Audit and Accountability Fund

Winter Control Modernization Review

Final Report to the City of Waterloo

THE CITY OF Waterloo

Deloitte.

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No opinion, counsel, or interpretation is intended in matters that require legal, tax or other appropriate professional advice. It is assumed that such opinion, counsel, or interpretations have been, or will be, obtained outside of the scope of this report.

The absence of independent verification of the information supplied in respect of both historical and projected information, in some cases can limit potential findings. It is likely that there will be restrictions or limitations in the resulting data that could impact the accuracy of our report and therefore we have indicated in our report the source of the data that was obtained by us but disclaim any responsibility for its accuracy. The scope of this work was not responsible for implementing the findings and therefore, the ability to realize the potential efficiencies identified is based on the ability to implement the opportunities. Our work does not and will not result in the expression of an opinion or other form of assurance.

Executive Summary

Background to the Review

The Corporation of the City of Waterloo (the "City") received funding from the Province of Ontario Audit and Accountability Fund. The funding was to cover for a review of Winter Control operations (the "Review"), the aim of which was to identify opportunities to modernize and improve the efficiency of Winter Control operations.

Deloitte (hereinafter referred to as "we", "our" or "us") was engaged by the City to complete the Review. The scope of the Review as specified by the City included a review of the policies, procedures and processes from a Lean Six Sigma perspective with a focus on to plow route optimization, salt management strategy, personnel and equipment resource allocation, and consideration of the use of Artificial Intelligence (AI) systems.

This report provides 20 actionable recommendations organized by theme. The potential net annualized efficiency or cost saving and service or community impact of each recommendation is described. We also highlight the possible implications of interdependencies between opportunities. Finally, this report provides a summary for the City's consideration on how to proceed with the recommendations associated with each opportunity.

Objectives, project principles, and scope

The Review had three key objectives:

1. To identify service delivery cost savings and improved efficiencies;
2. To identify innovation opportunities to modernize service delivery; and
3. To demonstrate how the application of Lean Six Sigma methodologies could help drive improvement.

Reducing the service to citizens and reducing City headcount were ruled out of scope by the City.

Approach and program of work

Our work was delivered in three phases:

1. Phase one began on August 26th, 2019 by reviewing City data to develop an understanding of the City's policies and processes and to establish a financial baseline for typical Winter Control operations against which we could provide quantified opportunities for improvement.
2. Through phase two we developed, qualified and quantified our findings and opportunities by organizing over 20 meetings and three workshops from September 10th to October 17th, 2019 with the City's Commissioner, Integrated Planning & Public Works, Director of Transportation, Director of Environment & Parks and other key stakeholders. Our approach was therefore highly collaborative.
3. In phase three, we applied an opportunity characterization framework to help develop and shape the opportunities. This framework served as an evaluation tool to assess the financial benefit, citizen impact and overall complexity of each opportunity. Our Senior Project Advisory team also applied it's extensive Public Sector experience to provide a view of comparable and leading practices, helping to ensure that the opportunities identified were actionable by Winter Control operations.

By applying our approach we confirmed 20 opportunities organized under five themes.

How to read this Executive Summary

The Executive Summary describes the baseline studied, the opportunities identified and how implementing them should reduce costs / improve efficiency and improve the service offered to citizens of the City. The Winter Control Modernization Opportunities section provides further details of the background, characterizations, annual cost savings, implementation steps and other considerations.

Expense Baseline

The expenditures of $4.26 million in the chart below were subject to the Review. These expenditures are from September 2018 to August 2019 inclusive and were provided by the City's Finance team as being representative of a typical Winter Control operations year.

Expenses by Functional Area

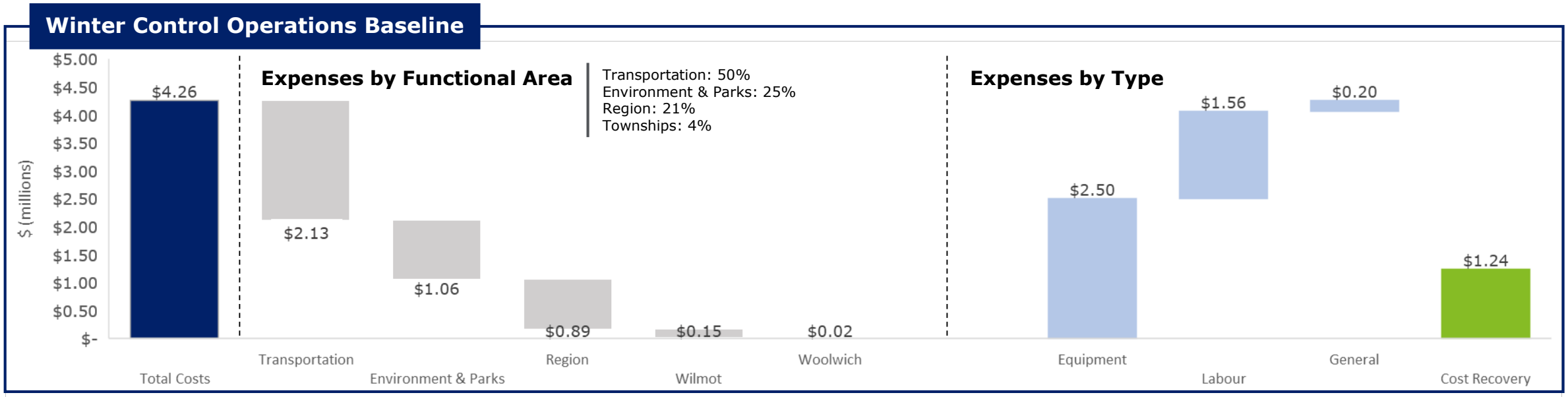
These expenditures are sourced from five cost centres, including Transportation, Environments & Parks, and cost centres dedicated to services provided to the Region of Waterloo (the "Region"), Wilmot and Woolwich (the "Townships").

As Transportation is primarily responsible for plowing activities on major arterial roads and laneways throughout the City, this functional area is naturally significant, representing 50% of the total baseline. Environment & Parks are primarily responsible for service delivery to multi-use trails, sidewalks and segregated bike lanes, contributing to 25% of the total baseline. Lastly, Winter Control services delivered to the Region and the Townships form the remaining 25% of expenses. These services are primarily plowing activities on neighbouring regional roads.

Expenses by Type

The majority of Winter Control expenditures relate to equipment and supplies; more specifically the cost of operating equipment and purchase of material such as salt. Labour costs are naturally the next highest expense as the City employs full-time and seasonal employees across the functional areas of Transportation and Environment & Parks. Additional activities related to service delivery such as the removal of cleared snow or ad hoc salting activities are captured as general expenditures.

The City also recovers costs related to the services delivered to the Region and Townships per shared services agreements.



Summary of Opportunities

If the City implemented all of the opportunities identified it would expect annualized cost savings of 7–13% of the baseline. The following provides a brief synopsis of the 20 opportunities identified by common theme.

Labour Management

The City currently employs full-time and seasonal employees by way of a Collective Agreement between the City and CUPE 1542 (the "Collective Agreement"). While the majority of the team has significant experience in Winter Control operations, there are improvements that can be made to the staffing complement and practices to help ensure that personnel are strategically allocated to help drive operational efficiencies and improve service levels.

Standard Operating Procedures

The City currently operates with a team that is experienced with the unique challenges and nuances of Waterloo's winter season, enabling it to manage operations to consistently achieve service levels that meet or exceed the Minimum Maintenance Standards as set by Ontario's Municipal Act. However, the City would benefit from codifying standard operating procedures such as plowing techniques to help ensure they are consistently applied and effective.

Trails, Sidewalks and Laneways

The City is home to many trails, sidewalks and laneways that facilitate the use of alternative methods of transportation for citizens. In recent years, enhancements to these trails, sidewalks and laneways have been made, thereby challenging operational efficiencies and budgets. The City can apply Lean Six Sigma methodologies to help ensure equipment and material resources are operating efficiently and allocated effectively.

Salt Optimization

Salt is highly important to Winter Control operations as approximately 7,400 metric tonnes of salt is used each winter season. While the City has taken recent steps to modernize its Service Centre with a dedicated salt shed, further steps could be taken to help increase the accessibility of salt at an economical price by improving procurement, inventory management and increased accessibility of salt.

Future State Vision

The City is a unique beneficiary of the technology rich environment that exists within the local ecosystem. Engaging with local partners specializing in emerging and disruptive technologies such as artificial intelligence and machine learning will ultimately benefit the City's Winter Control operational efficiencies and service levels.

Opportunity Characterization

Cost Savings (Annualized)	Service Level Impact	Investment (One-time)	Risk	Duration to Implement
H 2+% of baseline $100,000+	H Direct improvement that increases citizen satisfaction	H 2+% of baseline $100,000+	H Highly impactful and likely obstacle	ST Upcoming Winter
M 1–2% of baseline $50,000–$100,000	M Indirect improvement that increases citizen satisfaction	M 1–2% of baseline $50,000–$100,000	M Moderately impactful and possible obstacle	MT Next Winter
L 0–1% of baseline $0–$50,000	L Marginal impact on citizen satisfaction	L 0–1% of baseline $0–$50,000	L Remote possibility of a low impact obstacle	LT 2+ Winters

Summary of Opportunities Agreed on with the City

Below are the 20 opportunities organized under five themes. The application of Lean Six Sigma methodologies have also been identified.

Theme	Opportunity	Brief description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement	Lean Six Sigma
Labour management	1. Departmental sharing	Formalize sharing staff across departments to maximize efficiency	L	M	L	L	MT	✓
	2. Re-design shift balance	Re-design the standard shift to match peak demand for services	L	H	L	H	LT	✓
	3. Optimize staffing mix	Increase the use of third-party contractors for ad hoc services	L	H	L	M	LT	
	4. Overtime management	Strategically manage overtime to avoid periods of short staffing	L / M	H	L	M	LT	
Standard operating procedures	1. Operator fleet booking	Standardize the process of allocating equipment to operators	L	M	L	L	ST	✓
	2. Communication with Council	Deliver unified and standardized progress updates to citizens	L	H	L	M	ST	
	3. Tandem / echelon plowing	Increase tandem / echelon plowing to realize time savings	L	H	L	L	ST	✓
	4. Installation of wing on plows	Increase application of the wing accessory to reduce passes required	L	H	L	L	ST	✓
Trails, sidewalks and laneways	1. Analyze slip and fall data	Apply correlative analysis to ensure operations are efficient / effective	L	H	L	M	ST	✓
	2. Trail equipment rotation	Allocate the bulk of operations to the most cost effective equipment	L	M	L	L	ST	✓
	3. Maximize equipment utilization	Leverage Lean Six Sigma practices to maximize equipment utilization	L	H	L	L	LT	✓
	4. Enhanced trail equipment	Source enhancements to adjust equipment for new trail infrastructure	L	H	L	M	MT	
	5. Tiered levels of service for bike lanes and trails	Apply correlative analysis to ensure operations are efficient / effective on the basis of delivering increased services to the most active routes	L	H	L	M	MT	✓
Salt optimization	1. Automated salt application	Install sensor technology to automate salt application	L / M	H	M	L	MT	✓
	2. Salt inventory management	Manage procurement effectively to yield sufficient inventory reserves	L / M	H	L	L	MT	✓
	3. Minimize plow standby and travel time	Increase the active time plowing using a secondary refilling location	L / M	H	H	H	LT	✓
	4. New solutions for salt supply	Continue to explore innovative solutions to procure and store salt	L	H	L	L	LT	
Future state vision	1. Integrate live GPS for plow operators	Leverage existing GPS data to provide operators with live insights	M	H	L / M	M	LT	
	2. Dynamic routing	Integrate machine learning to dynamically recalibrate operator routes	M	H	H	H	LT	
	3. System harmonization	Integrate information systems to accurately inform management	M	M	H	H	LT	

Opportunity Prioritization

The chart on the right lays out the complexity of each opportunity against its service level impact (all of which are improvements to each service). The size of each circle represents the financial benefit as the larger circles depict a medium impact ($50,000–$100,000) while the smaller circles depict a low impact (up to $50,000).

The prioritization chart distinguishes all opportunities into those that are:

- Quick wins – opportunities that fall in the upper left quadrant, which may improve service levels and are less complex to implement; and
- More effort – opportunities that fall in the upper right quadrant, which may enhance service levels but are more complex to achieve.

Quick Wins

There are nine opportunities in the left hand side of the chart. Quick wins are those opportunities on the far left and the most attractive quick wins would be those at the top of the chart. The nine opportunities are:

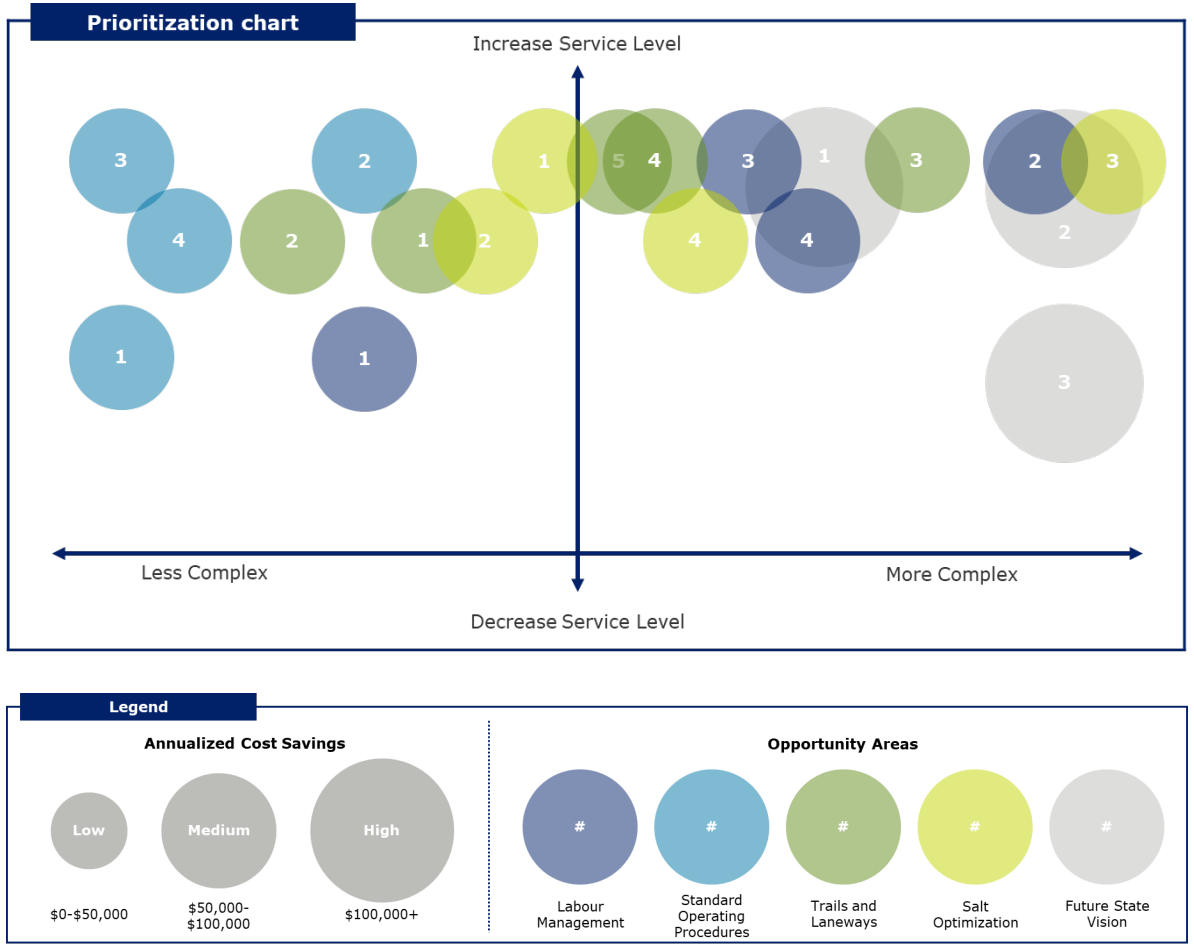
Labour Management – Departmental sharing (1)

Standard operating procedures – Operator fleet booking (1), Communication with Council (2), Tandem/echelon plowing (3) and Installation of wing on plows (4)

Trails, sidewalks and lane ways – Analyze slip and fall data (1) and Trail equipment rotation (2)

Salt Optimization – Automated salt application (1) and Salt inventory management (2)

Immediate next steps for each opportunity can be found in the "Implementation Steps" section of each detailed opportunity description on pages 22–76 of the Review.



