

5. ASSET MANAGEMENT FRAMEWORK & STRATEGY

A two-stage process is developed to ensure alignment between the corporate goals, and how the assets are managed. The first step is the development of an Asset Management Framework that ties municipal goals (e.g. Official Plan, Strategic Plan) and planning (Departmental Business Plans and capital budget) to infrastructure management. The second step is the development of the Asset Management Strategy, a set of planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest life cycle cost. Both steps commits the City to provide approved levels of service in the most effective and efficient way, through the planning, design, construction, acquisition, operation and maintenance, renewal and disposal of assets.

5.1 MARKHAM ASSET MANAGEMENT FRAMEWORK

The City's Asset Management Framework provides a common understanding and lexicon for describing the business processes and activities conducted by the City to manage its various physical assets, and to illustrate the relationships between those activities. Establishment of the Corporate Framework is consistent with leading practices, as defined in the International Infrastructure Management Manual (IIMM), PAS55 and ISO 55000.

The Markham Asset Management Framework, developed in consultation with senior staff and industry experts is illustrated in Figure 5-1: Asset Management Framework. The Framework consists of several major elements:

- Regulatory Requirements, Business Drivers (orange)
- Core Processes (blue) supported by Core Support Services
- Asset Management Life Cycle (centre)
- Excellence Markham Business Outcomes (multi-coloured squares)

Figure 5-1: Asset Management Framework



5.1.1 Business Drivers (Orange)

Business Drivers are the influences that govern how the infrastructures are managed and set overall expectations of how the department operates, including, but not limited to:

- Customer requirements (Levels of Service);
- Corporate goals and strategies;
- Regulatory requirements, such as the O. Reg. 588/17, Municipal Act, the Safe Drinking Water Act, the Ontario Water Resources Act, Regional By-law requirements, municipal bylaws requirements, the Planning Act and Places to Grow requirements; and
- Environmental factors, such as the economy, technology innovations, and political and social priorities.

5.1.2 Plan-Do-Check-Act Cycle (Blue)

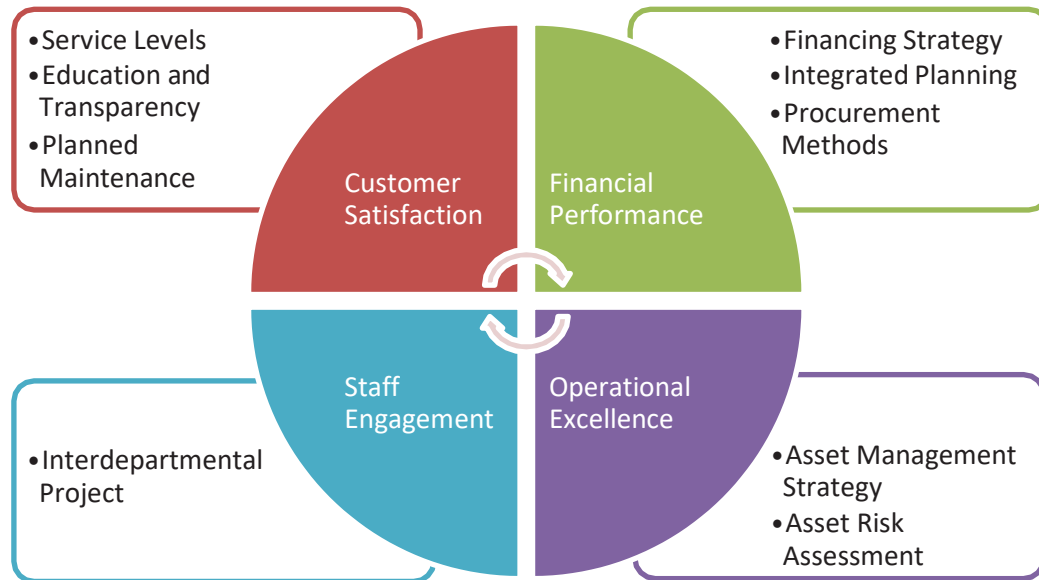
The underlying structure is based on the all-encompassing PDCA (Plan Do Check Act) cycle which is an iterative four step universal management method and principle used by various organizations to control and continuously improve on processes and products. This control/cycle has no end, and functions as a constant repetitious process through all business programs and initiatives.

The Core Supporting Services include finance and administration, information systems and data management, and human resources management, which provides the necessary support to the Business unit to successfully manage the infrastructure.

<p>Planning</p> <p>Strategic Planning</p> <p>Tactical/Financial Planning</p> <p>Operational Planning</p>	<p>Converts the Business Drivers (Orange) into a set of operational plans that describe how the department will deliver the service. The levels of planning include:</p> <ul style="list-style-type: none"> • Long-Term Planning which converts Corporate Strategic Plan/Goals, regulatory and customer requirements into high level strategic deliverables (e.g. Corporate Strategic Plan Actions, Master Plans, Policies, long term funding strategy) • Medium-Term Planning which cascades Corporate requirements to Departmental levels to allocate resources (natural, physical, financial, human, etc.), while meeting defined levels of service (e.g., Departmental Business Plans, Performance Management Plan, Asset Management Plan, 10-Year Capital program) • Short-Term Planning which converts medium term plans into tactical, short term executable plans (e.g. Annual Capital and Operating Budgets, Emergency Preparedness & Response Plans, Operational Standards & Specifications).
<p>Delivery</p> <p>Operations & Program</p> <p>Services e.g. Road, Water, Waste, Facilities etc.</p>	<p>Refers to the actual action of delivering the services to the customers, both internal and/or external. The services are delivered to meet the Excellence Markham business outcomes: Customer Satisfaction, Operational Excellence, Staff Engagement and Financial Performance.</p>
<p>Monitoring and Reporting</p> <p>Performance Assessment & Continuous Improvement</p> <p>Performance Monitoring & Reporting</p>	<p>Also known as performance management checks that measure if the Department is doing what it intended/planned to do, including:</p> <ul style="list-style-type: none"> • Monitoring actual results and reporting actual against targets over time • Conducting results based benchmarking • Assessing gaps, and report on lessons learned • Assess if the results meets the Business Drivers (orange) and modify plan/delivery for continuous improvement
<p>Core Support Services</p> <p>Information Systems & Data Management</p> <p>Finance & Administration</p> <p>Human Resources Management</p>	<p>These internal department services provide support to the various business units to achieve the planned business outcomes:</p> <ul style="list-style-type: none"> • Information Systems and Data Management – to provide support in the design, selection, implementation and maintenance of corporate information systems infrastructure to meet business objectives • Financial Management and Administration - to provide support to record and report original and depreciated costs of assets; all historical costs associated with service delivery including asset life cycle costs; and forecasts of future asset renewal costs, to develop short term implementation budgets • Human Resources Management – to provide support to recruit, manage and develop human resources to meet business objectives

5.1.3 Asset Life Cycle (Centre)

Centered amongst the Business Drivers, and overlaying the Plan-Do-Check-Act cycle, is the management of physical infrastructure. This Asset Management Cycle describes how the various assets are managed, and overall aligns to the Excellence Markham Business Outcomes as shown below:

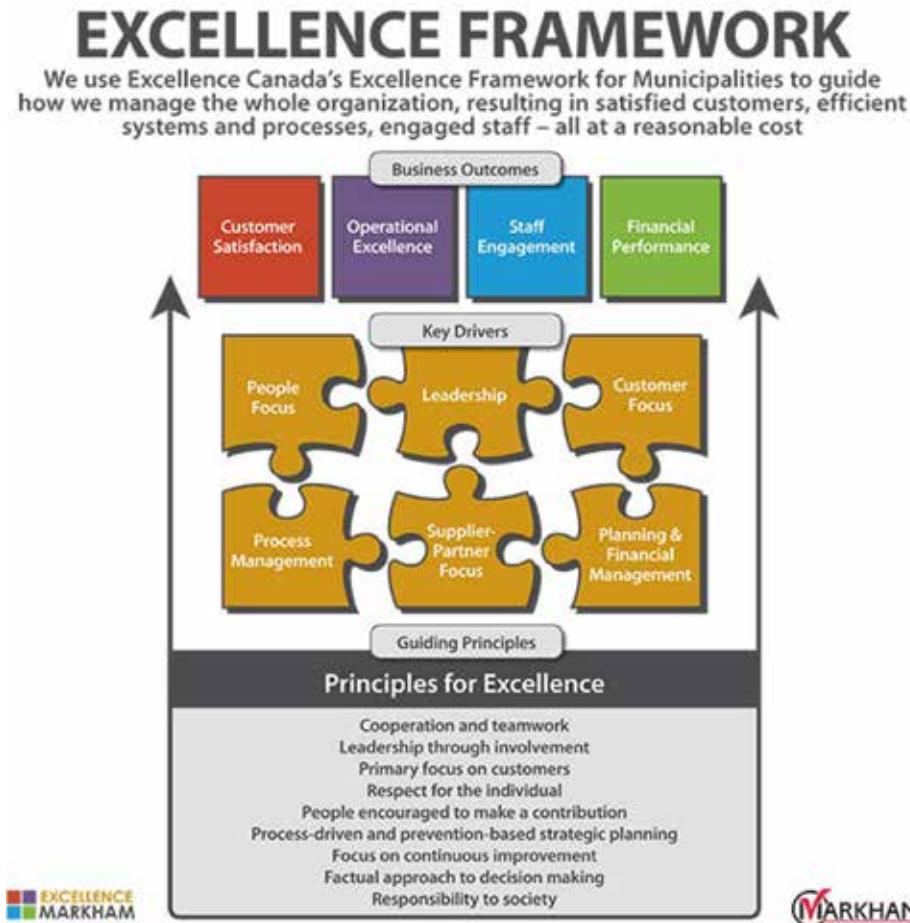


The Asset Life Cycle includes:

- Asset procurement, creation or acquisition - to provide assets that meet current and future needs while delivering levels of service and mitigating risks.
- Asset operations, maintenance – to maintain an asset to meet the required functional condition and/or extend its life.
- Asset disposal, replace - to rebuild or replace an asset to restore it to a required functional condition.

