Norfolk County – Asset Management Plan – Water Network

An overview of the County's Asset Management Practices based on the Ontario Ministry of Infrastructure's Building Together Initiative

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Sign-off Sheet

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Municipalities are stewards of Community infrastructure. Well-managed infrastructure fosters prosperity, growth, and quality of life for a Community's residents, businesses, and visitors.

Most Canadian municipalities are struggling to maintain existing infrastructure under current tax and rate levels. They continue to deal with downloaded responsibilities and, at the same time, face growing needs to maintain and renew aged and decaying infrastructure.

The subject of asset management has been gaining increasing public awareness as a result of the introduction of Bill 175, the Sustainable Water and Sewage Systems Act in 2002, and the implementation of "Full Cost Accounting" through the Public Sector Accounting Board (PSAB). The emphasis is now being placed on not only knowing the true cost of providing services to your customers today, but also understanding what will be required to maintain the services virtually in perpetuity (or as long as they are required), through the use of life cycle costing. In other words, we are moving towards Sustainable Asset Management.

Ontario's Ministry of Infrastructure has also recently released guidelines for the development of Municipal Asset Management Plans, which support the Province's 10-year infrastructure plan "*Building Together*". The objective of these guidelines is to provide a basis for the standardization and consistency of asset management practices across Ontario's municipalities.

This document follows the Ministry's guidelines for the development of an Asset Management Plan for Norfolk County's Water Network.

1.0 Introduction

1.1 GOALS AND OBJECTIVES

This Asset Management Plan has been prepared in response to the Ontario Ministry of Infrastructure's *Building Together* initiative, and provides the County with a medium-term business plan for ensuring long-term sustainability of the County's infrastructure.

1.1.1 Scope of Work

The scope and format of this document follows the Ministry of Infrastructure's *Building Together: Guide for Municipal Asset Management Plans*. The Guide outlines the specific elements of a detailed asset management plan, which includes:

1. Summary
2. Introduction
3. State of Local Infrastructure
4. Desired Levels of Service
5. Asset Management Strategy
6. Financing Strategy

The County has developed individual Asset Management Plans following the Ministry's guidelines and suggested format for roads, bridges, and water and wastewater networks. The County is not responsible for social housing, an asset group to be included, if applicable, as per the Ministry's guide.

This document focuses on the County's Water Network infrastructure.

2.0 State of Local Infrastructure

A State of the Infrastructure report provides the County with an understanding of the true cost of maintaining the infrastructure that is required to provide the services to the Community. The following State of the Infrastructure (SotI) assessment was developed through a Life Cycle Analysis, covering the County's water network.

The SotI was based on a high-level analysis of the replacement, rehabilitation, and maintenance needs of the County's water network assets. This included the preparation of a report on the current and assumed future state of these assets. The following water network assets were included in the study.

Table 2.1: Water Network Assets

Water Network	Pipes
	Valves
	Hydrants
	Meters
	Service Connections
	Elevated Tanks
	Stand Pipes

In November 2003, the National Guide for Sustainable Municipal Infrastructure published a Best Practices for Municipal Infrastructure Asset Management. This publication included a listing of seven questions, which could be used as a framework for an asset management plan. The SotI assessment employs this framework:

1. What do you have and where is it?
   (Inventory)
2. What is it worth?
   (Costs/Replacement Rates)
3. What is its condition and expected remaining service life?
   (Condition and Capability Analysis)
4. What is the level of service expectation, and what needs to be done?
   (Capital and Operating Plans)
5. When do you need to do it?
   (Capital and Operating Plans)
6. How much will it cost and what is the acceptable level of risk(s)?
   (Short- and Long-term Financial Plan)
7. How do you ensure long-term affordability?
   (Short- and Long-term Financial Plan)

The County's Public Works assets including roads, bridges, sanitary and storm sewer network, and water network have a replacement value of **$2.2** billion. The breakdown of those replacement values per serviced property, based on serviced properties or households in the County, are shown in Figure 2.1 below.

It can be noted that the water network accounts for approximately **10.5%,** or **$229** million, of the total asset replacement value.