Summary of Opportunities – Labour Management

Deloitte identified the following opportunities to modernize the City's labour management practices and ultimately improve Winter Control operations:

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Departmental sharing	• The City can execute the Lean Six Sigma method of flexible working and establish formal controls addressing departmental crossover. While the City's resources serve to protect the community and environment, formal controls can minimize the negative impacts felt by all functional departments when resources are redirected to address emergency events. Dedicated cross-functional roles can be created where a full-time employee formally supports Winter Control during the winter season and formally supports another functional department outside of the winter season. • Formal departmental sharing will reduce the time and cost investment of sourcing seasonal employees year over year as well as increase the consistency of service delivery for citizens.	Low	Medium	Low	Low	Mid-term
Re-design shift balance	• The City can re-design the existing shift balance using a data driven approach to execute Lean Six Sigma methods to increase the efficiency of matching the supply of labour and assets in order to better understand and manage demand. This will be achieved by analyzing and identifying ineffective times or conditions (e.g. peak vehicle and citizen traffic due to rush hour or accidents) for resources to be deployed. This will result in greater flexibility in the use of manpower by increasing the number of staff on the most effective shifts identified or modification in shift times. • Re-designing the shift balance to increase resources available for deployment during optimal times or conditions will yield maximized service levels and operational efficiencies.	Low	High	Low	High	Long-term

Summary of Opportunities – Labour Management (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Optimize staffing mix	• The City can further optimize its existing staffing mix to increase the use of third-party contractors–specifically for lower volume / capacity work (e.g. parking lots or complex streetscapes requiring handwork). Leveraging third-party contractors for lower volume / capacity work will result in reduced costs based on favourable wage rates and facilitate the redeployment of City staff to higher priority and higher value work. • This opportunity will increase service levels by reducing the City's overall response time during a snow event.	Low	High	Low	Medium	Long-term
Overtime management	• The City can continue to evaluate overtime approvals and alternative management strategies relative to the effort required to meet the Minimum Maintenance Standards to mitigate any negative effects caused by sub-optimal timing of overtime leave taken by staff. • Strategically managing the amount or timing of overtime requests will enable the City to mitigate the strain of staffing in following seasons or times of high resource demand.	Low / Medium	High	Low	Medium	Long-term

Summary of Opportunities – Standard Operating Procedures

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Operator fleet booking	• The City can implement an operating procedure that standardizes the assignment and use of equipment by operators. This Lean Six Sigma method of using standardized operations to control the quality and productivity of work will mitigate any variability caused by operators preferentially selecting equipment. Understanding non-value added activities will increase productivity of the equipment to operator allocation. • This opportunity will result in a more efficient process in assigning equipment, thereby increasing equipment utilization. Formalized procedures on the use of equipment such as checklists completed by operators will also assist in planning preventative maintenance. The City can gather this data to address operator feedback, identify indicators of preventative maintenance and ensure a consistent experience for operators.	Low	Medium	Low	Low	Short-term
Communication with Council	• The City can establish a forum to engage in proactive and real-time communication with Council with the goal of aligning and delivering consistent, accurate and updated information to citizens during significant weather events. This will also raise Council's awareness of the City's constraints and provide the City with greater flexibility in conducting operations. • Operational efficiencies will benefit as a result as increasing the awareness of ongoing operations with Council and citizens will allow staff to focus on completing the standard delivery service in a timely fashion and minimize disruptions.	Low	High	Low	Medium	Short-term

Summary of Opportunities – Standard Operating Procedures (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Tandem / echelon plowing	• The City can implement a standard operating procedure that codifies select routes where plows and salters travel in tandem or echelon in order to maximize efficiency and active time plowing. The City will gather data on lane kilometers that are suitable for tandem or echelon plowing and identify the adjacent zones from which the plows will synchronize coordination. Formalizing these areas within routes will result in fewer passes required to clean on a consistent basis. This Lean Six Sigma method of using standardized operations to control the quality, productivity of work and better understand non-value added activities will increase operational efficiencies and reduce costs. • Increased use of this method will also minimize re-work required to clear slushed-over areas, windrows or snow pushed back onto roadways by traffic after a single plow completes a pass, thereby increasing operational efficiencies and citizen satisfaction.	Low	High	Low	Low	Short-term
Installation of wing on plows	• The City can implement a standard operating procedure requiring the installation of the wing accessory on every available plow. This will increase operational efficiencies as the wing accessory has greater road surface area coverage while actively plowing. To realize this benefit, the City will standardize the lane kilometers on routes that the wing accessory is expected to be utilized by evaluating lane width and operator feedback. This Lean Six Sigma method of using standardized operations to control the quality, productivity of work and better understand non-value added activities will formalize the expectation of additional coverage with operators and yield improved service levels. • Further benefit will be gained by minimizing the time spent removing or installing the wing accessory based on operator preferences.	Low	High	Low	Low	Short-term

Summary of Opportunities – Trails, Sidewalks and Laneways

Deloitte identified the following opportunities to modernize Winter Control operations specific to trails, sidewalks and laneways:

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Analyze slip and fall data	• The City can correlate slip and fall data with current shoveling, salt management practices and historical weather data to validate the precise impact of varying service levels. The slip and fall accident rate can be plotted on a control chart to help identify and eradicate unique instances and link cause and effect for improvements. The use of statistical analysis is a key component of Lean Six Sigma and this will ensure tailored shoveling and salt usage is targeted at high risk areas to increase operational efficiencies and citizen safety.	Low	High	Low	Medium	Short-term
Trail equipment rotation	• The City can rotate trail equipment between the Service Centre and Waterloo Park to ensure that utilization levels of equipment are distributed more evenly. This is predicated on monitoring the equipment performance and average maintenance costs between the two sets of trail equipment as the more economical machines should be used more. At the end of each winter season, equipment can be rotated based on this data. • Improving equipment uptime, productivity and Overall Equipment Effectiveness (OEE) are key Lean Six Sigma methods that can be applied to help drive and measure improvement. Greater balance in utilization of trail equipment will facilitate more effective maintenance and reduce costs while increasing equipment availability and service levels.	Low	Medium	Low	Low	Short-term

Summary of Opportunities – Trails, Sidewalks and Laneways (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Maximize equipment utilization	• The City can leverage Lean Six Sigma practices such as standard operating procedures for the use and ordering of replacement parts, preventative / predictive maintenance tools, maintenance scheduling and consistent reporting of equipment damage in order to maximize equipment utilization. These practices will provide the City with robust controls to effectively manage unplanned maintenance and streamline operations. • Improving equipment uptime, productivity and Overall Equipment Effectiveness (OEE) are key Lean Six Sigma methods that can be applied to help drive and measure improvement. Increased equipment utilization due to availability will result in improved service levels.	Low	High	Low	Low	Long-term
Enhanced trail equipment	• The City can source enhancements or new attachments to existing equipment used for trail maintenance to address the changes in trail infrastructure such as street furniture or increased trail widths. • This will increase operational efficiencies and drive cost savings as enhanced trail equipment will facilitate faster route completion.	Low	High	Low	Medium	Mid-term

Summary of Opportunities – Trails, Sidewalks and Laneways (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Tiered levels of service for bike lanes and trails	• The City can offer tiered levels of service delivered to bike lanes and trails in order to deliver a higher service level to the most active routes. Trail user count data can be leveraged to ensure a data-driven approach is applied to identify the City's most active routes. The Voice of the Customer (VoC) Lean Six Sigma method can also be utilized to understand what is critical to quality (CTQ) for citizens, allowing the City to deliver more value, more effectively while also recognizing it needs to set and communicate realistic performance targets. • Throughout the process of classifying tiered routes, the City can also apply best practices from its Public Realm Strategy and Engineering Design manuals in vehicular and pedestrian traffic design that minimize any negative impacts to citizens. Ensuring the City's resources are effectively prioritizing service for the most active routes will direct resources to the areas of highest public usage and improve operational efficiencies and service levels. • Ensuring the City's resources are effectively prioritizing service for the most active routes will direct resources to the areas of highest public usage and improve operational efficiencies and service levels.	Low	High	Low	Medium	Mid-term

Summary of Opportunities – Salt Optimization

Deloitte identified the following opportunities to modernize Winter Control operations by optimizing the procurement and consumption of salt:

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Automated salt application	• The City can implement technology enabled sensors in equipment to disburse salt automatically based on the road surface temperature and speed of the plow. The sensors will facilitate real-time reporting and automatic adjustments to the rate at which salt is dispersed. • Temperature sensors will enable the application of the Lean Six Sigma method of interlocking of machinery to reduce operator judgment (Poka Yoke) and better process controls over the use of material. Poka Yoke will integrate mistake proofing into a process to eliminate the cost of correction. This can increase operational efficiencies, environmental benefit and cost savings in situations where the City may have previously re-salted routes.	Low / Medium	High	Medium	Low	Mid-term
Salt inventory management	• The City can apply the Lean Six Sigma methodology of a Kanban system to identify just-in-time material flow. This will effectively manage stockpiled salt levels and establish a float quantity to ensure sufficient reserves. Proactive management of salt inventory levels will improve the City's ability to respond to weather events and result in cost savings by purchasing fewer quantities during peak demand.	Low / Medium	High	Low	Low	Mid-term

Summary of Opportunities – Salt Optimization (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Minimize plow standby and travel time	• The City can further optimize plow routes by adjusting operations based on accurate analytics depicting active time plowing compared to idle time. Implementing inline hydraulic sensors will provide the City with precise data on when the blades on plows are active. • Plow standby and travel time can also be minimized by identifying favourable refilling locations, thereby enabling plows to increase operational time. Improving equipment uptime, productivity and Overall Equipment Effectiveness (OEE) are key Lean Six Sigma methods that can be applied to help drive and measure improvement. This will minimize standby time and the travel time spent to refill equipment, thereby increasing operational efficiencies and reducing costs.	Low / Medium	High	High	High	Long-term
New solutions for salt supply	• The City can continue to explore other sources of salt supply and different procurement arrangements. This will provide the City with more flexibility in acquiring or stockpiling salt. Solutions such as leveraging the local landfill or renting space from the Region of Waterloo can help the City address capacity constraints. Remote salt storage can reduce travel time and improve operational efficiency. • In the long-term, the City can continue the search for alternate suppliers and long-term contracts of purchasing salt in order to alleviate supplier risk arising from the supplier dominant market.	Low	High	Low	Low	Long-term

Summary of Opportunities – Future State Vision

Deloitte identified the following opportunities to modernize Winter Control operations by understanding the future state vision:

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
Integrate live GPS for plow operators	• The City can integrate its current live GPS or automatic vehicle location (AVL) data to allow plow operators to remotely view through the use of tablet devices fixed to the cockpit console. This will provide operators with an electronic display of their route and where they have already provided service. Should a shift switch or route deviation occur, an operator will be equipped with the relevant information to resume operations in an efficient manner. • This opportunity will alleviate an operator's responsibility of recalling where service was already delivered enabling them to focus on operating the equipment. This will facilitate faster route completion as operators will minimize inactive plowing time, thereby improving operational efficiency and citizen satisfaction.	Medium	High	Low / Medium	Medium	Long-term
Dynamic routing	• The City can re-design routes using disruptive and exponential technologies such as the Internet of Things ("IoT") and predictive analytics to adapt to the truly variable nature of clearing snow. Dynamic routing using advanced technologies such as the IoT or predictive analytics will automatically guide operators to respond to areas based on defined variables (e.g. priority, traffic, snowfall, etc.) in order to complete routes in the most efficient manner. Operational efficiency and citizen satisfaction will benefit as a result.	Medium	High	High	High	Long-term

Summary of Opportunities – Future State Vision (continued)

Opportunity	Description	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
System harmonization	• The City can implement system harmonization between functional departments' information systems to achieve increased accuracy and agility in management's cross-functional decision making. • This opportunity will yield streamlined service and back-office operations as management will be equipped with pertinent information in a more timely manner. While the one-time investment is high, the ongoing time invested and inherent risk associated with manually analyzing and collating data related to Winter Control operations will be minimized.	Medium	Medium	High	High	Long-term

Impact on Winter Control Operations

Service Modernization Citizen Impact

We have identified 20 impactful opportunities that will result in increased service levels for citizens. This remained a core focus and objective throughout the process to ensure that all opportunities either indirectly or directly improved service delivery to fulfill the expectations of the City's citizens.

Service Modernization Financial Impact

The comprehensive and collaborative approach undertaken through this review identified common themes and interdependencies within the opportunities that will facilitate recurring annualized benefits rather than identifying non-recurring opportunities. If the City implemented all of the opportunities identified it would expect annualized cost savings of 7–13% of the $4.26 million baseline analyzed. The one-time implementation costs of these opportunities would be approximately 7% of the baseline. Projecting the net impact of the annual costs savings and one-time implementation costs over 10 years, the City would expect total savings of $3–5 million.

