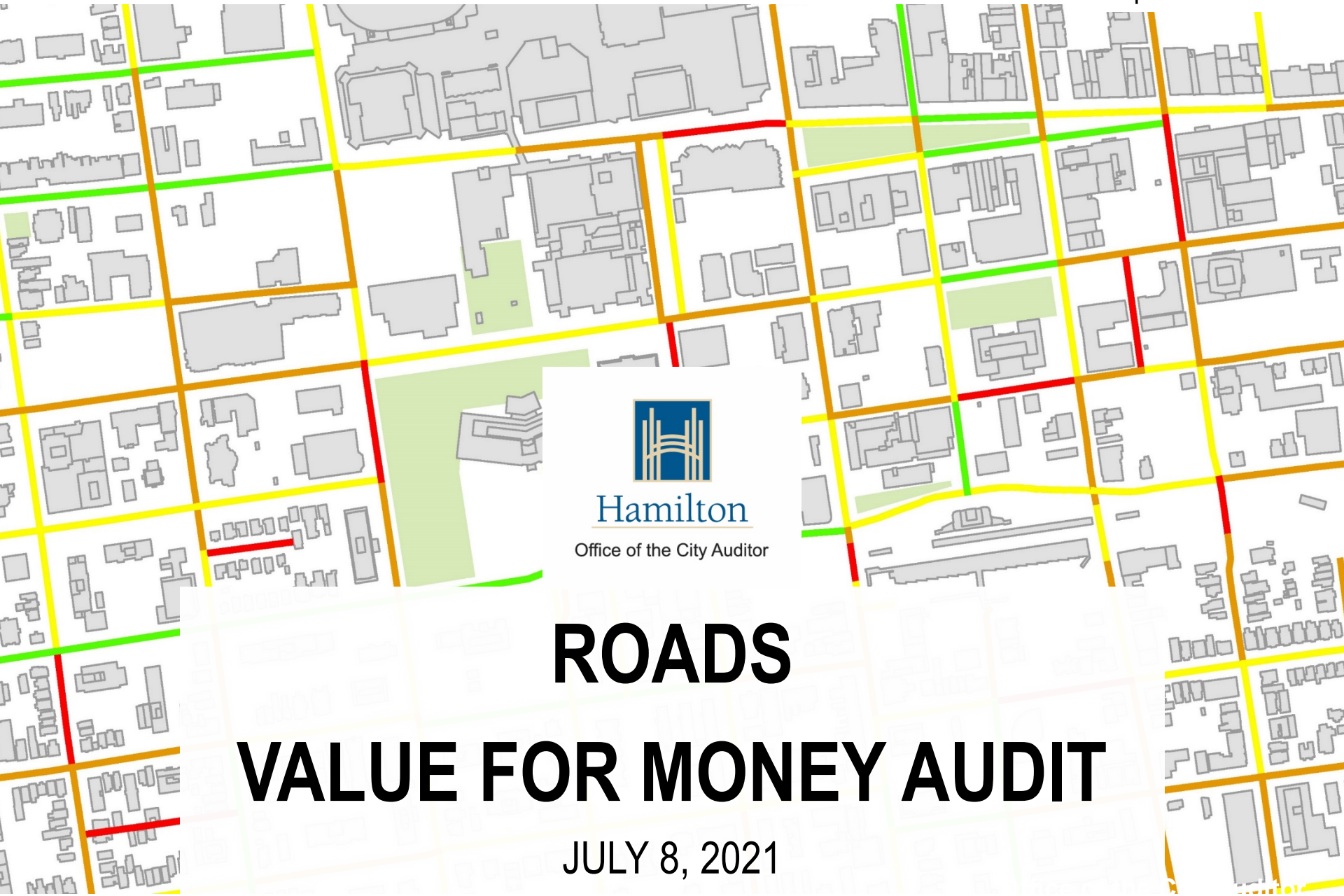


Hamilton

Office of the City Auditor

ROADS

VALUE FOR MONEY AUDIT

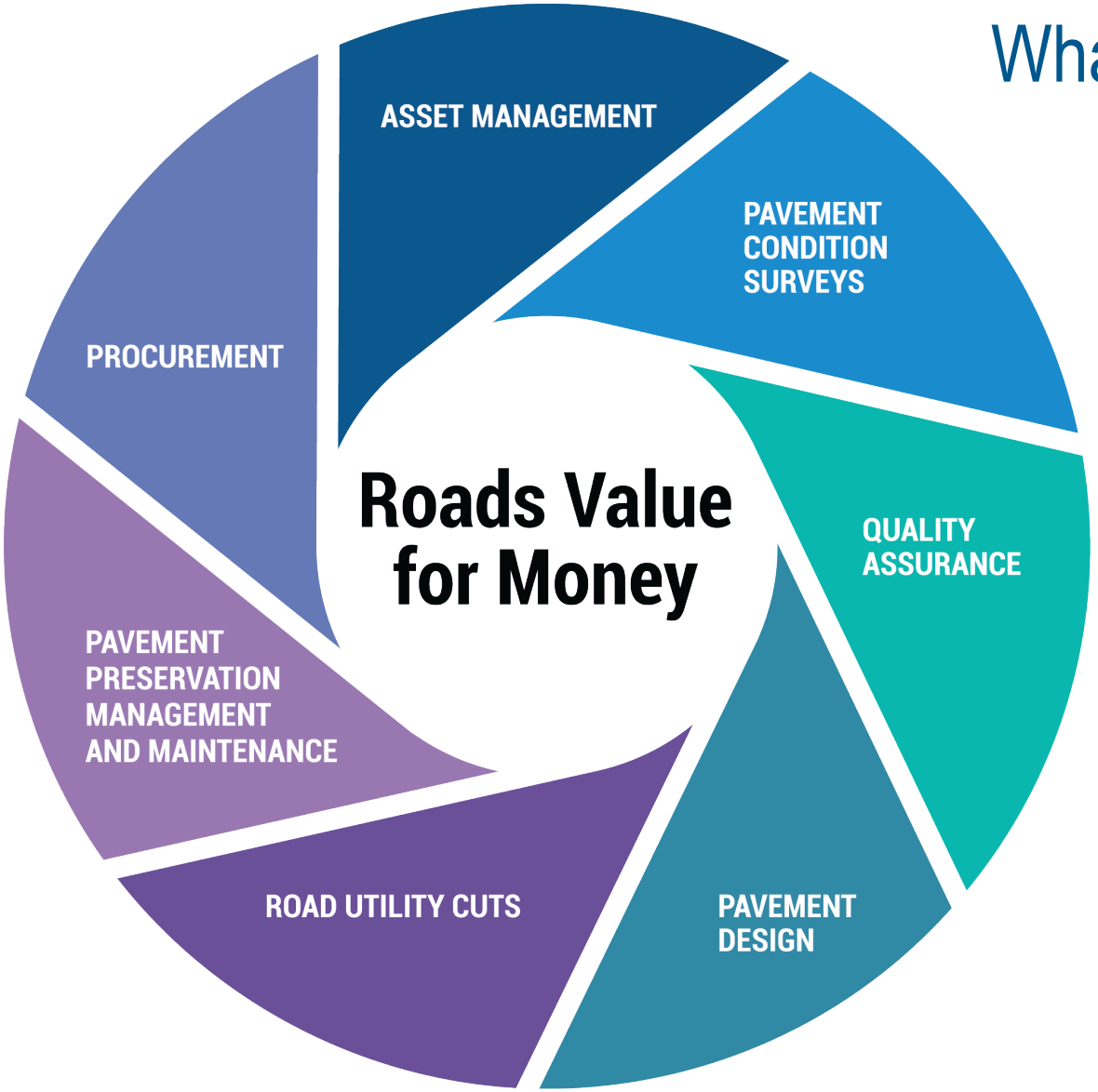
JULY 8, 2021

Charles Brown, City Auditor

What We Did

Assessed the management of the City's road assets in order to identify opportunities for improved economy, efficiency and effectiveness

