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1. Acknowledgements

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provided valuable information while others attended meetings and shared their perspectives and guidance.

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2. Executive Summary

Kitchener’s Asset Management Division has a documented purpose which is to develop a Corporate Asset Management program that will ensure the availability and sustainability of Kitchener's existing and future assets.

In 2011, the Ministry Of Infrastructure released its 10-year infrastructure plan “Building Together: Guide for Municipal Asset Management Plans”.

*Building Together responds to the far-reaching trends that will affect Ontario’s infrastructure needs, including a more global and service-oriented economy; a larger, older and more urbanized population; and the effects of a changing climate. A key element of this framework is ensuring good stewardship through proper asset management.*

Concurrently, the Federation of Canadian Municipalities (FCM) introduced the “Canadian Infrastructure Report Card”. Kitchener participated in the gathering of data which helped create this report.

*An AMP [Asset Management Plan] documents how a group of assets is to be managed over a period of time. The AMP describes the characteristics and condition of infrastructure assets, the levels of service expected from them, planned actions to ensure the assets are providing the expected level of service, and financing strategies to implement the planned actions.*

In response to the Ministry’s document, our active FCM participation, and a sincere desire to remain progressive and responsible asset owners, The City of Kitchener has produced this asset management plan for the City’s sanitary system assets, one of twelve of the City’s asset categories in-queue for this undertaking.

This asset management plan provides a detailed analysis of the current status of the City’s sanitary assets, what investigative and monitoring efforts are performed, and how current business processes align with the City’s corporate asset management strategy’s two guiding principles.

1. Balancing asset condition and level of service.
2. Allocating financial resources among priorities.

This plan will help understand useful life and forward-thinking cost projections from best-available data. This plan will identify and demonstrate proficiency in maintaining a number of levels of service.
The Sanitary Utility, which is chaired by the Director of Engineering, is the lead of the City’s wastewater assets. The Sanitary Utility is responsible for the installation and disposal of the variety of sanitary network assets, which include the likes of wastewater pipes, laterals, manholes, syphons, forcemains, pump stations. The City’s Operations – Environmental Services provides overall stewardship for the day-to-day operation and maintenance of the sanitary assets outlined in the utility. For the purposes of this plan, the existing asset inventory has been categorized into three asset groups:

- Sanitary Gravity Mains
- Sanitary Laterals
- Sanitary Manholes

It should be noted that while the Sanitary Utility is responsible for wastewater pumping stations and associated forcemains, those entities have unique attributes, and will be considered as a separate and distinct asset category and will be analyzed in a separate asset management plan.

An analysis of current and historic expenditures and costs for routine, betterment, service-oriented activities and capital replacements was undertaken. The analysis outlined within this document, including some descriptive charts, illustrates the current state of affairs and identifies that there are opportunities to fill in some data gaps.

As seen from the overall picture in *figure 4.3.2.1*, Kitchener has a healthy sanitary network, with 76% in excellent structural health and relatively few mains that are extremely old and/or in poor condition. *Section 7* describes how those which are in need or anticipated to be in need in short order, have a heavily scrutinized, long-term capital funding strategy in place.

Similarly, as seen from the overall picture in *figure 4.3.2.9*, Kitchener has a significant operations and maintenance need, with approximately 48% of the network with identified maintenance issues. *Section 7* describes an operations and maintenance strategy which only requires the rate of inflation to maintain these assets to the defined levels of service.

*Figure 6.2.2* shows analysis of lifecycle modelling, yet Kitchener data did not fit a modelled curve, and as such, we transitioned to a risk-based approach in planning for infrastructure degradation. This is seen in *figure 6.5.2*.

By documenting all current information sets including: asset inventories; defined service levels; service-oriented activities; betterment expenditures; projected capital revenues and costs, the Sanitary Utility has the information it requires to make future decisions that will incorporate asset management strategies in providing services to Kitchener’s residents.
Robust objective condition and performance data, defined maintenance procedures, planned capital works, interdepartmental governance structure, and responsive levels of service all show the Sanitary Utility to be very well-positioned to support the residents and businesses relying upon its services.
3. Introduction

The City of Kitchener is subject to the Municipal Act, Ontario Water Resources Act, and Environmental Protection Act. These provide statutory authority, immunity, and statutory obligations with respect to wastewater treatment. The upper-tier municipality, the Regional Municipality of Waterloo, also has by-laws (e.g. 1-90 and 50-92) with respect to the wastewater sewer network by which the City of Kitchener must abide.

Discussion of legal/statutory protections and requirements fall outside the scope of this Asset Management Plan. But for clarity, the City by virtue of this Asset Management Plan considers the ownership, stewardship, optimal physical and cost-effective operation of the Sanitary Utility of high importance. Within the geographic inclusion area for the Province’s Places To Grow Act, 2005 and 2017 update, Kitchener continues to recognize and prepare for the economic, ecological, and social growth within that framework.

The Sanitary Utility, as outlined in its charter, is a City-owned, user-funded, revenue-generating, non-profit enterprise which cost effectively plans, designs, builds, maintains and decommissions a high quality and reliable sanitary collection infrastructure system within the City of Kitchener. It is a full-cost recovery model for the lifecycle of the asset in which user rates account for all capital and operating costs needed to run the utility.

The Sanitary Utility is an inter-departmental asset category composed of staff from the Engineering Division, Operations – Environmental Services, Asset Management, and the Financial Planning Division. Wastewater asset management is led by the following organizational components of the Sanitary Utility:

Engineering: Acting as Asset Lead, their responsibility is to ensure that the capacity and integrity of the system is available for the City’s current and future needs. Engineering is further responsible for the planning and design of new wastewater network infrastructure in residential, commercial, and industrial developments; for facilitating the capital replacement, rehabilitation, disposal, decommissioning and/or removal of existing wastewater infrastructure.

Finance: To provide financial information for tracking, evaluating and projecting revenue, expenses and user rates. Finance provides accounting and reporting on the historical costs and service life of assets; prepares, summarizes, reviews capital budgets, current state and forecast.

Operations – Environmental Services: Acting as Asset Stewards, their primary responsibility is to maintain the most effective and risk-mitigating operation and reliability of the system. Environmental Services is responsible for the day-to-day maintenance and operation of the
wastewater network; serves a function as asset inspectors for wastewater manholes; and administers the annual and end-of-maintenance closed circuit television (CCTV) inspections of the sanitary network.

Asset Management: obtains and maintains condition and performance information on infrastructure assets; provides complex analysis including theoretical and risk-based modeling. Creates capital plans for these and other assets. The team provides both Operations and Engineering consolidated results and recommendations from the various sources, including inspection results. Maintains and develops the City’s work management software which plays a vital role in tracking operating costs for the various work activities for wastewater assets.

There are great benefits found in having a defined and documented asset management plan for any large grouping of infrastructure assets as is managed by the Sanitary Utility. These include effectively managing the total cost of owning and operating the assets, while delivering the desired levels of service, minimizing risk, and planning for future growth expectations.

There are direct links among this Asset Management Plan 2017 (AMP), The City of Kitchener Official Plan 2014 (OP), and the Kitchener Growth Management Plan 2015 (KGMP). The OP and KGMP provide the framework of goals, objectives, and policies with respect to the cultural, social, economic and natural environment of the City. This includes orderly and efficient development. This AMP document provides a state of the union and ongoing strategic and financial picture of the sanitary asset portfolio within that framework.

The assets described by this plan are scrutinized within the framework of an existing, and always forward-rolling 10-year capital program. The interval between the first sanitary asset management plan and this has been approximately five years. It is anticipated that the next iteration will be five years hence. This will coincide with a similar 5-year re-evaluation of the capital program described in Section 6.5.1 Non-Infrastructure Solutions / Integrated Infrastructure Planning.
3.1 Content
This Asset Management Plan (AMP) is the second to be developed for Kitchener’s wastewater collection assets. With a great deal of city staff input, the first AMP was developed by a consulting firm in 2013, entitled “Sanitary Asset Management Plan”. This first AMP focused heavily on the City’s capital responsibilities and thus there is opportunity in this second iteration to delve into the cause and effect of maintenance activities related to the condition of the asset; the long term lifecycle management plan associated with optimizing the level of service; and the financial management plan necessary to sustain the expectation of services provided by this asset category. The asset entities covered by this updated plan are:

- Sanitary Gravity Mains
- Sanitary Service Laterals
- Sanitary Manholes

Figure 3.1 Sanitary System Assets Groups

* Sanitary pumping stations and associated forcemains will be outlined in a separate and distinct asset management plan.

3.2 Purpose of this Asset Management Plan
This Asset Management Plan is a successor to the Phase 1 Asset Management Plan (AMP) developed in 2013. Sanitary system assets are undeniably some of the most critical assets the City owns and manages, and thus the plan update has been performed to help the City of Kitchener continue to excel at asset management principals in its efforts to meet corporate goals, levels of
services its customers expect, and aid in the development of long term sustainable funding strategies that will address the needs of its aging infrastructure.

This plan documents an exhaustive list of the core services provided by Kitchener with respect to the wastewater/sanitary asset category, along with associated costs, both historical and projected. By understanding the costs associated with providing existing levels of service and forecasting the renewal, replacement and future development of wastewater infrastructure, the City of Kitchener will remain an efficient and effective service provider and asset owner.

Kitchener recognizes the collaborative ambitions of the Province in:

> Asset management will be the foundation of the [Building Together] strategy. Asset management planning will allow needs to be prioritized over wants. It will help ensure that investments are made at the right time to minimize future repair and rehabilitation costs and maintain municipal assets.

> [The Ministry is] moving toward standardization and consistency in municipal asset management. The first step is requiring any municipality seeking provincial capital funding to prepare a detailed asset management plan and show how its proposed project fits within it. As part of this process, municipalities will need to demonstrate how they themselves are assisting financially with the proposed project, including engaging with Infrastructure Ontario.

> -- Ministry Of Infrastructure, Ontario

This Phase 2 AMP validates the commitment from Kitchener council, takes into account the Ministry Of Infrastructure’s goal of public involvement, capitalizes on experienced in-house professionals, and utilizes data-driven engineering best practices.

### 3.3 Assumptions and declarations, systems, terminology, and quality of data

With the City of Kitchener having robust datasets dating back in some cases on the order of decades, and contemporary software packages having replaced legacy information systems, there are a few points of clarity to be made.

#### 3.3.1 Assumptions and declarations

Replacement costs represent all diameter sanitary sewers with one total cost, unless otherwise noted, to align with Kitchener Accounting Division processes, while Kitchener’s project-level analysis and decision-making include replacement costs by diameter for better accuracy in project costs.
Capital replacement projects from 2017 were analyzed and the average cost actuals from those were determined; the closest representative project to that average was selected for the example from which values were used in this plan.

Replacement costs in the introductory 2013 AMP combined sanitary pipes, manholes, service connections together, whereas this Phase 2 AMP splits each asset cost within the sanitary system for analysis.

Forcemains and pumping stations were included in the Phase 1 AMP; these entities and associated statistics are excluded from this Phase 2 document and are to be provided in a separate plan.