5.1.4 Excellence Markham Business Outcomes

The City uses Excellence Canada's Excellence Framework for Municipalities to guide how the organization is managed, focusing on areas of Customer Satisfaction, Operational Excellence, Staff Engagement, and Financial Performance.)



5.2 CURRENT CITY OF MARKHAM ASSET MANAGEMENT STRATEGIES

Per the Guide for Municipal Asset Management Plans: The Asset Management Strategy is a set of planned actions that will enable the assets to provide the desired levels of service in a sustainable way, while managing risk, at the lowest life cycle cost. While based on the internationally recognized PAS55 by the Institute of Asset Management, asset management can be defined as “the continuous improvement of systematic and coordinated activities and practices through which the City can optimally and sustainably manage its infrastructure systems, associated performance, risks and expenditures over their life cycles for the purpose of achieving the organizational strategic plan”.

This chapter describes the current asset management strategies/practices adopted by individual department/asset classes based on the following questions:

- What is the condition audit process and the evaluation criteria?
- What is the rehabilitation/replacement/maintenance program?
- What is the population and employment forecasts for the municipality?

Overall, the City has a strategy to manage major assets through their life cycle which are generally consistent from condition assessment, to program development, to execution. However, the City does not have a documented corporate practice that considers:

- Risk analyses of critical infrastructure across the City;
- Prioritizing infrastructure investments that maximize benefits, reduce risk and provide desired levels of service;
- Making informed decisions over the life of the assets (including operation, maintenance, renewal, replacement and decommissioning); and
- More efficient and effective ways to deliver services.

5.3 WATER INFRASTRUCTURE

5.3.1 Water Infrastructure

- The City of Markham’s Water Distribution System is governed by the comprehensive Ministry of the Environment, Conservation and Parks (MECP) Safe Drinking Water Act (SDWA) and associated Regulations. The MECP conducts a yearly inspection of the Drinking Water Distribution System to determine compliance with the Acts and Regulations. Waterworks exercises extreme rigour in operational excellence to remain in compliance and is diligent with conformance to the Drinking Water Quality Management Standard (DWQMS).

5.3.2 Rehabilitation / Replacement / Maintenance Programs

- Rehabilitation and Replacement Programs
 - Watermain Replacement Program
 - Fire Hydrant Replacement Program
 - Sampling Station Replacement Program
 - Auto Flushing Station Replacement Program
 - Water Meter Replacement Program
 - Valve Chamber and Valve Replacement Program
 - Bulk Water Station Replacement Program
 - Insulation Replacement Program for Suspended Watermains
 - Water Meters Replacement Program (annual replacement of approx. 4,000 meters)
- Preventive Maintenance
 - Auto-Flushing Station Maintenance
 - Flushing of Dead-End Watermains
 - Instrumentation Maintenance (Chlorine Pocket Colorimeter, Fluoride Pocket Colorimeter, Gas Detector, Turbidity Meters, pH Meters)
 - Sampling Station Maintenance
 - Water Sampling (THM, Nitrate/Nitrite, Microbiological, Chlorine Residual, Lead, Organic, Inorganic, Fluoride, Sodium)
 - Flushing of Pressure Separation Valves
 - Unidirectional Flushing

- Air Release Valve Inspection - Clean & Exercise
- Fire Hydrant Flushing & Calibration
- Hydrant Inspection (Spring and Winter)
- Visual Suspended Watermains Inspection (annual)
- Valve Inspection & Exercising
- Pressure Reducing Valve Inspection
- Fire Hydrant Painting
- Fire Hydrant Snow Clearing/Thawing
- Valve Chamber Inspection/Maintenance
- Curb Box Operation Check and Maintenance
- Cathodic Protection of Iron Watermains
- Corrective Maintenance
 - Water Sample – Water Quality (Ad-hoc)
 - Hydrant Repair
 - Water Service – Repair or Replacement
 - Watermain Repairs and/or Modifications

5.3.3 Condition Assessment

- Curb box inspections and repairs done by contractor annually; Average of 4,000 Curb boxes are inspected per year
- Detailed Suspended Watermain Inspection - Once every 5 years
- Fire Hydrant – Two inspections annually per hydrant; Replace obsolete hydrants
- Sampling Station – Maintenance once per year
- Auto Flushing Station – Maintenance and programming twice per year
- Systems Engineering Studies:
 - Backflow Prevention Program
 - Water Leak Detection Program
 - Water Pressure Transient Monitoring Study
 - Water Distribution Calibration Model Update
 - Water Distribution Calibration of Water Quality Model Update
 - Water System Instrumentation (Transient Pressure Loggers)
 - Pilot DMA Instrumentation Program

5.3.4 Supervisory Control and Data Acquisition (SCADA) System

The City operates and maintains two continuous chlorine-monitoring stations and four district metering areas where various instrumentation exists for monitoring chlorine and water pressure.

5.3.5 Climate Change Strategy

The water distribution network within the City consists of a network of pressurized pipes. These pipes are most vulnerable at river crossings where they may experience excessive stress due to scour or erosion of riverbanks. Another particularly vulnerable location exists when pipelines cross under bridge decks. If the flood water levels reach the bridge deck or come close, the debris may strike the pipes causing them to fail.

The City will continue to assess and implement climate change initiatives related to the water supply system through continued monitoring and detailed assessment programs such as erosion site inspections and condition inspections of suspended watermains to quantify impacts and risk in order to identify and prioritize implementable initiatives. Asset Management Plans will continue to be key to ensuring a long-term and effective response to future climate changes and to ensuring long-term sustainability of City assets.

Emergency Preparedness and Business Continuity Plans are in place in the event of extreme weather. In addition, climate adaptation requirements are assessed within the asset management planning process to inform:

- Operations and preventative maintenance programs; and
- Capital rehabilitation and replacement priorities.

5.4 WASTEWATER INFRASTRUCTURE

5.4.1 Sanitary Pipes

- Existing Asset Management Strategy/Program Description:
 - Includes CCTV inspection; rehabilitation of deficient pipe sections and flushing of clogged pipes identified through CCTV inspections.
- Condition Assessment:
 - Approximately 80-85 km are inspected by closed circuit television (CCTV) inspections every year over a 10-year cycle.
- Rehabilitation/Replacement:
 - Annual rehabilitation program is in place to rehabilitate the deficient pipe sections identified through CCTV inspection.
 - The City's 25-year Life Cycle Reserve Study includes:
 - ▶ CCTV Inspection (one ten-year cycle)
 - ▶ Sanitary Sewer Main Replacement Program (Gravity and Force mains)
 - ▶ Sanitary Sewer Rehabilitation Program
 - ▶ Sanitary Sewer Pipe Upgrade (Upsizing) Program
 - ▶ Wastewater Hydraulic Model Update (every 10 years)
 - ▶ Wastewater Flow Monitoring Program (annual)
- Preventive Maintenance:
 - Sampling of Wastewater Effluent
 - Sanitary Sewer Manhole Inspection
 - Sewer Flushing Maintenance
 - Sewer Pump Station Inspection and Maintenance
 - Sewer Siphon Flushing and Cleaning
 - Sewer Video Inspection (Mainline) Sewer Lateral Inspection
- Corrective Maintenance:
 - Mainline Sewer Reaming
 - Manhole Maintenance and/or Repair
 - Repair or Replace a Sanitary Sewer
 - Trunk Sewer & Manhole Zoom Camera Inspection
 - Sanitary Sewer Backup & Blockage Investigation & Corrective Action (Mainline)
 - Sanitary Sewer Lateral Blockage Investigation & Corrective Action
 - Odour Investigation and Corrective Action
 - Sanitary Sewer Lateral – Repair or Replacement
 - Smoke and Dye Tests for Sanitary and Storm Sewers and Laterals
 - Vermin Investigation and Corrective Action
- Evaluation Criteria:
 - The City conforms to National Association of Sewer Service Companies (NASSCO) Pipe Assessment Certification Program (PACP) for all Condition rating for:
 - ▶ Structural Pipe Segments
 - ▶ Operational and Maintenance

5.4.2 Sanitary Components (Manholes)

- Condition Assessment:
 - Manholes are not condition audited.
- Rehabilitation/Replacement:
 - Minor manhole repair/replacement works are completed through annual maintenance activities by Road Operations Department.