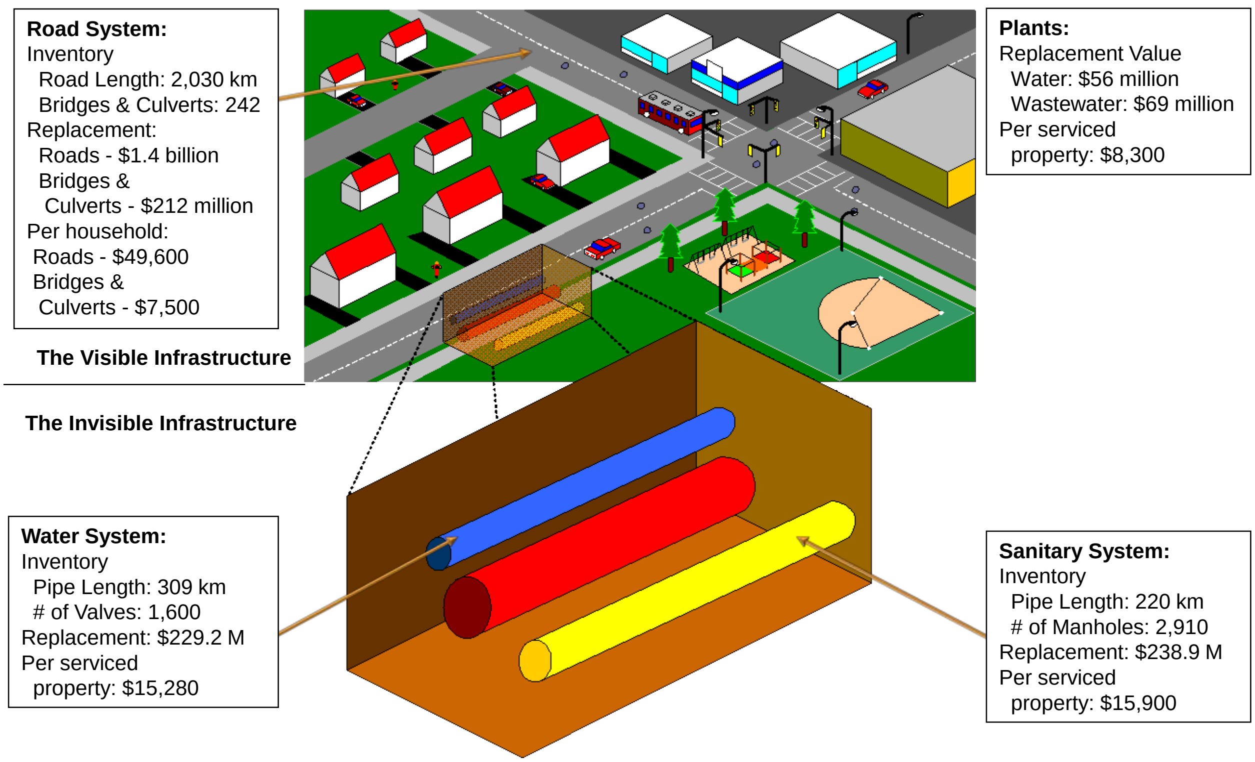

Figure 2.1: Asset Replacement Value per Serviced Property

2.1 WATER NETWORK

The County's water network consists of a group of components, including pipes, valves, hydrants, storage reservoirs, and so forth. The State of the Infrastructure analysis of these components was based upon existing inventories; the sources for these inventories include the County's current asset management Geodatabase. The following table summarizes these inventories:

Table 2.2: Water Network Inventory Summary

Asset Type	Asset Component	Inventory
Water Network	Pipes	309 km
	Valves	1,607
	Hydrants	1,469
	Meters	15,000 (assumed)
	Service Connections	15,000 (assumed)
	Elevated Tanks	3
	Standpipes	2

The water network consists of predominantly plastic, cast iron (CI), and ductile iron (DI) pipes. Figure 2.2 illustrates the distribution of the materials within the network.

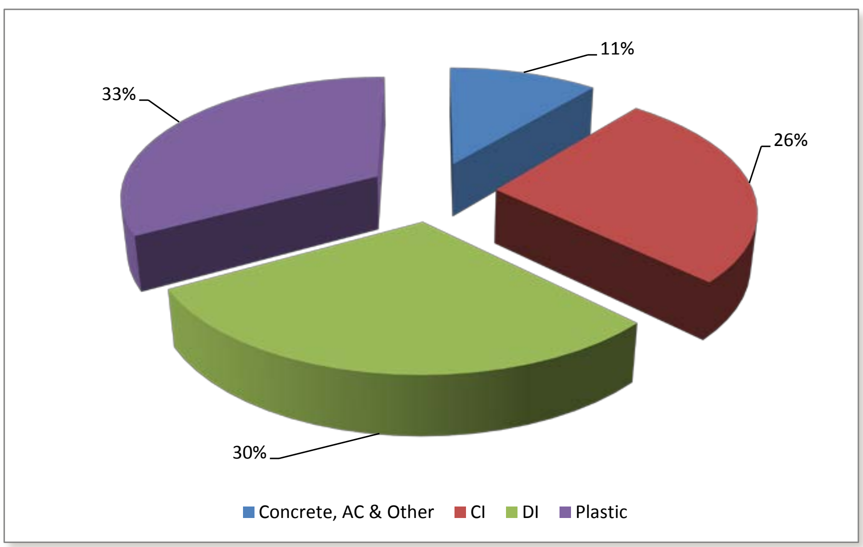

Figure 2.2: Material Distribution within Water Network

An area of potential concern might be the 30% or 92km of ductile iron pipe within the network, as this has been found to fail to meet the anticipated life expectancy due to corrosion and the resulting perforation of the pipe wall. This is heavily dependent upon the type soil in which the pipe is laid; therefore, if the soils in Norfolk County are not typically corrosive, this may not be a major concern in the short term.

Similarly, approximately 56% or 46km of the pipes identified as being cast iron within the databases provided, are also approaching the end of their design life. Both of these groups of watermains should be monitored to assess whether or not an increase in failure rates occurs, which would indicate that these pipes should be considered as candidates for replacement.

2.1.1 Valuations

The County's State of the Infrastructure analyses/reports did not use inflation rate factors. Table 2.3 outlines the assumptions made on asset valuation, within the state of the infrastructure report.

2.1.1.1 Replacement Cost Valuation

The estimated current replacement value of the water distribution network and associated assets is **$229** million. Table 2.3 provides a breakdown of the contribution of each of the network components to the overall system value.

If this total asset value is translated to provide an average value for each of the approximately 15,000 serviced properties, then an average serviced property will be responsible for approximately **$15,280** for water assets.

Table 2.3: Water Network Replacement Value

Asset Type	Asset Component	Inventory	Unit Replacement Cost (as noted)	Current Replacement Value (millions)
Water Network	Pipes	309 km	$600/m	$185.7
	Valves	1,607	$included	-
	Hydrants	1,469	$included	-
	Meters	15,000 (assumed)	$300	$4.5
	Service Connections	15,000 (assumed)	$1,800	$27.0
	Elevated Tanks – Equipment	3	$600,000 ea	$1.8
	Elevated Tanks – Structure	3	$1,800,000 ea	$5.4
	Standpipes – Equipment	2	$600,000 ea	$1.2
	Standpipes – Structure	2	$1,800,000 ea	$3.6
				$229.2

2.1.1.2 Financial Accounting Valuation

Based upon the County's 2012 Financial Information Return filed with the Ministry of Municipal Affairs the Net Book Value of the County's Water assets at the end of 2012 was **$35.6** million. The assets included in this figure are outlined in Table 2.4 below:

Table 2.4: FIR Schedule of Tangible Capital Assets (Schedule 51)

Asset Type	Asset Component	2012 Closing Net Book Value (million)
Water Network	Water distribution/transmission	$35.6

2.1.2 Age and Remaining Service Life

A useful life span can be assigned to an asset type, such as 90 years of useful life for a watermain. However, there are many conditions that can affect the true life of an asset, such as: design, construction, and manufacture quality, maintenance standards, surrounding environment, construction material, and so forth.

