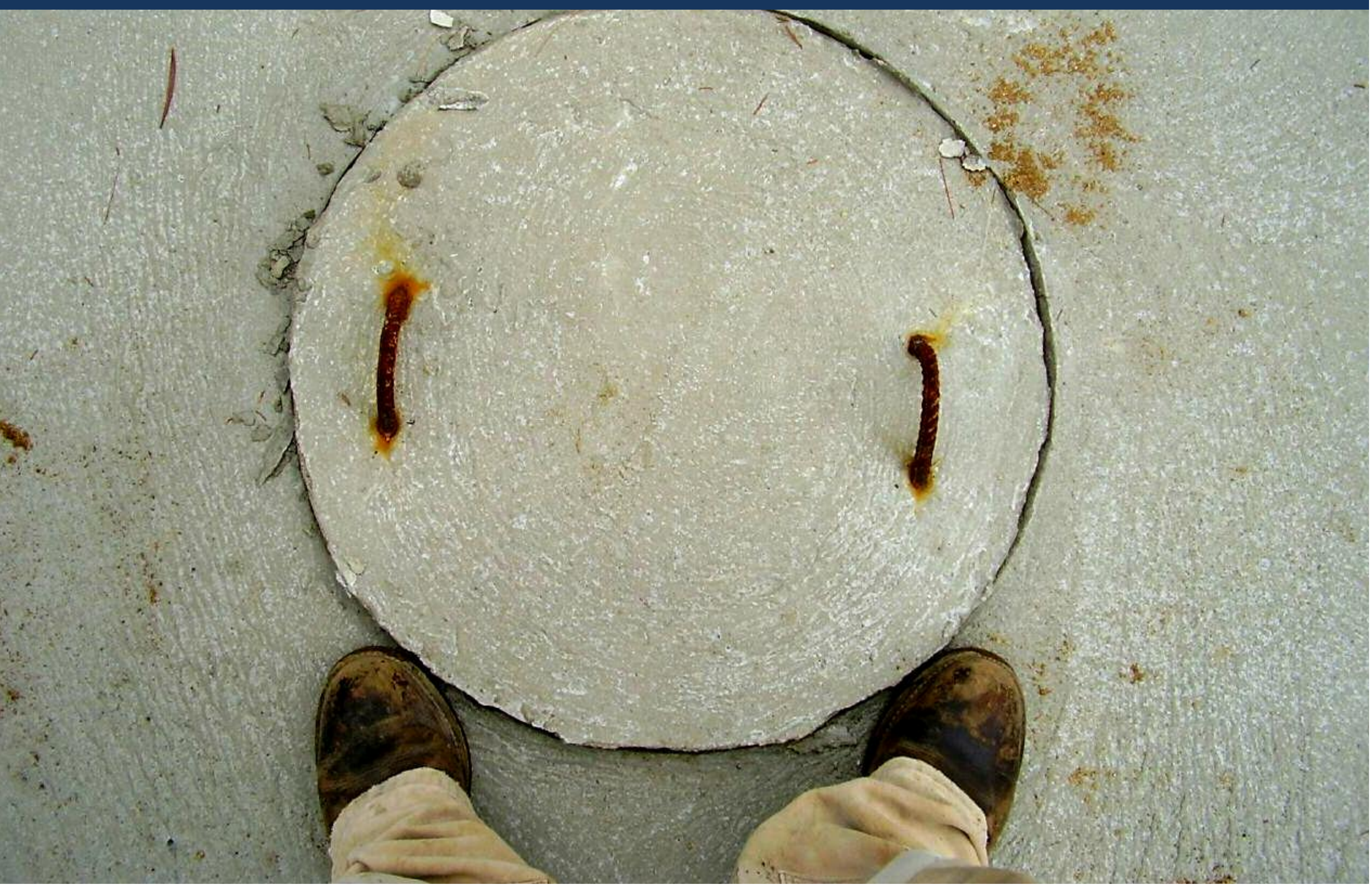
PUBLIC SECTOR DIGEST
CRITICAL KNOWLEDGE SERIES

OPTIMIZED ASSET DECISION MAKING
@ THE REGION OF PEEL



ABOUT THE REGION OF PEEL







With over 1.2 million residents and more than 85,000 businesses in the cities of Brampton and Mississauga, and the town of Caledon, Peel is one of the fastest growing municipalities in Canada.

As a municipality, we are leaders in public service excellence and take pride in providing responsive, quality services for our community.

With every decision we make and every action we take, the Region is planning to meet the needs of our community now and into the future.

PSD CRITICAL KNOWLEDGE SERIES

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OPTIMIZED ASSET DECISION MAKING

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FOREWORD > >

Organization-wide asset management is complex. Municipalities are challenged with assessing diverse infrastructure needs and priorities across a broad range of programs in order to maintain sustainable services to their citizens and businesses.

The Region of Peel employs a two-tiered approach to enterprise asset management. The programs provide the expertise for managing their unique services and assets and, therefore, understand the assets needs required to sustain service delivery. The organization uses this program knowledge to make enterprise-wide decisions on assets, services, and funding priorities.

In order to reconcile program level needs with organizational level priorities, the Region of Peel developed methodologies, tools, and processes to facilitate enterprise-wide asset planning and decision making to support long-term sustainable service delivery.

THE REGION OF PEEL

Situated in the heart of southern Ontario's major urban centres, the Region of Peel is an upper tier municipality and the second largest municipality in Ontario, with a population of over 1.2 million people.

Peel has undergone a major transition during the past few decades. Rapid population growth and commercial development have transformed what was primarily a rural area of farms and villages into a dynamic blend of rural and urban, industrial and residential areas. The Region provides a diverse range of services supported by a growing infrastructure portfolio now estimated at approximately $13 billion. Peel’s services include water and wastewater treatment, distribution and collection, arterial roads, solid waste management, social housing, paramedics, health, long-term care, child care, shelters, and heritage.

CORPORATE ASSET MANAGEMENT

The Corporate Asset Management (CAM) Section at the Region of Peel was created to establish a consistent, effective enterprise asset management strategy for all Regional assets. CAM's focus is to develop practices and tools to support transparent organizational decision-making toward determining sufficient asset investments to meet immediate service needs and to forecast long-term funding requirements to ensure the assets and services remain sustainable.

This three-part document will connect the methodologies and processes that CAM developed and undertook to develop a basis for organizational-wide asset decision-making at the Region of Peel. The document will begin with a case study in developing levels of service (LOS) for a particular asset category (built environment), then progress through to connecting the levels of service to risk, and finally, using this information to make optimized decisions on asset priorities. A high level overview of the CAM methodology and the key outputs can be found in **Figure 1**.