Implementation

While it is necessary to implement the full suite of recommendations under each service area, prioritization of implementation steps is a key success factor on the road to modernizing Winter Control operations. The remainder of this report will provide detailed information on each opportunity with further insight into the challenge addressed, characterization, and other considerations. Next steps for each opportunity can be found in the "Implementation Steps" section of each detailed opportunity.

Internal Collaboration

It is important to note that the success of the City's Winter Control operations to date is largely driven by the primary functional departments of Transportation and Environment & Parks as well as supporting functional departments such as Fleet & Procurement and Finance. This cohesion has been demonstrated by the City and will continue to be a key success factor throughout the implementation process.

Winter Control Modernization Opportunities

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LABOUR MANAGEMENT

Labour Management Opportunities

The City currently employs full-time and seasonal employees by way of a Collective Agreement between the City and CUPE 1542 (the "Collective Agreement"). While the majority of the team has significant experience in Winter Control operations, there are improvements that can be made to the staffing complement and practices to help ensure that personnel are strategically allocated to help drive operational efficiencies and improve service levels. These labour management techniques focus on enabling the City to dynamically respond to the variable nature of weather conditions.

Deloitte identified the following opportunities to modernize the City's labour management practices and ultimately improve Winter Control operations:

	Opportunity	Scope Area	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
1	Departmental sharing		Low	Medium	Low	Low	Mid-term
2	Re-design shift balance		Low	High	Low	High	Long-term
3	Optimize staffing mix		Low	High	Low	Medium	Long-term
4	Overtime management		Low / Medium	High	Low	Medium	Long-term

 **Plow Route Optimization**

 **Salt Management**

 **Personnel / Equipment Allocation**

 **Artificial Intelligence Systems**

Departmental sharing

Description and Rationale

- During significant winter events staff from across the city organization may be redeployed to respond to Winter Control needs. This redeployment can negatively impact the originating department. Retaining seasonal staff has also proved to be a challenge for the City, resulting in higher turnover and the loss of the City's investment in training.
- The City can execute the Lean Six Sigma method of flexible working and establish formal controls addressing departmental crossover. While the City's resources serve to protect the community and environment, formal controls can minimize the negative impacts felt by all functional departments when resources are redirected to address emergency events. Dedicated cross-functional roles can be created where a full-time employee formally supports Winter Control during the winter season and formally supports another functional department outside of the winter season.
- Departmental sharing will reduce the time and cost investment of sourcing seasonal employees year over year as well as increase the consistency of service delivery for citizens.

Characterization

Service Level Impact	Medium	• This opportunity will minimize seasonal staff turnover and retain experienced staff, thereby increasing the consistency of service delivery for citizens. Departmental service levels will also be less sensitive to variable staffing needs or emergency scenarios. • As a result, this opportunity will yield indirect improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to convert seasonal employment roles to full-time roles is incremental and therefore low.
Risk	Low	• Departmental sharing bears low risk as this opportunity mitigates the inherent risk that is present in hiring seasonal employees year over year due to lack of experience, training and turnover.
Duration to Implement	Mid-term	• This opportunity will require the engagement of relevant stakeholders and administrative approval to formalize controls and ensure boundaries are adhered to.

Departmental sharing (continued)

Annual Cost Savings – Low

Initial Investment

- Assuming a 5-6 month winter season, the incremental cost of replacing seasonal employment roles with full-time employment roles is approximately $5,000 per position. This includes the increase in wage rate, vacation and benefits.
- Time must also initially be invested designing and formalizing full-time roles subject to departmental sharing.

Annualized Cost Savings

- Annualized cost savings will be driven by reduced recruitment activity, reduced employee turnover and the indirect opportunity cost of service levels impacted by inexperienced seasonal staff. It is deemed a conservative assumption that savings from these activities will outweigh the incremental initial investment of $5,000 per position during winter. This will yield low annualized cost savings (up to $50,000).

Net Present Value

- Considering the low initial investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operating conditions.

Implementation Steps

Short-term

1. Engage relevant stakeholders and initiate approval process to increase the full-time employee budget.
2. Define cross-functional full-time role.
3. Demonstrate formal business case for cross-functional full-time employee hiring instead of multiple seasonal employees spanning a year.

Mid-term

4. Formalize controls that address emergency situations faced by the City and their impact on departmental sharing.

Other Considerations

- As all of the City's labour management opportunities are interdependent, formalizing departmental sharing can have positive residual effects in Winter Control operations. Formalizing controls that address emergency situations faced by the City can ensure that dedicated Winter Control staff are not redirected during snow events, which can ultimately reduce the amount of overtime requests and increase service levels.

Re-design shift balance

Description and Rationale

- Winter Control operations are driven by three 8-hour shifts throughout the week with the quantity of staff varying by peak demand on each shift. The current balance can result in periods of inefficiency or prove to be a constraint during significant weather conditions.
- The City can re-design the existing shift balance using a data driven approach to execute Lean Six Sigma methods to increase the efficiency of matching the supply of labour and assets in order to better understand and manage demand. This will be achieved by analyzing and identifying ineffective times or conditions (e.g. peak vehicle and citizen traffic due to rush hour or accidents) for resources to be deployed. This will result in greater flexibility in the use of manpower by increasing the number of staff on the most effective shifts identified or modification in shift times.
- Re-designing the shift balance to increase resources available for deployment during optimal times or conditions will yield maximized service levels and operational efficiencies.

Characterization

Service Level Impact	High	• This opportunity will achieve a more consistent level of service across shifts and increases the City's flexibility staffing in response to weather conditions. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The City will need to invest sufficient time in conducting a thorough analysis of idle time vs. peak time in both personnel and equipment resources to identify a more optimal shift balance.
Risk	High	• Re-designing the shift balance using a data driven approach increases the inherent risk of inaccurate data negatively impact operations. This risk will require sufficient pilot testing to ensure the appropriate and relevant variables have been included.
Duration to Implement	Long-term	• Since this opportunity is sensitive to the quality of data, the City should invest time in pilot testing and monitoring initial data prior to full scale implementation. • Engagement with the labour union will be key in expediting the codification of the new shift balance.

Re-design shift balance (continued)

Annual Cost Savings – Low

Initial Investment
- This opportunity does not require a significant monetary investment, but rather a time investment in conducting a thorough analysis of idle time vs. peak time in both personnel and equipment resources to identify a more optimal shift balance.

Annualized Cost Savings
- Since this opportunity is not predicated on changes in headcount, annualized cost savings are expected to be low (up to $50,000).
- Value is instead driven by the high service level impact.

Net Present Value
- Considering the low initial investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1–2 years assuming typical operational conditions.

Implementation Steps

Mid-term

1. Assess current shift balance and resource allocation (overtime use, availability of staff, Winter Control vs work performed in other departments).
2. Collect data on peak traffic by zone that may interfere with Winter Control operations to identify trends over the course of a winter season.
3. Align more optimal shift design options to the City's defined Winter Control objectives taking into consideration adequate lead-hand and management positions required.

Long-term

4. Engage labour union on revised shift balance.
5. Conduct pilot testing of re-designed shift balance. Refine based on observations and staff feedback.
6. Execute change management with City staff.

Other Considerations

- As all of the City’s labour management opportunities are interdependent, re-designing the shift balance can have positive residual effects in Winter Control operations. Increasing the number of staff on the most effective shifts identified can ultimately reduce the amount of overtime requests and increase service levels.
- This opportunity also coincides with the salt optimization opportunity of minimizing plow standby and travel time (pages 63 and 64). Any data gathered from the implementation of said opportunity on inactive or standby time spent by plows can be leveraged to inform the re-designing of the shift balance as this would also identify sub-optimal resource allocation.

Optimize staffing mix

Description and Rationale

- Winter Control staff currently service lower volume / capacity work throughout the City that may reduce their efficiency in completing large scale operations. Areas such as stairways and some sidewalks prove challenging for City staff to efficiently service with the equipment they transport throughout a shift.
- The City can further optimize its existing staffing mix to increase the use of third-party contractors–specifically for lower volume / capacity work ((e.g. parking lots or complex streetscapes requiring handwork). Leveraging third-party contractors for lower volume / capacity work will result in reduced costs based on favourable wage rates and facilitate the redeployment of City staff to higher priority / value work.
- This opportunity will increase service levels by reducing the City's overall response time during a snow event.

Characterization

Service Level Impact	High	• Further optimizing the City's staffing max will facilitate a more effective distribution of personnel resources throughout the winter season, thereby improving service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• An initial low investment will be required to further optimize the staffing mix as the City will need to invest in implementing a request for proposal and executing a contract with a third-party contractor. The on-going costs of the third-party contractors will be offset by the annualized cost savings.
Risk	Medium	• As this opportunity will alter the service delivery model, change management will be required with existing City staff to ensure it is understood that full-time hours are not being reduced per the Collective Agreement.
Duration to Implement	Long-term	• In order to successfully implement this opportunity, the City must conduct its procurement process to identify a favourable third-party contractor.

Optimize staffing mix (continued)

Annual Cost Savings – Low

Initial Investment
- In order to further optimize the City's staffing mix without reducing existing City staff hours, a low investment is required to implement a request for proposal and execute a contract with a third-party contractor.

Annualized Cost Savings
- Annualized cost savings will be driven by the expected marginally favourable wage rate of third-party contractors compared to full-time City staff as well as the opportunity cost of having limited flexibility in redeploying staff to areas of need.
- Since this opportunity is not predicated on reducing the hours of existing City staff, but rather redeploying them to other areas of focus, annualized cost savings are expected to be low (up to $50,000).
- Value is instead driven by the high service level impact.

Net Present Value
- Considering the medium investment required, the payback period for this opportunity is mid-term as the investment can be recouped in 2–4 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Identify current areas of fine work that can be re-allocated to third-party contractors.
2. Quantify the number of third-party contractors required by ensuring current service hours are matched or reduced. This can be informed by tracking data on the workforce effort and service delivery in challenging conditions.

Long-term

3. Identify favorable third-party contractor.
4. Create and formalize deployment plan for redeployment of staff time.
5. Develop third-party contractor management and compliance requirements.

Other Considerations

- As all of the City's labour management opportunities are interdependent, further optimizing the staffing mix can have positive residual effects in Winter Control operations. Increasing the flexibility of redeploying staff to other areas of focus can ensure that Winter Control staff are supported in completing activities at a faster pace, which can ultimately reduce the amount of overtime requests and increase service levels.

Overtime management

Description and Rationale

- Per the Collective Agreement, Winter Control staff are eligible to bank 80 hours of overtime and have up to one year to claim as either paid time off as mutually agreed to by Management or a one time payment. This has proved to be a challenge for the City as staff typically prefer to request the use of their banked overtime at times when significant operations are required or during other seasons, which may negatively impact another functional department.
- The City can continue to evaluate overtime approvals and alternative management strategies relative to the effort required to meet the Minimum Maintenance Standards to mitigate any negative effects caused by sub-optimal timing of overtime leave taken by staff.
- Strategically managing the amount or timing of overtime requests will enable the City to mitigate the strain of staffing in following seasons or times of high resource demand.

Characterization

Service Level Impact	High	• This opportunity will facilitate an improved distribution of personnel resources throughout the Winter season and beyond, which will ultimately result in an increased level of service delivered to citizens. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• As the City will be exercising their right to manage overtime requests per the labour agreement, the initial investment required to implement this opportunity is minimal.
Risk	Medium	• Communication of this change in the management of overtime may be met with resistance from existing staff. This inherent risk will be mitigated by coordinating effective change management activities.
Duration to Implement	Long-term	• The City must communicate this management directive to staff immediately to provide advance notice and allow for effective change management.

Overtime management (continued)

Annual Cost Savings – Low / Medium

Initial Investment
- As this opportunity is not predicated on altering headcount, the investment required is minimal and therefore classified as low.

Annualized Cost Savings
- The annualized cost savings are driven by the number of overtime hours that can be addressed with a lower wage rate. Overtime wages are paid at 1.5x or 2x factor depending on the shift type and time.
- Based on the typical expenditure on overtime wages during a winter season and an assumed conservative approach to managing overtime, annualized cost savings will be low (up to $50,000). This benefit can be levered to a medium level should the City aggressively manage the amount of overtime utilized in Winter Control operations.

Net Present Value
- Considering the low to minimal investment required, the payback period for this opportunity is short as the investment can be recouped in 1–2 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Communicate the importance and purpose of this management directive to staff, referencing the Collective Agreement and its provisions.

2. Develop a model for overtime approval that considers the value of use of overtime. Ensure use of banked overtime does not disrupt programmed work.

Long-term

3. Augment tapered overtime hours by further optimizing the staffing mix with third-party contractors (refer to pages 28 and 29) or re-designing shift balance (refer to pages 26 and 27).

Other Considerations

- As all of the City's labour management opportunities are interdependent, increased management of overtime hours can be facilitated by successfully formalizing departmental sharing, further optimizing the existing staffing mix or re-designing the shift balance. This will alter yet improve service delivery while generating annualized cost savings.

