



Sewer Capacity Management Processes Audit

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The City Auditor's Office completes all projects in conformance with the *International Standards for the Professional Practice of Internal Auditing*

Executive Summary

Water Resources (WR) provides the city of Calgary an extensive sanitary system which is delivered over approximately 4,200 km of wastewater mains¹. The city is growing at a rate of approximately 25,000 people per year², and as per The City of Calgary's Framework for Growth and Change over the next five years the City is projected to grow by 118,600 people. "Meeting the needs of a city experiencing unprecedented growth, while keeping pace with increasingly stringent regulatory requirements"³ is an ongoing challenge for Water Resources.

The City's Transit Oriented Development (TOD) initiative will promote higher density developments, which in turn increases the need for greater sewer capacity in the inner city. Given the initial design of an upgrade to a sanitary trunk and construction takes four to five years to complete, an agile planning process is critical to ensure appropriate levels of service to customers. WR implemented new and revised processes to support capacity requirements to meet these growth challenges. The application of these revised planning processes led to the identification of the West Memorial ⁴capacity limitation and the recognition of the importance of robust sanitary capacity assessments.

The Sewer Capacity audit was conducted as part of the approved City Auditor's 2014 Annual Audit Plan. The objective of this audit was to assess the effectiveness of prioritization of sewer projects; communication channels between WR and other business areas that can impact capacity needs; evaluation of design standards; and monitoring of high inflow and infiltration levels in order to successfully mitigate sewer capacity risk. Insufficient sewer capacity poses a high risk to the public's health and safety. It also may cause financial and reputational risks such as developments completed without services or future development restrictions.

WR has proactively implemented enhanced computer modeling procedures over the past 14 years for assessing capacity in the sewer system but in the last 3 years, these procedures have been refined and formally adopted to support improved forecasting and identification of future sewer capacity requirements. We believe there are additional opportunities to further improve resiliency to manage this risk against escalated growth projections.

Based on our scope of review, WR processes for long term planning, capacity assessment and the prioritization of projects were in place and operating to support effective risk management of insufficient sewer capacity. Our testing confirmed the identified capacity upgrades from the modeling process are integrated into the SLRP (Sanitary Long Range Plan). The SLRP identifies the capital investment requirements for the next 10 years but also outlines the infrastructure that Water needs for the next 30 years and beyond.

Our testing of sample sewer upgrade projects noted on an annual basis WR re-prioritize the sewer upgrades projects as per population growth projections. The risk based identification and prioritization of the capital projects are included in the WIIP (Water Infrastructure and Investment Plan).

¹ A network of pipes that collect and transport sewage from residential and non residential entities to the wastewater treatment plant.

² As per the City of Calgary Action Plan 2015-2018

³ UEP's Action Plan 2015-2018

⁴ The west Memorial was the first of the detailed sanitary capacity studies undertaken by WR in which capacity issues were identified.

We determined that WR completes ongoing monitoring of sewer capacity such as monitoring of high inflow and infiltration (I&I) ⁵ areas, as well as completing capacity assessment studies of the sewer districts and conducting current and proposed sanitary sewer systems sufficiency reviews.

Recognizing that forecasted growth will continually place pressure on the management of sewer capacity we raised four recommendations to WR targeted to further enhance resiliency:

- Formalize the SLRP update methodologies; the documented processes will support consistency in the application of SLRP update methodologies in event of staff turnover.
- Document and communicate the rationale including the cost effectiveness and relevance of the City's growth with the current service level investment standard (1 in 50 storm event⁶) to senior management. This initiative will assist senior management to approve a level of service that is consistent with the City's strategy and risk appetite.
- Develop documented procedures for the review of Sanitary Servicing Studies to ensure consistent assessment and approval practices are in place.
- Revise the Water Infrastructure and Investment Plan business case guide to include guidance on processing and approval of the business cases for projects beyond 10 years.

WR's Management has agreed to our recommendations and has indicated in their responses a commitment to implement action plans.

We would like to thank WR staff for their assistance and support throughout this audit.