What We Did


ASSET MANAGEMENT
PAVEMENT CONDITION SURVEYS
QUALITY ASSURANCE
PAVEMENT DESIGN
ROAD UTILITY CUTS
PAVEMENT PRESERVATION MANAGEMENT AND MAINTENANCE
PROCUREMENT
Roads Value for Money

Out of Scope

Two areas were out of scope for this audit:

1. Pavement management practices related to the management or reporting of skid resistance or friction

2. Pavement related activities performed by Growth Management Division in Planning and Economic Development Department

Background

$4B Infrastructure Replacement Cost

$203.7M Rehabilitation & Reconstruction (last 5 years)

240 years to recycle the network through reconstruction

2016 SOTI rating for roads "C"

Annual spend 1% of replacement cost

WHAT WE FOUND

Location: Balmoral Ave. S
Source: Office of the City Auditor staff

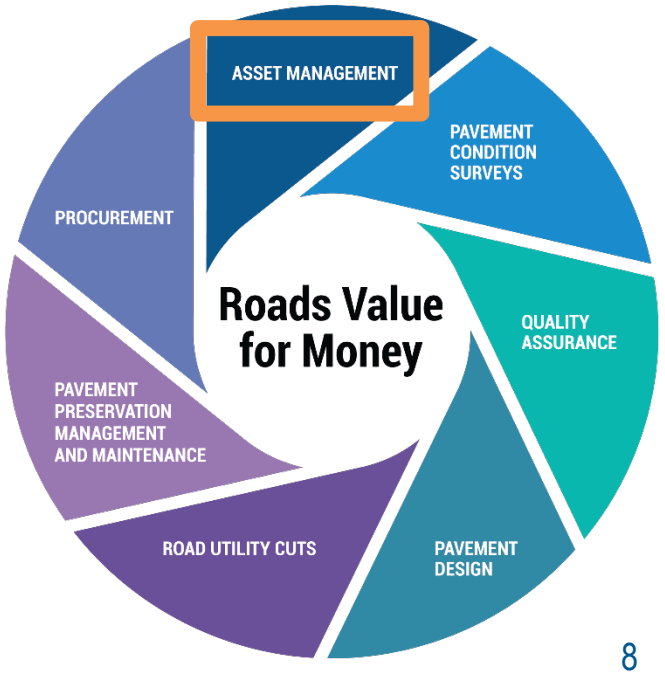
ASSET MANAGEMENT

Asset Management

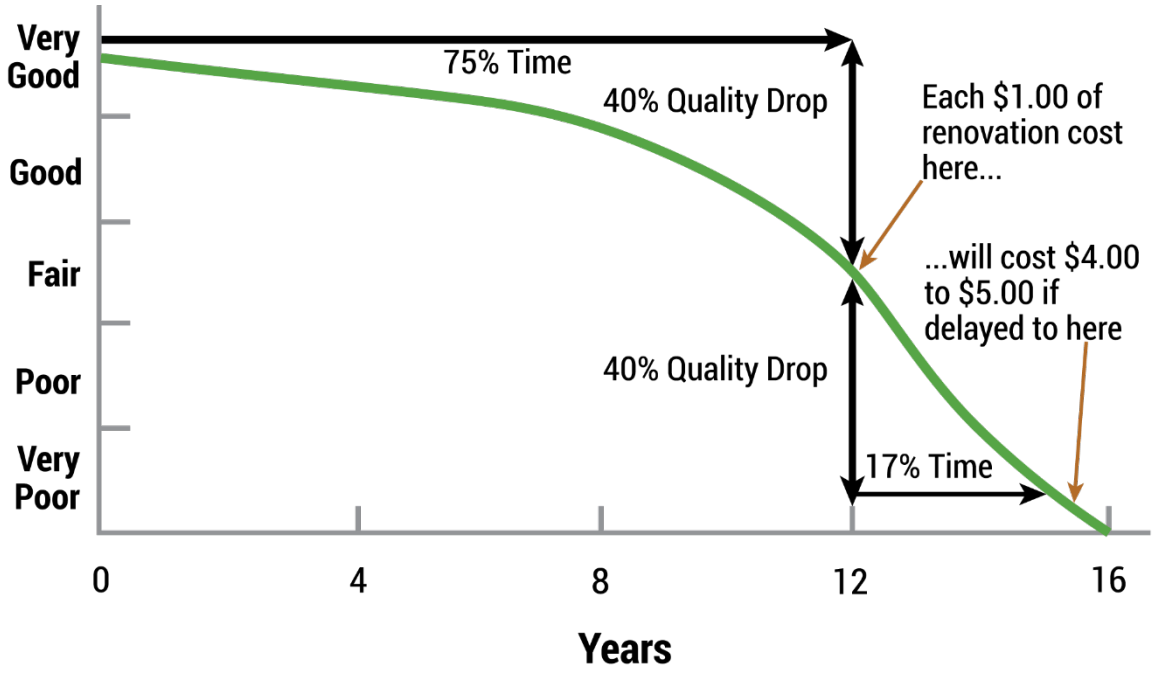
Set of activities for making the best possible decisions about use of resources.

It helps:

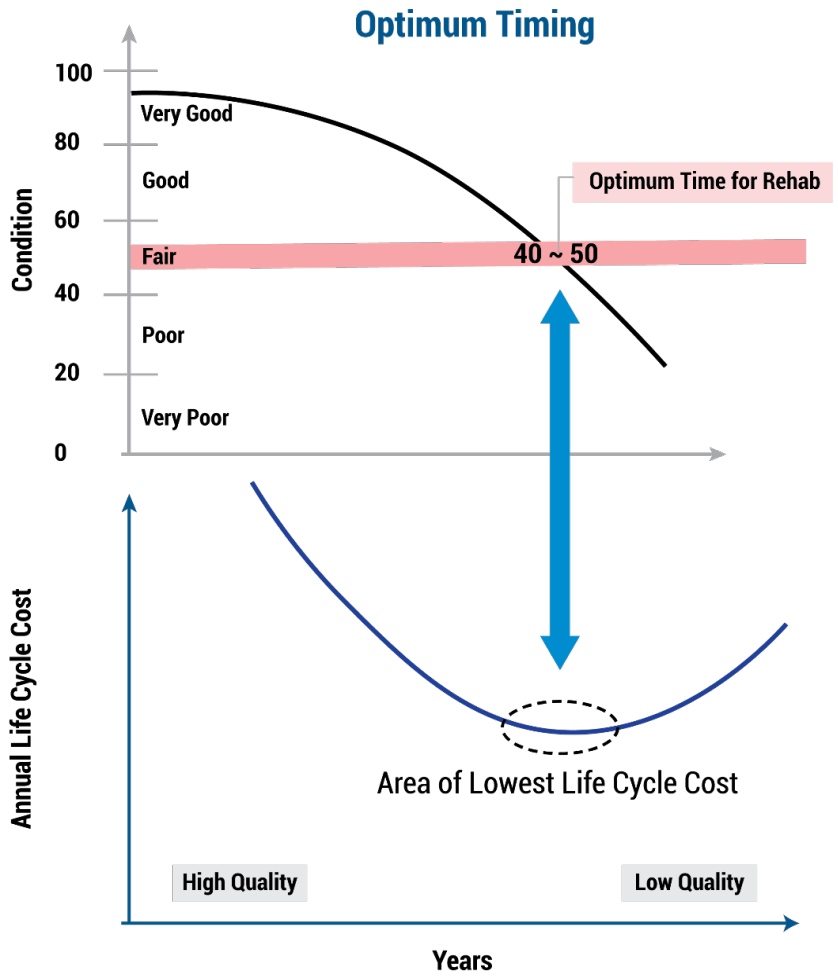
- Address risk of sustainability
- Prioritize projects
- Align goals/resources
- Be accountable