For the purposes of the SotI analysis, the following intuitive failure distribution model was utilized to provide a more realistic representation of the actual asset replacement quantities than would be achieved if the analysis only assumed a fixed time of failure for all assets. The following example, based upon longer-lived assets such as water or sewer pipes, illustrates the failure model that was used. For an asset with a longer life, an assumption was made that: 5% would fail at 50% of the asset life; 15% would fail at 75% of the asset life; 15% would fail at 125% of the asset life; and the balance, or 65%, would fail at the prescribed or fixed asset life. An example of this method applied to an asset with a 100-year design life is represented graphically in Figure 2.3.

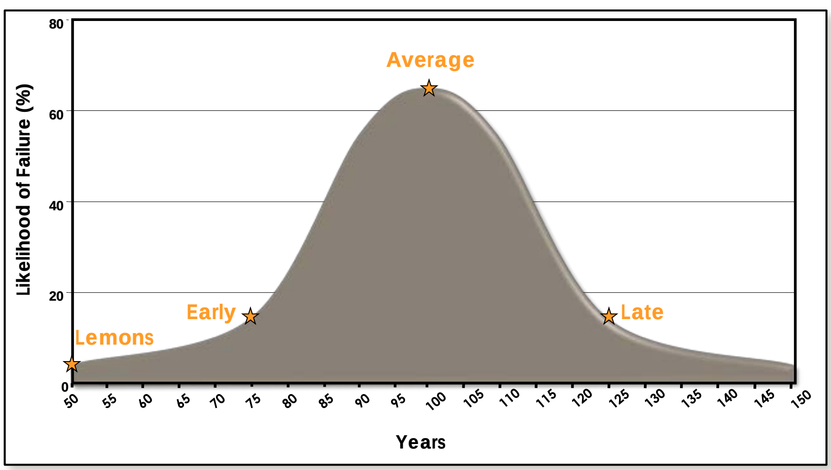

Figure 2.3: Failure Distribution

The level of intervention on infrastructure will vary significantly over the life cycle of an asset. The process of maintenance, rehabilitation, and failure is a very dynamic system. Therefore, it is essential that we take a life cycle approach to assessing the financial needs for the future.

This dynamic process of asset aging has a significant financial impact attached to it that can be quantified. Therefore, our financial analysis is based upon a life cycle model that identifies upcoming trends in asset replacement and, hence, funding needs.

County staff have the best understanding of the local variables that impact the useful life of the water network assets. As a result, the range of values used for the typical useful lives of assets was adjusted, for the purposes of this Report, based on discussions with County staff, the actual known condition of the assets, internationally recognized standards, and Canadian climate and conditions. These values can be refined over time, as more specific data becomes available. These values do., however, serve a purpose in planning financial investment requirements on a life cycle basis, with specific projects being identified on a segment-by-segment basis, as part of the regular budget preparation process. The following table identifies the useful life used within the analysis for each Asset Component.

Table 2.5: Water Network Useful Life

Asset Type	Asset Component	Typical Useful Life (years)
Water Network	Pipes	80-100
	Valves	70
	Hydrants	50
	Meters	20
	Service Connections	60
	Elevated Tanks - Structures	70
	Elevated Tanks - Equipment	20
	Standpipes - Structures	70
	Standpipes - Equipment	20

As can be seen from Figure 2.4, approximately 25% of the County's water network is reaching the end of its design life. However, of particular interest over the next 15-20 years, will be the 40% of the network that is currently identified as being halfway through their design life. Therefore, over this period the County will need to assess the overall condition of the water network, in more detail, to determine the level of effort and associated funding required to meet the rehabilitation and replacement needs for these assets.

Life Consumed	
0 – 25%	33.8%
25 – 50%	25.8%
50 – 75%	16.1%
75 – 100%	24.3%

Figure 2.4: Water Network – Life Consumed (%)

A key component of this high-level analysis required to estimate the timing of the major interventions specifically, rehabilitation and/or replacement, is the age of the asset, which would be based on the construction year. This data was available for the water pipes within the County's asset inventory, and formed the basis of the analysis to develop the 100-year replacement profile for the water pipes shown in Figure 2.5.

The profile displayed in Figure 2.5 represents the replacement profile for the water pipes, and does not include any form of rehabilitation. There are a number of rehabilitation techniques that may be applicable and considered for each water pipe project, to add to the useful life. Applying such techniques at an appropriate point, prior to the end of an asset's useful life, would have the effect of flattening the profile illustrated in Figure 2.5. This type of analysis is beyond the scope of this report, but should be considered as part of a more detailed review and subsequent development of a tactical plan with respect to the water network.