Summary of Opportunities–Labour Management

Legend

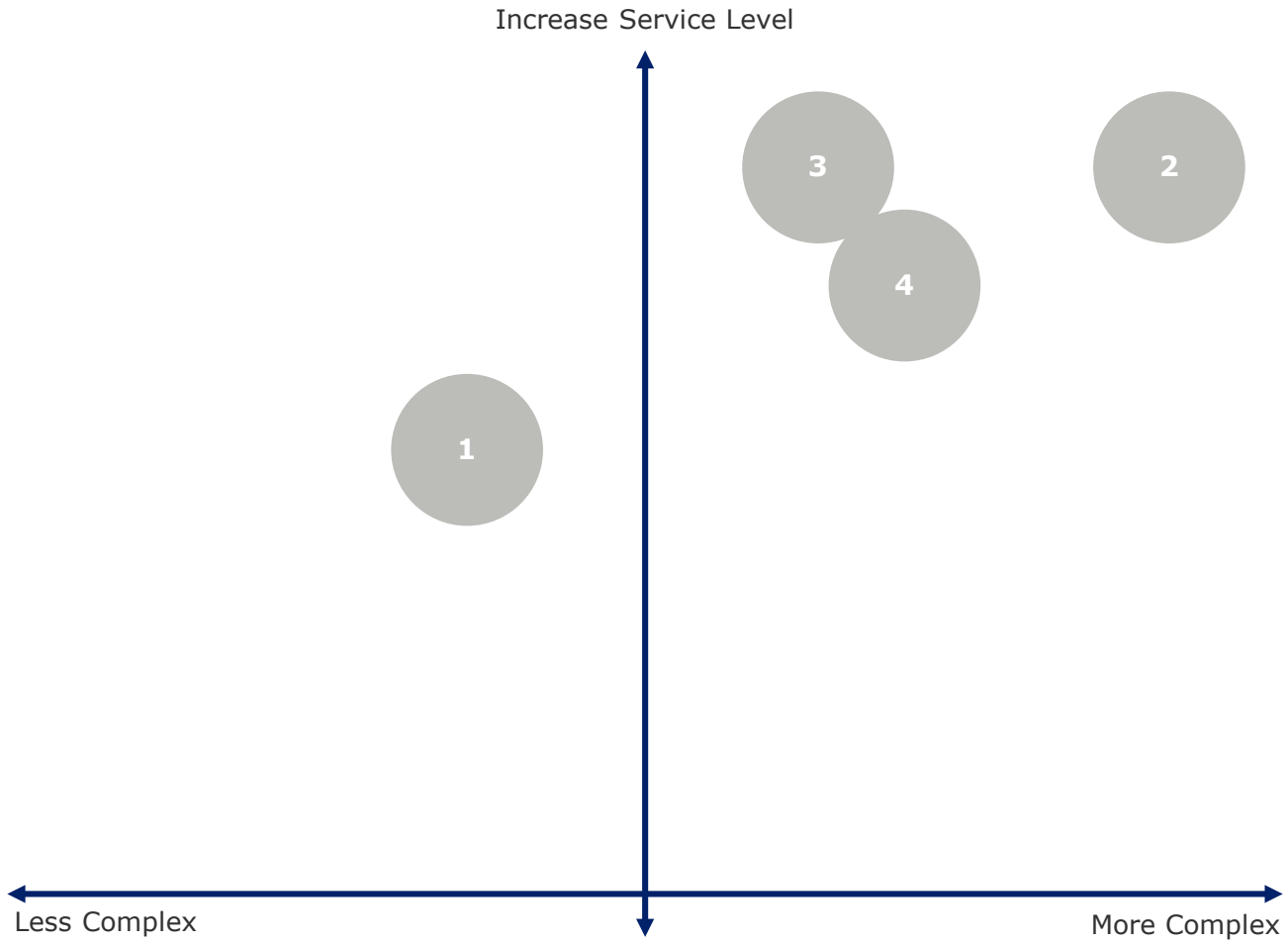
Opportunities:

1	Departmental sharing
2	Re-design shift balance
3	Optimize staffing mix
4	Overtime management

Annualized Cost Savings:

$0–$50,000 | $50,000–$100,000 | $100,000+

Prioritization Matrix



STANDARD OPERATING PROCEDURES

Standard Operating Procedures Opportunities

The City currently operates with a team that is experienced with the unique challenges and nuances of Waterloo's winter season, enabling it to manage operations to consistently achieve service levels that meet or exceed the Minimum Maintenance Standards as set by Ontario's Municipal Act. However, the City would benefit from codifying standard operating procedures such as plowing techniques to help ensure they are consistently applied and effective. This will enhance the current functional environment of the City to operate with industry–leading practices.

Deloitte identified the following opportunities to modernize Winter Control operations by identifying impactful operating procedures to standardize:

	Opportunity	Scope Area	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
1	Operator fleet booking		Low	Medium	Low	Low	Short-term
2	Communication with Council		Low	High	Low	Medium	Short-term
3	Tandem / echelon plowing		Low	High	Low	Low	Short-term
4	Installation of wing on plows		Low	High	Low	Low	Short-term

 **Plow Route Optimization**

 **Salt Management**

 **Personnel / Equipment Allocation**

 **Artificial Intelligence Systems**

Operator fleet booking

Description and Rationale

- Winter Control's plow operators exercise preference when selecting equipment, which can cause challenges when allocating zones or shifts.
- The City can implement an operating procedure that standardizes the assignment and use of equipment by operators. This Lean Six Sigma method of using standardized operations to control the quality and productivity of work will mitigate any variability caused by operators preferentially selecting equipment. Understanding non-value added activities will increase productivity of the equipment to operator allocation.
- This opportunity will result in a more efficient process in assigning equipment, thereby increasing equipment utilization. Formalized procedures on the use of equipment such as checklists completed by operators will also assist in planning preventative maintenance. The City can gather this data to address operator feedback, identify indicators of preventative maintenance and ensure a consistent experience across all equipment. Operational efficiencies and citizen satisfaction will benefit as a result.

Characterization

Service Level Impact	Medium	• This standard operating procedure will improve equipment utilization and planned preventative maintenance, thereby further optimizing Winter Control operations and facilitating faster route completion. • As a result, this opportunity will yield indirect improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed. Instead time will be invested formalizing the standard operating procedure and conducting training with operators.
Risk	Low	• As this opportunity focuses on minimizing the risk borne by management from the variability caused by operators preferentially selecting equipment, the risk is low.
Duration to Implement	Short-term	• This standard operating procedure can be formalized and implemented this upcoming winter.

Operator fleet booking (continued)

Annual Cost Savings – Low

Initial Investment
- The initial investment required to implement this opportunity is low as there is little to no capital investment needed.

Annualized Cost Savings
- Annualized cost savings are based on the indirect opportunity cost of service levels being impacted by the variability of operators preferentially selecting equipment or not identifying indicators of preventative maintenance.
- Since this opportunity is not predicated on reducing the City's fleet, annualized cost savings are expected to be low (up to $50,000).
- Value is instead driven by the medium service level impact.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Establish a standard operating procedure for equipment allocation and use by operators.
2. Conduct training with operators and execute change management.
3. Monitor operator feedback and data gathered via equipment checklists to ensure necessary improvements or planned preventative maintenance can be addressed.

Other Considerations

- This opportunity can be introduced in combination with other standard operating procedures by expanding the annual 'Technical and Best Practices' training for City staff. This will stress the importance of standardization and facilitate continued change management.

Communication with Council

Description and Rationale

- Winter Control reliably meets or exceeds the Minimum Maintenance Standards as set by Ontario's Municipal Act. Despite meeting legislative requirements, citizens often reach out to Councillors for information on when services are to be delivered. This can cause disruptions in operations if the City is addressing individual requests for information or re-routing resources.
- The City can establish a forum to engage in proactive and real-time communication with Council with the goal of aligning and delivering consistent, accurate and updated information to citizens during significant weather events. This will also raise Council's awareness of the City's constraints and provide the City with greater flexibility in conducting operations.
- Operational efficiencies will benefit as a result as increasing the awareness of ongoing operations with Council and citizens will allow staff to focus on completing the standard delivery service in a timely fashion and minimize disruptions.

Characterization

Service Level Impact	High	• A key outcome of this opportunity is keeping Council and citizens as key stakeholders informed with clear and effective communication of service level expectations. This will ultimately enable the City to conduct operations to the highest degree of efficiency in significant weather conditions and minimize disruptions. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed. Instead time will be invested engaging with Council to establish standardized forum / process for effective communication.
Risk	Medium	• This opportunity bears the inherent risk of increased citizen demand. The increased flow of information to the citizens may increase the demand for information over time, which could bear increased costs.
Duration to Implement	Short-term	• This standard operating procedure can be formalized and implemented this upcoming winter.

Communication with Council (continued)

Annual Cost Savings – Low

Initial Investment
- The initial investment required to implement this opportunity is low as there is little to no capital investment needed.

Annualized Cost Savings
- Annualized cost savings are based on the indirect opportunity cost of operational inefficiencies stemming from communication gaps during significant weather events.
- Since this opportunity is not predicated on reducing operations, annualized cost savings are expected to be low (up to $50,000).
- Value is instead driven by the high service level impact.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Establish a formalized communication protocol from the City to Council (consideration for communicating pre-season, pre-snow event, mid-snow event, and post snow event, and season end).
2. Report real-time zone performance / completion updates to Council based on defined communication protocol.

Other Considerations

- A long-term consideration of the City includes reporting real-time zone completion updates directly to citizens via web-based communication. This will alleviate the need for citizens to reach out to Councillors and provide them information on which areas of the City have been addressed.
- A regular and consistent briefing with Council outlining the performance of Winter Control operations the Minimum Maintenance Standards and weather will help ensure that Council's expectations for service are aligned with the resources required. A public and transparent communications plan will ensure that the City's Service Levels are well understood and supported.

Tandem / echelon plowing

Description and Rationale

- Winter Control plow operators retain the responsibility to conduct tandem / echelon plowing in areas based on their experience, judgment and coordination efforts. This may result in inconsistent operations between snow events depending on the operator assignments.
- The City can implement a standard operating procedure that codifies select routes where plows and salters travel in tandem/echelon in order to maximize efficiency and active time plowing. The City will gather data on lane kilometers that are suitable for tandem / echelon plowing and identify the adjacent zones from which the plows will synchronize coordination. Formalizing these areas within routes will result in fewer passes required to clean on a consistent basis, thereby increasing operational efficiencies and reducing costs. This Lean Six Sigma method of using standardized operations to control the quality, productivity of work and better understand non-value added activities will increase operational efficiencies and reduce costs.
- Increased use of this method will also minimize re-work required to clear slushed-over areas, windrows or snow pushed back onto roadways by traffic after a single plow completes a pass, thereby increasing operational efficiencies and citizen satisfaction.

Characterization

Service Level Impact	High	• This standard operating procedure will facilitate faster route completion, increase service levels and produce trending data that management can leverage to adjust operations as necessary. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed. Instead time will be invested formalizing the standard operating procedure and conducting training with operators.
Risk	Low	• There is little to no risk associated with the implementation of this opportunity.
Duration to Implement	Short-term	• This standard operating procedure can be formalized and implemented this upcoming winter.

Tandem / echelon plowing (continued)

Annual Cost Savings – Low

Initial Investment

- The initial investment required to implement this opportunity is low as there is little to no capital investment needed. The City has a sufficient quantity of plows to execute the tandem / echelon plowing method.

Annualized Cost Savings

- Increasing the total lane kilometers subject to tandem / echelon plowing within the City will reduce the total pass kilometers, thereby facilitating faster route completion while reducing total labour and equipment costs.
- A sensitivity analysis was conducted based on the levered variable of time saved. Considering that the total plow hours per winter season is approximately 750 hours, time savings of up to 30 minutes per 8 hour shift will yield low annualized cost savings (up to $50,000). While the 8 hour shift per the Collective Agreement will not be altered, this operation will yield faster service delivery as less shifts will be required to complete plowing activities.

Net Present Value

- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Formalize standard operating procedures for identified tandem / echelon routes.
2. Review the eligibility and suitability of major roads (i.e. regional, arterial, multi-lane) for tandem / echelon plowing.
3. Document rationale for each decision on eligibility.
4. Conduct training session with operators to facilitate change management.
5. Monitor performance and integrate improvements as necessary.

Other Considerations

- This opportunity can be introduced in combination with other standard operating procedures by expanding the annual ‘Technical and Best Practices’ training for City staff. This will stress the importance of standardization and facilitate continued change management.

Installation of wings on plows

Description and Rationale

- Winter Control plow operators exercise preference in deciding whether the wing accessory is installed on the equipment they are operating. Judgment is also exercised on the use of the wing accessory based on their expertise. This can result in inefficiencies due to either an increased number of passes or time lost repeatedly removing and installing the wing accessory.
- The City can implement a standard operating procedure requiring the installation of the wing accessory on every available plow. This will drive an increase in operational efficiencies as the wing accessory allows for greater road surface area coverage while actively plowing. To realize this benefit, the City will standardize the lane kilometers on routes that the wing accessory is expected to be utilized by evaluating lane width and operator feedback. This Lean Six Sigma method of using standardized operations to control the quality, productivity of work and better understand non-value added activities will formalize the expectation of additional coverage with operators and yield improved service levels.
- Further benefit will be gained by minimizing the time spent removing or installing the wing accessory based on operator preferences.

Characterization

Service Level Impact	High	• Increased application of the wing accessory will facilitate faster route completion, thereby increasing service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed given the City already possesses the necessary equipment. Instead time will be invested formalizing the standard operating procedure and conducting training with operators.
Risk	Low	• There is little to no risk associated with the implementation of this opportunity.
Duration to Implement	Short-term	• This standard operating procedure can be formalized and implemented this upcoming winter.

Installation of wings on plows (continued)

Annual Cost Savings – Low

Initial Investment

- The initial investment required to implement this opportunity is low as there is little to no capital investment needed. The City has a sufficient quantity of wing accessories to outfit all available plows.

Annualized Cost Savings

- A sensitivity analysis was conducted based on the levered variable of the number of plows with the wing accessory installed. Currently, 3–4 plows may operate without the wing accessory installed during typical operations. Ensuring that all available plows are outfitted with the wing accessory will yield low annualized cost savings (up to $50,000). This is based on the fact that utilization of the wing accessory yields an approximate 29% increase in surface width coverage on typical lanes within the City and facilitates faster route completion.

Net Present Value

- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Formalize the standard operating procedures of installing the wing accessory on all plows. Define the lane kilometers available for application of the wing accessory.
2. Conduct training session with operators to facilitate change management.
3. Reallocate staff that are not able to use the wing to other supporting functions.
4. Monitor performance and integrate improvements as necessary.

Other Considerations

- This opportunity can be introduced in combination with other standard operating procedures by expanding the annual ‘Technical and Best Practices’ training for City staff. This will stress the importance of standardization and facilitate continued change management.

