Infrastructure Master Plan

November 2013

Building a Liveable Ottawa 2031

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Executive Summary

The purpose of the City of Ottawa's Infrastructure Master Plan (IMP) is to support the overall city-wide Official Plan (OP) goals of creating more vibrant, healthy and complete neighbourhoods across the municipality while ensuring long-term affordability for both the City government and residents.

Efficient management, responsible operation and judiciously targeted growth of water, wastewater, and stormwater infrastructure play a major role in the pursuit of these goals. The IMP supports the OP by ensuring there is enough infrastructure capacity in the right areas of the municipality at the right service levels at the right time to accommodate development and redevelopment until 2031 when the City of Ottawa population is expected to reach 1.14 million.

The IMP accomplishes this by taking high-level directions on infrastructure growth, operation, and renewal from relevant long-term planning documents, including the Long Range Financial Plan (LRFP), the OP, the Fiscal Framework, the Comprehensive Asset Management (CAM) Plan, the Transit-Oriented Development (TOD) Plans, Community Design Plans (CDPs), and the Plan for Sustainability and Resilience in Canada's Capital Region.

Taken together, these documents call for the creation of more compact neighbourhoods where people live, work, enjoy recreation opportunities, shop, do business and have less need to drive personal vehicles due to increased use of transit, walking and cycling as primary transportation choices.

These are the City's goals because this type of neighbourhood is best for the health, social well-being and quality of life for residents, and these neighbourhoods also limit the environmental impact of the city.

Of fundamental importance to the IMP, the neighbourhoods envisioned by the City's high-level planning documents are also best for long-term economic sustainability of governments and residents. This is because they allow more people to be serviced with less capital, operating and renewal budget pressures, which in turn maximizes the return on investments. This point is made clear by the fact that the City's water, wastewater, and stormwater assets have an estimated replacement value of $17 billion. All of this needs to be operated, maintained and eventually replaced and every new pipe put in the ground adds to this long-term financial liability.

While the OP calls for the majority of intensification to take place in specific target areas, some intensification will be permitted outside of these areas if it is compatible with the surrounding context, and recognizes the variation between existing neighbourhoods.

Notwithstanding the City's intensification objectives, there are significant tracts of vacant land within the existing urban boundary which are expected to develop, in accordance with approved CDPs, by 2031. Overall, roughly 70% of the expected population growth and 65% of the expected employment growth is expected to occur outside the Greenbelt. However, the impact of a higher proportion of growth inside the Greenbelt has been considered in the planning of infrastructure to ensure that target area intensification objectives are supported.

A Liveable City is an affordable City, and to help achieve this goal, the IMP combines an array of system-specific policies, plans and strategies related to infrastructure investment and management. These include the Water Master Plan, Water Treatment Master Plan, Wastewater Master Plan, Wastewater Treatment Master Plan, Stormwater Management Plan, Wet Weather Infrastructure Management Plan (WW-IMP), and Rural Servicing Strategy, among others. The IMP combines relevant elements of these plans to form a cogent and practical document that sets out how the backbone of the City's water, wastewater, and stormwater systems will be managed in order to support the creation of more vibrant, healthy and complete neighbourhoods as contemplated in the OP and other planning documents.

The IMP combines the principles of these plans into a strategy for making sure the core system is robust, reliable and able to accommodate the anticipated demand for capacity in a cost effective manner.

To accomplish this, the IMP aligns itself with the OP by examining existing population and growth patterns and using the same future development and growth projections. In order to ensure demand for infrastructure is met, the IMP examines trends in demand for water and wastewater capacity, demand and supply management, and weather trends. The IMP set levels of service (LOS) expectations for water quality and reliability across the city and for different areas of the city and system on the wastewater side of the equation.

The IMP then sets out a series of projects that will have to be undertaken in the coming years in order to achieve the City infrastructure, land use, and affordability goals. These include specific projects to take place during the planning horizon until 2031 and high-level works that will be needed to accommodate projected growth and development until 2060.

These projects include works needed to allow for intensification in target areas including those surrounding major rapid transit stations, works needed to allow for development of greenfield land currently slated for development, and works to accommodate growth in existing serviced rural villages. These projects are then prioritized on a risk and value-for-money basis. The IMP financial affordability assessment sets out a funding strategy to 2022.

The total cost of the major infrastructure projects outlined in the IMP is estimated at $1.7 billion. This figure excludes the many projects which are managed under the City’s infrastructure renewal programs, as well as many relatively minor projects that are needed in local areas to support the development of growing communities within the city.

The IMP also recognizes that the work is not complete. There are several future initiatives identified in the IMP where future work is needed to establish programs and projects to achieve the integration of land use with infrastructure and environmental objectives. These include completing new and updated master plans; more detailed assessments of infrastructure required to support growth in developed areas; and efforts to move forward on making sure infrastructure can be designed appropriately for changes in local climate.

List of Acronyms

Acronym	Full Term
APT	Apartments
BARR	Barrhaven (pressure zone)
BSDY	Basic Day
CAs	Conservation Authorities
CAM	Comprehensive Asset Management
CDP	Community Design Plan
CSOs	Combined Sewer Overflows
CWDS	Central Water Distribution System
CWWCS	Central Wastewater Collection System
Development Charges	Development Charges
DWAP	Drinking Water Awareness Program
DWF	Dry Weather Flow
DWQMS	Drinking Water Quality Management Standard
EA	Environmental Assessment
ECA	Environmental Compliance Approval
EOWRC	Eastern Ontario Water Resources Committee
EOWRMS	Eastern Ontario Water Resources Management Study
GMS	Groundwater Management Strategy
HGL	Hydraulic Grade Line
IDF	Intensity/Duration/Frequency
IGB	Inside Greenbelt
I/I	Inflow and Infiltration
ILI	Infrastructure Leakage Index
IMP	Infrastructure Master Plan
LID	Low Impact Development
LOS	Level of Service
LRFP	Long Range Financial Plan
MCEA	Municipal Class Environmental Assessment
MDWL	Municipal Drinking Water License
MDU	Multiple Dwelling Units
ME	Meadowlands (pressure zone)
MG	Morgan's Grant (pressure zone)
MLD	Million Litres per Day
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MONT	Montreal (pressure zone)
MXDY	Maximum Day
OCP	Ottawa Cycling Plan
OGB	Outside Greenbelt
OLRT	Ottawa Light Rail Transit

Acronym	Full Term
OP	Official Plan
OPP	Ottawa Pedestrian Plan
ORAP	Ottawa River Action Plan
PPCP	Pollution Prevention and Control Plan
PandR	Prescott and Russell
PSA	Public Service Area
PSs	Pumping Stations
PTTW	Permit To Take Water
QMS	Quality Management System
ROPEC	Robert O. Pickard Environmental Centre
SCADA	Supervisory Control and Data Acquisition system
SDA	Special Design Area
SDD	Single Detached Dwellings
SDandG	United Counties of Stormont, Dundas and Glengarry
SOAR	State of Asset Report
SPAs	Source Protection Areas
SPPs	Source Protection Plans
SPRs	Source Protection Regions
SSOs	Sanitary Sewer Overflows
SUC	South Urban Community
SWM	Stormwater Management
Ptot	Total amount of Precipitation
TIMP	Total Imperviousness
TOD	Transit Oriented Development
TMP	Transportation Master Plan
UCSA	Ultimate Combined Sewer Area
WEfP	Water Efficiency Plan
WEfS	Water Efficiency Strategy
WES	Water Environment Strategy
WDG	Water Design Guidelines
WPPs	Water Purification Plants
WWF	Wet Weather Flow
WW-IMP	Wet Weather Infrastructure Management Plan
WWTP	Wastewater Treatment Plant

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1.0 Introduction and Approach 2013 Infrastructure Master Plan

1.1 Introduction

The Infrastructure Master Plan (IMP) is an overarching City of Ottawa planning document aimed at ensuring the long-term sustainability of the City's water, wastewater and stormwater infrastructure. The IMP applies to infrastructure located in the urban as well as the rural area. It provides a framework for integrating the planning of growth and renewal infrastructure as well as assessing the affordability.

The IMP has been prepared to support the goals of other major planning documents including the Official Plan (OP), Transportation Master Plan (TMP), Ottawa Cycling Plan (OCP) and Ottawa Pedestrian Plan (OPP). The IMP will provide high-level guidance for more detailed assessments and evaluations as water, wastewater and stormwater infrastructure projects described in the IMP are implemented. Reviews, in advance of the annual budgeting process, will be completed to assess the implementation of the recommended infrastructure projects as well as the effectiveness of infrastructure policies. These reviews will generate needed changes to the IMP project lists, priorities and policies and the IMP will be updated accordingly.

1.1.1 Purpose

The purpose of the 2013 IMP, as part of the OP review, is to determine infrastructure requirements for the 2031 planning horizon to serve a projected population of 1.14 million residents, and to support the land-use policies and goals contained in the OP. The IMP considers those infrastructure policies and supporting projects which may require changes and/or tailoring to better align with and support the City's planned direction on key infrastructure planning issues, including intensification, Transit-Oriented Development (TOD), suburban and rural growth and affordability integration with OP/TMP (Part of Building a Liveable Ottawa 2031).

The City of Ottawa provides for: centralized public water and wastewater services to its residents who are located within the urban boundary not including a few enclaves on private individual services; public water and/or wastewater servicing to a number of villages in the city's rural area; and, public water servicing to select rural locations within the city where these services are needed to address unique situations. The City also has an agreement to sell water outside the city-limits to the Township of Russell.

The City is responsible for ensuring stormwater management (SWM) is designed and implemented as part of any planned development within the city. Along with the province of Ontario, the City has a share of responsibility to protect both its surface water and groundwater resources.

The IMP identifies the major public water, wastewater and stormwater infrastructure expansion projects, and the City's role in protecting the natural resource base which supports both public urban and village systems, and private wells and septic systems. The IMP also sets direction for the City's day-to-day infrastructure programs consistent with the city's growth management policies.

1.1.2 What's New in this IMP

A number of City initiatives have been started or completed since the 2009 IMP. These have served to inform this plan and include:

- Intensification Studies – studies have been completed which provide a better understanding of the requirements to meet the projected long-term vision for intensification in various areas throughout the city, e.g. TOD studies at proposed Light Rail Stations and Community Design Plans (CDPs) at other areas of intensification.
- Focus on Affordability – this IMP has been subject to an affordability analysis which integrated the projections of the Long Range Financial Plan (LRFP), the Comprehensive Asset Management (CAM) Strategy as well as the growth-related projects.
- CAM Strategy – to implement the CAM strategy, CAM policy was adopted in 2012 which states that the City shall adopt and apply recognized Asset Management practices in support of delivering services to its customers; this policy has informed the IMP projects and priorities.
- Water Demand Projections have Decreased Significantly - reductions in outdoor water use has also resulted in a reduction in maximum day water demands which is related to the shift in new dwelling types (shift from Single Detached Dwellings,

SDD[1]), development characteristics (higher density), and fewer people watering (shift in behavior).

- Critical Water Infrastructure Assessment complete – identified priority components of the water system, including the system backbone (bulk water transmission, pumping and storage elements), and the watermains that are critical to the supply of water to customers that provide key public health and safety services to the community.
- Models - a new comprehensive model has been developed for the major elements of the wastewater system. A new comprehensive model was also prepared for water.
- Ottawa River Action Plan (ORAP): Stormwater Retrofit Studies – a number of studies have been completed which provided direction on what needs to be implemented in certain older neighbourhoods to retrofit stormwater systems to minimize the impact of stormwater on the city's watercourses.
- Wet Weather Infrastructure Management Plan (WW-IMP) Completed - the intent of the plan is to develop and prioritize strategic programs for managing wet weather flows (WWF) within the wastewater and stormwater collection systems which is critical to improving level of service (LOS) and freeing-up capacity in older areas slated for intensification
- Climate Change and Adaptation – work has been initiated to better understand the trends in local climate and potential adaptation measures that may affect infrastructure requirements.

1.1.3 Integration with OP/TMP - Building a Liveable Ottawa

The IMP together with the OP, the TMP, Ottawa Cycling Plan (OCP) and Ottawa Pedestrian Plan (OPP) represent the strategic plans, which determine land use, transportation and infrastructure policies, as part of the 'Building a Liveable Ottawa 2031' initiative.

This initiative is about making Ottawa more vibrant, healthy and sustainable; in other words, a 'Liveable' City. The updated IMP supports the OP with revised policies and priorities that provide direction to the future growth of the City.

[1] Formerly known as Single Family Homes (SFH)

1.1.4 Integration with Class Environmental Assessment

The IMP has been undertaken in accordance with the Municipal Class Environmental Assessment (MCEA), an approved process under *Ontario's Environmental Assessment Act*. The IMP has followed the MCEA's Master Planning Process and as such satisfies the first two Phases of the Class EA process.

The 2013 IMP is basis for, and will be used in support of, future environmental assessments (EAs) and evaluations for the specific projects identified in the plan. Any projects deemed to be Schedule B projects under the MCEA process will require the filing of a Project. Any projects deemed to be Schedule C projects will have to fulfill Phases 3 and 4 of the Class EA prior to filing an Environmental Study Report. Other projects which are deemed to be Schedule A or A+ projects are considered to be pre-approved in the context of the Class EA and may proceed to implementation without further assessment with Schedule A+ projects requiring public notification prior to project implementation. *Figure 1.1* shows the integrated planning and EA processes.

1.1.5 Public and Stakeholder Consultation

The 'Building a Liveable Ottawa 2031' initiative was supported by an integrated public and stakeholder consultation strategy. The consultation began in the fall of 2012 and continues to December 2013. A Sponsors Group of Members of Council was established to ensure that OP and Master Plan reviews were interconnected and that all stakeholders were considered. Two consultation panels, a Development Industry Panel and a Community Panel, provided the Sponsors Group and staff with advice and feedback from their affiliated stakeholders. *Annex E* provides a detailed summary of the consultation activities conducted.

1.1.6 IMP Scope

The scope of the 2013 IMP was defined by the statement of work approved by Council on July 11, 2012. The intent was to produce an updated IMP which will be used to inform the review of development proposals, the planning for capital works as well as the planning for operational improvements and rehabilitation.

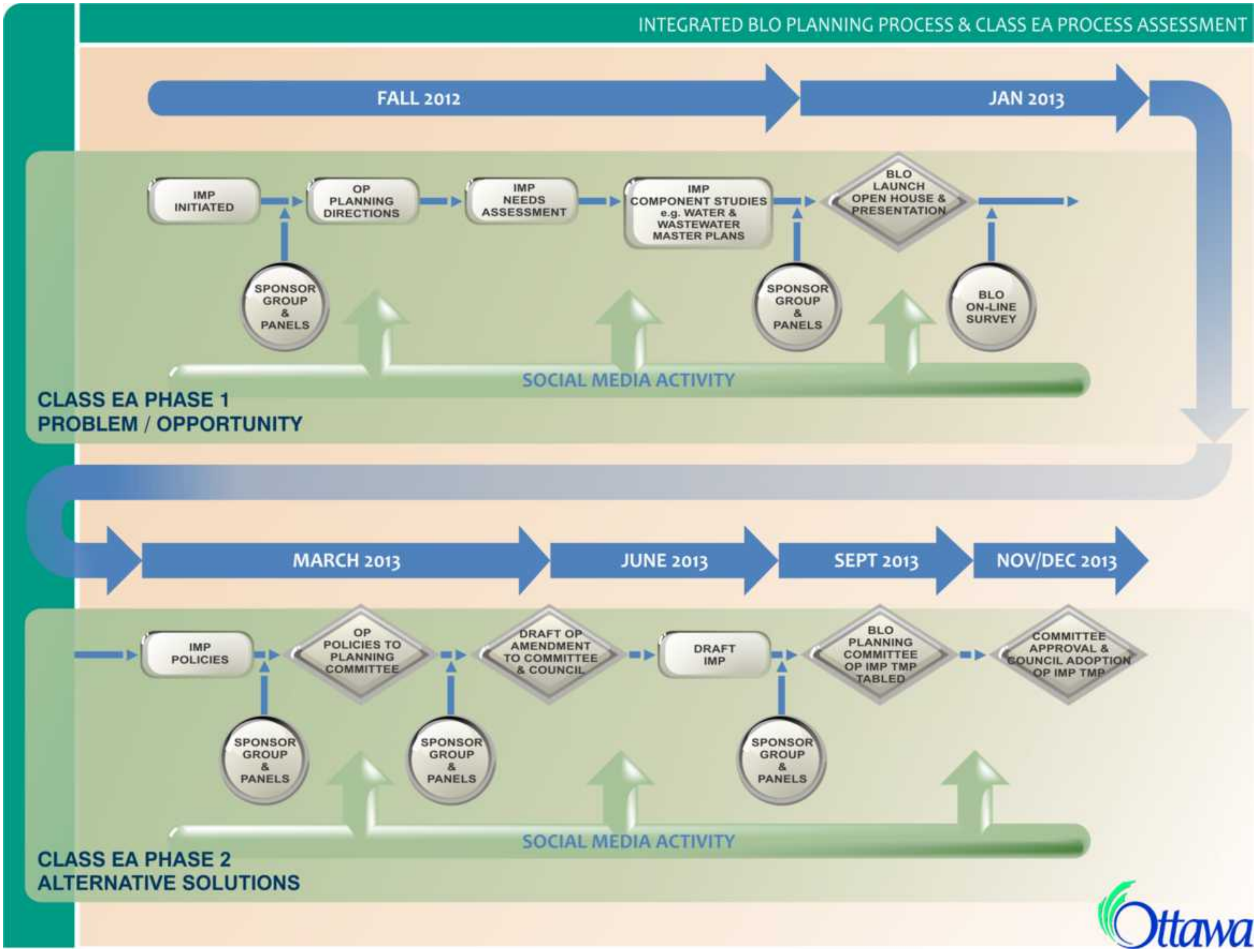


Figure 1.1: Infrastructure Master Plan Integrated Planning, Environmental Assessment and Consultation Process

1.1.7 IMP Structure and Component Studies

The 2013 IMP is preceded by an Executive Summary and has been structured into sections as follows:

Section 1 provides an introduction to the IMP and its purpose. It also outlines the various IMP integrated planning processes, the consultation strategy and the overall IMP scope.