As at time of writing, a backlog of as-built information exists and are not transitioned into the Corporate Database (i.e. GIS). Where data is missing, the year’s values are excluded from analysis within this plan where applicable.

Capital and Operating forecasts provided herein are subject to annual vetting and review by the Financial Planning Division, with final analysis and decision-making by City Council.

3.3.2 Systems
The City’s ESRI Geographic Information Systems (GIS) databases contain the authoritative digital source of asset inventories (with Engineering as-builts being the legal authoritative source) for analysis. The data is queried and analyzed by experts across the Corporation for data-driven decisions. ArcGIS is the application front-end.

The City’s computerized maintenance management system CityWorks is the definitive source of work history and operating expenditures for labour, equipment and material costs.

The City’s sanitary modelling software InfoSWMM, is a fully dynamic, geospatial wastewater modeling and management software application. It is a fully ArcGIS-integrated, highly advanced, and comprehensive hydrologic, hydraulic simulation model package for the effective management of wastewater collection systems.

The City’s financial management system SAP is the definitive repository of capital expenditures.

The custom, in-house created Microsoft- and ESRI-software-based Condition Analysis Tool is the primary capital project selector. Analysis derives from GIS layers and MS Access databases into an ArcGIS map document file.
3.3.3 Terminology

The terms wastewater and sanitary, and occasionally drainage, are used interchangeably in description of this high level asset type, sanitary. All are industry and governmental descriptors of the assets discussed in this plan, with drainage primarily found in standard specification documents.

The terms service and lateral are used interchangeably in description of the pipes that lead from a sanitary main to a property and/or building. Ownership of this pipe changes from municipality to private where this service lateral crosses onto private property.

The terms asset and structure are used interchangeably in describing a physical feature of the system. Both are industry and governmental descriptors of the assets discussed in this plan. Asset is often used more for financial discussions, while structure is often used more with engineering and project level parlance.

The terms main, pipe, and conduit are used interchangeably in describing a physical conveyance feature of the system. All are industry and governmental descriptors of the assets discussed in this plan. The hydraulic modelling software, described in Section 6.1 Service Oriented Activities, in particular refers to conduits in this context.

The terms manhole and node, and occasionally chamber, are used interchangeably in description of that structure. The hydraulic modelling software, described in Section 6.1 Service Oriented Activities, in particular refers to nodes in this context.

The Accelerated Infrastructure Replacement Program, with the acronym AIRP, is the predecessor to the current Water Infrastructure Program, with the acronym WIP, as at mid-2017. They both represent the same capital program with financing sources of the Sanitary Utility, Water Utility, Stormwater Utility.

3.3.4 Quality of data

Due to a lack of data reliability prior to 2013, although there is a comprehensive asset specific dataset dating back to 2008, for the purposes of analysis and reporting from CityWorks, this Phase 2 AMP will only leverage sanitary maintenance data from 2013 onwards.

A highly detailed quality check of sanitary main installation dates and material types was performed in 2017, such that these attributes are the best possible quality. This was used to inform updated values for sewer laterals and manhole structures as well. The sanitary data for these asset types are of very high quality. There may be a discrepancy in statistics between the 2013 AMP and plan this because of this quality increase.
4. State of Local Infrastructure

The City of Kitchener’s population is predicted to grow from the 2016 census count of 233,222 to 304,655 residents, an approximately 30% increase, over the next 14 years (source: Region of Waterloo, 2008). The City must continue to champion asset management principles to grow and maintain its wastewater infrastructure responsibly, while providing levels of service that are agreed upon by council, and accepted by the public.

This AMP presents the estimated asset replacement costs in 2017 dollars, figure 4.0.2. As noted with the introductory Sanitary Asset Management Plan of 2013, to understand the City’s investment in public works infrastructure and to focus on the need for renewal, it is helpful to understand the value of the assets in question. The main methodology by which underground assets are replaced at Kitchener – gauged by both dollars spent and kilometers replaced – is by full reconstruction. The process which derives this program is described in Section 6.5.1 Non-Infrastructure Solutions / Integrated Infrastructure Planning.

The cost to replace sanitary assets (excluding restoration, etc.) within a full reconstruction – determined to be 31.8% of total cost – is the basis for calculations for replacement cost. Notably, these reconstruction costs include paying for portions of an entire project cost, including the likes of excavation, structure disposals, new structures, traffic control, road and site restoration. Thus the Sanitary Utility cost-shares all reconstructions at 46% of each project. Project engineering and
administration at 20% is a component of all these capital projects, and is included in the values in figure 4.0.2.

The estimated replacement value of the City’s sanitary mains, manholes, service laterals is $955,133,112. This most current valuation parallels with the approximate 4.5% growth of infrastructure asset inventory counts, and 4.5% reconstruction cost increase since the 2013 plan.

Figure 4.0.2 Estimated replacement costs of sanitary (wastewater) infrastructure, as at time of writing, December 2017:

![Pie chart showing the breakdown of replacement costs for different categories of infrastructure.]

* replacement cost in dollars; with percentage of overall asset category value

4.1 Asset Inventory
The physical assets owned by the City are represented in the Corporate database (i.e. GIS). This makes visualization, statistical analysis, reporting, and other information queries quite easy, while reliant on quality data.

Asset leads collaboratively work with the GeoSpatial Data & Analytics team on how they would like their data represented, and from within what information system viewers. These decisions are
typically based on how the data is to be used for display, planning, modeling, and analysis purposes, and what audience is the recipient.

Inventory base datasets and records are generally created and maintained by the GeoSpatial Data & Analytics team, with a small number of City business processes which allow departmental users to make attribute changes based on field inspections, consultant inspections, and other observations. One such example is the in-house-performed field inspections of manholes wherein the inspectors are able to change values for physical and legal accessibility.

Inputs to the asset inventories can also come from external parties such as consultants, in the form of as-built submissions, with an in-house data integrity checker ensuring quality standards are met. Sanitary CCTV inspections inform and verify base data material types and diameters, but in these instances, GeoSpatial Data & Analytics is presented a table of data.

Internal Service Level Agreements between the GeoSpatial Data & Analytics team and other operating areas outline the responsibilities, accountabilities, and timing of inputs to the GIS-based asset inventory.

In order to understand local rates of sanitary main degradation since the Phase 1 AMP was completed in 2013, an effort to store data about disposed pipes was undertaken. Prior historical information was removed from the primary GIS layer and inspection history and related condition was unavailable. The updated process allows for information queries to be made against sanitary mains which have been removed. The disposed asset data is stored in a separate data table and each disposed asset record has a retired year entered.

4.1.1 Sanitary Mains

Sanitary mains are the primary conveyor of wastewater effluent and are typically found beneath municipal streets, inaccessible except via manholes, and following the lie of the land to ultimate treatment primarily at the Kitchener Wastewater Treatment Plant, with some pumped or flowing to Waterloo and Cambridge. With an average age of about 33 years – a generic and average 41% proportion of 80-year expected useful life consumed – there are indeed a handful of full-functioning pipes over a century old.
There are 13,269 active sanitary segments between manholes at time of writing totaling 799 kilometers, representing about 4.2% growth since the Phase 1 AMP in 2013. There are no combined storm water and sanitary sewers. This inventory of sanitary mains has an approximate replacement value of $733,983,600, at 77% of the overall asset category value.
Notable attributes of the inventory of sanitary main assets include but are not limited to the following:

Figure 4.1.1.2  Sample sanitary main attributes

<table>
<thead>
<tr>
<th>sanitary main attributes</th>
<th>sample values</th>
</tr>
</thead>
<tbody>
<tr>
<td>structure identifier number</td>
<td>100001</td>
</tr>
<tr>
<td>source date</td>
<td>5-Nov-55</td>
</tr>
<tr>
<td>installation year</td>
<td>1955</td>
</tr>
<tr>
<td>status</td>
<td>active, proposed, historic</td>
</tr>
<tr>
<td>material type</td>
<td>VCP - vitrified clay pipe</td>
</tr>
<tr>
<td>associated road segment</td>
<td>10060</td>
</tr>
<tr>
<td>upstream manhole</td>
<td>300001</td>
</tr>
<tr>
<td>downstream manhole</td>
<td>300002</td>
</tr>
<tr>
<td>up invert</td>
<td>326.3</td>
</tr>
<tr>
<td>down invert</td>
<td>324.6</td>
</tr>
<tr>
<td>slope</td>
<td>1.28</td>
</tr>
<tr>
<td>named drainage area</td>
<td>Montgomery - Freeport</td>
</tr>
<tr>
<td>category</td>
<td>gravity, syphon, stub</td>
</tr>
<tr>
<td>length</td>
<td>55.5</td>
</tr>
<tr>
<td>shape</td>
<td>round</td>
</tr>
<tr>
<td>diameter</td>
<td>250</td>
</tr>
<tr>
<td>trunk identification</td>
<td>yes, no</td>
</tr>
<tr>
<td>liner rehabilitation</td>
<td>2010</td>
</tr>
<tr>
<td>comments and issues</td>
<td>missing document; date updated by field check</td>
</tr>
</tbody>
</table>

Diameter classification of sanitary sewers in Kitchener is as follows:

Figure 4.1.1.3  Diameter classification of sanitary mains

With the three charted values below representing:
• sum length of pipes of the specified material type,
• percent of sum length that the specified material type represents,
• average age of the pipes of the specified material type,

Material type classification of sanitary sewers in Kitchener is as follows.

Figure 4.1.1.4 Material classification of sanitary mains

* Kitchener sanitary main length, material percent of total, average age
4.1.2 Sanitary Service Laterals

Sanitary service laterals provide inputs to the sanitary main via smaller-diameter pipe connections to a property. The municipality owns the service from the main to the property line.

There are 61,449 active sanitary services laterals of Kitchener ownership at time of writing. This inventory has an approximate replacement value of $150,500,891, at 16% of the overall asset category value.

Notable attributes of the inventory of sanitary service lateral assets include but are not limited to the following:

Figure 4.1.2.1 Sample sanitary service lateral attributes

<table>
<thead>
<tr>
<th>sanitary service attributes</th>
<th>sample values</th>
</tr>
</thead>
<tbody>
<tr>
<td>structure identifier number</td>
<td>100001</td>
</tr>
<tr>
<td>source date</td>
<td>November 5, 1955</td>
</tr>
<tr>
<td>installation year</td>
<td>2000</td>
</tr>
<tr>
<td>status</td>
<td>active, historic</td>
</tr>
<tr>
<td>material type</td>
<td>PVC - polyvinyl chloride</td>
</tr>
<tr>
<td>length</td>
<td>11.1</td>
</tr>
<tr>
<td>diameter</td>
<td>100</td>
</tr>
<tr>
<td>comments and issues</td>
<td>street rehabilitation drawing used as spatial source</td>
</tr>
</tbody>
</table>

4.1.3 Sanitary Manholes

Sanitary manholes provide access to the network of sanitary mains. There are 12,128 active sanitary manholes at time of writing. This inventory has an approximate replacement value of $70,628,621, at 7% of the overall asset category value.