The fundamental issue with asset management – understanding the lifecycle of the asset(s)



Asset Management



ESSENTIAL TOOLS:

ASSET MANAGEMENT PLAN

STATE OF INFRASTRUCTURE

PREDICTION & MEASUREMENT METHODOLOGIES

LOWEST LIFE CYCLE COST

TRACKING INFRASTRUCTURE GAP

Asset Management

- First asset management plan was in 2014 but City has been evolving its asset management for many years
- Should be well positioned for the new regulatory framework however future asset plans will need a more robust approach for levels of service and risk management
- Need for a strategic plan that articulates the full breadth of goals and strategies necessary to achieving improvements to pavement management and achieving long term sustainability

Roads Asset Information

SOTI (State of the Infrastructure) reports have not been a reliable tool for reporting the state of road infrastructure. Predictions of a deteriorating network have not been realized

2009/10

Rating: D-

Trend: 

Annual Infrastructure Deficit: $96M

OCI: 55.8

2016

Rating: C

Trend: 

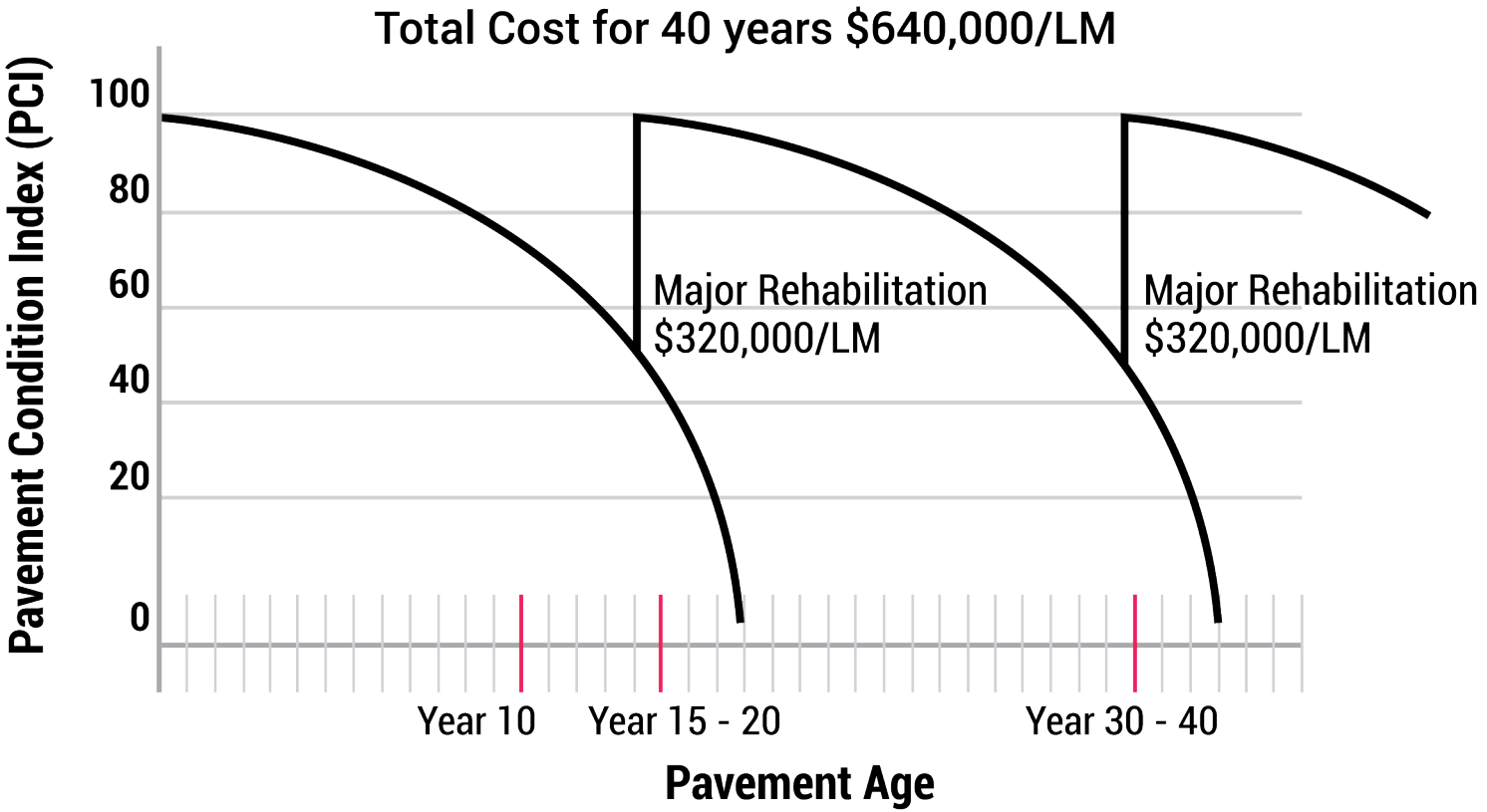
Annual Infrastructure Deficit: $104M

OCI: 66

Asset Management

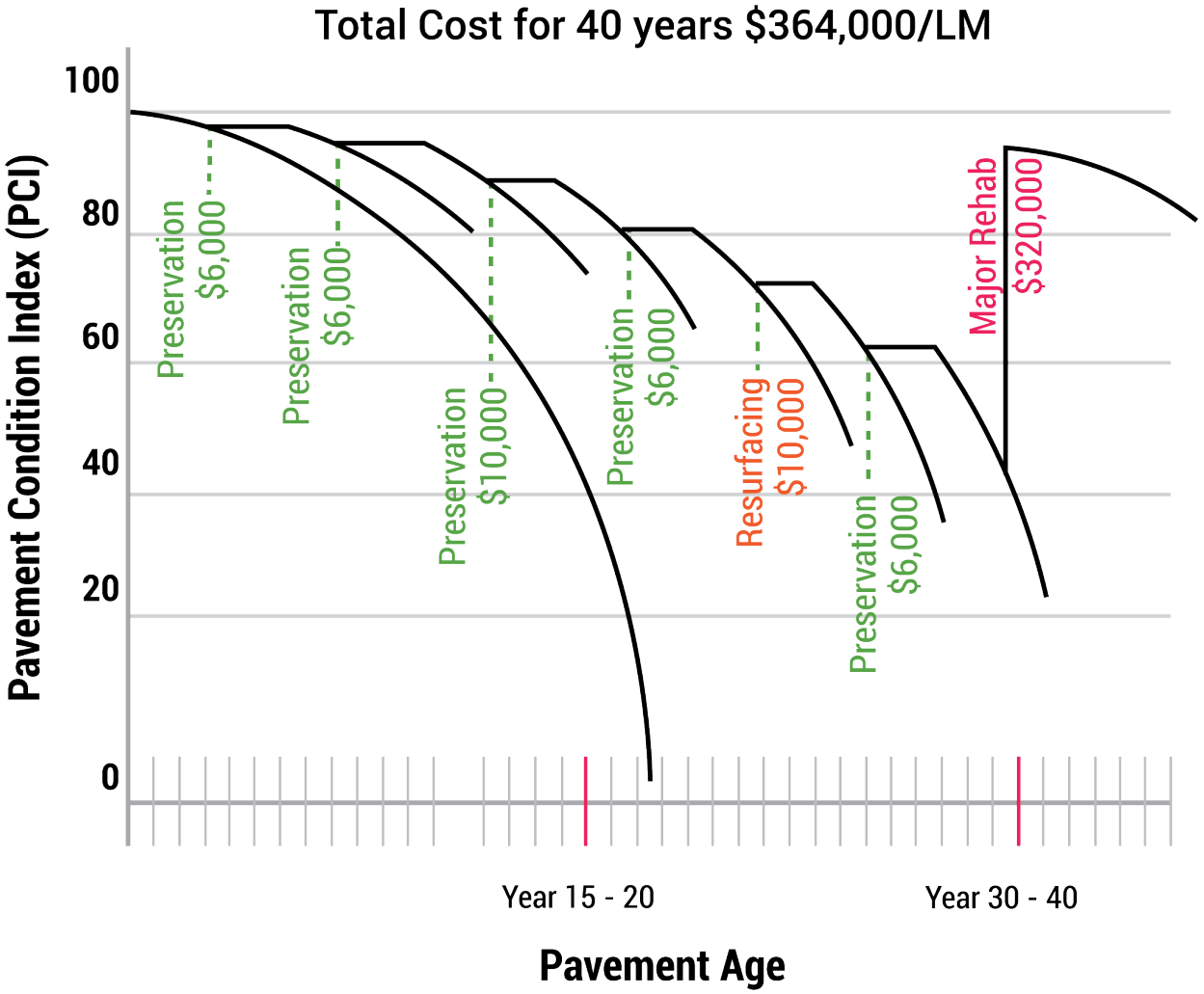
- The City's asset management approach relies heavily on resurfacing and reconstruction strategies with little emphasis on proactive preservation
- Over the years there has been a preponderance of resurfacing in treatment selection
- Preventive treatments used on a sporadic basis
- A more rigorous application of Life Cycle Costing principles in treatment selection and timing would help to optimize return on investment

Pavement Deterioration - No Preservation Management



Source: City of Durham, N.C.

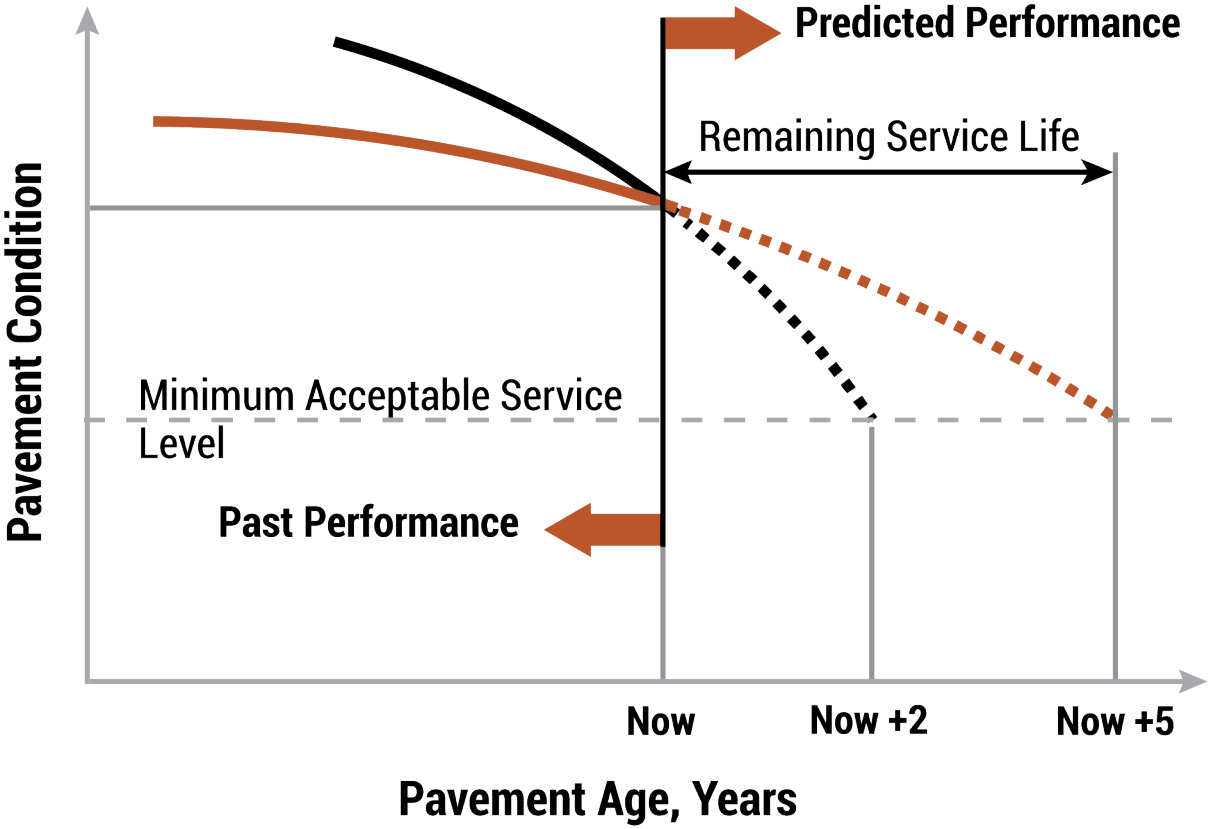
Pavement Deterioration - With Preservation Management



Source: City of Durham, N.C.

Asset Management

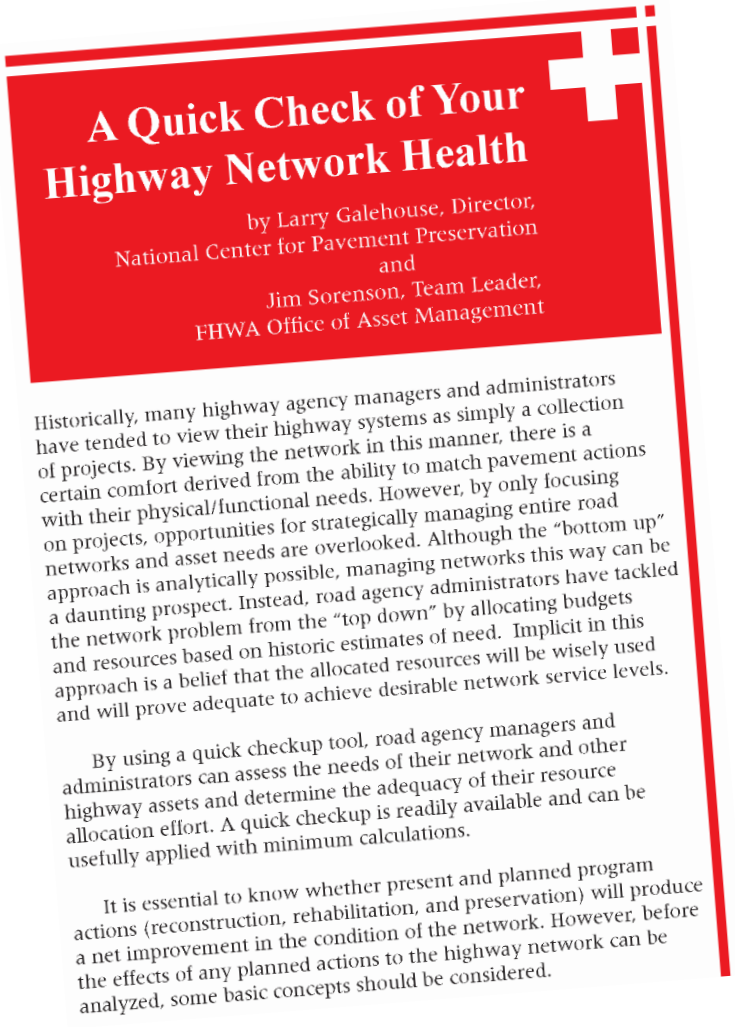
There should be a mechanism/process for tracking the accuracy of predicted life cycle costs and deterioration curves