Section 2 summarizes a review of existing infrastructure policies and programs and provides recommendations for new infrastructure policy directions.

Section 3 summarizes land use, population and employment considerations to 2031.

Section 4 details the current trends in infrastructure system demands, demand and supply management, climate trends and LOS expected by 2031.

Section 5 describes the growth and renewal of major system infrastructure project plans, for the water, wastewater, stormwater and rural systems.

Section 6 provides the City's Groundwater Management Strategy (GMS) and recommendations for the protection and management of this natural resource.

Section 7 assesses affordability of the projects and suggests financing strategies and priorities.

Section 8 details the monitoring and reporting on the IMP's policies, actions and recommended projects.

Section 9 identifies future planning initiatives that go beyond the timeframe of this IMP.

Annexes to the IMP include:

- Infrastructure project lists detailing the projected construction date and 2013 capital cost estimates for water and wastewater projects;
- Individual project sheets which summarize the scope and justification, timing, EA requirements and consultation, and follow up actions for the projects as well as detail the estimated breakdown of funding required between the rates and Development Charges;
- Schedules which map the existing water distribution network and wastewater collection system, watersheds and subwatersheds, water and wastewater growth projects from 2013-2031, existing village servicing, and public service areas;

- Links to supporting technical studies;
- Links to related City Programs, supporting plans, and strategies; and
- Public consultation summary.

1.2 Approach

1.2.1 IMP Guiding Directions

The focus of the Building a Liveable Ottawa review was to consider and propose solutions to the 12 planning, infrastructure and transportation planning issues. The issues were reviewed to assess those which may impact or influence infrastructure decisions. It was determined that the issues of impact to the IMP were focused in a number of key areas including intensification, servicing employment lands, making decisions about village servicing, and affordability. These areas provided the guiding directions for the IMP review.

1.2.1.1 Intensification

This 2013 IMP has considered infrastructure capacity requirements and assessed the requirements to service those areas where intensification development will be directed. These include TOD areas, Mixed Use Centres and Mainstreets.

1.2.1.2 Employment Land

In addition to assessing the infrastructure capacity requirements for intensification, capacity needs were assessed for identified employment lands. This was particularly critical for employment lands being considered in the rural area.

1.2.1.3 Village Servicing

The OP envisions that at least 50% of the rural growth will occur in villages; predominantly where a concentration of community services already exists. This is considered a minimum and the actual share of the growth within villages will most likely be greater. As part of the 2013 IMP, the need for additional servicing for the villages was assessed.

1.2.1.4 Affordability

The 2013 IMP assessed infrastructure needs and costs (including those for growth and renewal), and set priorities with the objective of keeping any infrastructure investment requirements affordable. Affordability is discussed further in *Section 7.0*.

1.2.2 Planning Horizon

The Council-approved planning horizon for the 2013 OP is 2031. For this planning horizon, infrastructure requirements were determined considering both growth requirements and infrastructure renewal needs. Opportunities were also explored to integrate growth projects with operational and system renewal projects. In assessing requirements, demand projections, LOS requirements, and trends in water demand and climate were considered.

In addition, to provide further insight into when limits to growth (from an infrastructure perspective) may be reached beyond the planning horizon, the potential for major infrastructure needs to the year 2060 was assessed. This exercise was undertaken to provide a better understanding of opportunities for integration of future growth and renewal needs and to ensure that infrastructure will be able to effectively adapt to future growth, as opposed to adding new infrastructure. In the 2060 scenario a potential increase in population of approximately 250,000 above the projected 2031 population was considered. Incremental requirements associated with meeting the demands for this additional growth were determined.

1.2.3 Infrastructure Planning Process

Planning for water, wastewater and stormwater infrastructure is an integrated process. *Figure 1.2* shows how the IMP relates to other City of Ottawa plans and policies. As illustrated, the IMP receives direction from major City plans like the OP and CAM Strategy, and contains high-level plans for the management of the city-wide backbone or major elements of the wastewater, water and storm water systems. In turn, the IMP gives direction to local system master servicing plans and area-specific infrastructure development, capital project integration analysis, and long-range and annual budgeting exercises. In summary, the IMP takes high-level direction on the future of the city, determines the infrastructure needs to support these directions, and determines the affordability of these needs. It is then able to sets the stage to develop individual local projects consistent with the City’s long-term planning, growth and sustainability aims.

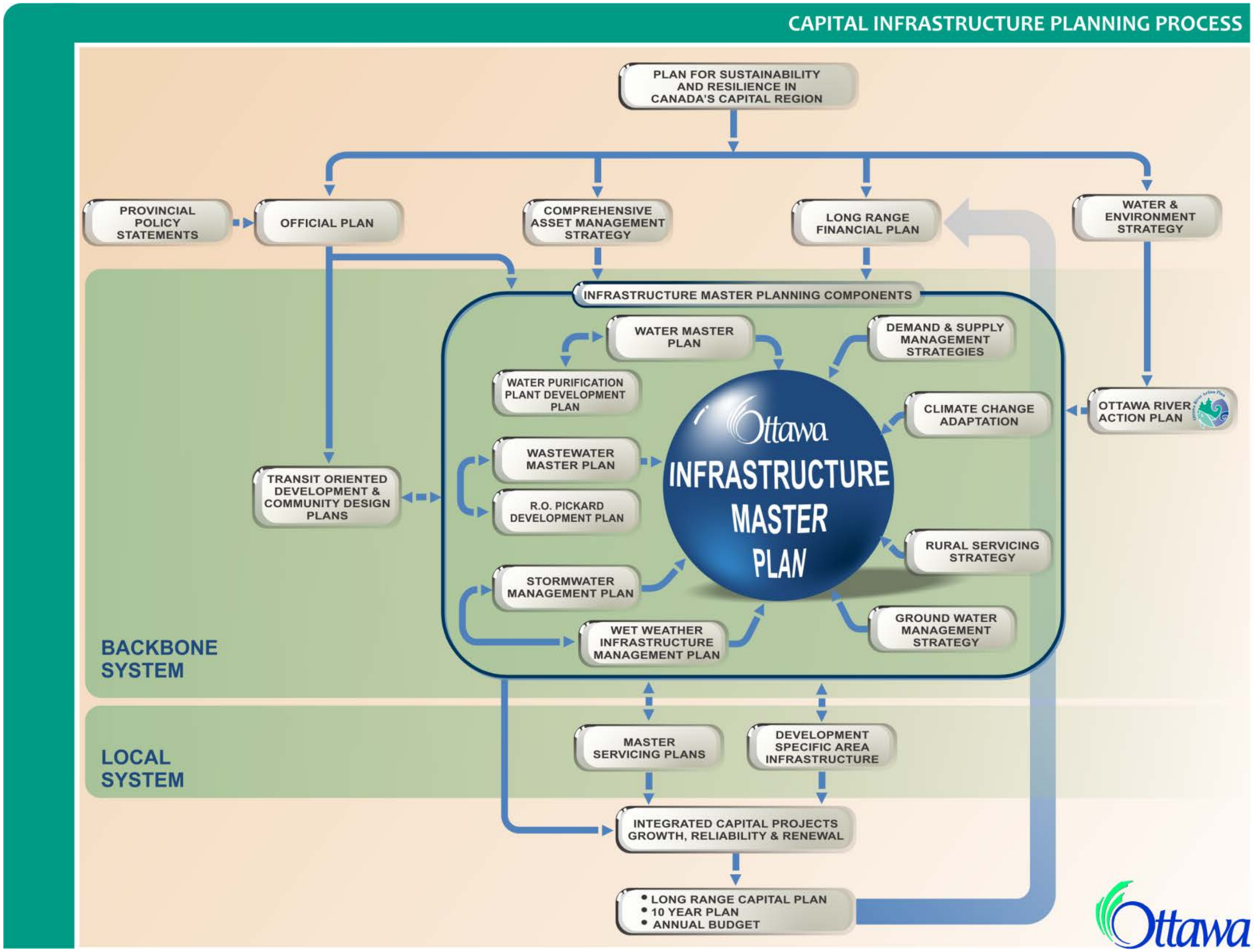


Figure 1.2: Integration of the City's Growth Management Strategy with the Master Plans and other Plans

2.0 Infrastructure Policy

Generally, infrastructure policies identify the mechanisms by which services for new growth will be provided, how the levels of service will be established and define the limitations and restrictions on the infrastructure services to both existing and new growth. The goal is to provide efficient, safe, socially and environmentally sound infrastructure that supports:

- Water treatment and distribution;
- Wastewater collection and treatment; and
- Stormwater collection and treatment.

2.1 Policy Directions

Overarching guidance to the infrastructure policies in this Plan come from the *Provincial Policy Statement* (PPS), legislative requirements, as well as strategies, policies and other plans approved by City Council. The *Provincial Policy Statement* provides priorities for servicing and protection of ground water. Legislative requirements spell out such things as the required standards for water treatment. Council approved strategies, policies and other plans provide direction for specific City issues. All of these together provide justification for the policies.

The following sub-sections highlight some key Council approved strategies, policies and plans which have influenced the IMP policy directions.

2.1.1 Comprehensive Asset Management

The City physical assets have an estimated replacement value of more than $32 billion. Of this, almost $17 billion represents the water, wastewater and stormwater infrastructure. Much of this infrastructure was created to support growth in the city's urban area and to service rural communities. This infrastructure requires continued investment to ensure it is kept in good working order.

In recognition of the growing importance of asset renewal, the City adopted a CAM strategy to direct basic renewal needs in 2003. Since then, it has become a recognized industry best practice to develop CAM programs to help prioritize these investments and ensure best value for rate payer dollars. CAM programs are also becoming pre-requisites to secure funding for infrastructure renewal from upper levels of government.

In 2011, Ottawa City Council mandated the creation and adoption of a CAM Program. City Council adopted a CAM policy in October of 2012. The policy states that the City shall adopt and apply recognized Asset Management practices in support of delivering services to its customers.

CAM is an integrated business approach involving planning, finance, engineering, maintenance and operations. The approach is aimed towards effectively managing existing and new infrastructure to maximize benefits, reduce risk and provide safe and reliable LOS to community users.

The CAM Strategy includes a framework aimed at making sure the City targets the right infrastructure renewal investments at the right time. To achieve this, the City is in the process of reviewing and updating LOS that will allow for a risk-based approach to investment decisions.

The 2012 State of the Asset Report was the first comprehensive report on the state of the City's physical assets. For the water and wastewater assets, about 60% was rated to be in good to very good condition, with about 13% rated as poor condition, and the remaining 27% being in fair condition. Over 70% of the stormwater assets were rated as being in good to very good condition, with about 6% rated as being in poor condition. Assets in good condition are generally considered to be in the middle range of their expected service life. Fair means the assets require attention and are showing signs of deterioration, with some elements showing deficiencies. Poor means the asset requires attention and at risk of affecting service.

There is a shift taking place from focusing on infrastructure investments to address growth towards understanding that significant investments are needed to renew or rehabilitate aging infrastructure. Assets only exist for the purpose of supporting the delivery of a service. Having well-defined customer LOS is an essential element. It is important to understand what LOS can be delivered based on the funding that is available. Given this pressure, there is a need to continue to apply a risk-based approach to investment decisions. The objective of asset management is to apply an optimal investment on the right asset at the right time considering the trade-off between what is affordable and what is an acceptable level of risk.

These current challenges are creating funding pressures for capital investments across different service areas. This leads to the need for a comprehensive and systematic asset management approach. Future LRFPs, renewal funding targets and funding strategies will be informed and updated based on the LOS and asset management plans being developed to support the different service areas.

Refer to *Annex D.1* for more information and links.

2.1.2 Ottawa River Action Plan

In June of 2009, City Council received a report on a comprehensive program to protect the Ottawa River entitled the Ottawa River Water Quality Assessment. This assessment report was the result of an initiative to improve the health of the Ottawa River. A dynamic model of the Ottawa River indicated that the main sources of pollutants were from Combined Sewer Overflows (CSOs), stormwater discharges, and the effluent from the wastewater treatment plant (WWTP).

In 2010, City Council adopted a policy of zero CSOs during the swimming season for the ‘design year’ (which represents an average precipitation year). Council also approved the implementation of 17 projects with a five year spending plan. This shorter term plan, including a project to control CSOs, comprises ORAP. Council also approved the development of a longer term Water Environment Strategy (WES) that will eventually provide a broader context for ORAP (refer to *Annex D.6* for more information and a link).

The 17 projects which form ORAP are listed as follows (refer to *Annex C.1* for more information and links to the projects):

1. Implementation of Real Time Control
2. Critical CSO and Storm Outfall Monitoring
3. CSO Storage for Ultimate Combined Sewer Area (UCSA)
4. Review Sewer Interconnections
5. Sewer Separation outside of UCSA
6. Development of a WW-IMP
7. Implementation of a WW-IMP
8. Installation of Floatable Traps in CSA catchbasins
9. Pinecrest Creek/Westboro Stormwater Management Retrofit Plan
10. Eastern Subwatersheds Stormwater Management Retrofit Plan

11. Implementation of Stormwater Management Retrofit Plans
12. R.O. Pickard Environmental Control Effluent Chlorination
13. Development of a WES
14. Monitoring and Source Control Programs
15. Wastewater and Drainage Environmental Quality Management System (QMS)
16. Updates to the Ottawa River Bacterial Water Quality Computer Model
17. Public Outreach and Education

2.1.3 Financial Policies

The City produces a LRFP that provides a series of financing strategies that balance the need to maintain and build capital assets with the need to manage debt, reserve balances and rate increases. The strategy reflects the capital intensive nature of delivering the water and sewer services with assets that last for multiple generations. The annual reinvestment requirements for existing assets are determined using a risk based approach. The value of growth projects in the water and sewer systems are forecasted and strategic initiatives that Council has approved or as a result of new or changes regulatory requirements are also detailed.

Recommendations from the 2012 LRFP include the following (refer to *Annex C.2* for more information and links):

- Growth must pay its own way. Accordingly, Development Charges should be increased to the highest feasible level.
- Projects that create additional infrastructure should also generate an added pay-as-you-go contribution. This added pay-as-you-go contribution should also be incorporated for all assets built by others but whose ongoing costs are assumed by the City. These costs should be summarized clearly, with detailed utility rate implications part of the budget documentation.
- The City's capital planning process should identify the true lifecycle cost of City assets. Further, over time, additional funding should be provided to increase pay-as-you-go financing for lifecycle projects.
- Future operating costs for capital projects should be considered as part of the capital budget development. Since these costs will carry over to future operating budgets,

they must be clearly itemized to determine whether they will be covered by new money, or from within the existing rate payer base.

- Public-private partnership opportunities should be identified and investigated in both the City's capital and operating budgets. Investigation of these opportunities should include a review of the City's capital plan to bundle capital works into packages that present design-build-finance opportunities to the private sector. Any costs or savings of these public-private partnerships should be identified in future budget documents. The City has adopted a P3 policy and has several P3 projects approved and in process of development.

2.2 2013 IMP Infrastructure Policies

2.2.1 2013 IMP Policy Directions

Policies for the IMP have been developed considering:

- Supporting the direction of the OP to ensure vibrant, healthy and complete neighbourhoods, while ensuring long-term affordability.
- In areas subject to intensification, developing policies which support the effort to understand the cumulative impact of anticipated intensification on infrastructure capacity, and specific requirements to address the capacity needs, taking into account infrastructure rehabilitation and renewal plans.
- The potential need for Development Charges and front ending agreements for system up-grades in intensification areas.
- Taking a risk based approach to infrastructure requirements to address the impact of climate change and adaptation.
- Addressing stormwater management requirements for development inside the Greenbelt based on current technical knowledge and experience.
- Updating wording of policies to reflect current City policies and legislative requirements.

2.2.2 2013 IMP Infrastructure Policies

The 2013 IMP policies and related actions are presented below. Infrastructure policies are structured and organized under the general headings of Protecting Public Health, Safety, Environment and Property, Servicing Intensification, and Financing Infrastructure.

1. Protecting Public Health, Safety, the Environment and Property

The City owns and operates water, wastewater and stormwater infrastructure to promote and protect public health and safety to the public, in a manner that respects the environment and the protection of property.