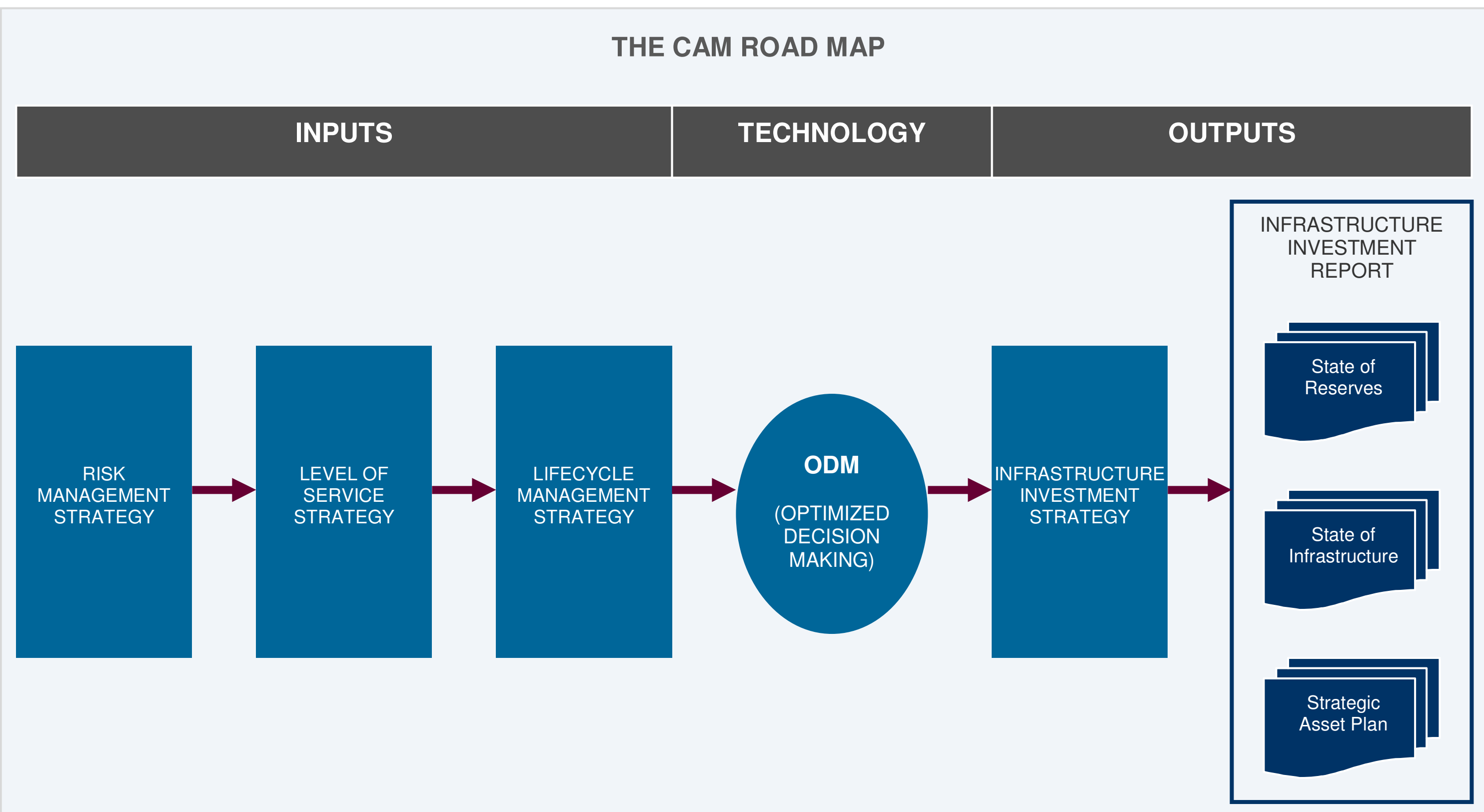

FIGURE 1: CAM METHODOLOGY

I.
DEVELOPMENT OF A FACILITY RATING MODEL

While core infrastructure assets such as water, wastewater, and roads remain persistent priorities, little attention is paid to the facilities that support these services, or the buildings that are critical to service delivery, such as Social Housing or Child Care Centres. This neglect in facilities management has created a gap in understanding and measuring how buildings need to perform to provide both front line public services, and the environment that supports the process equipment essential to providing the hard services.

The philosophy of the Region of Peel toward facilities has been that every Program has unique condition and performance requirements of its assets to support its services. Therefore, a flexible, customizable methodology and tools are required to address the unique condition and performance level of service needs for each building and program. The methodologies developed to ensure the connection between Peel's facilities assets and the services that are to be provided will be outlined along with a discussion about the pilot project results and the additional applications of the modeling.

DEVELOPMENT OF A FACILITIES RATING MODEL

The objective of developing a facilities rating model was to enable consistent assessment and rating of buildings across all facility asset classes and to compare facility needs against other infrastructure needs (i.e., watermains, roads, sewers, etc.). The basic principle in developing the model was that it had to reflect the requirements of the program services and whether they were being adequately supported by the facility assets. There were many challenges encountered in developing a model to quantitatively evaluate the condition and performance of facilities, including:

- Lack of industry research and modeling precedents;
- Identifying and engaging internal facilities experts as well as program service delivery experts;
- Identification of a method or process to quantify the programs' intuitive knowledge of their facility's performance in a meaningful way;
- Dealing with staff that have other core responsibilities and priorities;
- Maintaining momentum on a long-term project; and,
- Being able to build flexibility and resiliency into a meaningful model.

To overcome all of these challenges, there was a progression of meetings with senior staff in the program areas throughout the Region. These meetings raised awareness of the need for a comprehensive facility rating system and obtained management staff's buy-in so that CAM could attain access to their staff to participate in the initiative. The foundations of change management were used throughout the development, to ensure that the change was embraced and there was acceptance from the earliest stages of the work. The progression of developing Peel's Facilities Rating Model followed several distinct steps.

STEP 1: CLASSIFICATION OF FACILITIES

The first step involved dividing the assets into groups or classes of assets having similar Levels of Service requirements. For facilities in particular, this step produced a Regional profile that includes 20 distinct Asset Classes, as illustrated in **Table 1**.

DEPARTMENT	PROGRAM SERVICE	ASSET CLASS
Health Services	Long Term Care	Long Term Care Centre Facilities
	Peel Regional Paramedic Services (PRPS)	PRPS Reporting Stations
		PRPS Satellite Stations
Human Services	Ontario Works	Shelter Facilities
	Children's Services	Child Care Centre Facilities
	Social Housing	High Density Social Housing
		Medium Density Social Housing
		Low Density Social Housing
Employee & Business Services	Peel Heritage	Heritage Facilities
	Real Property Asset Mgmt	Public & Administrative Offices
Public Works	Includes: Water, Wastewater, Transportation and Waste Management	Heavy Industrial
		Labour Intense - Heavy Industrial
		Light Industrial
		Administrative Offices
		Public Offices
		General Storage
		Ancillary Storage
		Process Enclosures
		Public Access Light Industrial
		Retail Spaces

TABLE 1: FACILITIES ASSET CLASSES

STEP 2: DEVELOPMENT OF STANDARD LOS CATEGORIES

A generic framework was developed to identify the prime areas of condition and performance LOS that would affect all facilities across the different asset classes. This step yielded a list of LOS categories that included:

CONDITION LOS	Building and Property Condition Facility Quality and Relationship to Current Standards
PERFORMANCE LOS	Environmental Sustainability Finishes Capacity and Change Adaptability Building Environment and Security Building Amenities Accessibility

It was recognized that Peel already had a significant amount of data and the evaluation criteria to assess the Condition LOS through Building Condition Assessments (BCA). For the most part, this information could be used within the model to assess the condition of the facilities across all program service portfolios. For the Performance LOS, the initial framework was supplemented with generic evaluation criteria which would be vetted and refined by program experts according to what was critical to each of the programs' unique service needs. A visual representation of the model can be seen in **Figure 2**.

