

Request for Decision

Impact of Changes To Road Design (Asphalt Grindings and Road Cross-fall Audit)

Presented To:	Audit Committee
Presented:	Tuesday, Aug 14, 2012
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Type:	Presentations

Recommendation

The Auditor General Recommends:

THAT the City of Greater Sudbury adopt the conclusions and recommendations in the report dated August 1, 2012 from the Auditor General regarding an audit of the Impact of Changes To Road Design;

AND THAT the report be forwarded to the Operations Committee for information.

Signed By

Auditor General

Brian Bigger

Auditor General

Digitally Signed Aug 1, 12

Summary

Attached is the Auditor General's report entitled "Impact Of Changes To Road Design". This audit was conducted as part of the Auditor General's 2012 Audit Plan.

The Auditor General's Office reviewed the achievement of value for money through road design specifications as well as uses of and controls surrounding asphalt grindings.

Our audit procedures also evaluated whether:

- Value for money was achieved and expected costs/benefits of road projects were evaluated in regards to the design change impacting cross fall, the quality of the road constructed and/or volume of reclaimed asphalt pavement (RAP);
- Contractors were delivering the cross fall as specified in the contract;
- The City of Greater Sudbury's (City) controls and safeguards for proper asphalt mix ratios were operating effectively;
- The asphalt removed from City road projects were safeguarded and could be accounted for; and
- The asphalt removed from City road projects was directed to the City's highest and best use.

The attached report contains 13 recommendations along with a management response and action plan for each of those recommendations.

Audit Impact

We acknowledge that due to the low volumes that can be produced through the road construction process, and the local asphalt producers stated lack of interest in this product (quality is the issue), it can be difficult at times for the City to use all of the available RAP. We encourage the ongoing efforts of City staff to search for additional uses for RAP as it has already been paid for, and can contribute to reduced operating expenses, as well as reduced capital costs when directly recycled back into City roads (the highest and best use from the taxpayer's perspective).

We found that:

- There was inconsistent handling of the three percent road cross fall specification within City contracts and specifications for the three percent road cross fall, and acceptable tolerances were not clearly stated;
- Contractors had not consistently delivered the three percent road cross fall specified in City contracts;
- The City's quality assurance testing of asphalt was not operating effectively to ensure that the asphalt mix supplied and installed in City roads met OPSS 310 and OPSS 335 tolerances;
- The City was not able to account for the volume of RAP removed from City road projects, and when RAP was hauled to City Depot sites, any value that it might have had, was quickly reduced due to the City's storage and handling methods.

The most notable of improvements expected as a result of this audit will be to increase the effectiveness of the City's quality assurance procedures related to asphalt. The assurance that asphalt producers will be accountable to deliver quality asphalt products in accordance with OPSS, and each producer's unique job mix formulas. Other recommended improvements are intended to achieve the highest and best value through more consistent improvement of road cross fall to three percent.

It has been recognized that the demand for funds to support maintenance of the City's roads exceeds available funding. As a result, the quality of service delivery (the longevity and condition of roads), is heavily reliant on the City's stewardship (inspection and testing controls) over the reliability of the contractor's quality control systems and procedures to comply with City engineering designs, standards and specifications.

Implementing the recommendations contained in this report will enhance the value for money achieved in Roads Construction.

2011



IMPACT OF CHANGES TO ROAD DESIGN

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1.0 Purpose

The purpose of this review was to assist Council in holding itself and its administrators accountable for the quality of stewardship over public funds (and assets), and for achievement of value for money in municipal operations.

2.0 Legislative Authority

This review of the Impact of Changes to Road Design was conducted by the Auditor General's Office (AGO), pursuant to section 223.19 (1) of the Municipal Act, 2001; Part V.1 - Accountability and Transparency; Auditor General.

223.19 (1) Without limiting sections 9, 10 and 11, those sections authorize the municipality to appoint an Auditor General who reports to council and is responsible for assisting the council in holding itself and its administrators accountable for the quality of stewardship over public funds and for achievement of value for money in municipal operations. 2006, c. 32, Sched. A, s. 98.

In completing this audit, we followed generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

3.0 Scope

City staff were formally advised by the AGO of the scope of this review in a letter dated January 26, 2012. The AGO reviewed the achievement of value for money through road design specifications as well as uses of and controls surrounding asphalt grindings.

Our audit procedures also evaluated whether:

- Value for money was achieved and expected costs/benefits of road projects were evaluated in regards to the design change impacting cross fall, the quality of the road constructed and/or volume of reclaimed asphalt pavement (RAP);
- Contractors were delivering the cross fall as specified in the contract;
- The City of Greater Sudbury's (City) controls and safeguards for proper asphalt mix ratios were operating effectively;
- The asphalt removed from City road projects were safeguarded and could be accounted for;
- The asphalt removed from City road projects was directed to the City's highest and best use.