1.1 Public Service Areas

Public Service Areas (PSA) are defined areas of the city that are serviced by a City water, wastewater and stormwater system. Policies on the potential expansion and changes to the PSA are as follows:

Public Service Areas Policies
i. New development within the defined urban boundary area can only proceed on the basis of public water and wastewater services. Some exceptions are permitted as described in the OP.
ii. New development within villages currently serviced by public water and/or wastewater must be serviced by these public water and/or wastewater services.
iii. Expansion of a PSA is subject to the policies in the OP and will be evaluated on a case by case basis.

1.2 Infrastructure Levels of Service and Reliability

Infrastructure is required to be designed, operated and maintained to meet a particular set of performance and reliability standards based on risk management and overall cost objectives.

Infrastructure Levels of Service and Reliability Policies
i. Growth shall be serviced to meet existing service standards.
ii. Infrastructure shall be planned, designed, operated, maintained and upgraded in accordance with industry best management practices and considering the benefits of the latest technological advances.
iii. Water, wastewater and stormwater infrastructure will be managed based on LOS standards, risk and liability objectives.

1.3 Monitoring, Modelling and Forecasting

Monitoring, modeling and forecasting water demands and wastewater generation is critical to assessing infrastructure needs and planning requirements.

Monitoring, Modelling and Forecasting
i. Infrastructure systems shall be monitored to ensure that sufficient data exists to inform decisions regarding infrastructure requirements.
ii. System modeling shall be comprehensive to enable decisions regarding infrastructure planning and operation.

1.4 Supply and Demand Management

Programs to manage the supply and demand for water, wastewater and stormwater systems are important to be implemented to minimize operating and capital costs while meeting customer service needs.

Supply and Demand Management Policies
i. The efficient use of the water will continue to be promoted to ensure the continued reduction in the wasteful use of water.

1.5 Resource Protection

Protecting both surface water and groundwater resources is a shared responsibility with the province of Ontario.

Resource Protection Policies
i. The City has a role in preserving and improving the environmental health of watercourses and the Ottawa River. ii. The City contributes to the conservation and protection of groundwater resources.

1.6 Communication and Consultation

Communicating with customers is an important aspect of the infrastructure planning process.

Communication and Consultation Policies
i. The City strives for open and effective communication.

2. Servicing Intensification

Intensification is an OP direction. Opportunities exist to support intensification by integrating infrastructure planning for growth with renewal.

Servicing Intensification Policies
i. Where possible, infrastructure growth and renewal priorities and projects will be consistent with facilitating re-development within the urban boundary.

3. Affordability and Financing Infrastructure

Planned infrastructure needs to be affordable over the OP planning horizon. Financing strategies need to support the design, construction, operation and maintenance of the infrastructure.

Affordability and Financing Infrastructure Policies
i. The City applies fair and equitable infrastructure financing.
ii. The City will continue to promote the implementation of efficient and affordable infrastructure.

2.2.3 Action Items

Action Items have been numbered to correspond with the policies above. Furthermore, in the following sections of the IMP, the actions have been highlighted to provide the reader with their underlying rationale.

A1.1-1. The City will assess the expansion of Public Service Areas on a case by case basis subject to capacity limitations and restrictions, and may not include both water and wastewater services.

A1.2-1. The City will maintain and regularly update the design, operating, maintenance, materials, construction and tendering standards for infrastructure works and services.

A1.2-2. The City will reference levels of service requirements in its design guidelines for water, wastewater and stormwater infrastructure.

A1.2-3. The City will investigate and consider emerging technologies for inclusion in City design guidelines, materials specifications, operation and maintenance practices and procedures, construction specifications and life cycle cost recovery models.

A1.2-4. The City will periodically review their design guidelines for the water, wastewater and stormwater systems to evaluate potential impacts from climate change and recommend changes as appropriate.

A1.2-5. The City will continue to assess and plan infrastructure to provide reliable water, wastewater and stormwater services.

A1.2-6. The City will operate, maintain and renew its infrastructure in a manner consistent with the Comprehensive Asset Management Program.

A1.2-7. In emergency situations, the City may place controls on water use if required to maintain a safe water supply to meet basic needs.

A1.2-8. The City will use the results of the wastewater risk-based management plan to establish priority needs for sanitary sewer segments.

A1.2-9. The City will evaluate the critical sanitary sewer segments to determine whether redundancy measures are warranted in the wastewater system.

A1.2-10. The City will form a Stormwater Management interdepartmental working group to develop and recommend actions for dealing with climate change and adaption.

A1.3-1. The City will track development approvals and growth characteristics to support infrastructure planning and the timing of capital projects.

A1.3-2. The City will assess how factors related to population growth, such as employment characteristics and household demographics, may impact infrastructure planning.

A1.3-3. The City will, on a regular basis, confirm system demands and performance through monitoring and analysis, and update design criteria and allowances based on the results of this monitoring, as appropriate.

A1.3-4. The City will assess requirements for and will develop detailed water, wastewater, and stormwater models to deal with the issues of intensification. Included in the assessment will be the resources required to ultimately develop and maintain the models.

A1.3-5. The City will continue to develop and maintain models of the Central Water Distribution System (CWDS) and Central Wastewater Collection System (CWWCS) to support performance analysis and infrastructure planning and to prioritize remedial actions.

A1.3-6. The City will review and update its wastewater flow monitoring requirements and its network on an annual basis.

A1.3-7. The City will further review the remaining build-out areas for large SWM facilities flagged for potential capacity constraints. Based upon the anticipated level of ultimate imperviousness, the need for additional measures that may be required to maintain water quality and/or quantity targets will be determined.

A1.3-8. The City will monitor the effectiveness of its policies, the status of its actions and the implementation of its projects and report on these on an annual basis as part of the 'Annual Development Report'.

A1.4-1. The City will continue to implement the Water Efficiency Strategy (WefS) through current programs and supporting initiatives.

A1.4-2. The City will review and determine whether the WefS and the Drinking Water Awareness Program (DWAP) can be merged and efficiencies derived.

A1.4-3. The City will continue to support ongoing and new strategies for the water system to reduce water lost through leakage.

A1.4-4. As part of the strategies to reduce water lost to leakage, the City will use leak detection information to assess the potential for failures of large diameter watermains.

A1.4-5. The City will continue to investigate options for creating wastewater capacity such as extraneous flow removal and flow diversions, as alternatives to upgrading or constructing new infrastructure.

A1.5-1. The City will work toward the goal of achieving zero CSOs during the swimming season for the 'design year' (which represents an average precipitation year).

A1.5-2. The City will continue to monitor trends in the Ottawa River water level conditions over time, and identify required adaptive measures and related water infrastructure improvements.

A1.5-3. The City will complete a city-wide Stormwater Management Retrofit Master Plan.

A1.5-4. The City will carry out low impact development demonstration projects, low impact development training, and adopt low impact development design guidelines and standards.

A1.5-5. The City will review the development review process and requirements for groundwater management, and develop recommendations to ensure the process protects public health.

A1.5-6. The City will liaise with all source water protection partners regarding source water protection issues.

A1.5-7. The City will maintain and enhance a monitoring system to assess the potential impacts of development on groundwater resources.

A1.5-8. The City will continue monitoring and assessing receiving watercourses to determine how they are adjusting and to support future decision-making.

A1.5-9. The City will educate property owners on retrofit opportunities at the lot level.

A1.5-10. The City will inform the community of the connection between the Ottawa River and public use of sanitary and stormwater systems, and how individuals can help protect the River and its many tributaries.

A1.5-11. The City will work with local Conservation Authority (CA) Partners to prioritize stream restoration projects.

A1.5-12. The City will work on a watershed-based Groundwater Management Strategy (GMS) led by its CA Partners, resulting in a document that will be used City-wide in the protection and management of groundwater.

A1.5-13. Groundwater level monitoring will be implemented at all municipal well locations and at strategic sentinel wells.

A1.5-14. The City will continue to perform groundwater studies in villages and some privately serviced enclaves within the urban area. Multiple sampling events within villages will help the City identify trends in groundwater quality as a result of ongoing development.

A1.5-15. The City will work with its CA Partners to develop and maintain a database system for water quantity and quality data from various sources, including information obtained from consultant reports prepared in support of development projects.

A1.5-16. In view of issues related to improperly constructed wells, the City, working with its CA Partners, will investigate the possibility of a well inspection program to ensure that all wells conform to the regulations and the requirements of the hydrogeological report.

A1.5-17. As part of the requirements of the Source Protection Plans (SPPs), the City will work with its CA Partners and the Ottawa Septic System Office to create a program for sewage system maintenance inspection in areas where sewage systems are significant threats. The City will also review the benefits of extending a similar program for other areas as well.

A1.6-1. The City will consult with its stakeholders when assessing and implementing IMP Projects.

A1.6-2. The City, as part of its ORAP Communications Plan, will continue to inform the community of requirements to eliminate household and business practices that negatively impact the wastewater collection and treatment systems.

A2-1. The City will, in areas with partially-separated sewers, give priority to extraneous flow removal projects that provide capacity for intensification.

A2-2. Capacity constraints that limit intensification potential will be addressed in planning and prioritizing infrastructure renewal programs.

A2-3. The City, as part of the planning for infrastructure, will continue to look at ways to integrate renewal and growth planning to achieve cost efficiencies.

A2-4. The City will maintain an internal working committee with representation from the various planning and operational City Departments, to consider opportunities to improve the integration of renewal and growth planning.

A2-5. The City will provide the necessary resources to support the implementation of the WW-IMP, in particular, in those areas slated for intensification.

A2-6. The City will prepare a Stormwater Collections System Master Plan as part of the Wet Weather IMP.

A2-7. The City will identify and incorporate Stormwater Management retrofit measures into City renewal projects where appropriate.

A3-1. Front-ending and negotiated agreements between the City and developers will be used to facilitate the construction of infrastructure required to support more than one development.

A3-2. Development charges will be used as the major source of funding to construct infrastructure for greenfields development.

A3-3. The City will implement an asset management strategy, based on a financial model that considers life cycle costing, as one component of the City's overall infrastructure management program.

A3-4. The City will annually report on the economic value and liability of the City's infrastructure as defined by the financial model.

A3-5. The City will assess the mechanisms available to support the operation and maintenance of its stormwater systems and determine whether a user specific rate should be developed to support this infrastructure.

A3-6. The City will update the 2014 Development Charges background study regarding Water, Wastewater and Stormwater services to reflect the requirements identified in the IMP.

3.0 Land Use, Population and Employment Considerations

To a large degree, the planning of infrastructure hinges on the patterns and rates of urban growth, trends in the demographics of the city's households, and how the people of Ottawa use water and dispose of it. Other factors related to the specifics of plumbing and the renewal of infrastructure also affect demand on services. This section of the IMP focuses on existing and projected population and employment across the city, as well as the scale and trajectory of the demand for water which is the primary driver for growth related water supply and sewage collection infrastructure requirements. The nature of land use and housing density have an impact on design considerations for stormwater facilities, as these factors have a direct influence on the runoff being generated from rainfall.

3.1 Existing Conditions

The existing magnitude and distribution of population and employment is estimated based principally on two sources: the Federal Census, which is updated every five years, and the City's Employment Survey, which is updated at roughly the same frequency. Building permit data is used to estimate changes in population and employment in interim years. To supplement this information, water billing data and water facilities monitoring data is regularly analyzed. This provides corroboration on where new dwellings are occupied as well as how much water is being used and where.

3.1.1 Census Data

3.1.1.1 Population

The 2011 Census reported Ottawa's population at 883,395, an increase of 8.8% or 71,260 people from the 2006 Census count of 812,130. Population grew in all major areas of the city in the five-year period; inside the Greenbelt rose by 4.7%, outside the Greenbelt increased 16.8%, and the rural area grew 7.6%. Overall increases in population and dwelling counts over the last 20 years are noted in *Table 3.1*.

Table 3.1: Population and Dwelling Counts, City of Ottawa, 1991-2011

Area / Indicator	1991	1996	2001	2006	2011
City of Ottawa					
Population	678,125	721,100	774,075	812,130	883,395
Dwellings	259,815	276,550	301,765	320,890	353,260
Inside the Greenbelt					
Population	476,860	485,545	501,900	487,360	498,510
Dwellings	196,995	201,580	212,395	211,635	221,065
Outside the Greenbelt					
Population	136,555	165,060	197,955	244,055	299,125
Dwellings	41,890	51,705	64,235	81,340	102,040
Rural Area					
Population	64,735	70,495	74,220	80,720	85,760
Dwellings	20,930	23,265	25,135	27,915	30,155

Source: Statistics Canada, Census 1991-2011

3.1.1.2 Households

There were 353,245 private households in Ottawa in 2011, up 10% from 2006. The following is a summary of key statistics that are relevant to the IMP, and illustrate recent trends in development patterns.

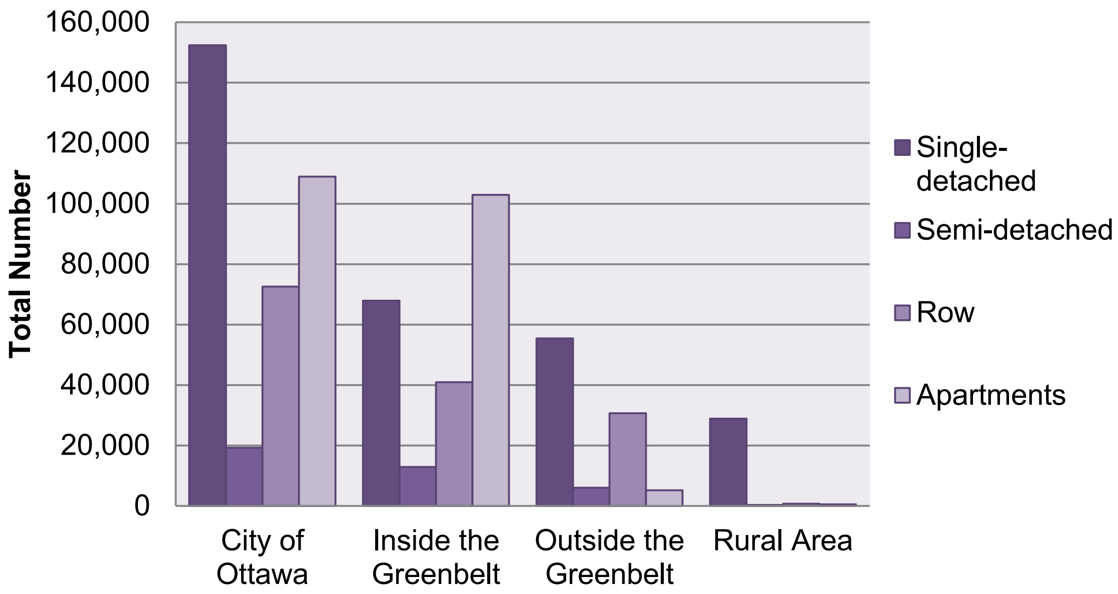
- Households with one or two people accounted for 61% of all households in 2011, an increase of 12% since 2006.
- city-wide, average household size stood at 2.45 persons in 2011, compared to 2.52 in 2001. Although it may appear insignificant, the decline of 0.07 persons required an additional 9,500 housing units to be provided during the 2001-11 decade.

3.1.1.3 Dwellings Types

Water usage and drainage in the city are correlated with land use, and differences in these parameters are detected across the various types of dwelling units as well. The following summarizes some key statistics and trends related to dwelling type (*Figure 3.1* and *Figure 3.2*):

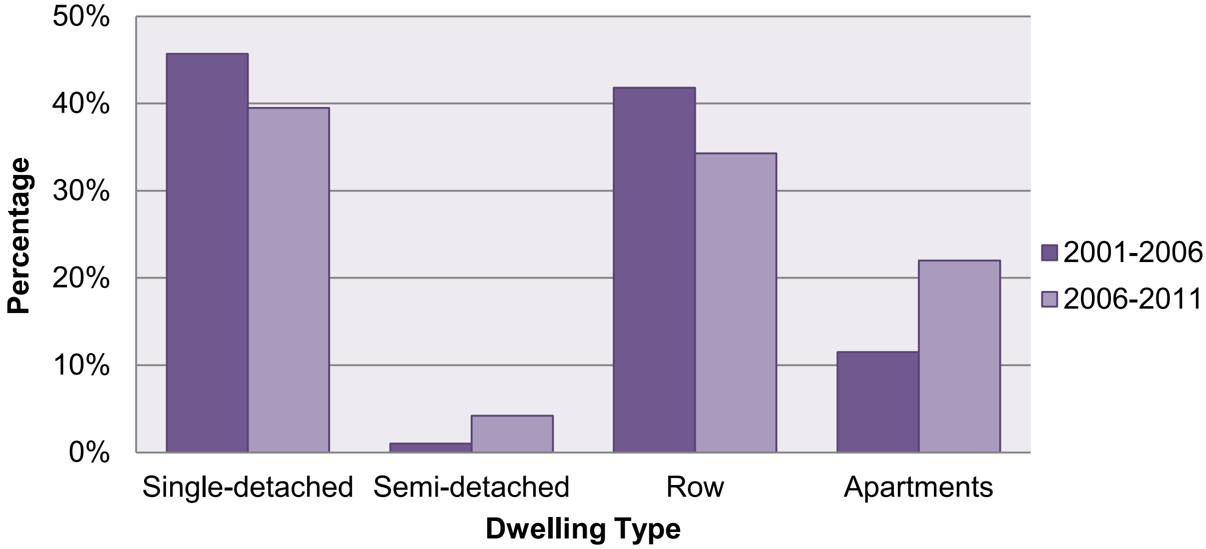
- SDDs, comprising 43% of occupied units in 2011, remained the most common housing type in Ottawa. However, their share of the housing stock is declining, and row (townhouse) and apartment units are on the rise.
- Row (townhouse) units increased their share from 19.1% of units in 2006 to 20.5% in 2011.

- Inside the Greenbelt, apartments comprised the largest share of housing (46%) in 2011.
- Outside the Greenbelt, SDDs accounted for 57% of the housing stock in 2011, while row housing represented 31.5%. Apartments comprised only 5.4% of units, but had the fastest growth since 2006.
- Outside the Greenbelt, apartments increased 37% since 2006, row units by 32%, and SDDs by 13%.
- In the rural area, SDDs grew by 9% and accounted for almost 95% of all housing. Row units, while few in number, increased 172% since 2006.



Source: Statistics Canada, Census 2011

Figure 3.1: Dwelling Type by Area, City of Ottawa 2011



Source: Statistics Canada, Census 2001-2011

Figure 3.2: New Dwellings by Type, City of Ottawa, 2001-2006 and 2006-2011

3.1.2 Employment Survey

The City recently completed a new survey of employment. The 2012 Employment Survey was the seventh comprehensive survey completed since 1976. It is done every five years[2] and contacts every employer with a business telephone in the city of Ottawa.

Between 2006 and 2012, employment in the city increased by 44,108 jobs. Employment grew by 8.5%, slightly lower than the average since 1976, but jobs still increased at a faster pace than households and population indicating continued high labour force participation. The total number of jobs enumerated for 2012 stood at 565,747.

According to the 2012 survey, employment grew in all major geographic areas of Ottawa over 2006. Between 1981 and 2006, the areas inside the Greenbelt added 185,000 jobs, urban areas beyond the Greenbelt grew by 74,000; and the rural area grew by 16,400 jobs.

3.1.3 Current Conditions

The 2012 population and employment statistics, as estimated by the City, are provided in *Table 3.2*.

[2] The 2012 survey was done on a six-year interval due to City budget constraints

Table 3.2: 2012 Population and Employment

	Population			Employment		
Area	2006	2012	Change	2006	2012	Change
Inside Greenbelt	533,127	529,787	-3,340	427,975	455,501	27,526
Outside Greenbelt	251,981	309,627	57,646	71,053	85,155	14,102
Total Urban	785,107	839,413	54,306	499,028	540,656	41,628
Rural	85,654	92,320	6,667	21,173	25,341	4,168
City of Ottawa	870,761	931,734	60,972	520,741	565,997	45,256

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: 2012 Mid-Year Population Estimates and City Employment Surveys.

3.1.4 Water Billing Data and Supervisory Control and Data Acquisition

New dwelling units and employment-related buildings can be identified by the City's increasing inventory of water meters that track the local consumption of water, and provide the basis for water billing. For the purposes of developing the models used to simulate the existing operation of the CWDS and the CWWCS, this information is critical. It provides a convenient basis for the spatial distribution of dwellings, employment, and the actual water demands associated with each. The Census and Employment data provides the means of calibrating the distribution of people and jobs, and is used to establish important statistics, such as the average number of people per dwelling unit, water demand per capita, and per employee.

The City maintains a Supervisory Control and Data Acquisition (SCADA) system to monitor and control all water supply facilities, including pump stations and water storage facilities. A similar system exists for the CWWCS. The data generated by this system provides estimates of the total water supplied to each water pressure zones.

3.2 2031 Future Development Conditions

3.2.1 Overall Projections and Considerations Supporting Strategic Infrastructure Planning

Population, housing and employment in Ottawa are all expected to grow significantly by 2031 (*Table 3.3*). In the period 2012 to 2031, the population of Ottawa is projected to grow by about 204,000 people, a 22% increase over 2012. Households are expected to increase even faster, by roughly 30% over 2012, whereas employment is expected to increase by 24% over the same period.

About 61% of the projected 2031 population growth is expected to be in the suburban areas outside the Greenbelt. While occupancy rates are expected to continue to drop (households will contain fewer people on average), a net increase of 61,000 people, or about 30% of the expected growth, is expected within the Greenbelt as a result of development intensification in established areas of the city, particularly in the vicinity of the future Ottawa Light Rail Transit (OLRT) stations.

Table 3.3: 2031 Official Plan Projections

	Population			Employment		
Sub-area	**2012**	**2031**	**Increase**	**2012**	**2031**	**Increase**
Inside Greenbelt	529,800	591,000	61,200	455,500	506,000	50,500
Outside Greenbelt	309,650	432,000	122,350	85,150	162,000	76,850
Total Urban	839,450	1,023,000	183,550	540,650	668,000	127,350
Rural	92,300	112,850	20,550	25,350	35,000	9,650
City of Ottawa	931,750	1,135,850	204,100	566,000	703,000	137,000

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: 2012 Mid-Year Population Estimates and City Employment Surveys and Ottawa Official Plan 2031 Projections.

Table 3.3 reflects the reduction in occupancy that is expected to continue for existing residential units. The expected average occupancy rates for all units over time is given in *Table 3.4*.

Table 3.4: Estimated Dwelling Unit Occupancy Rates, 2012 to 2031

Unit Type	city-wide	IGB	OGB
2012 - All units			
SDD	2.94	2.87	3.05
MDU	2.62	2.56	2.72
APT	1.65	1.61	1.71
2021 - All units			
SDD	2.77	2.71	2.86
MDU	2.50	2.45	2.58
APT	1.55	1.52	1.62
2031 - All units			
SDD	2.70	2.65	2.78
MDU	2.40	2.38	2.44
APT	1.50	1.47	1.57

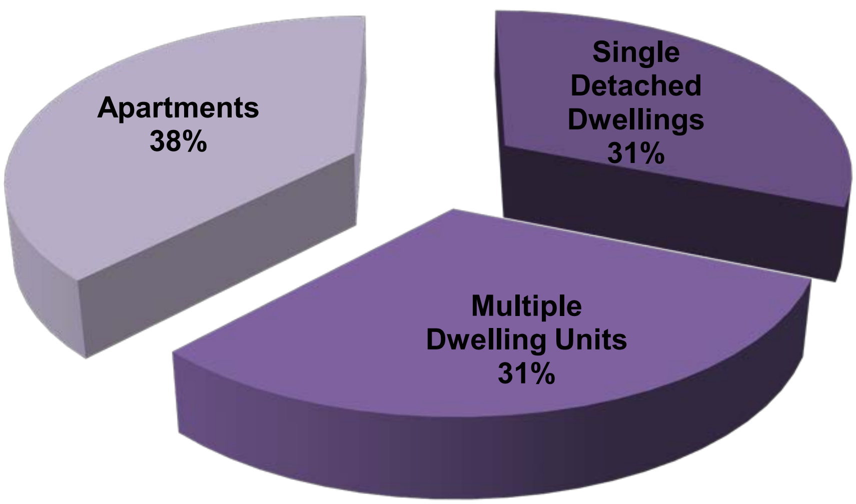
Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit.
IGB = Inside Greenbelt
OGB = Outside Greenbelt
SDD = Single Detached Dwellings
MDU = Multiple Dwelling Units
APT = Apartment

Detailed geographic and temporal identification of growth is required for effective infrastructure planning.

3.2.2 Components of Growth

Detailed projections of expected future growth were derived from several sources to address the characteristics of growth likely to affect infrastructure planning. The sources included the Vacant Urban Residential Land Survey; the Urban Expansion Lands added by OP Amendment 76 (OPA 76); an inventory of Vacant Industrial and Business Park Lands; the OP; and the Rural Residential Land Survey.

This information provided the basis for establishing the spatial distribution of the city's growth. The breakdown and distribution of SDD, townhomes and similar multiple dwelling units (MDU[3]), and apartments (APT) are illustrated in *Figure 3.3*, *Figure 3.4*, *Figure 3.5*.



Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Vacant Urban Residential Land Survey, Urban Expansion Lands added by OP Amendment 76, Residential and Intensification Potential, Vacant Industrial and Business Park Lands, OP, Rural Residential Land Survey.

Figure 3.3: Urban Growth by Housing Type (2013-2031)

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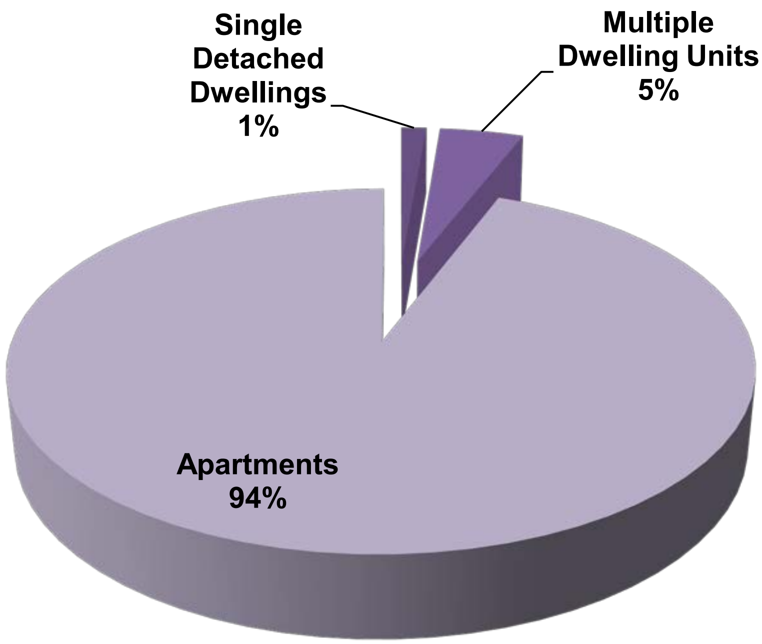
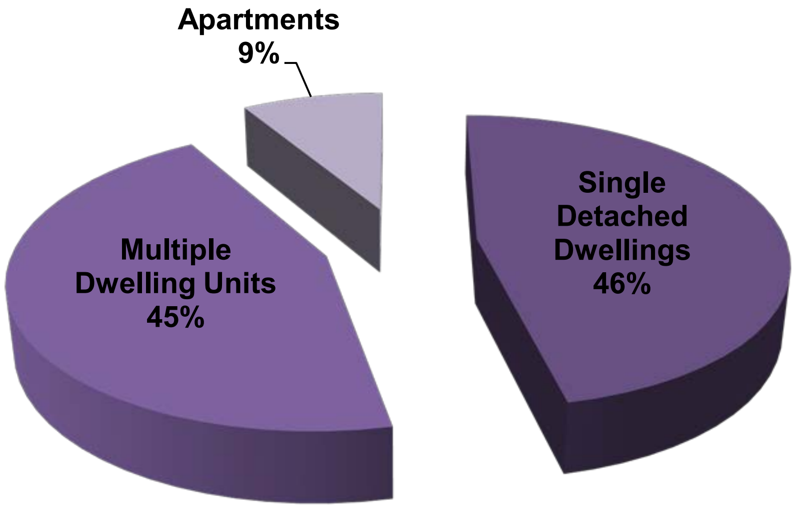
[3] Formerly MLT for multiple



Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Vacant Urban Residential Land Survey, Urban Expansion Lands added by OP Amendment 76, Vacant Industrial and Business Park Lands, OP, Rural Residential Land Survey.

Figure 3.4: Urban Growth by Housing Type Inside Greenbelt (2013-2031)



Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Vacant Urban Residential Land Survey, Urban Expansion Lands added by OP Amendment 76, Vacant Industrial and Business Park Lands, OP, Rural Residential Land Survey.

Figure 3.5: Urban Growth by Housing Type Outside Greenbelt (2013-2031)

3.2.3 Rural Growth Statistics

Table 3.3 shows the total population and employment projections for the Rural Area to 2031. For the purposes of the IMP, it is useful to delineate the distribution of growth. *Table 3.5* shows the partitioning of growth based on lot creation over the last 10 years between villages and country lots (i.e. outside villages); and *Table 3.6* shows some statistics within villages. Further analyses and discussions are provided in *Section 5.6*.

Table 3.5: Rural Lots Created Over the Past Ten Years

Type	03	04	05	06	07	08	09	10	11	12	Ave.[1]
Village											
Severance	14	7	5	6	7	7	15	12	9	44	12.6
Subdivision	111	59	48	218	67	53	88	140	159	135	107.8
Subtotal	**125**	**66**	**53**	**224**	**74**	**60**	**103**	**152**	**168**	**179**	**120.4**
Country Lot											
Severance	60	97	55	38	25	35	33	55	46	62	50.6
Subdivision	193	215	288	136	249	31	41	103	57	44	135.7
Subtotal	**253**	**312**	**343**	**174**	**274**	**66**	**74**	**158**	**103**	**106**	**186.3**

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Rural Lot Surveys.

1. Average number of lots created per year over the past 10 years

Table 3.6: Village Growth Statistics

Village	Total Area (ha)	No. of Units (2012)	Pop. (2012)	Housing Starts (2011-12)	New Units Per Yr.[1]	Add'l Units[2]
Ashton	16.03	36	111	0	0.4	5
Burritt's Rapids	13.35	23	64	0	1.6	2
Carlsbad Springs	31.23	80	235	0	0.0	1
Carp	216.85	649	1,907	74	25.8	479
Constance Bay	687.92	905	2,445	6	16.4	114
Cumberland	423.82	608	1,775	4	2.0	125
Dunrobin	51.62	112	304	1	2.6	13
Fallowfield	71.18	123	366	1	0.4	11
Fitzroy Harbour	154.81	231	651	9	4.2	128
Galetta	37.02	58	163	0	0.2	14
Greely	1,276.05	2,054	6,058	189	78.0	1,081
Kars	180.51	249	689	8	5.4	33
Kenmore	73.33	107	313	0	2.2	41
Kinburn	69.74	100	283	2	1.4	64
Manotick	826.05	1,821	5,372	33	10.4	1,763
Marionville	34.83	16	46	0	0.0	51
Metcalfe	425.11	755	2,198	5	6.0	308
Munster	105.24	438	1,357	0	0.0	0

Village	Total Area (ha)	No. of Units (2012)	Pop. (2012)	Housing Starts (2011-12)	New Units Per Yr.[1]	Add'l Units[2]
Navan	286.55	486	1,432	1	2.2	141
North Gower	736.90	625	1,731	6	4.6	591
Notre-Dame-Des-Champs	59.00	163	481	0	0.2	25
Osgoode	382.79	944	2,889	8	2.6	156
Richmond	831.22	1,736	4,809	103	47.6	3,203
Sarsfield	56.50	156	456	1	3.0	11
Vars	218.89	377	1,112	13	5.2	124
Vernon	154.52	223	649	5	2.6	56
Total		**13,075**	**37,896**	**469**		**8,542**

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Rural Lot Surveys.

1. New units are averaged over the last five years
2. Number of potential units at full village build-out

3.3 Long Term Infrastructure Planning (2060)

The life-cycle of municipal infrastructure can range from approximately 20 years for facility components such as pumps and motors, to over 100 years for sewers, watermains, and water storage reservoirs. As such, it is critical that the planning of major infrastructure consider potential continued growth that extends beyond the OP horizon. In addition such an assessment provides a better understanding of opportunities for integration of future growth and renewal needs ensures that infrastructure will be able to effectively adapt to future growth. The sizing of major 2031 infrastructure must consider cost-effective opportunities to add future facility components and capacity, where appropriate. It is important to emphasize here that potential incremental costs will always be small relative to the magnitude of the overall project.

To support this longer-term view required for infrastructure planning, projections to 2060 have been developed, as summarized in *Table 3.7*. Future updates to the OP will likely produce changes that differ somewhat from these assumptions. Thus, there is significant uncertainty involved in the planning of infrastructure when considering growth beyond 2031.

The numbers in *Table 3.7* reflect the significant intensification that is anticipated to continue beyond 2031 in established urban areas of the city. Most of this intensification is expected to take place inside the Greenbelt, particularly in the vicinity of transit stations, in mixed use centres and along mainstreets.

Table 3.7: Projected Urban Growth from 2031 to 2060

Area	New Units			New Jobs
	SDD	MDU	APT	
Outside Greenbelt	25,000	20,000	12,000	72,000
Inside Greenbelt	1,500	3,000	57,000	109,000
Total Public Service Area	26,000	23,000	69,000	181,000

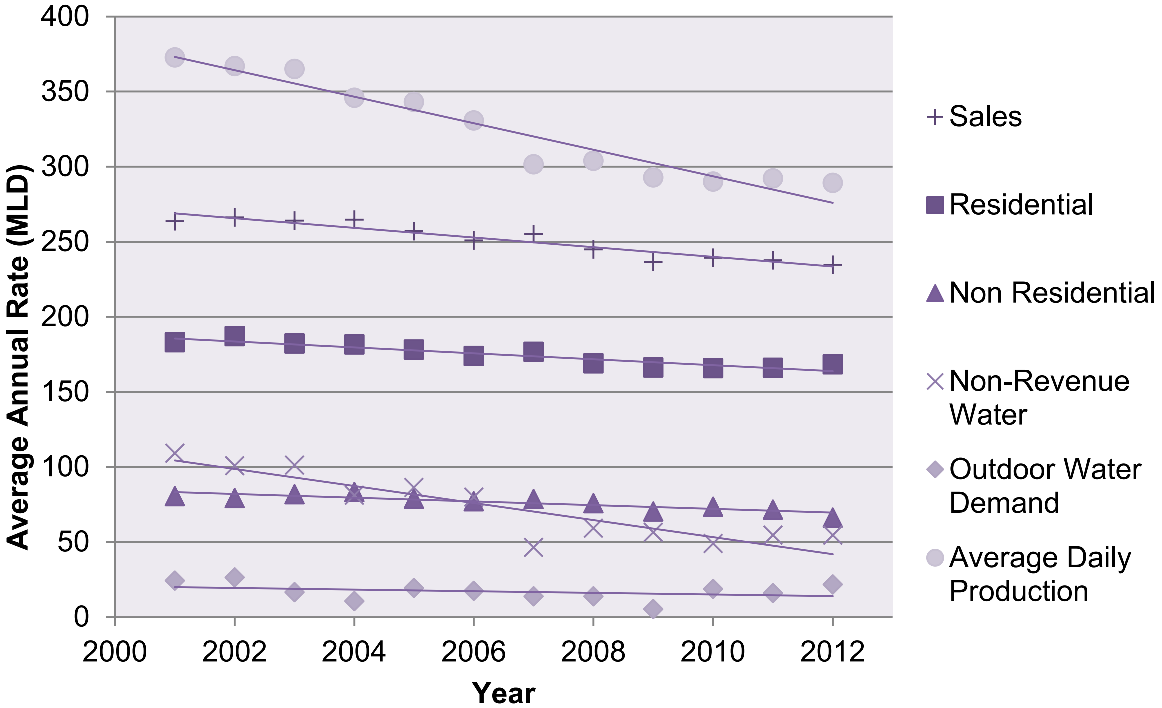
Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit.
SDD = Single Detached Dwellings
MDU = Multiple Dwelling Units
APT = Apartment

4.0 Demand and Supply Management, Trends and Levels of Service

4.1 Trends in System Demands

4.1.1 Water

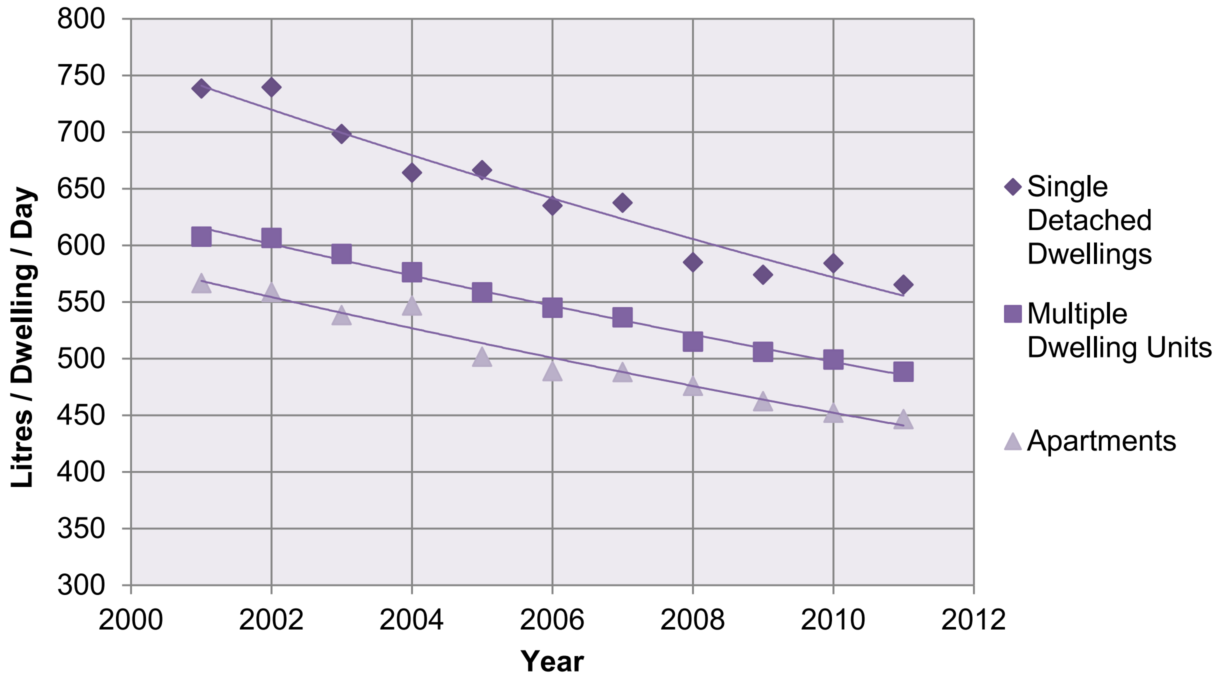
Despite the increase in population and employment over the last decade, water consumption for the central system shown in *Figure 4.1*, has been decreasing. Average water consumption rates as reflected by sales, appear to have stabilized and remain steady at 240 Million Litres per Day (MLD). Water production and unbilled and lost water also declined by approximately 20% and 40%, respectively.



Source: City of Ottawa AQUACIS and SCADA databases.

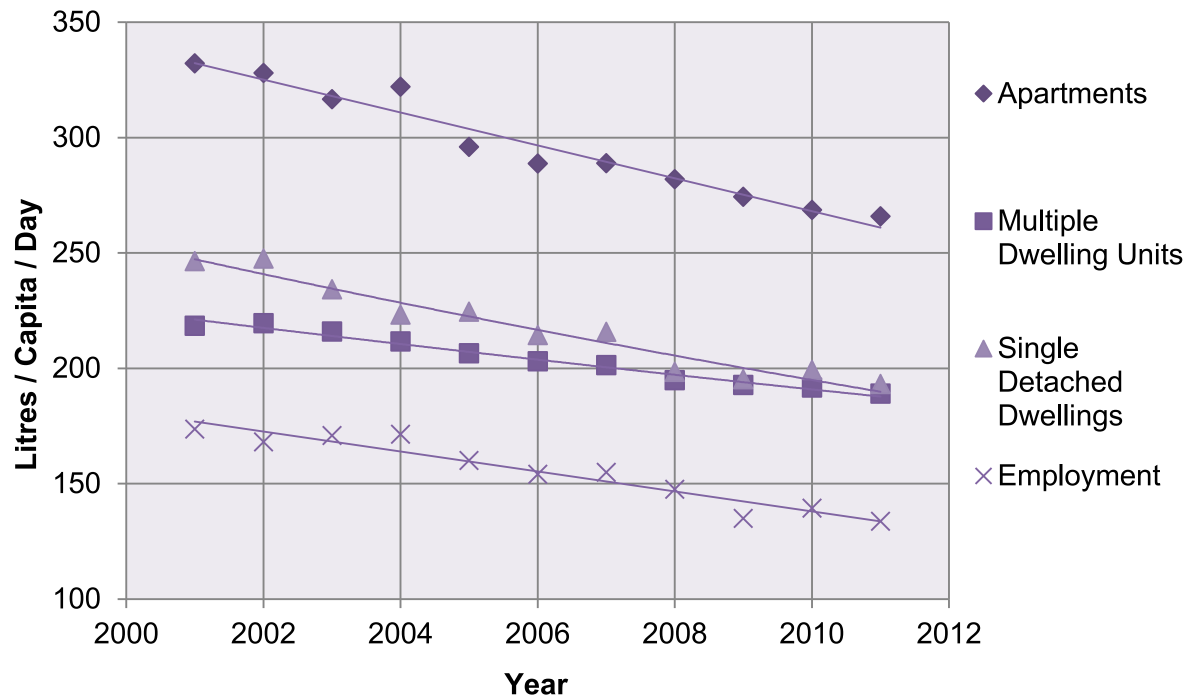
Figure 4.1: Overall Trends in Production and Sales

Trends in water demand for residential households are presented in *Figure 4.2*. The trend on a per capita basis is shown in *Figure 4.3*. Included in this figure are the changes in non- residential water use on a per employee basis. Although total production has stabilized, the water use per household is still declining and is compensating for added demand resulting from growth.



Source: City of Ottawa AQUACIS database

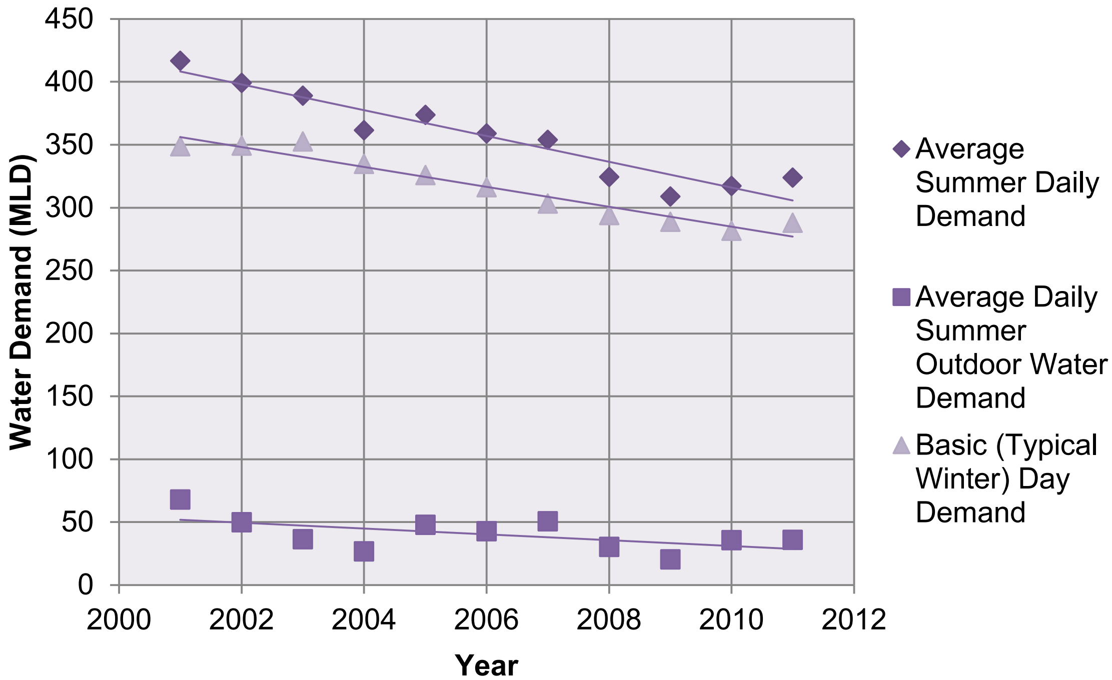
Figure 4.2: City Wide Household Water Use



Source: City of Ottawa AQUACIS database

Figure 4.3: City Wide Per Capita Trends

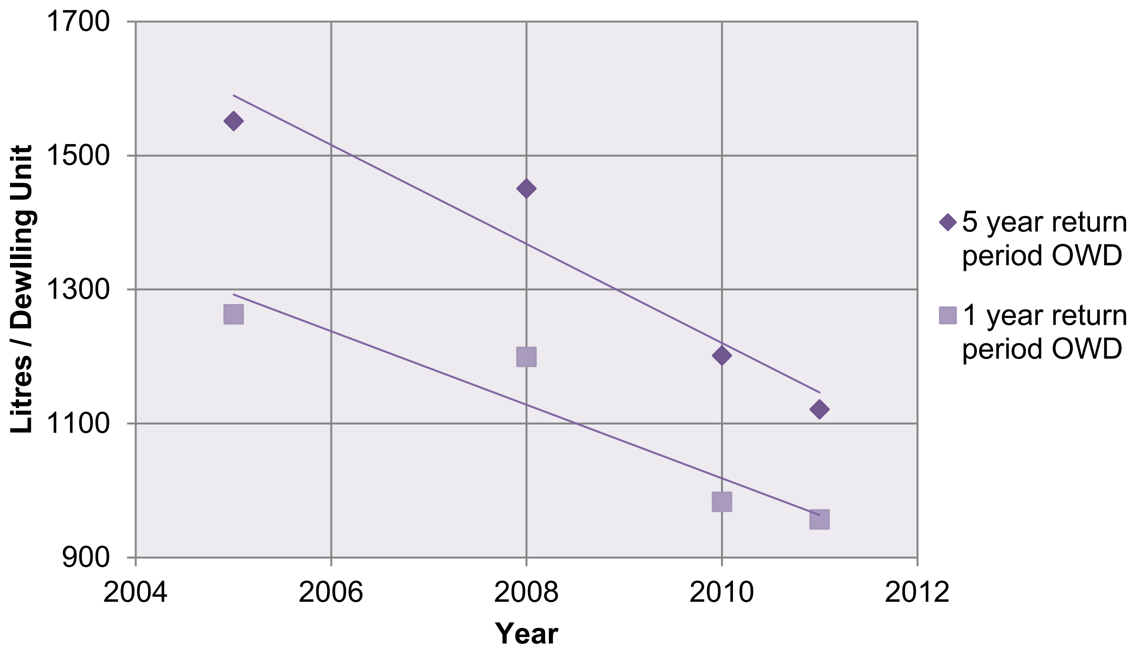
Summer water use, as measured by the average water production from mid-May to mid-September is also declining, as shown in *Figure 4.4*. This period normally experiences highest water demands of the year. The actual outdoor water use, however, is relatively stable at 30 to 40 MLD and most of the decline is attributed to reduced basic water demand. More significantly there has been a dramatic decrease in peak day outdoor water use per household. *Figure 4.5* shows the SDD outdoor water use change over the past decade. This is the outdoor water demand that can be expected to occur once every five years and is based on 10 years of records.



Source: City of Ottawa SCADA database

Note: Average Daily Summer Outdoor Water Demand taken from Mid-May to Mid Sept

Figure 4.4: Seasonal Water Production Trends



Source: City of Ottawa SCADA database

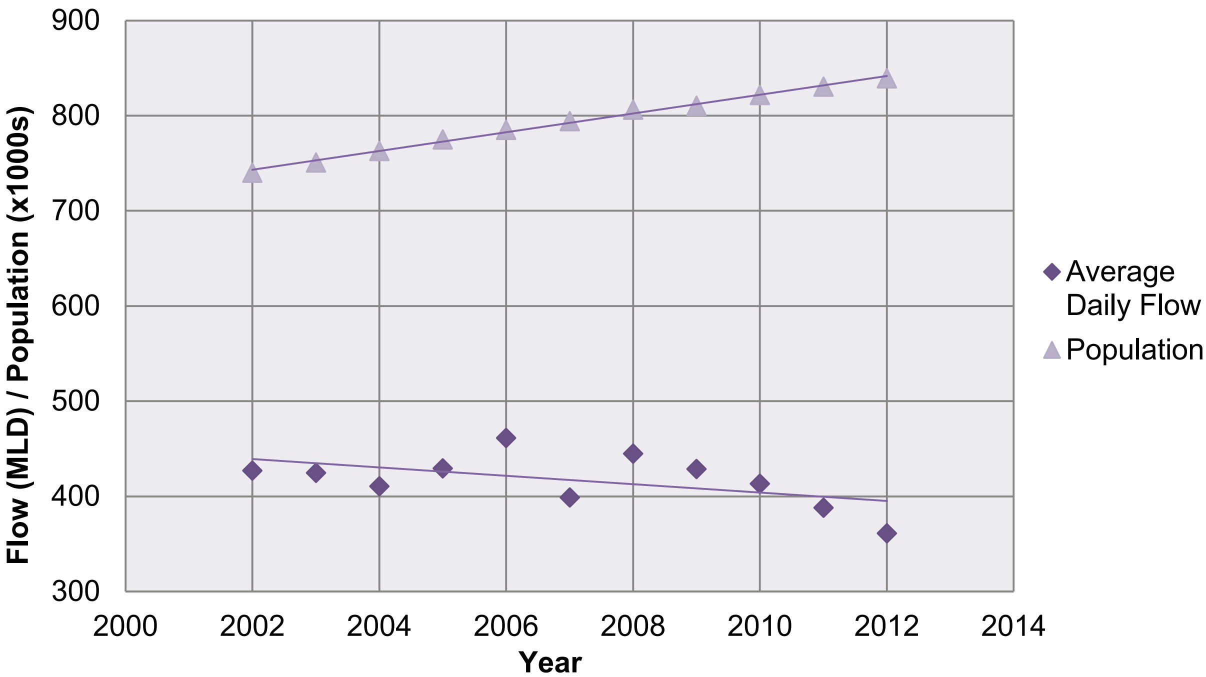
Figure 4.5: Outdoor Water Demand Based on Previous 10 Years

The reduction in water consumption may be attributed to a number of factors including:

- economic reasons such as price of water;
- water efficiency awareness;
- more water efficient fixtures and appliances replacing older models;
- Lower outdoor water demand resulting from less irrigable land being available as a result of higher density development
- Lower occupancy rates (affecting per dwelling unit rates); and
- Reduced leakage due to lifecycle replacement.