Asset Management

- The City lacks a mature process for identifying, tracking and reporting the infrastructure deficit or gap for roads
- Need a better line of sight on the accumulation of backlog and long term sustainability through improved measures and methods
- Road authorities have used various indicators to track the gap and long term sustainability (backlog as % of replacement cost, % roads in good or better condition, investment rate)

Asset Management



A Quick Check of Your Highway Network Health

by Larry Galehouse, Director,
National Center for Pavement Preservation
and
Jim Sorenson, Team Leader,
FHWA Office of Asset Management

Historically, many highway agency managers and administrators have tended to view their highway systems as simply a collection of projects. By viewing the network in this manner, there is a certain comfort derived from the ability to match pavement actions with their physical/functional needs. However, by only focusing on projects, opportunities for strategically managing entire road networks and asset needs are overlooked. Although the "bottom up" approach is analytically possible, managing networks this way can be a daunting prospect. Instead, road agency administrators have tackled the network problem from the "top down" by allocating budgets and resources based on historic estimates of need. Implicit in this approach is a belief that the allocated resources will be wisely used and will prove adequate to achieve desirable network service levels.

By using a quick checkup tool, road agency managers and administrators can assess the needs of their network and other highway assets and determine the adequacy of their resource allocation effort. A quick checkup is readily available and can be usefully applied with minimum calculations.

It is essential to know whether present and planned program actions (reconstruction, rehabilitation, and preservation) will produce a net improvement in the condition of the network. However, before the effects of any planned actions to the highway network can be analyzed, some basic concepts should be considered.

- One interesting and innovative approach to optimizing decisions and understanding whether the City is gaining or losing in terms of network health is the concept of remaining service life years
- This method tracks the remaining lane-km-years of service each year
- Starts with premise you lose 1 lane-km-year of service for each lane-km in the network

Source: Federal Highway Administration.
https://www.fhwa.dot.gov/pavement/preservation/if07006.pdf

Network – Traditional Programming

Programmed Activity	Lane-Kilometres-Years	Total Cost
Reconstruction (64 lane-km)	1,744	$20.2M
Rehabilitation (131 lane-km)	1,920	$15.6M
Preservation (134 lane-km)	659	$1.5M
Total:	**4,323**	**$37.3M**
Network Needs (Loss):	6,970	
Deficit:	**(2,647)**	

Network – New Programming

Programmed Activity	Lane-Kilometres-Years	Total Cost
Reconstruction (50 lane-km)	1,312	$15.2M
Rehabilitation (123 lane-km)	1,800	$14.6M
Pavement Preservation (134 lane-km)	659	$1.5M
Concrete Resealing (50 lane-km x 4 yrs)	198	$0.98M
Thin HMA Overlay (26 lane-km x 10 yrs)	256	$0.87M
Microsurfacing (70 lane-km x 7 yrs)	493	$1.3M
Chip Seal (126 lane-km x 5 yrs)	633	$1.1M
Crack Seal (810 lane-km x 2 yrs)	1,619	$1.3M
Total:	**6,970**	**$36.8M**

Asset Management

- Overall network health decreases under traditional programming but is maintained with the new alternative
- Less costly preservation treatments elsewhere in the network result in better condition overall by 2647 lane-km-years at more than half million less
- Shows the power of optimizing
- Enables City to incrementally define its goals
- Demonstrates why just spending more money may not work
- City can also increase the transparency of what its doing and answer the question “are we gaining or losing on the infrastructure gap”

PAVEMENT CONDITION SURVEYS

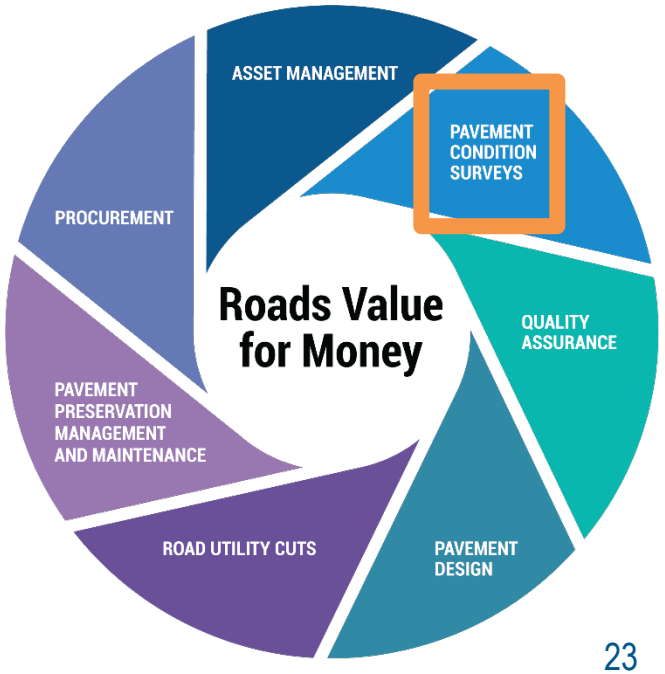
Pavement Condition Surveys

The condition of the City's roads is assessed in surveys conducted by independent engineering consultants.

These surveys combine measured and observed data into an evaluation of the level of distress and smoothness of ride.

Overall Condition Index (OCI) is calculated and is the average of:

- Surface Condition Index (SI)
- Ride Index (RI)



Pavement Condition Surveys

Scoring system out of 100

SI measures surface defects and RI ride smoothness

Overall Condition Index (OCI)
= 50% of SI Plus 50% of RI

SI = 43
RI = 36
OCI = 39

Location: Main St. N., from Highway No. 5 E to Church St. (Waterdown)
Source: Office of the City Auditor staff

Pavement Condition Surveys

- Effective asset management is built on reliable information for asset condition. Condition is used to monitor the need for renewal, report on state of repair, planning, identifying emerging issues and to manage long term sustainability

- Pavement condition surveys (conducted about every 5 years) are not reported in a consistent manner across different reporting mechanisms and time periods

- Scores not consistent with substantial underfunding

- Different scores in different reports

- Data collection methods have been evolving

Pavement Condition Surveys

- Condition data is not collected frequently enough to present timely information on condition status and confounds efforts to predict deterioration
- Most road authorities collect more frequently
- Hinders the tracking of performance, decision making and planning