Summary of Opportunities – Standard Operating Procedures

Legend

Opportunities:

1	Operator fleet booking
2	Communication with Council
3	Tandem / echelon plowing
4	Installation of wing on plows

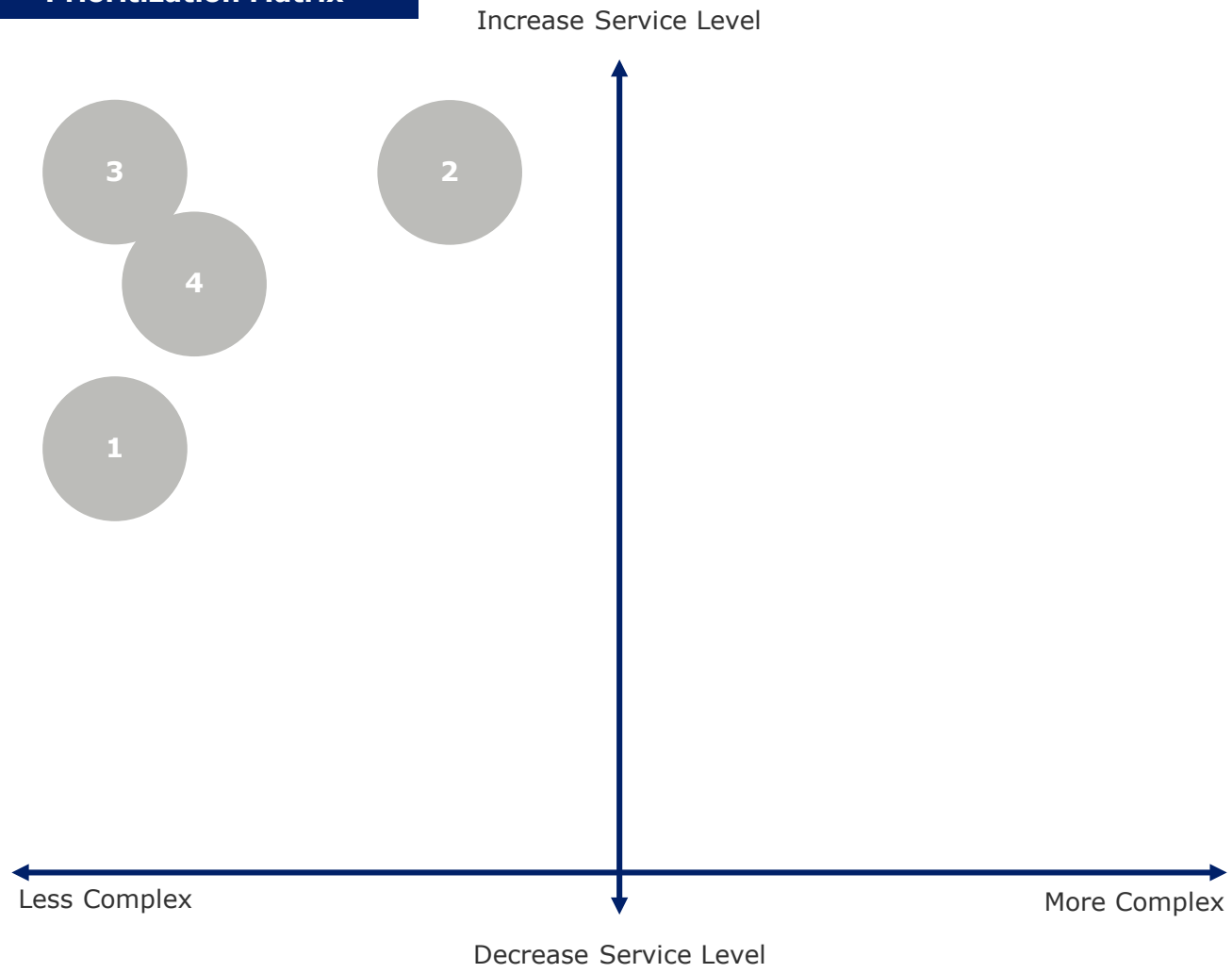
Annualized Cost Savings:

$0–$50,000

$50,000–$100,000

$100,000+

Prioritization Matrix



TRAILS, SIDEWALKS AND LANEWAYS

Trails, Sidewalks and Laneway Opportunities

The City is home to many trails, sidewalks and laneways that facilitate the use of alternative methods of transportation for citizens. In recent years, enhancements to these trails, sidewalks and laneways have been made, thereby challenging operational efficiencies and budgets. While the City has prepared for these changes, an increased application of data–driven analytics and Lean Six Sigma methodologies will enable the City to ensure its resources are available and allocated to the areas that will drive the highest impact for citizens.

Deloitte identified the following opportunities to modernize Winter Control operations specific to trails, sidewalks and laneways:

	Opportunity	Scope Area	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
1	Analyze slip and fall data		Low	High	Low	Medium	Short-term
2	Trail equipment rotation		Low	Medium	Low	Low	Short-term
3	Maximize equipment utilization		Low	High	Low	Low	Long-term
4	Enhanced trail equipment		Low	High	Low	Medium	Mid-term
5	Tiered levels of service for bike lanes and trails		Low	High	Low	Medium	Mid-term

 **Plow Route Optimization**

 **Salt Management**

 **Personnel / Equipment Allocation**

 **Artificial Intelligence Systems**

Analyze slip and fall data

Description and Rationale

- Slip and fall claims are submitted to the City on the premise that improved service levels could have prevented an incident. The City responds to these claims by increasing service levels to prevent future incidents from occurring. However, as there is a lack of a correlative analysis being conducted, the City may be missing opportunities to further standardize or specifically target operations in order to reduce slip and fall claims and keep citizens safe.
- The City can correlate slip and fall data with current shoveling, salt management practices and historical weather data to validate the precise impact of varying service levels. The slip and fall accident rate can be plotted on a control chart to help identify and eradicate unique instances and link cause and effect for improvements. The use of statistical analysis is a key component of Lean Six Sigma and this will ensure tailored shoveling and salt usage is targeted at high risk areas to increase operational efficiencies and citizen safety.

Characterization

Service Level Impact	High	• This analysis will identify areas that require increased resourcing compared to others. This will ensure that service levels are correlated to areas of need, thereby increasing citizen safety. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed. Instead time will be invested conducting the correlative analysis monthly.
Risk	Medium	• This opportunity bears an inherent medium risk based on the nature of slip and fall accidents as these incidents are unpredictable. Preventative measures such as targeted shoveling and salt usage for high risk areas will aid in mitigating this risk.
Duration to Implement	Short-term	• Based on the low complexity of this on-going analysis, it can be implemented this upcoming winter.

Analyze slip and fall data (continued)

Annual Cost Savings – Low

Initial Investment
- The investment required to implement this opportunity is low as there is little to no capital investment needed. Instead time will be invested conducting the correlative analysis monthly.

Annualized Cost Savings
- The annualized cost savings of this opportunity are driven by the opportunity cost of inappropriately allocating resources and operational efforts and increasing the chances of a slip and fall incident in a high risk area.
- Since this opportunity is not predicated on reducing operational hours or service levels, annualized cost savings are expected to be low (up to $50,000).
- Value is instead driven by the high service level impact as high risk areas where high quality service is required will be identified.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Conduct ongoing monthly analysis to identify correlation between claims received and current operational efforts.
2. Analyze claims data by relevant variables such as year, type, salt quantity applied, cost, weather event, etc.
3. Calculate labour hours and wage per km serviced.
4. Re-deploy resources based on analysis.

Other Considerations

- The rate of claims submitted to the City has decreased by over 80% in the past 3 years while the quantity of salt used has increased by over 10%. While this indicates that operational efforts have yielded improvements, the City can benefit from conducting this analysis consistently to mitigate trailing claims filed in following periods.

Trail equipment rotation

Description and Rationale

- Major trail equipment such as the 8 trackless trail plows are distributed evenly and stored between the Service Centre and a yard at Waterloo Park. Winter Control operations vary between the two locations as the 4 pieces of equipment at the Service Centre are typically in use for more equipment hours than the 4 pieces of equipment at Waterloo park, creating a sub-optimal balance in equipment utilization.
- The City can rotate trail equipment between the Service Centre and Waterloo Park to ensure that utilization levels of equipment are distributed more evenly. This is predicated on monitoring the equipment performance and average maintenance costs between the two sets of trail equipment as the more economical machines should be used more. At the end of each winter season, equipment can be rotated based on this data.
- Improving equipment uptime, productivity and Overall Equipment Effectiveness (OEE) are key Lean Six Sigma methods that can be applied to help drive and measure improvement. Greater balance in utilization of trail equipment will facilitate more effective maintenance and reduce costs while increasing equipment availability and service levels.

Characterization

Service Level Impact	Medium	• Increased availability of the trackless trail plow equipment due to a greater balance in utilization will facilitate faster route completion and increase service levels. • As a result, this opportunity will yield indirect improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed given the City already possesses the necessary equipment. Instead time will be invested formalizing the standard operating procedure for appropriate equipment rotation and monitoring equipment performance and maintenance costs.
Risk	Low	• As this opportunity focuses on minimizing the risk of sub-optimal balance in equipment utilization borne rendering equipment unavailable, the risk is low.
Duration to Implement	Short-term	• This standard operating procedure can be formalized and implemented this upcoming winter. Ongoing monitoring of equipment performance and maintenance costs should be performed to determine if adjustments are required.

Trail equipment rotation (continued)

Annual Cost Savings – Low

Initial Investment
- The initial investment required to implement this opportunity is low as there is little to no capital investment needed given the City already possesses the necessary equipment.

Annualized Cost Savings
- Cost savings are driven by the amount of maintenance costs that can be saved and the opportunity cost of having a trackless trail plow unavailable due to overutilization.
- Based on the current maintenance expenses attributable to the trackless trail plow equipment, annualized cost savings are expected to be low (up to $50,000). Indirect savings can be achieved as this opportunity will facilitate increased availability of the most efficient and effective trail equipment for faster route completion.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Formalize the standard operating procedure for trail equipment rotation.
2. Perform ongoing monitoring of equipment performance and maintenance costs by unit to determine an improved equipment rotation and adjust as needed.

Other Considerations

- This opportunity is interdependent on the trails, sidewalks and laneways opportunity of maximizing equipment utilization (pages 51 and 52). The application of Lean Six Sigma methodologies such as standard operating procedures for the use and ordering of replacement parts, preventative / predictive maintenance tools, maintenance scheduling and consistent reporting of equipment damage can improve the effectiveness and efficiency of this equipment, thereby impacting the rotation of these units.

Maximize equipment utilization

Description and Rationale

- The City has established methods that impact equipment utilization such as parts management or preventative maintenance, however, further steps can be taken to maximize the financial benefit and service levels associated with these activities. Specifically, an increased application of standardized operating procedures and data-driven analytics will enable the City to realize this benefit.
- The City can leverage Lean Six Sigma practices such as standard operating procedures for the use and ordering of replacement parts, preventative / predictive maintenance tools, maintenance scheduling and consistent reporting of equipment damage in order to maximize equipment utilization. With respect to preventative / predictive maintenance, alternative indicators of maintenance based on accurate data available should be considered (e.g. Mean Down Time, Mean Time Between Failures, etc.) as opposed to the current practice of monitoring odometer readings. These practices will provide the City with robust controls to effectively manage unplanned maintenance and streamline operations.
- Improving equipment uptime, productivity and Overall Equipment Effectiveness (OEE) are key Lean Six Sigma methods that can be applied to help drive and measure improvement. Increased equipment utilization due to availability will result in improved service levels.

Characterization

Service Level Impact	High	• Maximizing equipment utilization will facilitate greater availability of equipment and faster route completion, thereby improving service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is little to no capital investment needed given the City already possesses the necessary equipment. Instead time will be invested formalizing the standard operating procedures, monitoring performance and adjusting operations based on results.
Risk	Low	• As this opportunity focuses on minimizing the risk of lower equipment utilization due to increased unplanned maintenance rendering equipment unavailable, the risk is low.
Duration to Implement	Long-term	• Based on the many factors that impact equipment utilization, maintenance costs and records should be monitored over a sufficient period of time to maximize the benefit and determine if adjustments are required.

Maximize equipment utilization (continued)

Annual Cost Savings – Low

Initial Investment
- The initial investment required to implement this opportunity is low as there is little to no capital investment needed given the City already possesses the necessary equipment.

Annualized Cost Savings
- Average annual maintenance expenditures are approximately $300,000 and can be bifurcated as unplanned maintenance (54%) compared to planned maintenance (46%).
- A sensitivity analysis was conducted based on the assumption that instituting Lean Six Sigma practices will yield an industry standard savings factor of 10%. Gaining 10% savings on up to 25% of planned maintenance work orders and up to 50% of unplanned maintenance work orders yields low annualized cost savings (up to $50,000).
- The conservative approach of applying the industry standard savings factor to a smaller portion of planned maintenance work orders is appropriate as maintenance is to be expected. Unplanned maintenance is typically a result of inefficiencies or non-compliance with policies, indicating that a larger portion of these work orders can yield cost savings.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Mid-term

1. Establish policy manuals to be codified related to equipment utilization (e.g. operator damage, parts management, maintenance scheduling) leveraging Lean Six Sigma methodology.
2. Investigate alternative indicators of maintenance based on accurate data available.
3. Conduct pilot testing of these indicators prior to implementation.

Long-term

4. Monitor performance / incidents reported and integrate improvements as necessary.

Other Considerations

- This opportunity is interdependent on the trails, sidewalks and laneways opportunity of rotating trail equipment (pages 49 and 50) as creating an improved balance in trackless trail plow equipment will also increase equipment utilization. Lean Six Sigma methodologies such as standard operating procedures for the use and ordering of replacement parts, preventative / predictive maintenance tools, maintenance scheduling and consistent reporting of equipment damage can improve the effectiveness and efficiency of this equipment, thereby impacting the rotation of these units.

Enhanced trail equipment

Description and Rationale

- Major trail equipment such as the 8 trackless trail plows are distributed evenly and stored between the Service Centre and a yard at Waterloo Park. As the City's trails have undergone some major enhancements in the past few years such as increased widths, the challenge of efficiently providing service using existing equipment has increased.
- The City can source enhancements or new attachments to existing equipment used for trail maintenance to address the changes in trail infrastructure such as increased trail widths. This will increase operational efficiencies and service levels as enhanced trail equipment will facilitate faster route completion.

Characterization

Service Level Impact	High	• As major enhancements to trails have been made in the past few years, enhanced equipment will facilitate faster route completion as well as increased service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• An initial low investment is required to acquire enhancements to trackless trail plows such as wider shoveling blades or a sweeper.
Risk	Medium	• If trails continue to receive enhancements further equipment enhancements may be required, resulting in further costs.
Duration to Implement	Mid-term	• The City will source new equipment or enhancement parts through the standardized procurement policy. Management should invest time revising planned routes based on new equipment capabilities, monitor performance and adjust as necessary.

Enhanced trail equipment (continued)

Annual Cost Savings – Low

Initial Investment
- A low investment is required to acquire enhancements to trackless trail plows such as wider shoveling blades or a sweeper.

Annualized Cost Savings
- Cost savings are driven by the amount of time saved from enhanced equipment.
- Based on the baseline labour and equipment costs related to providing service to trails, time savings of up to 33% will yield low annualized cost savings (up to $50,000). Time savings within this range are reasonable as most major trails require up to 3 passes to clear the entire width of the trail due to the width of existing equipment. Enhancements such as a wider blade could decrease the number of passes required, thereby increasing operational efficiencies.
- Fewer equipment hours used to clear trails may also reduce maintenance costs, thereby increasing the annualized cost savings.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 2–4 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Identify trails that will benefit from enhanced equipment.
2. Conduct cost vs. benefit analysis for enhanced equipment.

Mid-term

3. Undertake procurement process to source new equipment or enhancement parts.

Other Considerations

- This opportunity coincides with the trails, sidewalks and laneways opportunity of tiering levels of service for bike lanes and trails (pages 54 and 55). As tiering levels of service for bike lanes and trails will determine the standardized level of service, this should be considered when enhancing trail equipment. Specifically, the number of enhancements purchased should be correlated with the number of trail kilometers subject to Level 1 full width clearing.