4.1.2 Wastewater

Annual average daily wastewater flows monitored at the Robert O. Pickard Environmental Centre (ROPEC) WWTP, generally have been decreasing over the last 10 years as shown in *Figure 4.6*. This is the same effect as found for water demand and is primarily reflective of reduced water consumption. The 360 MLD flow rate monitored in 2012 was the lowest annual average flow observed at ROPEC within the 1986 to 2012 period. Annual average rates exceeding the 440 MLD range generally have occurred during relatively 'wet' years which may be attributed to increased extraneous inflows into the separated collection system and more direct flow to the combined and partially separated sewer systems.

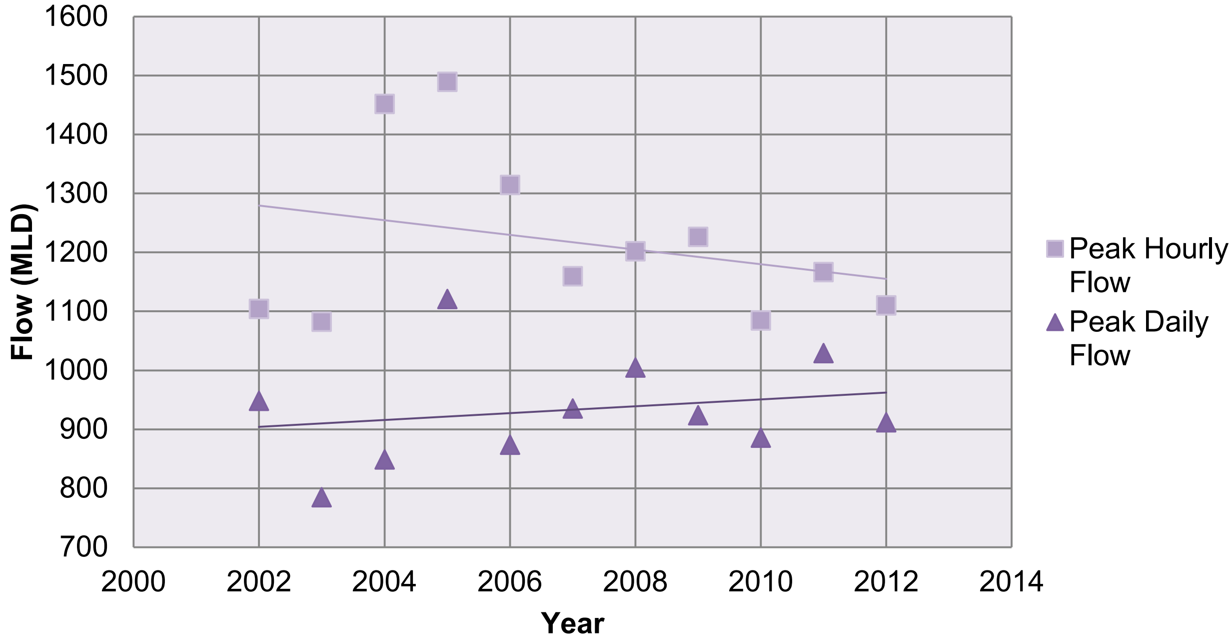


Source: City of Ottawa SCADA database

Figure 4.6: Average Daily Wastewater Flows

Annual peak flow rates to ROPEC occur during periods where non-waste flows such as groundwater infiltration enter the sanitary system via cracks and leaks in the pipe and by direct surface drainage or foundation drain connections to the sanitary sewer. Peak groundwater infiltration typically arises during the spring snow melt season and periods with high rainfall accumulation. Extreme precipitation events exceeding the design capacity of the storm drainage system can cause surface runoff to enter the sanitary sewer network.

Figure 4.7 illustrates the annual peak hour and maximum day (MXDY) flows observed at ROPEC during the 2002 to 2012 period. Approximately 55 % of the annual peak flows observed at ROPEC occurred during the snowmelt period accompanied with precipitation while the remaining occurrences were observed during extreme rainfall events or periods with high antecedent rainfall conditions.



Source: City of Ottawa SCADA database

Figure 4.7: Annual Peak Hour and Peak Day Flows

4.2 Demand and Supply Management

Both supply and demand management are tools the City uses to help maximize the efficient use of infrastructure and minimize the cost of new infrastructure needed to support growth.

Supply management focuses on programs to improve system supply efficiencies thereby minimizing the need for physical infrastructure expansion. A key supply management approach utilized by the City is the Water Loss Reduction Strategy. This Strategy is supported by programs such as the Leak Detection Program, which focuses on the early identification and repair of leaks in the city's water supply.

Demand management refers to encouraging and sometimes regulating efficient behaviors of individuals to reduce consumption to both extend the useful life of existing infrastructure and minimize the size of new infrastructure. Demand management ensures that the expansion of new infrastructure can occur at a slower rate than population growth. Examples of demand management utilized by the City are the Water Efficiency Strategy and the Provincial Plumbing Code requirement for installation of low-flow toilets.

4.2.1 Water Efficiency

In December 2004, the Province adopted the Water Taking Regulation O. Reg. 387/04 under the *Ontario Water Resources Act* that requires that municipalities demonstrate as part of their request for a Water Taking Permit, *"that water conservation is being implemented or is proposed to be implemented in accordance with the best management standards and practices for (the municipal) sector."*

In 2005 the City responded to this regulatory requirement by adopting a 10 year Water Efficiency Strategy (WEfS) with the goal of deferring capital expansion costs for the water infrastructure through the promotion of the efficient use of the water by all to ultimately reduce the wasteful use of water. The goal was to be achieved through the application of the following objectives:

- informing water consumers of the need for water efficiency and how to become water efficient through the use of education programs, popular media and demonstration projects;
- influencing water consumers to reduce consumption, and alter consumptive patterns through partnership initiatives, rebates, and other financial incentives; and;
- directing water consumers to change consumption patterns through judicious use of regulatory and financial tools, as warranted over time.

In 2006, the City developed a three year Water Efficiency Plan (WEfP). Initially, the WEfP focused on promoting water efficiency by reducing peak outdoor water consumption. In fall 2007, the City kicked-off the indoor efficiency program. *Table 4.1* identifies Council approved short-term water efficiency targets.

Table 4.1: Water Efficiency Targets

Parameter	2014	2016
Original Status Quo Maximum Day Projection (megalitres/day)	725	
Revised Status Quo Maximum Day Projection (megalitres/day)	542	550
Original Water Efficiency Target (megalitres/day)	595	
Revised Water Efficiency Target (megalitres/day)	504	511
New Status Quo Gross Per Capita Consumption (litres/day)	271	262
New Water Efficiency Target (litres/day)	264	255
New Status Quo Avg. Residential Per Capita Consumption (litres/day)	177	172
New Water Efficiency Target (litres/day)	168	163

Source: City of Ottawa, Environmental Services Department, Environmental Business Services Branch: Water Efficiency Strategy.

Progress towards these targets will be monitored on a regular basis. As part of the WEfS, reporting was undertaken to document activities and results. Links to the committee reports can be found in *Annex D.2*.

4.2.1.1 Program Success Overview

The results of monitoring production and consumption data indicates that the combination of supply and demand side initiatives being carried out, are yielding positive results, as evidenced by the trends described earlier in *Section 4.1.1*.

MXDY demand is the main driver behind the requirement for expansion of the backbone infrastructure such as the WPPs, pumping stations (PSs), and reservoirs. Reducing per capita demand is a major enabler of smart growth and urban intensification, since population growth may be accommodated using existing infrastructure and services.

Action:

- The City will continue to implement the WefS through their current program and supporting initiatives.

4.2.2 Drinking Water Promotion Program

Promotion of the drinking water supply is needed to maintain confidence in the brand, and to make it the source of choice in the community. Ready access to safe drinking water is essential to life, and the City delivers world-class quality water to a population of approximately 845,000 in the urban area. Despite this, concerns persist about Ottawa's drinking water quality, in part, due to a lack of understanding of the drinking water system and quality control processes. At the other end of the spectrum, there is public demand to make the municipal supply more readily available to people when they are in the community, at public venues and parks. The purpose of the Drinking Water Promotion Program is to address both of these needs in the community.

Action:

- The City will review and determine whether the WEfS and the DWAP can be merged and efficiencies derived.

4.2.3 Water Loss Program

In 2006 the City implemented a Water Loss program. This program was developed to ensure that the City remained progressive, environmentally conscious, and to demonstrate its commitment to best management practices in the area of water use management. The primary areas of focus of the program are to put processes into place to enable accurate water balance tracking and to investigate new technologies and implement new processes to identify and eliminate water losses from the distribution system.

The industry standard key performance indicator in the field of water loss is the Infrastructure Leakage Index (ILI). It compares the ratio of current annual real losses from the water system to the technically lowest level of losses achievable if all leaks that could be found using current technology could be repaired economically. At the outset of the program, the ILI in Ottawa was 5.8. While no timeframe was set, a target ILI of 4.0 was established. Through the implementation of best practices, primarily Active Leakage Control through the use of annual hydrant leak surveys, the target ILI of 4.0 has been achieved and has stabilized over the last two years at 3.7. While this is a marked improvement, a longer term goal of 3.0 has been targeted.

To achieve a lower ILI the City must continue to develop strategies to identify and minimize leakage from the system.

Action:

- The City will continue to support ongoing and new strategies for the water system to reduce water lost due to leakage.

Council approved the development of a Transmission Main Condition Assessment Program. The program is now in place and includes a focus on the investigation of large diameter watermains to assess the condition and risk of potential failures. The assessment strategy includes physical condition assessments and coordinated leakage inspections. Based on industry studies of large diameter leakage inspections conducted worldwide, it is expected that leaks will be identified. These leaks could be an indication of a potential failure and the appropriate risk-based evaluation will be conducted to identify the timing and follow-up actions to be implemented to further minimize water losses from the system.

Action:

- As part of the strategies to reduce water lost to leakage, the City will use leak detection information to assess the potential for failures of large diameter watermains.

4.2.4 Wet Weather Flow Management

Every year, the City undertakes projects that deal with the management of WWFs which affect the wastewater and stormwater collection systems. These can take the form of flooding improvement measures, reduction of CSOs, flow monitoring, sewer inspections and maintenance and removal of extraneous flows that could be consuming capacity of the sewer system.

The WW-IMP was completed in July of 2012 and is one of the 17 projects that make up ORAP. The intent of the plan was to develop and prioritize strategic programs for managing WWFs within the wastewater and stormwater collection systems. The plan focused on the development and prioritization of strategic programs for managing these WWFs. The 2012 WW-IMP was submitted for information to Environment Committee and Council in May of 2013. Along with the CAM program, the WW-IMP is a key component in supporting the objectives of the IMP to confirm capacity for growth in the form of intensification.

The overall objective of the WW-IMP is to recommend a set of initiatives or programs to cost-effectively provide:

- Basement Flood Protection – reduce threats to human health and property damage from flooding;
- Capacity for Growth – reduce infrastructure capacity restrictions that could limit planned growth and intensification; and
- Pollution Control – minimize adverse impacts on water environment from CSOs and sanitary sewer overflows (SSOs).

This overall objective is defined by six core programs, three of which are existing programs which are well established and need little to no modifications:

- Operation and Maintenance Program
- Pollution Prevention and Control Plan (PPCP)
- Sewer Separation, Replacement and Rehabilitation Program

The remaining three programs are new or updated programs which require near term focus:

- Capacity Management Program

- Extraneous Flow Reduction Program
- Flood Control Program

The phases and timeline for completion for the latter three programs is outlined in *Table 4.2*.

Table 4.2: Wet Weather Infrastructure Management Plan – New or Updated Programs

Programs	Phases	Timeline for phase completion
Capacity Management Program	Program Definition Master Planning Master Servicing Capacity Assurance Plan	December 2013 December 2014 June 2016 December 2019 and beyond
Extraneous Flow Reduction Program	Program Definition Study Area Assignments Implementation and Post-Construction Assessment	December 2013 December 2015 December 2019 and beyond
Flood Control Program	Program Definition Study Area Assignments Implementation and Post-Construction Assessment	December 2013 December 2015 December 2019 and beyond

Source: City of Ottawa, Infrastructure Services Department, Asset Management Branch: Wet Weather Infrastructure Master Plan, 2012.
*Subject to available resources

The timelines for implementation of the various measures are noted to be dependent on the availability of resources. Many measures supporting the WW-IMP have been implemented over the years. Funding to support ongoing initiatives is to be identified as part of the annual capital budget process. A main focus of the WW-IMP is improving the integration and coordination that occurs between the different departments to ensure the effective management of WWFs. Ongoing coordination between the above noted programs is also necessary to ensure their long term success. The WW-IMP's integrated governance structure is thus essential to meeting the objectives.

In terms of progress of the WW-IMP, three of the programs (the first three listed in *Table 4.2 above*) have been updated and are considered enhanced programs. Within the Flood Control Program, significant improvements have already been implemented in areas previously impacted by widespread sewer backup and basement flooding occurrences; and within the PPCP, a number of initiatives have been undertaken that have resulted in significant improvements. The implementation progress of the PPCP is being tracked and the management of CSOs is being reported to the Ministry of the Environment (MOE) on an annual basis.

Refer to *Annex D.3* for more information and a link to the WW-IMP.

4.3 Weather Trends

In addition to its overall ecological significance for an area, climate is a major influence on watersheds and their hydrology and on the demand for outdoor water use as well as the amount of water that enters the sewers. For these reasons when designing infrastructure that may be impacted by climate, it is important to understand a region's current climate and how it may be changing over time.

A standard of practice for characterizing climate is to use the past 30 years of record as representative of the climate. This practice is appropriate for understanding the current conditions and responses of existing systems. However, for long term planning for capital assets having a useful life of 100 years, the City must consider the potential variability of climate over a similar extended period.

The analysis in the following sections presents how the use of a 30 year period of record can result in significant variation in actual climate related data used to design infrastructure.

More detailed information concerning weather trends can be found through the synopsis and link to the Characterization of Ottawa's Watersheds in *Annex B.6*.

4.3.1 Ottawa's Seasonality

Ottawa has four distinct seasons that exhibit a large range of temperatures (refer to *Table 4.3*). Fall and spring are transitional seasons, moving from the winter sub-zero average temperatures of -9ºC to moderate summer average temperatures of 19ºC. This range has a major effect on the hydrologic cycle i.e., how water cycles between the atmosphere, the land and water bodies. From an assessment of the change in the ranges of temperature and precipitation in the seasons over time, it is evident that there have been changes. The scope of these changes is discussed in more detail in the following sections.