4.0 Review Methodology

This review evaluated various quality assurance components for road construction and design provided by the City of Greater Sudbury utilizing the Ontario Provincial Standard Specifications and drawings (OPSS & OPSD), City of Greater Sudbury Supplementary Standards and Drawings (GSSS & GSSD), other

Ministry of Transportation (MTO) publications, and other roads construction industry program publications as the criteria for analysis. Based on the completed review, our observations and recommendations were provided.

Our audit methodology included the following:

- Reviewed City standards, policies and procedures, Ontario Provincial Standard Specifications (OPSS) and Ministry of Transportation (MTO) policies and procedures;
- Reviewed contracts for five major construction projects done between 2008 and 2011;
- Reviewed asphalt test results performed by the City's lab and independent consultants;
- Measured delivered cross fall on the sample of five major construction projects;
- Reviewed controls over and alternate uses of RAP.

5.0 Accomplishments

The City has been recognized by the Ontario Hot Mix Producers Association for their use of recycled aggregates in road and pavement construction. Since the mid nineties, the City has been using pavement rehabilitation methods such as cold in-place recycling (CIP), full depth expanded asphalt treatment and cold-in-place recycled expanded asphalt mix (CIREAM).

Local asphalt producers referred to CGS as a leader with current asphalt technologies and design in Northern Ontario. They also commented that the City specifies high quality hot mix asphalt products for use in it's arterial roads, noting that the quality is comparable to the asphalt used on the 400 series highways.

For many years, the City has maintained small stockpiles of Reclaimed Asphalt Pavement (RAP) at Public Works Depots, using small amounts in shoulder washout repairs. Years ago, the City also tested the mixing of RAP into aggregates on local gravel roads with some success. Both were with the intent of saving money on roads maintenance.

The Auditors also observed that the City has been using the milled RAP from one road (under construction), to then place it immediately on another nearby road. This process minimizes handling of material, strengthens the pavement structure in the nearby road and eliminates the need to overbuild the road with virgin materials, therefore, saving costs. RAP has also been used to overbuild parking lots for City facilities, it was used in the construction of the BMX park for the 2010 summer games, as well as used to make small batches of hot mix asphalt for pothole patching during the winter.

6.0 Executive Summary

We acknowledge that due to the low volumes that can be produced through the road construction process, and the local asphalt producers stated lack of interest in this product (quality is the issue), it can be difficult at times for the City to use all of the available RAP. We encourage the ongoing efforts of City staff to search for additional uses for RAP as it has already been paid for, and can contribute to reduced

operating expenses, as well as reduced capital costs when directly recycled back into City roads (the highest and best use from the taxpayer’s perspective).

We found that:

- There was inconsistent handling of the three percent road cross fall specification within City contracts and specifications for the three percent road cross fall, and acceptable tolerances were not clearly stated;
- Contractors had not consistently delivered the three percent road cross fall specified in City contracts;
- The City’s quality assurance testing of asphalt was not operating effectively to ensure that the asphalt mix supplied and installed in City roads met OPSS 310 and OPSS 335 tolerances;
- The City was not able to account for the volume of RAP removed from City road projects, and when RAP was hauled to City Depot sites, any value that it might have had, was quickly reduced due to the City’s storage and handling methods.

The most notable of improvements expected as a result of this audit will be to increase the effectiveness of the City’s quality assurance procedures related to asphalt. The assurance that asphalt producers will be accountable to deliver quality asphalt products in accordance with OPSS, and each producer’s unique job mix formulas. Other recommended improvements are intended to achieve the highest and best value through more consistent improvement of road cross fall to three percent.

It has been recognized that the demand for funds to support maintenance of the City’s roads exceeds available funding. As a result, the quality of service delivery (the longevity and condition of roads), is heavily reliant on the City’s stewardship (inspection and testing controls) over the reliability of the contractor’s quality control systems and procedures to comply with City engineering designs, standards and specifications.

<p>Recommendation</p> <p>1. The City should improve policies, procedures and reports supporting accountability for rejection of inferior products and enhanced follow-up on warranty issues.</p>
<p>Recommendation</p> <p>2. The City should further investigate rejectable materials from previous and current projects, and establish appropriate remedies where warranty provisions allow.</p>
<p>Recommendation</p> <p>3. The City should require asphalt suppliers to provide their quality control test results in accordance with OPS to Construction Services (as they become available) for all asphalt supplied to the City. Any deficiencies in the quality of the asphalt should be made known to management immediately so that corrective action can be taken if deemed necessary.</p>
<p>Recommendation</p> <p>4. The City lab should immediately begin testing gradation and asphalt cement content according to the job mix formula as specified under OPSS 310 – Construction Specification for Hot Mix Asphalt.</p>
<p>Recommendation</p> <p>5. Costs and quantities related to major items used in change orders should be identified and tracked</p>