5.4.3 Pumping Stations

- Condition Assessment:
 - The City’s five sanitary sewer pumping stations are inspected every 5 years.
- Maintenance activities
 - Routine maintenance works are carried out as per manufacturer’s recommendations.
- Rehabilitation/Replacement:
 - The City’s 25-year Life Cycle Reserve Study includes \$4.2M for pump station rehabilitation and component replacement program.

5.4.4 Supervisory Control and Data Acquisition (SCADA) System

- The City owns, operates and maintains five sanitary pump stations, where various instrumentation exists for monitoring flow.

5.4.5 Climate Change Strategy

- Climate Change is expected to result in increased annual rainfall, and potentially more extreme weather events. This may result in the following:
 - Increasing number of erosion of the asset in close proximity to watercourses;
 - Increasing number of storm events causing basement flooding/power outages;
 - Increasing amount of inflow & infiltration (I & I) into the sanitary sewer system; and
 - Increasing stress/reduced life expectancy on sanitary and storm systems.
- The City has the following safeguards in place to deal with these impacts:
 - City’s Design Standards take into consideration of potential climate change impacts.
 - An active erosion inspection, assessment and restoration program to identify and restore erosion sites across the City to protect the City’s infrastructure.
 - Implementation of a Flood Control Program to upgrade the neighborhood to become resilient to 100 years storm event.
 - An inflow & infiltration (I & I) program to reduce potential infiltration of groundwater or stormwater into the sanitary system to mitigate basement flooding.
 - Emergency Preparedness and Business Continuity Plan are in place in the event of extreme weather or power outages.
 - Redundancies in City’s pump stations and SCADA system to ensure adequate standby power.
 - Assess climate adaptation requirements within the asset management planning process to inform:
 - ▶ Operations and preventative maintenance programs; and
 - ▶ Capital rehabilitation and replacement priorities.

5.5 STORMWATER INFRASTRUCTURE

5.5.1 Storm Pipes

- Existing Asset Management Strategy/Program Description:
 - Closed circuit television (CCTV) inspections
 - Rehabilitation of deficient pipe sections and flushing of clogged pipes identified through CCTV inspections.
- Condition Assessment:
 - Approximately 80-85 km are inspected by closed circuit television (CCTV) inspections every year over a 10-year cycle
- Rehabilitation/Replacement:
 - A rehabilitation program is in place every two years to rehabilitate the deficient pipe sections identified through CCTV inspection
 - The City’s 25-year Life Cycle Reserve Study includes:
 - ▶ CCTV Inspection: Currently only one ten-year cycle is included
 - ▶ Storm Sewer Pipe Rehabilitation
 - ▶ Replacement of Storm Sewer Pipes that are at the end of their life cycle
 - ▶ Storm Sewer Pipes Emergency Repairs

- Evaluation Criteria:
 - The City conforms to National Association of Sewer Service Companies (NASSCO) Pipe Assessment Certification Program (PACP) for all Condition Ratings for:
 - ▶ Structural Pipe Segments
 - ▶ Operational and Maintenance

5.5.2 Storm Components (Manholes and Catch Basins)

- Condition Assessment:
 - Manholes and catch basins are not condition audited.
- Rehabilitation/Replacement:
 - Minor manhole and catch basin repair/replacement are completed through annual maintenance activities by Road Operations Department.

5.5.3 Outfall Structures

- Condition Assessment:
 - Outfall structures visual condition inspection is carried out every four years.
 - Out of a total inventory of 367 outfalls, 245 (67 per cent) outfall structures have been condition assessed as of 2020.
- Maintenance Activity
 - Maintenance activities are carried out on as-required basis.
- Rehabilitation/Replacement:
 - A rehabilitation program is in place every four years for selected outfall structures.
 - The City's 25-year Life Cycle Reserve Study includes:
 - ▶ Outfall Inspections
 - ▶ Outfall Rehabilitation Works
 - The rehabilitation cost varies based on the condition assessment and is location specific over 25-year period.
- Evaluation Criteria:
 - Outfall structures are inspected based on Ontario Structures Inspection Manual (OSIM) by the Ministry of Transportation. This inspection is not legislated.

5.5.4 Climate Change Strategy

- Refer to Section 5.4.5

5.6 STORMWATER MANAGEMENT (SWM) PONDS / NATURAL INFRASTRUCTURE

5.6.1 Wet Ponds

- Condition Assessment:
 - The City has 57 wet ponds.
 - The City has a condition inspection program for wet ponds every two years where approximately 10-15 ponds are inspected for sediment levels through bathymetric surveys, and conditions of inlet/outlet control structures are visually assessed. Work includes updating the SWM pond database, sediment level of ponds, inspection of inlet/outlet structures and site restoration works as required.
- Rehabilitation/Replacement:
 - The City has a program to clean the sediment that is location based on an as-required basis to ensure that the approved quality control function of the pond is maintained. Sediment removal location is selected through the condition inspection program.

- The City's 25-year Life Cycle Reserve Study includes:
 - ▶ SWM Wet Ponds Inspection
 - ▶ SWM Wet Ponds Sediment Removal and Restoration Works
 - ▶ SWM Wet Ponds Maintenance
 - ▶ Pond Retrofit Study Update
 - ▶ Pond Retrofit Implementation
 - ▶ Swan Lake Chemical Treatment (phoslock application)
 - ▶ Water Quality Monitoring
- Maintenance Activities:
 - In order for the wet ponds to function efficiently, maintenance is required. Maintenance work includes repairing/replacing grates, minor repairs to headwalls, railings, inlet/outlet structures, fence and debris cleanup etc.
- Evaluation Criteria:
 - As per Ministry of the Environment, Conservation and Parks (MECP) Environmental Compliance Approval (ECA) requirements, a pond should be cleaned to avoid reduction of capacity of the pond, assumed to occur when five per cent of the facility treatment efficiency is lost through capacity reduction, or when the percentage of accumulated sediment is more than 15-30 per cent of the pool volume. The owner shall ensure that sediment is removed from pond at such a frequency as to prevent the excessive build up and potential overflow of sediment into the receiving watercourse.

5.6.2 Dry Ponds

- Condition Assessment:
 - The City has 41 dry ponds
 - Currently there is no condition inspection program for dry ponds.
- Rehabilitation/Replacement:
 - Accumulation is not expected for dry ponds. Hence, no sediment cleaning is required for dry ponds.
 - The City's 25-year Life Cycle Reserve Study does not include any dry ponds due to nature of the asset.
- Evaluation Criteria:
 - The City is currently re-evaluating a condition audit/maintenance program.

5.6.3 Underground Storage Tanks

- Condition Assessment:
 - There are currently five underground concrete tanks. The tanks are inspected every five years.
- Rehabilitation/Replacement:
 - The tanks are replaced at the end of their service life. Since the service life of these assets is beyond 25 years, they are not included in the City's 25-year Life Cycle Reserve Study. However, the 25-year Life Cycle includes sediment cleaning every five years.

5.6.4 Oil Grit Separators (OGS)

- Condition Assessment:
 - All OGS units are inspected bi-annually per manufacturer's recommendations.
- Maintenance activity:
 - OGS units are cleaned based on the condition inspection results.
- Rehabilitation/Replacement:
 - OGS are replaced at the end of their service life. Since the service life of these assets is beyond 25 years, they are not included in the City's 25-year Life Cycle Reserve Study. However, the 25-year Life Cycle includes annual sediment cleaning based on the results of condition inspection.

5.6.5 Pumping Stations

- Condition Assessment:
 - The two stormwater pumping stations are inspected every five years.
- Maintenance Activity
 - Routine maintenance is carried out as per manufacturer's recommendations.
- Rehabilitation/Replacement:
 - City's 25-year Life Cycle Reserve Study includes \$7.6M for various pump station component replacements.

5.6.6 Erosion Sites

- Condition Assessment:
 - The City's erosion restoration program has been set up to complete restoration where the movement of the natural drainage system impacts the environment or public health and safety
 - In 2013/2014, the City developed an Erosion Master Plan and identified the top 30 erosion sites for rehabilitation
 - In 2019, The City completed an Environmental Assessment for East Don Tributary and updated the Five Year Erosion Restoration Plan
 - Inspection Frequency:
 - ▶ Sites with high risk are inspected multiple times (2-4) times per year
 - ▶ Sites with medium-high risk of failure are inspected annually
 - ▶ Sites with low risk of failure are inspected on a five year cycle
 - ▶ Site prioritization is updated on an annual basis
 - Erosion Master Plan will be updated in 2023
- Rehabilitation/Replacement:
 - Based on the 2013/2014 Erosion Master Plan Study, 30 erosion restoration projects were completed between 2014 - 2019
 - The City's 25-year Life Cycle Reserve Study include:
 - ▶ Erosion Restoration Study update
 - ▶ 75 erosion sites for remediation within 25 years, approximately three sites are restored every year
 - No formal maintenance program for erosion site.
- Evaluation Criteria:
 - As part of Class EA, the Environmental Study Report (ESR) needs to be updated on a five- year basis to ensure consistency with new policies and to update priorities due to changes of erosion conditions over time.