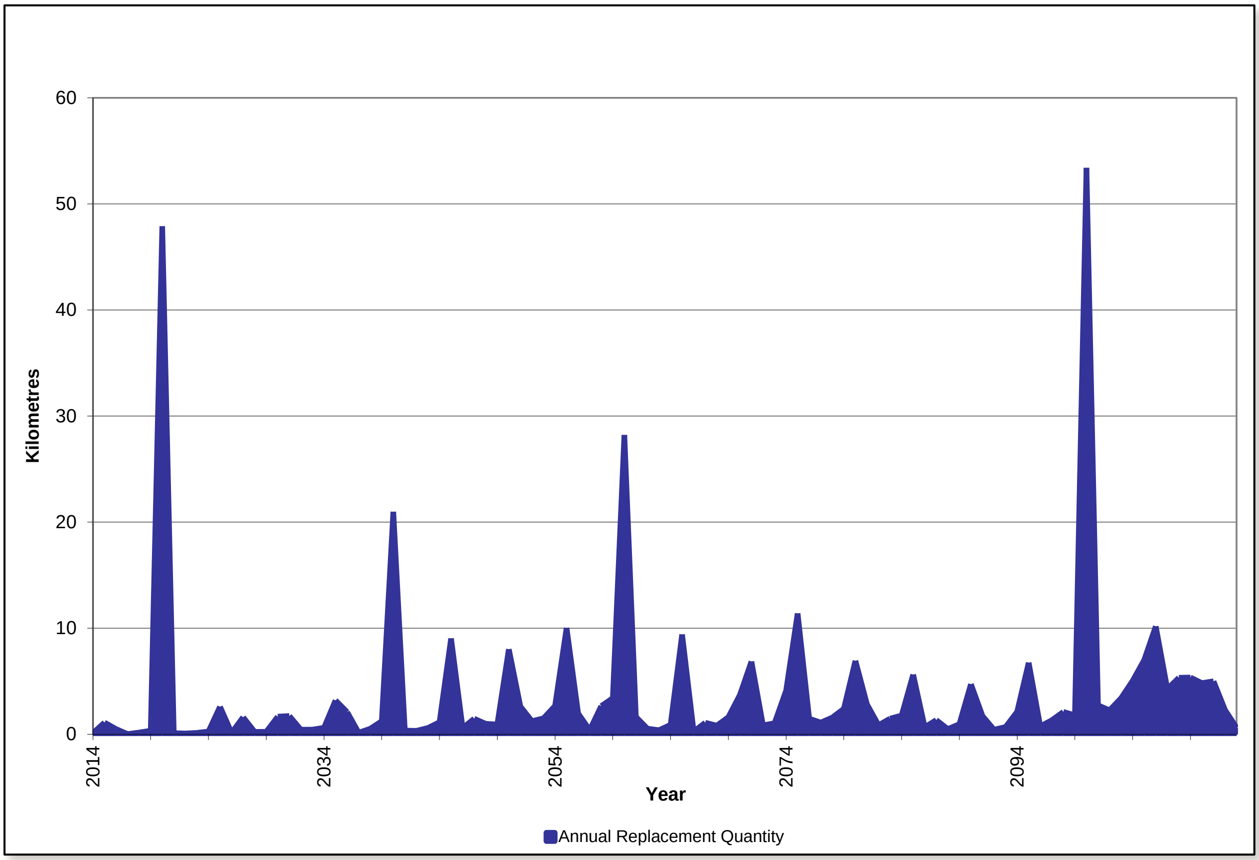

Figure 2.5: Replacement Profile for Water Pipes

2.2 ASSET CONDITION

Condition assessment of water distribution systems is notoriously difficult because the infrastructure is buried. The deficient condition of a pipe is often unknown until a leak develops. The condition of the immediately adjacent stretches of pipe can be observed during a leak repair, but it is often unclear whether the leak is an isolated incident of poor condition or a widespread concern. This section will attempt to provide an overview of best practice for condition assessment of water distribution systems.

2.2.1 Deterioration of Water Distribution Systems

Structural deterioration refers to the decline in the physical condition of a system. Determining short-term rehabilitation needs is often simple, but once the obvious defects are resolved, methods are needed to assess which watermains are experiencing active deterioration compared to those that are defective, yet stable. A relative risk of failure must, therefore, be established with consideration to cause and effect. The deterioration of these systems becomes apparent through one or more of the following symptoms:

- Impaired water quality – due to internal corrosion of unlined metallic components; biofilm build up and/or poor maintenance practices;
- Reduced hydraulic capacity – due to internal corrosion (tuberculation) of unlined metallic components, or calcium carbonate precipitation;
- High leakage rate – due to corrosion through holes in pipe barrels, and/or deteriorating joints;
- Frequent breaks – due to corrosion, material degradation, poor installation practices, manufacturing defects, and operating conditions.

2.2.2 Watermains

Based upon a review of the GIS database, the County's network consists of predominantly iron pipes with cast iron making up 26% of the network, followed by ductile iron at 30% of the network. Other materials include, but are not limited to steel, polyvinyl chloride (PVC), high-density polyethylene (HDPE), and asbestos cement (AC).

Due to the fact that the County's network, like many others across North America, is constructed with the use of metallic components and, specifically, cast or ductile iron, corrosion can cause the deterioration of these systems under certain conditions. PVC pipe deterioration can occur from either chemical attack from certain solvents, or mechanical wear caused by improper installation. HDPE pipes are also subject to the same failures caused by improper installation, as well as innate joint imperfections. AC pipe and cement mortar linings can deteriorate under conditions where aggressive water leaches the cement.

2.2.3 Water Services, Valves, and Hydrants

Cast iron, ductile iron, or PVC is typically used for water services greater than 50 mm in diameter. For water services 50 mm in diameter and less, copper, lead, galvanized iron, or polyethylene is or has been used. The deterioration processes for these are similar to those for watermains.

The most common type of valve used in distribution systems is an isolation valve. Isolation valves are susceptible to deterioration and failures such as stripped, broken, or bent stems; leaking O-rings or packing; corrosion of the valve body and connecting bolts; and wear on the valve disk and seat. Other valves include air release, drainage, check, and pressure reduction valves, which deteriorate/fail in the same modes.

Hydrants are vulnerable to the same modes of failure, but hydrant inspection and maintenance is usually more thorough compared to that of buried components. This is likely due to both ease of access and their natural association with emergency events.

2.2.1 External Corrosion

Numerous types of external corrosion can occur in watermains. These include galvanic, electrolytic, and microbiologically induced corrosion. The most common types of external corrosion found in water distribution systems are galvanic and electrolytic. External corrosion affects metallic pipes and is usually detected by the presence of a leak. The type of soil, moisture in the soil, damage during installation, and stray currents can all have an impact on the presence and intensity of corrosion. The photograph to the right, illustrates the impact of external corrosion on the County's iron pipe network.

2.2.2 Internal Corrosion

The majority of metallic pipes produced today come with internal linings, to prevent internal corrosion. However, many older pipes were not produced this way, and as a result, are susceptible to internal corrosion. Internal corrosion can become apparent through: pipe degradation, which can result in leakage or vulnerability to mechanical failure; tuberculation and scale formation, which can reduce hydraulic capacity and impair water quality; and corrosion by-product release, which can impair water quality. The rate of internal corrosion can be influenced by the physical, chemical, and biological characteristics of the water.

The following photographs illustrate the impact of biofilm growth on the pipe. In this particular example, it would appear that the 100mm/4" watermain was almost completely blocked; the second image shows the internal surface of the same pipe after sandblasting, and shows the pitting on the internal surface caused by this internal corrosion.

2.3 PRELIMINARY ASSESSMENT

Through the use of readily available data, the current condition of a water distribution system can be assessed. Table 2.6 outlines what should be done in the preliminary investigation, and outlines the four most commonly occurring problems in water distribution systems: structural condition, hydraulic capacity, leakage, and water quality. With respect to structural condition, leak tracking is the most useful tool for preliminary assessment. Although it is possible to perform leak tracking manually on a paper map, this is the type of data collection that lends itself to GIS mapping. Tracking leaks allows the municipality to establish trends and identify “hot spot” locations.