separately under the change order item in progress payments.
<p>Recommendation</p> <p>6. The City's current standard and tolerances to achieve a three percent cross fall on new construction, reconstruction or when grinding is done during a resurfacing or rehabilitation process, should be clearly stated in the contract.</p>
<p>Recommendation</p> <p>7. The City should improve policies, procedures and reports supporting accountability for rejection of incorrect cross fall as specified in the contract and/or drawings in order to comply with City standards.</p>
<p>Recommendation</p> <p>8. The City should communicate their willingness to accept RAP in the job mix formula for local roads in accordance with OPSS standards.</p>
<p>Recommendation</p> <p>9. The City should communicate their willingness to accept RAP mixed with Granular A and Granular B Type I in accordance with OPSS standards.</p>
<p>Recommendation</p> <p>10. The City should continue to identify further opportunities for cost savings where road work is planned so that the asphalt removed from one road can be used on other nearby City use(s). The objective is to minimize trucking costs while recycling the greatest volume of RAP possible (in it's highest and best use) to the advantage of the City.</p>
<p>Recommendation</p> <p>11. The City should continue to work with other interest groups and other Departments that could use the City's RAP in their nearby projects.</p>
<p>Recommendation</p> <p>12. Ownership and disposition of RAP should be clearly stated in the contract documents.</p>
<p>Recommendation</p> <p>13. If alternate City uses are not identified for the RAP, they should be directed to go to the contractor.</p>

7.0 Audit Results

7.1 Quality Assurance Testing For Asphalt Should Support The Rejection Of Inferior Materials

It has been recognized that the demand for funds to support maintenance of the City's roads has long exceeded available funding. As a result, the quality of service delivery (the longevity and condition of roads), is heavily reliant on the City's stewardship (inspection and testing controls) over the reliability of the contractor's quality control systems and procedures to comply with City engineering designs, standards and specifications.

There are three asphalt producers within the city. Each year, each asphalt producer provides the City with their Job Mix Formula (JMF) which specifies the asphalt design (recipe) for each type of asphalt and represents the asphalt product that is being sold to the City. The JMF remains in effect until the contract administrator receives any requested changes in writing and approves them.¹ It is very important that the asphalt producer follows their specific job mix formula very closely to ensure that an asphalt product with "optimal" performance is delivered and built into City roads.



Exhibit 1 – Inferior Asphalt Supplied



Inferior Asphalt Removed Next Day

The above sequence of photos shows that vigilance in quality assurance and inspection is essential, and was successful in this case.

The responsibility for quality control (QC) resides with the contractor. An asphalt contractor's QC testing is performed at the plant or in the field to control the level of quality of the asphalt against the unique JMF.

It is then up to the City to perform appropriate quality assurance (QA) procedures independent of the asphalt contractor to determine if the asphalt supplied and installed in our road (amongst other testing),

¹ Ontario Provincial Standard Specification 1003, Material Specification For Hot Mix Asphalt, November 2010, 1150.07.02

reasonably conforms with the asphalt product (JMF) we paid for. Good practice involves the City performing/obtaining independent sampling and testing and may include periodic examination of the contractor's QC results.

In search of good industry practice, the auditors referred to the MTO Construction Administration and Inspection Task Manual. The MTO manual states that "failure to prevent rejectable material from being incorporated into the work when rejectable [quality control] test results were available (or should have been available) beforehand, or when [quality control] results were not available/required but rejectable [quality assurance] results had been given to the contractor beforehand"² is a major deficiency.

HL3	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	25	4	16%	3	12%	2	8%
Regent Street	10	0	0%	0	0%	0	0%
MR 80	5	2	40%	0	0%	0	0%
Main Street	3	3	100%	0	0%	0	0%
Radar Road	16	8	50%	4	25%	1	6%

HL8	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	2	0	0%	1	50%	0	0%
Regent Street	1	0	0%	0	0%	0	0%
MR 80	4	2	50%	0	0%	2	50%
Radar Road	3	1	33%	0	0%	0	0%

HDBC	Number of Samples Tested	Number Rejectable Due to Gradation	Percentage Rejectable	Number Rejectable Due To A/C Content	Percentage Rejectable	Number Rejectable Due to Gradation and A/C Content	Percentage Rejectable
Lasalle Blvd	23	2	9%	5	22%	1	4%
Regent Street	5	0	0%	2	40%	0	0%
MR 80	10	2	20%	7	70%	1	10%
Main Street	1	0	0%	0	0%	0	0%
Radar Road	12	0	0%	1	8%	0	0%

Exhibit 2 – Results of hot mix asphalt testing done by the City using OPSS 310.