5.6.7 Storm Channel (Don Mills Channel, Rodick / Miller Ditch)

- Condition Assessment:
 - The City has an easement along the majority of the Don Mills Channel and the condition has been assessed as part of the Erosion Master Plan Study. Culverts along the Channel are assessed under the Structures Program.
- Rehabilitation/Replacement:
 - A Municipal Class Environmental Assessment Study has been completed for the Don Mills Channel and study outcomes are to be implemented from 2023 to 2030.
 - Annual maintenance activities include removal of vegetation, overgrowth and debris to ensure proper storm water conveyance, included in the City's 25-year Life Cycle Reserve Study.
- Evaluation Criteria:
 - Cleaning to maintain treatment efficiency and taking steps to ensure public health and safety.

5.6.8 Climate Change Strategy

- Refer to Section 5.4.5

5.7 STRUCTURE – VEHICULAR BRIDGES, PEDESTRIAN BRIDGES, CULVERTS

5.7.1 Existing Asset Management Strategy / Program Description

- Condition Assessment:
 - The City has an annual detailed condition inspection program for vehicular bridges, pedestrian bridges, culverts and boardwalks.
 - As per this program, all bridges (vehicular and pedestrian) and culverts over 3 metres are assessed every other year (biennial basis) in accordance with the OSIM (Ontario Structure Inspection Manual). Culverts less than a three metre span are assessed every four years, if they are in good condition.
 - All vehicular bridges, pedestrian bridges and culverts have been condition assessed as of December 2020.

- Rehabilitation/Replacement:
 - The City has an annual Structures Rehabilitation/Replacement Program for vehicular bridges, pedestrian bridges, culverts and boardwalks.
 - The annual amount allocated in this program varies each year based on the quantity and condition of the asset.
 - All vehicular bridges, pedestrian bridges and culverts have been captured in the 25-year Life Cycle Reserve Program (2020). Ten boardwalks that were constructed as part of Multi-use Pathway (MUP) are captured in the 25-years Life Cycle Reserve Program.
 - The 25-year Life Cycle (2020) Reserve Program includes:
 - ▶ Rehabilitation Works for Vehicular Bridges
 - ▶ Rehabilitation Works for Pedestrian Bridges and Boardwalks
 - ▶ Rehabilitation Works for Culverts
 - ▶ MNR Monitoring for Capital Projects
 - ▶ Structure Preventive Maintenance
 - ▶ Structures Annual OSIM Inspection
 - ▶ Confined Space Assessment for culverts
 - ▶ Toogood Dam Inspection and Rehabilitation

The City has the following annual maintenance activities for vehicular bridges, pedestrian bridges and culverts:

- Vehicular bridges are washed every year in spring.
- Bridge Preventive maintenance is an annual program (for both vehicle and pedestrian bridges). The work includes asphalt, concrete and wood repairs.
- Pedestrian bridges and culverts - There are no planned maintenance activities for pedestrian bridges and culverts.

5.7.2 Condition Audits

- Vehicular bridges, pedestrian bridges and culverts over a three metre span are inspected on a biennial basis (once every two years) in accordance with the OSIM 2008 (Ontario Structure Inspection Manual by the Ministry of Transportation).
- Every year, staff identifies the structures to be visually inspected as per OSIM requirements. The City also performs CCTV inspections for all culverts that are less than 1.2m diameter irrespective of their material type every four years.

5.7.3 Evaluation Criteria

- All vehicular bridge, pedestrian bridge and culvert inspections are performed by or under the guidance of, a structural engineer, and include such information as structure type, dimensions and span lengths, other key attribute data, detailed photo images, and structure element by element inspection, rating and recommendations for repair, rehabilitation, and replacement.
- Based on the inspection of each structure, a Bridge Condition Index (BCI) is allocated for all structures by qualified Licensed Engineer. For BCI, each element of the structure is inspected in accordance with Ministry of Transportation (MTO) Ontario Structures Inspection Manual (OSIM, 2008) and is rated according to three condition states ((good, fair and poor). The weighted average of all structural elements and their condition states is then summarized in a Bridge Condition Index (BCI) using MTO specifications.

5.7.4 Climate Change Strategy

The City will continue to assess and implement climate change initiatives related to the structures (bridges and culverts) through continued monitoring and detailed assessment programs such as OSIM condition inspections. Such programs will help to quantify impacts and risk in order to identify and prioritize implementable initiatives through business planning and asset management planning processes to ensure a well-positioned and proactive approach. Asset management plans will continue to be key to ensuring a long term and effective response to future climate changes and to ensuring long-term sustainability of City assets.

5.8 STREETLIGHTS

5.8.1 Streetlight Poles

- Existing Asset Management Strategy/Program Description Program description:
 - Condition assessment
 - Annual program to replace, rehabilitate and repair deteriorated streetlight poles and components.
- Condition Assessment:
 - Streetlight pole inspection program is scheduled every three years with approximately 5,000 to 8,000 poles inspected during each inspection cycle.
 - Streetlight poles that are older than 15 years are inspected once in nine years. Poles that are in fair to poor condition are candidates for re-inspection every three to six years.
 - As of 2020, all City-owned streetlight poles have been inspected at least once since 2013.
- Rehabilitation/Replacement:
 - Based on the condition inspection results, streetlight poles are either replaced or rehabilitated based on their condition priority.
 - The City's 25-year Life Cycle Reserve Study includes:
 - ▶ Pole Condition Inspection
 - ▶ Pole Replacement - Due to service life of the poles, not all the poles are captured under the City's 25-year Life Cycle Reserve Study. Replacement of 2,725 poles (average age – 57 years) out of a total inventory of 25,182 poles, has been included in 2020 Life Cycle.
 - ▶ Pole Rehabilitation
 - ▶ Pole component repairs/replacement (hand holes, foundations, brackets etc.)
 - The City has an annual maintenance program which includes maintenance of the street lighting system, emergency repairs to the damaged poles and fixtures, replacement of burned out bulbs, ballasts, light sensors, fixtures (based on residents' complaints to the City's Contact Centre and outages reported by the City's night patrols), re-lamping of HPS fixtures where bulbs are replaced and fixtures are cleaned on a 5 year cycle, underground and overhead supply line repairs and locating services for underground streetlight infrastructure.
- Evaluation Criteria:
 - Level 1: No concerns; minor, non-critical deficiencies;
 - Level 2: Deficiency identified with potential to deteriorate to point of failure; monitoring recommended; and
 - Level 3: Serious deficiency or safety concern; remediation, immediate repair or replacement recommended.

5.8.2 Underground Streetlight Cables

- Existing Asset Management Strategy/Program Description:
 - Condition Assessment Program
 - Annual program to replace, rehabilitate and repair deteriorated streetlight cables; maintenance program.
- Condition Assessment:
 - Cable condition inspection program is scheduled for every five years based on condition index and Megger testing techniques. Condition Index is a visual inspection of the underground streetlight cables based on their age and condition of the fuse, hand hole, cable and connector condition. For those segments where cable and connector condition were reported to be “fair”, a Megger test is performed. The Megger test is a non-destructive method of testing using an insulation resistance meter to verify the condition of electrical insulation. The test collects data about continuity, resistance and insulation integrity. The combined results are used to compute the overall health index to determine which cable section requires replacement.
 - As of 2020, 354 km of cables out of a total inventory of 1,025 km (approx. 35per cent) have been inspected.
- Rehabilitation/Replacement:
 - Based on the condition inspection results, deficient streetlight cables are replaced/repared every two years after each inspection cycle.
 - The City's 25-year Life Cycle Reserve Study include:
 - ▶ Condition Inspection Program – Currently accounts for only 500 km of cable lengths within 25 years.
 - ▶ Cable Replacement/Rehabilitation Program - Currently accounts for only 388 km (average age 53 years) of cable lengths. Due to the average service life of the cables, not all the cables are captured under the City's 25-year Life Cycle Reserve Study.

- Evaluation Criteria:
 - Overall Health Index through visual inspection based on age, fuse, hand hole and cable/connector's condition.

5.8.3 Streetlight Fixtures

- Condition Assessment:
 - Majority of the LED fixtures are monitored through Philips Starsense software system, therefore condition assessment is not required.
 - HPS fixtures are not condition assessed, deficiencies are identified through routine patrols, resident calls, etc.
 - The City inspects all luminaires twice a year to check to see they are functioning per O. Reg. 239/02.
- Rehabilitation/Replacement:
 - Deficient fixtures are replaced via the annual streetlight infrastructure maintenance program within the Operating budget as required.
 - City's 25-year Life Cycle Reserve Study includes LED fixtures (decorative and cobra head). HPS fixtures are not included in the City's 25-year Life Cycle Reserve Study.
 - Maintenance program includes washing the LED and re-lamping the HPS lamps every five years through the City's operating budget.