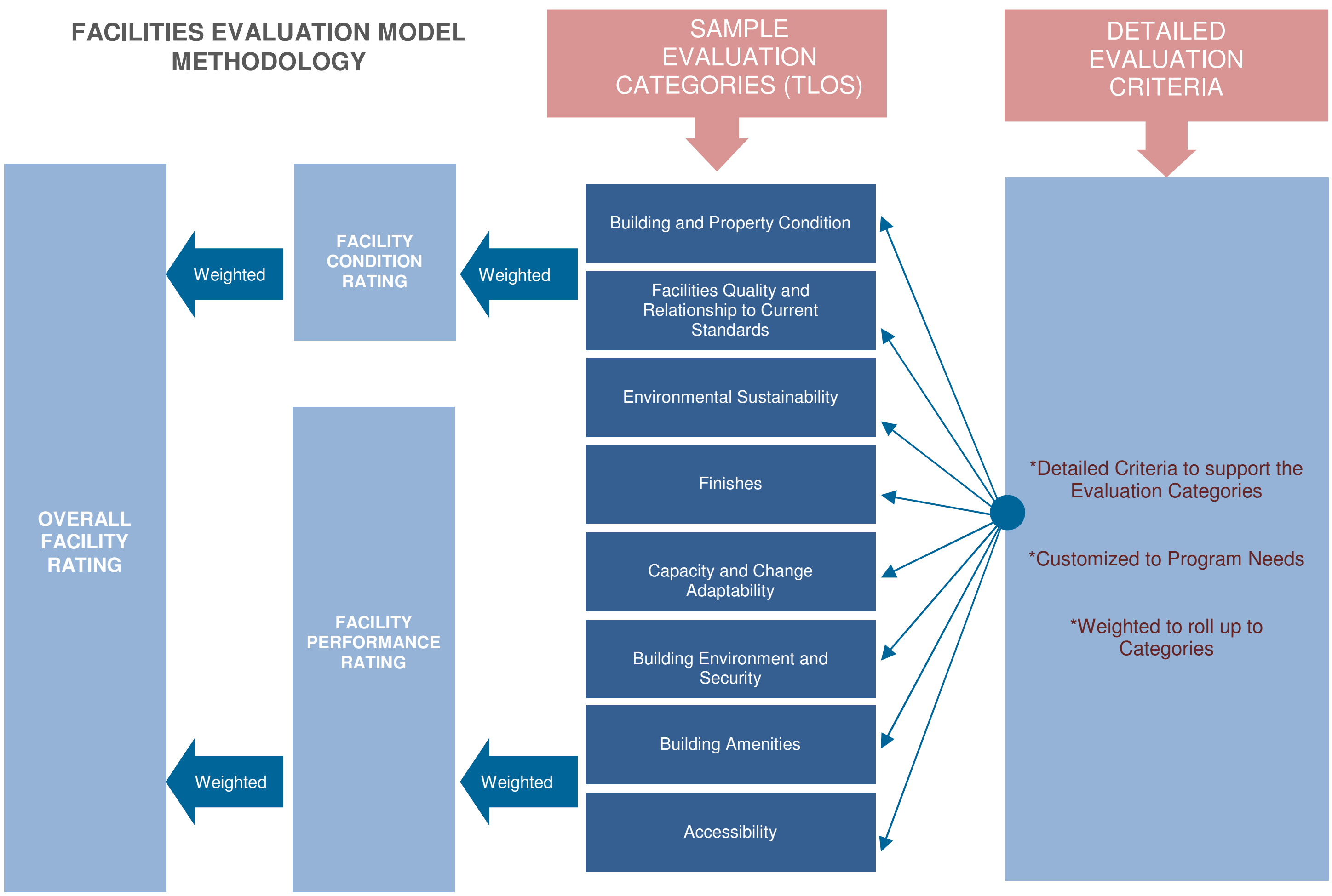

FIGURE 2: FACILITIES EVALUATION MODEL METHODOLOGY

STEP 3: CUSTOMIZATION OF LOS CRITERIA AT A SERVICE LEVEL BY ASSET CLASS

Using this initial framework, CAM engaged program experts to vet and refine the list of generic evaluation criteria that was created in Step 2. The vetting process served two purposes:

1. It ensured that the facility rating model was relevant to each of the programs' unique service needs.
2. Achieved buy-in by the programs on the use of the model for evaluating their asset needs.

As an example, one category and its corresponding criteria for a Child Care Facility can be seen in **Table 2**.

EVALUATION CATEGORIES	EVALUATION CRITERIA	EVALUATION STANDARDS/REFERENCES	SCORING METHODOLOGY
Building Amenities	Sufficiency of parking capacity	Program & Provincial Standards (Day Nurseries Act)	Performance Rating Score
	Visibility of entrance signage		Yes/No
	Access to public transit		Yes/No
	Access for service vehicles (emergency, waste management, deliveries etc.)		Yes/No
	Adequacy of storage space, including pantries		Yes/No
	Adequacy of kitchen facilities		Performance Rating Score
	Adequacy of child friendly washroom and change table facilities		Performance Rating Score
	Availability of stroller/car seat parking/storage		Yes/No
	Adequacy of meeting space		Performance Rating Score
	Adequacy of recreational space indoor/outdoor		Performance Rating Score

TABLE 2: SAMPLE EVALUATION CATEGORY AND DETAILED CRITERIA

Some of the detailed criteria such as stroller parking/car seat storage are amenities requirements unique to Children Services facilities and would not be a requirement for other services. In other cases, some criteria appear under all of the facility asset classes, such as ‘access for service vehicles’. The key is to ensure that sufficient detail is achieved to evaluate how well the performance of the facility is meeting the programs’ end service needs. At this stage, it was also determined what should be the standards for the evaluation and the methodology for scoring (either yes/no, or on a continuum).

STEP 4: WEIGHTING AND TARGET SETTING FOR LOS

Each of the criteria and categories was weighted in accordance to its importance to service delivery, and target LOS were set for each Evaluation Category to reflect their importance to the overall service delivery. The LOS ratings and importance weightings enabled a roll-up of the scorings to an overall facility rating score. Detailed Weighting Guides and Performance Rating Guides were used to ensure consistent application of the weightings and ratings when engaging front-line program staff from different areas in this stage of the process.

STEP 5: FACILITY SCORING AND DATA COMPILATION

The facility evaluation matrix that was developed with the program experts was turned into a working spreadsheet that would automatically calculate the scores for each of the categories and whether they were meeting LOS based on the information being entered. All of this information would roll up at each level of the model to a final overall facility score and Asset Class totals.

				Property Scoring					
	TLOS Category	Evaluation Criteria	Eval. Method	Building A	Building B	Building C	Building D	Building E	**Asset Class Totals**
Facility Condition Assessment	Building and Property Condition	Major Stuctural Components, Building Envelope, Site Works, Building Services	FCI	3.69%	2.37%	2.00%	1.01%	0.58%	
		Category Score:		**1.56**	**1.12**	**1.00**	**0.50**	**0.29**	0.90
	Facilities Quality and Relationship to Current Standards	Absence of Controlled Materials (i.e. PCBs, asbestos)	Yes/No	**No**	**No**	**No**	Yes	Yes	
		Compliance with all current Codes and Regulations	Yes/No	**No**	**No**	Yes	Yes	Yes	
		Category Score:		**5.0**	**5.0**	**3.0**	**1.0**	**1.0**	3.0
	Facility Condition Score			2.545	2.232	1.857	0.789	0.578	1.600
Facility Performance Assessment	Finishes	**Category Score:**		**2.9**	**2.0**	**1.4**	**1.6**	**1.6**	**1.9**
	Capacity and change Adaptability	**Category Score:**		**4.1**	**3.8**	**2.5**	**2.5**	**2.5**	**3.1**
	Building Environment and Security	**Category Score:**		**3.3**	**2.4**	**2.0**	**2.2**	**2.4**	**2.5**
	Building Amenities	**Category Score:**		**2.8**	**3.0**	**2.7**	**2.3**	**2.1**	**2.6**
	Accessibility	**Category Score:**		**1.4**	**2.1**	**1.4**	**1.4**	**1.4**	**1.5**
	Facility Performance Score			2.764	2.574	1.953	1.954	1.956	2.240
Overall Facility Score				2.655	2.403	1.905	1.372	1.267	1.920

FIGURE 3: SAMPLE CONDITION AND PERFORMANCE EVALUATION RESULTS

Figure 3 depicts the roll-up of the data to a category level for five of the buildings. The colour coding is used to highlight existing and potential issues in a complete model that spans many pages. Areas falling below levels of service targets highlight in red, those approaching the targets come up yellow; those areas that meet established levels of service are not highlighted or come up light green. This gives a clear picture of what areas require attention now, or those that could become problematic in the near future. The condition evaluation information from the Building Condition Assessments process was input by facilities management experts. The performance information was input by program scoring teams that usually comprised property managers, facility managers, and service level experts.

STEP 6: MODEL VALIDATION

The model results were then validated with program staff outside of the scoring teams including senior program managers. This process ensured a correlation between the calculated results from the model and the intuitive feel for the facility assets by the frontline staffs who work with the facilities on a daily basis.

PILOT PROJECT

A pilot project test of the Facility Rating Model was undertaken with the Social Housing portfolio. The pilot was an opportunity to work through scoring and validation process (Steps 5 and 6), challenge the assumptions and methodologies developed through Steps 2, 3 and 4, and fix any issues with the model. The social housing pilot included: In excess of eight months of intense work; three asset classes; High, Medium, and Low Density Social Housing Facilities; more than 80 facilities; the participation of more than ten expert staff; and, numerous workshops, working, and validation sessions. The pilot project was a successful test and validation of the Facilities Rating Model. The model successfully documented, in a transparent way, what was intuitively known by program staff such as: The buildings that scored poorly were in fact the known “poorer facilities”; the buildings that scored well were in fact known “good facilities”; the known problem areas were highlighted and reflected well through the weighting system established; and, the success of the results added credibility to the model and the scoring process.