² Ministry of Transportation, Construction Administration And Inspection Task Manual, Appendix C, April 2008

The Auditors reviewed the results of the City's quality assurance tests and compared the aggregate gradation and asphalt cement test results to the standards and tolerances outlined in OPSS 310 based on the JMF for hot mix asphalt. Through doing so, it was discovered that the City's laboratory has never directly tested hot mix asphalt samples against the JMF's provided to the City by the asphalt producers. According to the OPSS 310, the "JMF is the target to which the hot mix shall be compared to determine the acceptance of the aggregate gradation and asphalt cement".³ Instead the City has been comparing test results against OPSS 1150 – Material Specification for Hot Mix Asphalt.

The City has not been ensuring that the hot mix asphalt producers meet JMF quality standards within tolerances specified in OPSS 310 for aggregate gradation and AC content.

Four of the five projects also used a recycled asphalt product called CIREAM.

OPSS 335 provides the minimum standards for measuring the tensile strength of CIREAM. In testing for CIREAM, both "dry tensile strength, wet tensile strength, and tensile strength ratio are used to determine moisture susceptibility, rutting potential and cracking potential of the binder."⁴ According to OPSS 335 (November 2009), if the CIREAM does not meet the minimum tensile strength, an acceptable solution would be to remove the CIREAM to its full depth and replace with an acceptable binder course HMA.

The Auditors acknowledge that across Ontario, asphalt producers have not consistently reproduced the tensile strength of CIREAM in the field, as compared to tensile strength achieved under laboratory conditions. The OPSS 335 Tensile Strength standards for CIREAM have been significantly revised from the 2005 and 2009 standards. Even so, independent quality assurance test results for the three City projects still indicate significant volumes of CIREAM would be rejectable. The Auditors confirmed with local asphalt producers that the 2011 OPSS 335 standards for CIREAM are fair and achievable.

Project Name	Number of Samples	2005 OPSS Standards		2009 OPSS Standards		November 2011 OPSS Standards	
		Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength	Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength	Number Rejectable Due to Dry Tensile Strength	Number Rejectable Due to Wet Tensile Strength
Lasalle ISF (2009)	20	20	0	19	2	5	0
Regent Street (2011)	11	NA	NA	11	11	4	1
Radar Road (2011)	9	NA	NA	9	9	8	9

Exhibit 3 – Results of CIREAM testing by independent laboratories using OPSS 335.

³ Ontario Provincial Standard Specification 1003, Material Specification For Hot Mix Asphalt, November 2010, 1150.07.02

⁴ Pavement Preservation Journal, "Expanded' Asphalt for CIP Recycling", Summer 2011.

When the City does not receive quality of asphalt as designed, there is the risk to the City for premature failure of the asphalt which will lead to the need for future rehabilitation sooner than designed.



Exhibit 4 – Lasalle Boulevard

As part of the City’s General Conditions, there is a minimum two year warranty period from the date of substantial performance for road work.

According to CGS General Conditions, section 104 “Control of the Work”, “General Manager’s Authority”, “Notwithstanding any inspection that the City might carry out, the failure of the General Manager of the inspector to condemn or object to any defective work or material shall not constitute a waiver of any specification or the approval or acceptance except as otherwise provided herein, and the contractor shall be and remain liable for such defective work or material and any loss, costs, charges or expense in connection therewith.”

The City did identify the CIREAM concern and obtained an extension of the warranty for this section of Lasalle Blvd.

An independent third party has been retained to test and evaluate the reasons for this apparent “premature failure” of the road.

<p>Recommendation</p> <p>1) The City should improve policies, procedures and reports supporting accountability for rejection of inferior products and enhanced follow-up on warranty issues.</p>
<p>Recommendation</p> <p>2) The City should further investigate rejectable materials from previous and current projects, and establish appropriate remedies where warranty provisions allow.</p>
<p>Recommendation</p> <p>3) The City should require asphalt suppliers to provide their quality control test results in accordance to OPS to Construction Services (as they become available) for all asphalt supplied to the City. Any deficiencies in the quality of the asphalt should be made known to management immediately so that corrective action can be taken if deemed necessary.</p>
<p>Recommendation</p> <p>4) The City lab should immediately begin testing gradation and asphalt cement content according to the job mix formula as specified under OPSS 310 – Construction Specification for Hot Mix Asphalt.</p>

7.2 Unit Price Reductions Should Be Identified and Recovered For Extra Work For Major Items

For a major item, when the “quantity of work done or material furnished exceeds the tender amount by more than 20 percent, a reduction will be made at the rate equal to 10 percent of the tender unit price on the amount of overrun in excess of 20 percent of the tender quantity.”

The meaning of the term “Major Item” is defined as “any individually bid tender item that has an actual value, calculated on the basis of it’s actual or estimated tender unit price, equal to or greater than five percent of the total tender value, calculated on the basis of the total estimated tender quantities, and the tender unit prices.” In the contracts reviewed, the auditors found cold mix asphalt and hot mix asphalt quantities to be major items in these two projects.