Notable attributes of the inventory of sanitary manhole assets include but are not limited to the following:
4.2 Installation Profiles

In order to assist the City with analysis, it is helpful to understand the installation profiles of the wastewater assets. As noted, a concerted effort to update installation dates for wastewater assets was performed in 2017. (For display purposes, and in absence of some recently constructed project as-built information, the following charts show build-outs to end-of-year 2014).

As is common for municipalities in Canada, post-war city-building activity boomed, and the installation profiles of sanitary assets show this at Kitchener. Critically, for interpretation of the following charts, new installations were the sole sanitary network changes until reconstructions of existing rights-of-way began in earnest in the 1970s. Thus, these charts show new installations and replacement activities thereafter.
Figure 4.2.1 Asset Installation Profile – sanitary mains

Installation Profile for Sanitary Mains

Figure 4.2.2 Asset Installation Profile – sanitary manholes

Installation Profile for Manholes
For asset lifecycle planning purposes, the installation profiles of sanitary main assets in relation to the material type used at the era of installation is compared and analyzed. There is an expectation of differing longevities of asset materials which informs Kitchener's planning for replacement, while data-driven decision-making on asset condition and performance is completed, and not on age alone.
4.3 Asset Inspection and Asset Condition

The City inspects sewers and associated service laterals for the following purposes:

- Annual condition inspection of gravity sewers – proactive inspection to identify potential failures and for planning routine Operations and Maintenance (O&M) programs, capital replacement, and rehabilitation projects.
- Troubleshooting – investigation of problem incidents to identify issues and select the appropriate remedial action.
- End of warranty inspections – inspection of new or renewed sewers to ensure that construction meets specifications and to document as-recorded conditions.
Wastewater conveyance is generally via gravity sewers following the lie of the land, though many meters subsurface, through standard collection pipes, local trunks, and trunk sewers. The inspection of gravity wastewater sewers and sewer services may be initiated to serve multiple purposes, but the end result is always to document and analyze the pipe’s structural and operational condition. Due to limited access options, syphons and forcemains are uninspected (and forcemains and pumping station are outside the purview of this asset management plan).

The assessment of an asset’s condition is a valuable source of information to asset leads. The timely and cyclical capturing of condition data provides important insight into the performance of assets and what impact betterment and routine maintenance activities are having on extending the serviceable life of infrastructure (i.e. improving or sustaining the overall health of the asset).

Without this critical information, the inferred condition of the assets has been evaluated on noted failures and/or inferred degradation based on the initial installation date, thereby not taking into account the effect of use, environment factors, and other influences. This limits the ability of the asset owner to plan the rehabilitation or replacement for assets in the short and long terms from a financially strategic perspective.

4.3.1 Asset inspection regimen – sanitary mains

The methodology for sanitary main inspection and condition assessment at the City of Kitchener has been and continues to be via an annual closed-circuit television (CCTV) program, averaging about 43,000 meters a year over the past five years.

The City of Kitchener inspects an average of approximately 6% of the linear wastewater network, based on values from 2004 through 2017, fluctuating between 3% and 9% based on contractor unit rates and budget allowances. From calculations of network length and percent inspected per year, it is determined that the City is on an approximate 17-year cycle to inspect the entire network of sanitary pipes. An internal preference is a 12-year cycle. Both non-trunk sewer mains and trunk sewer mains are inspected, though there is an opportunity to increase the inspection of the latter.

The field inspection duties of this program have been tendered out annually since the program inception with a small number of inspections in 1997.

While different contractors provide their own report formats, the data and defect codes and scoring are that of a defined and standardized type, providing for easy interpretation by internal analyst staff. In fact, in recent years, Kitchener staff and contractor partners have shared the same pipeline assessment training and certification program.
For well over the past decade, and continuing today, pipe condition at Kitchener is determined as per the National Association of Sewer Service Companies’ (NASSCO) Pipeline Assessment Certification Program (PACP), using the assessment codes and data standards they have developed and refined. PACP allows operators in the field to document the inspection observations from a defined list of defect codes into a computer as they pilot a remote camera apparatus. These codes provide standardized scoring for all but the most obscure observation found during the inspection of a sanitary sewer.

Defect codes are assigned 1 through 5 inclusive (with 0 indicating no defects), for both structural defects and maintenance defects. These observations can then be calculated into an overall score for a sewer segment, from manhole to manhole. This information is routinely used for assessment of individual pipes, whole street segments, neighbourhoods, catchments, city-wide consideration, and consistently apply these values as a primary criterion for all-structure right-of-way infrastructure replacement via the Water Infrastructure Program capital program.

Specific codes, such as the structural defect type BSV (Broken Soil Visible) are used to quickly identify defects requiring attention, and do feed the Operations Division’s spot repair program independently and synergistically in advance of road resurfacing works. This spot repair program is further outlined in section 5.15.

*Figure 4.3.1.1* shows how PACP codes can be used to show heat mapping of potential problem areas within the city with respect to sanitary network defects.
Figure 4.3.1.1  Defect scoring heat map visual sample

* sample of PACP scoring, mapping the sanitary network condition
While defect coding is highly valuable, care must be taken in making condition determinations or program predictions solely from PACP code values. NASSCO is clear in stating its approach to defect codes in that they “are assigned based on potential for further deterioration or pipe failure”, but the “mechanisms and rates of pipeline deterioration are highly dependent on local conditions”. Pipe failure itself being “defined as when the pipe can no longer convey the pipe design capacity”. For a myriad of reasons, a great percentage of sanitary pipes no longer convey the design capacity but such loss is inconsequential. A great number of pipes by this definition are in failure mode, but by targeting these pipes for replacement would mean a large added expense to the Sanitary Utility.

The code values – individually or summed – provide an analyst with a preliminary picture of network issues. A more robust investigation is required in all cases. For example, a category 5 (failed) structural-type code for a pipe segment with a code for B (broken) might hint at a catastrophic failure when with video review and best engineering judgement, it is found to be a defect that can be lined or even ignored based on location, severity, and clock position. Meanwhile, a maintenance-type defect of category 5 IG (infiltration gusher) can have unending and large cost implications for the Sanitary Utility. There are many such nuances.
In 2017 dollars, the cost per meter for inspection is $4.43 per meter, of which $2 per meter is a *pre-cleanse / flushing*.

A newly-introduced routine is that Operations – Environmental Services internal staff will flush sanitary mains where the CCTV contractor was unable to get the camera through. Then these pipe segments are put back on the list for inspection for the next year.

Due to the CCTV program, observation of areas where the structures are relatively new (i.e. decades younger than anticipated lifespan) are showing pipes in middling-to-poor condition. Equally, some uncharacteristic findings are some long segments of pristine sanitary sewer pipes on the order of a century in age – well beyond an expected condition and estimated lifespan.
4.3.2 Asset condition – sanitary mains

Kitchener’s robust asset inspection program provides a very objective source of information for sanitary main asset condition. The following depiction in figure 4.3.2.1 of overall sanitary pipe network structural condition shows strong asset health, with substantially healthy older pipes, and with relatively few high-need defect observations. Further, as described in section 4.3.1, Kitchener performs detailed analysis of the defects which are showing as poorer in condition in order to verify the actual field functions of the asset(s).

*Structural Index*

**Structural** condition – collected along with Operations & Maintenance (O&M) condition – represents pipe issues which are related to the physical aspect of the pipe, such as with cracks, fractures, breaks, holes, surface damage.
Figure 4.3.2.1 Structural condition as of end of 2017 sanitary sewer camera inspection.

Figure 4.3.2.2 Kitchener sanitary pipe condition data rating ranges.

<table>
<thead>
<tr>
<th>PACP RATING</th>
<th>PACP GRADE</th>
<th>PACP RATING NUMERIC RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Immediate Attention</td>
<td>4.5 - 5</td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>3.5 - 4.4</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>2.5 - 3.4</td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>1.5 - 2.4</td>
</tr>
<tr>
<td>1</td>
<td>Excellent</td>
<td>0.1 - 1.4</td>
</tr>
</tbody>
</table>
Figure 4.3.2.3 Sanitary main structural condition status – vitrified clay pipe.

Figure 4.3.2.4 Sanitary main structural condition status – concrete pipe.
Figure 4.3.2.5  Sanitary main structural condition status – asbestos cement pipe.

Figure 4.3.2.6  Sanitary main structural condition status – plastic pipe.
Figure 4.3.2.7 Sanitary main structural condition status – other material pipe.
Figure 4.3.2.8 Sanitary main structural condition status – all material pipe types.

A further picture of network health comes from the total length of sanitary main pipe with excellent PACP scores and relatively young age. The total kilometers of poorer condition sanitary mains are not comparatively large. Figure 4.3.2.9 shows a healthy network at Kitchener.
Figure 4.3.2.9 Sanitary main structural condition of all Kitchener pipe, with associated lengths and average age.

Apart from structural condition, Kitchener also tracks operations and maintenance type defects through the same defect coding system via the same inspection regimen. The following figures show current state condition for operations and maintenance defects.

**Operations & Maintenance Index**

Apart from structural condition, Kitchener also tracks operations and maintenance type defects through the same defect coding system via the same inspection regimen. The following figures show current state condition for operations and maintenance defects.

**Operations & Maintenance (O&M) condition** – collected along with Structural condition – represents pipe issues which are related to the smooth functioning aspect of the pipe, such as with foreign objects, intruding objects, alignment.
Figure 4.3.2.9 Operations and maintenance condition as of end of 2017 sanitary sewer camera inspection.
Figure 4.3.2.10 Sanitary main operations and maintenance condition status – vitrified clay pipe.

Figure 4.3.2.11 Sanitary main operations and maintenance condition status – concrete pipe.
Figure 4.3.2.12 Sanitary main operations and maintenance condition status – asbestos cement pipe.

Figure 4.3.2.13 Sanitary main operations and maintenance condition status – plastic pipe.
Figure 4.3.2.14 Sanitary main operations and maintenance condition status – other material pipe.
Figure 4.3.2.15  Sanitary main operations and maintenance condition status – all material pipe types.

A further picture of network operations and maintenance health comes from the total length of sanitary main pipe with excellent PACP scores and relatively young age. The total kilometers of sanitary mains with higher O&M needs are not comparatively large. Figure 4.3.2.16 shows a healthy network at Kitchener.
Figure 4.3.2.16 Sanitary main operations and maintenance condition of all Kitchener pipe, with associated lengths and average age.

4.3.3 Asset inspection regimen – sanitary service laterals
In addition to mainline inspections, the CCTV camera operator pans the inspection apparatus such that the operator at the time or an analyst post-inspection can observe the general outlet condition of the lateral. The operator enters inspection codes denoting the existence of the lateral and the nature of its effects on the mainline, such as a tap break-in, or tap factory capped. While providing some value, this is not considered a service lateral inspection.