⁵ Inflow is the rapid flow of storm water into the sanitary sewer system. Infiltration is the gradual downward flow of water from the surface of the earth into the soil and into the wastewater collection system.

⁶ A 50-year storm event refers to rainfall totals that have a two percent probability of occurring at that location in any single year expressed as a one-hour or 24-hour period.

1.0 Background

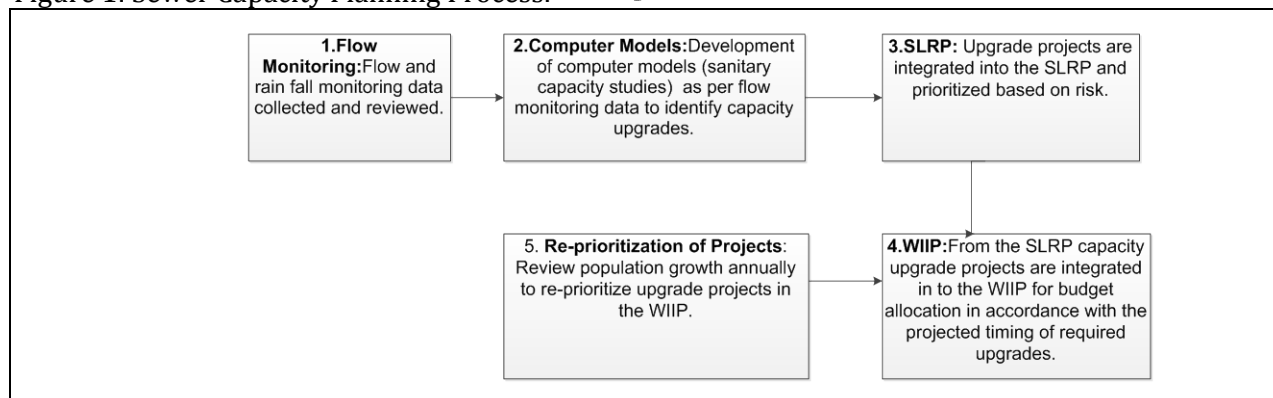
The City of Calgary, growing at a rate of approximately 25,000 people per year provides wastewater services to a population of over 1.1 million. The sanitary network is split into seven districts that feed the Bonnybrook, Fish creek or Pine Creek wastewater treatment plants.

Water Resources (WR) has been using the technology of computer modeling to assess the sanitary system for over ten years. WR has progressively implemented over 100 flow monitoring stations in high risk areas of the city in recent years. The data from these stations is used to develop computer models to identify any sewer capacity constraints. Water Resources uses a level of service criteria of 1 in 50 storm event in hydraulic simulations to assess the existing and future capacity of the sewer system, including capital improvement planning. WR has completed computer models (sanitary capacity studies) for all seven sanitary districts in the city.

The identified capacity upgrades from these studies are integrated into the Sanitary Long Range Plan (SLRP) which focuses on the capital investments for the next 10 years but also outlines the infrastructure that Water needs for the next 30 years and beyond.

From the SLRP, investment plans are developed and incorporated in the Water Infrastructure and Investment Plan (WIIP). However, on an annual basis the city's growth is reviewed and WR may re-prioritize the sewer upgrades and investments. This ensures that areas within the city that experience high growth have adequate sewer capacity. Figure 1 below provides the key elements of the sewer capacity planning process. A more comprehensive process flow chart is provided in Appendix A.

Figure 1: Sewer Capacity Planning Process.



The capacity assessment of sanitary system was limited to smaller catchments in the past. WR initiated changes to effectively plan and monitor sewer capacity for larger sanitary system in the last three years. As a result, a Hydraulic Modeling Guidance Document was prepared by a consultant. The consultant established a consistent framework and approach to computer modeling from conceptualization to documentation. Flow monitoring and data quality processes were enhanced as well to further improve the modeling process.