Radar Road

Item No	Description	Tender Quantity	Final Quantity	Additional Quantity	Volume Increase
1 a)	CIREAM	14,600	42,804.36	28,204.36	193%
2 a)	HMA HL3	2,800	9,052.14	6,252.14	223%
2 b)	HMA HDBC	2,700	7,119.08	4,419.08	164%

Regent Street

Item No	Description	Tender Quantity	Final Quantity	Additional Quantity	Volume Increase
1 a)	CIREAM	18,300	36,176.80	17,876.80	98%
2 a)	HMA HL8	2,900	4,769.37	1,869.37	64%
2 b)	HMA HL3	2,900	6,777.16	3,877.16	134%

Exhibit 5 – Major Items of extra work

City staff prefer to combine the volume or quantity of change order related work with the quantity of work specified in the original tender schedule of unit prices as this reduces the number of lines on a progress payment that must be updated.

A better practice would require that the costs and quantities related to major items used in change orders be identified and tracked separately under the change order item in progress payments. This will enable project managers to separately monitor, control and evaluate costs for major items, and to establish reduced unit prices for major items in change orders.

Recommendation

- 5) Costs and quantities related to major items used in change orders should be identified and tracked separately under the change order item in progress payments.

7.3 Acceptable Tolerances From The Three Percent Road Cross Fall Are Not Clearly Stated In Contracts

City supplemental specifications and drawings refer to a three percent cross fall, but the City's supplemental specifications and drawings do not specify any tolerances in achieving the three percent cross fall.

Ontario Provincial Standard Specification (OPSS) 310, Appendix A states that although it is not mandatory, cross fall should be specified in contract documents.

According to CGS Contract General Conditions Section 102-1, Conformity of Work with Plans and Specifications, "The Contractor shall perform all work and shall furnish all materials and complete the whole of the work in strict conformance with the plans and specifications."

City staff and local paving contractors stated that it was understood that a tolerance of up to +/- 1 percent was acceptable to the City. There was a different requirement for crossfall by the City for projects specifying CIREAM where the three percent cross fall shall be achieved "where possible" (dependent on the method).

Of the five contracts reviewed, five of five did not specify allowable tolerances in the contract. The contracts did refer to OPSS 310, which states that "after final compaction, each course shall be smooth and true to the established crown and grade." Without the City's standards clearly defined, contractors may deliver a cross fall other than what the current City standards are.

In search of good industry practice, the auditors referred to The Ministry of Transportation (MTO) Construction Administration and Inspection Task Manual. The MTO manual states that "Paving an incorrect super-elevation or cross fall" is a major deviation. The contractor is held accountable if it does not maintain appropriate quality controls to ensure that the specified cross fall is achieved.

It follows that any real or perceived performance benefits of the City's desired enhanced cross fall will be lost if the cross fall is not delivered.

Recommendation

- 6) The City's current standard and tolerances to achieve a three percent cross fall on new construction, reconstruction or when grinding is done during a resurfacing or rehabilitation process, should be clearly stated in the contract.

7.4 The City's Three Percent Road Cross Fall Is Not Being Consistently Delivered By Contractors

City staff told the auditors that they measure the cross fall throughout the project at each lift of aggregate and/or asphalt. In doing so, corrections can be made if deviation in the cross fall were identified.

The Auditors reviewed five major construction contracts that were started between 2008 and 2011 to determine if contractors had maintained appropriate quality controls to ensure that the specified cross fall was achieved. Measurements were taken at metered intervals on all lanes of the five roads (in full compliance with safety and traffic control requirements). In testing the cross fall, the Auditors did not include deviations from the cross fall when measurements were taken on super-elevated curves, or near intersections.

Project Name	Number of Measurements Taken	Number of Measurements Taken Within CGS Tolerance (+/-1%)	Percentage Within CGS Tolerance (+/-1%)	Number of Measurements Taken Outside Tolerance (+/-1%)	Percentage Outside CGS Tolerance (+/-1%)
Hwy 69 North (MR80)	32	23	72%	9	28%
Radar Road	20	16	80%	4	20%
Main Street (MR15)	24	22	92%	2	8%
Regent Street	24	15	63%	9	38%
Lasalle Blvd (MR71) ISF	36	30	83%	6	17%

Exhibit 6 – Percentage of cross fall measurements outside the tolerance range of 2% to 4%

The above chart shows that the three percent cross fall specification did not always conform with the informal CGS tolerance of 3 percent, +/- 1 percent.

Recommendation

7) The City should improve policies, procedures and reports supporting accountability for rejection of incorrect cross fall as specified in the contract and/or drawings in order to comply with City standards.

