poor weather conditions) or hot asphalt. Depots interviewed indicated that best practice pothole repair techniques are infrequently being utilized. The fill technique is determined by the raker (lead hand of crew) and/or foreman. Staff noted that resource constraints can contribute to lower quality fills. For example, using a plainer and/or jackhammer to square off a pothole prior to filling was mentioned by 4 of 5 depots, however, such an approach requires additional resources and equipment (the new asphalt carriers have not been designed to carry a jackhammer, if a jackhammer is required to remove any damaged pavement around the pothole, an extra truck would also be required). Foremen indicated that utilizing best practices means less potholes will be filled in a day.

All depots interviewed indicated that spot checks on quality only occur if resources are available; spot checks are typically completed by a foreman 4 if this position is scheduled on a shift. Otherwise, once the pothole is filled, the SR is closed without further quality checks. Foremen indicated that if the quality is poor a citizen will follow up with 3-1-1 or a new SR will be opened.

Recommendation 4

The Manager of Roads Maintenance establish quality expectations supported by training and define measures to track and report on quality repairs.

Management Response

Agreed.

Action Plan	Responsibility
<p>a) We will implement a quality control program to validate pothole repair quality, including definition of quality expectations and setting targets for the percentage of repairs that are expected to meet specifications. We will test for quality by sampling repair locations using a nuclear densometer to validate the compaction of pothole repairs, which will provide an indication of the quality of our repair processes.</p> <p>b) Roads will create a field repair manual with step-by-step instructions that can be used by staff as a field reference tool, and include this in our annual training program</p>	<p><u>Lead:</u> Manager, Roads Maintenance</p> <p><u>Support:</u> Business Services, Construction</p> <p><u>Commitment Date:</u></p> <p>a) August 30, 2020 b) October 31, 2020 c) October 31, 2020</p>

Action Plan	Responsibility
c) We will complete monthly assessments through the summer to determine whether pothole repairs are meeting the desired specifications, and adjust our processes as needed.	