Pavement Condition Surveys

- The index for pavement condition could be enhanced with the addition of a measure related to structural adequacy
- The current Overall Condition Index combines evaluations of smoothness and surface distress. No account taken of deterioration in underlying structural capabilities of the roadway
- Some road authorities use a third component called a Structural Adequacy Index to provide a more complete picture of the pavement condition

OCI = SI + RI + SA

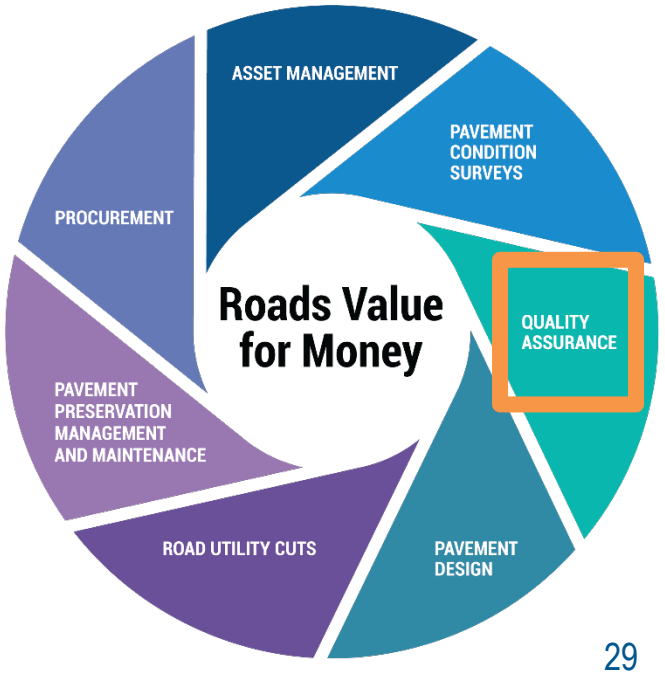
QUALITY ASSURANCE

Quality Assurance

The activities and procedures that are established to ensure roadways are constructed and rehabilitated to meet City expectations.

Relies on:

- Clear standards/specifications
- Robust inspection and testing
- Timely problem resolution
- Strong accountability



Our audit found that for many years the City has had problems managing contractor performance and achieving the quality expected

Location: Brea Crest Dr.
Source: Office of the City Auditor staff

Quality Assurance

- Work completed in 2014
- Photo taken in 2019
- Various types of defects can be seen

Pavement <u>should not</u> degrade this rapidly.

Only 10% of the samples tested from this contractor in 2014 were found to be of “acceptable” quality.

(Contractor A, Table 7 in report)

Location: Barons Ave. S.
Source: Office of the City Auditor staff

Quality Assurance

- As far back as 2009 there were growing concerns about the quality of new and rehabilitated pavements
- 2009 consulting study reported that pavement distresses were appearing prematurely and likely attributable to poor materials, poor construction practices, poor quality assurance, insufficient inspection/specification
- Found only 24% of Marshall asphalt mixes passed and 32% of Superpave mixes passed
- Although results improved in 2013, an in-depth review of 2014, 2015, 2016 revealed quality that was worse

Quality Assurance

Quality Results from Testing in 2014, 2015, 2016 by Contractor

	Year	Total Number of Tested Samples	Samples that were Acceptable	Samples that were Borderline	Samples that were Rejectable
Contractor A	2014	59	10%	42%	47%
	2015	31	0%	32%	68%
	2016	118	7%	29%	64%
Contractor B	2014	7	14%	43%	43%
	2015	NA	NA	NA	NA
	2016	2	50%	50%	0%
Contractor C	2014	56	20%	61%	20%
	2015	64	16%	45%	39%
	2016	58	50%	31%	19%
Contractor D	2014	16	31%	31%	38%
	2015	39	46%	44%	10%
	2016	83	25%	39%	36%
Contractor E	2014	43	23%	40%	37%
	2015	12	33%	42%	25%
	2016	33	9%	67%	24%
Contractor F	2014	79	22%	54%	24%
	2015	13	23%	38%	39%
	2016	6	50%	50%	0%
Contractor G	2014	76	26%	36%	38%
	2015	10	20%	50%	30%
	2016	42	14%	50%	36%

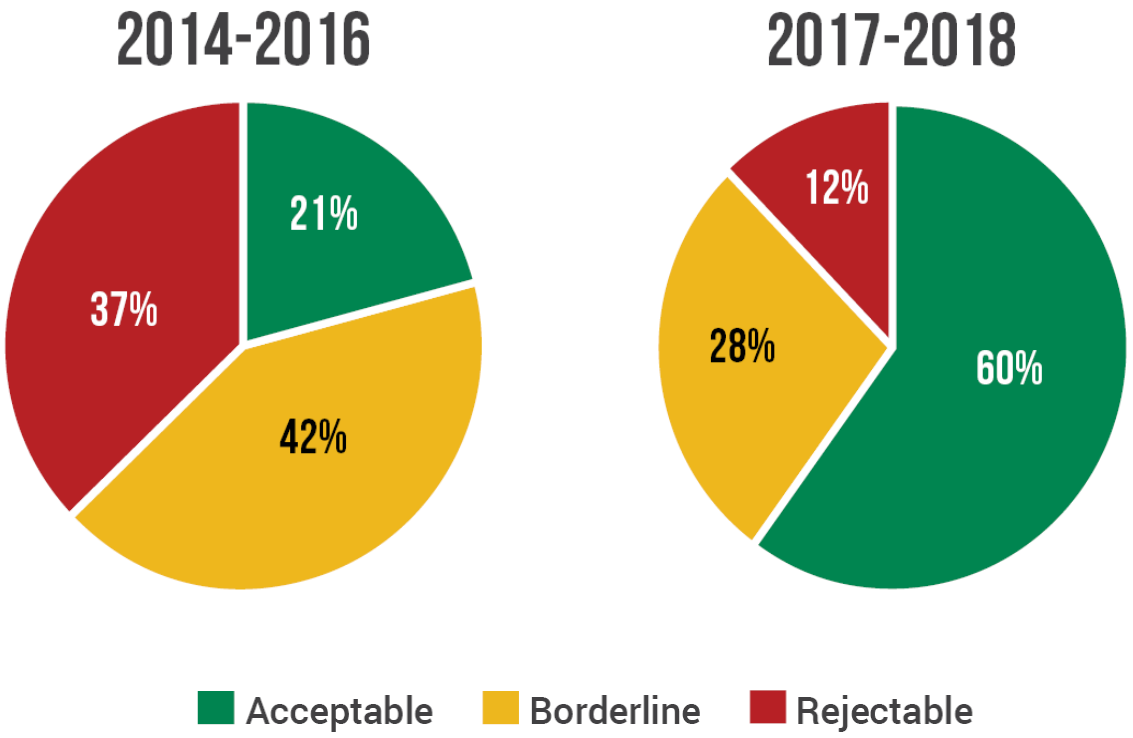
Rejectables as high as 68%

Acceptables as low as 0%

Results indicate a persistent quality problem

Quality Assurance

OCA review of 2017, 2018 indicates improvement but still high numbers of borderline acceptances



Quality Assurance- Contractor Performance

- Contractors have no incentive to ensure results meet acceptable results (City equally accepting of borderline results)
- Contractors have not been held appropriately accountable for poor performance
- Some minor penalties began in 2018

In 2014, one contractor delivered between 0%-10% acceptable asphalt and continued to receive City contracts without significant penalties.