Table 4.3: Ottawa Seasonal Temperature Ranges (1890 to 2012) in °C

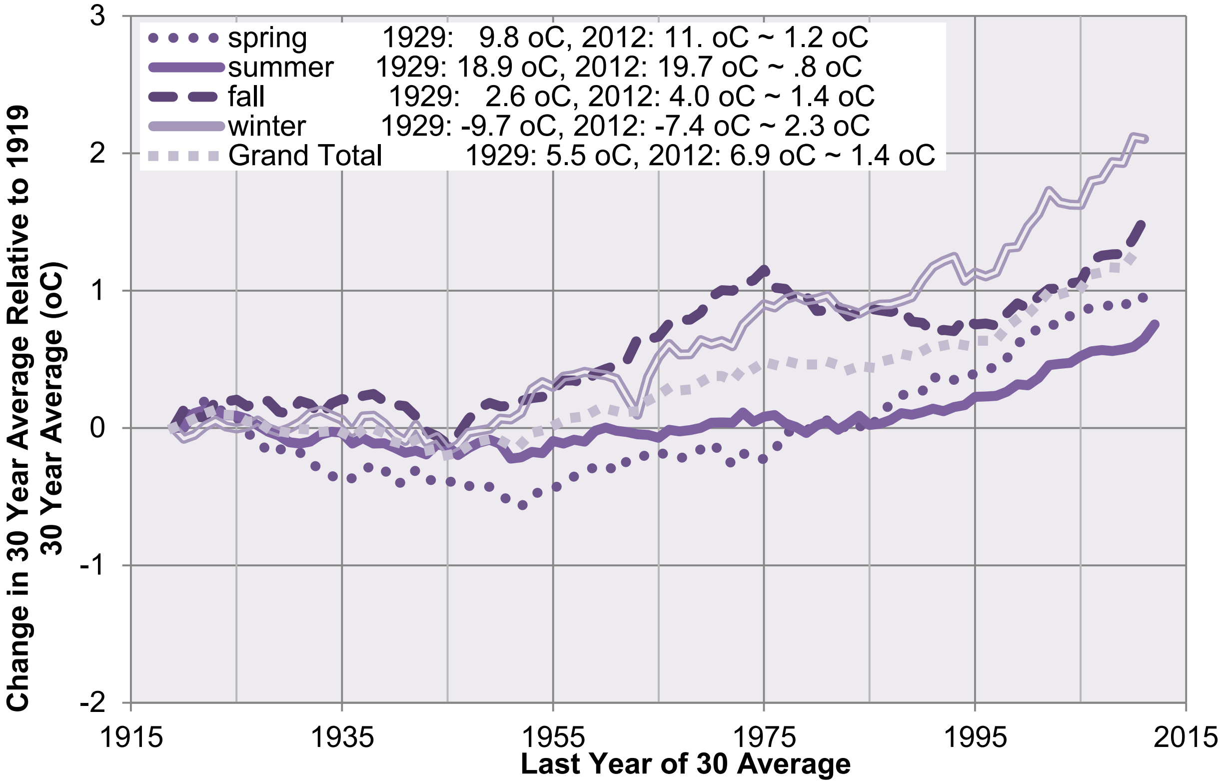
Statistic	Winter	Spring	Summer	Fall
Maximum: Extreme	26	36	38	33
Maximum: Average	-4	16	25	7
Average	-9	10	19	3
Minimum: Average	-14	5	13	-1
Minimum: Extreme	-39	-25	-2	-37

Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

4.3.2 Temperature

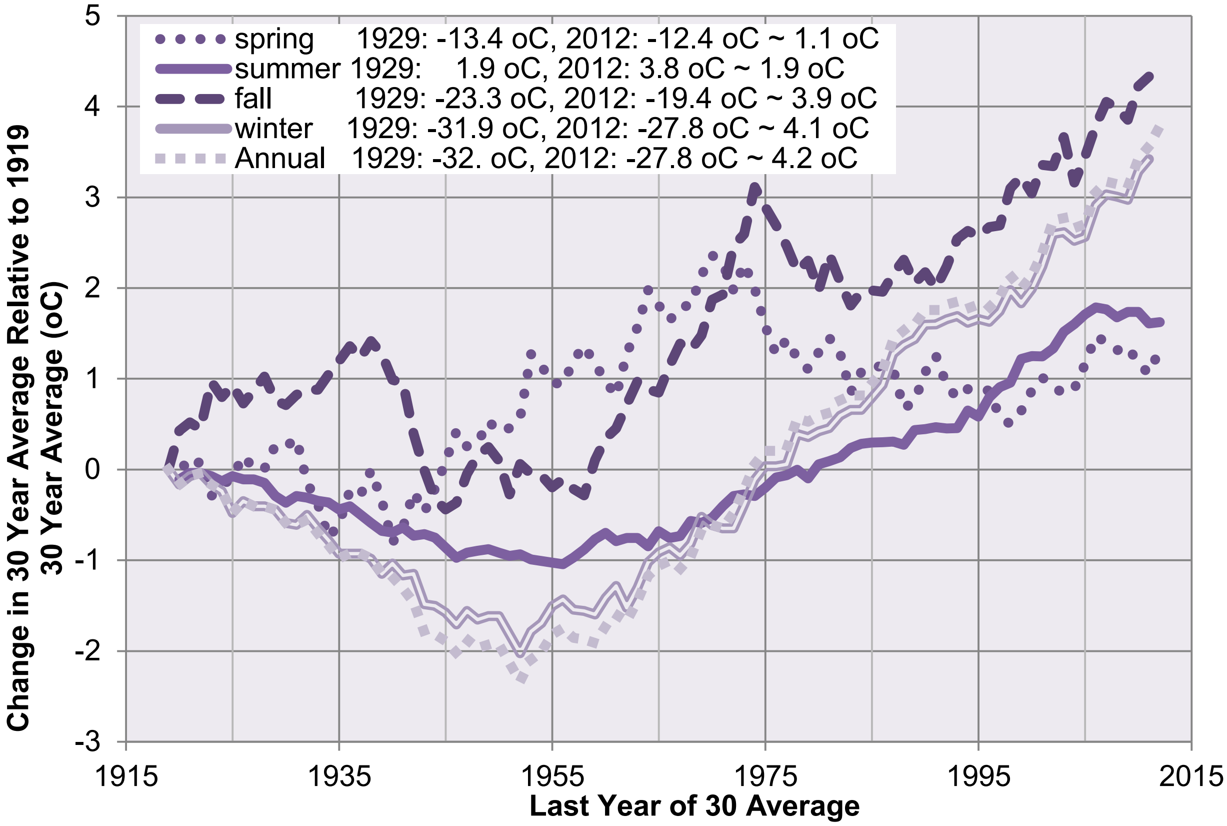
The average annual temperature in Ottawa has changed over the past 110 years. Average annual daily temperature rose about 1.3°C between the mid-1940s and the mid-2010s. Average annual minimum temperature rose 0.2°C during the same period, while average annual maximum temperatures have essentially remained the same.

An analysis of the 30-year moving average of the average seasonal daily average, minimum, and maximum temperatures shows that the average seasonal temperature has been rising for all four seasons since the mid-1940s relative to the reference year 1919. This increase in average seasonal temperatures is a result of an increase in minimum temperatures for all seasons and an increase in maximum temperature for the winter months. Of note, the smallest increase since 1919 in average seasonal temperature is about 0.6°C for summer. The increase in average seasonal temperature for spring and fall is close to 1°C. The greatest increase in average seasonal temperature is for winter at 2°C (refer to *Figure 4.8* to *Figure 4.10*).



Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

Figure 4.8: Change in Average Seasonal Daily Temperature 30-year Average: 1890 through 2012 Relative to 1919 Reference Year

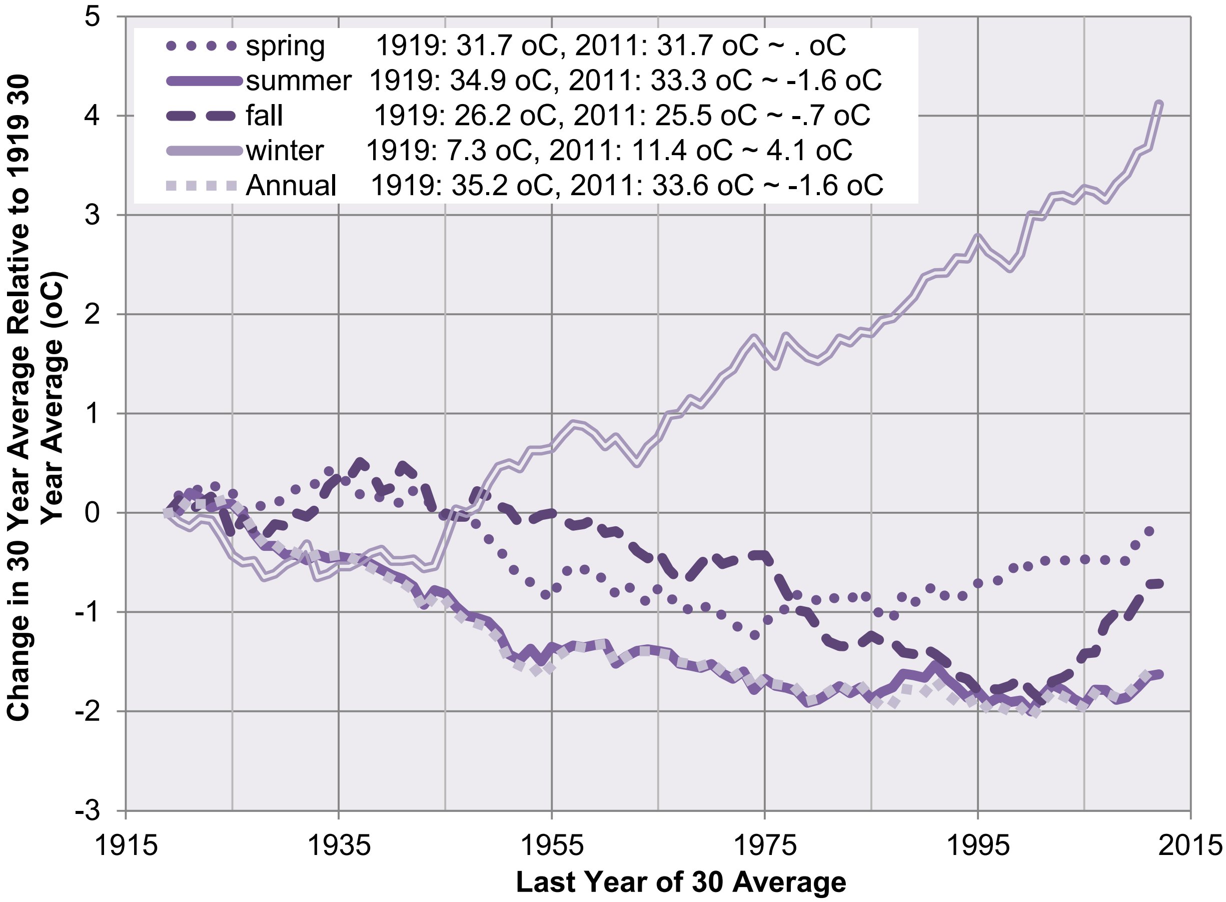


Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

Figure 4.9: Change in Average Seasonal Extreme Minimum Temperature 30-year Average 1890 through 2012 Relative to 1919 Reference Year

These figures show that the seasonal extreme minimum temperatures have all risen since 1919. Fall and winter temperatures are up the most at 4.8°C and 3.1°C respectively. Summer temperatures have risen by 2.2° C and spring minimum temperatures by 1.3° C. On the other hand, the seasonal extreme maximum temperatures have dropped for summer and fall. For spring they have dropped and recovered to no change and have risen for the winter. Winter extreme maximums are up by 3.3 °C, summer extreme maximums are down by 2.0°C, and fall extreme maximums are down by 1.9°C.

From the perspective of temperature, the climate can be described as becoming less cool rather than warmer. All minimum temperatures are increasing while maximum temperatures have only increased in the winter. This trend could result in more frequent occurrence of snowmelt, combined with rainfall during the winter season.



Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

Figure 4.10: Change in Average Seasonal Extreme Maximum Temperature 30-year Average: 1890 through 2012 Relative to 1919 Reference Year

4.3.3 Precipitation

4.3.3.1 Annual Trends

The precipitation data used in this assessment is limited to daily accumulations for the 119-year record. The data does not address the spatial component of rainfall i.e., how much volume falls where, or the relationship between storm volume, duration, and intensity and the resultant effects on the hydrologic response. The trends exhibited by the precipitation data are complex due to the different types of precipitation, e.g. snow vs. rain, as well as the seasonal and annual variability over time.

From *Figure 4.11*, the 30-year median total annual precipitation shows a nominal increasing trend from an 875 mm in 1920, to 920 mm in 2012. However, looking more closely within the nominal increasing trend there are significant variations. The 30-year median annual precipitation shows an increase from 875 mm in 1920, a local maximum of 909 mm in 1952, a low of 822 mm in 1970, and an increase to 922 mm in 2010. The variations within the nominal trend are large enough to provide caution in the interpretation of the overall nominal trend. Note also that the trends should also be considered understanding that there is a large annual variability as evidenced by the precipitation maximum/minimum.

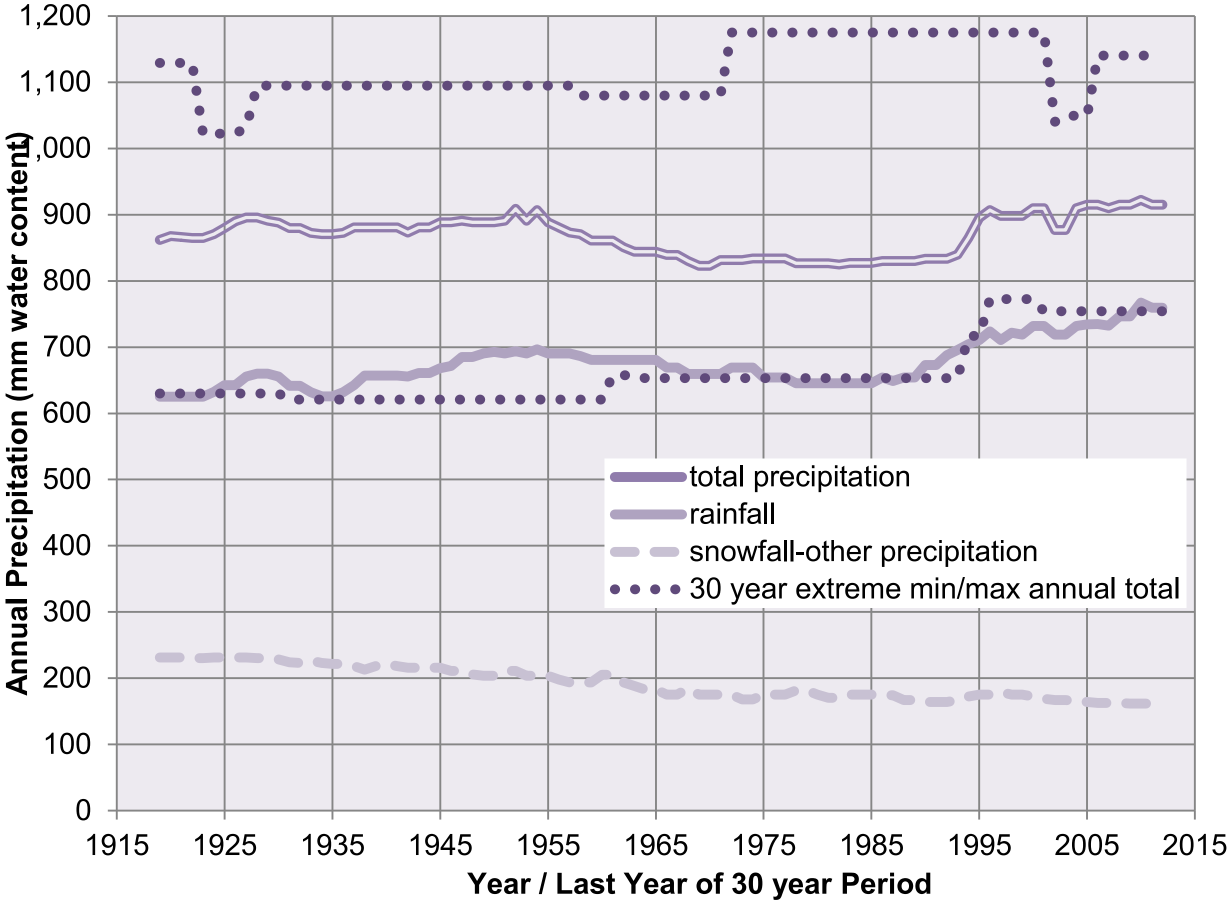
From the 30-year extreme maximum and minimum total precipitation trends there is no clear trend in annual maximum precipitation in the moving 30-year periods, however, the 30-year extreme minimum total precipitation has been increasing. This suggests that while Ottawa recently has had years where 'low water' conditions were a concern, in context of the overall climate the low water conditions are still significantly wetter than 50 to 100 years ago.

In contrast the 30-year median annual snowfall/other precipitation shows a consistent decreasing trend from 240 mm in 1920 to 165 mm (30-year median) in 2012 with the total rainfall, while exhibiting the variations notes present in the total precipitation, also shows a more distinct increasing trend than is evident in the total precipitation. While this diverging trend for snow and rainfall suggests more rain at the expense of snow/other precipitation, seasonal variations discussed below provide an additional context that further explains the decreases in snow/other precipitation. The decrease in snow/other precipitation is largely due to a significant decrease in winter precipitation.

The maximum annual precipitation has been relatively constant around 1,100 mm, with the highest annual precipitation of 1,175 mm occurring in 1972. In contrast, the lowest annual precipitation ranged from 620 to 650 mm between 1890 and 1960, and from 715 to 770 mm between1965 and 2012. The recent low water years of 753 mm in 2001 and 807 mm in 2012 are still significantly higher than the lows seen in the periods up to 1965.

4.3.3.2 Seasonal Trends

The 30-year median seasonal precipitation (*Figure 4.12*) shows pronounced variations over the period of record. All seasons have demonstrated significant change from the early 1930s, where all seasons had roughly 220 mm of precipitation. The 30-year median summer rainfall increased to 255 mm by 1965 and since has oscillated around that level. Winter precipitation has dropped from a level of 215 mm in the 1920s through 1950 down to the current annual level of 160 to 165 mm. The precipitation in the fall and spring has been trending up since the 1960s and 1970s to reach the current annual level of 245 mm.



