AN ADAPTIVE MANAGEMENT STRATEGY TO ADDRESS BASEMENT FLOODING

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Presentation Overview

• City of Toronto Water Infrastructure – Background
• Climate Change Effects
• Impacts From Recent Extreme Storm Event
• Basement Flooding Causes
• City-Wide Work Plan – Overview
• Basement Flooding Protection Strategy
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# Inventory of Assets

**Replacement Value of ~ $26.6 Billion**

<table>
<thead>
<tr>
<th>WATER - $8.7 Billion</th>
<th>WASTEWATER - $17.9 Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 water filtration plants</td>
<td></td>
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<tr>
<td>5,015 km of distribution watermains, 510 km of trunk watermains</td>
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<tr>
<td>18 pumping stations</td>
<td></td>
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<tr>
<td>14 storage reservoirs</td>
<td></td>
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<tr>
<td>470,202 water service connections, plus York Region (population served 400,000)</td>
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<tr>
<td>4 wastewater treatment plants</td>
<td></td>
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<tr>
<td>4,397km of sanitary, 1,301km of combined and 358km of trunk sewer</td>
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<tr>
<td>4,305 km of storm sewers and 546km of roadside ditches</td>
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<tr>
<td>371km of watercourses,</td>
<td></td>
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<tr>
<td>43 stormwater management ponds</td>
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<tr>
<td>2,300 sewer outfalls</td>
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Sewer Construction History

Year

Percentage of Total Sewer Infrastructure

“State of Good Repair”

Addressing Toronto Water’s state of good repair needs

Program Renewal Needs

SOGR Budget Proposed

Sewer Pipes by Age

- < 50 Yrs Old: 77.7%
- 50-80 Yrs Old: 15.0%
- 80-100 Yrs Old: 4.5%
- > 100 Yrs Old: 2.8%
WATERMAIN CONSTRUCTION HISTORY (1858-1900)

City of Toronto Watermains: Years of Installation

Legend
- Green: 1861 - 1900
- Red: 1858 - 1880
- Roads

km

0  2.5  5  10
WATERMAIN CONSTRUCTION HISTORY
(1858-1940)

City of Toronto Watermains: Years of Installation

Legend
- 1858 - 1889
- 1881 - 1900
- 1901 - 1920
- 1921 - 1940
- Roads
WATERMAIN CONSTRUCTION HISTORY
(1858-2000)

City of Toronto Watermains: Years of Installation

Legend:
- 1981 - 2000
- 1961 - 1990
- 1941 - 1960
- 1921 - 1940
- 1901 - 1920
- 1881 - 1900
- 1858 - 1880
- Roads

0 2.5 5 10 km
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The Effects of Climate Change

• There is confidence in our ability to forecast global warming trends/projections on air temperature.

• Increased open water evaporation expected as a result of warmer water temperatures: likely to affect future lake levels.

• Less certain about effects on precipitation.
The Effects of Climate Change

- Evidence suggests that intensity of rainfall events may increase, as a result of increases in “precipitable water” content of the atmosphere:
  - increased flooding risks
  - increased stream erosion

- Evidence leading to suggest substantial changes in seasonal distribution of flows and extremes:
  - high and low flow conditions
  - greater winter runoff
  - reduced summer flows
Are We Seeing the Effects?

North York area of Toronto

- 8 extreme events over 20 year period
- storm return frequencies > 25 years
- severe flooding: surface and basement
- works designed and implemented for a given storm condition - insufficient for larger/subsequent event
- public confidence?
Design Standards?

• Municipal Operations: service delivery focus

• Adapt:
  - change design thresholds?
  - change/alter service delivery expectations?
  - reduce infiltration/inflow (I/I) to sanitary sewer systems to the degree practical
  - joint responsibility (e.g. Homeowner: lot grading)

• Considerations in implementing changes:
  - increase sizing of storm sewers for minor system design?
  - what about areas without a major system (overland flow) design?