4.3.4 Asset condition – sanitary service laterals
Due to the excessive expense of a physical inspection of sewer laterals, they are not inspected with the exception of the completion of Engineering two-year maintenance after mainline replacement. (This is described further in Section 5, Levels of Service). Currently there is little value to a program of this nature, though other neighbouring municipalities are beginning to investigate value in this regard. No analysis is performed on sanitary laterals.
4.3.5 Asset inspection regimen – sanitary manholes
While the inspection of wastewater collection system of pipes in Kitchener is tendered out to contractors, wastewater manhole inspections are performed in-house by Operations Division – Environmental Services field staff. (This is described further in Section 5.10 of Levels of Service). A subset of the City-owned inventory of manholes is inspected annually, with recent inspection counts as show in in figure 4.3.5.1.

![Figure 4.3.5.1 Recent counts of in-house manhole inspections performed](image)

The notable decline in sanitary manhole inspections is explained because of a blitz of the sanitary manhole inventory when that was the only CityWorks inspection template available. Operations – Environmental Services now has storm manhole CityWorks templates and as such, their inspectors go back to the areas already done for sanitary for inspection of the storm manholes.

Manhole inspections areas are delineated by sanitary subdrainage areas, as identified by a GIS data source. A check-mark on map on field tablets is shown when a particular manhole is inspected. After 10 years, the inspection check-mark comes off via automated routine. Currently, 95.7% of the city-wide inventory of sanitary manholes have been inspected within this 10-year window, with the rest being those that are hard to uncover or couldn't be found in the field.
Noting that it is the sole inspection criterion that is not specifically related to the structure of the manhole asset itself, as shown in figure 4.3.5.2, most manhole inspection issues are related to **slow flow**. **Blockages** and **slow flow** are the inspection findings which can have negative impact on level of service, with the latter being observed in a fair percentage of inspections.

**Figure 4.3.5.2  Manhole inspection issues type counts, by year**

### MANHOLE INSPECTION ISSUE BY FINDING TYPE

<table>
<thead>
<tr>
<th>Component</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench</td>
<td>15%</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Blockage</td>
<td>5%</td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>Chamber</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Frame</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Ladder</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Lid</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Risers</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Slow Flow</td>
<td>15%</td>
<td>12%</td>
<td>12%</td>
</tr>
</tbody>
</table>

#### 4.3.6 Asset condition – sanitary manholes

Based on a fail result from the binary pass/fail-type findings of the in-house field inspection of sanitary manholes, service requests to City staff are generated as needed to address deficiencies. **Figure 4.3.6.1** outlines the failed component list which initiates a service request automatically.
A condition score is assigned to the inspection when a failed component is identified, but no analysis of asset condition is performed on sanitary manholes.

4.4 Asset Consumption by Asset Type

4.4.1 Asset consumption – sanitary mains

An important distinction should be made between asset condition indicators and asset consumption. While the City has quite robust condition data from camera inspections of the sewers and associated defect observation coding, this does not provide a correlation to consumption (of estimated lifespan) of sanitary pipes.

Asset consumption from available data shows an average asset age of 33 years of an expected 80-year lifespan, representing a 41% consumption.

4.4.2 Asset consumption – sanitary services

Absence of a defined program for sanitary service lateral inspections at Kitchener means that no analysis has been or can be performed on local degradation. City-side sanitary services are removed as a matter of course at time of main replacement.

4.4.3 Asset consumption – sanitary manholes

There is no performance measure for sanitary manholes which is indicative of replacement timing, and in fact there is little industry discussion about longevity of this asset. City-owned sanitary manholes are removed as a matter of course at time of main replacement.
5. Levels of Service

Levels of service fall into a number of categories – qualitative customer expectations, legislated obligations like minimum maintenance, operational standards such as response times, and technical standards as with engineering requirements. These define and inform the practices which are applied to sanitary assets at Kitchener.

On the topic of levels of service, the following sections speak to public attitudes, along with internal work process standard operating procedures, public service requests, environmental concern, inspections, safety, and engineering standards.

5.1 Sanitary Utility operating model

The 2013 Phase 1 AMP noted a gap in that there was not a published service level agreement with respect to the customer service level for the provision of wastewater collection. This was rectified by the Sanitary Utility, through which the City of Kitchener defines its core services and levels of service for this asset category. The 2015 [Sanitary] Enterprise Overview report provides a clear description in:

**Operating Model/Philosophy:**

The sanitary sewer utility performs the service of removal of wastewater generated in the city in an efficient, cost effective, and environmentally responsible manner that is in compliance with legislative and regulatory requirements.

**Services Provided:**

The performance of a wide range of activities and programs that together support the provision of safe and reliable collection of raw sewage generated within Kitchener and its subsequent conveyance through 800 kilometers of pipes and 22 pumping stations to a Regional wastewater treatment facility, where the City pays the Region for ultimate treatment and disposal. Such activities and programs of the utility include:

- The Accelerated Infrastructure Replacement Program
- Pumping station rehabilitation and replacement
- The trenchless sewer rehabilitation program
• Trunk sewer replacement
• Spot repair program
• Pumping station maintenance
• Flow monitoring program
• CCTV inspection program
• Flushing programs
• Emergency repair work
• Service connection blockage clearing
• Hydraulic modeling
• Condition assessment, scoring, and system analysis
• System for the remote control of and data acquisition from pumping stations (SCADA)

As of 2017, a set of new Core Service Key Result Indicators (KRI) will be provided on an annual basis from the Sanitary Utility. The five KRIs related to this Asset Management Plan will be provided as follows:

- % of length of sanitary sewer pipes flushed
- # of kilometers of sanitary sewer pipe replaced/rehabilitated
- % sanitary sewer pipes inspected
- # of wastewater main blockages per 100 km of pipe
- # of spills that reach the environment/total # of spills

5.2 Public expectations - national
Generally, for the assets discussed within this document, the levels of these services are based on de facto expectations of the public, business and industry, that wastewater assets are invisibly functioning and cost-effectively maintained. The relative importance is demonstrated through a RBC Canadian Water Attitudes Study, 2017, wherein two of the top 5 issues of urgency in 10 years’ time are sewage-related.

Indeed, sewage collection and treatment was ranked the fourth most highly prioritized of ten priority infrastructure areas for government funding.

5.3 Public expectations - local
As part of Kitchener’s Water Infrastructure Program evaluation, 2017, a randomly-selected and representative sample of adult Kitchener residents was polled for their considerations on Kitchener utility services, including wastewater. While subjective, the responses do help inform service level expectations from the users of the services themselves, and can also help demonstrate attitudes on tolerance for user rates which affect maintenance and rehabilitation efforts. Residents expressed clearly they were very satisfied and somewhat satisfied with reliability of sewer service.
5.4 Public contact services
The City of Kitchener maintains a number of methods – many of which are electronic – by which residents can receive service with respect to wastewater problems. A Corporate Contact Center (telephone call center) is staffed all day, every day and has procedures in place to assist residents both at the time of the call with advice, and by submitting service requests to the CityWorks maintenance management system described elsewhere in this plan. The procedures also allow for immediate call-out of staff depending upon the nature of the incident or request.

A call to the contact center which is categorized by the call-taker as sanitary-related is taken through a documented standardized process. A problem type description template helps the call-taker understand the nature of the issue, and call handling procedures assist in getting sufficient detail from the caller via scripted questions so as to be able to properly create a detailed service request. A procedural walk-through of the steps for service request generation is provided in the call center script document for the benefit of the call-taker.

Turn-around times from call to completion, based on request type, are the following:

Sewer blockages on private property are responded to immediately. Once the sanitary sewer inspection (SSI) is completed, the customer is booked into a scheduling system. There is a premium charged for after hours (after 15:00) appointments, so sometimes the customer opts to book for the following day.

Issues involving sewer mains, cave-ins, dye testing, or other sanitary network maintenance issues are scheduled at the discretion of the Sewer Supervisors.

Catchbasin or manhole repairs are typically dispatched out immediately (to on-call staff after hours). However, final repairs are scheduled at the discretion of the Sewer Supervisors.

5.5 Work management
Labour tracking, service requests, work orders, inspections, capital program tracking are all functions tracked via CityWorks at Kitchener.

Levels of service with respect to the work activity codes are stored within CityWorks templates. There are three priority levels assigned to activities:

LOW – ANY TIME; MEDIUM; EMERGENCY.

For each sanitary sewer-related activity for which a service request can be generated, an associated priority is defaulted. These defaults can be overridden.
Figure 5.5.1  Service request priority defaults by activity

<table>
<thead>
<tr>
<th>ASSET</th>
<th>ACTIVITY</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Sewer</td>
<td>Sewer Cleaning/Flushing</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Cover Inspection</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Cave-in/Dye Test</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Sewer Main Blocks</td>
<td>Emergency</td>
</tr>
<tr>
<td></td>
<td>Manhole Repair/Replace</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Main - Install/Repair</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Connection</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sanitary Lid Replace</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Blockage</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Sewer Odour</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Rodents in Sewer</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>CCTV Camera Inspection for Maintenance</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Manhole Casting Repair/Replace</td>
<td>Medium</td>
</tr>
</tbody>
</table>

* CityWorks service request activity default priority assignment

For each sewer-related activity for which a **work order** can be generated, an associated **priority** is defaulted. These defaults can be overridden.

Figure 5.5.2  Work order priority defaults by activity

<table>
<thead>
<tr>
<th>ASSET</th>
<th>ACTIVITY</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewer Laterals</td>
<td>CCTV-Sewer Service</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Hydro Excavation</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Repair/Maintain Sewer Lateral</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Blockade</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Connections-Install/Replace</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Lateral Cleaning/Flushing</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Lateral Dye Test</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Odour</td>
<td>Medium</td>
</tr>
<tr>
<td>Sewer Main</td>
<td>CCTV-Sewer Main</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Capital Construction</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Cave-In/Dye Testing</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Hydro Excavation</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Rodents in Sewer</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Clean/Flushing</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Sewer Main - Install/Repair</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Sewer Main Blocks</td>
<td>Emergency</td>
</tr>
<tr>
<td></td>
<td>Sewer Odour</td>
<td>Medium</td>
</tr>
<tr>
<td>Sewer Manhole</td>
<td>Hydro Excavation</td>
<td>Low</td>
</tr>
</tbody>
</table>
There are no tiered levels of service; that is to say there is no preferential or discriminatory treatment for customer service at Kitchener for any user.

5.6 Asset installation and replacement
Service levels for installation and replacement of sanitary assets are documented by the requirements contained in City of Kitchener General Conditions and Standard Specifications (CKSS), with the most recent revision of November 2017. This is a supplement to the commonly known (in the industry) Ontario Provincial Standard Specifications.

The Corporation of The City of Kitchener Standard Specifications are supplemental specifications and amend and take precedence over the Ontario Provincial Standard Specifications, the Ministry of Transportation of Ontario, the Regional Municipality of Waterloo Standard Specifications (RWSS) and Special Provisions (RWSSP), the Region of Waterloo and area municipalities Design Guidelines and Supplemental Specifications for Municipal Services (DGSSMS), and the City of Kitchener Development Manual (CKDM).