Low-pressure complaints are the primary tool for preliminary assessment of issues related to hydraulic capacity. Again, the use of GIS maps to track the locations of these complaints is ideal. Preliminary assessment techniques for detecting leakage focus on the monitoring of water flows/usage. Routine leak detection surveys can also be used to monitor the system. Water quality issues are identified by user-complaints and by sampling results. The preliminary assessment would identify areas that require more detailed investigation. A preliminary assessment of data concerning watermain breaks, complaints, unaccounted for water, and routine sampling and inspection should be conducted each year, to identify trends and the need for more detailed investigation (InfraGuide).

Table 2.6: Investigation of Water Distribution Systems (InfraGuide)

Problem	Preliminary Assessment	Reason for More Detailed Investigation	Detailed Investigation
Structural Condition	• Spatial and temporal analysis of watermain breaks • Compilation of soil map • Routine inspection of valves and hydrants • Routine inspection of insulation and heat tracing in northern areas	Level of Service • Preliminary investigations indicate an excessive break rate, excessive leakage, inadequate hydraulic capacity, and/or impairment of water quality Cost-Effectiveness • To facilitate capital planning and asset management programs • Pilot testing of new technologies to facilitate long-range planning support • Opportunistic work, such as when a watermain is temporarily out of service Risk Management • Risk analysis identifies critical watermains that have a high potential for significant property damage, environmental impact, or loss of service • Due diligence (e.g., failure analysis of a failed critical watermain)	• Detailed analysis of break patterns, rates, and trends • Statistical and physical models • Pipe sampling • Soil corrosivity measurements • Pit depth measurements • Non-destructive testing • Failure analysis • Visual Inspection • Thermal analysis (far north)
Hydraulic Capacity	• Low-pressure complaints • Hydrant flow tests • Rusty/coloured water occurrences • Visual inspection of pipe interior • Monitoring of pressure and pumping costs		• Hazen-Williams C factor tests (pipe roughness) • Computer modeling
Leakage	• Water use audit • Per capita water demand • Routine leak detection survey		• Leak detection survey • Detailed limited area leakage/demand assessment
Water Quality	• Water quality complaints • Routine sampling data • Result of flushing program		• Detailed water quality investigation • Computer modeling

2.4 DETAILED INVESTIGATION

After the preliminary assessment has been completed, the priority areas for a more detailed investigation can be determined. The need for a detailed investigation is based on an evaluation of the level of service, cost-effectiveness, and risk management. The detailed investigations are, as the name implies, more in depth and, therefore, represent larger cost expenditures. As such, the County should ensure that the benefits of such investigations are in line with the costs. Potential techniques for detailed investigation are listed in the final column of Table 2.6. A few notable techniques for detailed investigation are addressed in more detail below.

2.4.1 Hazen Williams C Factor Testing

The Hazen Williams C factor test is performed on a section of pipe to quantify the hydraulic capacity of that section of watermain. The C factor establishes the roughness of a given piece of pipe. Roughness is increased by encrustation or tuberculation, which effectively decreases the internal diameter of the pipe. Once the C factor of a given section of pipe is determined, it can be used to increase the accuracy of computer models showing the capacity of the system. The American Water Works Association (AWWA) Manual M32 (AWWA, 1989) describes the procedure for a C factor test.

2.4.2 Acoustic Testing

With respect to detailed investigation, acoustic testing is a relatively new technology for testing the structural condition of a watermain. The premise behind this method is that if the pipe material and size is known, then the pipe wall thickness can be calculated based upon the speed that sounds travels through the pipe. Two sensors are placed at easily accessible points on the watermain (i.e. valves, hydrants) and a noise source is introduced onto the pipe either by banging or with a mechanical shaker. The speed at which the sound wave travels between the two sensors is recorded and used to calculate the wall thickness. This technology is still in its infancy, and the reliability of the results is not proven.

3.0 Desired Levels of Service

Levels of Service for a water network are a combination of the Community's expectations and the County's required and desired maintenance and performance targets to meet legislative requirements.

It is important that the County first establish performance objectives for the Asset Management Program (AMP). Some typical examples of performance objectives are listed below.

- Produce high quality, safe, potable water
- Maximize hydraulic capacity
- Minimize customer complaints
- Minimize water losses
- Reduce structural deterioration and operational problems due to poor maintenance
- Perform system rehabilitation at the optimum point in the deterioration cycle
- Conducting benchmarking both internally and with other similar communities

Performance objectives may be based upon legislative requirements, or industry best practices, and values/goals are agreed upon by the County and Community, through Council policies.

Within future iterations of this Asset Management Plan, the County will consider further refining its service level targets for the water network. Under consideration will be:

- A desired network condition Index
- A maximum desired backlog of work
- A determination of funding and service goals for maintenance versus rehabilitation/replacement activities
- Seek further Community input to further refine expectations and targets

4.0 Asset Management Strategy

4.1 NON-INFRASTRUCTURE SOLUTIONS

Accurate and reasonable population growth forecasting allows the County to adequately plan the water network expansion activities, and ensure that infrastructure is built only to meet reasonable demands.

On a project-by-project basis, Environmental Assessment studies will explore various options, including alternatives to building new infrastructure, for any major developments being considered in the County.

4.2 MAINTENANCE ACTIVITIES

4.2.1 Cleaning

Cleaning of watermains typically involves flushing and swabbing. Flushing is the process of passing water through a section of pipe at a higher velocity than is normally seen, and discharging that water out of the system, usually through a hydrant. Flushing can be helpful in removing sediment or biofilms that accumulate in the pipe over time. Flushing can be implemented in known trouble spots, once a problem appears; however, preventative maintenance would employ a regular flushing program to remove sediment and biofilm before it becomes a problem. A uni-directional flushing approach is most effective. This approach starts at the plant, with the highest diameter pipes, and proceeds to the extremities (lower diameter pipes).

Swabbing is the process of flushing a foam swab through a main, and out a dismantled hydrant. This process is more effective at removing solids, including some tuberculation. Swabbing also uses less water than flushing, but is more costly and more time consuming.