• Rebuild system/s &, if so, when & how?
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Impacts of August 19, 2005 Storm

- Storm lasted 2-3 hours
- Exceeded 1 in 100 year storm in north part of the City (Highway 401 to Steeles Avenue corridor)
- City of Toronto rain gauge station recorded 153 millimetres (6 inches)
August 19 – 3:00 pm
August 19 – 3:30 pm
August 19 – 4:30 pm
August 19 – 5:30 pm
August 19 – 6:10 pm
August 19 – 6:30 pm
August 19 – 7:30 pm
Rain Gauge Data
(August 19, 2005)
Rainfall Comparison

- Design
- May-00
- Aug-05

Rainfall (max 3 hr mm)

[Bar chart showing rainfall comparison between Design, May-00, and Aug-05]
Insurance Bureau of Canada

- most expensive natural disaster in Ontario history
- expected to pay out more than $400 million
- impact from Kitchener to Toronto to Durham & beyond
- vast majority of claims for sewer back-ups

![Recent Canadian Natural Disasters](http://insurance-canada.ca/consinfohome/IBC-Ontario-storm-509.php)
Damage Summary

- Flash floods of creeks, rivers and ravines
- Overflowed stream banks
- Watercourse bank erosion
- Damage to public and private infrastructure and property
- Sewer Backups
Steeles Avenue @ Bathurst St
(Finch Avenue at Black Creek)
Highland Creek
WWFM Guideline
Rollout February 2007

1939 Highland Creek Centre Line

1978 Highland Creek Centre Line

2005 Highland Creek Centre Line

Ellesmere Rd

Trunk Sanitary Sewer
August 19, 2005
(48” Trunk Sanitary Sewer Collapse)
August 19, 2005
(Exposed Sections of 48” Trunk Sanitary Sewer)
Basement Flooding
Basement Flooding
(Over 4,200 complaints received)
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General Observations

- Sewer system performs as designed ("normal" storm conditions)

- During extreme storms:
  a) sanitary sewer system overloaded
  b) surface flooding onto private property
Causes of Basement Flooding

- Blocked street catch basin
- Flooded street
- Downspout to storm sewer
- Weeping Tile to sanitary or storm sewer
- Cracked MH or sewer
- Leaky laterals
- Blockage in sewer or house lateral
- Surface water through MH top
- Cracked Sewer
- Sewer Blockage
- Sewer Protrusion
- Reverse-slope Driveway
- Poor Lot Grading
- Cracked Basement Wall
- Surface Water Into Basement
  - Poor lot drainage
  - Eavestrough overflow
  - Plugged downspout
  - Leaky windows & doors
Sanitary Sewer System

Sources of high flows to sanitary sewers:

– Foundation drains
– Joints and pipe connections
– Broken pipes
– Cracks in the sewer system and maintenance holes
– Holes in maintenance covers (low areas)
– Stormwater-flooded basement (floor drain)
Surface Flooding

- Many low-points create ponding
- No outlet for extreme flooding
- Water backs onto private property
- Water enters basement:
  - cracks in the basement walls
  - doors
  - window wells
  - reverse-sloped driveways
- Poor lot grading
- Downspouts connected to sewer system
Lot Level Problems
General Surface Conditions of Ward 23
Under extreme events & once sewer capacity is reached, if no overland outlet, ponding will occur on the surface
General Surface Conditions of Ward 23

Patricia Ave.
Overland Flow Paths

Peckham Ave.

Homewood Ave.

Patricia Ave.

Cactus Ave.
Street Flooding Animation
Basement Flooding Animation
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City-Wide Work Plan

• Approved by Council in April 2006

• 31 Priority Study Areas Identified:
  - Investigations to take place over 6 year period

• Required to follow the Class Environmental Assessment (EA) for storm drainage & sanitary sewer system improvements

• Design Standards approved:
  – Sanitary Sewer back-up protection for the May 2000 storm
  – Upgrade storm drainage system to “New Development” standards: 100 year storm
Short-term Preventive Measures

• In short-term, the following measures are (or have been) being undertaken:
  – Closed circuit television camera inspection and corrective action taken
  – Sewer cleaning in areas hardest hit
  – Promotion of city programs to assist residents implementing preventive measures
    • Basement Flooding Protection Subsidy Program
    • Downspout Disconnection
    • Blocked Drain Program
Basement Flooding Protection Subsidy Program