Tiered levels of service for bike lanes and trails

Description and Rationale

- All bike lanes and trails are serviced by Winter Control operations throughout the City with a focus on service levels. While resources are primarily deployed to service bike lanes and trails based on experience and judgment, there is a lack of data–driven prioritization that could be applied to improve operational efficiencies and service levels.
- The City can offer tiered levels of service delivered to bike lanes and trails in order to deliver a higher service level to the most active routes. Electronic sensors installed on trail routes can be used to gather data on the number of citizens that use each trail. This data can be leveraged to ensure a data–driven approach is applied to identify the City's most active routes. The Voice of the Customer (VoC) Lean Six Sigma method can also be utilized to understand what is critical to quality (CTQ) for citizens, allowing the City to deliver more value, more effectively while also recognizing it needs to set and communicate realistic performance targets.
- Throughout the process of classifying tiered routes, the City can also apply best practices from its Public Realm Strategy and Engineering Design manuals in vehicular and pedestrian traffic design that minimize any negative impacts to citizens. Ensuring the City's resources are effectively prioritizing service for the most active routes will direct resources to the areas of highest public usage and improve operational efficiencies and service levels.

Characterization

Service Level Impact	High	• Implementing tiered levels of service based on the volume of citizen activity and the engagement of citizens will improve service levels as the most active routes will receive faster route completion. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• An initial low investment is required to ensure that all relevant bike lanes and trails are outfitted with the technology required to consistently track citizen activity. This investment is expected to be low as the City has already invested in this technology for existing trails.
Risk	Medium	• There is an inherent medium risk associated with this opportunity as a small portion of citizens may not be in favour of the new tiered levels of service if it alters their current route.
Duration to Implement	Mid-term	• Sufficient time should be invested in gathering trail count data prior to full scale implementation.

Tiered levels of service for bike lanes and trails (continued)

Annual Cost Savings – Low

Initial Investment

- A low investment is required to ensure that all relevant bike lanes and trails are outfitted with the technology required to consistently track citizen activity, as the City has already invested in this technology for existing trails.

Annualized Cost Savings

- Cost savings are driven by the amount of time saved from tiering levels of service.
- For the purposes of conducting a sensitivity analysis, tiered levels of service were defined as: a) Level 1–full width clearing, b) Level 2–half width clearing, c) no service. Assuming that current operations are at a Level 1 standard, low annualized cost savings (up to $50,000) can be achieved by designating up to 25% of lower activity trails for Level 2 or 3 service.
- Opportunity costs must also be considered as designating lower activity trails for Level 2 or 3 service will enable faster service delivery for Level 1 lanes and trails.

Net Present Value

- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Implement technology to track citizen activity analytics and gather data that supports the determination of level of service for selected routes.
2. Apply best practices from the City's Public Realm Strategy and Engineering Design manuals in vehicular and pedestrian traffic design.
3. Develop public engagement plan to facilitate route determination.

Mid-term

4. Engage citizens in delivering feedback to the City on tiered levels of service.
5. Evaluate level of service required for each lane and trail and implement new standard operating procedures based on revised service levels.

Other Considerations

- This opportunity coincides with the trails, sidewalks and laneways opportunity of enhancing trail equipment (pages 52 and 53). As enhanced equipment may facilitate faster route completion, this should be considered when implementing tiered levels of service for bike lanes and trails. Specifically, this may identify an increased number of trails eligible for Level 1 service as full width clearing would be feasible in one pass.

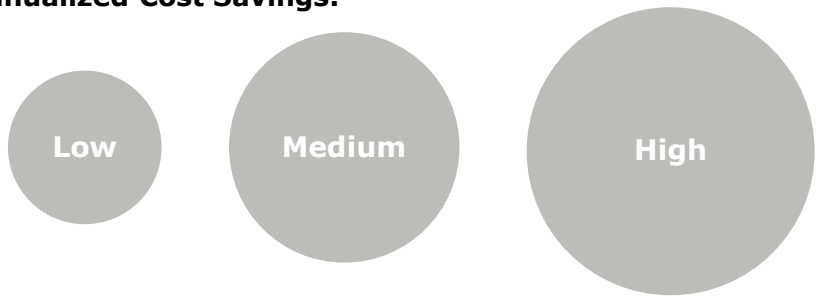
Summary of Opportunities – Trails and Railways

Legend

Opportunities:

1	Analyze slip and fall data
2	Trail equipment rotation
3	Maximize equipment utilization
4	Enhanced trail equipment
5	Tiered levels of service for bike lanes and trails

Annualized Cost Savings:

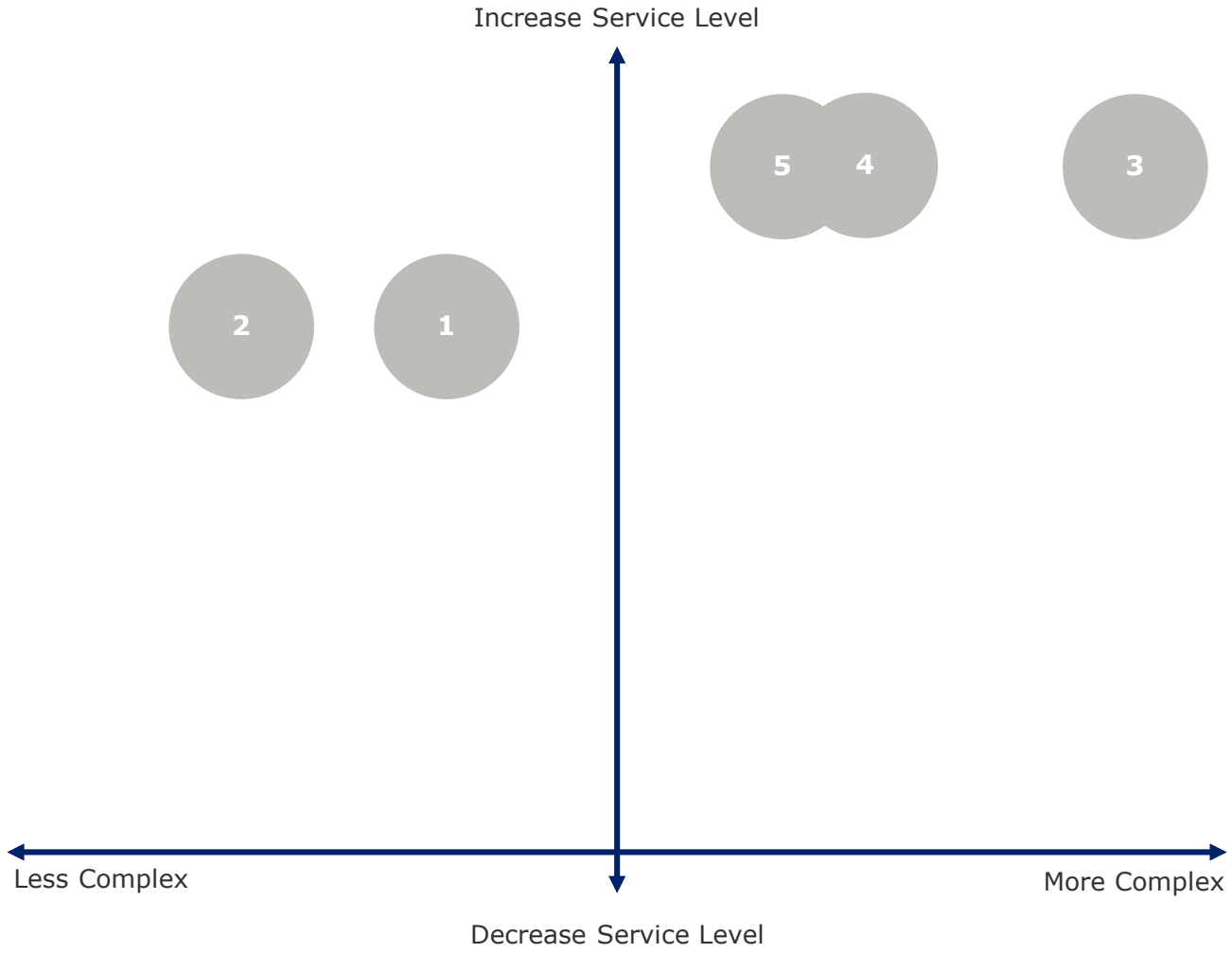


$0-$50,000

$50,000–$100,000

$100,000+

Prioritization Matrix



SALT OPTIMIZATION

Salt Optimization Opportunities

Salt is highly important to Winter Control operations as approximately 7,400 metric tonnes of salt is used each winter season. While the City has taken recent steps to modernize its Service Centre with a dedicated salt shed, further steps could be taken to help increase the accessibility of salt at an economical price by improving procurement, inventory management and increased accessibility of salt. Specifically, an increased application of technology and data–driven analytics will enable the City to operate with an industry–leading level of precision in managing this resource.

Deloitte identified the following opportunities to modernize Winter Control operations by strategically managing the procurement and consumption of salt:

	Opportunity	Scope Area	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
1	Automated salt application		Low / Medium	High	Medium	Low	Mid-term
2	Salt inventory management		Low / Medium	High	Low	Low	Mid-term
3	Minimize plow standby and travel time		Low / Medium	High	High	High	Long-term
4	New solutions for salt supply		Low	High	Low	Low	Long-term

Plow Route Optimization **Salt Management** **Personnel / Equipment Allocation** **Artificial Intelligence Systems**

Automated salt application

Description and Rationale

- Winter Control plow operators manually disburse salt based on the air temperature and their experience. However, the air temperature may not always be indicative of road surface temperature as this can vary significantly based on exposure to the sun. As road surface temperature has a significant bearing on effective salt usage, this can result in the inaccurate application of salt in certain areas leading to operational inefficiencies and sunk costs.
- The City can implement technology enabled sensors in equipment to disburse salt automatically based on the road surface temperature and speed of the plow. The sensors will facilitate real-time reporting and automatic adjustments to the rate at which salt is dispersed.
- Temperature sensors will enable the application of the Lean Six Sigma method of interlocking of machinery to reduce operator judgment (Poka Yoke) and better process controls over the use of material. Poka Yoke will integrate mistake proofing into a process to eliminate the cost of correction. This can increase operational efficiencies, environmental benefit and cost savings in situations where the City may have previously re-salted routes.

Characterization

Service Level Impact	High	• Automated salt application will increase operational efficiencies as the operator focus will remain on the road, minimizing the attention given to manually changing the rate of salt application. Citizen safety and the environmental impact will also benefit from accurate application. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Medium	• An initial medium investment is required to purchase and integrate the new technology sensors with current equipment.
Risk	Low	• While there is an inherently low risk associated with this opportunity, technology failure can cause disruption of operations. This can be mitigated by ensuring operators have the ability to revert to manual operation if required.
Duration to Implement	Mid-term	• The City must conduct a feasibility assessment of current equipment and procure the required sensors.

Automated salt application (continued)

Annual Cost Savings – Low / Medium

Initial Investment
- The initial investment required to automate salt application is medium.
- This includes the investment in the sensors and installation.

Annualized Cost Savings
- The automation of salt application can yield significant savings as sensors can identify variances between road surface and air temperature, thereby accurately applying the amount of salt required.
- Studies[1] have noted up to a 50% decrease in the amount of salt used throughout a winter. Applying a more conservative reduction of 15–35% in the quantity of salt applied, translates to low (up to $50,000) to medium ($50,000–$100,000) annualized cost savings.

Net Present Value
- Considering the medium investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1–2 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Conduct feasibility assessment of current equipment and determine whether it can support new sensors.

Assuming feasibility assessment is affirmative, proceed.

Mid-term

2. Procure and install the sensors in the equipment.
3. Conduct pilot testing prior to full-scale implementation.
4. Monitor performance and integrate improvements as necessary.

Other Considerations

- As increasing the accuracy of salt application is expected to temper overall salt consumption for the City, this opportunity may yield a positive effect on the related salt optimization opportunity of salt inventory management (pages 61 and 62). The City currently consumes approximately 7,400 metric tonnes of salt each winter season compared to the salt shed capacity of 4,000 metric tonnes. As a result, a reduction of 15–35% of total salt consumed would facilitate a lower effort required in actively managing inventory levels.

[1] Minnesota Pollution Control Agency (September 2017). *Minnesota Stormwater Manual: Salt Reduction and Cost Saving Examples*

Salt inventory management

Description and Rationale

- Salt is procured annually from a contracted supplier and stockpiled at the City's Service Centre where peak capacity is approximately 4,000 metric tonnes. On average, the City will consume approximately 7,400 metric tonnes of salt each winter, resulting in multiple orders of salt each winter season. There is currently no mandated procedure pertaining to the timing of the City's salt orders or maintained inventory levels. This can also increase the City's risk exposure to annual price increases as well as experiencing delays in receiving inventory and consequently negatively impacting service levels.
- The City can apply the Lean Six Sigma methodology of a Kanban system to identify just-in-time material flow. This will effectively manage stockpiled salt levels and establish a float quantity to ensure sufficient reserves. Proactive management of salt inventory levels will improve the City's ability to respond to weather events and result in cost savings by purchasing fewer quantities during peak demand.

Characterization

Service Level Impact	High	• Reducing the City's sensitivity to a supplier shortage of salt will prevent the disruption of salting roads and trails, thereby increasing service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as the City will not be changing the overall quantity of salt ordered, but merely the timing of orders. As a result, cash outflows will remain consistent from year over year, assuming typical operating conditions.
Risk	Low	• As this opportunity focuses on minimizing the risk borne by management from lacking sufficient inventory reserves or other variables such as loading equipment failure, the risk is low.
Duration to Implement	Mid-term	• The City must establish standard operating procedures for salt inventory management and conduct a historical analysis to forecast inventory levels required.

Salt inventory management (continued)

Annual Cost Savings – Low / Medium

Initial Investment

- The investment required to implement this opportunity is low as the City will not be changing the overall quantity of salt ordered, but merely the timing of orders.

Annualized Cost Savings

- As the City consumes ~7,400 metric tonnes of salt each winter season and the fact that the price of salt material increases annually on October 1st by the Consumer Price Index, the City can generate low annualized cost savings (up to $50,000) by maximizing initial orders prior to this date.
- In years in which a contract renegotiation takes place, the price of salt may increase significantly as the prior year saw increases by 20%. In this scenario, the City can generate medium cost savings ($50,000 to $100,000) if inventory is ordered in advance and stockpiled appropriately.

Net Present Value

- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Document the standard operating procedure of salt inventory management, specifically as it relates to preparing the salt shed and managing the timing of purchases.
2. Conduct training session with management to facilitate change management.

Mid-term

3. Analyze month over month purchase vs. consumption trends.
4. Correlate salt usage to winter storm events.
5. Determine minimum float level required to establish sufficient reserves.

