



Robert Prosser & Associates

CITY OF SASKATOON

Traffic Management and Traffic Signals

Reliance on the automobile makes the effective management of traffic a key factor in ensuring Saskatoon is an attractive city in which to live and work.

Adoption of technologies that improve traffic flow and public reporting of network performance would contribute to the achievement of this goal.

MAY 2008

Report Highlights

City of Saskatoon Traffic Management and Traffic Signals

Purpose of the Audit

The objective of this audit was to determine whether:

- Key aspects of performance are being monitored and whether operational and outcome-related objectives are being achieved,
- Adequate systems, practices and controls are in place to achieve the City's traffic management goals and mitigate related risks in terms of efficient, timely and safe movement of vehicles, and
- The City is pursuing new technology in order to increase program efficiency and effectiveness.

What Internal Audit Recommends

- Adopt of a set of operational and outcome-related performance indicators and establishment of specific, measurable objectives.
- Prepare a long-term capital funding and replacement schedule.
- Evaluate the use of real-time traffic monitoring technology.
- Assist in the assessment of the Transit Services transit signal priority system pilot project.
- Evaluate the potential for implementation of an emergency vehicle preemption system.

What Internal Audit Found

Regarding the overall transportation network, although traffic characteristics are extensively monitored and reported annually, only two key aspects of performance are being monitored and reported. Objectives have not been established, with the exception of an overall Level of Service.

Regarding the Programs' most significant traffic control initiatives, with the exception of work zones, performance is being monitored and management has prepared reports for City Council that have included performance information. Objectives have not been established for these initiatives.

There are several significant risks that affect the City's achievement of its traffic management goals (i.e., efficient, timely and safe movement of vehicles). There are adequate systems, practices and controls in place to manage many of these risks, and management has several additional controls planned. However, we believe additional steps should be taken to further minimize the likelihood or impact of following risks:

- Inadequate capital financial resources to maintain/improve current condition of transportation infrastructure,
- Traffic signal timings not optimized, and
- Severe weather event or other emergency.

The City has been implementing, is actively pursuing and is willing to evaluate new technology in order to increase program efficiency and effectiveness. For the most part, certain technologies have not been pursued due to cost constraints (i.e., above-ground non-intrusive vehicle detection, real-time traffic monitoring and emergency vehicle preemption).

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Chapter 1 – Introduction and Background

Introduction

The corporate audit plan included provision to conduct an operational audit of Traffic Management and Traffic Signals.

Background

The objective of the Traffic Engineering Section is to provide for the safe and efficient movement of people, goods and services within and throughout the City.

The Traffic Operations Group provides for the control and preservation of the City's traffic systems, including traffic signals, guide signs, highway route markers and traffic noise attenuation. This group evaluates and optimizes the City's transportation systems, including signal timing, traffic signal pre-emption/priority systems and transportation modeling. Freeways, expressways and arterial roadways fall under the responsibility of the Traffic Operations Group.

The Traffic Management Group focuses on initiatives that make our city, neighbourhoods and streets more liveable. This includes traffic calming measures, cycling and pedestrian programs, school safety programs, traffic safety programs, implementation of Local Area Plan initiatives, walkway closures and right-of-way closures. Some of the recent programs include the annual Walk your Child to School campaign and reduced speed zones around schools. This group manages local and collector roadways.

Table 1: Operating Funding 2004 - 2007

	2004 (actual)	2005 (actual)	2006 (actual)	2007 (budget)
Traffic Operations:				
Staff Compensation	\$804,300	\$844,400	\$939,900	\$895,900
Operating Costs	1,451,200	1,750,300	1,456,700	1,502,200
Cost Recovery	(1,323,400)	(1,618,900)	(1,526,600)	(1,419,800)
	\$932,100	\$975,800	\$870,000	\$978,300
Full Time Equivalents	11.1	11.5	12.6	12.6
Traffic Management:				
Revenue	(\$9,400)	(\$10,000)	(\$12,100)	(\$9,000)
Staff Compensation	\$588,800	\$624,400	\$573,600	604,600
Operating Costs	233,200	243,700	246,700	239,600
Cost Recovery	(1,200)	(600)	(300)	-
	\$811,400	\$857,500	\$807,900	\$835,200
Full Time Equivalents	9.4	9.0	9.0	9.0

Introduction and Background, cont'd

The Traffic Engineering Section also carries out a capital program each year.

Table 2: Approved Capital Funding 2004 - 2007

	2004	2005	2006	2007
Capital Projects:				
631 – Traffic Safety Improvements	\$300,000	\$300,000	\$400,000	\$250,000
1505 – Traffic Signal Upgrade	400,000	300,000	300,000	300,000
	\$700,000	\$600,000	\$700,000	\$550,000

Audit Objective & Scope

The scope of the audit included management systems, practices and controls related to vehicular traffic management and control. Specific lines of enquiry included the following:

- Are key aspects of performance being monitored? Are operational and outcome-related objectives being achieved?
- Are adequate systems, practices and controls in place to achieve the City's traffic management goals and mitigate related risks (e.g., technology failure, road closures, etc.) in terms of:
 - Efficient and timely movement of vehicles?
 - Safe movement of vehicles?
- To what extent is the City pursuing new technology in order to increase program efficiency and effectiveness?

Acknowledgements

Robert Prosser & Associates Inc. wishes to extend special thanks to the General Manager of Infrastructure Services, the Municipal Engineering Branch Manager, the Traffic Engineering Section Manager and their staff for accommodating our requests for interviews, information and documents, and reviewing our audit findings.

Chapter 2 – Performance

One of the objectives of the audit was to determine whether key aspects of performance are being monitored and whether operational and outcome-related objectives are being achieved.

Monitoring performance helps management assess the effectiveness of key strategies and initiatives, which can then be used to focus improvement efforts. Without a performance management system, successes and/or areas requiring attention might not be identified and staff may not be utilized effectively.

Regarding the overall transportation network, although traffic characteristics are extensively monitored and reported annually, only two key aspects of performance are being monitored and reported. Objectives have not been established, with the exception of an overall Level of Service.

Regarding the Programs' most significant traffic control initiatives, with the exception of work zones, performance is being monitored and management has prepared reports for City Council that have included performance information. Objectives have not been established for these initiatives.

We are recommending that a set of operational and outcome-related performance indicators be adopted by the Municipal Engineering Branch and that specific, measurable objectives be established.

Traffic characteristics are monitored and reported annually.