7.5 Increase Alternate Uses Of RAP To Maximize Value For Money Achieved By The City

“Asphalt pavement is the most recycled material in North America.”⁵ RAP can be used as follows in road construction:

- Up to 15% in surface asphalt mixes, and
- Up to 30% in base asphalt mixes.
- Up to 30% within Granular A and Granular B Type 1 gravel.⁶

⁵ The Ontario Hot Mix Producers Association, “Recycled Aggregate”, Issue 1.0, January 2010

⁶ The Ontario Hot Mix Producers Association, “Recycled Aggregate”, Issue 1.0, January 2010

In the past RAP has been viewed as an environmental liability by the City. As a result, any value recovered by the City for the asphalt removed from the City's roads during the construction process has been left to the competitive bid process.

Since asphalt is the most recycled material in North America, it does have value. In 2010, EXP Services Inc. (formally Trow Associates Inc.) estimated that the value of RAP would be between \$10 and \$15 per tonne, and one local asphalt producer confirmed to the Auditors that processed RAP would sell for \$15 per tonne from their Sudbury operations.

Industry literature indicates that the monetary value of RAP from the City's perspective, is equal to the cost of materials it replaces.⁷ As a result, there is some incentive for the City to make the following materials substitutions with this material:

- Substituting 15% of virgin asphalt materials with RAP in a surface asphalt mix, that producer will save up to 15% of material costs.
- Substituting 30% of virgin asphalt materials with RAP in a base asphalt mix, that producer will save up to 30% of material costs.
- Substituting 30% of Granular A and Granular B Type 1 aggregates with RAP, that producer will save up to 30% of material costs.

According to The Ontario Hot Mix Producers Association, "It is only when RAP is used as hot mix raw material that engineers can take full advantage of the engineering properties of both the aggregate and asphalt cement and maximize the economic value of recycling."⁸

Using RAP for hot mix reuses both the aggregate and the asphalt cement, both of which come from non-renewable resources. When RAP is blended with virgin asphalt mix, it has the same consistency as virgin asphalt. When RAP is used in hot mix, you can reduce costs without any impact on performance.⁹ Therefore, there is the opportunity to reduce costs of asphalt by allowing some RAP content in our asphalt mixes, rather than specifying virgin asphalt.

In discussions with local asphalt suppliers, City staff confirmed that the grindings supplied to their yards is used either by blending with granular material or used in the production of virgin asphalt.

The auditors confirmed that asphalt designed for City roads does not include any percentage of RAP in the Job Mix Formulas. In the past, the City has not requested a blending of RAP in the asphalt it uses on City roads. City Engineers and Local Asphalt Producers explained that since the mid nineties, the City has been using pavement rehabilitation methods such as cold in-place recycling (CIP), full depth expanded asphalt treatment and cold-in-place recycled expanded asphalt mix (CIREAM). Local asphalt producers

⁷ National Centre for Asphalt Technology, "RAP – Reclaimed Asphalt Pavement Frequently Asked Questions"

⁸ "The ABCs of Asphalt Pavement Recycling", The Ontario Hot Mix Producers Association Issue 1.1, March 2007

⁹ The Ontario Hot Mix Producers Association, "The ABCs of Asphalt Pavement Recycling", Issue 1.1, March 2007

referred to CGS as a leader with current asphalt technologies and design in Northern Ontario. They also commented that the City specifies high quality hot mix asphalt products on the City's arterial roads, noting that the quality is comparable to the asphalt used on the 400 series highways due to the amount of heavily loaded truck traffic using our roads. Local asphalt producers observed that if the City did specify any percentage of RAP in their hot mix asphalt, the City would bear the full warranty burden if the asphalt failed to perform as expected.

Furthermore, the City is currently not using RAP to blend with other aggregates other than with minor maintenance repairs such as washouts.

Our RAP can also be used to overbuild roads, parking lots, airport runways, in hot mix for pothole patching, for wash out repairs, for improving road shoulders and for stabilizing embankments. Other City departments or interest groups may be able to use these grindings for projects such as bike paths, walking trails, tennis courts, etc.

<p>Recommendation</p> <p>8) The City should communicate their willingness to accept RAP in the job mix formula for local roads in accordance with OPSS standards.</p>
<p>Recommendation</p> <p>9) The City should communicate their willingness to accept RAP mixed with Granular A and Granular B Type I in accordance with OPSS standards.</p>
<p>Recommendation</p> <p>10) The City should continue to identify further opportunities for cost savings where road work is planned so that the asphalt removed from one road can be used on other nearby City use(s). The objective is to minimize trucking costs while recycling the greatest volume of RAP possible (in it's highest and best use) to the advantage of the City.</p>
<p>Recommendation</p> <p>11) The City should continue to work with other interest groups and other Departments that could use the City's RAP in their nearby projects.</p>

7.6 Disposition and Storage of Grindings

The disposition of the grindings is normally specified in the contract. Grindings are either to be trucked to a City site, another City project, or they become the property of the contractor. If ownership is not specified, the City's General Conditions state that "all surplus material will be for the exclusive use of the City of Greater Sudbury."