Other Considerations

- This opportunity can positively benefit from the related salt optimization opportunity of salt application (pages 59 and 60) as increasing the accuracy of salt application is expected to temper overall salt consumption for the City. A reduction in total salt consumed would facilitate a lower effort required in managing inventory levels.
- The related salt optimization opportunities of minimizing plow standby and travel time (pages 64 and 65) and identifying new solutions for salt supply (pages 65 and 66) can also drive significant benefits as having a secondary refilling location will increase the City's current capacity of 4,000 metric tonnes. This will create the opportunity for the City to order more salt prior to annual price increases and establish sufficient reserves.

Minimize plow standby and travel time

Description and Rationale

- Plow equipment and the salt shed where plows will refill for material are stored at the Service Centre located on the East side of the City. It is a challenge for plows to reach the West side of the City during operations in a timely manner and requires plows to travel further when refilling is required. Standby and travel time is increased as the Service Centre is not centrally located.
- The City can further optimize plow routes by adjusting operations based on accurate analytics depicting active time plowing compared to idle time. Implementing inline hydraulic sensors will provide the City with precise data on when the blades on plows are active.
- Plow standby and travel time can also be minimized by identifying favourable refilling locations, thereby enabling plows to increase operational time. Improving equipment uptime, productivity and output quality (Overall Equipment Effectiveness or OEE) are key Lean Six Sigma methods that could be applied to help drive and measure improvement. This will minimize standby time and the travel time spent to refill equipment, thereby increasing operational efficiencies and reducing costs.

Characterization

Service Level Impact	High	• Reduced plow standby and travel time will facilitate faster route completion as less equipment hours will be required to complete the same lane kilometers, thereby increasing service levels. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	High	• An initial high investment will be required to minimize plow standby and travel time as identifying and implementing a secondary refilling location will bear a significant cost. Inline hydraulic sensor must also be purchased for each plow to facilitate accurate reporting on active time compared to idle time.
Risk	High	• Identifying a secondary refilling location bears an increased inherent risk due to the potential lack of viable salt storage locations and environmental concerns associated with potential sites.
Duration to Implement	Long-term	• Given the complexity of this opportunity, sufficient time must be invested in planning and analysis prior to execution.

Minimize plow standby and travel time (continued)

Annual Cost Savings – Low / Medium

Initial Investment

- The initial investment required in minimizing plow standby and travel time is high given the complexity in identifying a secondary refilling location.
- This includes investment options such as an overhead salt silo, salt shed and loader, acquiring land and a required investment in inline hydraulic sensors.

Annualized Cost Savings

- A sensitivity analysis was conducted based on the levered variable of time saved. As 5 of the 14 zones are located on the West side of the City and the fact that plows typically refill for salt 3 times per 8 hour shift, it was conservatively assumed that a refilling location more proximal to this area could yield 1-2 hours of time savings per shift. Considering operations in a snow event may run for 24 hours and current equipment and labour rates, this yields low (up to $50,000) to medium ($50,000-$100,000) annualized cost savings.

Net Present Value

- Considering the high investment required, the payback period for this opportunity is long-term as the investment can be recouped in 15-20 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Identify potential secondary refilling locations and conduct cost benefit analysis.
2. Procure inline hydraulic sensors.
3. Analyze data from inline hydraulic sensors to identify inefficient routes where plows are inactive.

Mid-term

4. Re-design refilling routes based on data collected from inline hydraulic sensors.

Long-term

5. Implement secondary refilling location.
6. Re-design routes based on secondary refilling location.

Other Considerations

- Identifying a secondary refill location will also significantly benefit the related salt optimization opportunity of salt inventory management (pages 61 and 62) as having a secondary refilling location will increase the City's current capacity of 4,000 metric tonnes. This will create the opportunity for the City to order more salt prior to annual price increases and establish reserve inventory levels.
- This opportunity also coincides with the labour management opportunity of re-designing the shift balance (pages 26 and 27). Any data gathered on inactive or standby time spent by plows can be leveraged to inform the re-designing of the shift balance as this would identify sub-optimal resource allocation.

New solutions for salt supply

Description and Rationale

- The commodity resource of salt is procured from one supplier due to the extremely supplier dominant market that exists within Ontario. While the City has made active efforts to identify a secondary supplier within the market, the lack of available suppliers has given rise to supplier risk. If this supplier faces any adverse economic or environmental conditions, the City's salt supply will be at risk. An industry wide phenomenon such as salt shortage may also directly impact the City's supply.
- The City can continue to explore other sources of salt supply and different procurement arrangements. This will provide the City with more flexibility in acquiring or stockpiling salt. Solutions such as leveraging the local landfill or renting space from the Region of Waterloo can help the City address capacity constraints. Remote salt storage can reduce travel time and improve operational efficiency. In the long-term, the City can continue the search for alternate suppliers and long-term contracts of purchasing salt in order to alleviate supplier risk arising from the supplier dominant market.

Characterization

Service Level Impact	High	• Minimizing supplier risk will provide the City with greater flexibility in conducting operations, increase equipment utilization, decrease resource idle time and ultimately increase citizen safety. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low	• The initial investment required to implement this opportunity is low as there is a lack of secondary suppliers. However, an investment may be required in the long-term should a secondary supplier arise. • In the interim, the City will invest time exploring innovative solutions for salt supply.
Risk	Low	• As this opportunity focuses on minimizing the risk borne by management from lacking sufficient inventory reserves or other variables such as industry-wide salt shortage, the risk is low.
Duration to Implement	Long-term	• Based on the current supplier market, a longer-term sales cycle would be required to secure additional vendors that offer favorable terms to the City.

New solutions for salt supply (continued)

Annual Cost Savings – Low

Initial Investment
- The investment required to implement this opportunity is low as there is currently a lack of secondary suppliers. However, an investment may be required in the long-term should an additional supplier arise.

Annualized Cost Savings
- Given the supplier dominant market, this opportunity is expected to yield low (up to $50,000) annualized cost savings in current market conditions.
- However, continuing the effort to identify innovative solutions to salt supply will mitigate the opportunity cost of the City reacting to market changes and paying a higher unit price or lacking supply during peak demand.

Net Present Value
- Considering the low investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1 year assuming typical operational conditions.

Implementation Steps

Short-term

1. Assess risk profile of significant industry salt shortage and determine City's risk tolerance as it relates to service level expectations.

Long-term

2. Continue to search for secondary suppliers and/or long-term contracts to mitigate the effects of supply and price sensitivity.
3. If another supplier cannot be identified, consider innovative solutions for salt supply (e.g. renting space in proximal vacant land to serve as reserve storage).

Other Considerations

- Creating new solutions for salt supply will also benefit the related salt optimization opportunities of salt inventory management (pages 61 and 62) and minimized plow standby and travel time (page 63 and 64) as leveraging another source of supply will increase the City's current capacity of 4,000 metric tonnes. This will create the opportunity for the City to establish reserve inventory levels at secondary refilling locations or other sites identified.

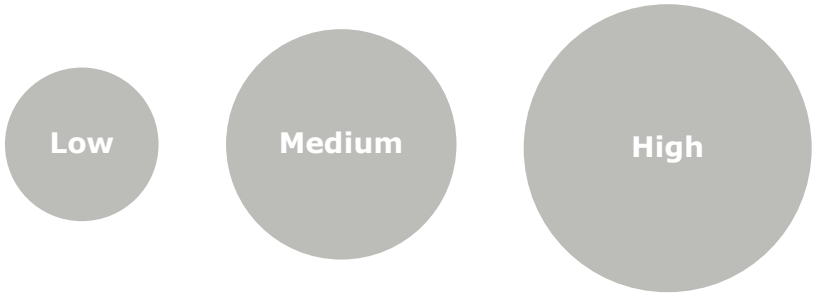
Summary of Opportunities – Salt Optimization

Legend

Opportunities:

1	Automated salt application
2	Salt inventory management
3	Minimize plow standby and travel time
4	New solutions for salt supply

Annualized Cost Savings:

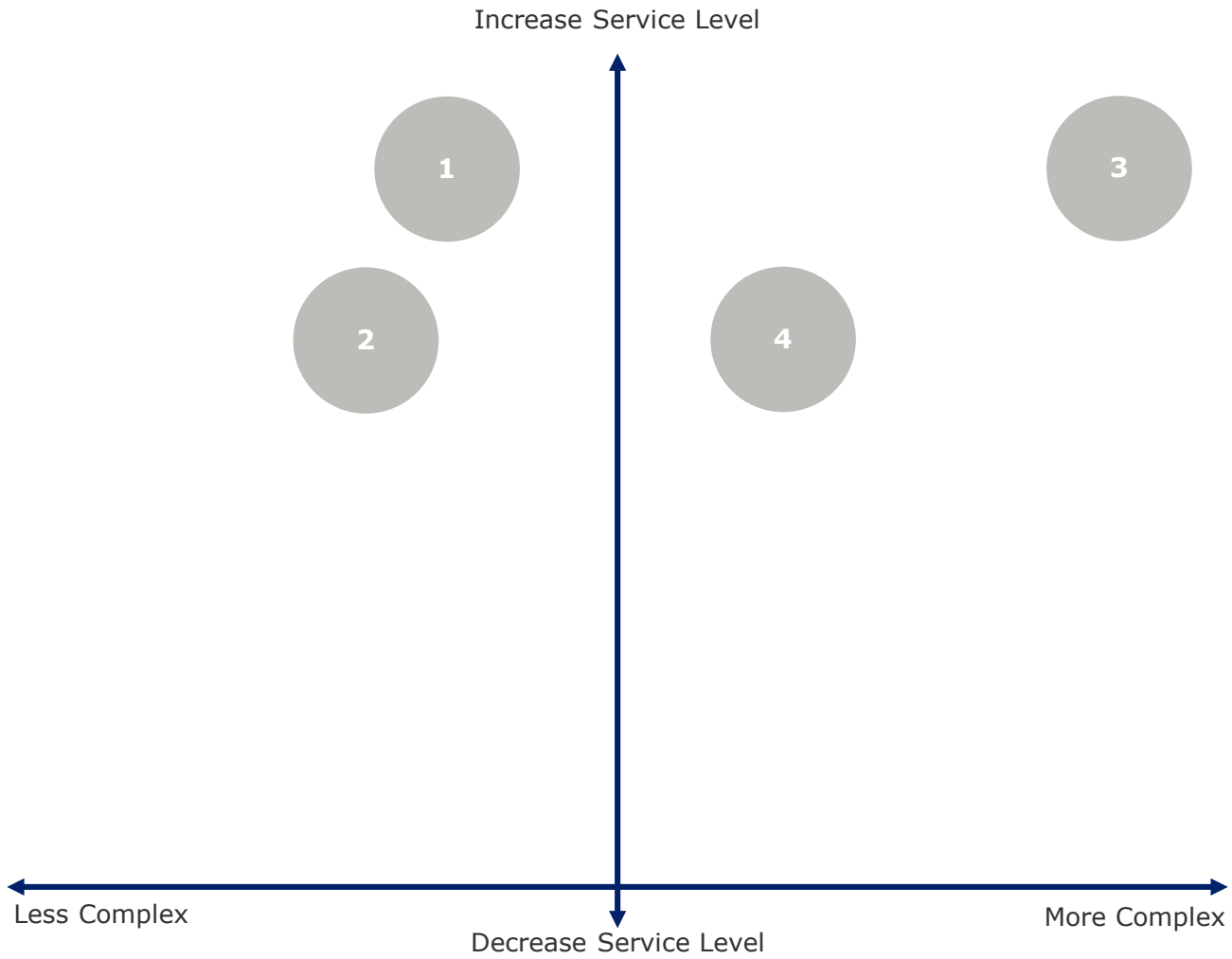


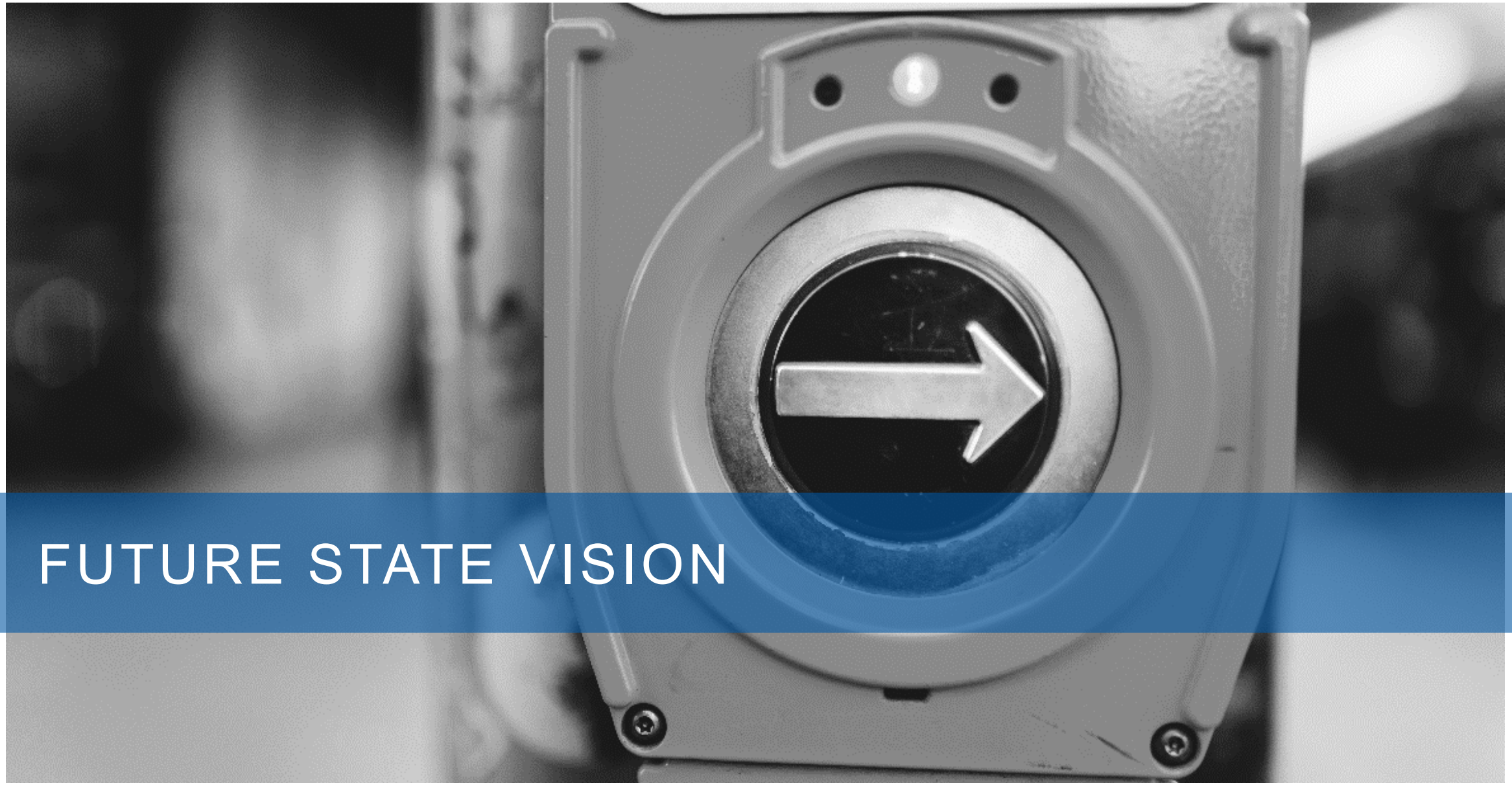
$0–$50,000

$50,000-
$100,000

$100,000+

Prioritization Matrix





FUTURE STATE VISION

Future State Vision Opportunities

The City is a unique beneficiary of the technology rich environment that exists within the local ecosystem. Engaging with local partners specializing in emerging and disruptive technologies such as artificial intelligence and machine learning will ultimately benefit the City's Winter Control operational efficiencies and service levels. While these opportunities may be implemented in the long-term, it is important for the City to consider the short-term steps to successfully plan for the future.