On an annual basis, the Municipal Engineering Branch publishes a Traffic Characteristics Report. This report includes the following information:

- Traffic volume counts from eight permanent and several portable count stations throughout the city,
- Population and vehicle ownership; vehicle ownership per capita,
- Vehicle kilometres and vehicle kilometres per capita,
- River crossing demand versus capacity (data gathered since 1960; reported since 2002),
- Highest volume intersections,
- Vehicle occupancy (data collected periodically, approximately every five years; studies completed in June 1997, June 2001 and June 2006),
- Mode share (data collected periodically, approximately every five years; studies completed in June 1997, June 2001 and June 2006), and
- Mode share comparison (from Statistics Canada every five years from census results; 1996 and 2001).

Review of industry publications suggests it is common practice to report such information as background or context in transportation network performance reports. However, these measures only report current state (i.e., what is) not performance (i.e., whether the network is operating safely and efficiently).

Of the six most common transportation system performance indicators noted, only reliability and citizen satisfaction are periodically reported.

The objective of the Traffic Engineering Section is to provide for the safe and efficient movement of people, goods and services within and throughout the City. This objective is similar to the stated objective of other transportation agencies in Canada and the United States.

Given similar objectives, we conducted a review of industry literature and examined a sample of transportation agency performance reports from across Canada and the United States. The following performance indicators are the most common:

- Level of service: operational conditions on a letter scale of A (best) through F (worst). Factors affecting level of service include the extent to which individual drivers are affected by other drivers (e.g., ability to make lane changes, speed selection, traffic queues, manoeuvrability, etc.), level of comfort and convenience, and driver frustration.
- Delay: the difference between actual travel time and a defined standard for acceptable travel time.
- Density: the number of vehicles traveling on each roadway segment, most commonly measured annually as vehicle kilometres per lane kilometre.
- Reliability: the extent to which travel time varies or is predictable; commonly measured through travel time studies (i.e., the average time required to travel from point A to point B based on a number of test trips).
- Incidents/accidents: the number of incidents/accidents by consequence (e.g., fatality, injury, property damage only); most useful if presented in relation to the level of activity (e.g., per million entering vehicles for a specific intersection, per vehicle kilometres traveled for the network as a whole).
- Citizen satisfaction: the extent to which citizens are satisfied with their experiences of the transportation network.

Approximately every five years, the Municipal Engineering Branch reports Travel Time in the Traffic Characteristics report. Results are presented in a contour map that depicts the points at which travelers could expect to be after 2, 3, 5, 8, 10, and 12 minutes of travel from the central business district during the afternoon peak hour (i.e., reliability).

Citizen satisfaction levels on a wide range of municipal issues, including traffic flow and congestion, are reported to City Council annually.

Management has adopted an objective of Level of Service C for the transportation network but has not reported on achievement of this objective. Other performance indicators have not been adopted and objectives have not been established.

With the exception of work zones, initiative-specific performance is monitored but has not yet been reported.

The Traffic Management and Traffic Signals Programs engage in certain specific initiatives that significantly affect the driving public and operation of the transportation network – work zones, school zones, automated enforcement (i.e., red-light cameras) and neighborhood calming measures.

Work zone traffic control measures are intended to “...promote the safe and efficient flow of traffic past the work zone¹.”

Industry literature suggests that performance measures regarding work zones could include the number and severity of traffic incidents/accidents in work zones, the average speed through work zones, the number of traffic tickets issued for speeding in work zones, delay, travel time and queue length.

Work zone performance has not been measured, monitored or reported and objectives have not been established.

School zones impose reduced speed limits on roadways adjacent to school property in order to improve safety for school children. Performance measures regarding school zones could include the number and severity of pedestrian incidents/accidents in school zones, the average speed through school zones and the number of traffic tickets issued for speeding in school zones.

School zone performance has been measured and monitored but specific and measurable objectives have not been established. Management is in the process of preparing a report for City Council that will include performance information.

Automated enforcement (i.e., red-light camera) technology was installed at one intersection in the city as a result of safety concerns – this intersection had the highest number of accidents in the city, with a large number of these accidents being right-angle collisions (which are often associated with running a red light). Industry literature suggests that performance measures regarding automated enforcement could include the number, severity and type (e.g., right-angle, rear end) of traffic incidents/accidents and the number of traffic tickets issued at the intersection.

Automated enforcement performance is being measured and monitored but data to date is limited, reporting has not yet occurred and specific and measurable objectives have not been established.

¹ City of Saskatoon Work Zone Traffic Control Manual, p. 1.

Neighborhood calming measures are installed on neighborhood streets as a result of complaints made by residents of excessive speeds and/or volumes of traffic on local roadways. Performance measures regarding neighborhood calming measures could include reductions in traffic speed and volume.

Neighborhood calming measure performance has been measured and monitored but specific and measurable objectives have not been established. Performance is typically reported to affected residents and the City Councillor representing the neighborhood. If the request for calming measures was made through City Council, performance is reported to City Council.

Transportation Demand Management (TDM) strategies are being explored

Transportation Demand Management (TDM) is a general term used to describe various strategies that increase the efficiency of the transportation system as a whole. Rather than emphasizing the movement of vehicles, it emphasizes efficient movement of people and goods. TDM strategies aim to improve the transportation options available to consumers, provide incentives to change behaviour and reduce the need for physical travel through more efficient land use or transportation substitutes (e.g., walking, biking). TDM is gaining in popularity across North America as cities try to cope with increasing populations, residential and commercial development, traffic demand and environmental impacts.

In 2008, City Council approved a \$60,000 capital project to identify potential TDM tools that could be successful in Saskatoon and to evaluate the level of success those tools have had in other municipalities. Representatives from throughout the organization are involved in the project (e.g., Transit, Environmental Services, Planning, Traffic, etc.) and Terms of Reference are currently being developed.

Recommendation

1. That the Traffic Engineering Section:
 - adopt operational and outcome-related performance indicators, in addition to current indicators, that may include, but do not necessarily have to be limited to, those presented in this report;
 - establish specific and measurable objectives for each performance indicator adopted;
 - implement a system to monitor actual performance in relation to each performance indicator adopted; and
 - report to the General Manager of Infrastructure Services and/or City Council, on an annual basis, actual performance in relation to performance objectives.

Management Response

1. *Agree.*

Chapter 3 – Risk Management

One of the objectives of the audit was to determine whether there are adequate systems, practices and controls in place to achieve the City’s traffic management goals and mitigate related risks (e.g., technology failure, road closures, etc.).

There are several significant risks that affect the City’s achievement of its traffic management goals (i.e., efficient, timely and safe movement of vehicles). There are adequate systems, practices and controls in place to manage many of these risks, and management has several additional controls planned. However, we believe additional steps should be taken to further minimize the following risks:

- Inadequate capital financial resources to maintain/improve current condition of transportation infrastructure,
- Traffic signal timings not optimized, and
- Severe weather event or other emergency.