- Provides financial subsidies (up to $3200) to help isolate home from City’s sewer systems & prevent basement flooding:
  - sewer service connection severing & capping
  - downspout disconnection
  - sump pump
  - backflow valve
  - low uptake!
Class EA Studies

- Studies involve a detailed analysis, consisting of:
  - Flow monitoring
  - Developing and calibrating computer modes of the sanitary, storm, and overland drainage systems
  - CCTV inspection of sewers
  - Die and smoke testing to identify defects in system
  - Separate meetings with Councillors, public, affected City divisions (e.g., Parks, Transportation) and review agencies (e.g., TRCA) at key stages
  - Assessment and evaluation of a range of alternatives
  - Documentation of recommended solutions
  - 30-day public review period
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Adaptive Management Approach Advocated

- Lot Level Controls
- Sanitary Sewer System Improvements – as necessary
- Inlet Controls on Storm Sewer System
- Provision of Overland Flow Control and/or Storage, as feasible
- Prioritization of Construction of System Improvements
Basement Flooding Protection Strategy

Lot Level Controls

• Downspout Disconnection
• Proper Lot Grading
• Installation of Backwater Valves on Sanitary Laterals
• Capping off of Storm Laterals & Installation of Sump Pump
• Repairing Cracks in Foundation Walls & Sealing Window Wells
• Covering Basement Stairwells
• Disconnecting “illegal” Sanitary Sewer Connections

• PUBLIC EDUCATION!
Basement Flooding Protection Strategy

Surface Flow Controls

- Catchbasin Inlet Control
- Increased No. of Catchbasins
- Sealing Maintenance Hole Covers
- Surface Flow Path Diversion

Involves:
- Minimal effort and time to implement
- Will control excess stormwater from overloading the sewer system

TORONTO Water
Basement Flooding Protection Strategy

Pipe Conveyance Controls (Storm and Sanitary)

- Increasing Sewer Pipe Size
- Relief Sewer (Twinning)
- High Level Relief Storm Sewer

Involves
- Road excavation within City limits
- Removal of old sewer and structures
- Disconnection of sewer service line
- Placement of new sewer and structures
- Reconnection of to new sewer
- Restoration of road and boulevard
Basement Flooding Protection Strategy

Storage for Sanitary and Storm

- Offline and online underground storage tanks
- Dry Pond

Involves

- Facilities to be constructed in existing Parks or open spaces
- Temporary loss of open space and/or traffic disruptions
- Excavation and placement of storage elements
- Landscaping opportunities
Implementation Considerations

• Preliminary analysis of 4 study areas:
  - over 200 infrastructure improvement projects
  - ~$240M

• City-wide: several hundred $Millions

• Approved 2008-2012 Capital Budget only ~$80 million

• Apply a phased-in implementation schedule
Implementation Considerations (Cont’d)

First Priority:

- Sanitary sewer improvements as identified by modelling

- Storm drainage system improvements where:
  - More than “X” properties affected
  - “Cost per benefiting property” is “$X” or less?

- Extend mandatory downspout disconnection program, City-wide

- Amend By-Laws/Requirements:
  - Backwater valves for all new developments
  - Banning construction of reverse slope driveways

- Public Education Campaign: Opportunity to work with IBC?
Implementation Considerations (Cont’d)

• Longer implementation schedule for remaining projects:
  - high “cost to benefiting property” ratio
  - only used during “extreme” storm events
  - implement through City’s longer term infrastructure renewal programs (ie. roads and sewers)

• Apply adaptive management approach City-wide:
  - incorporate elements of Basement Flooding Protection Strategy, in areas prone to flooding, or have history of flooding complaints, in coordination with infrastructure renewal
Next Steps

• Finalize Class EA documents and reports
• Report to Committee/Council on update of work completed to date & recommendations on implementation of Basement Flooding Protection Strategy
Comments/Thoughts?

• What can we do to increase public awareness of the issue & the need to undertake lot level improvements?

• How can we work together on a Public Education Campaign?

• Comments on criteria proposed for selecting high priority projects:
  - Benefiting large clusters of properties
  - “Cost per benefiting property” concept?

• Comments on longer term phased-in approach for the “high cost to benefit” projects?

• Longer term adaptive management strategy, as we renew infrastructure?
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