5.8.4 Segment Controllers

- Condition Assessment:
 - Segment controllers are not condition assessed. They need to be replaced every 10 years in line with the evolving technology.
- Rehabilitation/Replacement:
 - Program to replace these assets every 10 years due to technology obsolescence is included in the City's 25-year Life Cycle Reserve Study.
 - There is no maintenance program associated with this asset.

5.8.5 Climate Change Strategy

- The City is contributing to a climate ready City by installing energy efficient technology, such as Light Emitting Diode (LED) streetlights, in all new neighbourhoods since 2014.
- To date, as part of the City's LED conversion program, approx. 12,500 existing HPS cobra-head fixtures have been converted to LED, reducing total energy consumption by approximately 5,297,128 kilowatt-hours annually and reducing greenhouse gas emissions.
- Energy efficiency contributes to resiliency by lowering energy demand. This allows current supply to meet potential future demand growth.
- Use of energy efficient LED technology in street lighting is in line with the City's Sustainability initiatives and moves closer to the Greenprint's Energy and Climate objective of zero energy and emissions by 2050.
- LED luminaires meet the requirements of the International Dark-Sky Association (IDA) as dark-sky friendly by eliminating 'up light' that produces obtrusive sky glow from streetlights.

5.9 ROADS AND SAFETY DEVICES

5.9.1 Road Surface & Base

- Existing Asset Management Strategy/Program Description: includes condition assessment; complete road segment rehabilitation inclusive of identified asphalt resurfacing strategies, concrete curb and sidewalk, catch basin and manhole repair; and maintenance activities.
- Condition Assessment:
 - A consultant is hired to use mechanical testing equipment to evaluate road surface condition and produce an overall condition index (OCI). This index is then used to identify the poorest sections of the road network. Testing is completed every two years and becomes the basis for further evaluation to select roads for repair. The 2,223 lane km of the roads are condition audited every other year.
 - In addition to the consultant, regular road patrol identifies locations for temporary and permanent repairs.

- Rehabilitation/Replacement:
 - Markham's pavement management program incorporate sustainable elements focusing on community, economic and environmental drivers, with the following three goals:
 - ▶ Maintain high ratio of roads rated good or very good (Socially focused)
 - ▶ Reduce the overall life cycle cost (Economically focused, fiscally and financially prudent)
 - ▶ Reduce the environmental impacts of rehabilitation/replacement (Environmentally focused)

The Pavement Preservation Strategy has been in place since 2010, where an estimated annual savings of \$1.3M to \$1.9M over the entire network since implemented.

Based on the pavement evaluation on each road section every two years, the City determines which roads are suitable candidates for rehabilitation. Once a pavement segment's Pavement Condition Index (PCI) falls below a predetermined threshold level, it becomes a candidate for rehabilitation. Subsequently, staff utilizes pre-engineering data and Annual Average Daily Traffic (AADT) volumes to assess the structural capacity of the potential candidates and confirms the feasibility of in-place asphalt recycling. The City then hires a consultant to perform a pavement evaluation and subsequent design, considering all of the potential rehabilitation strategies such as Full Depth Reclamation (FDR) with Foamed Asphalt, and mill and overlay, with and without the use of a Stress Absorbing Membrane Interlayer.

Through the City's routine condition assessment and rehabilitation/replacement program, the City proactively preserves the roads to prolong their service life. Roads are categorized to three different classification with its targeted PCI ranking. The target PCI for Arterial roads, Major/Minor Collectors and Local/Laneway is 80 per cent, 75 per cent and 70 per cent respectively. The City established the PCI target based the University of Waterloo and Ontario Good Road Association (OGRA) pavement management reference materials.

The City of Markham's road preservation and rehabilitation program strategy is to achieve 80 per cent of the entire road network meeting its PCI targets (i.e. Very Good Condition). The attached maps shown the current status of PCI condition of each classification of road with respect to the defined target level of service.

The current Overall Condition Index of the City road network is 79.87 per cent, which proven the City's pavement preservation and rehabilitation strategy help reduce maintenance costs and extending the life cycle of the pavement.

- An annual resurfacing program of approximately 15-20km is in place where select sections of roadway are repaired based on condition rating vs. target level of service, traffic volumes and budget availability.
- The City's 25-year Life Cycle Reserve Study include 15-20 km resurfacing per year only. The total lane kilometre of roads is not included in the 25-year Life Cycle Reserve Study because it is dependent on condition assessment and prioritized accordingly every year.
- The 25-year Life Cycle Reserve Study includes the following components:
 - Asphalt Rehabilitation (sub base, curb and sidewalk, preservation, steel, FTE) – varies every year, includes approximately 15-20 km.
 - Asphalt-Asphalt Inspection.
 - Asphalt-AC Index – is only incorporated into the life cycle reserve for five year cycle as it is based on the renewal of the contract that is highly dependent on posted price of crude oil.
 - Asphalt-Route and Seal.
- The City has the following annual maintenance activities:
 - Localized asphalt repair - provides repairs to specific locations of the road network.
 - Pothole repairs - utilize artificial intelligence to inspect the road network to identify and keep track of potholes.
 - Minor manhole and catch basin repair/replacement.
- Evaluation Criteria - Empirical OCI data is used to identify roads in most need of repairs. Further subjective evaluations are completed to confirm empirical data and to evaluate the importance of roadway within the transportation network. OCI criteria is rebalanced periodically to ensure quality results

5.9.2 Curbs & Sidewalks

- Existing Asset Management Strategy/Program Description: In addition to the curb and sidewalk embedded in the Road Surface and Base (resurfacing) program, there is an annual localized repair program which repairs deficient concrete curb and sidewalk City wide. The deficiencies are prioritized every year and repaired within the annual budget allowance. Segments not repaired are recorded and prioritized for next year's repair program.
- Condition Assessment:
 - Sidewalks are patrolled once per year and through road patrol identifies deficient locations in alignment with Minimum Maintenance Standards, O. Reg. 239/02.
 - Curb deficiencies are identified through road patrols, resident calls, etc.
- The City has the following annual maintenance activities:
 - Eliminating trip edges of sidewalks includes grinding, asphalt ramping and mortar repairs.
- Annual program is included in the 25-year Life Cycle Reserve Study.
- Evaluation Criteria
 - Sidewalk - Trip ledges greater than 20mm, O. Reg. 239/02
 - Curb – N/A

5.9.3 Parking Lots

- Existing Asset Management Strategy/Program Description: condition assessment, annual replacement program supported by localized repair.
- Condition Assessment: 101 parking lots are visually condition inspected Bi- annually.
- Rehabilitation/Replacement:
 - Rehabilitation - The City has an annual program for the removal and replacement of concrete, interlock and asphalt infrastructure. The annual amount allocated in this program varies each year based on condition and location of the asset. All 101 parking lots are accounted for in the 25-year Life Cycle Reserve Study.
 - Localized repairs – Annual maintenance and repairs include localized repairs, maintenance holes and catch basin adjustments. The locations are prioritized annually.
- The City has the following annual maintenance activities:
 - Pothole repair, catch basin repair/replacement.
 - Snow removal, line marking and painting.
- Evaluation Criteria – Subjective evaluation based field inspection of surface and support apparatus, based on defects, age and frequency of use of the lot.

5.9.4 Safety Devices: Guide Rail

- Existing Asset Management Strategy / Program Description: condition assessment, annual replacement program supported by localized repair.
- Condition Assessment: Guide rail deficiencies are identified through road patrols, resident calls, etc.
- Rehabilitation/Replacement:
 - Rehabilitation - The City has an annual program for replacement guide rail and recently documented guide rail end treatment replacement in the asset inventory. End treatment is required to be in compliance with provincial engineering guideline and requirements. The annual amount allocated in this program varies each year based on condition and location of the asset. All 14.7 km are accounted for in the 25-year Life Cycle Reserve Study.
 - Localized repairs – Annual maintenance and repairs are performed.
- Evaluation Criteria – Subjective evaluation based field inspection of guide rail based on if the posts are rotten, failing, and those requiring upgrading to current OPSD standards.

5.9.5 Safety Devices: Railway Crossing

- Existing Asset Management Strategy / Program Description: condition assessment, location specific rehabilitation program of level crossings to ensure vehicular and pedestrian safety. There are no operating and maintenance impacts on this program.
- Condition Assessment: 13 Locations are visually condition inspected annually.
- Rehabilitation/Replacement: Based on the condition audit, each crossing is identified for either grind-and-pave operation once every seven years, or full depth removal and replacement of rubber rail. All 13 locations are accounted for in the 25-year Life Cycle Reserve Study.
- Evaluation Criteria: Subjective field inspection evaluation based on if there are trip ledges near rails, condition of pedestrian crossing areas adjacent to roadway, condition of rubber mud rail, movement of rails affecting structural integrity of adjacent asphalt, approach areas.