Transportation infrastructure capital reserves have been depleted.

The two capital reserves established to fund transportation infrastructure maintenance and improvement – the Infrastructure Replacement Reserve (Surface) and Traffic Safety Reserve – are both forecasted to be in deficit positions as of January 1, 2008. Inadequate funding will lead to capital work being deferred, which will result in more costly repair and replacement costs in the future.

A long-term capital funding and replacement schedule will allow management to identify and prioritize infrastructure maintenance and improvements given scarce capital dollars. Much of the information needed to prepare such a schedule is already gathered by management (i.e., asset inventory, estimated useful lives and condition assessments).

Periodic review of traffic signal timings would enhance transportation network efficiency.

Industry literature indicates that one of the most cost-effective improvements local transportation agencies can undertake to improve their transportation network efficiency is the periodic review and adjustment of traffic signal timing plans.

Traffic signal timing plans for approximately half of the city’s signalized intersections were reviewed in conjunction with the implementation of the ATMS (2003 – 2007). Management agrees that reviewing timing plans for signalized intersections on a risk-based, priority basis would ensure network efficiency is maximized.

Recent events have demonstrated the need for emergency planning to involve traffic management.

Three recent events – the 2007 blizzard, the 51st Street train car derailment and the College Drive interchange rollover – have shown how severe weather or other emergencies can significantly affect the efficiency of the transportation network.

Although such events are largely unpredictable, they can be planned for. Management agrees that having alternative traffic signal timing plans in place to accomplish certain broad goals (e.g., clear the downtown core, bypass a major corridor/ intersection/interchange) could help reduce the impact severe weather or other emergencies have on the traveling public.

Recommendations

2. That management prepare a long-term capital funding and replacement schedule for the Infrastructure Replacement Reserve (Surface) and Traffic Safety Reserve.
3. That management develop a risk-based traffic signal timing plan review process.
4. That management develop alternative traffic signal timing plans for key intersections and/or corridors.

Management Response

2. *Agree.*
3. *Agree.*
4. *Agree.*
Will require 0.5 additional staff year for one year.

Chapter 4 – Technology

One of the objectives of the audit was to determine the extent to which the City is pursuing new technology in order to increase program efficiency and effectiveness.

The City has been implementing, is actively pursuing and is willing to evaluate new technology in order to increase program efficiency and effectiveness. For the most part, certain technologies have not been pursued due to cost constraints (i.e., above-ground non-intrusive vehicle detection, real-time traffic monitoring and emergency vehicle preemption).

Light Emitting Diode (LED) bulbs.

Light Emitting Diode (LED) traffic signal lights are becoming more common in the United States and Canada. LED's are tiny electronic lights that are extremely energy efficient and have a very long life. Each LED is about the size of a pencil eraser, with hundreds of them used together to form a traffic signal light.

On April 30, 2007, City Council approved a Productivity Improvement Loan for \$884,200 to finance the conversion of incandescent bulbs to LED bulbs for the City's traffic signal system. Over 90% of the City's 230 signalized intersections have been converted, with the final 20 intersections scheduled to be completed by spring 2008. LED bulbs have several benefits:

√ Safety

- LED's are brighter and more visible to motorists.
- LED's do not burn out all at once like incandescent bulbs – an individual LED may burn out, but the entire signal face only gradually dims.

√ Cost Savings

- LED's are 75-80% more energy efficient than incandescent bulbs, resulting in estimated annual energy cost savings of \$200,000.
- LED's last 7-8 years versus 2-3 years for incandescent bulbs. Replacing bulbs less often requires less staff time and equipment.

√ Network Efficiency

- There is less traffic disruption (i.e., lane closures) as a result of replacing LED bulbs every 7-8 years as compared to replacing incandescent bulbs every 2-3 years.

Real-time traffic detection.

There are few things more frustrating to motorists than waiting through a red light when there is no cross-traffic or a turn arrow when there is no one turning. Real-time traffic detection technology helps avoid these situations and improves the efficiency of the traffic network as a whole.

Traditionally, vehicle detector loops have been embedded within pavement surfaces near the cross-traffic stop line and/or turning bay stop line in order to ensure the traffic flow on the major roadway is only interrupted when required. However, these in-ground detector loops can fail due to pavement movement (i.e., freeze/thaw cycles) or construction activities. If in-ground detectors fail, the traffic signal's default timings assume a vehicle is always there, triggering cross-traffic or turning movements during every cycle.

At certain intersections, management has been installing above-ground non-intrusive video or microwave vehicle detectors (e.g., Warman Road and Circle Drive, Taylor Street and Circle Drive). While these technologies are more expensive initially, they have the following benefits:

√ Safety

- Unwarranted stops are minimized. Such stops increase motorist frustration which can lead to disrespect for, and failure to comply with, traffic control measures in an effort to “make up time.”

√ Efficiency

- Above-ground vehicle detectors can be repaired and maintained at any time, regardless of season. In-ground detectors can not be repaired and can only be replaced when the weather is mild.

√ Network Efficiency

- Above-ground vehicle detectors are more reliable than in-ground detectors (i.e., are not affected by freeze/thaw or construction), triggering cross-traffic or turning movements only when justified, thereby maximizing intersection and corridor capacity.
- There is less traffic disruption (i.e., partial lane closure for a limited time) when an above-ground detector requires repair as compared to replacing in-ground detectors (i.e., full lane closure for an extended time).

Management indicates that although these benefits would often justify installation, funding is a constraint – above-ground detection technology costs up to \$5,000 per intersection approach; in-ground detectors cost less than \$1,000 to install or replace.

Real-time traffic monitoring.

Travelers increasingly desire more information regarding traffic conditions before they head out – to work, home from work, to a meeting or social event, etc. Many cities provide real-time traffic information through the internet from traffic cameras (still pictures every few minutes or live streamed video) or interactive maps (color coded congestion levels, icons depicting road closures or construction zones, etc.). Such information allows motorists to make informed decisions regarding which route to take to avoid congested areas.

The City of Saskatoon does not have traffic cameras or interactive maps, although the Advanced Traffic Management System (ATMS) does support such capabilities. Management is considering installing additional permanent traffic count stations at certain key intersections and on the bridges that do not currently have permanent stations installed. If video traffic count technology is installed, it is possible to make the video footage available to the public over the internet. The benefits of real-time traffic monitoring technology includes:

√ Safety

- Monitoring of real-time traffic video footage could allow for identification and public notification of incidents/accidents and resulting congestion at an intersection, along a corridor or on a bridge. Emergency services could be notified.