$2,433

Financial penalty on a $3,400,000 contract

Quality Assurance – Contractor Performance

- Must ensure penalties are adequate to ensure quality and/or action is taken where necessary to correct substandard asphalt
- Some road authorities have moved to a pass/fail system with no borderline acceptances
- City has no systematic method of tracking contractor performance, and the constraints of the current procurement approach which is based on the lowest compliant bid, limits its ability to manage risk
- Consider implementing a contractor evaluation and rating system similar to other jurisdictions where contractor ratings factor into future bids

Quality Assurance – Testing

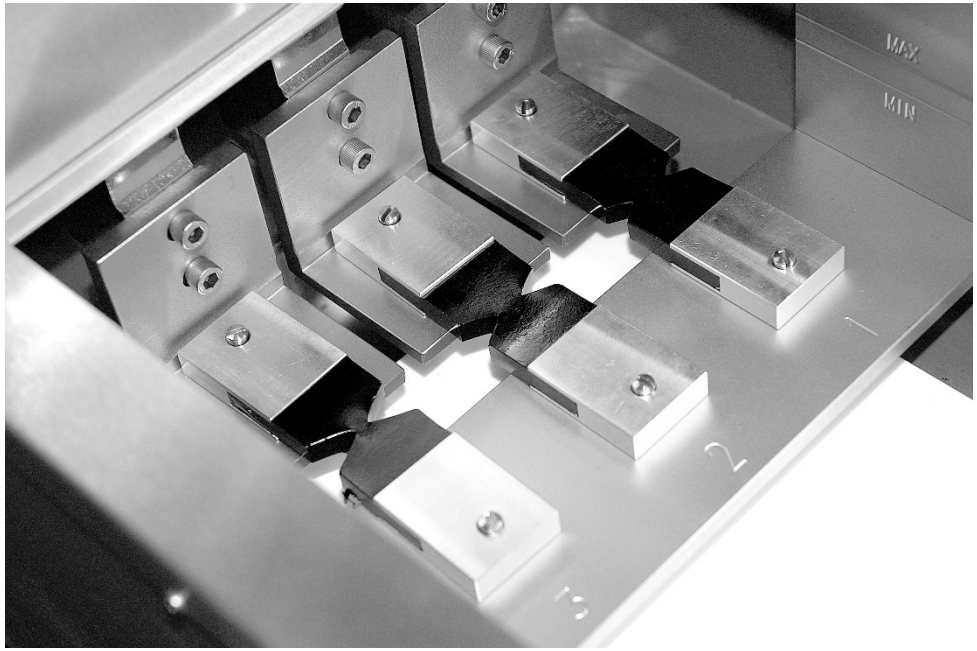
- City (as do many municipalities) uses the Superpave method of asphalt mix design
- Involves a battery of tests that ensure asphalt cement meets the “grade” specified in the contract
- Since about 2000 premature cracking began to appear in pavements throughout Ontario. As a result MTO and Queen’s University embarked on years of research and concluded the problem was poor quality asphalt cement
- They developed and advocated 2 new tests (EBBR and DENT) and recommended the use of 2 others (ASH and MSCR tests)

Quality Assurance - Testing

eBBR Testing

The BBR machine, which is used to test samples after 1, 24 and 72 hours of cold conditioning

DENT Testing



Three specimens that are pulled apart at 15ºC to measure the tolerance of the binder to stretch before failure

Photo Source: Dr. Simon Hesp, Queen's University, used with permission.

Quality Assurance

- Hamilton does not use the EBBR or DENT tests
- These tests have been implemented by a number of municipalities as far back as 2015 and became part of the Ontario Standard Specification for Municipalities “OPSS MUNI 1101” in 2016
- OCA interviewed experts at MTO, Queens, and 2 municipalities using them and found there to be consensus that they are vital to ensuring quality asphalt
- By not using these tests the City has far less assurance in obtaining the quality of asphalt it pays for and needs
- OCA also found that the City isn’t necessarily testing the asphalt cement being used on a specific project, and if it does it may only be from the supply tanks of the plant as opposed to recovered samples from laid down mix

Quality Assurance – Recycled Asphalt Pavement "RAP"

- RAP consists of asphalt recovered from existing pavements and re-used as part of new or rehabilitated pavement
- Its use can be detrimental to durability and life of pavement
- Practices vary - some jurisdictions don't allow it while others limit the extent of its use
- Consensus appears to be that properly controlled it can offer benefits while minimizing risk
- However there need to be controls in place to ensure the quality, uniformity and suitability of RAP for each project
- Hamilton has no systematic, documented policies and procedures to ensure RAP introduced in projects will not adversely affect quality

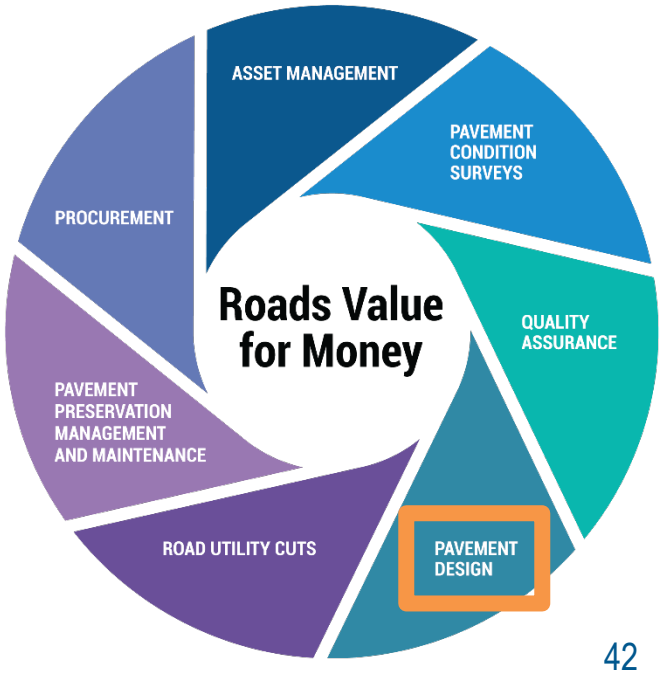
PAVEMENT DESIGN

Pavement Design

Pavement must be properly designed to have lasting durability to withstand the loads applied by vehicles using the road

Pavement Design considers:

- Strength of underlying subgrade
- Drainage characteristics
- Loading/service level requirements
- Construction materials and techniques
- And many other variables that require complex engineering and geotechnical considerations



Pavement Design

- Pavement design practices have been codified in two recognized standards: AASHTO 93 and MEPDG

- In a study in 2012 one consultant reported that:

  - Hamilton “uses an off the shelf method for pavement design. This oversimplifies the pavement design process and in some cases may result in poor pavement performance…..As a long term solution the pavement design methodology outlined in AASHTO 93 should be followed…Ultimately MEPDG should be followed. However, its implementation requires significant experience and practical training…”

Pavement Design

- OCA assessed the current situation with the help of an external consultant

- Improvements have been made but the City has not formalized its processes to reach the maturity other cities have, and there is a lack of formal policies and procedures as to how these standards are to be used

- Roads management should continue to move away from “boilerplate” design to embrace standards in a systematic way, and develop a design guide, protocols, and training to bring more sophistication to this important function