5.9.6 Safety Devices: Fencing / Retaining Wall / Entrance Features

- Existing Asset Management Strategy / Program Description: Not condition assessed, annual replacement program supported by localized repair.
- Condition Assessment:
 - The inventory has been updated to capture the fencing, retaining wall and entrance features that are in public right-of-way. Deficiencies are identified through patrols, resident calls, etc.
- Rehabilitation/Replacement:
 - An annual replacement program of deficient assets located within the City's property and is included in the 25-year Life Cycle Reserves.
 - Localized repairs – Annual maintenance and repairs are performed.
- Evaluation Criteria: Subjective evaluation based field inspection based on:
 - Fence - deficient material, decaying, leaning, or rotten wooden
 - Retaining wall - spalling, missing coping stone, leaning, vandalized, damaged due to vehicular accidents

5.9.7 Safety Devices: Signs

- Existing Asset Management Strategy / Program Description: Condition assessed for Regulatory and Warning Sign only, annual maintenance / replacement program.
- Condition Assessment:
 - Regulatory and Warning Signs - Minimum Maintenance Standards dictate a Reflectivity Program. Reflectivity is measured against industry standard yearly.
 - Inventory update is in progress to capture the signs.
 - Deficiencies are identified through patrols, resident calls, etc.
- Rehabilitation/Replacement: City has an annual maintenance and replacement program.
- Evaluation Criteria: Minimum Maintenance Standards set out criteria for replacement of Regulatory and Warning Signs.

5.9.8 Climate Change Strategy

The City's Operations Department has engaged the University of Waterloo and other industry leaders in numerous research papers and strategies, all intended to extend the life of our road pavement. The City's pavement preservation and rehabilitation program reduces the environmental footprint while employing various technologies to achieve a financially sustainable program.

The City continues to improve standards for road construction and survey technologies to inspect the pavement condition to monitor the road network. Furthermore, The City has a fulsome maintenance program focusing on preventative maintenance.

More details on the road maintenance program are outlined below:

- Preserve the road by proactively treating the surface early in its life to prolong its state of good repair and reduce the need for raw material and energy required by full reconstruction strategies – primary preservation treatment applied is micro-surfacing
- Strengthen roads during rehabilitation for longer life. Revise standards for new road construction to reflect a longer life cycle – using various design such as the Expanded Asphalt Stabilization (EAS) technique.

- Trial green technologies such as warm asphalt mix designs to reduce emissions, save energy, and use recycled aggregate and asphalt roofing shingles in order to reduce use of virgin material, and divert shingles from landfill.
- Monitor, track performance, and survey pavement condition on a regular two year cycle to monitor the network's overall level of service and ensure the road network remains in good repairs.

The key of the program to minimize climate change impact is to apply the right strategies to the right locations at the right time. Taking a proactive approach to preserve the existing assets in a timely manner is the key to achieving a state of good repair of the entire road network, and eventually reducing the overall cost and environmental and social impact.

5.10 FACILITIES

The City's strategy for successfully delivering the set levels of service for its facilities are given below. These strategies relate to ongoing monitoring of facility components, evaluation of underperforming components requiring preventive maintenance or replacement and capital life cycle planning of major rehabilitation/replacement of facility components.

5.10.1 Existing Asset Management Strategy / Program Description:

- Building condition audits are completed every 10 years;
- Annual reviews of the building components due for rehabilitation/replacement over the next two years;
- Replacement/repairs program on building components as required; and
- Preventive maintenance activities.

5.10.2 Rehabilitation/Replacement:

- Repairs/replacement - The City has an annual life cycle program for repairs/replacement of building components. The annual amount allocated varies each year based on the annual review and 10-year building condition audit results. Each facility has a 25-year Life Cycle Reserve Study to ensure that funding for future capital works is available.
- Programs – A plan that is implemented city wide and not specific to one building. The plan helps the City to ensure that minimum standards are met (e.g. dark-sky compliant light fixtures) and that projects are completed to meet corporate strategic goals (e.g. AODA compliance). Facility related programs are also included in the Life Cycle Reserve Study as shown below
 - Accessibility improvement to meet or exceed AODA (Accessibility for Ontarians with Disabilities Act) and Markham's Accessibility Design Guidelines
 - Corporate security operations and system improvements
 - Designated substance management program
 - Parking lot lights replacement program
 - Roofing replacement program
 - Municipal building backflow prevention program; and
 - Corporate accommodation program
- Annual maintenance activities required to operate the buildings and maintain the targeted levels of service are included as part of the annual operating budget, including over 20 City wide maintenance contracts (e.g. janitorial, elevator, ESA, Emergency generator, Roofing, Mechanical maintenance etc.)

5.10.3 Evaluation Criteria:

The condition of each component of a facility is evaluated based on year of installation, typical life cycle of the component, frequency of use, reported issues, recent repairs and overall functional quality. Most components such as flooring, painting, and ceiling are evaluated through visual inspections. Technical components such as electrical, fire systems are evaluated by licensed contractors or specialized professionals on an as required basis.

The City recently reviewed and changed its evaluation criteria for the condition for each component from a three scale rating to a 5 point rating. The new scale is as follows 'Very Good', 'Good', 'Fair', 'Poor' or 'Very Poor' based on the component condition, design fulfillment and service level. The Life Cycle Reserve Study is used to develop annual repair/replacement programs and it is being updated to reflect the five point rating. Components rated as 'Very Good' are in life cycle plan for longer term replacement or repair. Components rated as 'Fair' are planned for shorter term replacement. Components rated as 'Very Poor' are planned for immediate (soonest possible) replacement or repair.

5.10.4 Climate Change Strategy

New Construction & Major Renovation

New buildings constructed for a growing population will result in increased energy consumption, water, waste, and GHG emissions in the City. To mitigate these impacts, the City of Markham has pursued a sustainable approach to growth since 2009 by ensuring all new facilities, and major renovations to existing buildings, are designed and constructed to higher energy efficiency and sustainability standards beyond those set forth in the Ontario Building Code (OBC).

In addition to meeting OBC requirements, all new buildings (and major renovations) aim to achieve:

- LEED Silver or higher,
- Designed as 'solar-ready', and
- Connect to Markham District Energy's efficient district energy system, where feasible.

Existing Building Modifications

Additionally, in 2014 the City adopted higher energy-efficiency standards for equipment replacement that are incorporated in the long-term planning and life cycle asset renewal process. This strategy is advantageous because the City is better able to leverage the capital renewal schedule and a zero-over-time approach to retrofit existing facilities to lower energy consumption and carbon emissions. When equipment, systems, and components in facilities have reached the end of their service life and are due for replacement, the new equipment should aim to achieve:

- Minimum energy-efficiency criteria as outlined in the latest version of ASHRAE Standard 90.1

This approach focuses on long-term planning to deliver a series of cost effective incremental projects over time that, together, can amount to zero energy emissions for the entire building portfolio.

Increased Community Resilience

Community resilience is defined as a community's reduction of, and preparation for risk. Energy efficiency can support community resilience by strengthening local energy systems and delivering more reliable and affordable energy for the local governments, households and businesses.

Detailed throughout the 2019 Corporate Energy Management Plan (CEMP), the City values the importance of increasing community resilience and prioritizes initiatives that enhance our ability to build more reliable, healthy, resilient, and sustainable infrastructure.

Energy Efficiency Measure	Resilience implications	Markham examples
Microgrids	Cost-effective heating, cooling, and/or electricity using local energy sources. Can reduce peak power demand, GHG emissions, and provide backup power during emergencies. Can provide cost savings	Markham District Energy, net-metered solar, Combined Heat and Power (CHP), geothermal
Energy efficiency programs	Increases reliability, resilience against extreme weather events, and indoor air quality. Reduces energy consumption, costs, GHG emissions, and exposure to rate fluctuations	Over 200 energy initiatives implemented since 2013
Demand Management programs	Decreases stress on utility grid, ability to respond to system emergencies, reduces costs, and can provide revenue source	Demand Response, peak reduction initiatives, EV Workplace Charging Pilot

5.11 TRAFFIC SIGNALS

5.11.1 Condition Assessment

Condition assessments are completed twice annually (spring and fall) through visual and physical inspection by qualified electrical contractors for above ground infrastructure only. Below ground infrastructure are not condition assessed.

5.11.2 Rehabilitation/Replacement:

The City has an annual program for replacement of signal equipment that has reached the end of its expected life. The annual amount allocated in this program varies each year based on the condition and location of the asset. All 92 signalized intersections and their associated components are accounted for in the 25-year Life Cycle Reserve Study. However, if conditions assessment identifies that such equipment is still in good operating condition, replacement will be deferred to a future year. Replacement scheduling is based on anticipated life cycle derived based on industry standard and benchmarking against other municipalities.