√ Network Efficiency

- When motorists bypass congested areas and choose an alternate route, additional congestion is avoided and traffic flows can return to normal conditions sooner after an incident/accident.
- A more effective response to congestion could be initiated (e.g., implement alternate traffic signal timing plans) in response to actual traffic conditions.

Management indicates that there would be resource implications to installing such technology (i.e., CIS staff and staff to monitor conditions) and ongoing funding requirements (i.e., purchase, installation and ongoing maintenance of the technology).

**Weigh-in-Motion
(WIM).**

Weigh-in-motion (WIM) devices are designed to capture and record truck axle weights and gross vehicle weights as they drive over a sensor installed in the pavement surface. Unlike older static weigh stations, current systems do not require the subject trucks to stop, making them much more efficient.

Three WIM stations have been installed in Saskatoon on Circle Drive (northbound near Taylor Street, westbound just before the Circle Drive Bridge and eastbound just after the Circle Drive Bridge). The WIM stations measure vehicle weight and speed and take a picture of the side and front of the vehicle. At the present time, this information is not being utilized.

Management is working in cooperation with Police Services on developing and implementing an enhanced overweight vehicle enforcement program that will make extensive use of the WIM data. Police will have access to the WIM data on a real-time basis and will be equipped with laptop computers and portable weigh scales. The benefits of such a program include:

√ Safety

- Industry studies indicate that overweight trucks pose a safety risk – they take longer to stop, are more prone to roll-over in an accident and often other safety violations are noted upon inspection.

√ Cost Savings

- Removing overweight vehicles from our roadways reduces the damage to those roadways, increases their effective useful life and delays the need for major (and costly) rehabilitation/reconstruction treatments.

Management indicates that a report is being prepared for City Council approval regarding funding for ongoing maintenance costs (i.e., calibration).

Special event management.

Special events at permanent multi-use venues create unique, recurring and intense peaks in travel demand, both before and after an event, that affect travel in all the corridors serving the venue. In Saskatoon, the venue for which such peaks are most apparent is Credit Union Centre – it is not uncommon for traffic to be congested from the Marquis and Idylwyld Drive intersection all the way back to the 51st Street interchange (east approach), and along Highway 16 (west approach).

Management has engaged Credit Union Centre in discussions to evaluate measures that could be implemented to help address the traffic management challenges associated with major events. Measures management is considering include special event traffic signal timings at the Marquis and Idylwyld Drive intersection and the use of changeable message signing (permanent or portable) before the Marquis and Idylwyld Drive intersection to alert southbound motorists of upcoming congestion. One measure already implemented is the use of dedicated transit buses to ferry patrons to and from the event which helps reduce congestion. The benefits of such measures include:

√ Safety

- Less congestion and delay results in less frustrated drivers who may otherwise disrespect and/or fail to comply with traffic control measures, placing themselves and other motorists at risk.
- Motorists who are aware of upcoming congestion will be in a better position to react to potential problems.

√ Network Efficiency

- Traffic signal timings that account for peaks in travel demand increase the capacity of an intersection and the network as a whole, allowing it to operate more effectively and reduce congestion and delay.

Transit signal priority.

It is estimated that transit vehicles spend an average of 15% of their trip time waiting at traffic signals. Transit signal priority gives transit vehicles a little extra green time or a little less red time at traffic signals to reduce the time they are slowed down by traffic signals. On average, transit service providers find that time savings of approximately 15% result when transit signal priority systems are implemented².

The City of Saskatoon does not have transit signal priority, although a pilot project along the College Drive corridor is being considered. The Advanced Traffic Management System (ATMS) supports such capabilities. Management indicates that they would be willing to work with Transit Services to evaluate the results of the planned pilot project and the costs and benefits of expanding the technology to major transit corridors. The benefits of this technology include:

- √ Transit Service Delivery
 - Priority systems improve transit schedule adherence, improve service reliability, reduce travel time and reduce emissions which leads to increased transit quality of service and increased attractiveness of transit.
- √ Network Efficiency
 - Saskatoon Transit provided 343,600 hours of service in 2007. Assuming that Saskatoon Transit experiences the same delay and time savings as found in the industry (above), a priority system could potentially reduce network delay by 7,700 hours per year, thereby improving overall network efficiency.

² “An Overview of Transit Signal Priority,” Intelligent Transportation Society of America, revised and updated 2004, http://ptvag.com/download/traffic/library/2001%20ITS%20America%20Transit_Signal_Priority.pdf.

Emergency vehicle pre-emption.

The sudden appearance of an emergency vehicle en route to an emergency can be extremely disruptive as individual drivers attempt to get out of the way. Some drivers become confused and create conflicts that can cause accidents or block traffic lanes (especially under already congested conditions), thereby increasing emergency response times. Studies in the United States show that more than 25% of all emergency vehicle crashes occur at signalized intersections³.

Emergency vehicle pre-emption systems are designed to interrupt normal traffic signal operation and give emergency response vehicles a green light on their approach to a signalized intersection while providing a red light to conflicting approaches.

The City of Saskatoon does not have emergency vehicle pre-emption, although the Advanced Traffic Management System (ATMS) does support such capabilities. Management indicates that they would be willing to work with emergency service providers (i.e., Police, Fire and ambulance) to evaluate the costs and benefits of an emergency vehicle pre-emption system. The benefits of this technology include:

√ Safety

- Emergency vehicles would not have to proceed through an intersection against a red light, thereby reducing their risk of an accident.
- Other motorists can safely proceed through an intersection in order to allow the emergency vehicle to pass, reducing the risk of accident for those motorists.

√ Emergency Response

- Sequential green lights along an emergency vehicle's route results in a higher average speed and faster response time which can potentially reduce property damage and save lives.
- The effective service radius of each emergency station is increased.

√ Cost Savings

- The cost of replacing emergency vehicles damaged in accidents would be reduced.
- Fewer emergency vehicle accidents would reduce the legal liability associated with injury (emergency vehicle personnel and other motorists).

³ "Traffic Signal Preemption for Emergency Vehicles – A Cross-Cutting Study," The Federal Highway Administration, January 2006, http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/14097_files/14097.pdf.

Other initiatives.