Section 400 of the CKSS speaks to the drainage works assets. The standards in use at the City are extremely well vetted both provincially and internally at Kitchener. Installers – exclusively external contractor forces at Kitchener – of new or replacement assets are required contractually to abide by these principles, and in-house inspection staff works to ensure these specifications are met at the design & approvals and construction stages.
5.7 Environmental protection

A documented level of service within the city is to maintain a Sanitary Utility which takes the utmost care in protecting the local environment, meeting all regulatory requirements. The Ministry of Environment and Climate Change (MOECC) has a legislative-based mandate for dealing with spills and related emergencies. The Environmental Protection Act deals specifically with spills, within which sewage pollutants are classified.

Related definitions of this failure of the sewer system include:

**Spill**
*As defined in Part X of the Environmental Protection Act: a discharge of a pollutant into the natural environment, from or out of a structure, vehicle or other container and that is abnormal in quality or quantity in light of all the circumstances of the discharge.*

**Bypass**
*A wastewater treatment plant bypass means the bypassing of a process within a sewage treatment works with the associated sewage flows being returned to the sewage treatment flow and discharging to the environment through the final effluent outfall of the sewage treatment plant.*

**Sanitary Sewer Overflow**
*A discharge to the environment from a sanitary sewer collection system.*

Kitchener retains a copy of the MOE form **Grand River Watershed Sewage Discharge Notification Form for Spills and Bypasses** and is prepared to respond to this mandated service level as per legislation.

Spill response at Kitchener is based on assessment of the hazard, and the work process flow is determined by a classification of **isolated/contained** versus **travelling/not contained**.

This is a low risk-tolerance level of service. But as outlined in the submission **Canada’s Core Public Infrastructure Survey, 2016 Wastewater Assets** for Statistics Canada, indeed service levels were met with respect to environmental concerns. There was no release of untreated wastewater into the environment, and no flood events occurred that were attributable to Kitchener’s wastewater collection system. This was equally the case in 2017 with no spills requiring Ministry Of Environment involvement.
5.8 Inspections – sanitary mains

As was the case in the Phase 1 AMP, one current level of service for sanitary pipes is technical in nature and is represented by the assessment of the condition rating of the assets, via the PACP rating system. A detailed evaluation of that inspection regimen at Kitchener is introduced earlier in Section 4.3 State of Local Infrastructure.

Risk of unforeseen asset failure is significant in the overall definition of this service level, as the inspection regimen presents quantitative data on condition and performance that otherwise would not be known.

5.9 Inspections – sanitary services

With respect to levels of service since the Phase 1 AMP, a new level of service has been introduced in 2014. Included into the standard Engineering contract for road (all-structure) reconstructions was that CCTV inspections of sanitary laterals prior to the two-year maintenance will occur for these capital projects. Laterals are camera-inspected with a lateral launcher post-construction and at the two year maintenance point in time to pick up any deficiencies, and inspection goes a meter past the Kitchener connection point.

There is great value in this effort with about one defective lateral connection found per reconstruction project, with the level of service being met by repair under warranty or an engineering decision to allow for a deficiency which would be problematic to resolve.

5.10 Inspections – manholes

Sanitary manholes are inspected annually by the Infrastructure Services Department, Operations Division - Environmental Services. This provides a check for level of service both for internal purposes such as for access to the sewer asset, and to the public such as with checks for sewer blockages. Defects are identified as failed components and provided a default score and weight factor, and as at time of writing, all are entered into the CityWorks maintenance management system as a matter of process, as service requests. (See section 4.3.6 Asset condition – sanitary manholes). However, it has been determined that service requests in future will be initiated only for work tasks Operations performs, with the rest being performed via a manhole repair tender partnered with the roads program.
The following table figure 5.10.1 outlines the list of inspection checks.

<table>
<thead>
<tr>
<th>FAILED COMPONENT</th>
<th>SERVICE REQUEST DESCRIPTION</th>
<th>Score</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder</td>
<td>Manhole Repair/Replace</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Benching</td>
<td>Manhole Repair/Replace</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Lid</td>
<td>Sanitary Lid Replace</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>Frame</td>
<td>Manhole Casting Repair/Replace</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>Risers</td>
<td>Manhole Casting Repair/Replace</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>Chamber</td>
<td>Manhole Repair/Replace</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>Slow Flow - Need of Washdown</td>
<td>Sewer Cleaning/Flushing</td>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>Blockage - Need to Flush</td>
<td>Sewer Main Blocks</td>
<td>5</td>
<td>100</td>
</tr>
</tbody>
</table>

* list of sanitary manhole failed components as identified by a condition field inspection

Identification of a failed component is determined by a binary **good** / **not good** check. While a **condition score** is applied, the level of service remains simply a binary service request or no service request result. Approximately **5.5%** of the manhole inventory has a non-zero condition score in CityWorks.

### 5.11 Informal performance target – service disruption

Informal performance targets can represent a statistical measure for level of service the Sanitary Utility provides. Some of the most disruptive issues of the sanitary asset category are a result of **sewer blockages** and **sewer repairs**. Fewer city-issue sewer blockage work orders can indicate an overall increase in health of the asset.

As shown in figure 5.11.1, over the past 6 years, the frequency of action and associated costs needed to maintain these service levels is generally declining for main blockages and repairs. Action and costs on service laterals, noting a slight uptick in 2017, has been relatively stable or declining as well. Though data-backed, this increase in sanitary network health is confirmed anecdotally via staff in Operations – Environmental Services.
5.12 Service disruption and litigation
The undocumented expectation by the public, business and industry is that sanitary sewer service be such that failures do not interfere with quality of life or cause property damage. Risk mitigation efforts – described in the section 6.5.2 Sanitary network risk model – exist, yet a failure-free asset system is near impossible, and sewer back-ups which could be considered city-fault do occur.

Figure 5.12.1 Sewer back-up claims and costs through Risk Management

![Sewer Back Up Claims Summary](image)

* cost and count of sewer back-up claims; Risk Management as at November 2017

The number of claims and cost associated is in fact trending downward of late. Risk Management (a function housed at Kitchener which is part of the Waterloo Region Municipalities Insurance Pool) does not draw any conclusions as to the nature of these statistics as claims are highly dependent on circumstances and nature of back-up.

5.14 Sanitary capacity
Apart from customer access to the sanitary system is the issue of capacity of the system. The consultant noted succinctly in the Sanitary Asset Management Plan, 2013, that “capacity has not been an issue”, and this remains the case for this plan update. There are risks of inability to allow infill growth such as with site redevelopment – a major tenet of the Places To Grow Act, 2005 – which exist with this level of service. However, the data described in Section 6.1 sanitary network modelling, allows for analysis of this service level, and a recent forcemain addition redirecting flows has alleviated one of the most risky sanitary capacity asset areas of the city.

The number of pipes with noted capacity concerns has shown variation between 2% and 5%, the latter being the most recent observation, though the quality of modeled data has been enhanced as of the 2017 model update such that previous observations may have underreported. Equally, new development does add sanitary volume, and further tracking of this level of service is critical.

**Summary, levels of service**

<table>
<thead>
<tr>
<th>LOS CATEGORY</th>
<th>INDICATOR</th>
<th>DATA RESULT</th>
<th>SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public expectations</td>
<td>Percent of surveyed local residents somewhat or very satisfied.</td>
<td>84%</td>
<td></td>
</tr>
<tr>
<td>Public contact services</td>
<td>All-hours contact center capability.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Work management priorities</td>
<td>Defined priorities by activity type.</td>
<td>Set, adjustable.</td>
<td></td>
</tr>
<tr>
<td>Standard operating procedures</td>
<td>Published procedures and repair timelines.</td>
<td>Yes. Full list of activities not encompassed.</td>
<td></td>
</tr>
<tr>
<td>Asset installation and replacement</td>
<td>Regulatory requirements met; specifications documented.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Environmental protection</td>
<td>Defined protocols meeting MOECC requirements.</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Inspections - sanitary mains</strong></td>
<td>Physical inspection of infrastructure and condition rating.</td>
<td>Annual selected sets and targeted inspections for specific projects. 64% inspected.</td>
<td></td>
</tr>
<tr>
<td><strong>Inspections - sanitary services</strong></td>
<td>Physical inspection of infrastructure and condition rating.</td>
<td>100% rate for post-reconstructions only.</td>
<td></td>
</tr>
<tr>
<td><strong>Inspections - manholes</strong></td>
<td>Physical inspection of infrastructure and condition rating.</td>
<td>Annual. 95.7% inventory inspected.</td>
<td></td>
</tr>
<tr>
<td><strong>Informal performance target - service disruption</strong></td>
<td>Statistical indicator of fewer main blockages and repairs; lateral blockages and repairs.</td>
<td>Past five years averages: Main blockages 1% decrease. Main repairs 9% decrease. Lateral blockages 0% change. Lateral repairs 8% increase.</td>
<td></td>
</tr>
<tr>
<td><strong>Service disruption and litigation</strong></td>
<td>Statistical indicator of fewer litigious claims through Risk Management.</td>
<td>Past three years average: Sewer back-up claims 23% decrease.</td>
<td></td>
</tr>
<tr>
<td><strong>Sanitary capacity</strong></td>
<td>Statistical observation of sanitary conduits with depth over diameter &gt; .85</td>
<td>Sanitary conduits with potential capacity issues: 5%, an increase over previous models from 2%, 3%.</td>
<td></td>
</tr>
</tbody>
</table>

A balanced approach to sustain the sanitary assets to retain the highest value in the longer term is still aligned with the 2013 Phase 1 AMP. As always with asset management, the challenge will be achieving the right balance between cost, [condition], level of service and risk. The City of Kitchener has elected to place risk [mitigation] at the top of the priority measures, thereby ensuring that the City’s current investment in sanitary infrastructure is safeguarded. The City believes that its strategy for long term sustainability will result in lower costs overall over the long term.
6. Asset Management Strategy

6.0.1 Condition-based analysis

Over the past several years, various condition and performance datasets have been combined – from road needs, sanitary condition, water age and break history – into a multiple-structure prioritization tool. Having an existing infrastructure replacement program (WIP, described in Section 6.5.1 Non-Infrastructure Solutions / Integrated Infrastructure Planning) well underway from which projects were selected primarily based on age, a shift towards a principle and practice of condition-based strategy was adopted.

As provided in a synopsis for Kitchener’s presentation to the 2013 Water Environment Association Of Ontario conference:

As a first step to producing an integrated condition assessment for each right-of-way segment in the city, the condition scores for each of the three asset types as described previous are drawn from their respective databases, and linked to form a condition analysis database for the CAT [condition analysis tool] analysis. This resulting table includes all relevant condition data and scores for each particular piece of infrastructure, the most important being the overall condition score for each asset type within each right-of-way segment – with each asset having a score out of a possible 100 points (with 100 being perfect) for each segment.

To produce an overall condition score for each right-of-way segment in the city, once individual asset condition scores have been imported into the CAT database, queries and routines developed by the Asset Planning Section are then used to produce a weighted integrated condition score for each right-of-way segment. A similar process is used to produce overall condition scores for each individual asset earlier in the process.

JH, CH, RW to WEAO 2013

The pinnacle of effective asset management is well stated in the Ministry’s Building Together in that 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 lifecycle cost (e.g., through preventative action).