The West Memorial study finalized in January 2013 was the first of the detailed sanitary capacity studies undertaken by applying modeling procedures and criteria for larger systems, in which capacity issues were identified. In July 2013 Utilities & Environmental Protection reported to Council that certain sections of the West Memorial Trunk are at capacity due a combination of growth and infiltration. WR has completed four additional sanitary capacity studies since the West Memorial study.

2.0 Audit Objectives, Scope & Approach

2.1 Audit Objectives

The objective of this audit was to provide assurance on controls used to manage sewer capacity risk. Specifically the audit assessed the design and effectiveness of controls in place to ensure:

- Wastewater (sewer) projects are adequately prioritized in order to address any capacity constraints in a timely manner;
- Adequate communication exists within Water Resources and between Water Resources and other relevant areas/business units to ensure sewer capacity is being adequately assessed;
- Design standards are adequately evaluated to ensure capacity of new or upgraded sewer infrastructure is built to meet future servicing needs in a cost efficient manner; and
- Areas within the city that have high inflow and infiltration are adequately monitored and addressed.

2.2 Audit Scope and Approach

The audit focused on processes and controls in place to mitigate sewer capacity risk within WR and as such the following areas were excluded from the scope of the audit:

- Infrastructure delivery and construction;
- All linear water systems, all drainage infrastructure and water and wastewater treatment plants; and
- Maintenance of existing WR's infrastructure.

Our comprehensive audit approach included:

- Conducting interviews with management and staff at WR;
- Reviewing documentation for planning, capacity assessment & upgrade projects and the prioritization of sewer infrastructure (SLRP, WIIP, Sanitary District Studies, 2013 and 2014 Annual Suburban Residential Growth Report, Corporate Growth Management Framework: Sequencing of Priority Growth Area 2015-2018;
- Reviewing relevant policies, procedures and guidelines;
- Testing business cases for sewer capacity growth and upgrade projects;
- Testing area structure plans completed in the most recent 12 month period; and
- Testing a risk based population (25% of multi-housing development permits with more than 42 units in the inner city) for the most recent 12 month period to determine if adequate sewer capacity was addressed.

3.0 Results

Our review of current processes, procedures and controls specific to the audit scope determined they were in place and operating effectively to address sewer capacity risk as discussed below.

Flow monitoring data quality is maintained by a contractor in consultation with Water Resources staff. Population data confirmation and validation is completed by using the Geo-Demographic population projections. We confirmed that WR has completed a SLRP. The SLRP incorporated results /recommendation of the Sanitary District Studies based on the flow monitoring data. The

SLRP focuses on the capital investments for the next 10 years but also outlines the infrastructure that WR needs for the next 30 years and beyond.

Recommendations from the SLRP are incorporated into the WIIP and are used to prioritize infrastructure projects. Our testing of a sample of upgrade projects concluded that the upgrades/replacements projects are prioritized based on defined risk criteria. Water incorporates and prioritizes growth changes into the planned projects (WIIP) in alignment with the Growth Management and Change Framework, population projections and area structure plans completed by the Planning, Development and Assessment department.

A business case is prepared and approved for significant projects prior to submitting it for WIIP consideration. We tested 31 business cases (the complete population of growth and upgrade projects) for approval and did not identify any concerns. We noted that the SLRP and WIIP results are then communicated to management and other stakeholders to ensure alignment with the Corporate Framework of Growth and Change and business priorities. The city's growth is reviewed by WR on an annual basis to re-prioritize the long term sewer upgrades and investments projects.

Our testing determined that WR is monitoring high inflow and infiltration (I&I) areas through sanitary district studies to manage sewer surcharge risks in wet weather.

We identified improvements to the sewer capacity planning process, which will allow WR to better manage the planning cycle as the population continues to increase.

A framework to ensure consistency in application of SLRP update methodologies in event of staff turnover is needed. The framework will ensure consistent steps to manage sewer capacity planning effectively in case of staff turnover.

Level of service represents a trade-off between the cost of the infrastructure and risk mitigation in a storm event. Water Resources uses design standards for 1:50 to provide a high level of service. An independent consultant recommended design standards for 1:25 year storm event based upon the analysis of a single catchment area. However, Water Resources continues to use design standards for 1:50 based upon historical practice and the incremental cost of 15% is considered good value for larger pipes.