There are several other initiatives being investigated or pursued by management that will increase the efficiency or effectiveness of the program, including:

- Handheld/portable computers: management is planning to equip Electronics Shop staff with handheld/portable computers for use when they perform maintenance work on traffic signals. This will allow staff to upload/download traffic signal timings and will replace the manual system currently used to record all repair and maintenance work. This should result in more efficient use of staff time.
- Wireless communication: for outlying intersections, the cost of installing traditional communication lines is quite expensive and therefore the intersection is required to operate on a stand-alone basis, not connected to the ATMS. At one test location, management has connected the intersection to the ATMS using wireless technology. This technology could be used to connect other stand-alone intersections, or intersections that have other physical constraints, to the ATMS.
- Changeable message signs: several Canadian cities utilize changeable message signs to inform motorists about traffic conditions (e.g., accident ahead, expect delays, use alternate route), weather conditions (e.g., fog ahead, reduce speed) or other information (e.g., Amber Alerts). Management is considering installing changeable message signs at key strategic points in the city, but has not yet determined where those points might be.
- Variable lane control: similar to reversible lane control used in the United States on heavily traveled bridges or tunnels, variable lane control can be used to manage directional peaks in traffic demand. Management is considering utilizing this traffic control measure at one test intersection in order to effectively accommodate the high directional demand during peak hours.

Recommendations

5. That management prepare a prioritized listing of key intersections/corridors in the city for which above-ground, non-intrusive vehicle detection technology would be beneficial and include the cost of installation in the long-term capital funding and replacement schedule recommended in Chapter 3.
6. That management evaluate the costs and benefits of real-time traffic monitoring technology, including the potential for making such information accessible to the public through the internet.
7. That management work with Credit Union Centre to evaluate and implement measures that would help address the traffic management challenges associated with major events at the venue.
8. That management work with Transit Services to evaluate the results of the planned pilot project and the costs and benefits of implementing a transit signal priority system along major transit service corridors.
9. That management work with Saskatoon's emergency service providers (i.e., Police Services, Fire and Protective Services and MD Ambulance) to evaluate the costs and benefits of implementing an emergency vehicle pre-emption system.

Management Response

5. *Agree.*
6. *Agree.*
Initial response is that the benefit within the City of Saskatoon is questionable – further evaluation will determine this.
7. *Agree.*
Discussions in progress.
8. *Agree.*
9. *Agree.*

Chapter 5 – Implementation Plan

	Recommendations	Implementation Date
1.	That the Traffic Engineering Section: <ul style="list-style-type: none"> • adopt operational and outcome-related performance indicators, in addition to current indicators, that may include, but do not necessarily have to be limited to, those presented in this report; • establish specific and measurable objectives for each performance indicator adopted; • implement a system to monitor actual performance in relation to each performance indicator adopted; and • report to the General Manager of Infrastructure Services and/or City Council, on an annual basis, actual performance in relation to performance objectives 	March 2009
2.	That management prepare a long-term capital funding and replacement schedule for the Infrastructure Replacement Reserve (Surface) and Traffic Safety Reserve.	December 2008
3.	That management develop a risk-based traffic signal timing plan review process.	December 2008
4.	That management develop alternative traffic signal timing plans for key intersections and/or corridors.	August 2009
5.	That management prepare a prioritized listing of key intersections/corridors in the city for which above-ground, non-intrusive vehicle detection technology would be beneficial and include the cost of installation in the long-term capital funding and replacement schedule recommended in Chapter 3.	December 2008
6.	That management evaluate the costs and benefits of real-time traffic monitoring technology, including the potential for making such information accessible to the public through the internet.	March 2009
7.	That management work with Credit Union Centre to evaluate and implement measures that would help address the traffic management challenges associated with major events at the venue.	December 2008 (to develop plan)
8.	That management work with Transit Services to evaluate the results of the planned pilot project and the costs and benefits of implementing a transit signal priority system along major transit service corridors.	June 2009
9.	That management work with Saskatoon's emergency service providers (i.e., Police Services, Fire and Protective Services and MD Ambulance) to evaluate the costs and benefits of implementing an emergency vehicle pre-emption system.	June 2009

Appendix A – Risk Matrix

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
FINANCIAL			
<p>Capital financial resources are inadequate to maintain/improve current condition of transportation infrastructure.</p>	<ul style="list-style-type: none"> • Inadequate capital financial resources can lead to deterioration in the condition of transportation infrastructure necessitating more costly repairs on an emergency basis in the future. Since capital funding is also utilized to make intersection improvements to address safety concerns, a lack of capital dollars could delay implementation of such improvements. • The City of Saskatoon has established two capital reserve funds to help minimize this risk – the Infrastructure Replacement Reserve (Surface) and the Traffic Safety Reserve. <ul style="list-style-type: none"> ○ However, both of these reserves are forecasted to be in deficit positions as of January 1, 2008⁴. • Preparation of a long-term capital funding and replacement schedule would help management reestablish the financial health of the capital reserves and minimize risk. The following controls are in place which would aid in the development of such a schedule: <ul style="list-style-type: none"> ○ An inventory of all transportation infrastructure is maintained. ○ Estimated useful lives have been estimated. ○ Condition assessments are completed on a regular and periodic basis. 	<p>High. Capital reserve balances have been depleted.</p>	<p>Moderate. Deferred capital work will result in the requirement for more costly repair/replacement in the future.</p>
<p>Operating financial resources do not keep pace with growth in transportation infrastructure.</p>	<ul style="list-style-type: none"> • Inadequate operating financial resources can result in an inefficient transportation network (i.e., delay and congestion) if staff are unable to respond in a timely manner or be proactive in identifying and remedying emerging network problems. • Over the five year period 2003-2007, transportation infrastructure, staff resources and operating financial resources have grown at a similar rate. • However, management indicates that current staff levels have been supporting a reactive or complaint-based approach to network problem solving rather than a proactive one. 	<p>Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Network efficiency can be negatively affected</p>

⁴ City of Saskatoon Preliminary Capital Budget and Capital Plan, December 3, 2007, p. 8.

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS				RESIDUAL RISK	
					LIKELIHOOD	IMPACT
		2003	2007	% Change		
	Signalized Intersections					
	• Full	175	191	9.1%		
	• Pedestrian Actuated	37	44	15.8%		
	• Active Pedestrian Corridors	-	7	-		
		213	242	13.6%		
	Staff (fte's)					
	• Electronics Shop	13.0	14.4	10.8%		
	• City Hall	9.0	9.5	5.6%		
		22.0	23.9	8.6%		
	Travel ¹ (million km)	1.456	1.420	(2.5%)		
	Operating budget	\$1,610,900	\$1,813,500	12.6%		
¹ Data from 2002 and 2006 (most recent available).						
TECHNOLOGY						
Failure of the Advanced Traffic Management System (ATMS).	<ul style="list-style-type: none"> • The Advanced Traffic Management System (ATMS) centrally monitors half of the City's signalized intersections in the downtown core and along major corridors. • The following controls are in place to minimize the risk of ATMS failure: <ul style="list-style-type: none"> ○ Corporate Information Services (CIS) performs system backups on a regular and periodic basis. ○ Access to the ATMS server at City Hall is limited to authorized staff through an electronic door lock. ○ Access to the ATMS program is limited to authorized staff through the use of user ID's, passwords and software key. 				Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.	Minor. Traffic signals would continue to operate on default timings which may affect network efficiency but would not jeopardize motorist safety.