Deloitte identified the following opportunities to modernize Winter Control operations by understanding the future state vision:

	Opportunity	Scope Area	Cost Savings	Service Level Impact	Investment	Risk	Duration to Implement
1	Integrate live GPS for plow operators		Medium	High	Low / Medium	Medium	Long-term
2	Dynamic routing		Medium	High	High	High	Long-term
3	System harmonization		Medium	Medium	High	High	Long-term

 **Plow Route Optimization**

 **Salt Management**

 **Personnel / Equipment Allocation**

 **Artificial Intelligence Systems**

Integrate live GPS for plow operators

Description and Rationale

- Winter Control operators use physical maps of each City zone to guide route completion. These maps clearly identify road types and the boundaries of the zone. This can create inefficiencies as an operator cannot view their current location or where service has been provided.
- The City can integrate its current live GPS or automatic vehicle location (AVL) data to allow plow operators to remotely view through the use of tablet devices fixed to the cockpit console. This will provide operators with an electronic display of their route and where they have already provided service. Should a shift switch or route deviation occur, an operator will be equipped with the relevant information to resume operations in an efficient manner.
- This opportunity will alleviate an operator's added responsibility of recalling where service was already delivered enabling them to focus on operating the equipment. This will facilitate faster route completion as operators will minimize inactive plowing time. Operational efficiency and citizen satisfaction will benefit as a result.

Characterization

Service Level Impact	High	• This opportunity will facilitate faster route completion as time lost due to shift changes or route deviations will be minimized. It will also enable increased synchronous collaboration between operators. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	Low / Medium	• An initial low to medium investment will be required in order to equip each plow with a tablet device and facilitate the remote integration of current GPS / AVL data in a secure environment.
Risk	Medium	• Technological errors or areas with poor reception could yield inaccurate data and negatively impact operations. This risk will require a sufficient backup protocol to mitigate any of these instances. • Given the routine nature of current operators and advancement in the use of technology through this opportunity, change management will be required.
Duration to Implement	Long-term	• Since this opportunity is sensitive to the quality of data, the City should invest time in pilot testing and monitoring initial data prior to full scale implementation.

Integrate live GPS for plow operators (continued)

Annual Cost Savings – Medium

Initial Investment
- The investment required to integrate the City's current GPS / AVL data into remote viewing tool such as an tablet device is low to medium.
- This includes the investment in sufficient iPads to outfit all operational plows as well as software and hardware installation costs.

Annualized Cost Savings
- The annualized cost savings is primarily driven by operational time savings.
- A sensitivity analysis was conducted based on the levered variable of time. Given the fact that operations in a snow event may run for 24 hours, a range of 1-2 hours of time savings from quickly regaining their position on a map and/or avoiding repeat plowing (4-8%) is deemed conservative. This yields medium annualized cost savings ($50,000-$100,000).

Net Present Value
- Considering the low to medium initial investment required, the payback period for this opportunity is short-term as the investment can be recouped in 1-2 years assuming typical operational conditions.

Implementation Steps

Short-term

1. Investigate current GPS / AVL system integration capabilities and define requirements.
2. Conduct pilot testing with select plows and monitor data obtained.

Long-term

3. Refine the live GPS / AVL information display for operators based on pilot testing and operator feedback.
4. Design backup protocol procedures in case of technological failure.
5. Conduct training with operators to facilitate successful change management.
6. Implement new process for all plows.

Other Considerations

- An operational benefit of this opportunity resides in the nuance of jurisdiction in the City of Waterloo. As it currently stands, the City of Waterloo and the City of Kitchener engage in some crossover operations where each City will service bordering roads. Leveraging the live GPS data, the City of Waterloo can increase collaboration with the City of Kitchener and accurately report which bordering roads have been serviced. This will benefit the broader local community.

Dynamic routing

Description and Rationale

- Plow routes are periodically evaluated prior to the winter season and adjusted as needed within the City's defined zones. Routes are therefore static throughout the winter season, which can result in operational inefficiencies if disruptions such as increased traffic or accidents occur.
- The City can re-design routes using disruptive and exponential technologies such as the Internet of Things ("IoT") and predictive analytics to adapt to the truly variable nature of effort (i.e. time to clear routes).
- Dynamic routing using advanced technologies such as the IoT or predictive analytics will automatically guide operators to respond to areas based on defined variables (e.g. priority, traffic, snowfall, etc.) in order to complete routes in the most efficient manner with the minimum required equipment based on the circumstance. Operational efficiency and citizen satisfaction will benefit as a result.

Characterization

Service Level Impact	High	• This opportunity will facilitate faster route completion and increase service levels as it will dynamically direct resources and equipment using data rather than judgment. • As a result, this opportunity will yield direct improvements that will increase citizen satisfaction.
Investment	High	• The initial investment required in the implementation of dynamic routing is high given the complexity and specialization of the project.
Risk	High	• There is an inherent risk in the quality of data that drives this opportunity as inaccurate data can lead to sub-optimal routing and/or resource deployment. • The variable nature of this route design may increase number of operator incidents due to unfamiliarity.
Duration to Implement	Long-term	• This project will require numerous consultations with subject matter experts to understand current system capabilities and the required inputs for future state system functionality.

Dynamic routing (continued)

Annual Cost Savings – Medium

Initial Investment
- The initial investment required in implementing dynamic routing is high given the unique complexity and specialization of the project.
- Investment components to consider include a feasibility assessment, data architecture, data infrastructure, subject matter experts and a machine learning platform.

Annualized Cost Savings
- The annualized cost savings is driven by operational time savings as well as the indirect opportunity cost of service levels impacted by inefficient routes.
- It is important to note that a key component of the required feasibility assessment will be to assess financial benefit.

Net Present Value
- Considering the high initial investment required, the payback period for this opportunity can conservatively assumed to be long-term. Given the unique complexity and specialization of this project, the precise payback period has not been estimated.

Implementation Steps

Mid-term

1. Conduct feasibility assessment.

Assuming feasibility assessment is affirmative, proceed.

Long-term

2. Engage an external vendor with artificial intelligence and machine learning expertise.
3. Engage with a technology partner for data integration and implementation in vehicles.
4. Perform user acceptance testing (UAT).
5. Implement dynamic routing.
6. Conduct training with operators to facilitate successful change management.

Other Considerations

- From a financial reporting perspective, there are strategic considerations that should be evaluated as projects of this nature (and certain associated costs) can often be capitalized if specific Public Sector Accounting Standards are met.

System harmonization

Description and Rationale

- The City uses various information systems between functional departments to manage various information including asset, garage and financial data. Integration between these systems is limited, which can reduce management's agility in cross-functional decision making.
- The City can implement system harmonization between functional departments' information systems to achieve increased accuracy and agility in management's cross-functional decision making.
- This opportunity will yield streamlined service and back-office operations as management will be equipped with pertinent information in a more timely manner. While the one-time investment is high, the ongoing time invested and inherent risk associated with manually analyzing and collating data related to Winter Control operations will be minimized.

Characterization

Service Level Impact	Medium	• Increased accuracy and agility in cross-functional decision making will enable the City to ensure that Winter Control operations are further optimized. • As a result, this opportunity will yield indirect improvements that increase citizen satisfaction.
Investment	High	• The initial investment required in system harmonization is high given the complexity and specialization of the project.
Risk	High	• This opportunity impacts information systems containing confidential information and as such the risk of a breach must be mitigated with sufficient data security. • There is also a risk that system harmonization may not be feasible if systems currently used are deemed incompatible.
Duration to Implement	Long-term	• A system harmonization project will be intensive and require significant planning and execution time.

System harmonization (continued)

Annual Cost Savings – Medium

Initial Investment
- The initial investment required in a system harmonization is high given the unique complexity and specialization of the project.
- Investment components to consider include a feasibility assessment, data architecture, data infrastructure, subject matter experts and new information systems if required.

Annualized Cost Savings
- The annualized cost savings are driven by operational time savings as well as the indirect opportunity cost of service levels impacted by delayed reporting.
- It is important to note that a key component of the required feasibility assessment will be to assess financial benefit.

Net Present Value
- Considering the high initial investment required, the payback period for this opportunity can conservatively assumed to be long-term. Given the unique complexity and specialization of this project, the precise payback period has not been estimated.

Implementation Steps

Short-term

1. Discuss plan for system harmonization with key stakeholders.
2. Conduct feasibility assessment.

Assuming stakeholders wish to continue and feasibility assessment is affirmative, proceed.

Long-term

3. Establish a steering committee for this project.
4. Conduct procurement process to identify external vendors that can facilitate this integration.

Other Considerations

- System harmonization will serve as an integral foundational layer in exploring artificial intelligence and/or machine learning opportunities. As the City continues to welcome disruptive and exponential technologies, system harmonization will aid in constructing the data architecture, infrastructure and integrity required to fully leverage these technologies.
- From a financial reporting perspective, there are strategic considerations that should be evaluated as projects of this nature (and certain associated costs) can often be capitalized if specific Public Sector Accounting Standards are met.

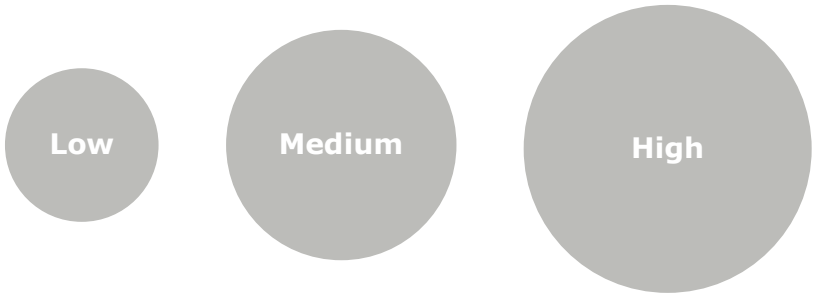
Summary of Opportunities – Future State Vision

Legend

Opportunities:

1	Integrate live GPS for plow operators
2	Dynamic routing
3	System harmonization

Annualized Cost Savings:

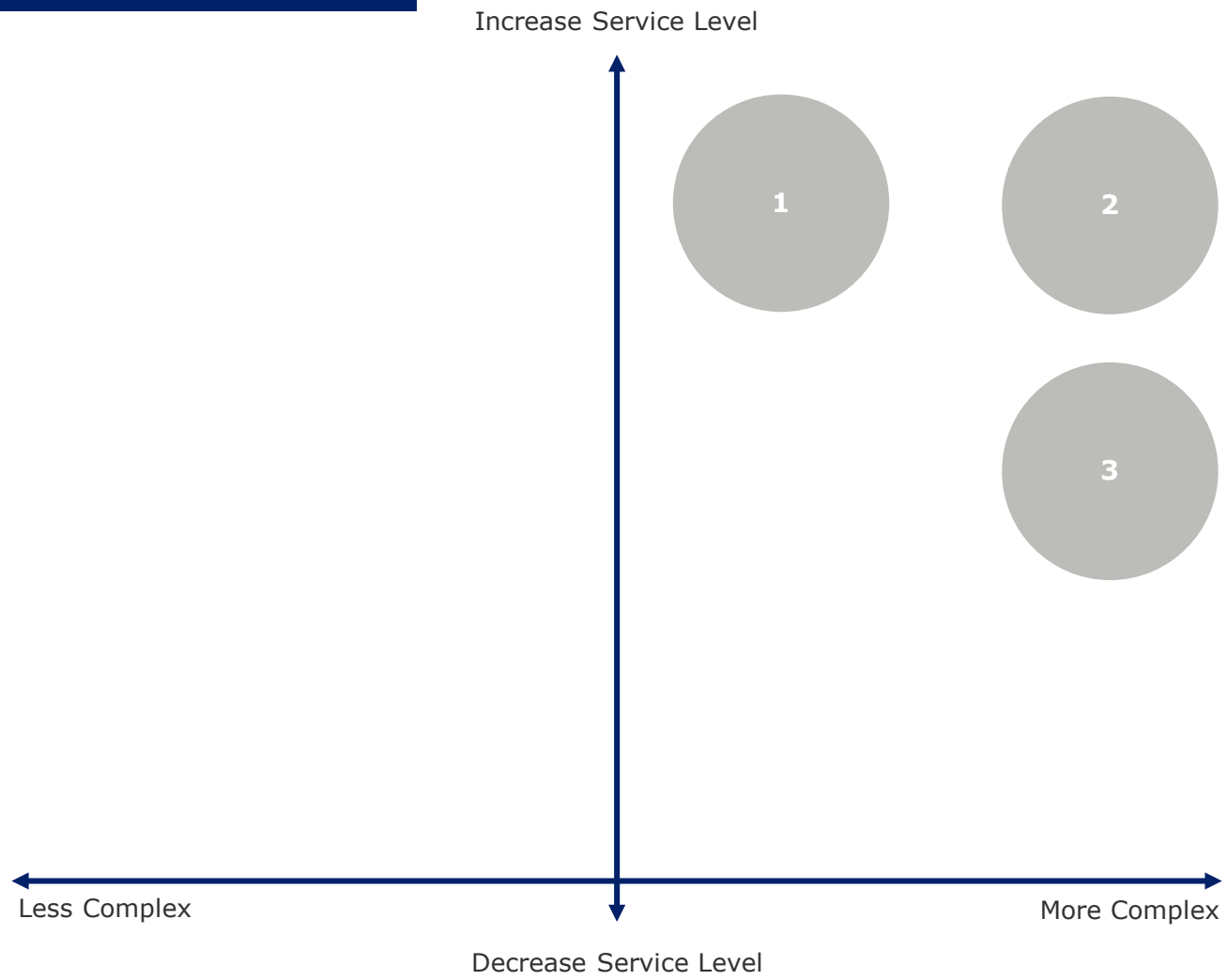


$0-$50,000

$50,000-$100,000

$100,000+

Prioritization Matrix



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