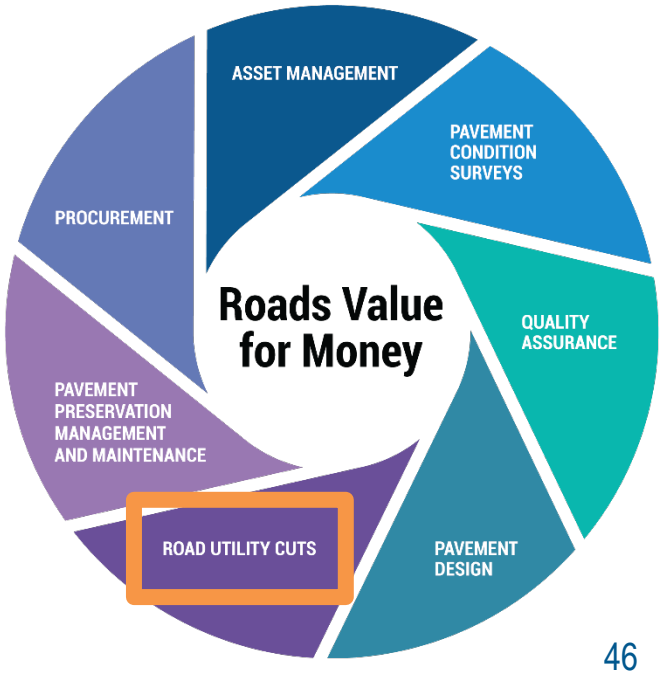
ROAD UTILITY CUTS

Road Utility Cuts

The excavation of a hole or trench on a City pavement, usually performed in urban areas, to repair or install utilities such as water mains, drainage structures, sewers, and gas mains.

Road utility cuts need to be strictly controlled to avoid premature damage.

No matter how well a road is repaired after a road cut, a certain amount of degradation is unavoidable.



Road Utility Cuts

Location: Cameron Ave. S.
Source: Office of the City Auditor staff

Road Utility Cuts

- The City has a well defined process to ensure minimal damage, adequate inspection and recovery of costs
- Pavement restoration costs are recovered from the utilities (in 2019 over $5M) plus administration surcharges of 15% plus degradation fees
- According to the FHWA (Federal Highways Administration) road cuts “increase pavement roughness…introduce discontinuities in the pavement structure. Both can cause the pavement’s expected lifespan to decrease”
- Studies confirm that utility trenching significantly shortens the overall lifespan of urban pavements causing reduction in asset value and serviceability

Road Utility Cuts

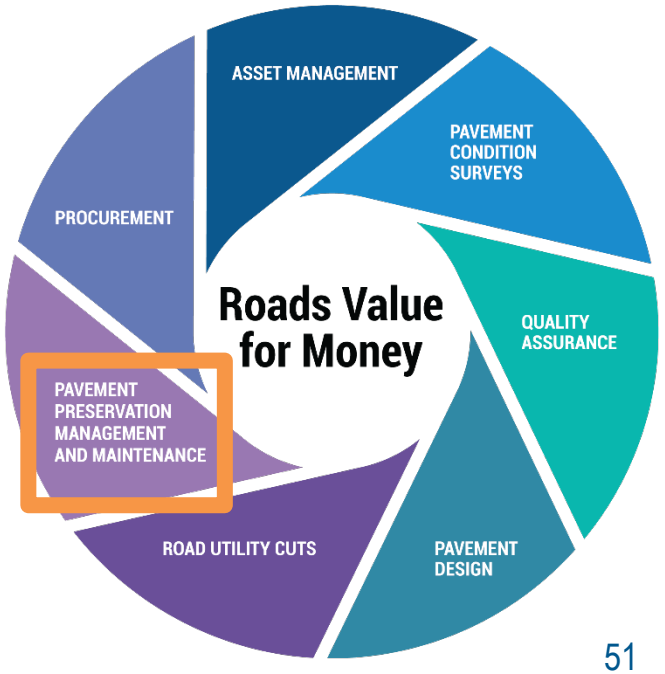
- Most significant study we found was by Saskatoon (2018) that concluded degradation ranged from a low of $34 per sq.metre for local roads to $164 per sq.metre for arterials
- There has been no formal study done by Hamilton to determine whether the amount collected adequately compensates the City for the actual level of road degradation
- 2019 Hamilton fees averaged $39 per sq.metre
- In light of this OCA recommends the adequacy of the current fee be reviewed

PAVEMENT PRESERVATION MANAGEMENT AND MAINTENANCE

Pavement Preservation Management and Maintenance

The objective of preservation and maintenance is to properly maintain pavements in order to maximize life and service.

Proactive pavement preservation
Warranties
Potholes



Pavement Preservation Management and Maintenance

- Preservation - little evidence of systematic preservation management. Preventive treatments are applied only sporadically

- Symptomatic of a reactive system of asset management

- Warranties - contractors slow to correct deficiencies under warranty. Significant number we examined not corrected long after warranty expiration

- Potholes – Ontario sets standards for timely remediation of potholes that meet certain criteria. However these “MMS” potholes only make up 6% of all Hamilton potholes. Non-MMS potholes are not subject to timeliness standards

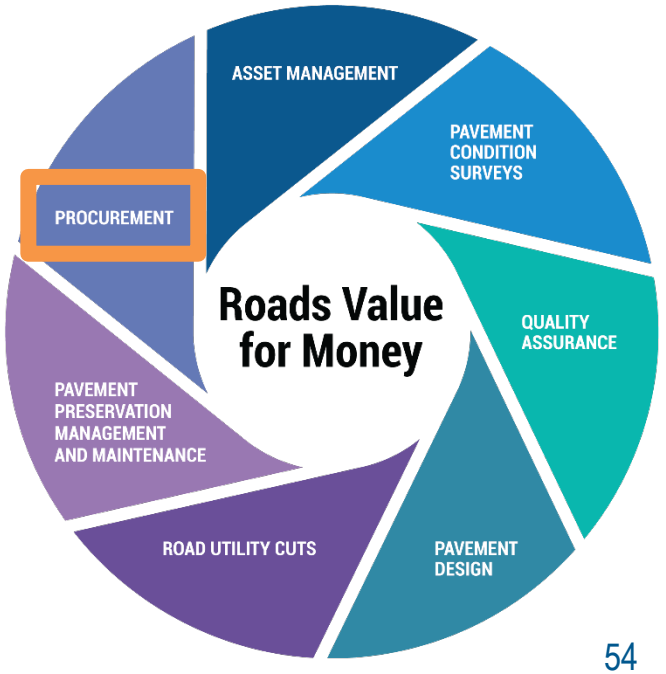
- Non-MMS potholes as well as those derived from public complaints should be subject to remediation time standards that are tracked and publicly reported

PROCUREMENT

Procurement

The City invests about $40M+ in the Road network annually.

It is critical for the City to have solid procurement and vendor management processes.



Procurement

- Red flags were noted that signal risks related to market domination, bid suppression, cover bidding and low-bid/low-quality events

- OCA found several examples where **large procurements were split into smaller projects** so that the roster method could be used

> One large procurement was **divided into four** separate procurements of $149,900 in order to come under the $150,000 roster limit and avoid lengthier procurement alternatives.

- Rather than rely on Contractors to submit invoices for payment, City staff were themselves generating progress payment certificates (PPCs)

- Budgeted funds from completed projects with unspent/surplus balances were used to pay for unrelated **contracts**

AUDIT THEMES

Audit Themes

Robust and mature approach to road or “right of way” asset management and pavement analysis needed.

Strategic plan that can act as the blueprint for improvement goals and strategies for sustainability needed.

Developing more complete and effective systems of quality assurance and contractor management.

Greater emphasis on preservation management as an asset management strategy.