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> • Signalized intersection timings can be modified directly through the ATMS at City Hall or via handheld computer in the field. Regardless of implementation method, there are procedures in place to ensure that all changes are approved, documented and carried out in a safe manner. <ul style="list-style-type: none"> ○ If timing changes made in the field compromise safe signal operation (e.g., request green light for conflicting movements), the controller and conflict monitor will detect the critical error before it occurs and the intersection will revert to flash mode – flashing red for all directions; if changes affect minor aspects of signal operation (e.g., coordination), the intersection will revert to default signal timings and an alarm will be triggered in the ATMS at City Hall. ○ Such instances could occur as a result of programming fault, technician error or vandalism. • In the event of ATMS failure, signalized intersections continue to operate on default signal timings. The motoring public may notice a change in traffic signal performance (e.g., default timings do not respond to changes in actual traffic flows) but motorist safety would not be jeopardized. <ul style="list-style-type: none"> ○ The most significant effects of failure are a loss of communication (data would not be gathered in real-time) and certain traffic movements would occur all the time even if traffic flows did not warrant them (e.g., left turn arrow even though no turning traffic). 		
SERVICE DELIVERY			
Traffic signal timings not optimized.	<ul style="list-style-type: none"> • Poorly timed traffic signals can result in transportation network inefficiency (i.e., increases in travel time, congestion, emissions and fuel consumption) which could lead to safety concerns (e.g., driver frustration, motor vehicle accidents and inappropriate use of side streets to avoid problem areas). <ul style="list-style-type: none"> ○ The appropriateness of traffic signal timing can be affected by changes in traffic demand and traffic flow patterns, land development and retail development. 	Medium. Implementation of a risk-based traffic signal timing plan review would reduce the likelihood of this risk to an acceptable level.	Moderate. Network efficiency and motorist safety can be negatively affected.

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> • In conjunction with implementation of the ATMS, between 2003 and early 2007, traffic signal timings at all ATMS monitored intersections were reviewed and, if necessary, modified to better accommodate traffic flows. • Management’s goal is to maintain this practice and review traffic signal timings regularly (based on criteria – to be developed – but at least every three years). This would be consistent with industry best practice. • Alternate traffic signal timings have been implemented at key signalized intersections and along major traffic corridors for peaks in traffic demand based on factors such as: <ul style="list-style-type: none"> ○ Time of day (e.g., morning and evening rush hour), ○ Day of week (e.g., Saturday shopping), and ○ Time of year (e.g., Christmas shopping). • All proposed traffic signal timing changes are modeled/ simulated in the ATMS prior to being implemented in the field. 		
Detour not developed properly.	<ul style="list-style-type: none"> • Improperly developed detours can result in delay, congestion, accidents and the inappropriate use of side streets to avoid congested detour areas. • Permission must be obtained from the City of Saskatoon in order to close all or a portion of a public roadway. There are three main types of closures for which detours are typically required: <ul style="list-style-type: none"> ○ Planned closure (e.g., construction project), ○ Unplanned closure (e.g., water main break), ○ Special event closure (e.g., Fringe Festival). • For <u>planned closures</u>, the Traffic Operations Group reviews all requests and a detour plan is documented. To the greatest extent possible, detour plans attempt to divert traffic to a similar class of roadway as the one being closed – for example, from a major arterial to another major arterial. Detours through residential neighborhood are avoided unless no other alternative exists. <ul style="list-style-type: none"> ○ For some detours, depending on pre-existing traffic volumes and anticipated duration of the project, traffic signal timings for those signalized intersections in close proximity to, or likely to be affected by, the 	<p>Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Network efficiency and motorist safety can be negatively affected.</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>detour area may be modified to accommodate additional traffic volumes.</p> <ul style="list-style-type: none"> ○ If a detour will make use of a collector street or if pre-existing traffic signals will not be operational, temporary four-way stop signs are generally installed to allow side traffic an equal opportunity to proceed. ○ After the detour plan is documented, the Roadways Activity Coordinator will drive along the proposed detour route to identify any other affecting factors. ○ If a detour will be on a local street and/or adjacent to businesses, the residents and/or businesses will be notified about the upcoming detour. ○ Saskatoon Transit is notified about planned detours in order to allow for adjustments to transit routes if necessary. ○ Newspaper advertisements and/or Public Service Announcements may be used to communicate to the public. Advance message boards may be placed at key decision points in advance of a major detour to allow motorists to choose an alternate route and avoid the detour area entirely. ○ Inspections are conducted once a detour is in place to ensure traffic flows are responding as anticipated and to identify and correct any issues. <ul style="list-style-type: none"> ● Most <u>unplanned closures</u> are required by civic staff in response to an unanticipated event such as a water main break, although a small number may be required by private contractors. The Traffic Operations Group must still be notified about the road closure but a detour plan is typically not prepared – the detouring principles as outlined in the City of Saskatoon Work Zone Traffic Control Manual must be applied. <ul style="list-style-type: none"> ○ The City of Saskatoon Work Zone Traffic Control Manual reflects the current standards as specified in the Transportation Association of Canada's <i>Manual of Uniform Traffic Control Devices for Canada</i>. ○ Due to the nature of these detours, advance notice is not possible and Public Service Announcements are generally used to communicate to the public. 		

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> • <u>Special event closures</u> follow the same procedures as a planned closure (above). In addition, the special event organizer may also review the detour plan to ensure it adequately satisfies event logistics. 		
Detour tampered with unintentionally (e.g., accident) or intentionally (vandalism).	<ul style="list-style-type: none"> • Detour signage is important in order to guide motorists safely through an unfamiliar route. Missing signage can lead to driver confusion and frustration, accidents and unintended traffic on surrounding streets. • If a detour will be in place for longer than one day, inspections are conducted once per day by Sign Shop staff (approximately once every two days for long-term detours like interchange construction or bridge widening). Sign Shop staff generally try to schedule this inspection in advance of the morning rush hour. • Inspections may also be conducted by the Roadways Activity Coordinator, Civic Project Engineers or the project contractor. • Management indicates that although a contingency plan is not typically incorporated into a detour plan (i.e., motorists tend to keep going straight if detour signage does not direct otherwise; could this lead into a school zone, crescent, dead end, etc.?), there have been no problems or issues to date as a result. 	<p>Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Network efficiency and motorist safety can be negatively affected.</p>
HUMAN			
Loss of expertise/intellectual capital.	<ul style="list-style-type: none"> • The professional labour market in Saskatchewan is currently very competitive, making it harder to recruit qualified staff and retain experienced staff. • Management is undertaking the following initiatives to address these issues: <ul style="list-style-type: none"> ○ Succession planning has commenced. The skill sets of existing staff are being inventoried, retirement eligibility is being determined and potential successors are being identified. ○ Procedures, policies and standards are being documented to aid in the training of staff new to the organization and in new job positions. ○ Professional development and training opportunities are being identified and staff are being encouraged to enhance their skills and abilities. 	<p>Medium. Implementation of initiatives planned and in progress would help reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Lack of qualified staff could place program delivery at risk.</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> ○ Staff are being cross-trained for key duties in certain job positions in an effort to broaden the knowledge base. ○ Management is evaluating the concept of “pay for performance” for professional/technical staff for which there is limited opportunity for salary growth within existing pay grades. ○ Management is working with the University of Saskatchewan to “market” the benefits of internship and employment with the City of Saskatoon. ○ Management plans to strengthen its relationship with the University of Saskatchewan – College of Engineering Transportation Research Centre. ○ An apprenticeship program for Traffic Signal Technicians has been developed. 		
ADMINISTRATIVE			
Traffic control measures installed unnecessarily.	<ul style="list-style-type: none"> ● Installation of traffic control measures where they are not justified can reduce transportation network efficiency (i.e., cause unnecessary delays and congestion), instil motorist disrespect which could lead to safety concerns, consumes scarce capital dollars and increases operating and maintenance costs. ● Management evaluates potential traffic signal sites using nationally accepted guidelines called “warrants” which consider factors such as traffic volume, speed, roadway classification and intersection geometry. City Council Policy C07-007 “Traffic Control – Use of Stop and Yield Signs” governs the installation of stop and yield signs. ● After comprehensive analysis, a report is prepared for City Council outlining the pros and cons of installing a traffic control measure at the intersection and a recommended course of action is presented. ● City Council is the ultimate decision making authority and can adopt or override management’s recommendation. <ul style="list-style-type: none"> ○ Management indicates there is a case in Ottawa where civic engineers recommended against installation of a traffic control measure but their City Council overrode 	Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.	Moderate. Network efficiency and motorist safety can be negatively affected.

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>the recommendation. Ottawa’s civic engineers have refused to install the signal and the situation has escalated to require the involvement of legal counsel.</p> <ul style="list-style-type: none"> ○ Management wishes to avoid such a situation in Saskatoon and will be monitoring the outcome of this case. 		
<p>Traffic control measures in the field not reflected accurately in civic records.</p>	<ul style="list-style-type: none"> • Inconsistencies between civic records and traffic control measures in the field could result in network inefficiencies (e.g., actual traffic signal timings do not match planned timings) and/or contradictory instructions to motorists (e.g., no parking, parking allowed). • Regarding <u>traffic signal infrastructure</u>, management indicates in many cases “as built” drawings on file are inconsistent with the infrastructure actually installed in the field (e.g., wiring and/or components in the signal control box, underground lines). This makes it difficult for technicians to provide accurate information for “locate” requests and can hinder troubleshooting of signal operational problems. Management continues to dedicate staff resources, when possible, to address this situation. • Regarding <u>traffic signal timings</u>, all changes made in the field are documented. One copy of the documentation is retained in the traffic signal cabinet on site, one copy is retained at the Electronics Shop and one copy is sent to City Hall. <ul style="list-style-type: none"> ○ Management indicates that as part of the periodic traffic signal timing plan review (see above) the latest revision date on the documentation on site can be compared to the records on file at City Hall to ensure consistency. • Regarding <u>traffic signage</u>, neighborhoods that have had a Signing Plan completed have been inspected and civic records have been updated to reflect actual field conditions or inappropriate/contradictory signage has been removed. <ul style="list-style-type: none"> ○ Although 20% of local neighborhoods have not yet had a Signing Plan completed, traffic signage on local streets is typically minimal. • Several initiatives in recent years have provided management with the opportunity to update civic records or remove 	<p>Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Network efficiency and motorist safety can be negatively affected.</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>inappropriate/contradictory signage (e.g., school zones, snow routes).</p> <ul style="list-style-type: none"> • Management is also informed if citizen complaints are received involving signage (e.g., received a parking ticket but signage allowed parking) and corrective action is taken. • Management maintains a database of the location of all stop and yield signs in the city. All such installations require City Council approval so keeping the database current and complete is relatively straightforward. <ul style="list-style-type: none"> ○ Sign Shop staff also perform inspections of all stop and yield signs on a cyclical basis throughout the city. Each location is inspected approximately every 5 years. • Management is also considering implementing an enhanced traffic signage inspection schedule for major arterial roadways. 		
Detour conflicts with another detour or event.	<ul style="list-style-type: none"> • Given Saskatchewan's short summer season, many construction projects on public roadways must be completed within a constrained timeline and detours are common. Without adequate coordination, detours may overlap or contradict each other, leading to motorist confusion and frustration, and potential safety concerns. • All requests for closure of a public roadway are received by the Roadways Activity Coordinator. Having a single point of contact helps ensure potential conflicts can be avoided. • In advance of each construction season, all civic program areas submit their preliminary capital project schedule to the Coordinator and a master project map is prepared. This would allow for early identification of potential conflicts. • The master project map is typically available to the public at City Hall and on the City's website. 	<p>Low. Controls appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Significant. Detours could overlap or contradict each other.</p>
ACCIDENTS AND INCIDENTS			
Motor vehicle accident.	<ul style="list-style-type: none"> • Motor vehicle accidents can result in property damage and/or injury for the parties involved, and congestion and delay for other motorists as they try to safely manoeuvre around the accident scene. • For <u>minor accidents</u>, no actions are taken. Generally, the parties involved exchange the necessary information, call a tow truck if 	<p>Medium. Motor vehicle accidents occur and are unpredictable.</p>	<p>Moderate. Network efficiency can be negatively affected.</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>required, the scene is cleared relatively quickly and normal traffic patterns resume within a short time.</p> <ul style="list-style-type: none"> • For <u>major accidents</u>, emergency services may be called by the parties involved, witnesses or passers-by. <ul style="list-style-type: none"> ○ If required, Police perform traffic control duties in order to direct traffic around the accident scene. Police receive training on the safe performance of these duties. ○ Police will notify the Electronics Shop (directly or through Central Dispatch) if a roadway has been closed or if a traffic signal has been damaged. Electronics Shop staff are on standby 24/7 and may erect temporary traffic control devices. ○ Police may issue a news release warning motorists to avoid the area if an accident is severe and extended lane closures are required. ○ Management may visit the accident scene after it is cleared in order to determine if any other traffic control devices have been damaged, to understand the factors that may have contributed to the accident and to determine if any corrective actions are necessary to prevent a recurrence. 		
<p>Severe weather event or other emergency.</p>	<ul style="list-style-type: none"> • Recent events have highlighted the need for the traffic management program to be engaged in emergency planning (e.g., blizzard of January 2007, train car derailment on 51st Street in June 2007, semi rollover on the College and Circle Drive interchange in October 2007). <ul style="list-style-type: none"> ○ Traffic management staff are now involved in corporate EMO initiatives. Communication and response plans are being developed. • These events are unpredictable and their effect can be severe. Advance emergency planning measures can help minimize the impact on the transportation network when such events occur. <ul style="list-style-type: none"> ○ Management indicates that while traffic signal timings can not be modified on a real time basis, alternative traffic signal timing <u>plans</u> could be developed for a variety of emergency scenarios and tested in advance. 	<p>Medium. Severe weather or other emergencies occur and are unpredictable.</p>	<p>Significant. Development of alternative traffic signal timing plans would reduce the impact of this risk to an acceptable level.</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> ○ Such timing plans would reside in the memory of each signalized intersection controller and could be initiated from the ATMS at City Hall to take effect immediately (e.g., clear the downtown core, bypass a major interchange). 		
INFRASTRUCTURE			
Unplanned failure of traffic control measures.	<ul style="list-style-type: none"> • When traffic control measures fail, congestion and delay result, which can lead to safety concerns as motorists become frustrated. • For the most part, unplanned <u>traffic signage</u> failure is a result of unintentional (e.g., accident) or intentional (vandalism) damage or removal. <ul style="list-style-type: none"> ○ Management relies on citizen complaints and notification from civic staff of missing stop, yield and other traffic signage. Replacement is prioritized – stop and yield are most important (goal is to replace within 24 hours), informational signage less so. • <u>Traffic signal</u> failure can occur for a variety of reasons including accident (see above), power outage or equipment failure. In the event of traffic signal failure, regardless of cause, the intersection is to be treated by motorists as a four-way stop. Some motorists are not aware of this fact which increases the risk of accident, especially on high volume roadways where delays and congestion quickly result. <ul style="list-style-type: none"> ○ <u>Power outages</u> are unpredictable and may be short- or longer-term. Management minimizes the impact of power outages through the following: <ul style="list-style-type: none"> ▪ Electronics Shop staff are notified by the utility, the public and/or an alarm from the ATMS. ▪ Electronics Shop staff are on standby 24/7 and are to contact the utility in order to gain an understanding of the problem and the estimated duration of the outage. ▪ If the outage has effected a critical signalized intersection, several vehicles equipped with portable generators are available to 	<p>Low. Existing controls and planned initiatives appear to be adequate to reduce the likelihood of this risk to an acceptable level.</p>	<p>Moderate. Network efficiency and motorist safety can be negatively affected</p>

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>temporarily power the traffic signals.</p> <ul style="list-style-type: none"> ▪ Once power has been restored, the traffic signal goes through a start up sequence and will resume operations. Electronics Shop staff remain at the scene for a time and watch the signal's operations to ensure it is working properly. <ul style="list-style-type: none"> ○ Management notes that at a signalized intersection with a railway crossing in close proximity, a power outage results in the loss of railway flashing lights and traffic signal pre-emption (i.e., signal timings that clear vehicles from the railway tracks). Despite signage warning motorists not to stop on the railway tracks, there is a risk of severe accident if a train approaches and vehicles have not been cleared. <ul style="list-style-type: none"> ▪ This risk is lessened at those intersections where the railway crossing has traffic gates. In the event of power outage, the gates automatically lower. ○ Management has applied to Transport Canada for funding to install backup batteries at three critical intersections (Warman Road and 33rd Street, 22nd Street and Avenue F and Circle Drive and 11th Street). The batteries would operate the traffic signals (not the railway flashing lights) which would ensure vehicles are cleared of the railway tracks. ○ Notification of traffic signal <u>equipment failure</u> can come from various sources including ATMS alarms, public complaints and/or civic staff. Management minimizes the risk of equipment failure through the following: <ul style="list-style-type: none"> ▪ A comprehensive preventive maintenance program is in place for all equipment at signalized intersections. Conflict monitors (i.e., the equipment that prevents the display of a green light for conflicting traffic) are tested at least once per year due to their critical function. 		

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<ul style="list-style-type: none"> • Management indicates all scheduled preventive maintenance has been completed; there is no backlog of deferred maintenance. • A computerized preventive maintenance record-keeping system is being implemented for spring 2008 to increase efficiency. ▪ Critical parts have been specified and minimum inventory levels have been determined for all equipment. <ul style="list-style-type: none"> • Management indicates that there is no “hard to fix, hard to replace” equipment in use at this time. ▪ “Trouble slips” are prepared every time Electronics Shop staff respond to equipment problems. <ul style="list-style-type: none"> • The Electronics Shop Foreman enters the details from each trouble slip into a spreadsheet and can review the information to identify trends and respond proactively (e.g., a certain piece of equipment is having recurring problems at one intersection – let’s check other intersections that haven’t had a problem yet but have the same equipment). ○ The most common equipment failure experienced at signalized intersections is associated with detector loops (i.e., the “trigger” that notifies the signal controller that a vehicle is in the left turning bay or waiting on a side street). <ul style="list-style-type: none"> ▪ Detector loops are installed within the pavement surface and therefore are easily damaged (e.g., pavement movement during freeze/thaw cycles) and can not be inspected 		

Appendix A, cont'd

RISK EVENT	SYSTEMS, PRACTICES AND CONTROLS	RESIDUAL RISK	
		LIKELIHOOD	IMPACT
	<p>visually. Approximately 50% of detectors are monitored by the ATMS and failures trigger an alarm at City Hall.</p> <ul style="list-style-type: none"> ▪ Detector loops that are damaged as a result of construction work are repaired and the costs recovered from the appropriate party (e.g., civic program, utility or private contractor). ▪ When detector loops fail, the signal controller reverts to default settings (i.e., always on). This may affect intersection efficiency (e.g., left turn arrow even though there is no vehicle waiting to turn) but motorist safety is not jeopardized. ▪ Management maintains a prioritized detector loop replacement list and replaces them during the spring/summer months, resources permitting. <ul style="list-style-type: none"> ○ In conjunction with many recent roadway capital projects, rather than replacing detector loops, management has been installing detector cameras. Although more costly, detector cameras can be regularly maintained, regardless of season, and are more reliable than in-pavement detectors. 		