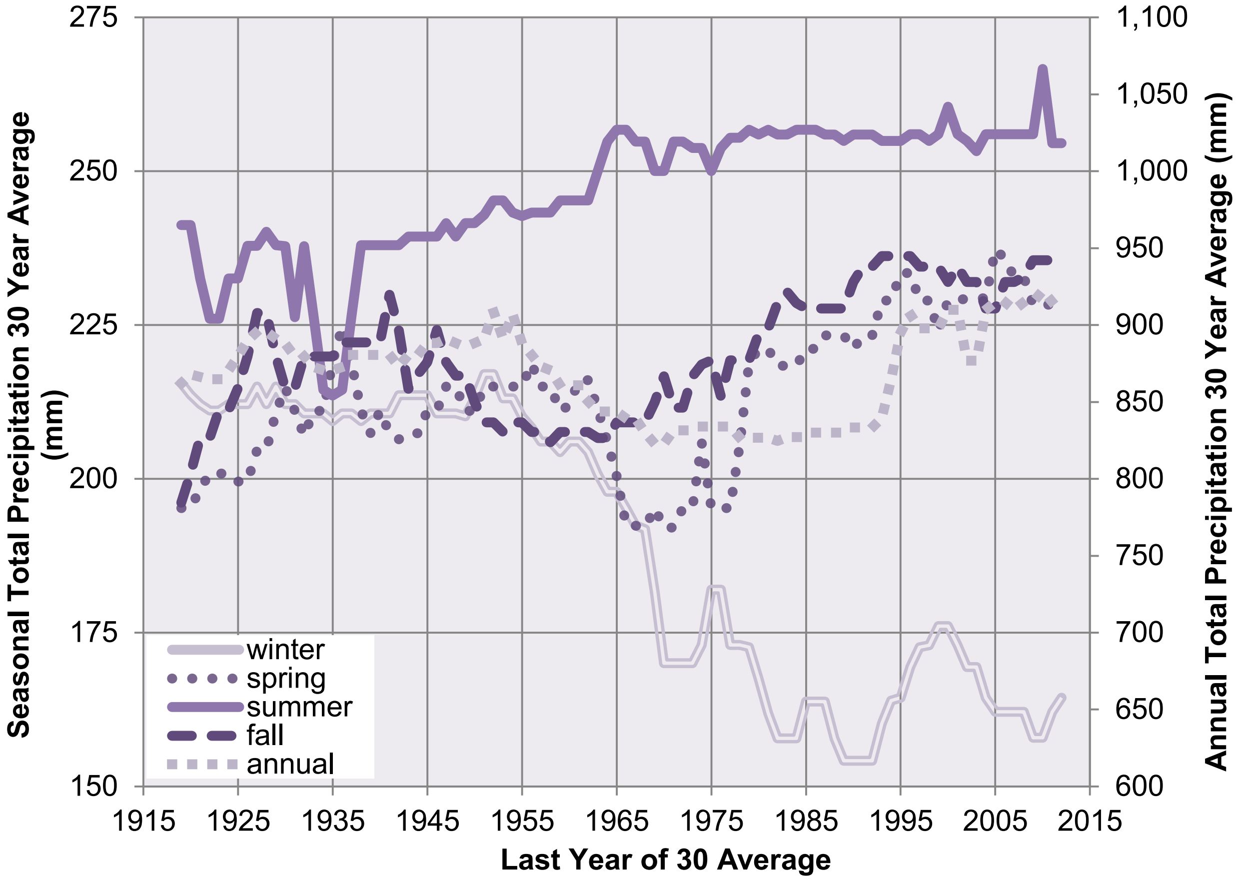
Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

Figure 4.11: Annual Precipitation 30-year Median and Annual Extremes: 1890 through 2012

These identified seasonal trends provide evidence that distribution of precipitation through the year does change over time. Implicit in the seasonal changes are changes in the types of precipitation events with seasonal variations in weather patterns and their associated precipitation events.

4.3.3.3 Use of Trends for Forecasting

From the perspective of precipitation, although there are trends in seasonal and annual precipitation, due to their variability they cannot be used to provide the basis for a future forecast.



Source: Environment Canada: Ottawa CDA (Experimental Farm) Weather Station

Figure 4.12: Change in Seasonal Precipitation 30-year Median: 1890 through 2012 Relative to 1919 Reference Year

4.3.3.4 Other Factors

Multi-day Rainfall Events:

Ranking the multi-day rainfall events provides an estimate of the frequency of occurrence and a simple estimate of return period. Comparison of the distribution of four periods (1890 to 1919, 1920 to 1949, 1950 to 1979 and 1980 to 2012) against the distribution of the full length of record provides an estimate of the changes in the characteristics of events over time. This comparison suggests that the frequent to mid-range events, i.e. a frequency of occurrence of two weeks though five to 10 years, are increasing in magnitude. There is however insufficient information to identify variations in the rare, i.e. 25 to 100 year events.

Extended Wet and Dry Periods:

While most precipitation events only last for a day, the frequency of one-day events has dropped from 53% of events prior to 1919 to 42% of events in the past 30-years. The Ottawa area is experiencing more frequent multi-day precipitation events. The frequency of precipitation events lasting three or more days has increased from 18% to 31%. The time between precipitation events shows some changes with a small increase in the occurrence of a single day between precipitation events and a decrease in occurrence of three days between precipitation events. Over the last 119 years, there has been a 25% to 30% increase in the number of days with some precipitation. Early in the 20th century, the City would have experienced precipitation about 130 days of the year, i.e. every third day in round numbers. The City now gets precipitation about 160 days of the year, i.e. every second day in round numbers.

In summary, the City is experiencing more days with precipitation and more multi-day precipitation events with wetter fall and spring periods. Winters have had less precipitation although the downward trend ended in 1990.

4.3.3.5 Potential Implications for Infrastructure Design

1. Thirty Years of Record may not be Representative of Climate for Infrastructure Design

- The standard of practice of using 30-years of record to define infrastructure design factors may be insufficient for infrastructure with a longer design life, i.e. greater than 20 years. The variation in seasonal and annual temperature and precipitation patterns based on 30-year estimates demonstrates that 30-years does not provide a good representation of climate.

2. Changes in Design Events need to be Considered

- Identified increases in the size of one to 10 year design events means that infrastructure designed 30-years ago based on the previous 30-years precipitation information is likely to provide a lower LOS. This fact is important to consider in areas that may be targeted for intensification.

3. Ottawa is Getting Less Cold

- In terms of temperature the climate is becoming less cool rather than warmer. All minimum temperatures are increasing while maximum temperatures have only increased in the winter. This may have an effect on design considerations such as frost depth.

4. Historical Trends and Forecasting

- The long term trends for temperature should be considered in estimating future conditions.
- However, the long-term trends for precipitation should be used with caution due to the demonstrated variability in seasonal changes.

5. Groundwater Monitoring as an Indicator of Regional Climate Changes

- Groundwater levels are a primary indictor of the local water balance. On-going monitoring of key groundwater wells, including the City's communal system, will provide a data over time that is an indication of climate change regionally.

The overall impact of climate trends on infrastructure is not clearly understood at this time, however the impacts may include sanitary sewers having to convey greater volumes of WWF over a longer time; a lower LOS for storm sewers; and increased erosion in urban streams to name a few examples. There also may be impacts to the expected durability of infrastructure due to greater number of freeze-thaw cycles, and effects of salt to deal with increased icy conditions during winter. A more in-depth review of the vulnerability of infrastructure and design criteria is needed to consider climate change adaptation.

Action:

- The City will periodically review their design guidelines for the water, wastewater and stormwater systems to evaluate potential impacts from climate change and recommend changes as appropriate.

4.4 Infrastructure Design Standards and Guidelines

The City continually reviews and updates design practices and standards to reflect good engineering practice and applied municipal standards. This involves defining design and operating standards and practices to better meet the desired LOS. It is prudent for the City to be continually evaluating their current standards against new technologies and practices as they are developed.

Actions:

- The City will continue to assess and plan infrastructure to provide reliable water, wastewater and stormwater services.
- The City will maintain and regularly update the design, operating, maintenance, materials, construction and tendering standards for infrastructure works and services.
- The City will reference LOS requirements in its design guidelines for water, wastewater and stormwater infrastructure.
- The City will investigate and consider emerging technologies for inclusion in design guidelines, materials specifications, operation and maintenance practices and procedures, construction specifications and life cycle cost recovery models.

4.5 Levels of Service

Assets exist for the purpose of supporting the delivery of a service to residents and businesses of the City. It is therefore important to define the LOS as this becomes the driver for how needs are defined and solutions prioritized. LOS are linked at three levels (Corporate, Customer and Asset (or Technical)) and define reasonable expectations taking into consideration present and future needs over the life cycle of the assets, affordability and risk.

Extreme and emergency operating conditions occur from time to time which reveal weaknesses in the city's infrastructure systems as well as customer's expectations. The LOS for water and sanitary sewer systems generally meets or exceeds industry standards. For SWM the LOS varies with the age of neighborhoods throughout the city as the standards and expectations for stormwater management have changed significantly over time. The LOS provided impacts both the cost of designing/building and maintaining/operating the infrastructure.

The CAM strategy, strives to balance competing objectives of customer service, operational risk, and lifecycle costs. Most of the City's infrastructure was created to support growth as the urban area expanded. Continued investment in infrastructure is required to ensure that it is kept in good working order, and that LOS expectations are still being met. CAM programs will help prioritize these investments and assess the best value for rate payer dollars.

As part of the CAM, the City is seeking to develop a better understanding of customer expectations. A comprehensive study is currently underway which will yield clear definitions and quantified LOS objectives. The results of this study will only be available following the completion of the 2013 IMP and thus will be used to inform and support the next IMP update.

For the purposes of the this IMP update, the City's Technical Advisory Committees for the component master plans that from part of the overall IMP have reviewed key industry standards and LOS objectives that have driven previous iterations of the master plans. Minor revisions to these standards and objectives have been carried out and can be found in the Water Master Plan and Wastewater Master Plan, referenced in *Annex B.1* and *B.2* respectively. The Wastewater Master Plan is presented in a document entitled "Infrastructure Master Plan Wastewater Collection System Assessment, Stantec (September 2013)" which includes all technical analysis needed to support the project recommendations.

Specific policies related to LOS are included in the Infrastructure Policy *Section 2.0*.

4.5.1 Water

Key aspects of customer service related to drinking water supply, and hence LOS, include water quality, operating pressures, fire fighting, and reliability. Design and LOS criteria that drive new infrastructure requirements are described in detail in the 2013 Water Master Plan, referenced in *Annex B.1*. A brief description of LOS considerations is provided below, and further related discussion is provided in *Section 5.0*.

4.5.1.1 Water Quality

Water quality control is provided at the source locations for the City's water supply systems. Sophisticated water purification techniques are used to treat Ottawa River water to drinking water quality standards. Water quality control in the central distribution system is through appropriate disinfection practices at the City's two WPPs. The City monitors water quality in the distribution system, including City owned groundwater wells, to ensure that the public water system meet the Ontario Regulation 169/03 (*Safe Drinking Water Act,* 2002) at all times.

4.5.1.2 Operating Pressures

Operating pressures in the central distribution system depend on pressure zone configuration, local elevation, and the level of water demand at any given time. The

City's 12 main pressure zones are each served by pumping facilities that boost pressures to levels that are appropriate for the range of elevations in each zone. The range of pressure within each zone varies considerably due to topographic variation and system-level demands. Each customer may experience a range in pressure, depending on both system-level and local-level demands. Industry standards related to pressure specify both minimum and maximum pressure targets. In some local areas of the city, these standard pressures may not be achieved. Typically, these local areas of low pressure are at high elevation relative to the surrounding community, are located at the periphery of serviced areas, and/or are limited by the number and character of possible connections to the watermain network. In most cases, there are no cost-effective City infrastructure solutions available to address these situations.

4.5.1.3 Fire Fighting

Local watermains typically operate at maximum capacity when water is drawn from the system for fire fighting purposes, and lower local operating pressures are tolerated during these operations. Fire fighting demands that are evaluated as part of water supply infrastructure design are dependent on factors such as the supply needed to limit property damage, building characteristics, and the proximity of adjacent structures.

4.5.1.4 Reliability

The City is committed to limiting interruptions in the supply of water to infrequent and brief periods of time, as dictated by emergency conditions and local construction projects. A key focus of the City's infrastructure planning process involves the integration of redundancy into the distribution system backbone. The main objective of the redundancy is to maintain near-normal operating pressures in the system during any single major infrastructure failure to supply basic day demands. However, there are circumstances where the City must temporarily place limitations on water use.

Action:

- In emergency situations, the City may place controls on water use if required to maintain a safe water supply to meet basic needs

4.5.2 Wastewater

LOS for the wastewater system is premised on providing safe and reliable collection and conveyance of wastewater through the collection system, while minimizing spills, backups and air emissions. The WWTP must treat the effluent and biosolids to meet provincially and federally regulations and discharge criteria.

The wastewater collection system includes separated sewers (designed to collect sanitary flows only), partially separated sewers (designed to collect dry weather flows (DWF) and some runoff primarily from foundation drains, sump pumps and driveway drains), combined sewers (designed to collect DWF and runoff) and wastewater PSs, reservoirs, odour control facilities and regulators. General LOS, which vary for each of these components of the collection system, are described in the following sections.

4.5.2.1 Level of Service for Separated and Partially Separated Areas

The City requires that new sewers, which are separated, are designed to operate under free flow conditions, i.e. with no surcharge, under peak flow for ultimate development conditions. In partially separated sewer areas with a history of surcharging, the potential impacts from surcharging must be assessed and mitigated.

4.5.2.2 Level of Service for Combined Areas

Combined sewer systems are located in parts of the older developed areas of the city. Their LOS varies with the ability of the individual systems to convey minor system flows, i.e. flows from more frequent rainfall event (typically two to five year events). Where development, including intensification, is proposed in areas serviced by combined sewers, the City may require renewal or upgrade projects to improve, to the extent possible, the LOS in that particular area.

4.5.2.3 Level of Service for Combined Sewer Overflows

Regulated overflows from combined systems are normally permitted without limit during spring runoff. During summer periods however they are provincially regulated to a maximum of two overflows for an average rainfall year. The City has adopted a more stringent compliance approach through ORAP, and is working toward the goal of achieving zero CSOs during the swimming season for the 'design year' (an average rainfall year).

4.5.2.4 Level of Service for Wastewater Pumping Stations

The City has standards and design guidelines for wastewater PSs that factor together operating cost and reliability. For example, the City ensures that stand-by power is provided for all wastewater pumping facilities in order to be able to operate during emergency conditions. The City also requires that safe emergency overflows are provided to mitigate the impacts of a potential PS failure.

4.5.2.5 Level of Service for Wastewater Treatment Plant

The City ensures that final treatment and disposal of treated wastewater at the WWTP meets the required effluent discharge and Biosolids disposal criteria established by the MOE and the Federal government.

4.5.3 Stormwater

The current LOS, provided in areas of the city that developed within the last 20 to 30 years, require that storm drainage collection and treatment systems safely convey runoff from both frequent and more extreme events to the nearest watercourse while mitigating the impacts of urbanization on these receivers (flooding, erosion, impaired water quality). These LOS require that the following design criteria be met for greenfield development (*the term 'greenfield' refers to development of existing un-developed land*):

Collection/conveyance:

- systems designed for dual drainage with a minor system (sewers) that conveys the five year event and a major system that conveys overland flow up to and including the 100 year event; Treatment: facilities designed to avoid increased flooding/erosion and mitigate water quality degradation in receiving watercourses.

In older areas of the city, the LOS vary as does the type of collection system (fully separated, partially separated or combined), depending primarily on the age of the infrastructure and the evolution of LOS over the past several decades. In general, for those areas built before the advent of dual drainage (*combination of major – 100 year and minor – five year capacity systems*) and receiving watercourse requirements, the LOS is typically a minor system with a two or five year capacity, no designed major system and direct discharge of runoff to the receiver with no quality or quantity control.

As existing storm sewers reach the end of their life cycle, it is City policy to upgrade the current LOS where feasible. Flood remediation studies in older areas strive to retrofit dual drainage systems to the extent possible, improving the existing LOS. With respect to receiving watercourses, the City has also started to identify SWM retrofit opportunities in older areas by completing retrofit studies of predominately urban subwatersheds.

Infill and redevelopment can often pose a problem in that there may not be available LOS to protect against basement flooding, therefore, in some situations, the City may require sump pumps to protect basements from flooding, with the onus on the individual property owner to maintain such systems.

4.5.4 Infrastructure Renewal

The CAM program brings together all aspects of assets such as capital requirements for growth, and renewal of existing and future infrastructure. The City has adopted the goal of ensuring funding strategies necessary to sustain a good state of repair for all its assets consistent with providing the required LOS to customers.

In addition to capital investments for water, wastewater and stormwater infrastructure, there are lifecycle costs associated with these assets that are included in the LRFP. As infrastructure ages, expected lifecycle costs become the dominant factor in the overall financial plan for the City. The lifecycle cost includes assessment-design costs, initial construction costs as well as operational, maintenance (including staff costs), and costs associated with rehabilitation/renewal, replacement cost and decommissioning cost. Operations and maintenance needs are often constrained by budget limitation, therefore the City needs to track these needs as more infrastructure is added to better understand resource needs to support sustainable operations and maintenance.

In the past, infrastructure investments focused primarily on the funding needs required to support continued growth. The infrastructure built as a result of the significant growth since the 1950s is reaching a stage where significant investments are needed to renew existing assets.

Over the course of the last two years, the City has tabled LRFPs for growth and renewal of assets for rate and tax supported programs. These plans are renewed every term of Council. As part of these plans, Council approved funding strategies that will allow assets to be maintained in a state of good repair. Council also approved as a policy that infrastructure renewal funding targets be indexed annually to construction inflation. Future LRFPs, renewal funding targets and funding strategies will be informed and updated based on the LOS and asset management plans being developed to support the different service areas.

Actions:

- The City will operate, maintain and renew its infrastructure in a manner consistent with the Comprehensive Asset Management Program
- The City will implement an asset management strategy, based on a financial model that considers life cycle costing, as one component of the City's overall infrastructure management program.
- The City will annually report on the economic value and liability of the City's infrastructure as defined by the financial model