Approval is required for a level of service that is consistent with The City's strategy and risk appetite. WR needs to document and confirm the business rationale including cost effectiveness and relevance of the city's growth with the current service level investment standard (1 in 50 storm event) to senior management.

WR reviews Sanitary Servicing Studies (SSS) to assess the impact of any development and/or redevelopment that will increase the density of parcel or development area to more than 55 persons per hectare and will be discharging a minimum of 1 liter per second. The proponent of a development has to show that the new development sanitary flows will not severely impact the sewer capacity. The purpose of the SSS is to provide assurance that the current and proposed sanitary sewer systems meet the demands of a new development or redevelopment. To obtain approval the developer must show the new development does not impact sewer capacity.

We tested 13 multi-housing developments to determine if there was adequate sewer capacity. We determined that documented procedures for the SSS are needed to ensure consistent review, approval and record retention practices. The 13 SSS reviews tested had been completed by new staff members under the supervision of WR senior engineers. Therefore, the documented procedures will further strengthen the SSS review process.

An up to date business case guide is required to educate new employees regarding completion and approval of business cases consistently for projects beyond 10 years.

The observations and recommendations were discussed with WR management to facilitate development of management responses.

4.0 Observations and Recommendations

4.1 SLRP Update Process

The Sanitary Long Range Plan (2014) recommended that The City plan to update the SLRP and its Sanitary District Studies (SDS) proactively. Water Resources has an internal tentative plan to update the SLRP in the next 3-5 years.

The methodology/framework to update the SLRP may not be applied consistently in the case of staff turnover. A framework is needed to outline all preparation work such as roles and responsibilities, risk based SDS, cost and risk analysis of service levels, project prioritization in order to facilitate the SLRP update process.

Recommendation 1

The City Auditor's Office recommends that the Manager Infrastructure Planning create a framework to ensure timely completion of all work to update the SLRP. The framework should be based on the following factors:

- Significant variance in population projections;
- Risk based Sanitary District Studies;
- Cost and risk analysis for service level;
- Prioritization of SDS recommendations;
- Higher than expected population growth; and
- Roles and responsibilities and timelines of milestones.

Management Response

Action Plan	Responsibility
The Infrastructure Planning (IP) Division will create a framework for the preparation of sanitary long range plans (SLRP). The framework will be in the form of a guidance document, defining the triggers for updates to the SLRP, the tasks to be performed, governance, roles and responsibilities, and timelines.	<u>Lead:</u> Manager Infrastructure Planning Division, Water Resources <u>Support:</u> IP Divisional subject matter experts <u>Completion Date:</u> 2015 March 31

4.2 Level of Service Business Decision

Water Resources uses a level of service criteria of a 1 in 50 storm event in hydraulic simulations to assess the existing and future capacity of the sewer system, including capital improvement planning.

Level of service represents a trade-off between the cost of the infrastructure and risk mitigation in a storm event. Analysis of these trade-offs has not been formerly documented and confirmed with Senior Management within Water Resources with the exception of the cost analysis for the West Memorial catchment.

Failing to document and communicate the trade-offs associated with the different service levels make it more difficult for Senior Management to allocate resources in accordance with The City's risk tolerance. This may result in The City being inefficient (too much capacity) or ineffective (inadequate capacity) in addressing risks associated with sewer capacity.

Recommendation 2

The City Auditor's Office recommends that the Manager Infrastructure Planning document and confirm the rationale including cost effectiveness and relevance of the city's growth with the current service level investment standard (1 in 50 storm event) to Senior Management. Further, the Water Resources Management team endorse a level of service that is consistent with their strategy and risk appetite.