4.2.2 Valve Inspection and Exercising

The purpose of valve inspection is to ensure proper functioning of the equipment. It is possible that valves can be neglected until required in a critical situation (i.e. major leak), at which point they are inoperable. The only defense against this situation is regular maintenance. Exercising valves on a regular schedule will improve their length of service and the likelihood that they will be operable at critical times.

A valve-exercising program should be composed of four parts: locate the valves, fully exercise the valves, maintain valve records, and perform needed valve maintenance/repairs. AWWA states, "Each valve should be operated through a full cycle and returned to its normal position on a schedule that is designed to prevent a buildup of tuberculation [rust formation in pipes as a result of corrosion] or other deposits that could render the valve inoperable or prevent a tight shutoff. The interval of time between operations of valves in critical locations or valves subjected to severe operating conditions should be shorter than for other less important installations, but can be whatever time period is found to be satisfactory based on local experience."

4.2.3 Flow Testing Hydrants

Hydrants must be tested on a regular basis, to ensure that they are capable of delivering water at a pressure and rate of flow for public health and effective firefighting operation. Measurements of system pressure should be taken at a nearby hydrant, when a given hydrant is being flow tested. The following precautions relate to fire hydrant flow testing.

- Schedule routine testing for warm weather to avoid freezing,
- Limit time of test to avoid flooding
- Diffuse / direct flow to avoid erosion and property damage
- Notify customers who may be affected by flow tests in advance
- Avoid water hammer by careful opening and closing of valves

4.2.4 Implement Cathodic Protection Systems

Cathodic protection (CP) systems employ sacrificial anodes to protect metallic pipes from galvanic corrosion. If CP has been installed in the County's network, it should be monitored on a regular basis to ensure that adequate protection is being provided. Good cathodic protection designs will provide test facilities and procedures for monitoring the system once it is in operation (NACE International, 1992).

4.3 REHABILITATION ACTIVITIES

The rehabilitation approach for a water distribution pipe has historically been to replace the offending section with a new pipe. In the more recent past, however, trenchless technologies have proliferated. Each one has its own unique characteristics and a brief description is provided below, along with a discussion of open cut construction.

4.3.1 Sliplining

Sliplining refers to the introduction of a flexible liner into a pipe. The liner is a continuous or discrete segment of pipe that is essentially pushed through the existing one. This results in the creation of a new pipe inside the old one – all without the need for excavation. The sliplined pipe is then simply reconnected to the existing one, at both ends. Cleaning of the pipe and grouting of the annulus between pipes is necessary prior to insertion. Sliplining can be applied to almost any pipe, is quick, and disruption of other nearby utilities is generally minimal. It is best used for pipes with few connections.

4.3.2 Diameter Reduction Sliplining

This method of sliplining involves the insertion of a thermoplastic tube, temporarily deformed into the existing pipe. The tube is then returned to the proper diameter to create a close fit between the lining and the pipe wall. To reduce the diameter initially, the tube is passed through a set of dies, a process called swageing, or through compression rollers, and then inserted using a winch. When the tension on the winch is removed, the lining resumes its original shape. Thus, there is minimal loss of pipe diameter and grouting of the annulus is not necessary compared to the original technique. Furthermore, the liner can provide full structural integrity if needed.

4.3.3 Fold and Form Sliplining

Using this technique, the liner is heated and folded at the factory before being transported to the work site. It is subsequently entered into the pipe and reformed with heat and pressure. As with the other sliplining techniques, this method can be used in most pipes, is quickly installed, and causes minimal site disturbance. In addition to the benefits mentioned in the previous two sections, this method can cut and reinstate service connections using robotic equipment to reduce excavation requirements.

4.3.4 Cured-in-Place Pipe (CIPP)

With this method, a fabric tube is either injected with thermosetting or ambient cured polyester, or an epoxy resin. The resin, once cured, then creates a stiff pipe. This new pipe can be engineered to have full structural or semi-structural capacity. .

4.3.5 Spray-applied Lining

Spray-applied linings are typically either cement-mortar or epoxy. The process involves excavation of the pipe to be rehabilitated at the beginning and end of the length to be lined. The pipe is typically cleaned with a mechanical scraper, and either swabbed or flushed of any debris. Mortar or epoxy is then applied by a special machine with a rapidly revolving head. The material is applied by centrifugal force as the machine moves through the pipe. The speed of the machine and the amount of material being pumped can be adjusted to match the desired thickness. Spray-applied linings are typically 1mm thick in the case of epoxy linings to 5+ mm for cement-mortar lining.

4.3.6 Pipe Bursting

The method of pipe bursting involves the replacement of a defective pipe by breaking the old pipe and simultaneously inserting a replacement in the void produced. A pneumatic, hydraulic, or static bursting mechanism is used to break the host pipe, in turn, compressing the pipe fragments into the surrounding soil. Then the new pipe is pulled or pushed to fill the void left behind.

4.3.7 Horizontal Directional Drilling (HDD)

This technique involves several stages. Initially, a bore is made with a drilling rig, which is guided to make a hole at the required line and grade. Reamers are then used to enlarge the diameter of the hole to the required size. In the last stage of reaming, the service pipe is pulled back into the bore.

HDD is normally favoured when an open cut excavation is not suitable and the new watermain needs to be realigned.

4.3.8 Internal Joint Seals

Internal joint seals are used to repair leaking pipes and are used mostly for water or force mains. The internal seal is flexible and water tight, while it allows water to flow without causing turbulent conditions. These joints are made of EPDM (ethylene propylene diene monomer) synthetic rubber. The pipe is prepared initially by ensuring that the joints are clear of all debris, both on the inner and outer surfaces. Then, a Portland cement grout is used to fill the joint and made flush with the internal surface of the pipe. The area is then cleaned using a dry brush and soap (that must be compatible with the seal about to be used). The seal is then positioned and stainless steel retaining bands are installed in the seal's grooves. A hydraulic expanding device applies a specific pressure to the bands to keep the seal in the correct location.

4.3.9 Full Tunneling and Micro-tunneling

Deep installations generally use full tunneling or micro-tunneling techniques. While these methods are primarily used for new installations, they can also be utilized for the redirection of existing watermains when necessary.

Full tunneling refers to a method whereby an opening below ground is created that is large enough to allow individuals to "access and erect a ground support system" in the location of the excavation. Alternatively, micro-tunneling "uses a remotely controlled boring machine combined with the pipe jacking technique to install pipelines directly." Since no human entry is needed, safety concerns are reduced, and it can be used even when unstable ground conditions persist.

4.4 REPLACEMENT ACTIVITIES

4.4.1 Open Cut Construction

The open cut construction method refers to the installation or replacement of watermains by trenching (NRC, 2001). This construction method has been used for many years, and the technique is well known.

4.5 DISPOSAL ACTIVITIES

The County does not anticipate the need for decommissioning watermains.

4.6 EXPANSION ACTIVITIES

The County expects modest growth in the foreseeable future. Expansion activities are reflected in the County's master plan. All major expansion projects are subject to Environmental Assessment studies, which evaluate the necessity of expansion of the asset portfolio and assess overall impact on the Community, environment, and so forth, for the various options available.

4.7 PROCUREMENT METHODS

To ensure the most efficient allocation of resources and funds, the County will consider:

- Bundling projects when issuing tenders, to realize cost-benefits of economy of scale

4.8 RISKS

There are several risks that could prevent the County from reaching/maintaining its target level of service for the water network:

Table 4.1: Risks Associated with Not Reaching Defined Level of Service Targets

Potential Risk	Potential Impact	Mitigation
Required Funding Not Secured	• Watermains deteriorate further • Network condition decreases • Watermains deteriorate beyond a condition where rehabilitation is a viable option • Backlog of work increases • More costly treatments are required	Ensure that annual funding is maintained at a level that is consistent with the investment required to sustain the water infrastructure
Substantial Increase in M&R Unit Costs in Future	• Inability to complete all planned projects with allotted budget levels • Network condition decreases • Watermains deteriorate beyond a condition where rehabilitation is a viable option • Backlog of work increases • More costly treatments are required	Ensure that sufficient reserve funds are available to provide additional funding required to meet increased funding needs resulting from exceptional increases in the unit costs of treatments/replacements

4.9 ASSET MANAGEMENT PLAN FUTURE UPDATES

The Asset Management Plan for the water network is a living document, and will require regular review and refinement. Specifically, the County will:

- Review the Asset Management Plan annually and confirm validity of assumptions
- Update the Asset Management Plan every five years
- Further refine its level of service targets by engaging in a Community outreach program, to help identify the desired levels of service of County's residents.

5.0 Financing Strategy

5.1 HISTORICAL INVESTMENTS

The County's investment in road operations for the period 2011-2012 is summarized in Table 5.1 below:

Table 5.1: FIR Schedule of Operating Expenses (Schedule 40)

Asset Type	Asset Component	2011 [1] (million)	2012 [1] (million)
Water Network	Water Distribution/Transmission	$1.873	$1.618

[1]Excludes amortization expense & interest on long term debt

This data was derived from the Financial Information Return (FIR) filed with the Ministry of Municipal Affairs and Housing (http://oraweb.mah.gov.on.ca/fir/welcome.htm).

5.2 WATER NETWORK REVENUE REQUIREMENTS

The analysis, which was completed to identify Capital and Operating revenue requirements, was based upon the following assumptions:

1. All values are calculated in current dollars (2013).
2. Replacement costs were based upon unit costs identified within Table 2.3
3. Investment in the replacement of the non-linear assets included in the study was defined as the total replacement value spread evenly across the useful life of the asset.
   An allowance was made in the analysis for Engineering (15%) and Contingencies (5%). No allowance was included for Utility Costs and Overhead and Admin.
4. Operating investments were estimated as 1.1% of the total replacement values of the sanitary system and excludes allowances for Overhead and Admin. Figure 5.1 shows the Operations and Maintenance (O&M) Cost profile for water pipes only and does not include the other asset components.