-- Ministry Of Infrastructure, Building Together
Condition-based needs, local degradation observations, targeted rehabilitation timing, and the need for maintaining the robust reactive, operational regimen are currently in place. Asset condition and performance along an anticipated lifespan are continually analyzed.

The following sections will convey the City’s current processes including usage of a capital planning tool and a work management system and how this addresses service-oriented activities, renewal / betterment activities, replacement, disposal activities, and lifecycle management.

### 6.1 Service Oriented Activities

For the purposes of this asset management plan, service oriented activities are those operational or maintenance activities that are performed on an asset during the course of its lifecycle in an effort to maintain its level of service. These activities do not have a direct impact on the overall condition of the asset, but simply maintain it at a defined service level.

#### 6.1.1 Sanitary flow monitoring

A primary and essential procedure for understanding sanitary network asset performance is via a flow monitoring regimen. Kitchener has a flow monitoring program which is both project specific and catchment area based; all field and data processing-and-storage work being contracted out to external parties.

Flow monitoring involves the strategic location in manholes of effluent monitoring devices which take readings of flow volume and rate at selected intervals. The data depict actual sanitary sewer usage, and when placed at locations for significant duration, can very accurately show typical flows and evidence of rainfall derived inflow and infiltration and spring freshet inflow. Data from flow monitoring is used both for project level decision-making and for data input to the sanitary network hydraulic model. (The sanitary model is discussed in Section 6.1.2)
* flow monitor data tracking shows temporal aspects of sewer flow volume and velocity

Kitchener has made a concentrated effort at sanitary flow monitoring by catchment, and this is to continue in future.

6.1.2 Sanitary network modelling
The purpose of a 2010 sanitary model study was to:

- evaluate available capacity and performance of the city’s existing sanitary sewer network both at that time, and the system’s ability to accommodate future growth scenarios

- identify potential constraints in the system, both as at that time, and under future growth scenarios, and identify remediation strategies

- facilitate best practices in infrastructure asset management as at that time, and in the future by enhancing growth planning of the sanitary sewer system
• provide the city with a hydraulic computer model of the sanitary drainage system that can be operated by staff on an ongoing basis

The model package is a representation of known asset location and attributes, combined with inferred performance of Kitchener’s sanitary sewer pipe network. Changing of new development, redevelopment, or rainfall scenarios allows for a variety of performance simulations and associated reporting. In order to calibrate the model to observed conditions, flow monitoring for a number of months was performed to gain actual flow data at key points in Kitchener’s wastewater network. (Sewer flow monitoring is a key technique in the city’s stewardship of the sanitary asset category, and is described in Section 6.1.1).

The hydraulic modelling was and continues to be used as a comprehensive tool to evaluate sanitary sewer network system performance, showing that remediation efforts such as upsizing are required. It has enabled Engineering Development staff to evaluate the impact of development proposals, and potential future zoning changes on the sanitary sewer network. It will continue to inform capital works via the Water Infrastructure Program (WIP).

A minor update to the model was performed in 2013, and a major update has been completed in 2017, showing an increase in number of Kitchener sanitary pipes with potential capacity concerns.

6.1.3 Sanitary network extraneous flow investigations
Intrinsically related to both sanitary flow monitoring and network modelling is the common issue of extraneous flows in wastewater systems – this having a substantial and unrecoverable processing cost to the Sanitary Utility.

The City of Kitchener is a lower tier municipality within the Region Of Waterloo. In this governance scenario, wastewater conveyance is via City assets and treatment is the purview of the Region. As such, the Region bills the City for processing of the entirety of wastewater volumes metered incoming to the Kitchener treatment plant. (There are occasions where volume is deducted from totals for the likes of the Region inputting to the sanitary network during their own procedures; these are accounted for in volumes hereafter shown).

There is some nuance to the sanitary catchments versus municipal boundaries of wastewater flows, as there are inputs to and from adjacent municipalities – Cambridge, Waterloo, Woolwich, Wilmot. These are accounted for, both financially and in data, by cross-border agreements and flow monitoring and customer billing, and are in the order of 5% of total flows.

A point of importance to the Sanitary Utility, is inflow and infiltration volumes, collectively and colloquially called I&I. The wastewater volumes shown in this section include inflow and
infiltration volumes, presumed to be the majority of extraneous flow. This presents on average annual cost over the past six years to the Utility of approximately $5,724,805.

Figure 6.1.3.1 Total metered sanitary flow with extraneous flow volumes

* historic percentage of typical sanitary network flow and unaccounted-for wastewater flow

The Sanitary Utility continues to monitor the discrepancy between volume of potable water metered and treated sanitary effluent volume at the Kitchener wastewater treatment plant. The issue has financial implications as treated volumes - the greater value – are billed by the Region Of Waterloo.

6.2 Betterment Activities

A betterment activity can be defined as a work task that when completed will provide added value to the asset that is being worked on and have the potential to extend the life of the asset through increasing the asset’s condition.

A relatively recently-used technology for interim remediation of sanitary mains and services is lining, first used in Kitchener in 2004. Of great benefit is the fact that this treatment typically requires no excavation whatsoever. It provides a barrier protecting the internal wall of the existing pipe, guards against infiltration, and enhances the flow characteristics of the original deteriorated pipe.
Claims around longevity of lined pipes are 50 years, yet there is increasing indication that lined pipe treatments will easily surpass that 50 year life. The United States Environmental Protection Agency performed a comprehensive evaluation of lined pipes and concluded:

> All of the samples retrieved ... were in excellent condition after being in use for 25 years, 23 years, 21 years, and 5 years. There is no reason to anticipate that the liners ... will not last for their intended lifetime of 50 years and perhaps well beyond”.

* A Retrospective Evaluation of Cured-in-Place Pipe (CIPP) Used in Municipal Gravity Sewers

All sanitary main and service lining in this municipality has been performed by external contractors. An internal evaluation of lining efficacy at Kitchener has found very few liner failure defect codes, and a quick investigation of some of these suggest installation issues as opposed to material problems, and the word failure is an exaggeration of the problem in other cases.

Properly installed, the cured-in-place sanitary lining process is an excellent methodology by which to extend the life of assets well beyond the expected life of the original materials. There is an Ontario Provincial Standard Specification (OPSS460) which outlines the requirements for cured-in-place lining.
Figure 6.2.1 Sanitary main lining program

* City of Kitchener sanitary main lining meterage 2003 - 2016

Lifecycle management strategy and modelling

A sanitary lifecycle model has been created to outline the optimum timing of lining for all sanitary pipes.

From an estimated service life of 80 years and known structural condition PACP score, a recommended lining intervention year is provided. If the condition is unknown due to lack of inspection, an inferred condition is derived from the condition curve shown in figure 6.2.2. Lined pipes are assigned a new estimated service life after treatment, of an additional 60 years after which time they are deemed in theoretical need of disposal. Relined pipes have a newly assigned condition curve.
Figure 6.2.2 Pipe life condition curve and sanitary lining treatment

* pipe condition score as derived from estimated service life; post-treatment service life

The functions of these curves are used to inform age-based condition in the Sanitary CCTV database for sanitary pipes which are without a current inspection, and are not used to inform any work program.

While the lifecycle model provides a general snapshot of future works, capital program drivers have been superseded by the risk-based model approach and presented to City Council through the Water Infrastructure Program (WIP) as the driver of capital planning until 2044.

As introduced in Section 5.5 work management, a level of service provided by the Sanitary Utility, via Operations – Environmental Services in-house staff, is sanitary spot repairs. Data shown in figure 6.2.3 indicates the average pre-repair score and associated post-repair betterment value.
6.3 Replacement and Disposal Activities

* pipe condition score as derived from estimated service life; post-treatment service life potential

Replacement of any individual asset or group of assets should be driven by a detailed analysis of that asset or group. It should not be automatically dictated by financial plan assumptions.

-- Ministry Of Infrastructure, Ontario

Replacement and disposal activities of Kitchener’s wastewater assets are well planned and well documented. Funding for asset replacement primarily comes from capital budgets (with some for emergencies in maintenance budgets) – planned up to a decade in advance – with most assets being replaced as a function of all-structure right-of-way reconstruction. Indeed, the driving factors for replacement are by way of detailed analysis of asset condition and performance. The resulting analysis is then aligned with the capital budget forecasts.

Figure 6.3.1 shows sanitary main replacement length through these capital works.
* historical sanitary main replacement via full reconstructions

Context for the notably higher budget expenditures in 2010 and 2015/6 are by way of infrastructure stimulus funding and light rapid transit funding from senior levels of government.

Apart from replacement via integrated planning, condition and performance drives discrete dispose and replace projects – often within easements, or of older trunk main portions. Figure 6.3.2 shows the sum lengths of these capital works projects, both historic and planned.
Figure 6.3.2 Non-full reconstruction sanitary main replacement

* historical, current, future sanitary-only replacement, outside of full reconstructions

The financial aspect of disposal activities is described in more detail in Section 7.0.1 Asset accounting.

6.4 Growth

Sanitary asset expansion – typically in suburban locations – is determined through Community Services Department / Planning Division in conjunction with Engineering Development Section of Engineering Division. The planning documents which describe the requirements for future growth include the Development Charges (DC) Background Study, 2014, and associated by-law 2014-068, and the Kitchener Growth Management Plan (KGMP).

Although Planning Division co-ordinates the preparation of what amounts to expansion activities, it is appropriate to state that multiple City areas and City Council act as a shared determiner.

Sanitary Processing Volume Trends
As introduced in Section 3, Kitchener is within a Provincially-designated growth area, and wastewater processing volumes will increase.

To a reasonably high degree, we can correlate inputs to the sanitary system from the Finance Department’s water/sewer billing system, to wastewater treatment volumes. That is, potable water billing is the best correlation to wastewater generation in absence of ubiquitous sanitary service metering. The Sanitary Utility calculates the sewer surcharge at 98.5% of metered water usage. (There are caveats in non-standard scenarios where some users have septic systems, and with cross-border servicing).

Using this information, The City of Kitchener has well over 65,000 wastewater system users.

**Figure 6.4.0.1**

<table>
<thead>
<tr>
<th>user classification</th>
<th>count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>61,561</td>
</tr>
<tr>
<td>Industrial</td>
<td>246</td>
</tr>
<tr>
<td>Commercial</td>
<td>2,453</td>
</tr>
<tr>
<td>Apartment</td>
<td>1,194</td>
</tr>
<tr>
<td><strong>(total)</strong></td>
<td><strong>65,454</strong></td>
</tr>
</tbody>
</table>

Processing volumes have shown a drop per capita with the advent of low-water-usage fixtures, and water conservation educational efforts. However, the drop per-capita will not be sustained when much retrofitting will have been done, and while all new development and redevelopment uses these same low-water-usage fixtures.

As the 2017 Region Of Waterloo Water And Wastewater Monitoring Report states:

*The MOE Guidelines do not allow anticipated water use reductions to be used in calculating future demands, but require future water use projections to be based on historical water use trends.*

*Using the 5-year average... per capita flow... there is capacity to service approximately 147,000 additional people in the Kitchener Wastewater Service Area as of December 31, 2016. The present system capacity could service a population of approximately 425,000 people.*
As such, Kitchener is in very good shape with respect to population growth and associated sanitary network expansion.