OUTPUTS

Using the results from the scoring matrix from Step 5 (Figure 3), a number of graphics were developed to help interpret the results. **Figure 4** shows how far each of the facilities is from meeting each of its overall levels of service targets. Green bars extending to the right indicate that LOS are being exceeded, and the red bars indicate where LOS are not being met overall. Similarly, the information can be compiled to illustrate how closely the facilities are meeting LOS on both the condition and performance side, as illustrated in **Figure 5**. The yellow zones indicate areas in which either the Condition or performance LOS are not being met, and the red and green where neither or both LOS respectively are being met overall.

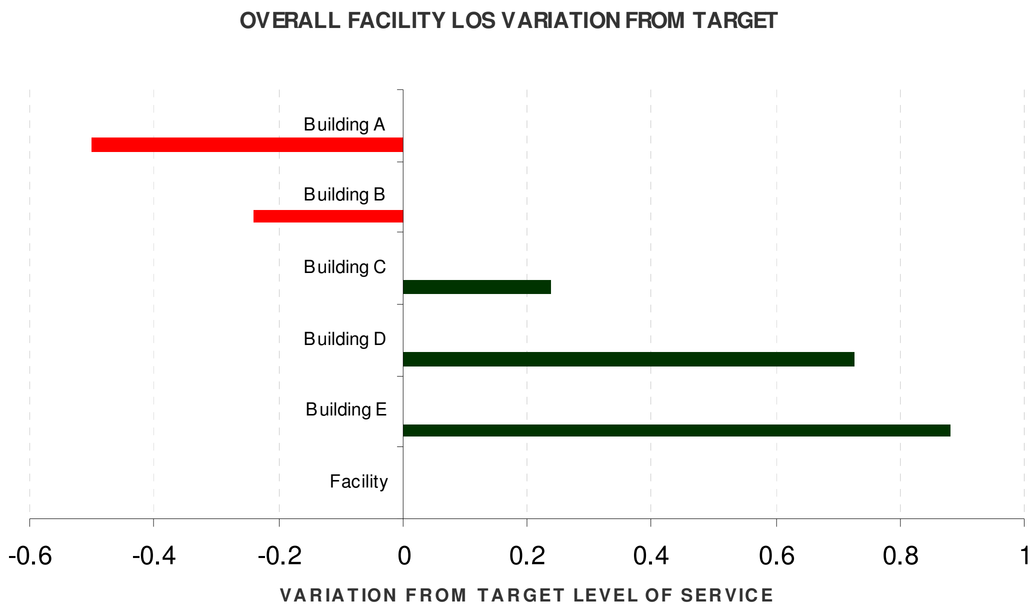

FIGURE 4: SAMPLE DATA INTERPRETATION-OVERALL FACILITY

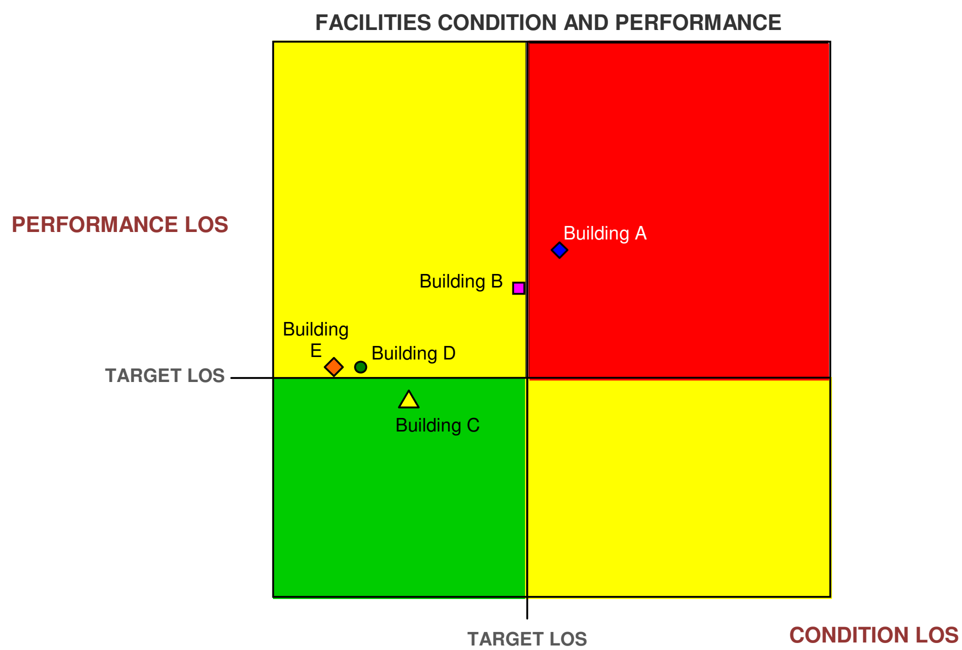

FIGURE 5: SAMPLE DATA INTERPRETATION-CONDITION AND PERFORMANCE

OBSERVATIONS

The modeling achieved the objectives of creating a tool that can bring a comparative view between different facilities in different asset classes supporting different services, by enabling the systematic roll-up of criteria to comparable LOS requirements based on service needs. The advantages of the model include:

1. *Direct application of the model for operational priority setting* – The model enables staff to set priorities in areas where LOS are deficient.

2. *Connecting the program services to the assets* - Creating measurable ways to evaluate the performance side of the facilities quantifies the softer side of the expectations of the facilities to ensures those considerations remain in future decisions.

3. *Quantifies and establishes consistent and defendable LOS standards for the entire portfolio* – This tool ensures the consistency of service provision across programs and political boundaries. If a decision to make a change in the standards is proposed by senior management or Council for a particular facility, it would need to be considered in the context of consistency across the entire portfolio and whether the exception is warranted.

4. *Forms part of a case to inform a business decision at a facility level* - Although the condition or performance of a building alone may not be sufficient to justify the replacement or relocation of a facility, when the combination of condition and performance is factored in, the view may change dramatically. Although there is often a social or political aspect of decisions to continue or not continue operating a facility, especially in the Health and Human Services worlds, the additional information that the Facilities Condition and Performance Evaluation model provides allows considerations that were previously only intuitive, to be brought to the forefront as quantifiable and accepted measured facts.

The Facilities Condition and Performance Evaluation Model developed at the Region of Peel has sought to fill the gap that exists in the understanding and measuring of how buildings need to perform to optimize service provision. A model that has a flexible and customizable methodology and accompanying measurement tools required to address the distinctive condition and performance level of service needs of each building and portfolio has been created to meet Peel's service environment. The unique connection between our facilities assets and our services has been achieved, and the capability to roll them up to the organizational level where they can be compared to all other Capital Assets is now possible.

The model forms a component of Peel's overall asset management strategy to bring a consistent and organizational-wide approach to prioritizing asset needs and aiding in long term capital and infrastructure decision making.

II.
CONNECTING RISK AND LEVELS OF SERVICE

LEVELS OF SERVICE

Two of the main components that can be seen in the CAM framework, Figure 1, and that CAM is striving to connect, are risk and levels of service. Risk represents the chance of an event occurring and its potential positive or negative impact on the achievement of objectives. Levels of Service (LOS) represent a defined amount of output for a particular activity or service area against which performance may be measured. LOS to the community represent objectives for the municipality against which risks must be considered and managed.

One of the key challenges for CAM was how to consider the broad range of services, LOS requirements and dissimilar asset types from across Peel's many programs, to determine asset needs and priorities at an organizational level. The method had to be flexible enough to evaluate this diverse infrastructure yet must have consistency and resiliency to provide comparable and defensible results. Peel's approach was to use a risk-centric methodology to analyse and prioritize asset needs.