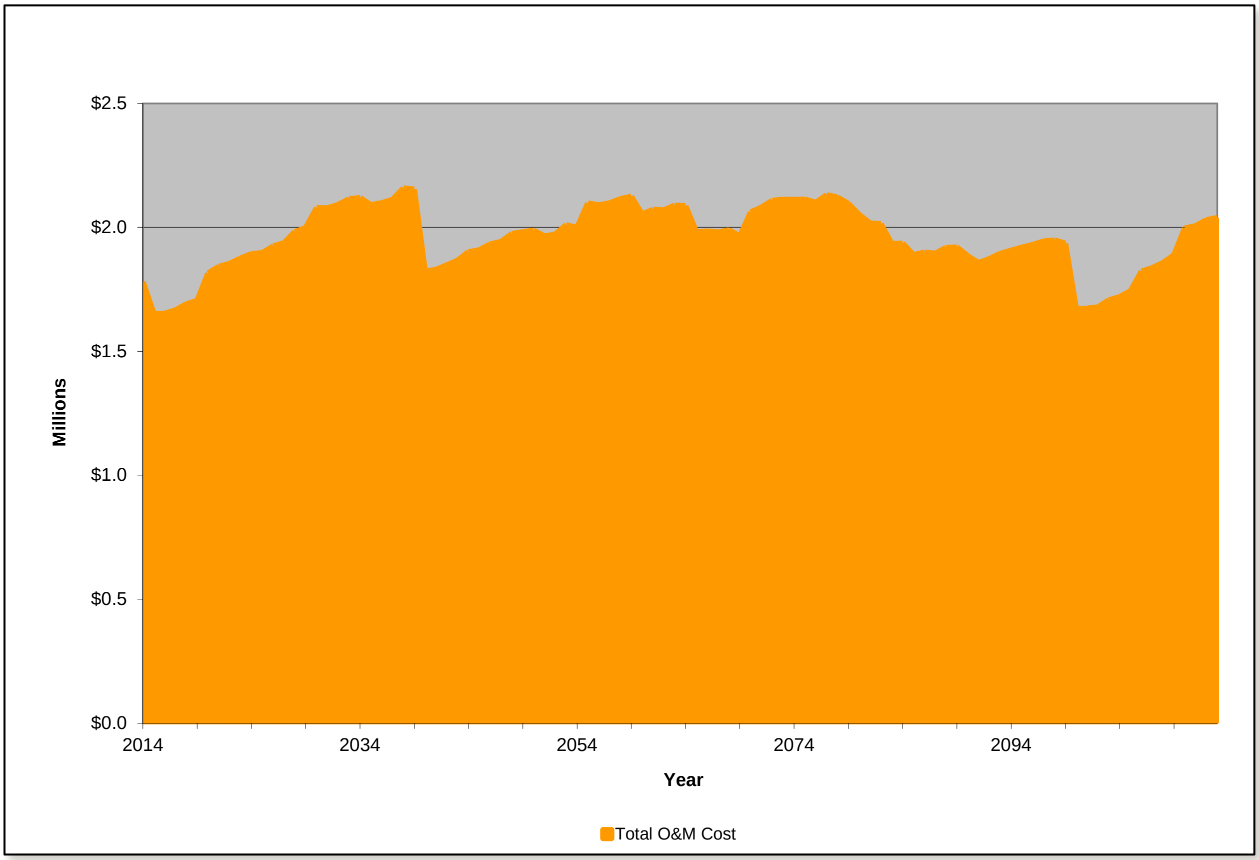

Figure 5.1: Watermain O&M Cost Distribution

Therefore, based upon these assumptions, for the period 2012 to 2111, the average annual revenue required to sustain the County's water network is **$6.4** million. Over this same period, and excluding growth, this represents 3.5% of the Water Network replacement value of **$229** million. Figure 5.2 illustrates the revenue profile from 2014 to 2113 derived from the analysis for all the assets within the Water Network.

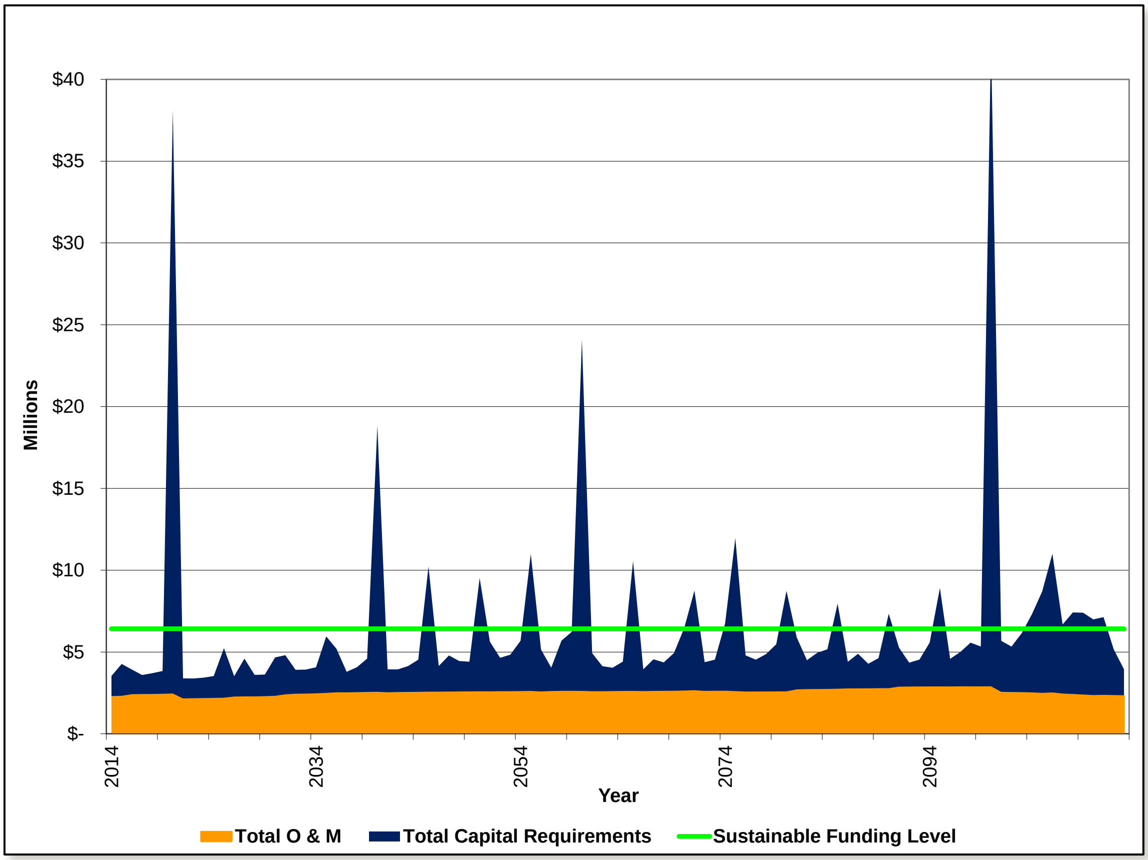

Figure 5.2: Water Network Revenue Requirements

Based on the SotI analysis results and a review of the 2014 - 2023 capital funding needs (as supplied by County Staff) for the 10-year period covered by the budget fall short of the sustainable revenue requirements. The table below illustrates the finance requirements for the water network, over a 100-year period, which represents the full life cycle of the assets.

Table 5.2: Sustainable Revenue - Capital (millions)

Program	2014 - 2023 Projected Revenues (average annual)	Projected Sustainable Revenue[1] (average annual)	Overall Surplus/ (Deficit)
Water	$2.6	$3.8	($1.2)

[1]Assumes no growth in the County's population and infrastructure

5.3 BUDGET PROJECTIONS - CAPITAL

The County's proposed 2014-2023 capital budget shows that approximately $26.4 million will be invested in the water network over this period. The projected capital investment and associated funding sources for the investment in the water network is summarized in Table 5.3.

Table 5.3 : Budget Projections & Funding Sources 2014 - 2023

	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Budget (millions)		$1.815	$3.330	$4.190	$2.080	$1.922	$3.840	$2.415	$2.435	$2.550	$1.830	**$26.407**
Funding Source	Debenture Proceeds			$1.065			$0.935					**$2.000**
	Gas Tax Reserve Fund							$0.350		$0.350		**$0.700**
	Water & Wastewater Rates	$0.035		$0.085			$0.045					**$0.165**
	Water Capital Replacement Reserve Fund	$1.780	$3.330	$3.040	$2.080	$1.790	$1.853	$2.065	$2.435	$2.200	$1.830	**$22.403**
	Water Development Charge Reserve Fund					$0.132	$1.007					**$1.279**