Preventative maintenance practices are completed twice annually, with minor repairs completed on an as-needed basis. Where possible, major preventative replacements are recorded and prioritized for incorporation into the following year’s capital budget, while failures/emergencies are addressed immediately.

5.11.3 Evaluation Criteria

Above-ground equipment is visually and physically inspected twice annually. There are no defined criteria to determine replacement requirements. Any minor repair or replacements are accomplished during inspection. Any repairs or replacements that are may pose a pressing (although not emergency) concern and require attention is documented by the maintenance contractor and submitted to the City for approval prior to executing repairs.

5.11.4 Climate Change Strategy

With respect to traffic signal assets, the City is taking any opportunity to adopt greener initiatives through the procurement of equipment that uses less energy (i.e. LED vehicular/pedestrian signal indications) and conducting regular condition assessment reviews in accordance with the Minimum Maintenance Standards for Municipal Highways to reduce unnecessary asset replacement resulting in a lower carbon footprint.

Signalized intersections across the City have been upgraded to meet the regulations of the Accessibility for Ontarians with Disabilities Act (AODA) through the City’s pedestrian accessibility improvement program. In addition, the City takes advantage of opportunities to upgrade intersections to accommodate cycling infrastructure (e.g. traffic signals for cyclists), where applicable. While making City facilities more accessible for vulnerable road users of all ages and abilities, these upgrades improve intersection safety and encourage the use of active transportation to reduce emissions.

The City is also working to upgrade the traffic controller systems to facilitate traffic signal coordination on the Denison Street and Main Street Markham corridors. A completed feasibility study has shown that the use of traffic signal coordination on these corridors can result in the following:

- Annual delay savings of 44,250 hours;
- Annual fuel savings of 8,450,250 litres; and
- Annual stop savings (i.e. number of vehicular stops) of 434,250.

The total monetized value of these annual savings amount to an estimated \$6.75M.

5.12 PARKS

Existing Asset Management Strategy / Program Description: condition assessment, annual replacement program supported by localized repair.

5.12.1 Sports Fields:

- Asset Management Strategy / Program Description - This is an annual program that involves the annual inspections and rehabilitation of the approximately 200 sports fields every season.
- Condition Assessment: Sports fields are inspected/reviewed four times a year.
- Evaluation Criteria: Based on condition assessment, use, field type and location.
- Rehabilitation/replacement: The fields are assessed and work is allocated according to those that require immediate attention. The 25-year Life Cycle reserve study allocates approximately \$3.3M each year. As a result a maintenance program is continued throughout the season that involves top-dressing, aerating, over-seeding, sodding, and fertilizing, as well as having at least one crew in the parks weekly to inspect bleachers and cut fields.
- Artificial turf fields are subject to their own program and are included in the 25-year Life Cycle Reserve Study and are inspected weekly and audited yearly.
- Protective netting is subject to monthly inspections and twice yearly condition assessment.

5.12.2 Electrical Structures/Lighting:

- Asset Management Strategy/Program Description - There is an annual program for repair and replacement however budget varies from year to year depending on inspections.
- Condition Assessment: All structures/lighting inspected once a year. Annual inspection of all lighting occurs every spring. Staff and various user groups continue to use lighting throughout the operating season and provide information to Operations of any deficiencies for repair or replacement.
- Evaluation Criteria: Based on condition assessment.
- Rehabilitation/Replacement: All lighting is being replaced with efficient environmentally friendly LED lighting the approximate capital project is estimated at \$416,400. An annual re-lamping program is performed every five years and includes the replacement of bulbs, blown ballasts, cables and broken lenses. Replacements are based on the life cycle analysis and actual condition after inspections. Operations retains an Electrical Consultant yearly to provide an independent assessment with costs.
- Annual maintenance as required.
- There is currently no information on age and inventory of parks pathway lighting.

5.12.3 Park Structures:

- Water play (splash pads) are inspected daily, and crews are in parks at least once a week overseeing the condition of the structures. Structures are inspected weekly as part of maintenance operations with repairs being performed as required on a yearly basis outside of life cycle replacements.
- Park Amenities: Parks Operations supervisors inspect amenities such as benches, waste receptacles, bike racks, picnic tables, game tables and Moloks as part of their weekly inspections. Parks Operations staff attends to waste receptacles, and recycling bins at least once a week. Moloks are inspected twice a week in the summer months and monthly throughout the winter season. Condition audits are conducted once a year. Crews are in parks all year emptying trash receptacles (at least once a week), removing damaged bins and reporting any damage or repairs necessary.
- Playgrounds: As per CSA guidelines, all 229 playgrounds are inspected twice a month from April 1st to October 31st and splash pads are inspected weekly throughout the operating season, with an annual audit performed by consultant. Average asset age is not available as there have been replacements to the older playgrounds and data is not available. Updates have been made to identify replacement playgrounds, age, costs, and life cycle cost consistent with three year average awards.
- Pathways: Existing annual programs for resurfacing and stairway repairs assess conditions once a year, and inspections occur weekly from April 1st to October 31st. The approximate yearly cost based on a three year average is \$326,900. The maintenance of these assets includes but is not limited to grading, adding material, blowing off debris, repairs due to tree roots. An improved inspection program and current inventory is needed to better address life cycle issues.

- Courts and Court Fencing are inspected monthly and audited yearly
- Trees (Forestry): Block pruning is performed every eight years. Forestry crews respond to residential concerns/ inquiries about trees on a regular basis using current inventory to track issues of the City's inventory of 177,368 trees.
- Replacements are tracked yearly and carried out within 12 months of the stump removal
- Irrigation: A program is in place where the irrigation systems are serviced in both the spring and fall, and repairs are completed throughout the season where needed from inspection on a yearly basis. Systems are tested in the spring for leaks and other problems, and again in the fall when blown out for the winter. Issues addressed weekly as required.

5.13 FLEET

5.13.1 Existing Asset Management Strategy / Program Description - Overview

The Corporate Fleet Maintenance and Management Policy identifies the baseline criteria established for the fleet refurbishing and fleet replacement programs. The City's Life Cycle Reserve is the source of funding for both these programs. The refurbishing program has an annual amount of approximately \$30,000. The replacement program has an annual amount that varies each year based on the number of units recommended for replacement, based on age and annually assessed condition. Fleet Services monitors use of assets through specific maintenance schedules and data that highlight fleet and equipment that require replacement. This reduces down time of vehicles and equipment and increases efficiency. Maintenance of fleet and equipment is in accordance with the performance standards set out in the Highway Traffic Act regulations.

Various maintenance programs exist, such as Fleet refurbishing, which is an annual program that includes refurbishing and corrosion protection at approximately \$30,000 per year. The activities involved in this process include body work and other repairs that extend an asset's useful life to meet or exceed its anticipated replacement timeframe.

A Life Cycle Replacement program exists and utilizes parameters that identify the most cost effective time period for replacement or optimal replacement interval (ORI). The ORI program considers fleet unit downtime, operating and maintenance costs, reliability and serviceability as factors in performing fleet condition audits/assessments identified in each year's replacement program schedule.

5.13.2 Condition Audits

All units are inspected at scheduled preventative maintenance service intervals and tracked in Fleet Maintenance software program flagging exceptions that may accelerate or defer units that are outside set criteria as identified in the Fleet Policy.

5.13.3 Evaluation Criteria

Scheduled maintenance programs with condition assessments along with repair history and downtime are applied to all units.

5.13.4 Climate Change Strategy

Fleet acquisition and replacement provides opportunities for continuous improvement in the reduction of greenhouse gas emissions from vehicles and equipment. Other strategies includes right-sizing of vehicles to consider not only what vehicles and equipment are used for, but also the way in which they are used.

5.14 INFORMATION TECHNOLOGY INFRASTRUCTURE HARDWARE

5.14.1 Existing Asset Management Strategy / Program Description – Overview

The City of Markham demonstrates responsive management of Information Technology Services assets. Unlike most of the City's assets, IT asset types do not display visible physical deterioration over time, however the functional condition can decrease over time. In addition the other contributing factors are changing technology and short useful life, so it is not practical to implement a condition monitoring program. New technology standards and current performance of the assets drives the current replacement strategy.

The life cycle replacement of the asset is based on historical data, industry standards and best practices, as well as vendor support for the hardware.

ITS uses various tools for monitoring of the performance of its assets to inform decision making for asset renewal, replacement, upgrade and disposal. Technology asset concerns are captured on a reactive basis through routine maintenance program executions or problems reported by the user to the internal IT Helpdesk.

5.14.1 Evaluation Criteria

Due to the relatively short life of IT assets, physical conditions are not a key driver for replacement. The technology and ability to maintain the service level drive the performance measure of the assets. The assets are evaluated as:

- Excellent condition: when no routine maintenance is required
- Good: planned routine maintenance is required.
- Fair: minor unplanned maintenance (with part replacement) is required.
- Due for Immediate Replacement: when the manufacturer has discontinued the hardware model and replacement parts are hard to find.

5.15 ENTERPRISE ASSET MANAGEMENT (EAM)

The City is in the process of implementing software as part of its Enterprise Asset Management solution. The initial software will be implemented in three Phases over a total period of 18 months. The anticipated project schedule is given below:

- Phase 1 (May 2021 – February 2022): Water, Wastewater, Stormwater, Structures and Streetlights
- Phase 2 (February 2022 – August 2022): Roads, Traffic Signals, Parks and Fleet
- Phase 3 (August 2022 – November 2022): Facilities

The successful implementation of initial software will enable the business units to efficiently manage maintenance activities relating to tangible assets and will form the basis for a decision support system that will be implemented in future.

5.16 CLIMATE CHANGE MITIGATION

5.16.1 Greenhouse Gas Reduction Goals & Targets

The Greenprint, Markham's Community Sustainability Plan

In 2011, the Greenprint was endorsed by Council as a plan for Markham over the next 100 years to become one of the most sustainable communities in North America. The energy objective of the Greenprint is to achieve net-zero energy by 2050.

Building Markham's Future Together (BMFT)

Building Markham's Future Together: 2020 - 2023 Strategic Plan goal is "ensure business continuity of our services and infrastructure, and enable community resilience and safety."

Municipal Energy Plan (MEP) Getting to Zero

In 2017, the City set aggressive targets via Markham's long-term Municipal Energy Plan (MEP) "Getting to Zero" to achieve net zero energy emissions for Markham's community by 2050, across all sectors.

2019 Corporate Energy Management Plan (CEMP)

The City is committed to leading the community by example, through its City assets, towards a sustainable future. To accomplish this, the City develops five-year forward-looking CEMPs to improve energy management and reduce GHG emissions for the City's corporate operations.

5.16.2 Improvement Commitments

- Continue increasing staffing capacity, literacy, and capabilities to design, build, retrofit, operate, and maintain energy-efficient, resilient, low-carbon assets.
- Aspire to design and construct new and retrofit assets that are lower carbon and more resilient.
 - Complete feasibility analysis of lower energy and reduced carbon options in new construction and major equipment replacement.
 - ▶ Embed Federal Carbon Pricing escalation of \$170/ton in business case analysis.
- Improve monitoring, verification, and reporting of energy and GHG reduction projects.
- Re-evaluate the City's green building standards (LEED Silver and ASHRAE 90.1) to determine if they are still the most suitable to combat climate change and achieve net-zero carbon by 2050.
 - Investigate green building standard alternatives and options of layering on additional energy and GHG efficiency performance metrics and testing.
- Develop a Corporate Net-Zero Energy Emissions (NZEE) reduction strategy with short, medium, and long-term reduction goals.

5.17 NON-INFRASTRUCTURE SOLUTIONS

Non-infrastructure solutions includes but are not limited to studies, needs assessments, policy development, data collection, condition assessments and benchmarking against industry best practices. These solutions are implemented to explore and develop strategies that will result in extension of useful life of assets and/or lower total asset program costs in the future.

The City has adopted the 2020 – 2023 Strategic Plan in consultation with residents, businesses and community stakeholders that will guide the City's actions through to 2023. The strategic plan focuses on following four goals:

- Exceptional Services by Exceptional People
- Engaged, Diverse, Thriving & Vibrant City
- Safe, Sustainable & Complete Community
- Stewardship of Money & Resources

The plan further lays out the goal description, how to achieve the goal and how the success will be measured. Based on success indicators, the future asset management strategies will be configured with reference to lessons learned and best practices to further optimize fiscal and resource management.

Through the implementation of this plan the City aims to demonstrate 'Stewardship of Money and Resources' by proactively managing City assets to maximize the return (financial, social, environmental and cultural) on taxpayer investment. The City of Markham will be reviewing the overall asset management program in 2021 with the help of a consultant that will review the City's existing policies, practices and procedures with reference to industry best practices. The intent of this assignment is to complete a strategic level review of the City's Corporate Asset Management (CAM) activities and to create a 'roadmap' of activities that the City can plan and implement. The roadmap will provide detailed needs for near term activities and high level details for medium and long term tasks. The intent of this project and the resulting roadmap is to enable the City to mature their Asset Management (AM) practices to be able to proactively plan infrastructure investments on the right assets at the right time for the right benefit to customer Levels of Service (LOS).

Staff in relevant departments will be interviewed and current practices/initiatives will be reviewed to identify long term asset management objectives and identify key projects. Current corporate best practices will be reviewed, outlining a variety of successful strategies implemented by other Canadian municipalities in order to highlight the return on investments that asset management approaches can achieve. This will result in an asset management roadmap, tailored to the needs of the City. The resulting projects will be scoped, and cost and resource estimates provided to assist with later implementation and procurement phases.

In 2019, the City of Markham Auditor General audited the City’s 2016 Asset Management Plan. This audit resulted in identifying a number of gaps in the implementation of the asset management plan between the period 2016 and 2019. In order to achieve compliance with the Auditor General Report and to bridge these gaps, staff has identified the following projects that are planned for execution through the years 2022 to 2023.

- Create outcome-based levels of service
- Create performance management framework
- Create risk management framework and strategy
- Create performance monitoring and reporting system that enables staff to measure performance in an efficient way
- Create an Asset Management Manual that details both business-unit specific and enterprise-wide business processes along with transition and resource planning

5.17.1 Disposal Activities

The practice for linear assets is generally to retain the asset and maintain its life through renewal/rehabilitation/replacement activities. Facilities and land are the only asset classes that may be disposed of, and the process is managed through the City’s Real Property Department, where a business case is prepared to make the decision regarding the disposal of an asset.

5.17.2 Expansion Activities & Growth Forecast

The City’s strategy related to expansion activities is driven by long range planning documents such as the Official Plan, Secondary Plans of subdivision, Master Transportation Plans, Integrated Leisure Master Plan, Culture Strategic Plan, Public Realm Master Plan, Public Art Policy, etc. The long-range plans dictate the timing of the growth activities and provide appropriate funding sources (e.g. Development Charges) for the construction of new infrastructure.

The population and employment forecast for City of Markham as set out in the York Region 2010 Official Plan are given in Table 5.1 below:

Table: 5.1: City of Markham Population & Employment Forecast

Markham	2006	2016	2021	2026	2031
Population	273,000	337,800	370,300	398,300	421,600
Employment	144,800	200,300	221,500	231,200	240,400

Source: The Regional Municipality of York Official Plan, 2016 Office Consolidation, Table 1.

Notes:

- The forecasts are based on the Schedule 3 forecasts for York Region in the 2006 Growth Plan which was based on a 2031 planning horizon.
- Schedule 3 in the 2017 Growth Plan updated the 2031 forecasts and extended the forecast horizon to 2041. The 2017 Growth Plan was replaced by the 2019 Growth Plan, but the Schedule 3 forecasts did not change from the 2017 Growth Plan.

- The Region has been working on updating its forecasts to reflect the 2017 Growth Plan Schedule 3 since 2015, but various changes to the Growth Plan since then have prevented them from finalizing and seeking Regional Council endorsement of the new forecasts. Most recently, the forecasting work has been put on hold, pending the Province's release of an updated Schedule 3, which has extended the forecast horizon to 2051. The Region anticipates having new forecasts for local municipalities by the end of Q2 2021.
- In the meantime, both the Region and Markham used (unofficial) updated Growth Plan 2017 Schedule 3 figures for 2031 in our latest respective Development Charges Background Studies.

5.17.3 Procurement Methods

The City utilizes a number of procurement strategies and delivery mechanisms in order to ensure the most efficient allocation of the City's resources. The key strategies include undertaking spend analysis, membership with the York Purchasing Co-operative, and utilizing Supply Chain Ontario's Vendor of Record Arrangements.

The Procurement Department regularly reviews purchasing card transactions, small invoices less than \$5,000 and purchasing acquisitions between \$5,000 and \$25,000 in order to complete a spend analysis. By collecting, classifying and analyzing expenditure data, goods and contracts sourced from numerous suppliers may be consolidated to reduce procurement costs and increase efficiency.

Membership with the York Purchasing Co-operative allows the City to realize savings by combining individual requirements and seeking bids for larger volumes of goods and services. In addition, one agency within the Co-operative takes the lead and awards the bid on behalf of the group, reducing the workload which would normally be done by each agency.

The vendor of record arrangement provides a list of vendors resulting from a procurement process that meets the requirements of the government procurement directive. An arrangement is valid for a defined time period, with defined terms and conditions and pricing. The arrangement allows the City to leverage the greater buying power of Provincial agencies.

5.17.4 Risks Associated with the Strategy

The risks associated with the current City of Markham asset management strategy are:

- Lack of funding to proceed with projects identified for 2022 as a result of the latest Asset Management Plan Audit
- Delays in timely completion of outstanding asset management projects due to lack of dedicated human resources
- Proceeding with inefficient practices without exploring and adopting feasible best practices
- Aging infrastructure, climate change impact and legislative changes may create a need for imminent actions resulting in higher costs