RISK FRAMEWORK

The Australian and New Zealand risk management frameworks (AS/NZS 4360) provided the starting point for Peel's Risk Management Strategy. Impact and likelihood measurement tools were customized to meet the asset evaluation needs of the Peel environment. While this framework was selected by CAM for the development of the asset risk assessments, other risk frameworks and measurement tools could be applied within Peel's Risk Management Strategy. In developing Peel's overarching risk strategy, and assessing the gaps in other industry methodologies, the following were determined to be the key requirements:

- Asset risk must be measured in relation to the end services that the asset supports.
- An organizational context on the level of risk that each asset presents is required.
- A correlation must be enabled between the LOS the asset is targeted to meet, and the risk it imparts on the services the asset supports.
- A dynamic comparative basis for prioritization across diverse assets needs to be achieved.
- A direct connection between comparative risk and funding is needed.

One of the traps that decision-makers can fall into is having a lack of context to the level of risk that an asset presents to the services. The assets with the highest risk score can often get priority for funding; but should that always be the case? The organization needs to accept that some assets may always score high because of the criticality of the asset to service delivery, and the risk that it inherently presents to the service. A methodology is needed to identify where the most cost effective risk reductions lie, how to identify the true level of additional risk that an asset is imparting, and what amount of that risk can be mitigated. This will enable a true prioritization of asset needs. To achieve this, several key enablers were developed under Peel's Risk Management Strategy to give senior decision-makers a true comparative basis upon which to assess diverse asset priorities across the organization.

KEY ENABLER #1 – ASSESSING LEVELS OF RISK

Existing methodologies and tools enable the calculation of current risk and current LOS, but do not speak to their direct relationship. So how do you connect LOS and risk, and understand the extent of how changes in one affect changes in the other? Peel started with the range of risk that the asset presents to its services and where each asset falls within that range. Each asset class is initially represented by the following levels of risk:

1. **INHERENT RISK:** The level of risk that the asset presents to the service before undertaking any mitigation measures. Inherent Risk can also indicate the most critical assets to the quality of service delivery.

2. **RESIDUAL RISK:** The remaining risk after desired mitigation measures are put into effect. Mitigation measures include achieving the levels of service at which the assets need to perform, undertaking proactive maintenance practices, adhering to regulatory requirements, or enacting service improvement objectives. Residual Risk is often the organization's risk objective.

3. **CURRENT RISK:** The level of risk the assets currently present to service delivery. The Current Risk is calculated based on how well the organization is meeting its levels of service, regulatory requirements, maintenance practices and service improvement objectives today.

The gap between Residual Risk and Current Risk represents the unmet asset and funding needs. The relationship between the three risk levels for each asset class can be seen in **Figure 6**. In and of itself, the assessment of the gap of asset needs and risk that can be mitigated enables comparison of relative gaps and needs across the organization regardless of the service or program the asset supports. Although it does provide a comparative measure, it forms one piece in the entirety of the model that will be further described.

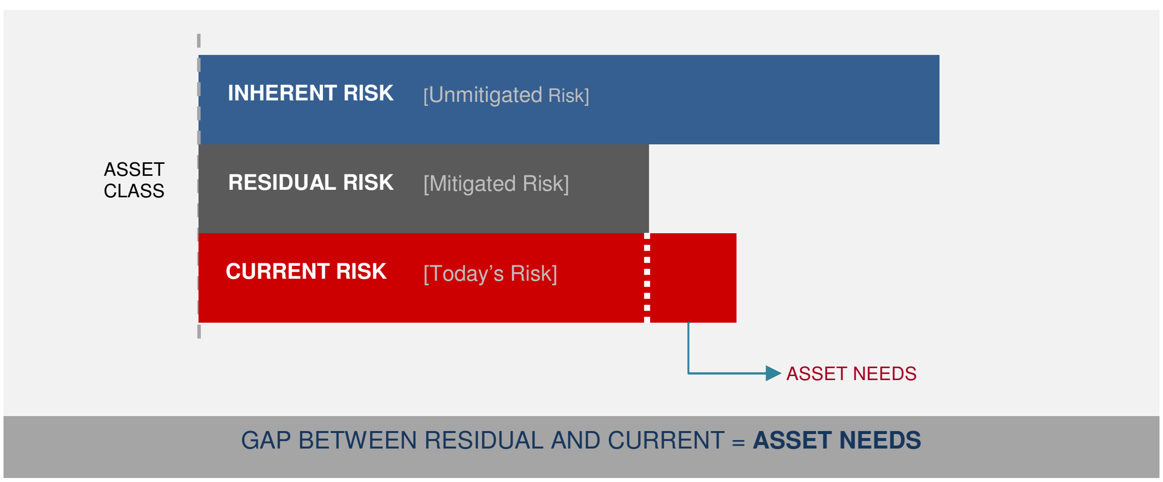

FIGURE 6: ASSET RISK PROFILE

The identification of this risk gap enables the connection between the asset levels of service and risk to service delivery. If the asset is measured at inherent or worst case risk, it is failing its service requirements and is deemed to be at its failure point. If the asset is measured at residual risk the asset is meeting its target LOS requirements. The current risk is the dynamic measure between the two extremes according to the state of the asset LOS today. Visually, the connections are presented in **Figure 7**.

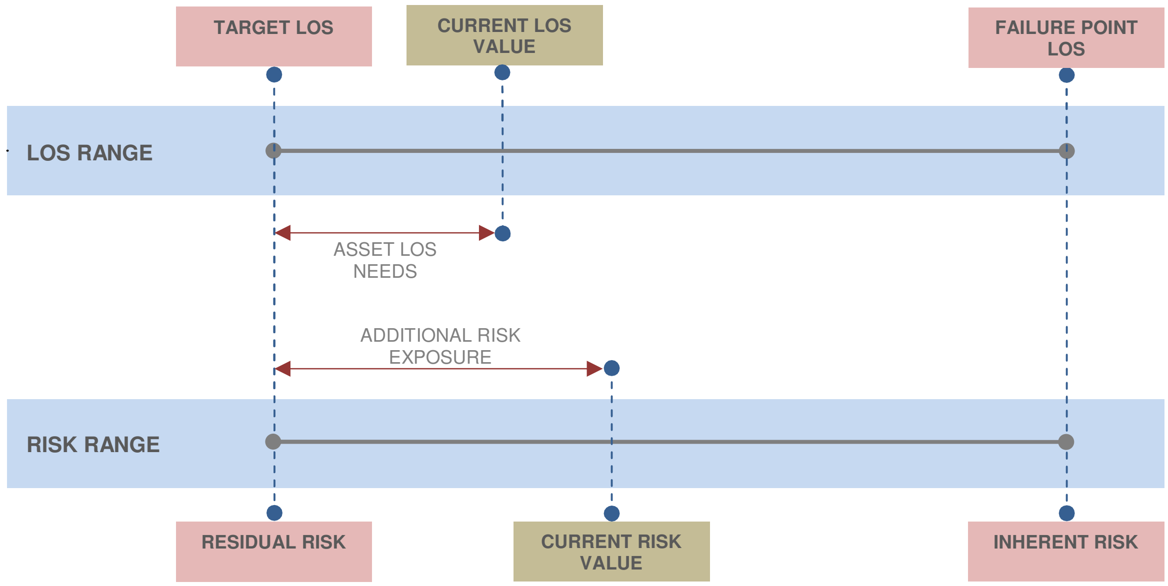

FIGURE 7: CONNECTIONS BETWEEN RISK AND ASSET LEVELS OF SERVICE

The range between the residual risk and inherent risk measures become directly linked to the range between the asset LOS requirements and the asset failure point. The relationship between these two ranges, and the non-linear and dynamic relationship between the assets' current LOS and its resulting current risk, is developed through an additional two enablers.

KEY ENABLER #2 – EQUALIZING LOS MEASURES

Building on the connections established between risk and LOS, the issue became, how do you determine where an asset falls on that continuum between asset failure and meeting the targets for the overall infrastructure? A methodology was required that could be used across diverse asset types and their related LOS requirements (e.g., a building has different LOS definitions and measures from those of a watermain or a road). Initial consideration was given to measuring only the proportion of assets that were meeting LOS versus those that were not. However, this was insufficient as there was a need to assess how bad the conditions of the assets not meeting target LOS were.

For example, if the condition of the assets were fractionally below the LOS targets, then the infrastructure is likely in pretty good condition and not causing any significant additional risk to the services. But if the condition of the assets not meeting LOS were all substantially below targets, the infrastructure could be posing a very significant risk to the continuing services. What was devised was a LOS Value calculation used across all asset classes that takes into account both factors and calculates the placement of the asset class along the assets' LOS range between the target LOS and the failure to meet service needs:

LOS Value =	% of Assets Meeting LOS	+	% of Assets Not Meeting LOS	X	Average Condition of Assets Not Meeting LOS

This allows the assessment of where the asset class as a whole falls along the LOS range, as illustrated by the Current LOS Value in Figure 8. The connection between how the asset LOS Value directly relates back to the level of additional risk the asset is exposing the service to can be seen in the last key enabler.

KEY ENABLER #3 – THE DIRECT RELATIONSHIP BETWEEN RISK AND LOS

The connection between the assets LOS Value, or the positioning along the LOS range, needed to be associated with a Risk Value, or placement along the risk range between inherent and residual risk. The relationship underwent intensive review and testing, considering options including direct linear relationships and different polynomial curve relationships. Through modelling, testing, and logic validation, it was determined that the relationship between the LOS and risk ranges most closely follows an S-type curve, as illustrated in **Figure 8**.

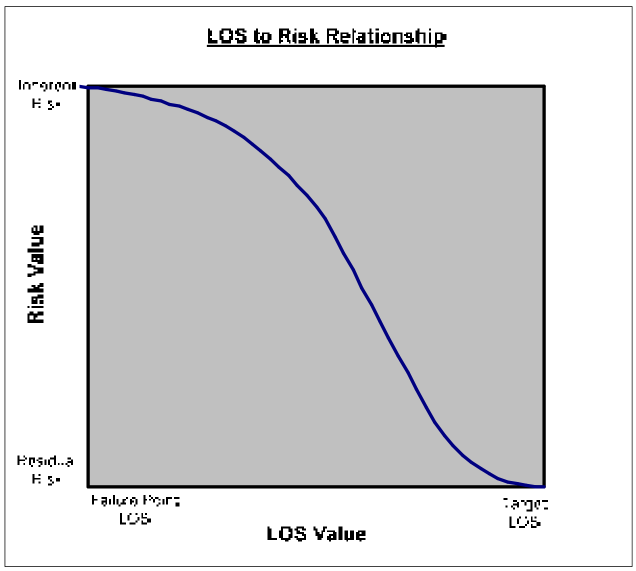

FIGURE 8: LOS VALUE TO RISK VALUE RELATIONSHIP CURVE

What the shape of the curve and relationship between service risk and asset LOS indicates is that as the asset approaches either end of the curve, the target LOS requirements or the point where it fails service delivery needs, those LOS changes have a lesser impact on the additional level of risk exposure. The most cost effective and efficient point to improve the infrastructure is in the middle of the curve, where small improvements in the assets' LOS will result in the highest gains for risk mitigation. At the high end of the curve nearer to inherent risk, selective improvements will have little effect, and the complete or substantial replacement of the assets, becomes a probable, and likely very costly, option. While at the lower end of the curve closer to residual risk, significant investments in the assets yield less proportional risk mitigation gains, and those funds and resources might be better spent on other asset classes which fall closer to the mid-range of the curve.

OBSERVATIONS

The Region of Peel adopted a risk-centric approach to assessing asset needs and priorities at an organizational level that was made possible by the development of this complete LOS to risk relationship:

- **KEY ENABLER #1** identifies the risk and LOS ranges and how they connect.
- **KEY ENABLER #2** facilitates the placement of the current LOS value along the LOS range.
- **KEY ENABLER #3** defines the LOS to risk range relationship enabling the placement of the current risk value along the risk range.

This methodology and its outputs provide the clearest approach to senior decision-makers in determining the most effective options to meet asset needs and satisfy service delivery. Some specific advantages of Peel's Strategic Asset Management Strategy include:

1. The establishment of a link between an asset's current LOS and current risk, so that as the condition and performance of the asset changes, the risk values realign in accordance with their defined relationships. This association can be used for performance monitoring of the assets across the organization.

2. The Risk Value and associated asset needs gap of an asset class can be used as a direct comparator to that of other asset classes to assess which ones are furthest from their target and requiring the most attention and highest prioritization.

3. Further to Point 2, by applying costs to the asset LOS requirements, they can be directly associated to the Risk Values, and an organization can determine which asset improvements can reduce risk most cost effectively.

4. Performance measures can be established to track improvements in LOS and risk over time. Progress in asset planning and capital improvements can be monitored to verify that as Capital works dollars are applied to the asset classes, the additional risk exposure is reduced proportionately.

5. The model enables the regular review and adjustment of the boundary risk scores—inherent and residual risk—at any time, as programs and the environments in which they operate change. This could include new levels of service expectations, new regulations, technology advances, or changes in public demands. This automatically generates revised risk measures and new risk objectives.

6. This holistic and comparative view of the asset infrastructure enables the establishment of risk tolerances or the level of risk the organization is willing to accept according to available funding and resources. Given that funding cannot always be made available to fully achieve all the residual or target risk levels, the organization can make informed decisions and/or provide for open dialogue about how much additional risk the organization, Council, or the public is willing to accept.

7. The application of this methodology and tools has proven beneficial at a portfolio basis to help inform and provide evidence to support program level decision making. The methodologies have been applied within asset classes or portfolios to help identify specific assets exposing the program to significant additional potential service risks.

The dynamics and relationships between asset levels of service and the levels of risk that they expose to the services that the assets support can be complex and difficult to quantify. The creation of the three key enablers to formalize this relationship was fundamental to fill the gaps in the existing methodologies and to the structure of the Region of Peel's Risk Management Strategy. This enabled risk-centric prioritization of the infrastructure needs and the overall Strategic Asset Management Strategy under which assets are assessed, prioritized, and planned at the Region of Peel.

III.
RISK-CENTRIC OPTIMIZED DECISION MAKING

LEVELS OF SERVICE STRATEGY

Risk-centric optimization requires the development of the links between levels of service, risk, and lifecycles, as illustrated in Figure 1, the CAM framework. A *level of service* is a defined output for a particular activity or service area against which performance may be measured. Service levels relate to quality, health, safety, quantity, reliability, responsiveness, environmental acceptability, and investment. As part of Peel's Levels of Service Strategy, the assets classes (types) were mapped to the services they support and links were established between the levels of service provided to the customer and the technical levels of service (LOS) required of the assets to meet customer service expectations.

Condition and performance LOS provide the basis for measuring the state of the assets for strategic planning purposes. The establishment of LOS, which are measurable and financially quantifiable, is essential to risk based optimized decision modeling. The LOS are defined at the minimum condition and performance thresholds at which assets should be maintained to cost effectively manage service risks and meet customer service expectations. The LOS drive capital planning, as they determine to what extent the assets need to be upgraded to meet minimum service performance requirements.

RISK MANAGEMENT STRATEGY

In order to achieve a risk based decision model for Corporate Asset Management, the establishment of a Risk Management Strategy was imperative to link the effects of changes to LOS with changes to asset risk. Levels of service to the community are key objectives for the municipality that can be impacted by events for which the risks must be considered and managed.

The Australian and New Zealand risk management frameworks (AS/NZS 4360) provided the start for Peel's Risk Management Strategy and risk measurement tools were used to assess the asset risk in three (3) categories for the risk profile:

1. **INHERENT RISK:** The level of risk that the asset presents to the service before undertaking any mitigation measures.

2. **RESIDUAL RISK:** The remaining risk after desired mitigation measures are put into effect. Residual Risk is often the organization's risk objective.

3. **CURRENT RISK:** The level of risk the assets currently present to service delivery.

The risk profiles provide the main parameters for determining the optimized allocation of capital funds to areas where infrastructure investments will yield the greatest risk reduction.

LIFECYCLE STRATEGIES

Lifecycle strategies are unique to different asset classes and provide the basis for predicting changes to LOS and asset risks as the assets age over time. Using watermains as an example illustrates the concept of lifecycle modeling for strategic planning purposes. **Figure 9** shows a family of lifecycle curves for local distribution mains, differentiated by material type.

The horizontal red line represents a condition LOS value of 5 breaks per km of watermain; the point at which watermains have deteriorated to a level where repair or replacement should be considered in order to meet customer expectations of a reliable water system. When the assets no longer meet the condition LOS

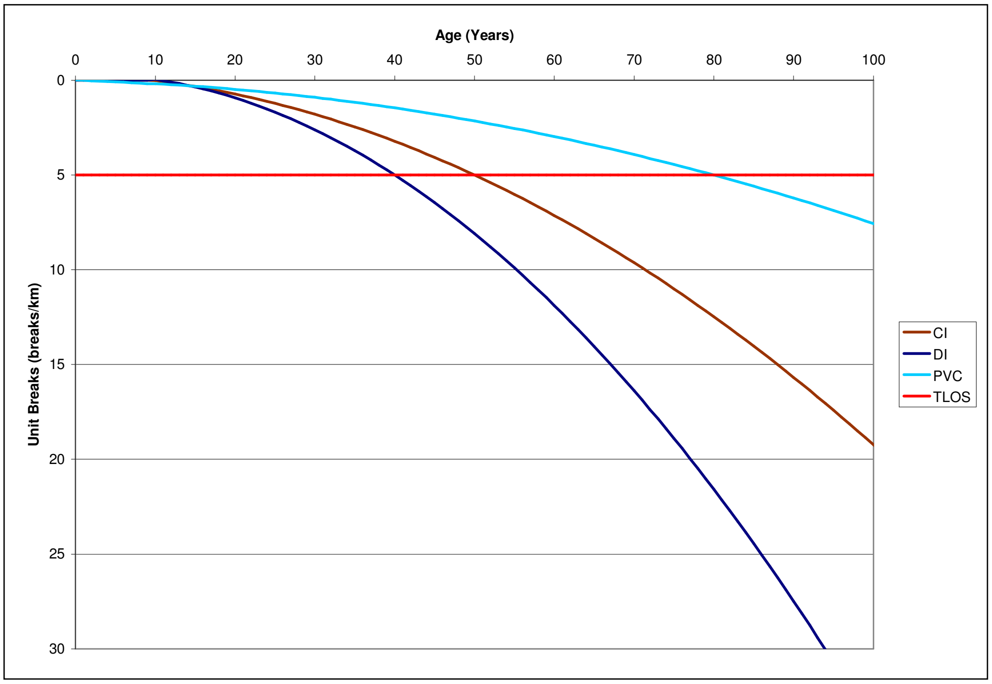

FIGURE 9: LIFECYCLE CURVES FOR DISTRIBUTION MAINS

requirements for the asset class (in this case, 5 breaks per km of watermain), the risk score will begin to rise above the desired level of risk (residual risk) and will continue to increase as the average number of breaks in the system increases. As funding is committed to repair the watermains and the number of breaks in the system decreases, the risk score will reduce toward desired levels. Should the number of watermain breaks be reduced to the point they fall below LOS requirements, the corresponding risk score would improve to be better than the risk level objective; thereby, indicating that some funds can be shifted to other asset classes in need of additional capital funding.

A lifecycle curve similar to Figure 9 cannot be constructed for all LOS. Curves work best for asset classes made of similar assets, for which a distinct parameter can be used to define asset failure. Where the nature of the asset class consists of more complex structures, (buildings, bridges, pumping stations) alternate methods of lifecycle modeling must be considered.

As mentioned previously, both condition and performance LOS are used to assess the state of the assets and they are combined to provide the overall asset risk value. Performance-based LOS are not readily represented through a lifecycle strategy; however, they are selected to account for those desired operational parameters that affect the functionality of the assets and their ability to meet program service requirements. Performance parameters are more difficult to forecast than condition-based parameters, as they may not apply to all assets in the same way (e.g., replacement of assets to fix a low water service pressure area may affect assets only within a geographic location) or may be triggered by unforeseen changes such as changes in legislation, service improvements or intended use of the assets (e.g., reconfiguring homeless shelters to meet accessibility regulations, changes to long-term care facilities to provide adult day programs). Performance parameters are input into the model as capital requirements, and the risk scores are adjusted as funds and works are committed.

THE OPTIMIZED DECISION MODEL

The purpose of optimized decision modeling (ODM) is to arrive at the best balance between managing risk to services at desired levels and the financial costs to do so. For each asset class, the ODM combines existing levels of service parameters, the range in risk values between residual and inherent risk and the lifecycle information with the intents of:

- evaluating current condition and performance of the asset class;
- calculating the current risk score and the deviation from the desired risk score;
- forecasting the level of service and risk parameters for future years based on predictive lifecycle information;
- producing capital plan recommendations, based on the current and forecasted ability of the asset class to meet the required levels of service; and
- forecasting risk levels to prioritize investments across asset classes to meet budgetary constraints.

Three asset classes were selected as part of a pilot project to test the procedures associated with ODM and show its applicability across a diverse group of assets. Water distribution mains, road pavement, and social housing facilities were chosen as they make up a significant portion of the Region's infrastructure and a good amount of condition and performance data was readily available for these assets. Asset data related to basic asset parameters (age, location) and specific to the LOS (e.g., number of watermain breaks) was sourced from existing asset management systems, and used for input into the ODM model.

The first run of the ODM set budget constraints for the upgrades to each asset class. **Figure 10** illustrates the output for a scenario of $30 million per year investment in watermain replacement. It then calculates the equivalent network condition (the percentage of assets meeting LOS), the total length of watermain which can be replaced given that investment, and the change in risk score for the asset class as a result of the work, accounting for the aging of the existing infrastructure as time progresses.

Distribution Mains

ID	Years	Input Type	TLOS	Cost (in millions)	Length To Repair	Current Risk	Reduced Risk	Percent Change
	2010	COST	94.15	$30.000	33834.14	126.31	125.85	1.11
	2011	COST	94.11	$30.000	30487.64	125.90	125.86	0.11
	2012	COST	93.52	$30.000	30760.65	125.92	125.86	0.15
	2013	COST	93.22	$30.000	33088.45	125.93	125.74	0.44
	2014	COST	92.44	$30.000	31233.67	125.81	125.75	0.15
	2015	COST	91.74	$30.000	35091.35	125.82	125.75	0.16
	2016	COST	91.17	$30.000	36249.73	125.83	125.77	0.16
	2017	COST	90.27	$30.000	37289.24	125.86	125.81	0.10
	2018	COST	90.29	$30.000	34586.16	125.91	125.84	0.17
	2019	COST	90.00	$30.000	35650.36	125.94	125.88	0.16

FIGURE 10: CONSTRAINED BUDGET ODM OUTPUT–DISTRIBUTION MAINS

An alternative modeling scenario applied unlimited funding and resources in order that 100 percent of the assets achieve the established LOS requirements. As illustrated in **Figure 11**, distribution mains would require significant investment in the short term to fully meet the desired LOS, which goes beyond the scope of the current capital works plans (currently about $30 million per year). Once the older inventory is assumed to be replaced, the model shows diminishing capital needs for this asset class. Road pavement and social housing assets, on the other hand, are shown as needing a smaller investment in the shorter term, but the investment needs escalate in future years as more assets fail to meet the desired LOS.