6.4.1 Development charges background study

Sanitary servicing, and associated budget implications, has been calculated from 2014 through 2031.

The development-related capital program for Sanitary Servicing includes $70.6 million of capital works, including $69.3 million of trunk sewer extensions, pumping stations and pumping station upgrades, and storage facilities, and $1.3 million of sanitary servicing development charge credit and/or refund repayments to which the City is committed. No grants or subsidies have been identified for any of the projects. Therefore the net cost of the program remains at $70.6 million.

Notably, pump stations and associated appurtenances account for the bulk of that nearly $70 million value, and those assets are not within scope of this asset management plan. Further, between the 2014 study publishing and creation of this asset management plan, some work has been completed. Total remaining DC-eligible costs attributable to the relevant sanitary assets of this plan through 2031 is estimated at $11,066,906.

While there is a lifecycle model which estimates lifespan, there is no methodology by which to attribute lifecycle costs to these new assets.

6.5 Non-Infrastructure Solutions

6.5.1 Integrated Infrastructure Planning

The Ontario Ministry of Infrastructure in “Building Together: Guide for Municipal Asset Management Plans”, suggests there is value in integrated planning to optimize lifecycle costs. A common strategy is to coordinate capital spending across multiple assets. A good example is coordinating water and wastewater repair/replacement with municipal road replacement. Municipal roads periodically need to be rebuilt, and the associated schedules are part of the municipal planning cycle. If there is a good possibility that a watermain or sewermain will fail or start to provide degraded service — during the life of the road that is being rebuilt, significant cost savings can be achieved by replacing the watermain or sewermain at the same time.
While this type of all-structure-replacement capital works has been in place for decades at Kitchener, in 2002 the city embarked on an acceleration of this work with the aptly-termed Accelerated Infrastructure Replacement Program (AIRP). What originated as an age-based criterion for structure replacement identification, was refined to a condition-based assessment via an in-house-designed Database Management System and Geographical Information System linked tool. This was termed the **Condition Analysis Tool**, and is described briefly above.

The other asset (structure) types accounted for within a full reconstruction are or will be described in their respective asset management plans. With respect to the sanitary sewer network, full reconstructions under the AIRP program of 2002 has led to the replacement, as of the completion of the 2017 construction season, of approximately:
69 kilometers of sanitary main.

Figure 6.5.1.1 Sanitary main replacement

* lengths are approximated and includes the scope of Light Rail Transit construction works
1,209 manholes.

Figure 6.5.1.2  Sanitary manhole replacement
It is important to note that the financing of the WIP initiative capital projects are not split in the same manner in which the condition and performance factors create the projects. In fact, the cost breakdowns of the project from a constructability perspective do not match them either.

Determination of funding source dollars originated from the approximate cost to excavate and replace the deepest structures targeted for replacement and restore the right-of-way. Currently, the Sanitary Utility pays 46% of each project, with the Water Utility paying 31% and the Stormwater Utility paying 23%. Prior to the inception of the Stormwater Utility in 2010, capital from current (municipal tax money) was the third funding source.

Beyond this description, these project-level nuances are not part of the scope of this asset management plan.
As of 2017, the capital replacement program has been updated to include the following changes:

- an extended timeline of anticipated completion of removal of problem structures (assets)
- a revised funding scenario
- service level definition
- enhanced risk-based approach
- increased consideration of preventative maintenance
- potential incorporation of funding sources from other levels of government

This long-term capital replacement program is now called the Water Infrastructure Program (WIP).

6.5.2 Sanitary network risk model

The City of Kitchener has undertaken an initiative to create a risk model for linear wastewater (sanitary) assets. The value in risk modelling is to aid in prioritizing and planning asset rehabilitation and replacement, both in the near-term and long-term. There is further value in the ability to provide an objective answer to media, residents, senior management, council, other levels of government regarding the risk of failure of assets in question.

Ultimately, a total risk score is derived by running a series of mathematical calculations from a variety of pertinent data sources. A probability of failure and consequence of failure score informs the final score.

Figures 6.5.2.1 and 6.5.2.2 show the results of the risk scoring at Kitchener by segment count and by length. With a maximum risk score of 100, very little of the sanitary network is in a state of any consequential risk. This speaks to good design and stewardship of the sanitary network such that there are not a lot of compounding factors of concern: e.g. large diameter mains, near watercourses, with high traffic on the road above; or institutional connections with distance of less than three meters to a main and an inspected poor sewer condition.
Figure 6.5.2.1  Sanitary risk scoring by number of sanitary main segments
Figure 6.5.2.2  Sanitary risk scoring by kilometers of sanitary main segments

Risk Scores of Active Sanitary Mains

Sanitary Mains (km)

Risk Score
To determine a **probability of failure**, we have sewer main condition structural rating – from the CCTV camera defect inspections described elsewhere in this plan. This is the objective, standardized description of sewer condition by rating of all defects found.

To determine a **consequence of failure**, we use a comprehensive array of attribute, locational, connectivity elements. Sewer main diameter, land use, traffic counts are used to create *potential disruption* factors. Sewer connectivity to critical life and health, and institutions of importance, and large employers feeds an *effect of service disruption* factor. Similarly, distances to watercourses, buildings, other high value utilities feeds the *effect of service disruption* factor.

The model has been created in the City’s GIS environment in-house which allows for easy modification, adjustment, changing of model parameters. The model is functional as of 2017 and now informs capital planning via the in-house condition analysis tool.
Figure 6.5.2.4  Generalized Kitchener sanitary pipe risk score

* a summation of risk scores can be mapped to show a city-wide picture
Risk mitigation protocols

The City of Kitchener has a 10-year capital outlook which plans for replacement of the infrastructure assets which have been objectively determined to be most at risk of failure, both from a condition and performance perspective, and from a risk-assessment perspective. As such, failure of assets that might fail to meet expected service levels in the interim will fall to the purview of Operations Division - Environmental Services. Those protocols are outlined in Section 5 Levels of Service, including a strict adherence to environmental and other regulatory requirements.

6.5.3 Managed failures

Recurring maintenance activities such as flushing, reaming or other continual activities are necessary across the City. The Sanitary Utility considers these to be managed failures and are termed hot spots at Kitchener.

The Operations Division - Environmental Services maintains a list of a series of hot spots to which field staff must regularly attend. Hot spots represent city infrastructure assets which are not performing optimally due to the likes of physical sags, intruding roots, deposited grease, and other issues. Without this special attention to hot spots through maintenance routines, the assets would not function.

The cyclical work order tasks performed with respect to hot spot attention include:

Figure 6.5.3.1 Cyclical work tasks
- Manhole Cleaning
- Sewer Clean/Flushing
- Sewer Lateral Cleaning/Flushing
- Sewer Manhole Inspection

The asset issues covered by these hot spot activity templates are such that invasive rehabilitation or outright replacement is unwarranted – as in the likes of PACP maintenance-type defects – or not on any rehabilitation list due to lack of funding, or are already scheduled for replacement. That is, in the last case, usually through full reconstruction as described elsewhere in this plan.
For about a decade, an up-to-date listing of hot spots has been integrated as a geographic layer in the in-house condition analysis tool, and informs decision-making for capital works. While not a driver of capital works, a consistent expenditure of Operations budget on defects maintenance of known problem pipes does influence selection and timing of full reconstruction (WIP) projects.

Hot spot locations have been housed directly in CityWorks and tied to asset identifiers since 2015. That means while we have good locational information, there is a dearth of historical data wherein we can tie work costs (labour, material, equipment, contract, other) to specific structures with simple queries.

Figure 6.5.3.3 Operations sanitary cyclical hot spot locations

Noting that each attendance to a work location is tracked via distinct work order, cyclical work at specific hot spot locations is decreasing, pointing to an overall health increase of the sanitary pipe network asset.
6.5.4 Inter-municipality pooled projects

The City of Kitchener partners with other government entities for purposes of efficiency and in the spirit of collaboration for the better public good, including a longstanding protocol of partnering with the Region Of Waterloo on City infrastructure replacement within Regional rights-of-way.

The City maintains strong engagement and representation with relevant organizations, many of which are described herein, including National Water & Wastewater Benchmarking Initiative, Water Environment Association Ontario, Municipal Finance Officers Association, Federation Of Canadian Municipalities.

6.5.5 Options analysis

In order to facilitate the levels of service outlined in Section 5 Levels of Service, Kitchener maintains an experienced Asset Planning Section.

The Ministry Of Infrastructure proposes:

For example, planned maintenance projects could use a standard inflation measure, while large capital project may require a more specific measure that better reflects changes in construction costs.

In fact, Kitchener has undertaken an investigative process in 2017 to evaluate and update the accelerated capital infrastructure asset replacement program. From this it was determined that the current scenario of 2% annual inflation for maintenance activities, and project-level analysis for large projects remains the preferred methodology for the Infrastructure Services Department.

6.6 Climate Adaptation

The City of Kitchener is in the process of developing a framework to address the impacts of the effects of climate change. The scope of this model includes risk factors associated to condition,
on-going cost escalations, staff resources, changes in maintenance requirements, condition degradation impacts and analysis methodologies. External data sources will be added and analyzed to correlate the cause and effect of adaptation and mitigation steps related to the on-going changes.

This framework and subsequent models will inform the Sanitary Utility with respect to funding allocation, analysis methodologies, and mitigation strategies which will be determined in 2018 and onward.
7. Financial Strategy

In 2017, as part of a City Council-driven Water Infrastructure Program (WIP), described earlier, a thorough investigation of operating and capital programs was undertaken. This evaluation included “the relationship between capital and maintenance investments and looked to balance affordability with these infrastructure investments”. Some guiding principles of the endeavor outlined the correlation between capital and maintenance programs in:

[Recognition] that preventative maintenance activities and inspections are important activities to provide lowest lifecycle cost for infrastructure.

Failure to renew and replace infrastructure has an impact on reactive/emergency maintenance activities and increases lifecycle costs

Growth of [an] asset base should recognize total costs of ownership including maintenance and operating cost impacts.

7.0.1 Asset accounting

There is a necessary connection between Financial Reporting and Asset Management at Kitchener. The City’s, Accounting Division maintains an annual financial reporting business process as required by Province Of Ontario regulations. PSAB3150 (Public Sector Accounting Board) requirements came into effect as of 2009, at which time municipalities were expected to enable financial statements which moved beyond solely expenditure on tangible capital assets, but to include their amortization / decrease in value since construction or acquisition or contribution via development.

An original cut of data – apropos to this plan, including wastewater assets – was done for the initial PSAB3150 efforts in 2008. The data is stored in cost center repositories in the SAP financial management software solution. The required historical costs were compiled from 2008 approximate replacement costs, and a discount factor was applied which effectively removed inflation, to get an estimated acquired asset cost.

Financial Reporting tracks only one asset type sanitary sewer – which includes pipes and manholes and excludes laterals – as a pool. Amortization, for the purposes of Accounting Division, is by straight line amortization – a linear degradation of value over time. Notably,
Accounting applies an assumed 50-year lifespan to sanitary assets, whereas Asset Management considers estimated lifespans to be based on diameter and material type, and even more generally 80 years.

Capital works through Engineering Division, where structures are replaced, are considered disposals and new acquisitions to Accounting Division. This aligns with the terminology of Engineering contracts wherein contractors price out disposals and new assets.

### 7.1 Operating Expenditures

The following figures express the operating expenditure data extracted from the City’s maintenance management system, CityWorks, for the years 2012 through 2017. The data is grouped by asset type where appropriate, and represent full-city totals otherwise. A number of analysis options are feasible.

For each of the asset types – sanitary mains, service laterals, manholes – the capability exists to differentiate amongst **general city costs**, **externally-billable costs**, **internally-billable costs**, and the sum of the three cost types. General city costs are those that are borne by the city by the nature of operating the Sanitary Utility. Externally-billable costs are those that are attributed to investigation and repair of third-party, typically homeowner, assets of responsibility and ownership. Internally-billable costs are attributable to work performed for other departments or City entities.

Equally, we can demonstrate operating costs which are **reactive** type activities and **non-reactive** type activities. Reactive activities are those which are ad hoc or unplanned, whereas non-reactive activities are those which result from planned work to remedy known issues or keep assets functioning.

Further, we can view operating costs by categorization of **inspection** activity, **routine** activity, **service-oriented** activity. Inspection activities are surveys of condition, performance, and safety in order to maintain best available objective knowledge of the assets. Routine activities are those activities that help support the condition of that asset throughout its expected lifecycle. Service-oriented activities are those activities that don’t affect health of assets but provide for maintenance of level of service.
Figure 7.1.1 Sanitary main operating expenditures – full city, externally-billable, internally-billable costs

![Graph showing operational expenditures from 2012 to 2017 for total, external, internal, and city costs.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>External Cost</th>
<th>Internal Cost</th>
<th>City Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>$651,524</td>
<td>$13,906</td>
<td>$9,211</td>
<td>$628,407</td>
</tr>
<tr>
<td>2013</td>
<td>$543,290</td>
<td>$44,182</td>
<td>$4,770</td>
<td>$494,338</td>
</tr>
<tr>
<td>2014</td>
<td>$375,725</td>
<td>$33,063</td>
<td>$2,728</td>
<td>$339,934</td>
</tr>
<tr>
<td>2015</td>
<td>$336,923</td>
<td>$2,788</td>
<td>$2,946</td>
<td>$331,190</td>
</tr>
<tr>
<td>2016</td>
<td>$252,041</td>
<td>$4,904</td>
<td>$12,315</td>
<td>$234,822</td>
</tr>
<tr>
<td>2017</td>
<td>$300,836</td>
<td>$4,331</td>
<td>$5,312</td>
<td>$291,193</td>
</tr>
</tbody>
</table>

Figure 7.1.2 Sanitary main operating expenditures – full city activity, externally-billable, internally-billable counts

![Graph showing the number of operational projects from 2012 to 2017 for total, external, internal, and city counts.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>External Count</th>
<th>Internal Count</th>
<th>City Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>279</td>
<td>23</td>
<td>13</td>
<td>243</td>
</tr>
<tr>
<td>2013</td>
<td>212</td>
<td>19</td>
<td>9</td>
<td>184</td>
</tr>
<tr>
<td>2014</td>
<td>181</td>
<td>22</td>
<td>5</td>
<td>154</td>
</tr>
<tr>
<td>2015</td>
<td>879</td>
<td>4</td>
<td>9</td>
<td>866</td>
</tr>
<tr>
<td>2016</td>
<td>789</td>
<td>5</td>
<td>6</td>
<td>778</td>
</tr>
<tr>
<td>2017</td>
<td>696</td>
<td>6</td>
<td>7</td>
<td>683</td>
</tr>
</tbody>
</table>
Notably, the count of activities has increased in recent years due to a migration from city-wide work orders to structure (asset)-specific work orders.

Figure 7.1.3  Sanitary service lateral operating expenditures – full city, externally-billable, internally-billable costs

![Bar chart showing operational expenditures for full city, externally-billable, and internally-billable costs from 2012 to 2017.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>External Cost</th>
<th>Internal Cost</th>
<th>City Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>$622,052</td>
<td>$44,890</td>
<td>$14,904</td>
<td>$562,258</td>
</tr>
<tr>
<td>2013</td>
<td>$667,437</td>
<td>$50,449</td>
<td>$9,362</td>
<td>$570,626</td>
</tr>
<tr>
<td>2014</td>
<td>$625,078</td>
<td>$52,009</td>
<td>$2,545</td>
<td>$570,525</td>
</tr>
<tr>
<td>2015</td>
<td>$531,283</td>
<td>$47,548</td>
<td>$5,027</td>
<td>$478,709</td>
</tr>
<tr>
<td>2016</td>
<td>$396,161</td>
<td>$51,588</td>
<td>$5,530</td>
<td>$339,044</td>
</tr>
<tr>
<td>2017</td>
<td>$476,634</td>
<td>$53,335</td>
<td>$4,597</td>
<td>$418,702</td>
</tr>
</tbody>
</table>

Figure 7.1.4  Sanitary service lateral operating expenditures – full city activity, externally-billable, internally-billable counts

![Bar chart showing operational project counts for full city, externally-billable, and internally-billable counts from 2012 to 2017.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>External Count</th>
<th>Internal Count</th>
<th>City Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>533</td>
<td>148</td>
<td>10</td>
<td>375</td>
</tr>
<tr>
<td>2013</td>
<td>578</td>
<td>154</td>
<td>4</td>
<td>420</td>
</tr>
<tr>
<td>2014</td>
<td>590</td>
<td>128</td>
<td>7</td>
<td>455</td>
</tr>
<tr>
<td>2015</td>
<td>581</td>
<td>131</td>
<td>8</td>
<td>442</td>
</tr>
<tr>
<td>2016</td>
<td>552</td>
<td>152</td>
<td>11</td>
<td>389</td>
</tr>
<tr>
<td>2017</td>
<td>546</td>
<td>111</td>
<td>13</td>
<td>422</td>
</tr>
</tbody>
</table>
Figure 7.1.5  Sanitary manhole operating expenditures – full city costs

Figure 7.1.6  Sanitary manhole operating expenditures – full city counts
Figure 7.1.7  Sanitary total operating expenditures – reactive versus non-reactive activities costs

Figure 7.1.8  Sanitary total operating expenditures – reactive versus non-reactive activities counts
Against a notable trend, the increase in total count of operational service-oriented activities as seen in figure 7.1.10, is accounted for by tracking work against assets, as opposed to a legacy of city-wide work tracking.
Meanwhile, a trend is showing of significant expenditure decreases, which is due to the split resourcing of sanitary and storm Operations staff, of late being tasked with prioritizing storm network maintenance work. It will require additional cycles of CCTV inspection to determine how this affects asset condition.

Noting that the Sanitary Utility’s charter states it is a non-profit enterprise, a review of CityWorks operating costs and cost recovery suggests a small percentage of sum unrecovered costs per year, averaging 92% cost recovery over the past six years. This is due to the standard procedure of only charging a two-hour flat rate and no charge for camera inspections.

Figure 7.1.11 Sanitary lateral blockages work costs with unrecovered or over-recovered costs.

With respect to maintenance programs, it was determined through the aforementioned Water Infrastructure Program evaluation that “sanitary did not have a maintenance gap”. However, as per internal business process which aligns with Ministry Of Infrastructure expectations, 2% inflation on all expenses is applied to the sanitary maintenance budget each year in the City’s budget.
Kitchener’s Financial Planning area maintains Operating Budget Projections, and provides City Council with this financial picture.

Revenues include the likes of the sanitary sewer surcharge, which is a consistent **98.5%** of metered water usage; miscellaneous revenue from cross-border billing, late charges, sewer blockages billing; Engineering billed time for flow modelling site reviews.

Expenses include the likes of the cost of sewer processing from the Regional Municipality of Waterloo; Engineering internal costs; Operations maintenance activity costs; sewer rebates for users. Transfers to capital include WIP capital funding and sundry other capital needs including CityWorks and SAP.

The Stabilization Reserve Fund is designed to dampen dramatic rate increases, with this strategy following Government Finance Officers Association (GFOA) recommendations. Kitchener has a consistent reserve over the course of the 5-year projection, yet is currently below minimum target.

The Capital Reserve Fund is via budget close-outs from projects which are not from WIP.

Anticipated growth and water usage trends round out the values for increases or decreases in rates and water consumption.

### 7.2 Capital Revenue and Cost Projections

In 2017, a thorough investigation of operating and capital programs was undertaken. This exercise determined the future funding requirements for the multi-utility-funded capital program, which almost wholly performs sanitary asset replacement at Kitchener, from data outlined in *Section 4 State of Local Infrastructure*.

No change was recommended or enacted to the selection or estimating methodology of this integrated infrastructure replacement scenario, which serves to provide the vast majority of sanitary asset replacement. The target planning horizon of the program was updated from 2032 to 2044, and the near-term rate increase – notably for the entire integrated program, which includes sanitary components – was modified to a **6.5%** increase. With this long-term program being funded by three City utilities, the percent increase to the Sanitary Utility is pegged at **6.9%** for 2018 and onward.
The funding formula has determined the budget allotment for a timeframe for the upcoming 26 years. Recommendations for the re-evaluation of utility rates are annual. Specific project selection is performed annually, with a consistent 10 year time horizon for all static, newly-injected, or moved projects.

The following Figure 7.2.1 represents the historical budget target for sanitary replacement in the capital program:

Figure 7.2.1 Historical capital replacement budget targets, and budget increases to meet the target.

The following Figure 7.2.2 represents the projected budget target for sanitary replacement in the capital program:
Figure 7.2.2  Forward-looking capital replacement budget targets, and budget increases to meet the target.

* projected Sanitary Utility capital replacement budget allotment; static rate increase

Planned capital funding for the primary rehabilitation strategy for sanitary mains – trenchless sanitary main rehabilitation – is defined by the WIP-proposed capital plan of a 2% annual increase, as shown in Figure 7.2.3.
7.3 Long Term Capital Funding Requirements

By virtue of detailed planning via the Water Infrastructure Program (WIP) in mid-2017, rate increases and timelines mean costs are planned and smoothed over the upcoming 25 years, and in fact beyond. As earlier described, the WIP accounts for three asset categories – storm water, potable water, wastewater, and as such, this detailed long term capital plan uses useful life characteristics of the potable water asset type to determine an overall replacement scenario.

The Council-approved scenario most closely aligns to replacement needs post 2044 and represents the most stable, “smoothed” capital program increase option. It was determined that this long term funding scenario means essentially closing the capital needs gap by 2044.
Figure 7.3.1 outlines the City build eras correlated to anticipated replacement needs, along with the extended-term capital outlay projected to close the identified infrastructure gap.

Figure 7.3.1 Long-term capital replacement needs and timeline.

All-structure full reconstructions of the right-of-way is the primary methodology for asset replacement, and as such, all three asset types covered by this asset management plan – mains, manholes, services – are accounted for within this long-term capital replacement plan.