Exhibit 7 – Grinding Brady Street

Of the five contracts we reviewed in this audit, the MR80 Frost to Glenn contract did not specify who owned the grindings, and although this material would be owned by the City under the General Conditions of the contract, the contractor took ownership of them.

The recent Roads Infrastructure Stimulus Projects (2009-2010) that saw rehabilitation of Paris/Notre Dame, Lasalle Blvd, and Falconbridge Road. Auditors observed that the disposition of very significant volumes of asphalt grindings simply could not be accounted for. When RAP was hauled to City Depot sites, any value that it might have had, was quickly reduced due to the City's storage and handling methods. The City was not properly prepared to handle, store or recycle this large volume of RAP.

The competitive bid process was relied upon in this case. The local asphalt producers confirmed that they estimate the volume of RAP to be hauled away from the project site, relative to a 1% increase in cross fall. Based on this assumption, their bids would likely have included the cost of hauling approximately 44,000 tonnes of RAP from the project sites to the Frobisher yard. Once these projects were complete, the auditors asked City staff to measure the volume of asphalt grindings that ended up at the City's Frobisher depot.

- Only 14,000 tonnes of asphalt grindings are in the stock pile at Frobisher Depot.
- Some of the RAP was used in parking lots, for erosion control and for other maintenance items such as in walkways.

- Any value the RAP might have had, was quickly reduced due to the City's storage and handling methods.

We acknowledge that due to the volumes that can be produced through the road construction process, and the local asphalt producers stated lack of interest in this product, it can be difficult at times for the City to use all of the available RAP.

We encourage the ongoing efforts of City staff to search for additional uses for RAP as it has already been paid for, and can contribute to reduced operating expenses, as well as reduced capital costs when directly recycled back into City roads (the highest and best use from the taxpayer's perspective).

Recommendation 12) Ownership and disposition of RAP should be clearly stated in the contract documents.
Recommendation 13) If alternate City uses are not identified for the RAP, they should be directed to go to the contractor.

8.0 Conclusion

This report contains 13 recommendations related to changes in Road Design, Contract Documents, and Quality Control. In times of financial constraint, a heightened focus on quality control, inspection, testing and warranty processes, the oversight of major project scope changes and further opportunities to save money through increased recycling of the City's asphalt is warranted.

Our recommendations relate to the need to:

- Improve the quality assurance testing of asphalt to ensure that the asphalt mix used in the road meet OPSS 310 and OPSS 335 tolerances;
- Ensure the City's standards for road design are clearly specified in the contract and that the required cross fall is being consistently delivered to achieve the expected benefits;
- Identify further opportunities for the highest and best use of RAP and ensuring that value for money is achieved.

Implementing the recommendations contained in this report will enhance the value for money achieved in Roads Construction.

9.0 Appendices

A. Appendix - Background

The City's road network assets are currently valued at a total estimated replacement cost of \$2.5 billion (as of December 31, 2009). The City's design life of a newly constructed road is 20 years before major rehabilitation is required. As each year passes, the overall condition of pavement will deteriorate. With limited resources available for ongoing maintenance, the importance of quality control and assurance cannot be underestimated. The design life of a road is determined by many factors including the engineering design of the road as well as the materials and work methods used to construct the road.

The City's Engineering department follows strict engineering standards to which roads are designed, built and rehabilitated. Quality control against City design standards is essential to ensure roads last and perform as designed.

The City is facing considerable challenges in funding infrastructure projects and needs to identify opportunities to reduce costs or maximize value for money spent. Recycling asphalt is one method that can rehabilitate roads by achieving more with the same expenditure. Using RAP is safe, efficient and environmentally friendly which meets the needs of present-day users without compromising those of future generations.¹⁰

"Asphalt pavement is the most recycled material in North America."¹¹ Recycling asphalt saves aggregate resources, recovers non-renewable petrochemical resources, diverts materials from landfills, reduces road construction costs (less virgin product and less hauling), and reduces green house gas emissions.¹²

According to the Ontario Hot Mix Producers Association "Using RAP reduces costs without any impact on performance. The key to success is proper management and processing".¹³

The Ontario Provincial Standards sets standards of which both virgin and recycled asphalt pavement must meet to ensure a quality product is put in the roads. Inferior products (those that do not meet established job mix formulas) can reduce the design life of the road which can result in premature maintenance costs, or accelerated failure of roads.

The value of the grindings is equal to the virgin material it substitutes.¹⁴ Recognizing asphalt grindings as a valuable City asset and ensuring that the City receives full benefit or compensation for their highest

¹⁰ Kazmierowski, T., "Evolution of In-situ Recycling in Ontario - An Agency's Perspective", North American Recycling Seminar, Ontario Ministry of Transportation

¹¹ "The ABCs of Recycled Aggregate", Ontario Hot Mix Producers Association, Issue 1.0, January 2010

¹² The Ontario Hot Mix Producers Association, "The ABCs of Asphalt Pavement Recycling", Issue 1.1, March 2007

¹³ "The ABCs of Asphalt Pavement Recycling", Ontario Hot Mix Producers Association, Issue 1.1, March 2007

and best use can significantly contribute towards reducing the City's infrastructure gap and future sustainability.

¹⁴ National Centre for Asphalt Technology, "RAP – Reclaimed Asphalt Pavement Frequently Asked Questions"

Auditor General's Office

Management Response and Proposed Actions

2011

Audit of Impact of Changes to Road Design

Brian Bigger, C.G.A

Auditor General, City of Greater Sudbury

Appendix 2

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/ Time Frame
1	The City should improve policies, procedures and reports supporting accountability for rejection of inferior products and enhanced follow-up on warranty issues.	X			Will formulate reporting procedure for test results. This can be completed within six months (March 2013).
2	The City should further investigate rejectable materials from previous and current projects, and establish appropriate remedies where warranty provisions allow.	X			Will monitor and continue to monitor areas already identified and determine corrective measures. This has been implemented.
3	The City should require asphalt suppliers to provide their quality control test results in accordance with OPS to Construction Services (as they become available) for all asphalt supplied to the City. Any deficiencies in the quality of the asphalt should be made known to management immediately so that corrective action can be taken if deemed necessary.	X			Asphalt suppliers will provide their quality controls results to Construction Services as per Ontario Provincial Standard Specification 310 Construction Specification for Hot Mix Asphalt Table 6 Sampling & Testing Frequency of Hot Mix Asphalt. This will be introduced starting January 1, 2013 and will become a standard for all future contracts. Contractors will be informed at the Annual Contractors Meeting.

Appendix 2

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: (Comments are required only for recommendations where there is disagreement.)	Action Plan/ Time Frame
4	The City lab should immediately begin testing gradation and asphalt cement content according to the job mix formula as specified under OPSS 310 – Construction Specification for Hot Mix Asphalt.	X			Our laboratory started testing the gradation and asphalt cement content of the job mix formula in June 2012.
5	Costs and quantities related to major items used in change orders should be identified and tracked separately under the change order item in progress payments.	X			This was performed in the past when requested by the Project Manager. To be consistent, this had been implemented as of July 2012.
6	The City's current standard and tolerances to achieve a three percent cross fall on new construction, reconstruction or when grinding is done during a resurfacing or rehabilitation process, should be clearly stated in the contract.	X			Will state or indicate 3% crossfall and tolerances in standard drawings & specifications effective January 1, 2013. Contractors will also be made aware of this standard and tolerance at the Annual Contractors Meeting.
7	The City should improve policies, procedures and reports supporting accountability for rejection of incorrect cross fall as specified in the contract and/or drawings in order to comply with City standards.	X			Will research policies and procedures of the Ministry of Transportation and other municipalities in Ontario. Time frame may be 12 to 18 months.

Appendix 2

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/ Time Frame
8	The City should communicate their willingness to accept RAP in the job mix formula for local roads in accordance with OPSS standards.	X			Will communicate our willingness and encouragement to local asphalt suppliers to use RAP in the production of hot mix asphalt. Will communicate this to contractors at the Annual Contractors Meeting.
9	The City should communicate their willingness to accept RAP mixed with Granular A and Granular B Type I in accordance with OPSS standards.	X			Will communicate our willingness and encouragement to local aggregate suppliers to use RAP in the production of granular products. This will be communicated to contractors at the Annual Contractors Meeting.
10	The City should continue to identify further opportunities for cost savings where road work is planned so that the asphalt removed from one road can be used on other nearby City use(s). The objective is to minimize trucking costs while recycling the greatest volume of RAP possible (in its highest and best use) to the advantage of the City.	X			Have performed this recommendation in the past and will continue to do so. Will continue to monitor best practices and other uses. (i.e. shouldering around guiderails, washouts, etc.).

Appendix 2

Management Response: 2011 Audit of Impact of Changes to Road Design

Rec No	Recommendation	Agree (X)	Disagree (X)	Management Comments: <i>(Comments are required only for recommendations where there is disagreement.)</i>	Action Plan/ Time Frame
11	The City should continue to work with other interest groups and other Departments that could use the City's RAP in their nearby projects.	X			Have performed this recommendation in the past and will continue to do so. By January 2013, establish a request process where a master list will be created and maintained.
12	Ownership and disposition of RAP should be clearly stated in the contract documents.	X			Will include appropriate clauses in contract specifications for all future contracts starting January 1, 2013.
13	If alternate City uses are not identified for the RAP, they should be directed to go to the contractor.	X			Have performed this recommendation in the past and will continue to do so as contractors become better equipped to handle large volumes of RAP.