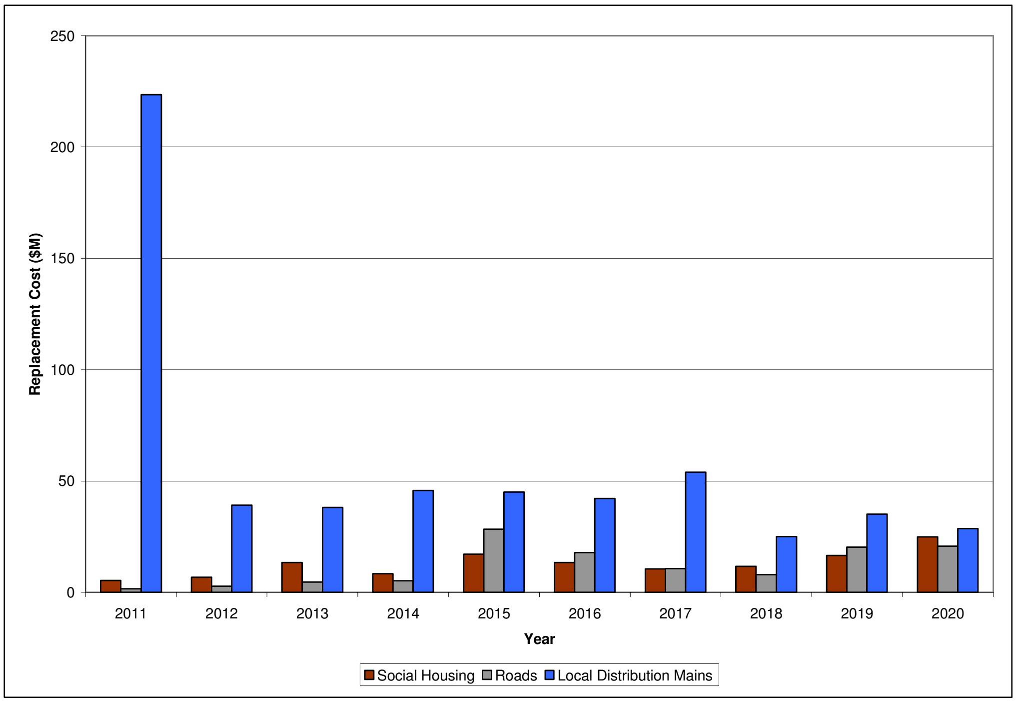

FIGURE 11: STATE OF GOOD REPAIR NEEDS-UNLIMITED FUNDS SCENARIO

A different picture arises when examining the most cost effective approach to addressing asset needs using risk centric modeling. This is when a risk centric approach to asset management can provide the clarity to make better decisions on asset investment. The ODM model calculates the risk reduction per capital investment dollar (benefit cost) and is then able to prioritize asset classes in order of highest risk mitigation potential from an organizational standpoint.

Figure 12 shows that the risk reduction per dollar spent is low for a relatively large, low risk (less critical) asset class like local distribution mains. Since the Regional watermain network is already performing very close to its desired levels of service (achieving 90 percent or better of LOS requirements) and watermain replacement has a comparatively high cost, investing additional capital in watermain replacement to get 100 percent compliance with the LOS would be an expensive and less cost effective exercise than tackling some of the more critical, higher risk asset classes. Social Housing, on the other hand, has a much better risk improvement return, as it is presently further from its minimal risk thresholds. It is a more critical asset to service delivery and more can be done with less funding to improve service and the level of risk. Road pavement, while also being a large network of assets, is a faster deteriorating asset, and presents a higher level of risk due to its heavy use and significant economic and safety impact to the community. For this

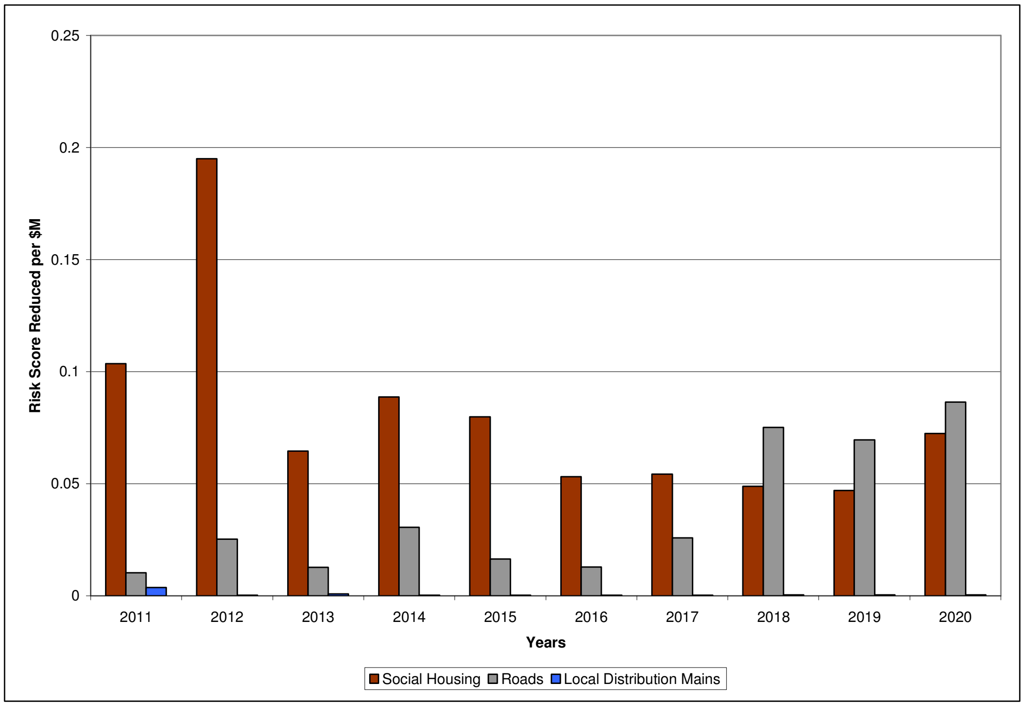

FIGURE 12: RISK SCORE REDUCED PER MILLION DOLLAR SPENT

reason, investment in pavement improvements also presents a better financial opportunity for service improvement and risk reduction than the local watermains.

This does not mean that work can be deferred indefinitely for lower risk asset classes. Due to the non-linear nature of risk, once the condition and performance for an asset class deteriorates significantly, risk for the asset class will increase exponentially. The ODM is useful when applied to rebalance capital investment while still preserving all asset classes' ability to continue to work as closely to the desired LOS as possible and remain within risk tolerances.

The risk centric optimized decision making methodology helps to justify and prioritize capital budgets, and provides the additional benefit of monitoring the effectiveness of asset management strategies. Where the LOS is difficult to achieve in the shorter term, and risk to the Region is relatively low, such as with distribution mains, a decision may be taken to operate below the selected LOS on a short term basis, or change the LOS to less stringent criteria. The ODM tool makes such considerations and discussions with senior management, Council, and the public possible as they can see the impacts of changing LOS and what the associated costs will be in terms of dollars and risks to their services.

OBSERVATIONS

The pilot asset classes used in the testing of the ODM model were selected in keeping with the availability, completeness, and reliability of asset related data. When creating a methodology and procedures for implementing a risk centric ODM, ensuring quality of data is one of the most significant challenges. Where accurate records and asset inventories are not available, a number of assumptions must be made in order to fill in the gaps. Tapping into industry standards and documented research can be useful to formulate assumptions, but the knowledge of program staff is essential in verifying their applicability to local conditions.

When dealing with asset management at the corporate level, there is also the tendency to treat an asset class as a single identifiable unit rather than as a grouping of individual assets. For example, define levels of service in terms of number of breaks/100km/year for the entire network of watermains rather than breaks/km at the individual watermain level. Analyzing assets as individual components of a greater grouping, rather than as a whole allows for integration between corporate level asset management and the more detailed asset management undertaken at the program level.

A significant challenge inherent to implementing a risk-centric ODM comes in ensuring that all programs and services are equally treated in the setting of the asset management decision parameters and the collection of data. In this way, all programs and services regardless of size have their assets assessed equally in the asset management plans and thereby increase the reliability of the ODM outputs.

Implementing a corporate-wide risk centric optimized decision modeling tool is central to CAM's Asset Management Strategy. It fulfills CAM's objectives of improving planning and prioritization of infrastructure needs across the organization, meeting the long-term sustainability of assets and service, improving transparency of the annual budgets and forecasts. While the task of collecting data and forecasting LOS for each asset class is daunting, the rewards of a uniform, defensible asset prioritization are well worth the effort.

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