Management Response

Action Plan	Responsibility
<p>The Infrastructure Planning Division will prepare a report to the Water Management Team (WMT) detailing the level of service and planning criteria used for sanitary capacity assessments and planning, for endorsement by WMT.</p> <p>The SLRP Framework (under Recommendation 1 above) will include the review of service level investment standards and planning criteria. The communication and endorsement will also be incorporated in the framework.</p>	<p><u>Lead:</u> Manager Infrastructure Planning Division, Water Resources</p> <p><u>Support:</u> IP Divisional subject matter experts</p> <p><u>Completion Date:</u> 2015 February 28</p>

4.3 Sanitary Servicing Studies

As a pre condition of development approval, WR assesses the impact of any development/redevelopment that may increase the density of a parcel or development area. The proponent of a development has to show that the new development sanitary flows will not severely impact the sewer capacity.

We extracted 241 multi-housing development permits issued in the last 12 months. Next, we selected the multi housing permits with more than 42 dwellings since it represents the top 25% of multi-family developments across the city. For our testing we used a risk based sample. We tested properties with more than 42 units located in the Inner City or City Center / Beltline neighbourhoods. This gave us development permits for 13 addresses. This approach allowed us to focus on the highest risk permits, since these are the developments with the highest densities, located in areas where the infrastructure was not originally built for this development.

We determined four SSS (out of 13) were approved by a trainee rotational staff member. We determined that WR does not have any documented procedures for review, approval and record retention of the SSS. Inconsistent practices could lead to developments being approved with insufficient capacity. However, work is performed under the supervision of the Leader Development Approvals.

We also noticed that record management for the SSS review process (intake/review/signoff) process is not consistent and efficient. The Leader Development Approvals indicated that WR is planning to establish a workflow including documented procedures to have an automated SSS intake, review, signoff and record retention process in the Development Approvals Management System.

Recommendation 3

The City Auditor's Office recommends that the Leader Development Approvals create documented procedures for the review of SSS to ensure consistent review, approval and record retention practices.

Management Response

Action Plan	Responsibility
<p>The Infrastructure Planning (IP) Division will create a guidance document outlining the process to be followed when reviewing Sanitary Servicing Studies, including key standards and requirements. The guidance will also reinforce the record retention practices to be followed.</p> <p>The guidance document will be included in the training of new staff in the Development Approvals Section of Infrastructure Planning.</p>	<p><u>Lead:</u> Manager Infrastructure Planning Division, Water Resources</p> <p><u>Support:</u> IP Divisional subject matter experts</p> <p><u>Completion Date:</u> 2015 February 28</p>

4.4 Business Case Guide Update

Recommendations from the SLRP are incorporated into the WIIP and are used to prioritize pipe replacement. The upgrades and replacement projects are prioritized based on risk.

A business case is prepared and approved for significant projects prior to submitting it for WIIP consideration. We examined 31 business cases for sanitary upgrade and growth projects. The capital budget details are mandatory for approval of a business case as per The WIIP's Business Case Guide. We determined that projects beyond 10 years (8 out of 31) were approved without the total capital budget details. Further testing confirmed that the projects beyond 10 years are included in the WIIP for identification and prioritization reasons. However, inconsistent processes like these may lead to confusion and inefficiencies. An up to date business case guide would ensure consistent processing and approval practices of business cases.

Recommendation 4

The City Auditor's Office recommends that the Manager Strategic Services update the WIIP Business Case Guide for instructions regarding completion and approval of the business cases for projects beyond 10 years to prevent process inconsistencies.

Management Response

Action Plan	Responsibility
<p>The Infrastructure Planning Division will expand the WIIP Business Case database to capture infrastructure needs, defined as infrastructure required beyond the 10 years of the Water Infrastructure Investment Plan (WIIP).</p> <p>The Strategic Services Division will update the WIIP Business Case Guide to include instruction on the completion of <i>infrastructure needs</i>, as well as instructions to transfer the needs into a full business case when an infrastructure project moves into the 10 year WIIP timeframe.</p>	<p><u>Lead:</u> Manager Strategic Services (SS) Division, Water Resources</p> <p><u>Support:</u> SS and IP Divisional subject matter experts</p> <p><u>Completion Date:</u> 2015 February 28</p>

Appendix A:

