INFLOW & INFILTRATION REDUCTION PROGRAM

September, 2010

INFLOW / INFILTRATION REDUCTION STRATEGY
INDUSTRY BEST IN CLASS REVIEW

York Region

The Regional Municipality of York, 17250 Yonge Street, Newmarket, ON, L3Y 6Z1

AURORA · East Gwillimbury · Town of Georgina · Markham · Newmarket · Richmond Hill · Vaughan · Town of Whitchurch-Stouffville

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The following have contributed to the preparation of the Inflow and Infiltration Reduction Strategy Best in Class Review:

Project Advisors

York Region Contributing Staff

Tracey Carrigan, Manager Environmental Education and Promotion
Sabrina Botham, Senior Document Specialist

Consulting Contributing Staff

AECOM Canada Ltd.

Editing services provided by

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1. Executive Summary

The Regional Municipality of York (the **Region**) is one of ten regional, "upper tier" municipalities in Ontario. There are nine local area, or "lower tier", municipalities in York Region: the City of Vaughan, the Towns of Aurora, East Gwillimbury, Georgina, Markham, Newmarket, Richmond Hill, Whitchurch-Stouffville, and the Township of King.

Wastewater servicing within York Region is multi-jurisdictional based on the Region's location and two-tier municipal governance structure.

Responsibility for wastewater servicing in the Region is similarly divided between the municipalities, which are responsible for local wastewater collection and local pumping, and the Region, which is responsible for major pumping stations, trunk sewers and treatment facilities.

York Region's wastewater system is also divided into two distinct service areas:

The York-Durham Sewage System (YDSS), which serves York Region's larger urban communities; and, The individual systems serving the smaller communities, located mainly in the northern and central parts of the Region.

The local municipalities provide direct collection and management of the local system flow. In addition, private property owners are responsible for laterals within their properties to the connection point of the municipal lateral.

Due to the nature of the wastewater collection system, it is estimated that over 95% of the total flows within the Region's trunk system originate from within the member municipalities.

Reducing I/I has been an integral part of servicing considerations of the Region since the first Water and Wastewater Master Plan was developed in 1997. Inflow and Infiltration reduction efforts were stepped up in 2007 with a Regional commitment of $23 million in the 10 year capital plan to study and implement pilot remediation projects in both Regional and Local Municipal systems.

The **Southeast Collector Trunk Sewer (SEC)** is a critical component of the YDSS that conveys wastewater flows from York and Durham Regions to the Duffin Creek Water Pollution Control Plant in the City of Pickering.

Future upgrades of the SEC involve the construction of a 15 km tunnelled sanitary trunk sewer from Box Grove in the Town of Markham in the Regional Municipality of York, to the intersection of Finch Avenue and Valley Farm Road in the City of Pickering, in the Regional Municipality of Durham. This capital project is vital to service approved growth to the year 2031. On March 31, 2010 the Minister of the Environment approved the Individual Environmental Assessment (IEA) for the project and imposed a series of conditions on the recommended solution.

Section 8 of the Minister's Conditions of Approval for the SEC refers to Water Efficiency and Inflow and Infiltration (I/I) Reduction Monitoring. Condition 8.1 of the "Notice to Proceed with the Undertaking" specifies that a *Water Conservation and Efficiency Strategy* **(Strategy)** for water and wastewater flows

to the SEC be prepared. The Strategy is to include *"targets for conservation, efficiency, inflow and infiltration reduction to the SEC and timelines for achieving the targets, as well as the strategies, tactics, programs and initiatives to be used, including the cost to implement these".*

Under Section 8.2 of the Conditions, the Region is required to develop an *Inflow and Infiltration Reduction Strategy* (the **Strategy**) which by condition "*shall include a program for the reduction of inflow and infiltration by the Regional Municipality of York to the SEC from its and its lower tier municipalities' sewage systems. This program shall include reduction priorities, targets, timelines, tactics and initiatives, and the associated costs to implement these*."

Section 8.4 of the Minister's conditions requires that the Region complete a review of **"Best in Class"** Inflow and Infiltration reduction programs including initiatives, strategies and tactics adopted by other jurisdictions.

The Strategy will be developed to align with the specific conditions (Condition 8) set out by the Ontario Ministry of the Environment's approval of the SEC Individual Environmental Assessment in light of the findings of the Best in Class Review.

A comprehensive research study and a review of 16 International and North American agencies were conducted. The selected agencies shared similar problems and approaches to the Inflow and Infiltration as experienced within York Region. Each agency had well documented components of a strategy, a similar governance structure, were considered progressive in flow reduction and had similar goals and objectives to the Regional program.

Of the 16 agencies where the highest level of research was completed, 4 were International (Greater Dublin – Ireland, Mullumbimby-Australia, Auckland – New Zealand and North Shore City –New Zealand), 5 were Canadian (Metro Vancouver and Capital Regional District -British Columbia, Halifax Regional Municipality- Nova Scotia and the Region of Niagara and Region of Waterloo in Ontario), with the remaining 7 from the United States (Metropolitan Council, St. Paul Minnesota , Western Lake Superior Sanitary District (WLSSD), Renewable Water Resources, South Carolina, Milwaukee Metropolitan Sewerage District, Wisconsin King County, Washington Metropolitan Sewer District of Greater Cincinnati and Massachusetts Water Resources Authority (MWRA).

Based on the industry review, the Region was able to develop a program and activity matrix which summarised the key components to be incorporated within the I/I Strategy.

The key areas of the practice scan included the following:
Program strategy and origin,
program management/governance structure,
Program goals and objectives,
Statutory regulations,
Sanitary sewage system knowledge,
Data and information management,
Audit and measure methodologies
Program tracking and reporting
Private side flow management,
Program management,
Public education and outreach programs.

Section 4.2 of this report describes some of the key findings and opportunities that were documented as a result of the practice scan. The Best in Class scan played a key role in developing the I/I Reduction Strategy document and in particular meeting Condition 8.4 of the Minister's condition. The knowledge gained through this research will be used in the development of the Strategy.

York has also recognized that in order to stay abreast of new technologies and approaches an update of this report in the future would be beneficial.

2. Introduction

The Regional Municipality of York (the "Region") Southeast Collector (SEC) project involves construction of a 15 km tunnelled sanitary trunk sewer from Box Grove in the Town of Markham in the Regional Municipality of York, to the intersection of Finch Avenue and Valley Farm Road in the City of Pickering, in the Regional Municipality of Durham. This capital project is vital to service approved growth to the year 2031 across the Region. On March 31, 2010 the Minister of the Environment approved the IEA for the project and imposed a series of conditions on the recommended solution.

Approval of the SEC Trunk Sewer project is subject to stringent conditions set forth by the Minister based upon numerous overall directions. Section 8 of the Minister's conditions of approval for the SEC refers to Water Efficiency and Inflow and Infiltration (I/I) Reduction Monitoring. Under Section 8.2 the Region is required to develop an *Inflow and Infiltration Reduction Strategy* (the "Strategy") which shall include a program for the reduction of inflow and infiltration by the Region to the SEC Trunk Sewer from its and its lower tier municipalities' sewage systems. This program shall include reduction priorities, targets, timelines, tactics and initiatives, and the associated costs to implement these.

Section 8.4 of the Minister's conditions requires that the Region prepare a review of best in class water conservation and inflow and infiltration reduction programs, initiatives, strategies and tactics adopted by other jurisdictions. Per the Ministry the review must include an analysis of best in class tactics/strategies used by jurisdiction throughout the world. In response to this condition and in support of the Strategy development, AECOM undertook a comprehensive Industry Wide International Best Practices Scan which included several tasks. These include the development of a framework of components and programs to be reviewed based on the Inflow and Infiltration (I-I) Strategy terms of reference. Once the framework was identified a detailed questionnaire was created which focused on and used to collect information from 16 International and North American agencies regarding specific I-I strategies , programs and tactics and the key focus areas of the I-I Strategy Document Framework .

The selection of the final list of agencies was refined to ensure the following characteristics were met. The Agencies selected:

Had well documented and current strategies (or components of strategies).
Were operated in a similar governance structure to York Region
Were considered progressive based on industry knowledge and reputation
Had similar goals and targets for I-I reduction as York Region

The questionnaire/survey was circulated to an agreed-upon list of agencies after which the results were compiled, and follow-up telephone interviews and web scans were conducted as necessary. After

final assembly of the response data a GAPS analysis between Regional and Best Practices was completed and the observations documented in this Industry Practice Review Technical Memorandum.

3. York Region Inflow and Infiltration Strategy

3.1 Strategy Components

Condition 8.1 of the "Notice to Proceed with the Undertaking" specifies that a *Water Conservation and Efficiency Strategy* (Strategy) for water and wastewater flows to the Southeast Collector Trunk Sewer be prepared. The Strategy is to include targets for conservation, efficiency, inflow and infiltration reduction to the SE Collector Trunk Sewer, and timelines for achieving the targets, as well as the strategies, tactics, programs and initiatives to be used, including the cost to implement these. More specifically, Condition 8.2 requires the development of a program for the reduction of inflow and infiltration by the Region to the SE Collector Trunk Sewer from its and its lower tier municipalities' sewage systems.

Creation of the individual program initiatives will be used and rolled up to form the final I/I Reduction Strategy document which will include Purpose, Background Rationale and, System Overview. For reference a draft copy of the proposed table of contents of the Strategy document has been included in Table 1.

Table 1 Inflow & Infiltration Reduction Strategy Draft TOC (Aug. 12, 2010)

1.0 Purpose of the Strategy
2.0 Regional & Municipal I-I Steering Committee and Workgroups
3.0 York and Municipal Sewerage System Description
4.0 Inflow and Infiltration – What is it
5.0 Minister's Conditions and Background
6.0 Region and Municipal Goals & Objectives (Targets)
7.0 Audit & Measure Procedures
8.0 Linkage of this Strategy to International Practice Scan
9.0 Statutory Regulations
10.0 Schedule
11.0 I-I Reduction Program Existing Infrastructure
a. Establish System Priority Areas
b. System Knowledge
c. Flow, Rainfall and GW Measurement
d. Flow and Rainfall Data Analysis and Assessment
e. Identify I/I Sources through Condition Assessment
f. Rehabilitation Plan/Costing & Financial Forecasts
g. Intervention / Remediation Project Construction (Public Infrastructure)
h. Intervention/Remediation Project Construction (Private Infrastructure)
i. Data and Information Management
12.0 Program Funding
13.0 Inter-Agency Reporting
14.0 Bylaws and Agreements
15.0 Public Education and Outreach
16.0 Managing Inflow and Infiltration from Private Property
17.0 Mitigating Inflow and Infiltration in New Infrastructure
18.0 Annual Reporting Requirements to Ministry
19.0 Linkage to Water Efficiency

3.2 Program Components

In general the following main Strategy components were reviewed as part of this best in class review:

- **Governance** – Describes how the wastewater system is operated including general ownership and responsibilities.
- **Goals & Objectives** – Describes the drivers, goals and objectives for the agencies I/I reduction strategies
- **Statutory Regulations** – Describes the Regulatory Framework that the agency operates under.
- **Sewage System Knowledge** *(Existing Infrastructure, hydraulics, operational parameters)* – Describes how agencies gain understanding of their system including flow monitoring, condition assessment, flow data analysis, lifecycle analysis and prioritization programs.
- **Data & Information Management** – Describes how information is managed and shared internally and between organizations
- **Program Tracking & Reporting** – Describes the processes used to measure and report success and achieve progress toward stated goals and targets.
- **Private-Side Management** – Describes policies, programs and procedures for reducing extraneous flows from private property.
- **New Infrastructure** – Describes procedures for ensuring that new infrastructure is constructed in an optimal manner
- **Program Funding** – Describes how agencies fund I/I mitigation programs including inter-municipal funding scenarios
- **Program Management** – Describes project teams, organizational structure, personnel, resources -
- **Bylaws & Agreements** – Describes the authoritative mechanisms and policies required in order to mitigate I/I flows
- **Public Education & Outreach** – Describes practices related to educating customers and rate payers about the benefits or programs/projects required for reducing extraneous flows.

4. International I/I Strategy Program Review

4.1 Survey Agency Matrix

The following agencies were reviewed at various levels ranging from a scan of available information via web to formal questionnaires and personal contact.

Table 2 Survey Agency Matrix

	AGENCY	Web Scan	Document Review	Survey/ Interview Recommended	Survey/ Interview Completed
American	Metropolitan Council, St. Paul Minnesota	✓	✓	✓	✓
	Western Lake Superior Sanitary District (WLSSD)	✓			
	Renewable Water Resources, South Carolina	✓			
	Milwaukee Metropolitan Sewerage District, Wisconsin	✓	✓	✓	✓
	King County, Washington	✓	✓	✓	✓
	Metropolitan Sewer Distri	✓	✓		

	ct of Greater Cincinnati				
	Massachusetts Water Resources Authority (MWRA)	✓	✓		
Canadian	Metro Vancouver, British Columbia	✓	✓	✓	✓
	Capital Regional District, British Columbia	✓	✓	✓	✓
	Halifax Regional Municipality, Nova Scotia	✓	✓	✓	✓
	Region of Waterloo, Ontario	✓	✓		
	Region of Niagara, Ontario	✓	✓		
International	Greater Dublin, Ireland	✓	✓		
	Mullumbimby, Australia	✓	✓		
	Auckland - New Zealand (WaterCare)	✓		✓	✓
	North Shore City, New Zealand			✓	✓

Also identified in 1999 **WERF: Predictive Methodologies for Determining Peak Flows After Sanitary Sewer Rehabilitation**

Table 3 Short-listed Agency Contact List for Peer Review

	AGENCY	Contact
American	Metropolitan Council, St. Paul Minnesota	Kyle Colvin, Assistant Manager, Engineering Planning, 651.602.1151
	Milwaukee Metropolitan Sewerage District, Wisconsin	Tim Bate, Head of Planning, 414-225-2156
	King County, Washington	Mark Buscher, Lead - RWSP/CSI / Capital Project Manager IV, 206-684-1242
Canadian	Metro Vancouver, British Columbia	Ed von Euw, M.Sc., P.Eng., Senior Engineer, Policy & Planning Department, 604.436.6900
	Capital Regional District, British Columbia	James McAloon, B.Sc Engineering Technician, Engineering Services, Environmental Services, T 250-360-3309

4.2 4.2 Notable Program Components/Practices

The practice scan revealed a number of consistent practices which in some way are conducted by various agencies within a notable majority of I/I programs as described further below.

General Findings

Most agencies that were reviewed measure sanitary flows coming from satellite municipalities at boundary meters, although not all bill satellite agencies based on actual flows. Thresholds and targets are often established for each satellite agency's ("excessive infiltration") with reporting processes required to demonstrate the success of I-I reduction.

All agencies recognized that flow monitoring pre and post construction is important to validate the success of flow reduction. However, this analysis is made more complex as rain events and other conditions change between monitoring periods (i.e. no two monitoring periods are alike).

Agencies indicated that new construction and inspection standards are required to ensure I-I flows are mitigated in the future.

Each agency's target reduction or strategy goals are based on local system issues or legislative/compliance requirements, meaning they are addressing I/I to eliminate specific issues. Most agencies are focussing on capacity related issues (overflows, basement flooding) and not on reduction of flows in general. The majority of agencies are focussed on reducing overflows and basement flooding, very few have reduction targets that are volume related

Many agencies have considered implementing a "surcharge" on excessive I-I but a collaborative approach tends to work best.

Upper tier agencies tend to take the lead on developing strategies and providing technical assistance. While many lower tier agencies are responsible for implementation of their own I/I programs, funding and cost sharing mechanisms must be in place to share financial burdens of I/I reduction

Communication programs must exist that will educate property owners on the impacts of I/I and what their responsibilities are regarding I/I reduction. Some kind of ongoing communication program between upper tier agencies and their satellite agencies is required in order to maintain future I/I reduction activities within the satellites.

Because sewerage systems degrade with age, an ongoing and adequately funded I/I reduction program is required for both upper tier and satellite agencies. The majority of agencies commented that continuous I/I reduction activities, application of appropriate construction standards and ongoing inspection and monitoring programs are necessary in order to avoid excessive future I/I reduction costs or "having to do it all over again."

All agencies recognised the need to address I/I coming from private property. It is generally accepted that 60-70% of extraneous flows are coming from private services.

4.3 Specific Program Practices

During the practice scan a number of unique "programs of interest" were also documented. These are summarized as follows:

Halifax Water - Private side inspections/remediation programs

Halifax Water (HW) has policies which prohibit any discharge of clear water into the sanitary system. They inspect properties in a priority sequence and the homeowner is responsible for completing repairs in the event that Halifax Water finds property is contributing to I/I. HW has policies in place to

enforce homeowner responsibilities. In addition, the agency has a documented notification process by which the homeowner receives a notice of pending inspection to which they must respond within a designated time frame. Failure to do so may result in penalties such as temporary disconnection of water services.

Capital Regional District / Metro Vancouver – Cost Sharing Allocation & By-law Review
Both CRD and Metro Vancouver have the ability to measure flows contributed from their satellite agencies for billing purposes (i.e. Boundary meters). This allows for the "true cost" of I/I to be passed down to the local communities and can provide incentive to reduce individual I/I contributions. As a further measure, Metro Vancouver has modified their cost allocation process so that instead of billing on average dry weather flow they have the ability to allocate costs and charges based on average wet weather flow.

CRD engaged a third party firm to undertake a comprehensive legal review of existing by-laws to determine rights of access to private infrastructure. This study confirmed the agency has the legal authority to conduct inspections and regulate flows into the public collection system as deemed necessary.

Metro Water (Auckland, New Zealand) - Private Sewerage Infrastructure
West Auckland implemented a scheme that linked house valuations to damaged lateral connections. Similar to Halifax Water home owners are issued a time limit to correct a damaged lateral. Three months later an assessment is carried out using smoke testing. If the lateral connection is still deemed to be a problem, then a 'final warning' letter is issued and a secondary check carried out three months hence. If the lateral connection is still inappropriate, the fault is reported on the house survey that can affect house prices. According to the agency, success rates have been excellent.

Renewable Water Resources- Governance Structure
In order to stimulate regional planning efforts and to accomplish long range plan initiatives, ReWa formed the *Upstate Roundtable Wastewater Infrastructure Committee*, a study group of 50 business, community, and neighbourhood leaders. Included in the Committee's review were recommendations concerning long range planning and system capacity including an evaluation of excessive wet weather flows to ReWa's wastewater treatment plants and the impact this increased flow would have on ReWa's operations. It was the conclusion of the study group that this increased flow would decrease available treatment capacity and should be solved by community-wide solutions such as intergovernmental agreements addressing I/I problems.

Metropolitan Council Environmental Services (MCES), Minnesota – Incentive Programs & Public Outreach

MCES has instituted several programs through their I/I reduction strategies including initiating an I/I financial assistance surcharge program with will allow MCES to surcharge communities to collect revenue for the community to use for solving I/I related problems. Communities which already have I/I reduction plans are able to opt out of the surcharge program to allow them to undertake activities for I/I reduction using local funds as long as those funds are equal to or greater than the surcharge program funds. As a further incentive MCES has the ability to limit future increases in service within those communities that have not met their I/I goals (starting in 2015). Also planned for 2015 is a wastewater rate demand charge program for those communities that have not met their I/I goal(s), and are not actively working to do so. This is intended to help defray the cost of providing attenuation within the MDS to recover the

capacity lost to their excessive I/I. MCES will continue to review communities and work with them on a case by case basis.

In 2009, MCES produced a comprehensive "tool box" that highlights programs and products as potential solutions to I/I problems that communities can use. This tool box addresses I/I control for both public and private systems and provides technical guidance and procedures to the satellite agencies around how to conduct I/I studies.

- MCES has determined target levels of I/I from each local community should be at 30 gpcd on a monthly basis to avoid building excessive capacity at treatment plants. They also have a comprehensive appeal process that satellite agencies can utilize in the event that they disagree with MCES findings.

Milwaukee Metropolitan Sewerage District, Wisconsin – Reduction Targets & Satellite Reporting Requirements

- In 2002 the Milwaukee Metropolitan Sewerage District implemented inflow and infiltration limits to reduce district-wide inflow and infiltration by 5 % through 2010. In MMSD's 2009 Facilities Plan this strategy was reconsidered and the volume-based reduction target was revised to reflect a peak flow-based reduction strategy.
-
- I/I reduction in the MMSD system was identified as a potential technology to improve the level of protection against SSOs. On a system wide basis, analyses are conducted using calibrated sewer shed flow models to characterize current and future I/I responses. Conceptual reductions in I/I are analyzed to predict the effectiveness and cost of I/I reduction efforts. The goal of the analysis is to determine if it is cost effective to pursue I/I reduction to achieve level of protection objectives or if it is more cost effective to utilize end-of-pipe facilities to achieve the same result (SSO elimination) without reducing I/I rates.
-
- A similar methodology is also used to estimate I/I reduction in specific sub-areas of the system. Maximum allowable peak flow rates in gallons per acre per day are calculated by MMSD and assigned to each sub-area, or metershed (a specific area where system wastewater flows are continuously measured). If the District finds that peak hourly flow reduction is necessary in a metershed, the District notifies the governmental unit and requires that they develop and implement a peak hourly flow rate reduction program.
-
- Each of the agencies and communities served by the MMSD system are required to submit an annual report to the District which must summarize I/I reduction programs and activities occurring in the preceding calendar year.
-

Metropolitan Sewer District of Greater Cincinnati - Sewer Connection Credits

MSDGC uses a system of connection "credits" to manage sewer connections. Any change that will increase wastewater flow into the sewer system requires a certain number of credits, depending on the amount of wastewater introduced through the new connection. In general, one credit is required for new connections that will generate a flow equivalent to that produced by an average single-family residential home. To obtain one connection credit, an amount of storm water equivalent to the amount of wastewater flow generated by four residential properties must be removed from the system.

MSDGC creates connection credits by completing sewer improvement projects that increase capacity and flow in the sewer system. MSDGC then banks its credits and makes them available to developers

on a first-come, first-served basis. Developers can also create credits and apply them toward their own projects.

King County – Program Management, Funding & Interagency Agreements
King County is generally considered to be one of the best documented international I/I programs. The program has been underway for over 10 years through a collaborative approach between the County and its satellite agencies. King County has completed numerous pilot projects and assessed the impact of these projects against their original reduction estimates

King County funds initial projects through King County wastewater revenue that is dedicated to funding CSI projects in the regional conveyance system. For future I/I reduction projects, options to supplement King County funding may be considered. For example, local agencies could contribute funds to expand the project scope in order to take advantage of construction efficiencies, as was done in some pilot projects, or to move a project into the cost-effective category.

Under long-term agreements with local sewer agencies in its service area, King County charges each agency a monthly amount for providing wastewater treatment. That amount is based on King County's monthly sewer rate and the number of customers served by the local agency

4.4 Overall Program Summary Table

The following table summarizes each of the 16 reviewed agencies I/I Strategy/Program components as they relate to the program components discussed in Section 2.2

Table 4 Program Summary Table

AGENCIES	Metropolitan Council, St. Paul, Minnesota, USA (MCES - Metropolitan Council Environmental Services)	Renewable Water Resources, South Carolina, USA	Milwaukee Metropolitan Sewerage District, Wisconsin, USA	King County Wastewater Treatment Division, Washington, USA	Metropolitan Sewer District of Greater Cincinnati (MSDGC), Cincinnati, Ohio, USA	Western Lake Superior Sanitary District, Minnesota, USA	Massachusetts Water Resources Authority (MWRA), Massachusetts, USA	Metro Vancouver (Greater Vancouver Regional District – GVRD), British Columbia, CAN	Capital Regional District, British Columbia, CAN	Halifax Regional Municipality – Halifax Water, Nova Scotia, CAN	Region of Waterloo , Ontario, CAN	Region of Niagara, Ontario, CAN	Greater Dublin, Ireland	Mullumbimby, Australia	North Shore City, New Zealand	Watercare Services Ltd. (Auckland, New Zealand)
Program / Strategy Origin	1993 - Instituted a grant program for local communities to aid in the identification, location and removal I/I sources. 2003 - Infiltration and Inflow Task Force formed	1988 - Wet weather engineering study and development of long range repair and rehabilitation plan. 2008 - Regional Sewer Use Ordinance amended to establish uniform standard for I/I reduction work plans	1986 - Water Pollution Abatement Program: a comprehensive, multi-year, sewer improvement program in order to comply with strict federal water quality standards and eliminate sanitary sewer overflows.	1999 - King County Regional I/I Control Program was created as part of the Regional Water Services Plan (RWSP).	Capacity Assurance Program Plan (CAPP) project was developed to meet Interim and Global Consent Decree mandates regarding assurance of capacity to control SSO's	2004 - EPA directive to eliminate SSO's by 2016	2002 - MWRA Regional I/I Reduction Plan initiated to develop goals and implementation strategies to reduce I/I to optimize local and regional sewer services.	1989 - Initial Liquid Waste Management Plan (LWMP) developed for MOE 2001 - LWMP addressed I/I management 2010-LWMP update	2003 - CRD's Core Area Liquid Waste Management Plan (LWMP).	1999/2000 – I/I Reduction Program	2007 - Wastewater Treatment Master Plan developed which recommended that the Region work with the Area Municipalities to develop aggressive inflow and infiltration studies and programs to reduce I/I.	2007 - CSO Policy developed and I/I reduction strategies implemented	Greater Dublin Strategic Drainage Study (GDSDS) - provided recommendations of policies for the future provision and management of drainage services in the Greater Dublin Area (GDA).	Council adopted a three year strategy to address the problem of storm water ingress into the Mullumbimby sewerage system and progressively rectify I/I related construction defects.	Wastewater Network Strategic Improvement Programme (WNSIP, 2002) started as part of Project CARE (Council Action in Respect for the environment). WNSIP goal is to reduce the number of overflows from the wastewater network caused by I/I in order to improve beach water quality	I/I Reduction targets based on mitigating overflows and percentage peak wet weather flow reduction
Goals & Objectives	•Local communities to include an I/I program within their comprehensive plan. •Develop I/I goals and guidelines •Require the community to reduce its I/I to reach the design flow standard within a 5 year period •Initiate an I/I financial assistance surcharge program •Limit increases in service within those communities where excessive I/I exists •Limit future increases in service within those communities that	1988 - Developed a long range plan which included initiative to encourage agencies contributing wastewater to ReWa trunk lines and treatment facilities to thoroughly evaluate their collection systems and reduce I/I to acceptable levels.	2002 Facility Plan • Implemented new I/I limits to reduce district-wide inflow and infiltration volume by 5% through 2010. This strategy was revised in 2009. 2009 Facility Plan • Implemented new I/I strategy to reduce sub-area peak flow rates to below defined acceptable levels.	Identify cost-effective I/I reduction projects on a project-specific basis • Conduct pre- and post-project flow monitoring • King County Code allows for 1,100 gallons-per-acre-day (gpad) of I/I.	Eliminate/ reduce SSO's	• Restrict I/I into the sewer system through water conservation education, sound operating procedures, proper design/construction practices, maintenance of existing facilities, & strict enforcement by all municipal and industrial sources. • Reduce I&I by providing leadership, education, monitoring, policy development and enforcement	•Continue identification, prioritization, and rehabilitation of structural and I/I problems. •Work to eliminate sewer system backups • Work cooperatively to expand existing efforts to educate and involve the public • Provide technical assistance & work cooperatively with member communities	2001 - Establish sewer system infrastructure management programs to maintain the regional trunks and interceptors, the municipal collection system, and the private service laterals in a state of good repair. Average daily I/I will not exceed 11,200 liters per hectare per day as a result of a storm with less than a 5 year return period	•reduce I/I to levels that minimize total conveyance, treatment and disposal system costs • To develop implementation plans for the 25-year life of the LWMP • To recommend to future councils that they commit funds for I&I • To conduct pre & post flow monitoring • To undertake a 4-year program to accelerate the identification of priority areas and projects	HRM implementing measures with the intent of achieving the CCME objective within the allotted 30 allocated year period. Implementation of the SIR program to meet objective	No clear identified goals at Regional Level. I/I reduction programs are run at the local government level.	To reduce the amount of untreated wastewater bypasses (CSO's)	• identify the presence and causes of I/I • Survey and reduction works will be carried out with optimum cost-benefit; • Specifications and practices for sewerage construction will be imposed to minimize I/I/E; • Asset management systems will be targeted to minimize I/I/E	2003 I/I Program: • Measure the levels of I/I by catchment. • Prioritize the Collection System by catchment • Identify the sources of I/I in the catchments identified as priority by undertaking a complete survey of the catchments from the house to the main. • Prepare and evaluate a cost effective correction plan. •Continue this process through the prioritized catchments until the	To have no more than 2 wet weather overflows per annum from the ww network by 2021	2005 - Metrowater committed to a 35% reduction in volume of polluted water entering the environment from it's networks over the period from 2005-2011

INFLOW / INFILTRATION REDUCTION STRATEGY INDUSTRY BEST IN CLASS REVIEW

AGENCIES	Metropolitan Council, St. Paul, Minnesota, USA (MCES - Metropolitan Council Environmental Services)	Renewable Water Resources, South Carolina, USA	Milwaukee Metropolitan Sewerage District, Wisconsin, USA	King County Wastewater Treatment Division, Washington, USA	Metropolitan Sewer District of Greater Cincinnati (MSDGC), Cincinnati, Ohio, USA	Western Lake Superior Sanitary District, Minnesota, USA	Massachusetts Water Resources Authority (MWRA), Massachusetts, USA	Metro Vancouver (Greater Vancouver Regional District – GVRD), British Columbia, CAN	Capital Regional District, British Columbia, CAN	Halifax Regional Municipality – Halifax Water, Nova Scotia, CAN	Region of Waterloo , Ontario, CAN	Region of Niagara, Ontario, CAN	Greater Dublin, Ireland	Mullumbimby, Australia	North Shore City, New Zealand	Watercare Services Ltd. (Auckland, New Zealand)
	have not met their I/I goal(s)													level of I/I is reduced to acceptable levels.		
Program Tracking & Reporting (measurement of success)	Measure peak inflow from the agencies during wet weather conditions	ReWa has of total of 93 permanent flow monitors and 25 temporary meters on an as-needed, part-time basis. Perform pre and post flow monitoring for all major rehabilitation projects.	Success is measured by SSO elimination and peak flow reduction. Satellite agencies submit an annual report to the District summarizing I/I reduction programs and activities occurring in the preceding calendar year.	•post-project flow monitoring conducted to evaluate results of projects	•pre- and post-flow monitoring was **not** conducted as part of the I/I Removal Program •program to date has resulted in a reduction in customer calls reporting basement backups in the targeted areas •SSOs have not been eliminated with the work completed •current I/I removal program is dramatically scaled back from the initial efforts	No reference found	• Utilizing the priority ranking to be completed, as well as system hydraulic analyses. •analyze available wastewater metering data to estimate community I/I rates. • I/I Task Force Reporting	Biennial LWMP progress report	Biennial LWMP progress report	SIR I/I reduction program List created with HIGH rate of I/I implementation	Rehabilitation of sections completed in 2008 – 2009 Further monitoring required	% of wastewater estimated to bypass treatment yearly	Infiltration in the Rinsend WWTP catchment is approx 50% dry weather flow	• Ratio Wet Weather Flow (Daily) / Dry Weather flow (Daily) < 7 – 8 • Number of Overflow events per year < 3 • Total System Flow per Rainfall Event	•Progress is tracked and reported on every 6 years. •Within first 6 years of program (2002 - 2008) approximately 50% of the beach areas have met the target for overflow numbers. •6 year review includes assessment of the benefits of the capital works projects completed to date •review allows for revision / update of future WNSIP projects	•pre & post flow monitoring in public and private lateral rehabilitation areas
Summary and Relationship to York's Audit and Measure Methodology	Target and measures are based on achieving the current infiltration design allowance, not volumetric reduction	Target reduction is based on elimination of overflows, not volumetric reduction	Target is a peak flow rate reduction	Initial program has identified a reduction of volume; however it appears that the cost/benefit approach is utilized.	Target reduction is based on elimination of basement flooding incidents not volumetric reduction	Target reduction is based on elimination of overflows, not volumetric reduction	DEP regulations and guidance documents indicates that excessive I/I is related to cost/benefit	Target and measures are based on achieving 11,200 l/h/day by 2030 not volumetric reduction	2009 –to reduce max DWWF to less than 4 times the ADWF by 2030	I/I reduction targeted on specific areas deemed to contribute high flows.	Focus on reduction overflows at plants by reducing flows, no clear measures established.	Focus on reduction overflows at plants by reducing flows, no clear measures established. Lower tier programs are focused on historic high flow, overflow or basement flooding incidents (i.e. Fort Erie)	No measures established	Measures not volumetric focus on ratio of overflow events and system flows.	Measures not volumetric, focus on reducing overflow occurrences	Focus on reducing flows volumetrically
Program Management / Governance	•I/I Task Force formed April 2003 •responsible for reviewing the I/I issues and formulating and proposing implementation strategies to reduce excessive I/I in local & regional systems.	• 9-member Board of Commission (BOC)	•MMSD was created in 1982 as a state-chartered government agency •has the authority to impose rules and regulations	35+ member agency Steering Committee	No reference found	October 2008 - I/I ordinance was adopted to maintain system capacity by insuring that communities within the WLSSD are continuing to reduce I/I	No reference found	LWMP managed at the Regional level - individual I/I Reduction Programs developed and managed at the local level.	LWMP managed at the Regional level - individual I/I Reduction Programs developed and managed at the local level.	In accordance with CCME comprising 14 Environment Ministers from Federal/Provincial/Territorial	Local municipalities responsible for administration of individual programs with assistance from Region	CSO Policy is the joint responsibility of the Region and area municipalities.	Greater Dublin Strategic Drainage Study	No reference found	North Shore City Council started the WNSIP as part of Project CARE	Metrowater Ltd. is a council-controlled organization and is 100% owned by Auckland City •council owns network •Metrowater is responsible for maintenance & operating costs
Statutory	Water Resources	Regional Sewer Use	Not referenced in	EPA Consent Decree	Consent Decree	Consent Decree		Liquid Waste	Liquid Waste	HRM Charter item	Referenced in WW	No reference found	No reference found	No reference found		

INFLOW / INFILTRATION REDUCTION STRATEGY INDUSTRY BEST IN CLASS REVIEW

Regulations	Management Policy Plan - I/I Policy Statements	Ordinance	strategy documents					Management Plan (MOE requirement)	Management Plan (MOE requirement).	348 Halifax Water Rules and Regulations	Master Plans & Drainage Studies					
Data & Information Management	100+ permanent flow locations.	118 flow meters, 13 rain gauges. •Data and reports are customized for each community	•Conveyance system was modeled as part of the 2020 Facilities Plan.	2009 Decennial Flow Monitoring (DFM) Project •232 flow monitoring units were installed in the separated portion of WTD's service area	No reference found	No reference found	No reference found	In addition to the plants and pump stations Metro Vancouver is able to meter at local municipal boundaries	In addition to the plants and pump stations CRD is able to meter at local municipal boundaries		2009-Flow monitoring 2010- Stormwater sewer inspection	Region has a flow monitoring team which gathers data from the Region's sanitary trunk network. Data has been collected since 1987	No reference found	Permanent flow recording technology installed at each of 112 pump stations c/w rain gauges	•effectiveness studies completed of the catchments that have been rehab'd • statistical analysis of I/I work results undertaken • data allows North Shore to estimate the reductions in PWWF and % rainfall ingress based by the catchment initial leakiness/peak flow characteristics and % of rainwater entering catchment	flow monitoring done on a catchment need basis (usually linked to wet weather issues such as flooding)
Private-Side Management	Local municipalities are running private property programs via their individual I/I Reduction Strategies.	Not referenced in strategy documents	• Federal I/I Reduction grant money provided funding to the municipalities for certain type of I/I reductions efforts on private property. •2020 Facility Plan prohibits illegal connections Charges local communities with implementing and enforcing prohibited connection ordinances.	Implemented private-side pilot projects as part of their 2005-10 pilot program developed guidelines and standards for the inspection and remediation of laterals	No reference found	No reference found	No reference found	•Legal review conducted by a local environmental law firm •By 2011 the Region has committed to working with the real estate industry and regulators to develop and implement a process for the inspection and certification of private laterals as a required component of real estate transactions	•legal review to look at their options/rights for access to inspect and do work on private side. •2011 - by commitment to the ministry CRD is responsible for updating and enforcing sewer use bylaws to prohibit the construction of rainwater and groundwater connections to sanitary sewers. •committed to identifying opportunities for the inspection of private sewers	•illegal to discharge stormwater into sanitary •Rules and regulations outline agencies rights for accessing private property •customer's responsible to cover costs of disconnection/rehab • inspection program is addressing areas on a priority basis •failure to comply to Halifax Water requests of inspection or work may result in the suspension of water service	Isolated local municipal disconnect programs completed	•Welland (2006) - 90% of downspouts disconnected. •Fort Erie (2006) - 90% of residential downspouts disconnected. Fort Erie staff check lateral condition during a house transaction - if connection is found not to be proper then existing owner must pay to have it corrected. •City of Niagara falls conducts residential foundation drain disconnections and covers 100% of the cost.	Strictly control the quality of new and renovated sewerage installed Private drains and abandoned sewers managed to minimize risk of I/I	No reference found	no reference found	Implemented scheme to line house valuations to damaged lateral connections with high success rate

INFLOW / INFILTRATION REDUCTION STRATEGY INDUSTRY BEST IN CLASS REVIEW

New Infrastructure	Developed design standards & rehab guidelines	No reference found	No reference found	Inter-agency agreements with local agencies require local sewers to be constructed and maintained in accordance with the rules and regulations of Metro (King County).	No reference found	No reference found	No reference found	To be addressed in future LWMP updates	To be addressed in future LWMP updates	Developed I/I standards for design/construction	Encourage use of low flow toilets in new developments	No reference found	Strengthened specifications and practices for sewerage construction imposed to minimize I/I	No reference found	No reference found	No reference found
Program Funding	1993 - Grant Program for local communities to address I/I. 2006 - I/I Surcharge Program 2013 - Wastewater Demand Charge Program	All ReWa expenditures funded through a combination of user fees, state revolving fund loans, revenue debt issues and internal equity generated from system revenues. No evidence of grant programs, cost savings or penalties for local communities.	Funding mechanism for municipalities for I/I reduction efforts on private property. $1 million per year for five years	Although primarily funded by the county; comprehensive formulas for cost-sharing with local communities exists	No reference found	No reference found	No reference found	•Metro able to bill communities on actual measured flows •Sewage cost allocation procedures modified to charge based on AWWF	Local municipalities are responsible for developing and funding their own I/I reduction strategies.	HRM initiated a budget of $250,000/year for implementation of the program	Local agencies responsible for funding of program/ projects 2006 Region received $725,000 from the Province to address I/I in St. Jacobs	No reference found	No reference found	No reference found	$231 million improvement program was approved in 2002 to achieve target of 2 wet weather overflows per annum by 2021	No reference found
Program Co-ordination	Local communities are charged with meeting I/I goals by 2013 through individual I/I reduction programs.	•ReWa operated as a business with Cooperative Agreements with each of its 17 satellite entities •Agreements have mandatory objectives •Each satellite must reduce the amount of excessive rain and runoff water entering the system	1998 - MMSD adopted rules directing municipalities to minimize I/I to the maximum extent economically achievable •Communities are required to: (1) develop and implement an I/I management plan (2) prohibit illegal connections	•Wastewater disposal agreements • King County Code - establishes an I/I threshold and corresponding surcharge penalties for exceedance of thresholds; although not been enforced to date	No reference found	No reference found	No reference found	•each community is responsible for developing and implementing individual I/I Reduction Strategies as part of their required Asset Management Plans	•each community is responsible for developing and implementing individual I/I Reduction Strategies as part of their required Asset Management Plans	Property owners are responsible to maintain wastewater connection from property line to their homes. Introduction of SIR – disconnection from CSO	Local agencies responsible for administration of program/ projects	No reference found	Drainage operation and maintenance opportunities of non legitimate flow	No reference found	North Shore City is responsible for managing infrastructure and services and administers Project CARE and WNSIP internally	Clean Harbour Alliance
Bylaws & Agreements	•MCES Waste Discharge Rules •Water Resources Management Policy Plan	Co-operative Agreements with satellite agencies	Not referenced in strategy documents	•King County Codes •Interagency agreements	No reference found	No reference found	No reference found	•LWMP (Regional) •Asset Management Plans including I/I Reduction Strategies (Community level)	•LWMP (Regional) •Asset Management Plans including I/I Reduction Strategies (Community level)	•Halifax Regional Municipal Charter •Halifax Water Rules and Regulations	Regional Municipality of Waterloo Act	No reference found	No reference found	No reference found	No reference found	No reference found
Public Education & Outreach	–MCES utilizes a public website http://www.metrocouncil.org/environment/projectteams/I-I-home.htm that includes I-I fact	In addition to a simple website, Renewable Water Resources (ReWa) has recently included a presentation titled "The Impact of	Not referenced in strategy documents, satellite agencies in MMSD do promote I/I programs on their local websites.	King County has developed a public website and outreach materials for both I/I reduction & specific projects their website at	MSDGC offers a presentation on the project groundwork along with numerous whitepapers on I/I reduction. http://www.msdgc.o	http://www.lakesuperiorstreams.org/stormwater/inflow.html Project specific information including a detailed presentation can be	MWRA has initiated programs for communities across the United States http://www.epa.gov/region1/sso/toolbox.html.	(GVRD), British Columbia Canada has provided a public workshop on the strategy for updating the liquid waste management plan"	•I&I website & brochures •developing video using actors, animation and CCTV video clips for education purposes	SIR Program website, promotional material, letters to residents requesting access for inspection. http://www.halifax.ca/hrwc/wastewaterin	Not addressed	Discussion of extraneous flow reduction in relation to their watersmart program. http://www.niagararegion.ca/government	Use websites to link to various policies impacting extraneous flows http://www.dublincity.ie/WaterWasteEnvironment/WasteWate	Community education and issuance of appropriate literature and web site	Simple reference to I/I program at http://www.byron.nsw.gov.au/sewer/mullumbimby	No reference found

INFLOW / INFILTRATION REDUCTION STRATEGY INDUSTRY BEST IN CLASS REVIEW

	sheets, brochures and FAQ's. For inter agency use they have also produced a "tool box" that highlights programs and products as potential solutions to I/I problems that communities can use (public and private). http://www.metrocouncil.org/environment/ProjectTeams/documents/I-I-tool-box.pdf	Infiltration and Inflow on Urban Sewer Systems" and can be viewed on their website www.**rewa**online.org/docs/**Infiltration**-Presentation.pdf		http://your.kingcounty.gov/dnrp/library/wastewater/ii/AltOptions/Report.pdf.	rg/downloads/wetweather/bundles/Documents_For_All_Bundles/RDII/I%20and%20I%20paper.pdf	found at http://www.lakesuperiorstreams.org/stormwater/duluth/resource/landI_ppt/index.html		http://www.metrovancouver.org/services/wastewater/planning/LWMP%20Docs/LWMP-publicPresentation-Apr08.pdf	which discusses the issues associated with I&I. http://www.crd.bc.ca/wastewater/sourcecontrol/residents/fats-oils-grease.htm. and (http://www.crd.bc.ca/wastewater/ii/index.htm)	filtration-inflow.html		/initiatives/nwqps/whatisbeingdone-ourproject.aspx	r/Drainage/GreaterDublinStrategicDrainageStudy/Pages/InflowInfiltrationandExfiltrationPolicy.aspx			

5. Individual Program Details

5.1 Comparator Agencies

5.1.1 *American*

5.1.1.1 Metropolitan Council Environmental Services, St. Paul Minnesota

The Metropolitan Council Environmental Services (MCES) is one of three divisions of the Metropolitan Council. The Minnesota Legislature established the Metropolitan Council in 1967 to coordinate planning and development within the Twin Cities metropolitan area and to address issues that couldn't be adequately addressed with existing governmental arrangements. The MCES collects and treats wastewater for Minnesota's largest urban area, including the cities of Minneapolis and St. Paul.

Governance

The 17-member Metropolitan Council has 16 members who each represent a geographic district and one chair who serves at large. The members and chair are appointed by the governor and confirmed by the State Senate.

The MCES currently provides wastewater collection and treatment to over 100 communities. Figure 1 below shows the MCES service area and Table 5 provides an overview of the District.

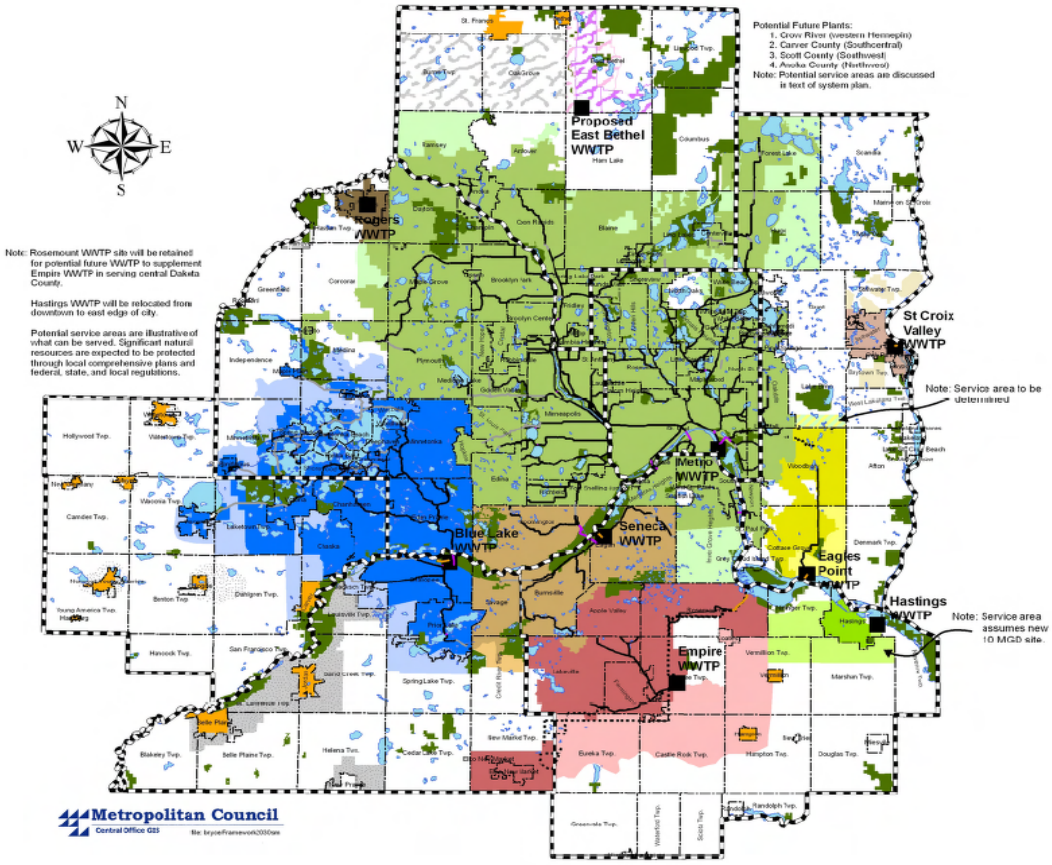


Figure 1 – MCES Service Areas

Table 5 MCES Profile

Metropolitan Council Environmental Services (MCES) Profile	
Population Served	Over 2 million
Service Area	7,705 square kilometres
# of Agencies / Satellite Communities	105 Communities
Length of Regional System	965.6 kilometres
Length of Local System	8,046.7 kilometres
# of Wastewater Treatment Plants	8
# of Pump Stations	61
# of Flow Metering Stations	190

The communities served by MCES own and operate their own local sewer system. MCES's system of interceptor sewers collect flows from the local sewer system and conveys it to one of eight treatment plants. The communities provide wastewater services to residents, commercial establishments, industry and public agencies. The end users are billed for this service by the local community on the basis of their metered water use. MCES bills each community on the basis of the metered wastewater flow for the regional wastewater collection and treatment services that it provides. Industries with high strength waste are the only users which are billed directly by MCES.

MCES was aware that excessive inflow and infiltration was a major issue for wastewater operations and in 1993 instituted a grant program for local communities to address I/I. The Council provided financial assistance to communities to aid them in identifying, locating and removing sources of I/I within local sanitary sewer collection systems. A total of $1.375 million was spent on this effort by the year 2000, leading to 800 million gallons / year (approximately 2 MGD) of I/I being removed from the system. However, the amount of I/I reduced was not sufficient and it was clear that additional steps would have to be taken to prevent significant future investments in regional sewers.

On April 8, 2003, the Metropolitan Council appointed individuals to serve on the Infiltration and Inflow Task Force, which was chaired by a Council Member. The task force included representatives from 15 communities from across the region as well as a representative from the Association of Metropolitan Municipalities. The task force was charged with reviewing the I/I issues and formulating and proposing implementation strategies to reduce excessive I/I in local and regional wastewater collection systems. Reporting back to the Environment Committee, the task force met monthly and reviewed information presented by Environmental Services Division staff, which provided facilitation and administrative support. The recommendations and conclusions were arrived at by consensus of the task force members.

Authority

The MCES has adopted Inflow/Infiltration Surcharge procedures. The procedures were adopted by the Metropolitan Council pursuant to Minnesota Statues (M.S.), Chapter 743, including Section 473.145-146 and Section 473.858, and the Metropolitan Council Environmental Services Waste Discharge Rules, and were declared to be necessary for the efficient, economic, and safe operation of the MDS and for protection of the health, safety, and general welfare of the public in the metropolitan region. In addition, the Council's Water Resources Management Policy Plan established goals for communities served by the regional Metropolitan Disposal System.

Conclusions reached by the Council staff and the I/I Task Force members were:

- The capacity of regional wastewater conveyance and treatment facilities was being exceeded during significant rainfalls because of excessive I/I.
- Excessive I/I has used up existing capacity for future growth.
- Overloaded wastewater conveyance and treatment facilities had resulted in unacceptable conditions such as private property damage, spills and sanitary sewer overflows (SSOs).
- MCES, as the regional wastewater utility and NPDES permittee, must take action to reduce the risk of overloading the regional wastewater facilities.
- It is not feasible to enlarge MCES's facilities to accommodate all the I/I from tributary communities.
- MCES has a fiduciary responsibility to not expend funds to convey and treat clear water from illegal connections associated with private property sources such as sump pumps and rain leaders.
- The MCES design allowance for I/I in the interceptor system is reasonable as many local communities meet this standard.
-
- For MCES the operating definition of excessive I/I to the MCES sewerage system is as follows:

"Excessive I/I is that I/I that caused the peak hours flow to exceed the value calculated by multiplying the average flow times the appropriate MCES peak to average ratio. The average flow is the three year running average flow at the point of measurement and the appropriate MCES peak to average ratio."

The Task Force recommended that the Metropolitan Council adopt the following I/I policy statements and corresponding implementation strategies for inclusion in their next Water Resources Management Policy Plan:

"The Metropolitan Council will establish I/I goals for all communities discharging wastewater to the Metropolitan Disposal System. Communities that have excessive I/I in their sanitary sewer systems will be required to eliminate the excessive I/I within a reasonable time period."

"The Metropolitan Council will not provide additional capacity within its interceptor system to serve excessive I/I."

Implementation Strategies

Implementation strategies developed by Council staff and I/I Task Force members were as follows:

Continue to use the current design standards for interceptors.
Require communities served by the MDS to include an I/I program within their next comprehensive plan.
Develop I/I goals for all communities as well as guidelines for the preparation of the local I/I programs.
Require the community to reduce its I/I to reach the design flow standard for each connection point to the MDS within a five-year period from the adoption of its comprehensive plan.
Measure peak inflow during wet weather conditions by either the MCES metering system or by temporary monitoring equipment installed in the sanitary sewer system.

Initiate an I/I financial assistance surcharge program, starting in 2008. This program will allow MCES to surcharge communities to collect revenue for the community to use for solving its I/I problem.

Allow communities with I/I reduction in place to continue with their programs and not participate in MCES's surcharge program. This will allow communities to undertake activities for I/I reduction using local funds, as long as those funds are equal to or greater than the surcharge program funds. *(MCES will work with communities with either option (A or B) to help solve their I/I problem on a case by case basis).*

Limit increases in service within those communities where excessive I/I jeopardizes MCES's ability to convey wastewater without an overflow occurring. MCES will work with those communities on a case by case basis.

Limit future increases in service within those communities that have not met their I/I goal(s), starting in 2015, until the problem is solved. *MCES will work with communities not meeting goals on a case by case basis.*

Institute a wastewater rate demand charge program, starting in 2015, for those communities that have not met their I/I goal(s), and are not actively working to do so, to help defray the cost of providing attenuation within the MDS to recover the capacity lost to their excessive I/I. MCES will continue to review communities and work with them on a case by case basis.

Work with the Public Facilities Authority to make funds available for I/I improvements.

Data and Information Tracking

MCES measures wastewater flow at over 100 permanent locations throughout the metropolitan area. The flow rate at each meter location is continuously measured. Flow data is recorded in three-second increments, from which 15 minute, hourly, daily, weekly, monthly and annual totals are derived.

The interceptor network is closely monitored by a sophisticated computerized telemetry system that provides continuous data and monitors the status of MCES facilities, flow meters and regulators.

I/I Surcharge Program

The purpose of the surcharge program is to provide the Council with contingency funding to build additional capacity if necessary. Or alternatively, provide an incentive and a mechanism for communities to fund the cost of mitigating their excess peak I/I. Communities can avoid surcharges and/or receive rebates of their surcharges by eliminating their excess peak I/I through a combination of programs and system improvements. It is the intent of this program to encourage communities to eliminate their excess peak I/I over the next five-year period from 2007 through 2011.

The Metropolitan Council's funding of I/I mitigation projects by communities through the surcharge credit and rebate programs are based on the eligibility of these projects as likely to reduce the community's I/I. However, the actual effectiveness of any project is the responsibility of the community and the Metropolitan Council's granting of a credit and/or rebate does not relieve the community of its obligation to reduce its I/I to an acceptable level as determined by MCES.

Starting in 2013, the Council will institute a wastewater demand charge program for those communities that have not met their inflow and infiltration goals(s). The demand charge will help defray the cost of providing attenuation or capacity improvements within the MDS to avoid overloading downstream facilities. No credits or rebates to communities will be allowed. MCES will continue to review the communities' progress and will work with them on a case-by-case basis. At this time the demand charge rate has not been set but it is anticipated to be significantly greater than the current exceedance rate of $350,000 per million gallons.

After extensive outreach, the Metropolitan Council adopted the I/I Surcharge Program by motion in February 2006. Inflow/Infiltration Surcharge procedures were adopted by the Metropolitan Council pursuant to Minnesota Statutes (M.S.), chapter 473, including section 473.145-146 and section 473.858, and the Metropolitan Council Environmental Services Waste Discharge Rules, and are declared to be necessary for the efficient, economic, and safe operation of the MDS and for protection of the health, safety, and general welfare of the public in the metropolitan region. Additionally, the Council's Water Resources Management Policy Plan established I/I goals for communities served by the regional

Metropolitan Disposal System. These goals were based on Metropolitan Disposal System design standards and regional growth requirements and projections. The I/I Surcharge is based on the authority in M.S. 473.517, subdivision 1, “Except as provided in Subdivision 3, the estimated costs of operation, maintenance, and debt service of the Metropolitan Disposal System to be paid by the council in each fiscal year, and the costs of acquisition and betterment of the system which are to be paid during the year from funds other than bond proceeds, including all expenses incurred by the council pursuant to sections 473.501 to 473.545, are referred to in this section as current costs, and shall be allocated among and paid by all local government units which will discharge sewage, directly or indirectly, into the Metropolitan Disposal System during the budget year according to an allocation method determined by the council. The allocated costs may include an amount for a reserve or contingency fund and an amount for cash flow management.” These funds will be held in reserve for Council costs to provide capacity unless municipal actions obviate the need for peak demand improvements to the MDS.

Satellite Response

Satellites of Metropolitan Council are responding to this Surcharge Program by actively working on I/I issues within their systems. Activities include:

Investigations, flow metering, hydraulic modeling, sewer televising;
Pipe and manhole rehabilitation;
Storm drainage improvements; and
Private property programs for sump pumps, foundation drains, downspout connections, and leaky laterals.

Ordinances

All communities served by MCES must have adopted ordinances that prohibit the connection of roof leaders, foundation drain tile and sump pumps from new construction to the sanitary sewer system. If these sources of I/I are significant in the community, the ordinances should also require the disconnection of any roof leaders, foundation drain tile or sump pumps currently connected to the sanitary sewer system.

Public Education and Outreach

In 2009, MCES produced a "tool box" that highlights programs and products as potential solutions to I/I problems that communities can use. This tool box address I/I control for both public and private systems. **MCES** has also developed a website aimed at educating the public on their I/I program. The website can be viewed at http://www.metrocouncil.org/environment/ProjectTeams/documents/I-I-tool-box.pdf.

Findings and Next Steps

Satellites of Metropolitan Council are responding to this Surcharge Program by actively working on I/I issues within their systems. Activities include:

- Investigations, flow metering, hydraulic modeling, CCTV inspections;
- Pipe and manhole rehabilitation;
- Storm drainage improvements; and
- Private property programs for sump pumps, foundation drains, downspout connections, and leaky laterals.

5.1.1.2 Renewable Water Resources, South Carolina

Renewable Water Resources (ReWa) is a special purpose district originally created in 1925 under the name of the "Greater Greenville Sewer District". In 1974, the name, Greater Greenville Sewer District was changed to Western Carolina Regional Sewer Authority and the name was changed to Renewable Water Resources (ReWa) in 2009.

Governance

ReWa is governed by a nine- member Board of Commission (BOC). Each member of the BOC is appointed to a four-year term by the Governor upon recommendation of the respective county legislative delegation. Seven members are residents of Greenville County with the remaining two required to be from Anderson and Laurens Counties.

ReWa serves 5 counties with a total of 18 satellites. Table 6 below shows their public partners.

Table 6 Renewable Water Resources Partners

ReWa Partners				
Anderson County Wastewater Management	Berea Public Service District	City of Fountain Inn	Gantt Fire, Sewer & Police District	City of Greenville
Greer Commission of Public Works	Laurens County Water & Sewer Commission	Marietta Water, Fire, Sanitation & Sewer District	City of Mauldin	Metropolitan Sewer Subdistrict
Parker Sewer & Fire Subdistrict	Pickens County Public Service Commission	Piedmont Public Service District	City of Simpsonville Public Works	Slater Water, Sewer & Light District
Taylors Fire & Sewer District	City of Travelers Rest	Wade Hampton Fire & Sewer District		

The ReWa service area and Table 7 provides an overview of the District.

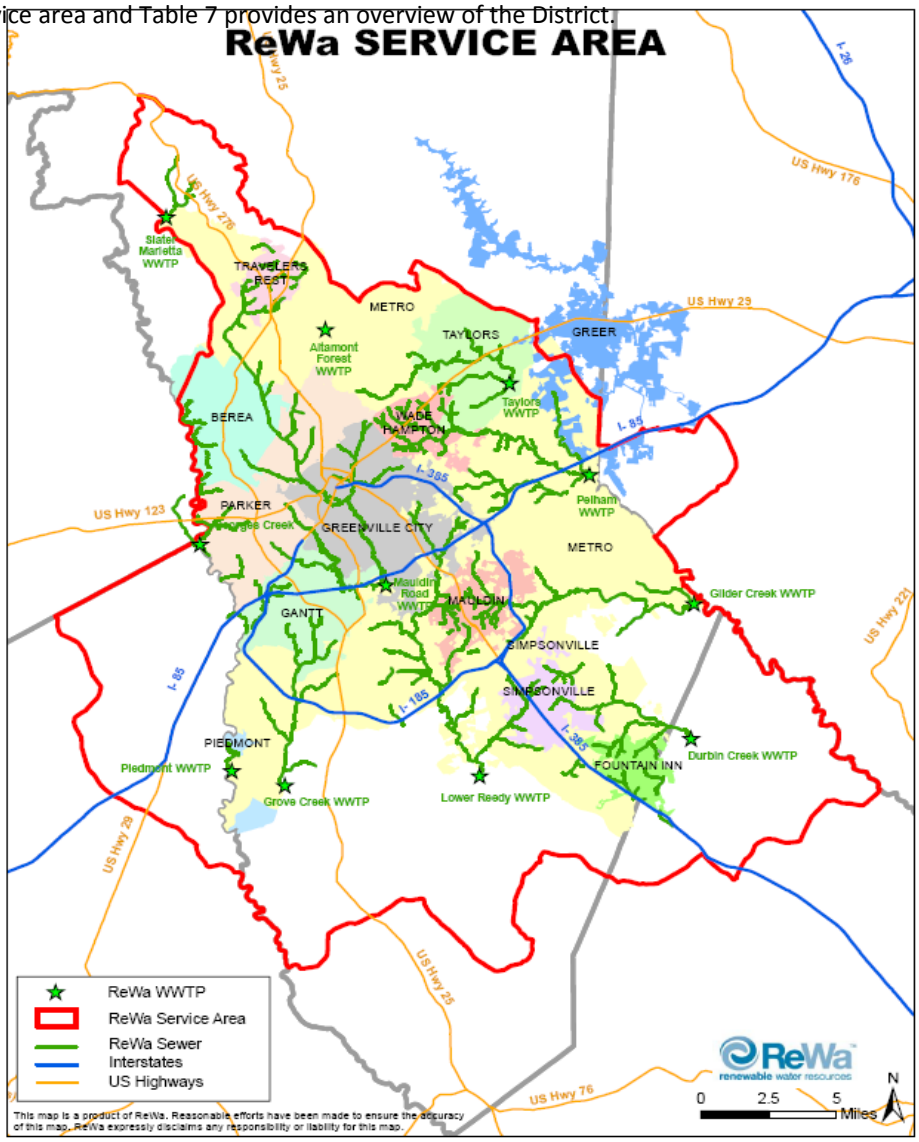


Figure 1 Renewable Water Resources Service Area

Table 7 Renewable Water Resources Profile

ReWa (Renewable Water Resources) Profile	
Population Served	450,000 industrial, commercial and residential customers
Service Area	767 km^2
# of Agencies / Satellite Communities	5 Counties/18 Satellites
Length of Regional System	565 km of Trunk Sewer
Length of Local System	2,815 km of Collector Sewer
# of Wastewater Treatment Plants	10
# of Pump Stations	63
# of Flow Metering Stations	93 permanent, 25 temporary

The individual partners served by ReWa own and operate their own local sewer systems. They work with 18 public partners to maintain their 2,815 km miles of lateral/collector sewer lines that connect to ReWa's 565 km of trunk lines and 10 treatment facilities. ReWa's systems of trunk sewers collect flows from the local sewer system and convey it to one of the 10 treatment plants operated by ReWa. In 1988 ReWa developed a long range plan consisting of three key initiatives. These were:

- Consolidation of thirty-seven wastewater treatment plants into seven regional treatment facilities.
- Increase trunk line design capacities and monitor flow levels to insure adequate capacity for economic and residential growth.
- Encourage agencies contributing wastewater to ReWa trunk lines and treatment facilities to thoroughly evaluate their collection systems and reduce infiltration and inflow to acceptable levels.

I/I Reduction

In order to stimulate regional planning efforts and to accomplish long range plan initiatives, ReWa formed the Upstate Roundtable Wastewater Infrastructure Committee, a study group of fifty business, community, and neighbourhood leaders. Included in the Committee's report were recommendations concerning long range planning and system capacity. Part of the report was an evaluation of excessive wet weather flows to its wastewater treatment plants and the impact this increased flow would have on ReWa's operations. It was the conclusion of the study group that this increased flow would decrease available treatment capacity and should be solved by community-wide solutions such as intergovernmental agreements addressing I/I problems.

In recent years, ReWa has seen the adverse wet weather impacts on its regional conveyance and treatment facilities. At some of their plants they have seen peak wet weather flows that are as much as six times average daily flows. These wet weather peak flows may cause trunk sewer surcharges which leave the potential for overflows from their system. In an effort to address these peak flows the ReWa board amended its regional Sewer Use Ordinance by a resolution adopted on May 5, 2008. The resolution added a requirement to Section 4.1, Prohibited Discharges. The requirement is as follows:

(15) Wastewater which includes excessive infiltration and inflow shall be defined as a flow which exceeds the applicable Babbitt Equation[1] for the pipe in question during a 10 year rain event. For purposes of this regulation, excessive wet weather flows for any 3 consecutive rain events above 1" shall

[1] The Babbitt Equation is $PF=5/P^{0.1667}$, PF=allowable peaking factor, P=residential population in thousands

be considered non-compliant. In the case of a conflict between this provision and any separate Agreement between WCRSA and a User regarding I/I, the terms of the Agreement shall be controlling.

This rule change by the Board established a uniform standard against which adequate progress on individual I/I reduction work plans could be measured.

Interagency Agreements

From 2004 through 2007, ReWa sent a total of 586 notification letters of excessive I/I to its satellites. Starting in 2006 ReWa initiated an extensive flow monitoring program by placing 118 flow meters into service to document the extent of I/I from its satellites. In studying the situation, ReWa determined that I/I from local industry contributed less than 2% of the region's wet weather flow.

As of 2009, ReWa was negotiating Cooperative Agreements with each of its 17 satellite entities. The agreements already negotiated have several mandatory objectives that apply to all satellites. Each satellite must:

- Provide a work plan that outlines the satellite's 15-year Sewer Maintenance and Rehabilitation Program,
- Provide a dedicated annual revenue stream to fund the program,
- Show individual progress and improvements to satellite's sewer system, and
- Reduce the amount of excessive rain and runoff water entering the satellite system

ReWa Support to Satellite Agencies

Apart from the four mandatory elements the cooperative agreements allow for an individual, satellite-specific approach to the other issues included. Once the agreement is negotiated, ReWa has committed to supporting the implementing party through the following activities:

- Treatment/Pre-Treatment Support: ReWa provides their treatment plants as disposal sites for satellites that vacuum out solids during their sewer cleaning activities. Pre-treatment support includes the Grease Control Program, investigating specific grease issues, providing public education brochures, ensuring industrial dischargers obtain approval from satellites for increasing discharges, and providing flow information about specific industrial users.
- Engineering: ReWa provides a variety of support to its satellites, including technical engineering advice, a Cooperative Computerized Mapping Program, basin flow monitoring data, piggy-backing onto ReWa supply and service contracts, and working to improve the County Planning Procedure.
- Collection System: Staff of ReWa provides technical advice on unusual sewer maintenance problems and assistance with short term emergency maintenance work. ReWa also provides specialty heavy equipment and crews under these challenging work conditions. Finally, ReWa works with satellites on chemical destruction of tree roots growing in local sewers.

Public Education and Communication

Renewable Water Resources (ReWa) has recently presented a slide presentation titled "The Impact of Infiltration and Inflow on Urban Sewer Systems" and can be viewed on their website. www.**rewa**online.org/docs/**Infiltration**-Presentation.pdf .

ReWa's goal is to promote a cleaner environment, and to protect the public health and water quality of the Upstate waterways, while providing and developing the necessary sewer infrastructure for the growing economy. The Upstate Roundtable is a volunteer collaboration of community, business and governmental leaders, as well as technical experts, to review and solve the challenges of aligning the Upstate's wastewater infrastructure capacity with its growth. The identified strategies are designed to

optimize future capacity and further information on this study is at:
http://www.upstateroundtable.org/docs/Upstate-Roundtable-Brochure.pdf

-

Data and Information Tracking

Data from ReWa's 118 meters and 13 rain gauges is collected, reviewed, analyzed and reported monthly. The data and reports are customized to the agencies needs and are certified by a South Carolina Professional Engineer.

Program Funding

ReWa does not receive funds from local or state taxes. All of their expenditures are funded through a combination of user fees, state revolving fund loans, revenue debt issues and internal equity generated from system revenues.

5.1.1.3 Milwaukee Metropolitan Sewerage District, Wisconsin

The Milwaukee Metropolitan Sewerage District (MMSD) is a state-chartered government agency that provides regional wastewater conveyance, treatment, and disposal to the City of Milwaukee and most of Milwaukee County, including 29 agencies and municipalities within Waukesha, Ozaukee, Racine and Washington County in the state of Wisconsin, USA. The MMSD was created in 1982 by the reorganization of its predecessor bodies – the Metropolitan Sewerage District of the county of Milwaukee and the city of Milwaukee Sewerage Commission.

Governance

The composition of the MMSD Commission, which functions as MMSD's board, is as follows: seven members are appointed by the Mayor of the city of Milwaukee (subject to Common Council confirmation) and four members are appointed by an Executive Council. The Executive Council includes the elected executive officer of each village and city (except Milwaukee and South Milwaukee) within Milwaukee County.

The municipalities served by MMSD own and operate their own local sewer system. MMSD's system of interceptor sewers collect flows from the local sewer system and conveys it to one of the two treatment plants or to the inline storage system. The inline storage system, known as the Deep Tunnel, are 19.4 miles of temporary storage located at depths of up to 325 feet, within which wastewater and combined sewer flows can be temporarily stored. The district also maintains overflow points that can discharge untreated wastewater into local waterways during periods of heavy precipitation when the conveyance and storage system capacity is exceeded. Below shows the MMSD service area and provides an overview of the District.

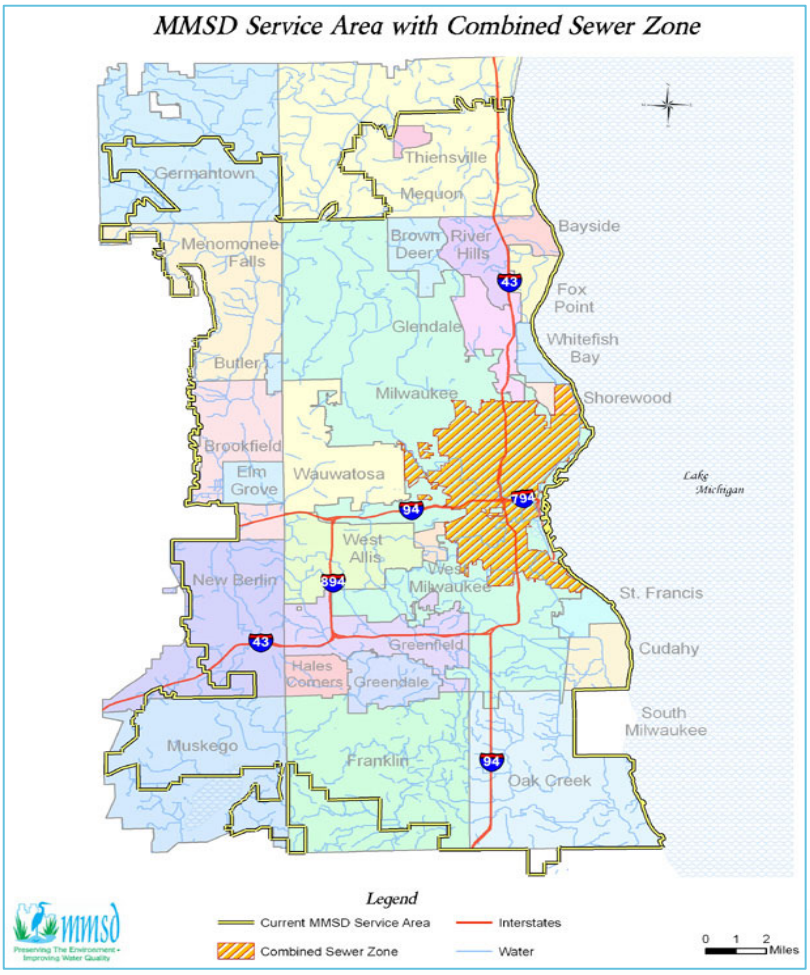


Figure 2 Milwaukee Metropolitan Sewerage District

Table 8 Milwaukee Metropolitan Sewerage District Profile

Milwaukee Metropolitan Sewerage District (MMSD) Profile	
Population Served	1,100,000
Service Area	987 km^2 of Sanitary Sewer Service Area 62 km^2 of Combined Sewer Service Area
# of Agencies / Satellite Communities	5 Counties, 29 Communities
Length of Regional System	350 km
Length of Local System	3,000 miles
# of Wastewater Treatment Plants	2
# of Pump Stations	8
# of Flow Metering Stations	147 permanent, 183 portable

The municipalities served by MMSD own and operate their own local sewer systems. MMSD's system of interceptor sewers collect flows from the local sewer system and conveys it to one of the two treatment plants or to the inline storage system. The inline storage system, known as the Deep Tunnel, is 31.2 km of temporary storage located at depths of up to 99 meters, within which wastewater and combined sewer flows can be temporarily stored. The district also maintains overflow points that can discharge untreated wastewater into local waterways during periods of heavy precipitation.

The MMSD is a state-chartered government agency tasked with the mission to protect public health, property and the environment by providing wastewater conveyance, treatment and flood management services. It is responsible for the construction, operation, and maintenance of interceptor sewers and wastewater treatment facilities within its sewer service area and has permissive authority for flood management and watercourse improvements. The MMSD has the authority to impose rules and regulations, which may be promulgated by MMSD so long as they are necessary and proper to promote the best operation of the system, prevent damage to the sewerage system, prevent surcharging in all or part of the sewerage system, prevent interference with the process of sewage treatment or disposal, or to comply with federal or state pre-treatment requirements. The MMSD may acquire by gift, purchase, lease (or other like methods), or by condemnation any land or property necessary for the operations of the Commission.

In 1986 the District began a Water Pollution Abatement Program, a comprehensive, multi-year, sewer improvement program in order to comply with stricter federal water quality standards and eliminate sanitary sewer overflows. The Deep Tunnel was built as part of this effort and was expected to end all sanitary sewer overflows. Prior to 1994, there was on average 50 overflows annually. In the first eight years since the Deep Tunnel began operating, the period 1994 through 2002, there were 39 sanitary sewer overflows and 24 combined sewer overflows. One of the factors contributing to continuing sewer overflows was an increase in inflow and infiltration into the satellite municipalities' sewer systems which had gone up by 17.4% over 1980 levels. Other factors that contributed to the continued overflows included large storms, capacity issues in the Deep Tunnel and the District's sewers and treatment facilities and operational policies.

I/I Reduction

In 1998, the District adopted new rules directing municipalities served by the District to minimize infiltration and inflow to the "maximum extent economically achievable." To assist the municipalities in implementing the rules, the District budgeted $8.6 million to provide funding for municipalities to

evaluate their sewer systems. In 2002, as part of its 2010 Facility Plan, in an effort to reduce the amount of storm water entering the District's sewer systems, treatment plants and Deep tunnel, the District:

- Implemented new inflow and infiltration limits to reduce district-wide inflow and infiltration by 5 % through 2010.
- Required municipalities to include runoff management systems as part of any development plans.
- Funded 8 local demonstration projects, at a cost of $2.1 million, to identify economically feasible approaches for addressing inflow and infiltration problems.
- Allocated $945,000 to address inflow and infiltration problems within its own sewer system.
- Implemented watercourse improvement projects. These projects were primarily aimed at reducing the damage to structures caused by flooding and improving water quality. However, they also served to reduce inflow into the sewer systems.
-

Definition of Excessive I/I

The District does not define excessive I/I instead it has a maximum allowable peak hourly rate. The maximum allowable peak hourly rate is based on the sanitary metershed area. If flow monitoring data from wet weather events shows that the actual peak hourly flow rate is less than the maximum allowable peak hourly flow rate then peak hourly flow rate reduction is not required.

-

Interagency Agreements

As of 2002, the District believed that the amount of inflow and infiltration contributed by the District owned sewer system was small and that a majority of it came from the satellite municipalities systems. In the District's 2020 Facility Plan, developed in 2007 and amended in January 2010, the district has requirements for inflow and infiltration management in the satellite municipalities. It requires the satellite municipalities to:

- Establish capacity assurance, management, operations and maintenance programs for their sewage systems.
- Develop and implement an infiltration and inflow management plan for a 5-year period. Plans should aim to achieve I/I rates and peak flow rates less than or equal to rates occurring as of year 2000. Rate increases are allowed, by District approval, where development has occurred.
- Prohibiting connections of artesian wells, cistern overflow, door well, roof, subsoil, unroofed basement excavation, window well, yard, or other drains from areas exposed to rain, melting snow, surface water, or groundwater, including certain foundation drains
- Implement and enforce prohibited connection ordinances.
- Prepare an Annual Report. Before March 1 of each year each governmental unit within the District's service area must submit an annual report to the District that summarizes actions occurring during the preceding calendar year. Topics that must be presented include items such as the location and length of all pipeline and manhole inspections that were conducted; the number and type of defects identified and corrective actions taken; prohibited connections identified and corrective actions taken, etc. Descriptions and the cost of new investigations, flow monitoring activities and rehabilitation activities must also be provided.

Public Education and Communication

- Public Information & Education Awards honour agencies for their inventive efforts to educate the public on the effects of waste water treatment and pollution control on the environment. To qualify, the program, publication, video or e-media must have been produced by the agency staff or by an outside vendor at the express direction of the

agency and must cover some aspect of the agency's operations. Materials must have been produced for general use or distribution. Information on this website can be viewed at:

- http://www.nacwa.org/index.php?option=com_content&view=article&id=190%3Apublic-information-and-education-awards&catid=36%3Aneaa&Itemid=62.
-

The Milwaukee Metropolitan Sewerage District (MMSD) launched an effort to reduce non-point water pollutants and to ensure success the MMSD believes it must increase public awareness and public education of the sources of pollutants, further information on this practice can be viewed on the website at:
http://books.google.ca/books?id=AXQx9xuIvBwC&pg=PA18&lpg=PA18&dq=public+outreach+education+at+milwaukee+metropolitan+sewerage+district&source=bl&ots=Ldx2IGwfz6&sig=271KezSl5ggGmuph135B87qbIcc&hl=en&ei=WeWtTIeXKZOcsQO4lYiLDA&sa=X&oi=book_result&ct=result&resnum=6&ved=0CCkQ6AEwBQ#v=onepage&q=public%20outreach%20education%20at%20milwaukee%20metropolitan%20sewerage%20district&f=false

Data and Information Tracking
The MMSD conveyance system was modeled as part of the 2020 Facilities Plan. During the calibration/validation period (1998 through 2001) hourly level and flow data was obtained from 191 permanent flow meters. In addition, flows from each of the wastewater treatment plant, flows from pumping stations, and levels in diversion chambers and bypass stations were used to validate their hydraulic model calibration.

Program Funding
The District's primary sources of revenue are taxes levied on property within the District, sewer user charges assessed against all municipalities served by the District, interest income, and capital charges on ten municipalities outside the District's service area that do not pay property taxes to the District.

The MMSD has financial powers to raise funds for both its capital improvement program and its operation and maintenance responsibilities. The Commissioners establish and enforce MMSD policy through two standing committees: the Policy, Finance & Personnel Committee and the Operations Committee. Most of MMSD's major financing decisions require an approving vote of two-thirds of all Commissioners.

The Districts 2010 Capital Budget included a project entitled "I/I Reduction on Private Property, Phase II" that served as a funding mechanism to the municipalities for certain type of I/I reductions efforts on private property. The budget provides $1 million per year for five years, for a total of $5 million from 2010-2014.

The District provides funding to local agencies to help them find I/I within their systems.

Satellite Reporting Requirements:
Prior to March 1 of each year, every governmental unit within the District's service area must submit an annual report to the District. The report summarizes actions occurring in the preceding calendar year. For new sewers, the report shall include the location and length of public sewers and private interceptor main sewers inspected during construction.

For existing sanitary sewers, the report shall include:

The number of manholes inspected the number and type of defects identified, and the action taken to correct the defects.
The length of public sewer and private interceptor main sewers inspected, the length of inspected sewer needing rehabilitation, and the length of sewer rehabilitate or relayed.
The length of building sewer inspected the length of inspected sewer needing rehabilitation, and the length of sewer rehabilitated or relayed.
Investigations of prohibited connections and the actions taken to eliminate the connections.
A description of where flow monitoring occurred and an analysis of flow monitoring results.
Costs for the management, operations, and maintenance activities required by Chapter 3 of the District's Rules.

5.1.1.4 King County Wastewater Treatment Division, Washington

King County provides wastewater treatment to 17 cities and 17 local sewer utilities. The county's wastewater treatment division (KCWTD) serves most urban areas of King County and parts of south Snohomish County and northeast Pierce County.

Governance

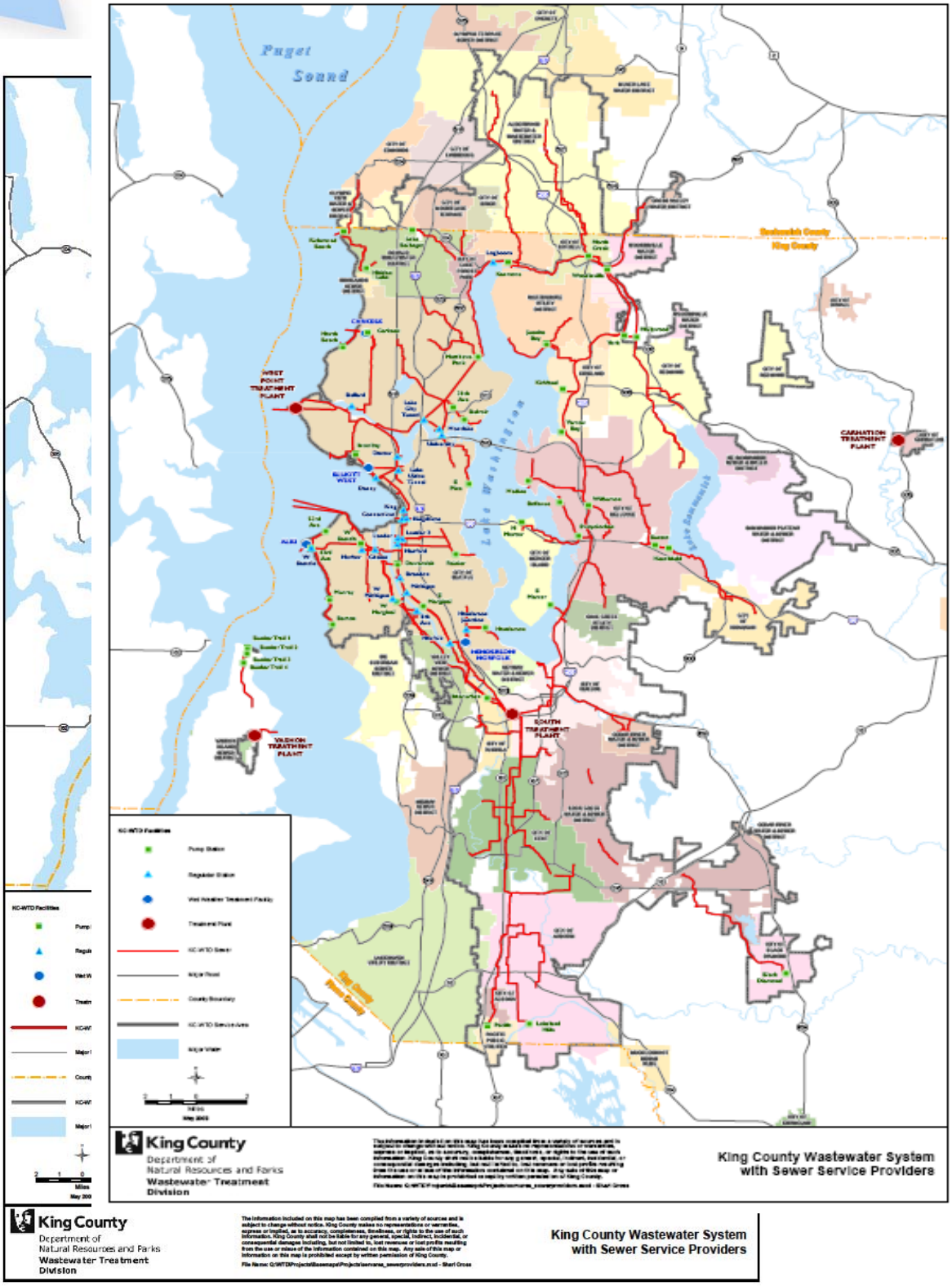
KCTWD is governed by a 34 member Board which reports to the KC council. It's I/I program is voluntary for the satellite agencies. A parallel committee, the Metropolitan Water Pollution Abatement Advisory Committee (MWPACC) advises the King County council and Executive in regards to water pollution abatement. Each member city and local sewer utility appoints a representative to the committee. It provides I/I oversight to the County. MWPAAC's Engineering & Planning subcommittee is actively involved with I/I standards and guidelines, policies and procedures development.

The KC council is the legislative branch of County Government. It adopts laws, sets policies and holds final approval over the budget. Council members represent geographic districts. Each county citizen has an opportunity to vote for a representative on the County Council. The King County Executive is the elected executive officer of county government. Every citizen of the County has an opportunity to vote for the Executive, who is elected on a countywide basis. **Error! Reference source not found.** shows their service area Table 9 provides an overview of the Division.

Table 9 King County WW Treatment Division Profile

King County Wastewater Treatment Division (KCWTD) Profile	
Population Served	1.5 million
Service Area	1,087.8 km^2
# of Agencies / Satellite Communities	17 cities, 17 local sewer utilities
Length of Regional System	Over 563 km
# of Wastewater Treatment Plants	2 large regional WWTPs 2 small WWTPs 1 community septic system 4 CSO treatment facilities
# of Pump Stations	42
# of Flow Metering Stations	232 (219 portable area-velocity flow meters and 13 pump station meters)

The communities served by KCWTD own and operate independent collection systems, which include pipelines and pump stations to collect and carry wastewater flows in their service area to King County's regional system for treatment and disposal. With the exception of portions of the City of Seattle that have combined sewers, sewers in the regional wastewater system are designed to convey only wastewater. However, infiltration and inflow is evident, and that the "separated" sewers also convey stormwater and groundwater. The local agencies have 30-year agreements with King County for this service. King County owns and operates the regional treatment plants, pipelines, pump stations and other related facilities.



I/I Reduction

Recognizing the need to explore the feasibility of infiltration and inflow control, the King County Regional Infiltration and Inflow Control Program was created in 1999 as part of the Regional Water Services Plan (RWSP). A key policy statement in regards to I/I control that was approved as part of the RWSP was I/IP-1. Policy I/IP-1 set forth development of the King County I/I Control Program, it states: "King County is

committed to controlling I/I within its regional conveyance system and shall rehabilitate portions of its regional conveyance system to reduce I/I whenever the cost of rehabilitation is less than the costs of conveying and treating that flow or when rehabilitation provides significant environmental benefits to water quantity, water quality, stream flows, wetlands, or habitat for species listed under the Endangered Species Act (ESA)."

Definition of Excessive I/I
King County Code allows for 1,100 gallons-per-acre-day (gpad) of inflow/infiltration. Design of conveyance facilities are based on this value and flows in excess of that would be considered excessive.

Interagency Agreements
Under long-term agreements with local sewer agencies in its service area, King County charges each agency a monthly amount for providing wastewater treatment. That amount is based on King County's monthly sewer rate and the number of customers served by the local agency. In turn, the local agencies bill the residences, businesses and industries in their wastewater collection system to recover the county charge plus the amount needed to operate their local collection systems.

In its wastewater disposal agreements with the 34 agencies that it serves King County addresses I/I control through reference to Section 28.84.050 of the King County Code. These references establish an I/I threshold of 1,100 gpad and a corresponding surcharge penalty for exceedance of the threshold. They also require local sewers to be constructed and maintained in accordance with the rules and regulations of Metro (King County).

As of 2005, the County had not enforced these provisions. No financial or penalties for I/I control have been implemented. All of the 34 agencies pay a uniform sewer rate. Enforcing the provisions is difficult because the agreements approach the threshold and surcharge in different ways. In 25 of the agreements the language of the agreement exempt pipes constructed prior to 1961 from the threshold or surcharge.

The agreements with the remaining nine agencies do not contain a pre-1961 pipe exemption. These agreements allow for a charge to be assessed for I/I flows above the established threshold if an agency fails to "undertake continual rehabilitation and replacement of…local sewage facilities for purposes of preventing, reducing, and eliminating the entry of extraneous waters" and to "expend annually, averaged over five years, an amount equal to two cents per inch of diameter per foot of its local sewage facilities, excluding combined sewers and force mains.

KCWTD Support to Satellite Agencies
As part of the RWSP I/I control program, beginning in 2000 the KCWTD staff worked with local sewer agencies on a comprehensive 6-year, $41 million I/I control study. The following work was completed as part of the study:

Defined current levels of I/I for each local agency tributary to the regional system through extensive flow monitoring and modeling program (2001-2002),
Selected and constructed 10 pilot projects in 12 local agency jurisdictions to demonstrate the effectiveness of collection system rehabilitation projects and to test various technologies and gain cost information (2003-2004),
Developed final draft model standards, procedures, policies, and guidelines (October 2004) for use by local agencies to reduce I/I in their systems,
Completed a thorough benefit-cost analysis to determine the cost-effectiveness of I/I reduction (November 2005),
Developed a long-term regional I/I control plan, approved by the King County Council (May 2006), and

King County worked with the local sewer agencies to conduct an I/I reduction feasibility analysis and selected three initial I/I reduction project areas (2007-2009).

Next steps include the construction of initial I/I reduction projects in drainage basins in Skyway (unincorporated King County), Bellevue, and Issaquah (2011-2012). These projects will test the cost-effectiveness of I/I reduction on a scale large enough to offset the need for larger conveyance or storage facilities. The results of these initial projects will be used to develop recommendations to the King County Council regarding long-term I/I reduction and control, including applicable changes to policy or code.

Final recommendations of the study were published in the document titled: "Executive's Recommended Regional Infiltration and Inflow Control Program". Recommendations for I/I reduction include:

- Identify cost-effective I/I reduction projects on a project-specific basis, rather than on a regional basis or by the need to meet specific I/I reduction targets.
- Select 2 or 3 initial I/I reduction projects for implementation from the list of 9 cost effective projects identified in the benefit-cost analysis. King County and MWPAAC (through the E&P Subcommittee) would work cooperatively to select these projects.
- In the next 3 to 5 years, construct the selected initial projects to test planning assumptions and to gain more information about costs.
- Proceed with work on private property when a project calls for it. Experiences on initial projects would be documented in terms of public involvement activities, private property participation rates, costs, neighbourhood impacts, groundwater effects, and special construction issues that arise.
- Fund initial projects through King County wastewater revenue that is dedicated to funding CSI projects in the regional conveyance system. For future I/I reduction projects, options to supplement King County funding may be considered. For example, local agencies could contribute funds to expand the project scope in order to take advantage of construction efficiencies, as was done in some pilot projects, or to move a project into the cost-effective category.
- Conduct pre- and post-project flow monitoring to test the ability of I/I reduction projects to reduce enough flow to delay, downsize, or eliminate the need for CSI projects.
- Reconvene the E&P Subcommittee when initial projects and post-project flow monitoring are completed to evaluate results of projects, adjust planning assumptions if appropriate, and further refine private property protocols or best practices to ensure that successful approaches are carried forward to future work.
- If the initial projects are deemed successful and future I/I reduction is approved, proceed programmatically to apply I/I reduction planning to all CSI project planning. Wherever an I/I reduction project is a cost-effective alternative to the planned CSI project, the County and local agencies would implement the I/I reduction project provided that it is environmentally and logistically feasible.
-

Recommendations for Long-Term I/I Control:

- Make use of existing local agency regulations to ensure that new development and redevelopment within the regional wastewater service area meet up-to-date construction standards for sewer conveyance lines and connections.
- Apply the standards, guidelines, procedures, and policies in final draft form to the initial I/I reduction projects. Once they have been tested on large-scale projects, the standards, guidelines, procedures, and policies would be reviewed and finalized by the local agencies and translated into King County policy in the form of an ordinance.
- Conduct a system flow audit of the regional and local systems every 10 years to track I/I levels. The County and local agencies would conduct the audits and use the information to cooperatively make decisions about how to adjust I/I control measures as may be necessary.
- Do not implement a surcharge on local agencies for flows that exceed targeted I/I reduction levels already established in the King County Code. The County and local

agencies found that implementing a surcharge, as contemplated in the King County Code, would be costly to administer and would pose difficulties in verifying violations.

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Recommendations for Program Administration and Policy

- Authorize King County to centrally manage the I/I control program, to develop public information materials for the overall program, and to serve as a central clearinghouse for program inquiries and training.
- Conduct flow monitoring to assess effectiveness of I/I reduction over time.
- After completion of the initial I/I reduction projects, develop recommendations regarding changes to local agency agreements and/or the King County Code.
-

Data and Information Tracking

The Decennial Flow Monitoring (DFM) Project began in 2009. A total of 232 flow monitoring units were installed in the separated portion of WTD's service area. These meters will be maintained and flow data will be collected over a two wet-season period from September 2009 through early-to-mid 2011. Data derived from the monitoring project will provide the information necessary to check and revised several planning assumptions for conveyance system projects slated for construction over the next 40 years. The final data will also be available to satellite agencies for use in planning and design.

Program Funding

The initial I/I reduction projects are funded with King County wastewater revenue that has been earmarked for funding CSI projects in the regional conveyance system. Future cost-effective I/I reduction projects would also be funded, at least in part, by King County.

During development of the *Alternatives/Options Report* 4 funding alternatives were considered for the regional I/I control program. The 4 funding alternatives and the feasibility of their application to future cost-effective I/I projects are as follows:

- King County funds the entire project. The County would fund I/I reduction projects that are cost effective as determined by criteria used in the cost-benefit analysis.
- King County and the local agencies share costs. If an I/I reduction project has a benefit-cost ration less than 1, a local agency may contribute its own funds to the project to make the project cost effective for the region.
- Private property owners participate. Unlikely this option would be used. King County has agreed to fund all cost effective I/I reduction work, including work on private property.
- Related project costs are funded as part of another agency's multipurpose project. An I/I reduction project that is not cost effective as a stand along project could be cost effective if other funding sources pay for related project costs.
-

King County charges each agency on a monthly basis for providing wastewater treatment. The charge is based on King County's monthly sewer rate and the number of customers served by the local agency. In addition, since 1990 King County has levied a capacity charge on new connections to the sewer system. New customers pay the capacity charge in addition to their monthly sewer bill. The County uses the capacity charge to cover the cost of sewer improvement and expansion projects needed to serve new growth.

KCWTD maintains a separate agreement with each satellite agency for which it provides sewer services. Wastewater disposal rules and regulations for local agencies discharging to the King County conveyance system are stipulated in the King County Code. The code has provisions to levy an additional charge for flows in excess of the volume established for design purposes. This flow, in addition to base wastewater flows has an allowance for I/I of 1,100 gallons per acre day (gpad). In addition the King County Code

serves to address I/I control by requiring local sewers to be constructed and maintained to King County standards. Up to now the County has not enforced these provisions. No financial incentives or penalties for I/I control have been implemented; all component agencies pay a uniform sewer rate.

Public Education and Outreach:
They have also developed a public website and outreach materials for both I/I reduction and specific projects can be found at http://your.kingcounty.gov/dnrp/library/wastewater/ii/AltOptions/Report.pdf. The ongoing statistics taken from the inception of the program in 2000 to 2004 has shown a remarkable increase for public awareness on the topic. King County offers wastewater tours that focus on several topics, including the impacts of stormwater and groundwater have on water management.

5.1.1.5 Metropolitan Sewer District of Greater Cincinnati (MSD)

The Metropolitan Sewer District of Greater Cincinnati (MSD) is the publicly-operated wastewater utility serving 43 out of 49 Hamilton Counties, Ohio political subdivisions, as well as parts of the three adjacent counties of Butler, Clermont, and Warren. It has a ratepayer base of approximately 230,000 residential and commercial users. MSD provides sewerage collection and treatment services to an area covering approximately more than 290 square miles, containing over 200,000 separate sewer connections which tie into approximately 3,000 miles of sanitary and combined sewers.

During Fiscal Year 2009, MSD operated seven major wastewater treatment plants, more than 120 pump stations, and three package treatment plants that resulted in treatment of approximately 184 million gallons daily of collected wastewater. It monitors about 200 industrial users who discharge pre-treated waste into the sewer system. MSD utilizes a five-year capital planning cycle for the repair, replacement, or improvement of its physical infrastructure assets, with estimated project legislations of $165M for 2010 and $908M for the five year cycle of 2010-2014.

The Board of County Commissioners of Hamilton County, Ohio created the sewer district in 1968. They fund and set policy for the district's operations. On April 10, 1968, they established a 50-year contractual arrangement with the City of Cincinnati, for the management of MSD's daily operations and sustainability.

The Capacity Assurance Program Plan (CAPP) project was developed to meet the Metropolitan Sewer District of Greater Cincinnati (MSD) Interim and Global Consent Decree mandates regarding assurance of capacity to control sanitary sewer overflows (SSOs).

Figure 4 shows the service area for MSD

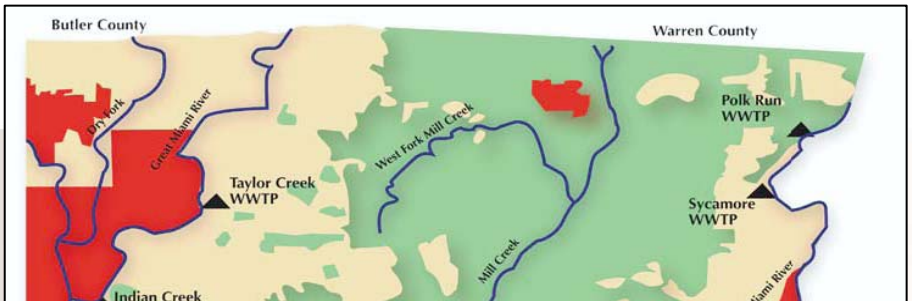


Figure 4 MSD Service Area

Table 10 Metropolitan Sewer District of Greater Cincinnati (MSD) Profile

Metropolitan Sewer District of Greater Cincinnati (MSD) Profile	
Population Served	1.5 million
Service Area	Over 1,036 square km
# of Agencies / Satellite Communities	43 political subdivision plus 3 counties
Length of Regional System	Over 563 km
# of Wastewater Treatment Plants	7 large regional WWTPs 6 extended aeration treatment plants
# of Pump Stations	141
# of Flow Metering Stations	230 flow monitors 32 rain gauges

I/I Reduction

MSDGC initiated the rainfall-derived I/I (RDI/I) Removal Program with a pilot study in the village of Mariemont in the eastern part of Hamilton County. Mariemont was an area that had SSOs and had experienced considerable basement backups due to the surcharging of the sanitary-only sewer.

The Mariemont project began with smoke testing followed by dye testing of all connections that smoked. This was quickly changed to smoke testing followed with dye testing of all downspouts, driveway drains, and area drains. In addition, any inlets on storm sewers that crossed the sanitary sewer were smoke and dye tested. Manhole inspection was also a part of this program, but no flow monitoring was done with this project.

This pilot program was then expanded to include all areas with active enumerated SSOs.
I/I identification and removal focused on inflow in the beginning of the program; this focus changed to infiltration as the I/I effort matured. Flow monitoring was utilized and MSDGC began to investigate infiltration sources such as sump pumps, foundation drains, and lateral integrity. The Matson Area in Deer Park was the pilot project for this next step.

MSDGC found a close correlation between the capacity and maintenance of the storm sewer system and the inflow into the sanitary sewer. The stormwater flows into houses in areas where the storm sewer system (or lack of storm sewer system) causes street flooding or flooding around the houses. The stormwater flows into depressed driveways under the houses, through window wells around the houses, and through cracks between the foundation and the soil surrounding the foundation.

Definition of Excessive I/I

The district has an allowance of 1,000 gallons per day for the gross tributary area of the drainage basin.

Sewer Connection Credits

For every new gallon of sanitary sewage added to MSDGC's combined sewer system, four gallons of storm water must be removed and for every new gallon of sanitary sewage added to MSDGC's sanitary sewers, five gallons of storm water must be removed.

MSDGC uses a system of connection "credits" to manage sewer connections. Any change that will increase wastewater flow into the sewer system requires a certain number of credits, depending on the amount of wastewater introduced through the new connection. In general, one credit is required for new connections that will generate a flow equivalent to that produced by an average single-family residential home.

To obtain one connection credit, an amount of storm water equivalent to the amount of wastewater flow generated by four residential properties must be removed from the system.

MSDGC creates connection credits by completing sewer improvement projects that increase capacity and flow in the sewer system. MSDGC then banks its credits and makes them available to developers on a first-come, first-served basis. Developers can also create credits and apply them toward their own projects.

Statutory Regulations

Hamilton County, the City of Cincinnati, and the U.S. and Ohio EPAs agreed to the Interim Partial Consent Decree on Sanitary Sewer Overflows (SSOs) (aka, *SSO Decree*) in February 2002. The decree focused on the overflows from the separated (or sanitary) sewer system and required the remediation of 17 highly active SSOs in MSDGC's separated system, the development of a comprehensive, system-wide sewer model, the development of interim and permanent solutions to the most active overflow (SSO 700), and the development of a sanitary system capacity study and capacity assurance plan, among other items. In August 200 the Ohio River Valley Sanitation Commission (ORSANCO) joined this action.

The City and County, federal and state EPAs, and ORSANCO agreed to the Consent Decree on Combined Sewer Overflows (CSOs), Wastewater Treatment Plants, and Implementation of the Capacity Assurance Plan for SSOs (aka *Global Decree*) in June 2004. This decree focused on MSDGC's combined sewer system and treatment plants and outlined the requirements to address wet weather overflows in the combined system (CSOs) and make capacity-based improvements to the 180 year-old sewer system.

To address the Global Decree's requirements and to implement capacity-based sanitary sewer and CSO issues of the Interim and Global decrees a plan known as MSDGC's *Wet Weather Improvement Plan* was developed in 2006. In 2008, MSDGC branded this improvement effort as "Project Groundwork."

In June 2009, state and federal EPAs and ORSANCO conditionally approved the Project Groundwork improvement effort. As of January 2010, Project Groundwork is awaiting final acceptance by the U.S. District Court for Southern Ohio Western Division.

Program Funding

The funds expended on the I/I identification and removal effort to date has been effective in removing flow from the system. The amount of flow effectively removed from the MSDGCGC system is difficult to quantify since pre- and post-flow monitoring was not conducted as part of the RDI/I Removal Program. The intent was to use the available funds to identify and eliminate the sources of the I/I as a first step. The program to date has resulted in a reduction in customer calls reporting basement backups in the targeted areas such as Mariemont in the Little Miami Basin. To date, SSOs have not been eliminated with the work completed.

I/I Program Status

Hamilton County, Ohio is embarking on the largest public works projects in its 200-plus year history. Called Project Groundwork, the major initiative is designed to:

Reduce or eliminate sewage overflows into local rivers and streams and sewage backups into backups.
Benefit Hamilton County communities through environmentally, socially, and economically sustainable solutions to these current problems.
Revitalize the economy through creation of jobs and growth opportunities for local businesses.

The Metropolitan Sewer District of Greater Cincinnati ("MSDGC") currently has a request for Qualifications Statements from interested teams to perform flow monitoring and rain gauge services in various locations in the MSDGC collection system in support of its Wet Weather Improvement Plan (WWIP). The services include a) flow monitor installation and maintenance, b) management of data from

the flow monitors, c) generation of reports, and d) maintenance of rain gauges. The timeframe for these services is from November 1, 2010 to December 31, 2013.

Ordinances

Under the Districts ordinances, no sanitary sewer or sanitary sewer system shall be constructed within any municipality, which connects either directly or indirectly to a wastewater treatment works controlled by the District, until such municipality has adopted an ordinance that prohibits any unpolluted waters from discharging to their system and that meets the standards of the District's Rules and Regulations. Each municipality shall be responsible to enforce the provisions of said ordinance. The Director may refuse to permit a connection, either directly or indirectly, to the wastewater treatment system by or within any municipality until that municipality adopts such an ordinance.

MSD had the authority, through the Rules and Regulations, to enforce the removal of I/I from private property; however, they had no practical way to do so. Instead MSD relied on the various municipal leaders to work with the property owners. MSD worked with the state legislature to amend state law to allow a municipal agency to pay for improvements on private property. The Board of County Commissioners, the body that governs MSD, voted to allow up to $3,000 per property for removal of these I/I sources from private property.

Public Education and Outreach

The MSDGC offers a presentation on the Project Groundwork as well as other opportunities to learn about the wastewater system. MSDGC offers public awareness programs and can be viewed at: http://www.metrocouncil.org/environment/projectteams/I-I-References.htm.

Other public awareness presentations to control rainwater infiltration and rain gardens is presented at: http://www.millcreekwatershed.org/assets/files/raingarden_workshop.pdf

5.1.1.6 Western Lake Superior Sanitary District

In 1971, the Minnesota Legislature created the Western Lake Superior Sanitary District (WLSSD), designated as a "special-purpose subdivision of the State of Minnesota, to address the serious environmental and pollution problems in the lower St. Louis River basin. Their initial goal was to improve and protect the waters of the St. Louis River and its tributaries.

Governance

WLSSD is governed by a nine- member Board of Directors. Chapter 458D of the Minnesota Statues outlines the framework by which the District is governed, the powers and duties of its Board and officers, taxing authority, cost sharing and planning responsibilities. Within their legislative boundaries are eight cities and ten townships. They are listed in Table 11 below:

Table 11 Western Lake Superior Sanitary District Membership

WLSSD Cities/Townships				
Duluth	Cloquet	Carlton	Scanlon	Wrenshall
Hermantown	Proctor	Thomson	Silver Brook (township)	Thomson (township)
Twin Lake (township)	Canosia (township)	Duluth (township)	Grand Lake (township)	Grand Lake (township)
Lakewood (township)	Midway (township)	Rice Lake (township)	Solway (township)	

In addition to the cities and townships within their legislative boundaries the District also serves the Village of Oliver in Wisconsin and the community of Knife River, which are not in their legislative boundaries.

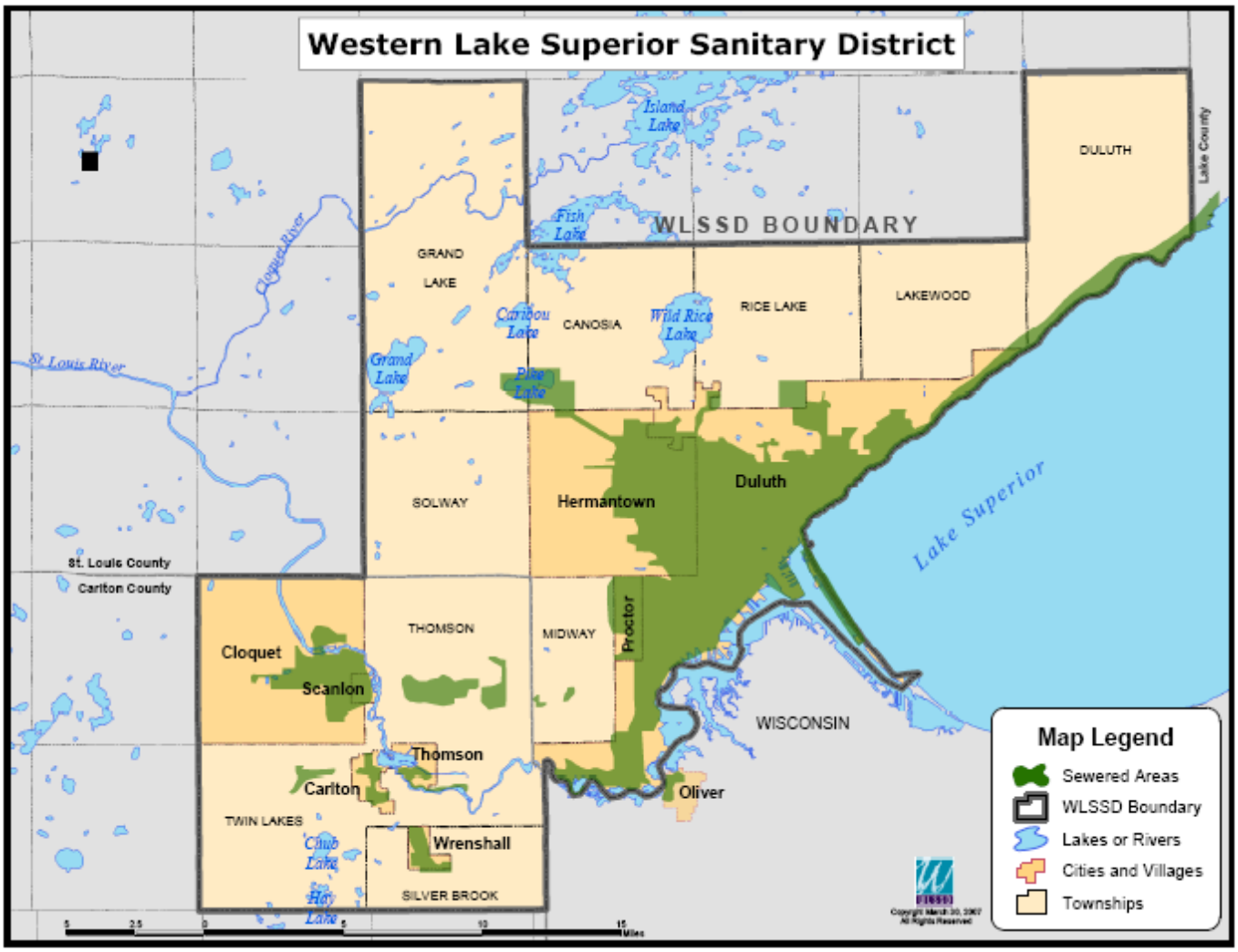


Figure 5 Western Lake Superior Sanitary District Map

Table 12 provides an overview of the District.

Table 12 Western Lake Superior Sanitary District Overview

WLSSD Profile	
Population Served	139,000
Service Area	1,373 km^2
# of Agencies / Satellite Communities	10 cities/10 townships

WLSSD Profile	
Length of Regional System	123 km
# of Wastewater Treatment Plants	1
# of Pump Stations	19

The individual partners served by WLSSD own and operate their own local sewer systems. WLSSD's system of trunk sewers collects flows from the local sewer systems and conveys it to the treatment plant operated by WLSSD.
Only 16.2% (approximately 223 km^2) of the total WLSSD service area is served by public sewers. Another 9.9% of the area has been identified in local plans as future sanitary sewer service to be constructed in the next 10-20 years.
The more concentrated and urban areas receive wastewater service, connected to the regional treatment plant through a 123 km network of interceptors and force main sewers.

I/I Reduction

The WLSSD sewer system was evaluated under both the existing and future conditions. The future condition does not include any assumptions for reductions resulting from an ongoing City of Duluth (Duluth) inflow and infiltration reduction program. I/I and associated sanitary sewer overflows (SSO's) are a major concern of Duluth, as well as WLSSD and other users. Duluth and the WLSSD are currently and jointly under an Environmental Protection Agency Order to eliminate all SSO's. Duluth and the WLSSD drafted a plan that outlines a twelve (12) year time schedule to meet the conditions in the EPA Order by 2016.

Six areas in the WLSSD interceptor system have experienced persistent overflows and are recognized locations in the consent decree.

Through discussions with the Minnesota Pollution Control Agency (MPCA), it has been generally accepted that the design level for basic components of the WLSSD collection system is that which will convey a design flow for a 25-year, one-hour rainfall event. Deriving a design flow event from a 25-year one-hour rainfall event is problematic because a rainfall event does not take into account antecedent conditions. However, an analysis was done and it was determined that the 25-year, one-hour rainfall event is approximately equivalent to the 10-year flow event. Based on that correlation, the 10-year flow event[2] was used for evaluation of capacity and flow conditions throughout the collection system. The 25-year, 1-hour storm event is the reference rainfall event for purposes of I/I reduction. Municipal and Industrial users are required to restrict flows below their peak limitations (LOS or CAPF) during this reference event.

Statutory Regulations

On May 14, 2004 the Western Lake Superior Sanitary District (WLSSD) and City of Duluth submitted a Plan of Action to the United States Environmental Protection Agency (EPA). The plan, which was required by an Administrative Penalty Order from EPA received in January 2004, detailed the separate and joint efforts that the City of Duluth and WLSSD would take to eliminate sanitary sewer overflows in the region. WLSSD and the City of Duluth received the 14-page Administrative Penalty Order as joint permittees of a National Pollutant Discharge Elimination System Permit (NPDES) issued in August 2002. The Administrative Penalty Order requires WLSSD and the City of Duluth to immediately stop sewer overflows.

Interagency Agreements

In October 2008 an inflow and infiltration ordinance was adopted. The ordinance supports the plan to maintain system capacity by insuring that communities within the WLSSD are continuing to reduce inflow and infiltration from entering the system which potentially uses system capacity which could be used for future growth.

Support to Satellite Agencies

The WLSSD goal is to reduce inflow and infiltration across the entire WLSSD system by providing leadership, education, monitoring, policy development and enforcement such that all requirements of the Consent Decree are met and the release of untreated sewage to the Lower St. Louis River and Lake Superior is eliminated.

Data and Information Tracking

WLSSD has several portable ISCO seasonal flow meters available for use within the WLSSD collection system. On occasion, customers of the WLSSD or the WLSSD itself have requested that portions of their collection systems should be metered as it relates to inflow and infiltration problems. WLSSD has in the past lent its meters to customers without any clear expectations on installation, maintenance, and data sharing or return practices. According to the 2010 Comprehensive Wastewater Services Plan, there is no

[2] *The 10-year Design Flow Event is used interchangeably by WLSSD with the 25-year, 1 hour Rainfall as the reference event for purposes of I/I reduction and system design*

mechanism currently in place to track if the meters are being used, which communities have the meters, if the meters are being used properly and what kind of data is being gathered.

Program Funding

The WLSSD is funded by user's fees. User fees are paid to municipalities who then pay the District. In addition, the District pursues grants, loans and other alternative funding sources to fund wastewater system improvement projects.

Interagency Agreements:

In October 2008 an inflow and infiltration ordinance was adopted. The ordinance supports the plan to maintain system capacity by insuring that communities within the WLSSD are continuing to reduce inflow and infiltration from entering the system which potentially uses system capacity which could be used for future growth.

Public Education and Outreach:

The City of Duluth in the WLSSD has posted some information on inflow and inflow reduction and posted on the websites at: www.**wlssd**.com/documents/**WLSSD**AR2006_Web.pdf and at: http://www.duluthmn.gov/planning/comp_plan/compplanfinal/BackgroundProfiles/PublicUts&Servs.pdf

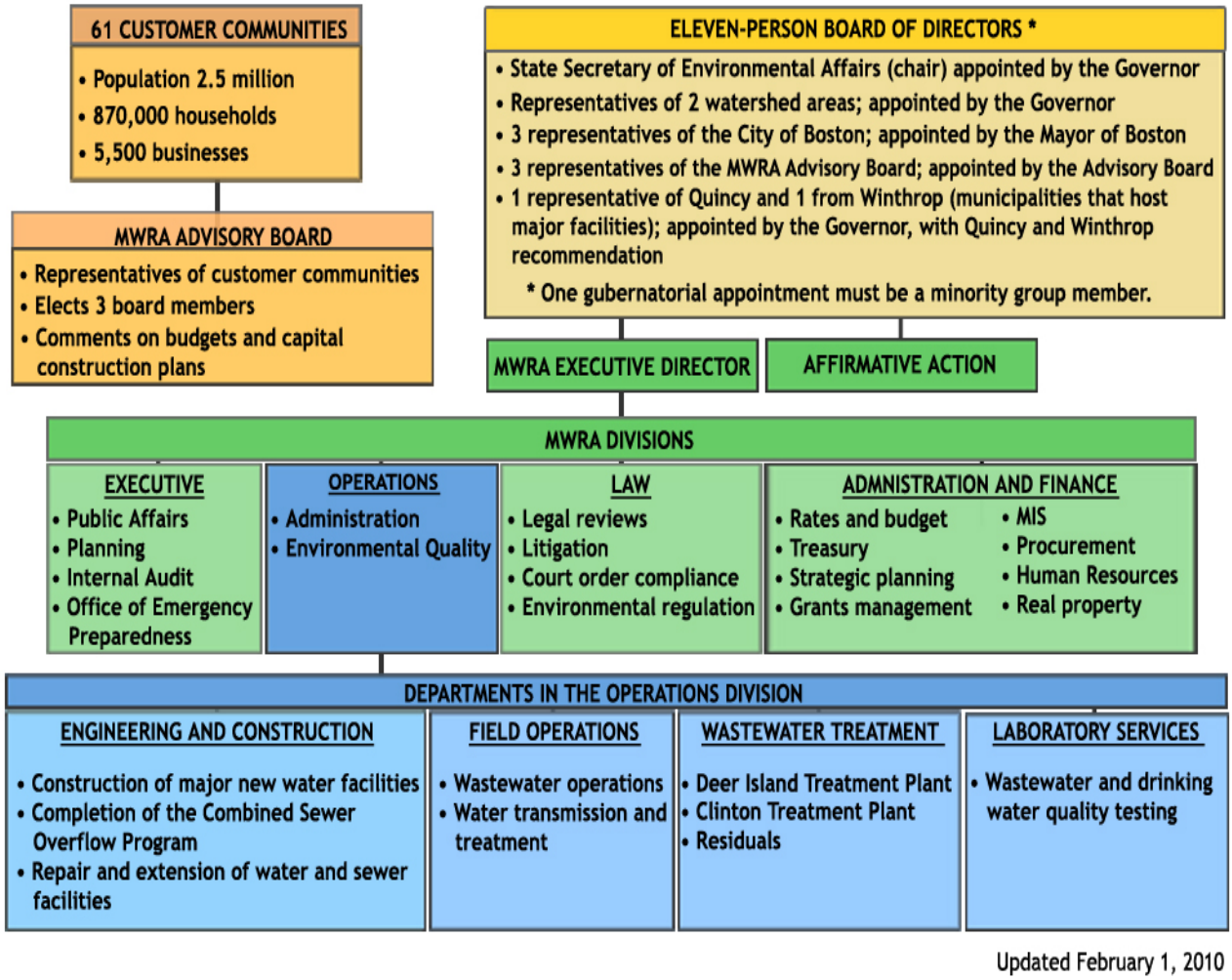
5.1.1.7 Massachusetts Water Resources Authority (MWRA), Boston, MA

Massachusetts public authority established by an act of the Legislature in 1984 to provide wholesale water and sewer services to 2.5 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities.

Governance

MWRA is governed by an 11-member Board of Directors who are appointed by the Governor or directly or indirectly by elected officials in MWRA customer communities.

MWRA has full legal and fiscal responsibility for implementation of operation, maintenance, and I/I reduction programs for the MWRA-owned interceptor system. Each member community retains full legal and fiscal responsibility for implementation of operation, maintenance, and I/I reduction programs for community-owned sewers. MWRA provides technical and financial assistance to member communities and work cooperatively with DEP, EPA and other stakeholders to help solve local and regional sewer problems. **Figure 7 MWRA Organizational Structure**



5,100 miles of local sewers transport the wastewater into 227 miles of MWRA interceptor sewers. The interceptor sewers, ranging from 8 inches to 11 feet in diameter, and carry the region's wastewater to

two MWRA treatment plants. Though most of the wastewater flows by gravity some low-lying areas require pumping.

Table 13 provides a summary of the MWRA's sewer system and **Error! Reference source not found.**illustrates the MWRA sewerage service area.

Table 13 MWRA Profile

MWRA Profile	
Population Served	2,550,000
Service Area	over 1,295 square km
# of Agencies / Satellite Communities	43 communities
Length of Regional System	365 km
Length of Local System(s)	208 km
# of Wastewater Treatment Plants	2
# of Pump Stations	20

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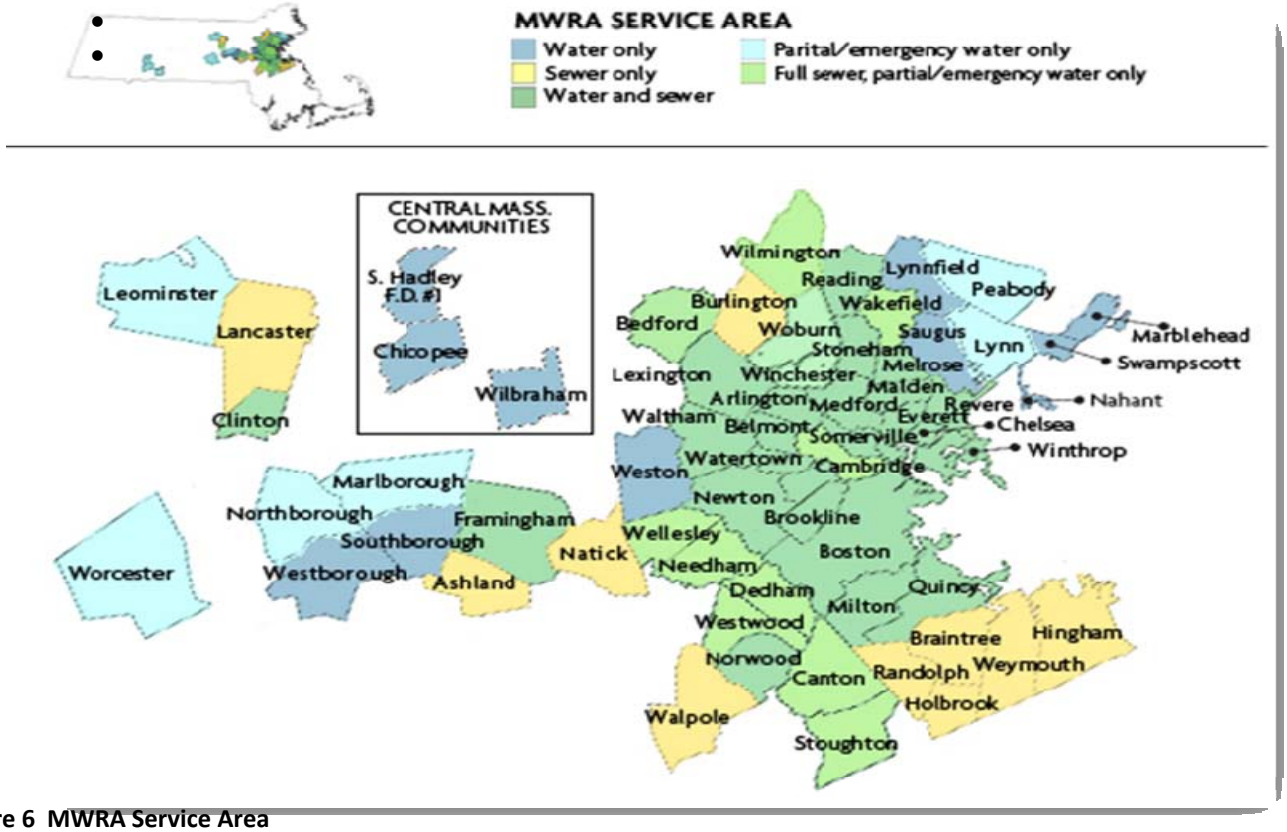


Figure 6 MWRA Service Area

The MWRA board of Directors approved the Regional Infiltration/Inflow (I/I) Reduction Plan on May 23, 2001 and submitted the Plan to the EPA (Environmental Protection Agency) and DEP (Department of Environmental Protection). The Regional I/I Reduction Plan combines recommendations from an I/I Task Force Report with existing MWRA I/I reduction strategies. 2002 goals were as follows:

1. Eliminate all sewer system backups;
2. Minimize, with a long-term goal of eliminating, health and environmental impacts of sewer system overflows related to I/I;
3. Remove all (and prevent new) inflow sources from separate sanitary systems;
4. Minimize system-wide infiltration;
5. Educate and involve the public;
6. Develop an operation and maintenance program; and,
7. Improve funding mechanisms for identifying and removing I/I.

A progress report of MWRA (2003) provides goals and strategies of the MWRA Regional I/I Reduction Plan
The 5 identified goals are as follows:

MWRA will continue its current operation and maintenance program for the MWRA-owned interceptor system leading to the identification, prioritization, and rehabilitation of structural and I/I problems.
MWRA will work cooperatively with member communities, DEP, and EPA to eliminate sewer system backups into homes and other buildings and to minimize health and environmental impacts of SSOs related to I/I.
MWRA will work cooperatively with member communities, DEP, and EPA to reduce I/I in the regional collection system with emphasis on the following: (1) inflow reduction in areas tributary to sewer backups and SSOs, (2) private source inflow reduction, (3) infiltration that may impact groundwater or surface water resources, and (4) excessive infiltration as defined in DEP regulations or guidance documents.
MWRA will work cooperatively with member communities, DEP, and EPA to expand existing efforts to educate and involve the public regarding regional sewer backup, SSO, and I/I reduction issues.
MWRA will provide technical assistance and work cooperatively with member communities, DEP, and EPA regarding guidance on local operation and maintenance and capital improvement programs intended to provide a reasonable level of sewer service to local sewer users/ratepayers.

To achieve the above 5 goals, various strategies have been developed as follows (Table 14):

Table 14 MWRA Regional I/I Reduction Plan Strategies

GOAL	STRATEGY NO.	DESCRIPTION
1	Strategy 1	Internal TV inspection and OZ-camera with annual inspection and O&M
	Strategy 2	Sonar camera to inspect siphons and force mains with annual inspection and O&M.
	Strategy 3	Physical inspection of collection system manholes and structures by operations division field crews with annual inspection and O&M.
2	Strategy 1	MWRA will provide technical assistance to DEP to develop a uniform format for use by communities for reporting wastewater backup and sewer system overflow information
	Strategy 2	MWRA will periodically delineate areas which may be “at risk” for backups and SSOs that may be impacted by the MWRA-owned collection system
	Strategy 3	MWRA - jointly with DEP - will provide technical assistance to member communities to evaluate potential improvements to local infrastructure that may reduce the risk of sewer backups and SSOs
	Strategy 4	For the MWRA-owned interceptor system, MWRA will review and analyze the health and environmental impacts of existing SSO sites.

GOAL	STRATEGY NO.	DESCRIPTION
	Strategy 5	Utilizing the priority ranking to be completed in Strategy D above, as well as system hydraulic analyses.
	Strategy 6	For those overflows that are unlikely to be eliminated in the short to mid-term MWRA will consider developing interim measures to relocate or otherwise mitigate the impact of existing overflows on human and natural resources
	Strategy 7	MWRA will assist DEP, member communities, and other regional stakeholders to inform local plumbing inspectors of the regional priority of eliminating sewer system backups.
3	Strategy 1	MWRA will continue to analyze available MWRA wastewater metering data to estimate community infiltration and inflow rates
	Strategy 2	MWRA, in cooperation with member communities, will evaluate the feasibility of developing and operating an expanded emergency notification system (ENS).
	Strategy 3	MWRA will provide technical assistance to member communities to establish written infiltration and inflow identification and removal programs as outlined in the I/I Task Force Report.
	Strategy 4	MWRA will provide technical assistance to member communities that seek to emphasize infiltration removal that may impact groundwater and surface water resource areas
	Strategy 5	MWRA, in coordination with the MWRA Advisory Board, will continue to fund the I/I Local Financial Assistance Program to provide grants and loans to member sewer communities to fund local I/I reduction projects.
	Strategy 6	MWRA, in coordination with the MWRA Advisory Board, will continue to provide emergency assistance to member communities for sewer services on local collection systems that are routinely performed by MWRA staff for the MWRA-owned interceptor system
4	Strategy 1	MWRA will act as a "clearinghouse" to collect and distribute information on I/I and SSO issues. Other groups, agencies, associations, community representatives, and local citizens wishing to disseminate information on I/I and SSO issues within the region can provide a copy to MWRA that will be copied and distributed.
	Strategy 2	MWRA will develop and distribute a summary of previous information/technology distributions regarding I/I reduction and SSOs
	Strategy 3	MWRA, jointly with DEP (and possibly other regional organizations), will organize periodic demonstration projects and/or workshops to bring together regulators, community representatives, vendors, environmental groups, consultants, contractors, etc
	Strategy 4	MWRA will develop a summary of available public education material such as local/regional billing inserts, Water Environment Federation (WEF) brochures, "How-To" pamphlets, etc
	Strategy 5	Depending on the outcome of the summary of available information being developed under Strategy D, MWRA (jointly with DEP and possibly other regional organizations) may develop informational materials that will educate the public on I/I and SSO issues.
	Strategy 6	Upon request from member communities, MWRA will assist member communities in providing a link from the local DPW or community Internet site to the MWRA internet site
	Strategy 7	MWRA will integrate information on I/I and SSO issues into existing MWRA school education materials. MWRA's School Education staff will identify what types of materials are appropriate for their programs. This strategy has an ongoing schedule that will be initiated in the mid-term
	Strategy 8	Upon request from DEP, MWRA will provide technical assistance to DEP to develop and issue DEP press releases prior to and during extreme wet weather events to notify the public of possible sewer system backups and overflow problems.
	Strategy 9	Upon request from member communities, MWRA will provide technical assistance to communities to provide residents with information on I/I reduction, SSOs and backups using local cable stations or other media outlets
5	Strategy 1	MWRA will provide all member communities a copy of the I/I Task Force Report (which includes recommendations for sewer system operation and maintenance)
	Strategy 2	MWRA will request member communities provide a copy of their existing local Sewer Use Regulations to MWRA, will review those local Regulations that are submitted, and will make recommendations for improvements.

GOAL	STRATEGY NO.	DESCRIPTION
	Strategy 3	MWRA will develop a Member Community Collection System Operation and Maintenance Manual Guidance Document and Overflow Response Plan. This guidance document will be provided to all member communities. This strategy will be completed in the short-term.

Governance
MWRA has full legal and fiscal responsibility for implementation of operation, maintenance, and I/I reduction programs for the MWRA-owned interceptor system. Each member community retains full legal and fiscal responsibility for implementation of operation, maintenance, and I/I reduction programs for community-owned sewers. MWRA provides technical and financial assistance to member communities and work cooperatively with DEP, EPA and other stakeholders to help solve local and regional sewer problems.

Funding
MWRA's I/I Local Financial Assistance Program provides $261 million in grants and interest-free loans to MWRA sewer communities to perform local infiltration and inflow "I/I" reduction and sewer rehabilitation. Funds are approved for distribution through Fiscal Year 2018.
Eligible projects include:

- pipeline replacement
- public and private inflow source removal
- I/I reduction planning
- sewer rehabilitation construction
- engineering design
- engineering services during construction

The program's goal is to assist MWRA communities in reducing I/I and repairing and/or replacing aging sewers.

This program is a critical component of MWRA's Regional I/I Reduction Plan. Specifically, local sewer system rehabilitation projects are intended to at least offset ongoing collection system deterioration thus preventing a net increase in regional I/I. In the long-term, system rehabilitation should result in lower I/I, which will allow for future increases in sanitary flows (residential, commercial, industrial, and institutional) without a net increase in total wastewater flow. The program fosters efficient operation and maintenance of local sewer systems.

I/I Local Financial Assistance Program funds are allocated to member sewer communities based on their percent share of MWRA's wholesale sewer charge.

Member sewer communities receive 45% grants and 55% interest-free loans for local projects. Interest-free loans are repaid to MWRA over a five-year period beginning one year after distribution of the funds. Since the program began in 1993, more than $200 million has been distributed to fund 400 local I/I reduction and sewer system rehabilitation projects.

Statutory Regulations
In 1987 MWRA accepted responsibility for developing a control plan to address the discharges from all CSOs hydraulically connected to the MWRA sewer system, including outfalls owned by its member communities. This was the result of a court case. Under a Court-ordered schedule, MWRA recommended a CSO Conceptual Plan in 1994 that included 25 site-specific CSO projects. The CSO Conceptual Plan was later refined in the 1997 Facilities Plan/EIR.

MWRA reached an agreement with the United States and DEP on the scope and schedule for additional CSO projects in March 2006. This agreement was filed with the Court as part of a joint motion to amend the Court Schedule. The Court allowed the joint motion and issued an Order with a new schedule in April 2006. As a result, MWRS's Long-Term Control Plan now includes 35 projects. MWRA has until 2020 to complete the remaining CSO wok and subsequent system monitoring which will be used to verify that the Long-Term Control Plans are achieved.

Public Education and Communication

Massachusetts Water Resources Agencies have initiated programs for communities across the United States to find cost-effective, long-term approaches to managing their aging wastewater infrastructure and preventing the problems that lead to sanitary sewer overflows. The Toolbox is an effort by EPA New England to provide examples of programs and educational efforts from New England and beyond showing the approaches being used to:

Communicate with and educate citizens and local officials
Address financial and regulatory needs
Develop and conduct preventive maintenance programs
Better manage infrastructure assets
Use information systems, including GIS
Improve system capacity and address system overflows

The goal is to develop the Toolbox over time, and is not to provide an exhaustive listing or endorse any particular approach, but to direct managers, local officials, and other decision-makers to a range of fact sheets, case studies, ordinances, and other information that shows how things are getting done. The main goal of this Toolbox is to be used only as a "template" for other agencies involved in the program, since the nature of the problem varies from location to location. Further details of the program can be viewed on their public website at: http://www.epa.gov/region1/sso/toolbox.html.

Estimated I/I Removal

The estimated average daily flow reduction associated with completed local I/I reduction projects that have received MWRA financial Assistance is about 81 mgd. This flow reduction is an estimate is based on the communities' (or their consultants') peak I/I reduction estimates. MWRA staff have prorated the peak I/I reduction estimates to develop an estimated annual average I/I reduction. The estimated I/I removals noted here represent groundwater and stormwater that no longer enter the collection system at the point of repair. Regional wastewater flow reductions resulting from specific local I/I reduction projects are difficult to substantiate through end-of-the collection system meter data, due to factors noted below:

- Wastewater flows within the collection system vary dramatically due to changes in precipitation. For example, annual average daily flow for MWRA's system varies up to 80 mgd from year to year. Small flow reductions for individual projects (typically less than one mgd) are dwarfed by regional flow fluctuations.
- Sewer capacity gained by elimination of I/I in one subsystem may, in some cases, allow for other I/I to enter the collection system at a different location, resulting in no net flow reduction at the end of the collection system.
- The consequence of ongoing pumping and interceptor upgrades, as well as combined sewer overflow and system optimization projects, is an increase in the capture and treatment of wastewater flow and the reduction of raw sewage discharges. These increased flows to the Deer Island Treatment Plant offset upstream I/I reductions.

Taking these factors into account, long-term metering records will continue to be analyzed to monitor regional wastewater flow trends.

5.1.2 *Canadian*

5.1.2.1 Liquid Waste Management Plans in British Columbia

The Environmental Management Act allows municipalities and regional districts to develop Liquid Waste Management Plans for approval by the Minister of Environment.

The Liquid Waste Management Plan (LWMP) consists of operational certificates, which replace waste discharge permits; a strategy to ensure liquid waste disposal conforms with Ministry objectives; an implementation schedule; and measures to accommodate future development. An approved plan authorizes a municipality to discharge waste and store recyclable materials in accordance with Operational Certificates, other provisions of the waste management plan, and the Minister's requirements. In most cases, LWMPs will prove more economical and more effective than the permit system, and it is anticipated that municipalities and regional districts will develop plans voluntarily. The Environmental Management Act now allows the minister to direct a municipality to prepare or revise a waste management plan. LWMPs must be consistent with the ministry's long-term waste management objectives. These guidelines will help municipalities determine what should be addressed in a Liquid Waste Management Plan.

References within the Guidance Document to Inflow and Infiltration

2.3 Source control and waste volume reduction
a) options for source control and reduction of sewage and industrial waste volumes and toxicity
b) infiltration control options are to be considered to reduce the hydraulic load on treatment facilities

3.3.1 Reduction
All options to reduce the amount of waste, particularly toxic waste, entering a disposal system should be explored. Measures should be taken to ensure that the system is in good order and that infiltration or inflow to sewers is minimized. Public education campaigns can promote conservation, minimize consumption, prevent toxins from entering the system, curtail the use of garburators, etc. Source control programs can significantly reduce the toxicity of sewage.

5.1.2.2 Metro Vancouver (Greater Vancouver Regional District – GVRD)

Integrated Liquid Waste and Resource Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities

The Greater Vancouver Sewerage & Drainage District (GVS&DD) which operates under Metro Vancouver collects and conveys all wastewater from municipal systems to 4 of the 5 regional wastewater treatment plants. Table 15 provides an overview of the agency.

Table 15 Metro Vancouver GVS&DD Profile

Metro Vancouver GVS&DD Profile	
Population Served	2,082,000
Service Area	639 km^2
# of Agencies / Satellite Communities	18 local municipalities
Length of Regional System	507 km
Length of Local System	6400 km
# of Wastewater Treatment Plants	5
# of Pump Stations	33

In 1989 Metro Vancouver (previously known as The Greater Vancouver Regional District – GVRD), submitted the first stage of their Liquid Waste Management Plan (LWMP) to the Minister of Environment, Lands and Parks, British Columbia. The LWMP was developed in accordance with the Ministry's *Guidelines for Developing a Liquid Waste Management Plan,* which specifies a three-stage process. This document, **Greater Vancouver Regional District Liquid Waste Management Plan, February 2001** completed the final step in the process.

The LWMP is specific to the geographic area of the Metro Vancouver Regional District which is made up of the following 22 electoral areas:

City of Burnaby
City of New Westminster
City of Port Moody
City of Vancouver
Langley Township
District of Pitt Meadows
Village of Belcarra
Electoral Area A (portion of)
City of Coquitlam
City of North Vancouver
City of Richmond
City of White Rock
District of Maple Ridge
District of West Vancouver
Village of Lions Bay
City of Langley
City of Port Coquitlam
City of Surrey
Corporation of Delta
District of North Vancouver
Village of Anmore
Bowen Island Municipality

The municipalities indicated in bold are members of the Greater Vancouver Sewerage and Drainage District (GVS&DD). The three villages (Anmore, Belcarra and, Lions Bay), Bowen Island Municipality, and portions of electoral Area A, which are not members of the GVS&DD did not participate formally in the development of the LWMP. Instead they addressed their local liquid waste management issues individually according to their specific issues and needs.

Governance
The BC Ministry of Environment allows all local governments to develop and periodically update a liquid waste management plan. Liquid waste management plans are authorized and regulated through the *BC Environmental Management Act.* Metro Vancouver's LWMP authorizes discharges to the environment associated with the management of liquid waste in Metro Vancouver according to the criteria set out in the plan and facility specific Operational Certificates. Once each updated plan is approved, it becomes part of local liquid waste regulations through the *BC Environmental Management Act*. In the absence of an approved liquid waste management plan, the provincial Municipal Sewage Regulation governs.

Localized Roles and Responsibilities
Metro Vancouver and the Greater Vancouver Sewerage and Drainage district (GVS&DD) own, maintain and operate regional trunk sewers and major wastewater treatment plants, regulate industrial waste discharges, implement required regional actions in its plans, report on plan progress, and collaborate with others as appropriate.

Municipal members of the GVS&DD own and maintain collector sewers, implement municipal actions set out in the regional liquid waste management plan, manage stormwater systems, report on their progress on actions required in the plan, set local land use plans and community development standards.

Homeowners, businesses, institutions, and crown corporations own and maintain private property sewer connections and private stormwater management systems.

The subsequent figures (9 and 10) illustrate the Metro Vancouver member municipalities and the Greater Vancouver Sewerage areas respectively.

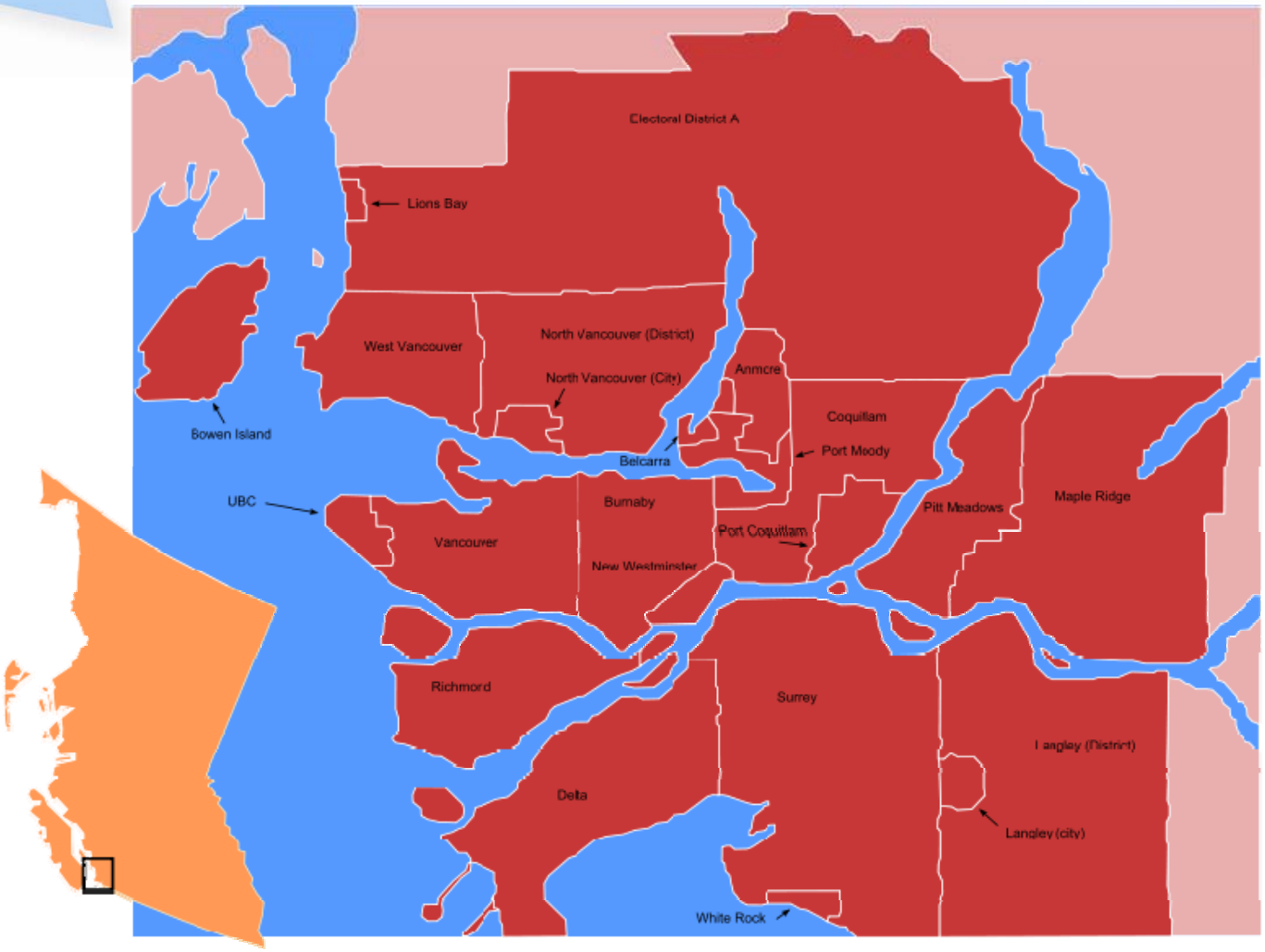


Figure 7 Metro Vancouver Member Municipalities

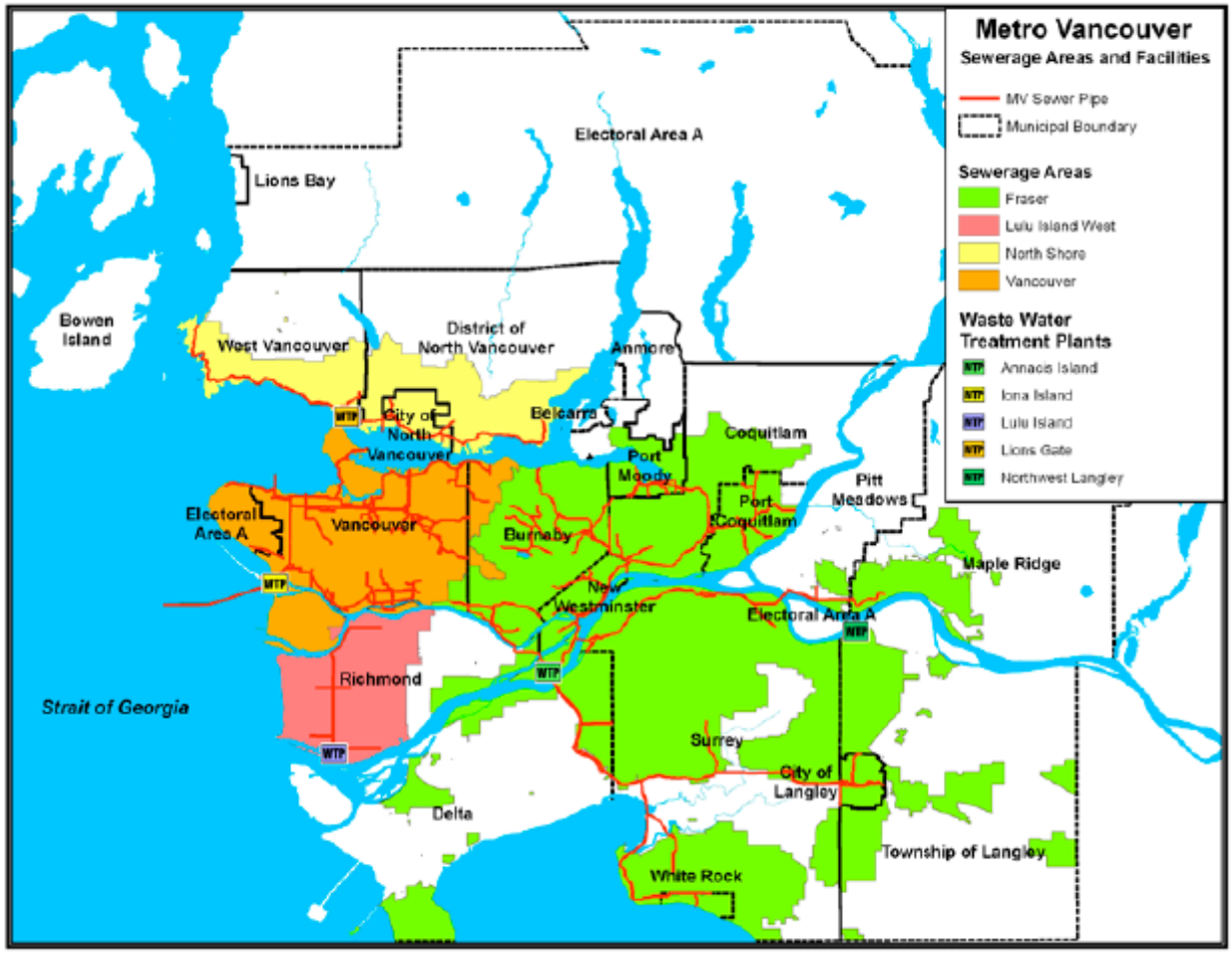


Figure 8 Metro Vancouver Sewerage Areas and Existing Wastewater Treatment Plant Locations

Source: Liquid Waste Management Plan for the Greater Vancouver Sewerage & Drainage District and Member Municipalities, May

The original (2001) LWMP was designed to protect the region's outstanding liveability and environmental quality and laid out the steps needed to enhance the current system as they prepare for population increases. The Liquid Waste Management Plan addressed the following issues:

- Wastewater treatment plant upgrading;
- Combine sewer overflow management;
- Sanitary sewer overflow management;
- Infiltration and inflow management;
- Emergency spill management;
- Source control;
- Residuals management;
- Stormwater management; and
- Non-point source pollution management

In 2002 the sewerage infrastructure within the region (District, municipal, and private) had a replacement value in the order of $12 billion. The region recognized that it is a critical asset that must be maintained so that it can provide adequate service, minimize risk of spills and avoid expensive future expenditures resulting from deferred maintenance and repairs. Also at this time, the sanitary sewer system was experiencing a fairly high level of wet-weather inflow and infiltration of rainwater because of system deterioration.

Through the LWMP infiltration and inflow management is addressed not as a stand-alone strategy but rather is incorporated within its commitments to combined sewer overflow elimination and separate sanitary sewer policies.

As part of the commitments to combined sewer overflow elimination (Section C15.) the cities of Vancouver, Burnaby, and New Westminster obligated themselves to implement combined sewer separation programs to replace aging combined sewers with separate sanitary and storm sewers. More specifically, the City of New Westminster committed to having the entire sewer system video inspected by 2012 and infiltration and inflow reduction achieved through sewer rehabilitation. In addition, source control projects (such as removal of rainwater roof leaders from direct connection to the sewer system) were to be implemented, and the effectiveness of these methods would be evaluated.

Under the separate sanitary sewer systems polices the following identified inflow and infiltration strategy directives are documented:

P8. Infrastructure Management
The District and its member municipalities will establish sewer system infrastructure management programs that will maintain the regional trunks and interceptors, the municipal collection system, and the private service laterals in a state of good repair. The objective will be to ensure the sustainability of the collection system to that expensive repair and rehabilitation is not deferred to future generations and that the average daily infiltration and inflow will not exceed 11,200 litres per hectare per day as a result of a storm with less that a five year return period.

P9. Basic Sanitary Sewer Service Capacity
The District will establish a basic level of service capacity for all District sanitary sewers that provides for the conveyance of measured dry weather flows plus a wet weather allowance for infiltration and inflow of 11,200 litres per hectare per day, such that the hydraulic grade lines do not exceed established safe operating levels.

P10. Sanitary Sewer Overflow Documentation and Targets
The District will document all sanitary sewer overflows from the collection system under its jurisdictions and determine the cause of overflow. The district and its member municipalities will establish targets for sanitary sewer overflow reduction as part of their sewer system infrastructure management programs to target reduction and long term elimination of wet weather sanitary sewer overflows caused by storms of less than a five year return period. Areas experiencing high growth and chronic sanitary sewer overflows with associated health or environmental risks will receive the highest priority of elimination of sanitary sewer overflows.

P12. Consideration of Consequence
When addressing sanitary sewer overflow issues, the District and its member municipalities will prioritize efforts and consider emergency spill locations to mitigate the consequence of overflows in the following priority:
Discharges that compromise public health;
Discharges that compromise public and private property damage; and
Discharges that have confirmed near-field environmental impacts.

P20. Elimination of Stormwater Discharges into Sanitary Sewers
The District will not permit new stormwater sources to be connected to its sanitary sewer system and will continue its current policy of eliminating stormwater discharges currently authorized by Authorizations and Permits. Any exception to this policy will be evaluated and considered with the affected discharger, host municipality, and representatives of the senior level of governments in charge of environmental protection. The District, in addition to not issuing new authorizations for discharges of stormwater into sanitary sewers, will continue the program of eliminating all stormwater contributions allowed under the

existing industrial permits. Each industrial operation will be required to develop and implement a plan for removal of the stormwater components from their sanitary sewer discharge.

Under the same policies the following relative commitments are documented:

C19. Infrastructure Management
The District and its member municipalities will establish ongoing sanitary sewer system evaluation programs to determine the condition of the regional trunk sewerage system, the municipal sewerage system, and private property service laterals. As required, legislative and legal authority will be sought to address infiltration and inflow originating from private property service laterals. These evaluation programs will be ongoing and determine the condition of the entire system over a 20 year time cycle. The District and its member municipalities will develop and apply a consistent approach to sewer system evaluation surveys. Repair and replacement programs will be established based on targets set for sanitary sewer overflow reduction and the severity of infiltration and inflow relative to the design allowance of 11,200 litres per hectare per day.

C20. New Construction Objectives
The District and its member municipalities will review engineering standards and guidelines for new sewer construction with the objective of ensuring a high standard for new construction to minimize future infiltration and inflow problems.

C22. Flow Monitoring
The District will maintain a network of flow monitors that will continually monitor sewer flows and will determine the daily average flow by specific catchments, or by municipality where the flow monitoring configuration is appropriate.

C23. Biennial Liquid Waste Management Plan Progress Report
Every two years, municipalities will summarize and forward to the District for inclusion in a biennial Liquid Waste Management Plan progress report, the following information:

- Sewer system mapping that indicated the overall extent of the current cycle of the sanitary sewer system evaluation program and the condition of sewerage infrastructure.
- The extent of new sewer construction and sewer repair and replacement work of the past two years.
- A summary of the results of all flow monitoring work undertaken as part of the sewer system evaluation program.
- The location and frequency of sanitary sewer overflows occurring from the municipal collections system.
- A summary of sewerage system expenditures for sewer system evaluation work, and repair and replacement work.

In 2008 Metro Vancouver began the process of updating its 2002 Liquid Waste Management Plan, which guides liquid waste programs and services in the region. The 2002 LWMP included three key strategies to help achieve sustainability: conserve resources, maintain infrastructure and stretch capacity, and focus effort to maximize environmental benefit per dollar spent. The update plans builds on these strategies by focussing on source reduction, materials and energy recovery, enabling innovation, ensuring appropriate asset management and building resilient infrastructure.

The 2010 LWMP has three goals, which are addressed by nine strategies and supporting actions for Metro Vancouver and member municipalities. Goal 1 is to protect public health and the environment which includes Strategy 1.1 Reduce liquid wastes at their source. Under this strategy the LWMP outlines the following actions to address inflow and infiltration:

Metro Vancouver will:

- Develop a template to guide the preparation and implementation of inflow and infiltration management plans as part of broader asset management plans and to support sanitary sewer overflow reduction strategies: *2011*
- Work with the real estate industry and their regulators, and the municipalities to develop and implement a process of the inspection and certification of private sewer laterals being in good condition as required component of real estate transactions within metro Vancouver. *2011*
- Develop and implement inflow and infiltration management plans that identify reduction strategies and timelines to ensure wet weather inflow and infiltration targets are within targeted levels. *2012*
- Work with municipalities to review historical data and adjust as necessary the average inflow and infiltration allowance for regional trunk sewers and wastewater treatment plants, and develop associated target allowances for municipal sewer catchments associate with a 1:5 year return frequency storm event for sanitary sewers to a level that ensures environmental and economic sustainability: *2013*
-
- Review progress in reducing inflow and infiltration every four (4) years: *Every 4 years*
-
- Enhance enforcement of sewer use bylaw prohibition against unauthorized discharge of rainwater and groundwater to sanitary sewers: *2010*
-
- Work with municipalities to:
- Facilitate research on watershed-based stormwater management approaches;
- Identify improvements to stormwater bylaws to include on-site rainwater managements requirements;
- Develop model utility design standards and options for neighbourhood design guidelines;
- Establish region wide baseline criteria for on-site rainfall management including variations for localized geology, rainfall and watershed conditions;
- Establish mechanisms to ensure continued performance on on-site rainwater management systems; and
- Work with senior governments and industry to develop codes of practice, certification, guidelines and standards which support this plan. All *2012*
-
- Decrease liquid waste volumes through complementary initiatives in the Metro Vancouver Drinking Water Management Plan to reduce potable water consumption: *Ongoing*
-
- Create incentives to reduce inflow and infiltration by adjusting Tier I sewerage cost allocation formulae within each sewerage area from an average dry weather flow basis (25th percentile) to average wet weather flow (75th percentile) with appropriate adjustments for combined sewerage areas. Tier II cost allocation would remain unchanged: *2010*

Municipalities will:

- Develop and implement inflow and infiltration management plans, using the Metro Vancouver template as a guide, to ensure wet weather inflow and infiltration volumes are within Metro Vancouver's allowances as measured at Metro Vancouver's flow metering stations: *Develop by 2012*
-
- Enhance enforcement of sewer use bylaw prohibition against the unauthorized discharge of rainwater and groundwater to sanitary sewers: *2010*
-

- Update municipal bylaws to require on-site rainwater management sufficient to meet criteria established in municipal integrated stormwater plans or baseline region-wide criteria: *2014*
-
- Update municipal utility design standards and neighbourhood design guidelines to enable; and

- Encourage on-site rainwater management: *2014*
-

GVS&DD Cost Allocation Process

The following diagram illustrates how the GVS&DD allocates sewerage and drainage district annual costs (Figure 9).

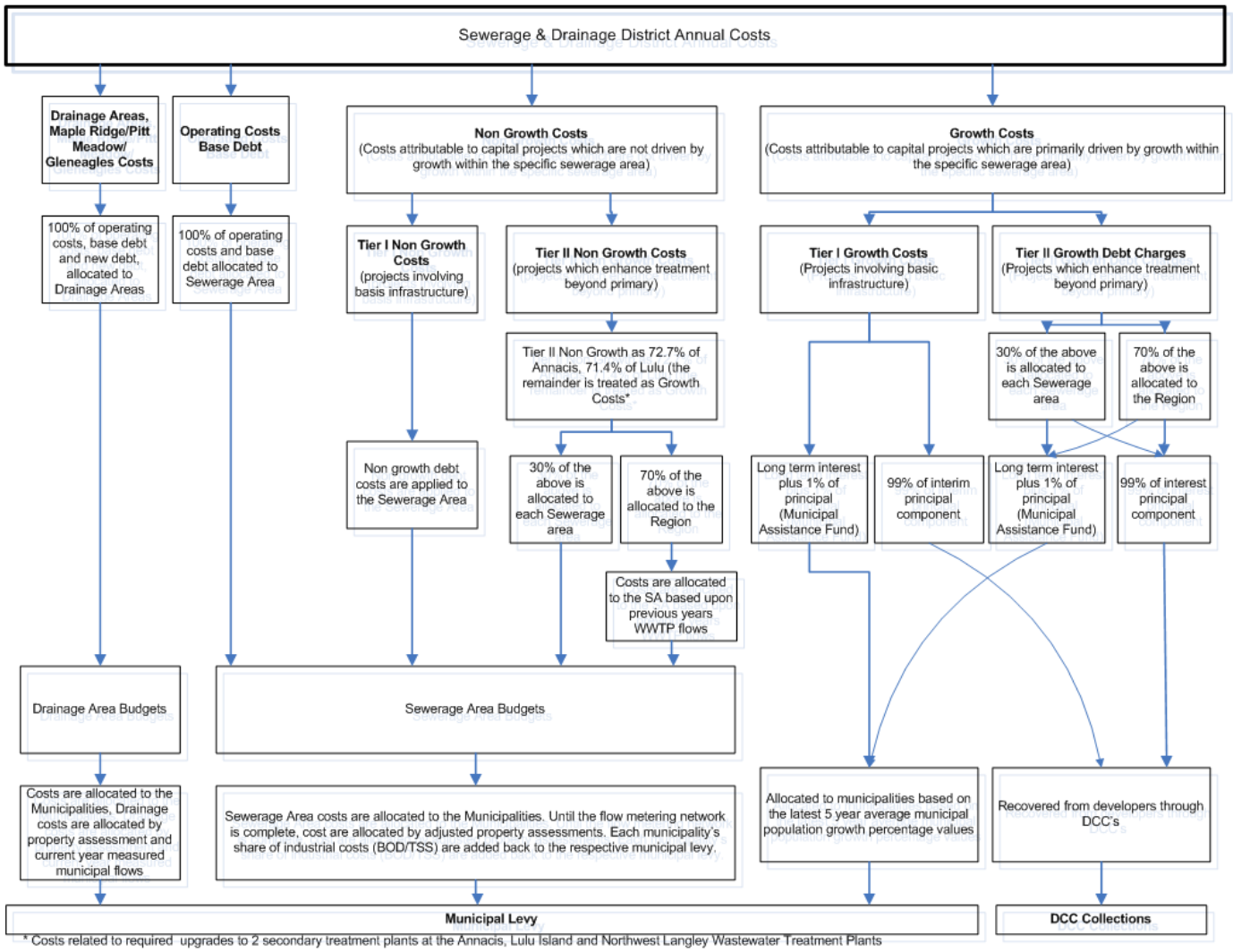


Figure 101 GVS&DD Cost Allocation Summary

Public Education and Communication

Metro Vancouver (Greater Vancouver Regional District – GVRD), British Columbia Canada has provided a public workshop on the strategy for updating the liquid waste management plan" GVRD has posted a website http://www.metrovancouver.org/services/wastewater/planning/LWMP%20Docs/LWMP-publicPresentation-Apr08.pdf

5.1.2.3 Capital Regional District

Capital Regional District Core Area Liquid Waste Management Plan – Management of Inflow and Infiltration

The Capital Regional District (CRD) is the regional government for the 13 municipalities and three electoral areas that are located on the southern tip of Vancouver Island. The urban centre of the CRD is the City of Victoria, and the regional district also includes many of the Gulf Islands, a number of rural municipalities and a vast tract of wilderness that lies along the south-western coast of Vancouver Island.

The Core Area of the CRD is a partnership of seven local governments and two First Nation areas with a total land area of about 215 square kilometres that make-up the majority of Greater Victoria, located at the southern tip of Vancouver Island. The CRD provides services that are regional in nature including the sewage system which serves some 320,000 people in the core area.

The Core Area sewerage system is primarily serviced by the northwest trunk sewer and the northeast trunk/east cost interceptor. These trunk sewer systems have a total approximate length of 55 km, are mostly reinforced concrete with some brink, high density polyethylene (HDPE), polyvinyl chloride (PVC), steel, and ductile iron mains (some of which are pressurized forcemains or inverted siphons). Pipe diameters range from 40mm to 1200mm. Due to undulating topography and subsurface conditions, 12 pump stations convey wastewater to the Clover Point and Macaulay Point pump stations; there the sewage is screened to remove solids, plastic and floatable materials larger than 6 mm, prior to discharge to deep sea outfalls. Table 16 provides a summary profile of the CRD system.

Table 16 CRD Profile Summary

CRD Profile	
Population Served	320,000
Service Area	215 km^2
# of Agencies / Satellite Communities	13 municipalities & 3 electoral areas
Length of Regional System	55 km
# of Wastewater Treatment Plants	5
# of Pump Stations	14

Prior to the formation of the regional district in 1966, each municipality designed their own sanitary collection system with, in some cases, multiple outfalls discharging at the low tide mark. Over the next few decades, the CRD then designed its system to intercept all of these outfalls and convey the wastewater to the Macaulay and Clover Point deep sea outfalls.

The CRD and local municipalities began working together in the mid-1990's to assess technical issues surrounding I&I identification and to discuss various strategies to control or reduce I&I flows. Part of this work included the creation of a subcommittee to coordinate work on the program. Today the subcommittee is made up of technical representatives appointed by the municipalities, the CRD and other agencies and its primary role is the following:

- Provide technical support;
- Resolve technical issues that affect more than one member of the CRD;
- Develop data sharing and reporting standards;
- Act as the forum for exchanging information;

- Report and make recommendations to the regional Engineering Liaison Committee (ELC) as required; and
- Standardize procedures, as much as possible, used by municipalities (or their consultants) when performing I&I investigations and analysis.

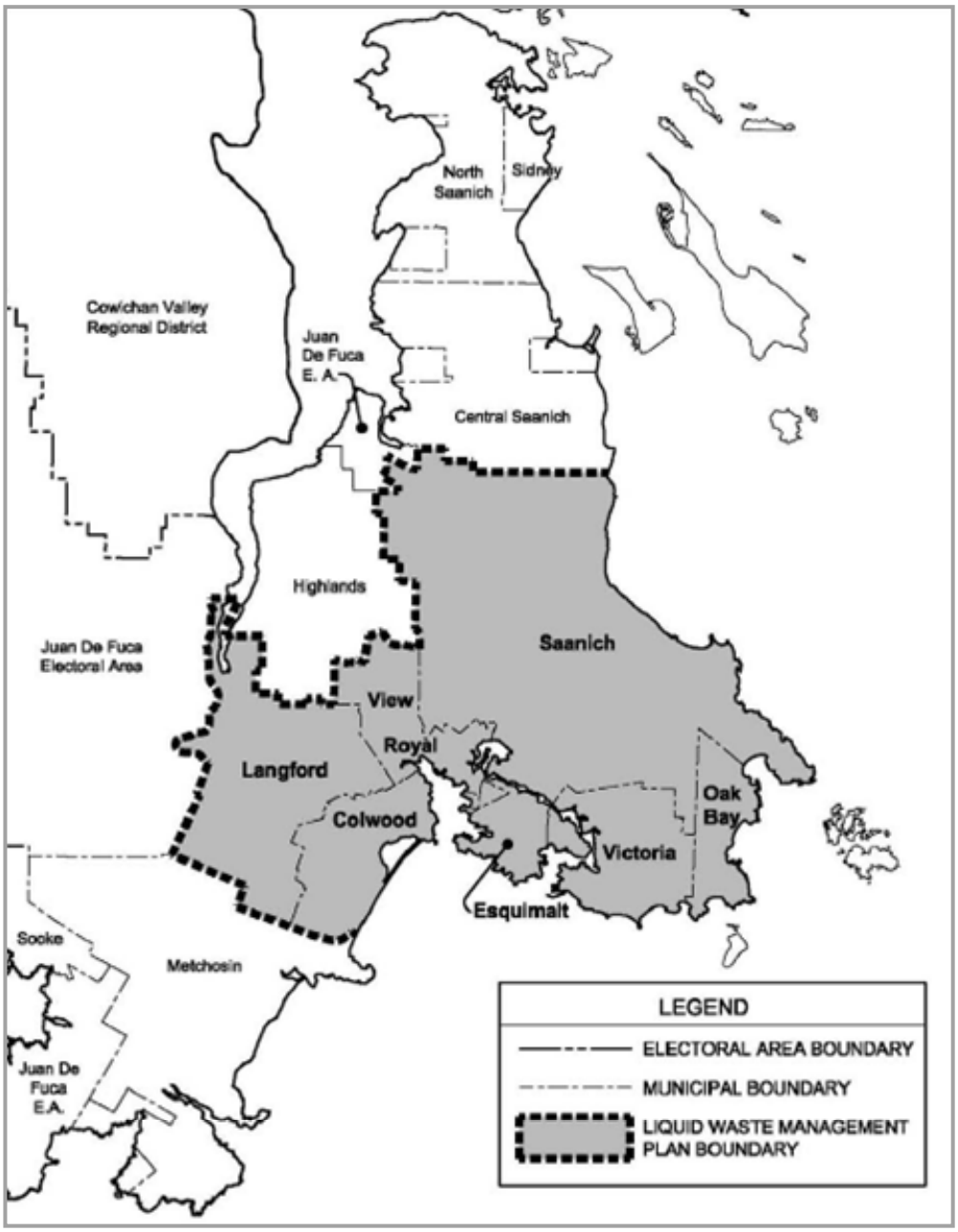


Figure 112 CRD LWMP Core Area

In mid 2001, the CRD augmented its I&I program to accelerate the identification of priority areas and projects. This included expanded flow monitoring, development of sewer models and further investigation of ways to reduce I&I.

The Ministry of Environment (MOE) approved the CRD's Core Area Liquid Waste Management Plan (LWMP) on March 26, 2003. The LWMP outlines the plans of the CRD, and its municipal partners, for the management of liquid wastes from communities within the plan area for the next 25 years. The LWMP

includes the municipalities of View Royal, Victoria, Saanich, Oak Bay, Colwood, Esquimalt, and Langford. **Error! Reference source not found.** illustrates the boundary area of the Core Area LWMP.

Excessive I/I

The provincial Municipal Sewage Regulation states that I/I shall not exceed the amount which causes the "average wet weather flow" (AWWF) to "average dry weather flow" (ADWF) ratio to exceed 2.0 for storm events having less than a 5-year return period.

Chapter 8 of the LWMP outlines goals, commitments and strategies for the management of inflow and infiltration (I&I). The goal of the program is to "reduce inflow and infiltration to levels that minimize total conveyance, treatment and disposal system costs, coincident with reduction of I&I induced overflows to acceptable levels" *(CRD LWMP Chapter 8, 2003).* In submission of the plan the CRD and the participating municipalities committed to the following:

- To develop implementation plans for staged reduction of inflow and infiltration over the 25-year life of the LWMP
- To recommend to future councils that they commit funds for I&I reductions that are economically justified by avoidance of future costs to treat and convey inflow and infiltration
- To measure flows before and after carrying out work on sewers to reduce I&I, to document I&I expenditures and achievements, and to use this information to refine cost benefit curves developed to optimize expenditures
- To undertake a four year program to accelerate the identification of priority areas and projects, including expanded flow monitoring, development of sewer models and preparation of cost estimates, at an additional annual cost of approximately $259,000.
-

Approach and Objectives

The overall approach of the program is to develop an integrated regional/municipal strategy to reduce I&I which, was acknowledged, requires input and good communication will all participants. At the onset of the CRD's enhanced program (mid-2001), a project definition statement to establish the scope and objectives was prepared and agreed upon. The frequency of subcommittee meetings to monitor and coordinate the program was also established at this time.

The general objectives and/or strategy goals of the core area I&I program are outlined in the following table.

Table 17 CRD Core Area I&I Program: General Objectives

Task Description	Status[3]	Notes
Compile all available flow data for the Core Area, analyze it for I&I, and document the results.	Complete	The data collected between October 2008 & March 2009 will be analysed and reported in the summer of 2009.
Divide the Core Area into moderately sized catchments & quantify I&I rates for each catchment.	Complete	When available, permanent locations are used to collect flow data so that flows can be compared over time.
Collect sewer data from portable meters and permanent flow monitoring locations.	Ongoing	Data had been collected and analyzed from all suitable CRD and municipal permanent flow monitoring locations. Data has been collected and analyzed from a number of portable flow meters. The CRD owns a number of flow meters which are available for loan to the Core Area municipalities.
Review current technologies available to reduce I&I.	Ongoing	Hosted a web cast pertaining to siting flow meters in I&I studies. Hosted web casts that compared flow meter technologies.

[3] *As of June 2009 as reported in the CRD LWMP Management of Inflow & Infiltration Biennial Report for 2007 and 2008*

Task Description	Status[3]	Notes
		Hosted a web cast that described a peer reviewed method for collecting and analyzing information pertaining to the condition of sewer infrastructure. Review journal articles. Ongoing interaction with product vendors and consultants and other experts.
Review mechanisms for addressing private property I&I.	Ongoing	An options report is being prepared. Hosted a web cast containing case studies from 3 jurisdictions that are taking steps to deal with private property I&I. Routine discussions at subcommittee meetings. Interactions with consultants, various experts, and a meeting with the GVRD.
Build a complete sewer network for the Core Area in a geographic information system (GIS) and compile I&I information into it.	Complete	The Core Area GIS is updated each year with data provided by the municipalities.
Use the GIS system for analysis, planning, tracking and presentation.	Complete	The Core Area GIS is routinely used for each of these items.
Map all Core Area sewer overflow locations & determine frequency and location of I&I related sewer overflows	Complete	
Undertake a cost-benefit analysis to determine the effectiveness of rehabilitation works	Ongoing	
Rank sewer catchments using I&I related data and develop long-term I&I implementation plans	In progress	I&I rates have been generated for the entire Core Area of the GRD and they can be used to rank catchments according to I&I. Some of these catchments will be further broken down in the future and others, when based on older rates, will be updated.

(CRD LWMP Management of Inflow & Infiltration Biennial Report for 2007 and 2008, June 2009.)

In late 2009, a Minister (MOE) directed amendment to the Core Area Liquid Waste Management Plan was submitted to replace several chapters of the original Plan. Amendment No. 7, Section 5 outlined the new directives for the management of infiltration and inflow and control of wastewater overflow. In such, the CRD and the participating municipalities committed to the following actions to reduce I/I sufficiently to reduce maximum daily wet weather flows to less than four times the average dry weather flow by 2030:

Continue flow monitoring in each municipality to further refine priority areas for remediation.

Develop, by the end of 2011, and submit to the MOE, comprehensive inflow and infiltration management plans for the core area that will:

Identify and evaluate options and opportunities that promote the minimization of groundwater and rainwater I&I into municipal sanitary sewer systems, including I&I originating from service laterals (private and public sections of sewer connections).
Identify needed changes to legislation and legal authority to enable options and strategies.
Identify opportunities for the inspection of private sewers connected to municipal sewers:

As part of the municipal process in evaluating and issuing renovation and building permits for serviced properties; and/or
At the time of property transfer; and/or
Targeted inspections.
Require the repair or replacement of private sewers that have cross-connections between storm sewers and sanitary sewer or, are identified as being in poor condition.

Update, by the end of 2011, and enforce sewer use bylaws to prohibit the construction of rainwater and groundwater connections to sanitary sewers.

Implement the overflow reduction plans contained in the sanitary sewer overflow management plan, which was submitted to the MOE in June 2008. These plans include:

- upgrades to existing pumping stations,
- capacity studies,
- sewer separation,
- twinning of mains,
- extension of forcemains,
- CCTV inspections,
- collection system maintenance,
- lift station maintenance,
- sewer re-lining,
- combination manhole separation,
- sewer main replacement,
- municipal-wide smoke and dye testing,
- manhole inspections,
- hydraulic model maintenance, and
- overflow eliminations.

The estimated completion dates for these activities *(List item 4)* range from 2008 to 2030, with some scheduled to reoccur on an annual basis. The overall estimated cost to complete the program (subject to approval by local municipal council) is $119,000,000 ($2008), *(CALMP, Amendment No. 7).*

Public Education
The CRD has an I&I section on its website (http://www.crd.bc.ca/wastewater/ii/index.htm) and has an I&I brochure. Both of these items were created to educate the public on issues regarding I&I. Currently the CRD is in the process of developing a video using actors, animation and CCTV video clips for education purposes which discusses the issues associated with I&I. They have recently provided information on their website educating the public about the complications caused by dumping their household fats, oils and greases (FOG) into the sanitary sewer waste further detail and information on this communication can be viewed on their website at: http://www.crd.bc.ca/wastewater/sourcecontrol/residents/fats-oils-grease.htm.

Private Property I&I
In the Core Area of the CRD (except for Oak Bay), property owners own and are responsible for maintaining the sewer service laterals on their properties to the property line. The municipality owns and is responsible for maintaining the public sewer mains and the part of the sewer service laterals located between the property line and the sewer mains. In Oak Bay the property owners own and are responsible for maintaining the sewer service laterals from their houses to the public sewer mains.

As of June 2009, there was no compliance program in the CRD to deal with private property I&I. Oak Bay and Esquimalt are the only Core Area municipalities that have bylaws that relate to private property I&I. Both bylaws require that sewer laterals be assessed and, if required, fixed if a property has a major renovation (greater than $100,000). However, property owners may circumvent this requirement, for

example, by splitting the renovation over multiple years. In addition, this type of bylaw only relates to a small number of properties.

5.1.2.4 Halifax Regional Municipality – Halifax Water

Halifax Water is the municipal water, wastewater and stormwater utility serving the residents of the Halifax Regional Municipality (HRM), pursuant to the Public Utilities Act. The services provided by Halifax Water, water, wastewater, stormwater, and fire protection, are regulated by the Nova Scotia Utility and Review Board.

Halifax Water maintains approximately 1000 km of wastewater sewers, 700 km of stormwater sewers, 300 km of combined sewers, 70 km of forcemains and pressure sewers and 160 wastewater pumping stations. Based on age, historical construction practices, maintenance, number of connections as well as other factors, there is significant opportunity for Infiltration/Inflow to enter the wastewater system.

Table 18 provides an overview of the Halifax Water sewerage system.

Table 18 Halifax Regional Municipality Profile

Halifax Water Profile	
Population Served	385,500
Service Area	5,490 km^2
# of Agencies / Satellite Communities	17 community areas
Length of Regional System	< 2,000 km
# of Wastewater Treatment Plants	13
# of Pump Stations	180

Halifax Water operates and maintains two types of collection systems: separated and combined systems. Their separated system conveys wastewater only. Separate systems are in all parts of HRM, with the exception of some of the older parts. The areas with separated wastewater systems may or may not also have stormwater systems, however, most areas constructed since the 1980 have both separate wastewater and stormwater systems. The combined systems, which accept both wastewater and stormwater, are found in the older areas including peninsula Halifax and older sections of Dartmouth.

In Halifax, excessive inflow and infiltration has led to wastewater backups in homes, and overflows into streets, stream, lakes and the harbour. To address these events Halifax Water continually maintains and upgrades the public portion of the wastewater systems. In addition, Halifax Water has also designed a program to address private side issues.

To address inflow and infiltration Halifax Water has conducted a number of investigations on the separate wastewater system:
Flow monitoring and rain gauges
Smoke testing
Dye testing
CCTV inspections
Visual inspections.
Works identified through these investigations are conducted on a priority basis both on private and public properties. Recommendations from investigations and studies may include rehabilitation or repair work on public and private properties.

In 1999/2000 Halifax Water initiated an Infiltration/Inflow Reduction Program to address the problem of excessive infiltration and inflow into the municipality's wastewater collection system. Funding in the amount of $250,000/year has been provided on an ongoing basis in the capital budget for the implementation of the program starting with the fiscal year 1999/2000. Following the approval of the

Capital Budget, a list of areas considered to be contributing a high rate of inflow and infiltration in order of priority is prepared with tentative schedules for implementation.

Halifax Water invests millions of dollars each year on the wastewater and stormwater infrastructure:
Rehabilitation, relining, and replacement of aged or damaged infrastructure
Installing deep storm systems
Pump station improvements
Wastewater treatment facility upgrades
Repairing leaking manholes and pipes
Replacing manhole covers
Utilizing waterproofing membranes for manhole construction

Privately Owned Systems

Addressing inflow and infiltration is joint effort between Halifax Water and the property owners. Property owners are responsible for the wastewater connections from the property line to the building. Property owners are therefore responsible to maintain the wastewater connection from the property line to their home or building and are asked to ensure that their property is not contributing to Infiltration/Inflow.

The Halifax Regional Municipality Charter Item 348 specifies that no person shall:
permit stormwater, surface water, ground water, roof runoff, subsurface drainage, cooling water or industrial process waters to be discharged into a sanitary sewer;
connect a sump pump to a sanitary sewer.

The Nova Scotia Utility and Review Board have approved the following rules and regulations for wastewater services:

Halifax Water shall have the right of access to all parts of a customer's property or premises at all reasonable hours for the purpose of inspecting any sewer pipes, fittings, appliances, or for the purpose of installing, removing, repairing, testing or inspecting the wastewater service connection. Halifax Water shall have the right to use all legal means including suspension of water service to any customer who refuses such access or does not respond to requests by Halifax Water for such access. (Halifax Water's Rules and Regulations for Wastewater Services, Item 11)

No owner or customer shall connect, cause to be connected, or allow to remain connected to the wastewater system or plumbing installation, without the express written consent of Halifax Water, any piping, fixtures, fitting or appliance in a manner which may allow water, stormwater to ingress or flow into the wastewater system. (Halifax Water's Rules and Regulations for Wastewater Services, Item 13)

Where in the opinion of Halifax Water, there may be a risk of water or stormwater flowing into the wastewater system, Halifax Water may require the customer, at the customer's sole cost and expense, to install (or remove) at any point on the customer's wastewater system, one or more fittings or appurtenances to prevent such connection. (Halifax Water's Rules and Regulations for Wastewater Services, Item 14)

Whenever in the opinion of Halifax Water, violation of the Schedule of Rules and Regulations is existing or has occurred, Halifax Water may cause the water service to be suspended from the premises where the violation has occurred or is existing and may keep the same suspended from the premises where the violation has occurred or is existing. (Halifax Water's Rules and Regulations for Wastewater Services, Item 62)

To assist customers identify measures to reduce inflow and infiltration on their properties, Halifax Water has designed the Stormwater Inflow Reduction (SIR) Program. The goals of SIR are as follows:

Raise awareness to reduce overflows and protect the health of HRM residents and our environment.
Inspect private properties (indoor and outdoor) for potential sources of Stormwater Inflow.
Require customers to disconnect sources of Stormwater Inflow.

The SIR program only applies to properties serviced by separated wastewater systems. Notwithstanding, there would be benefits if property owners serviced by combined systems would choose to disconnect sources of stormwater from these systems.

Selected properties owners receive a letter to book their inspections. Failure to comply can result in suspension of service or other penalties. Inspections of properties are done on a priority basis in areas

with severe inflow and infiltration or where significant capital projects are planned. Inspections of both the indoor and outdoor components are conducted.

Inside, inspectors look at the wastewater connection cleanout and other plumbing fixtures, as well as look at where sump pumps discharge. Cameras inserted through wastewater connection cleanouts are utilized to look for foundation drain connections, root intrusion, or pipe defects. Outdoors, downspouts, window wells, stair-well drains, driveway drains and yard drainage is inspected. In some cases, use of cameras or dye testing may also be used. Following the inspection, follow-up letters are provided which summarize identified issues. A timeframe to bring the property into compliance is specified if sources of inflow and infiltration are identified.

To date more than 200 inspections have been conducted since approximately late 2008. The program is administered by two full time employees. Halifax Water's right to enforce the SIR program through penalties or suspension of service have not been exercised however, they are currently seeking from the province the right to fine properties for non-compliance through tickets.

Halifax Water has conducted investigations in two areas and has discovered that it may only be effective to implement the SIR Program in one area. Halifax Water recognizes that it is important to have sustainable solutions for property owners and that issues identified through inspections cannot always be rectified; for example, in some situations it is not possible to discharge stormwater to the property.

Halifax Water is continuing to look for alternatives and are also currently looking to add some additional Rules and Regulations for wastewater services to address compliance prior to point of sale or prior to providing a new service.

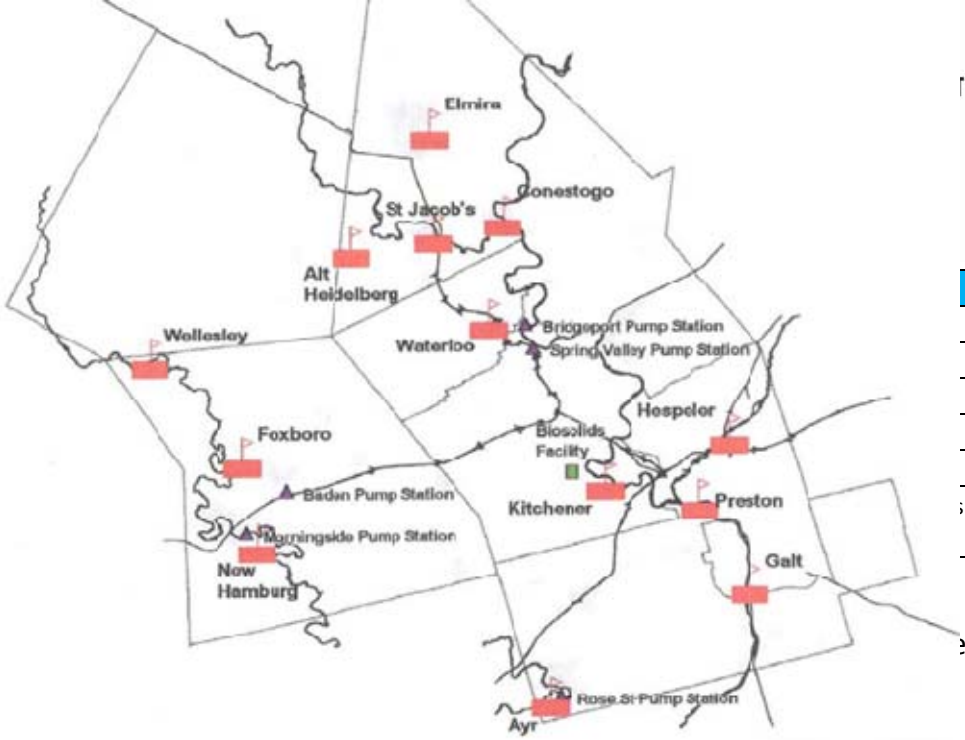
Canadian Council of Ministers of the Environment (CCME) - Canada-wide Strategy for the Management of Municipal Wastewater Effluent

One of the drivers for Halifax Water is the requirements of the CCME. The CCME is a council made up of 14 environment ministers from the federal, provincial and territorial governments. A main priority of CCME is to focus on national environmental issues and to assist its members to meet the mandate of protecting Canada's environment. The Canada-wide Strategy for the management of Municipal Wastewater Effluent was endorsed by CCME on February 17, 2009. This strategy seeks to ensure that there is regulatory clarity in managing municipal wastewater effluent under a harmonized framework that protects human health and the environment. National performance standards are outlined and the development and management of site-specific effluent discharge objectives is addressed. CCME has allotted a maximum 30 year implementation period for these standards and objectives.

Halifax Water is implementing measures with the intent of achieving the CCME objective within the allotted 30 year period. The implementation of the Stormwater Inflow Reduction Program is critical to reduce Infiltration/Inflow, minimize wastewater overflows and meet CCME's strategy as they are required to eliminate sanitary sewer overflows (SSOs) and reduce combined sewer overflows (CSOs). Halifax Water is now defining their objectives to ensure this will be achievable. These regulations will have significant financial and operational implications for owners of all municipal wastewater systems across Canada.

5.1.2.5 Region of Waterloo

The Region of Waterloo is located in South-western Ontario and consists of seven local municipalities, including the Cities of Waterloo, Kitchener and Cambridge, as well as the Townships of North Dumfries, Wellesley, Wilmot and Woolwich, each contributing to the Region's wastewater system. The wastewater system is summarized in the following Table (Table 19).



	; in total within the Region providing a

egion's WWTPs and main

Figure 123 Region of Waterloo – WWTP and Pumping Station Locations[4]

Responsibilities of Region and Area Municipalities

The *Regional Municipality of Waterloo Act* provides a legislative framework for the division of the responsibilities in terms of planning, financing, constructing and maintaining infrastructure between the Region of Waterloo and the Area Municipalities. In terms of wastewater, through this legislation, the Region is responsible for treating the wastewater generated within the Area Municipalities that are collected by the Area Municipal collection systems.

Area Municipalities are responsible for monitoring inflow and infiltration in their collection systems and completing Inflow and Infiltration Studies for the Region. The Region and the Municipality will then collaboratively establish a program to reduce I/I before consideration is given for the expansion or upgrade of a WWTP[5].

Inflow and Infiltration Issues in the Region

Between 2002 and 2006, the Region experienced a total of 42 WWTP bypasses, 48% of which were weather related. These wet weather events (snowmelt and heavy rains) overwhelmed the treatment plants, causing plant bypasses, due to high inflow and infiltration (I/I) in the collection systems[6].

The Region of Waterloo initiated a study in 2004 to identify and evaluate wastewater treatment and collection strategies to meet the current and long term needs of residents and businesses until the year 2041. This study was completed as a Wastewater Treatment Master Plan (WWTMP)[7], completed in 2007, which recommended that the Region work with the Area Municipalities to develop aggressive inflow and infiltration studies and programs to reduce I/I. Specifically, I/I reduction programs should be further investigated and implemented in the following areas:

Elmira
St. Jacobs
New Hamburg/Baden
Wellesley

[4] *Wastewater Treatment Master Plan, 2007*

[5] *Regional Official Policies Plan, Chapter 10 Infrastructure, September 2006 Consolidation.*

[6] *Report to Chair and Members of the Planning and Works Committee, Best Practices: Municipal Wastewater Treatment Plant Bypasses and Spill Prevention and Reporting in the Grand River Watershed, October 6, 2009.*

[7] *Wastewater Treatment Master Plan, McCormick Rankin Corporation, 2007.*

Waterloo

Addressing and Correcting I/I

Region: Identified in the 2007 Wastewater Master Plan, one of the recommended servicing alternatives was to carry out Inflow/Infiltration studies and implementing water conservation/sewage flow reduction measures such as the removal of weeping tile discharges from the sanitary sewer systems; encouraging the use of low flow toilets in existing and new developments; implementing a roof leader/sewer disconnection program; sanitary/storm sewer separation and/or improving sewer system performance by reducing I/I and undertaking rehabilitation activities[8].

The Region is currently (2010) undertaking a Storm Sewer Inspection Program. Video inspections are performed in order to determine the existing condition of the storm sewers and identify areas which require rehabilitation or have a reduced capacity due to accumulated debris. In the past, the Region has video inspected and flushed storm sewers on an as-needed basis. However, a more proactive approach is being undertaken for a 5 year period when the entire Regional storm sewer network will be video inspected and flushed. The storm sewer video inspection will identify storm sewer sections, manholes and catch basins that need repair/replacement[9].

Ayr: The I/I reduction program in Ayr is estimated to have reduced flows between 20-25%[10].

Elmira: Elmira experiences significant I/I problems which are being addressed by the Township and the Region. The Elmira WWTP was recently expanded from a design capacity of 4545 to 7800 m3/day. I/I flows were partially addressed through the installation of an equalization basin and low lift pumping station to address the variability in flows. Reconstruction on First Street (Elmira) occurred in 1998 to separate sanitary and storm flows, which was expected to have a significant impact on the reduction of I/I flows. The Township continues to implement and monitor I/I reduction initiatives in the collection system[11].

St. Jacobs: The I/I problem identified in St. Jacobs is being investigated with the Township of Woolwich and the Region. There is speculation that basement tile drain connections to sanitary sewers contribute significantly to I/I. The St. Jacobs/Elmira Inflow and Infiltration Project (undertook in 2006) is a joint initiative between the Region of Waterloo and the Township of Woolwich, with an agreement to share the cost on a 50-50 basis. This Project received $725,200 in Financial Assistance from the Province of Ontario[12].

Wellesley: The Wellesley WWTP currently experiences high fluctuations in flow due to high I/I, causing process upsets. It is recommended that consideration be given to construction of an equalization tank to mediate flows, or alternatively, a different process (e.g. SBR) which could better handle these variations without compromising effluent quality[13].

An I/I study of the Wellesley wastewater collection system was completed in early 2008. Based on the results of this study, design for the rehabilitation of sections of the collection system, where significant I/I was identified, was completed in 2008 and 2009. Following this completion, further system monitoring will be undertaken to evaluate the achieved reduction of I/I in the system[14].

[8] *Wastewater Treatment Master Plan, McCormick Rankin Corporation, 2007.*
[9] *Report to Regional Chair and Members of Regional Council, Storm Sewer Video Inspection Program, May 26, 2010.*
[10] *Wastewater Treatment Master Plan, McCormick Rankin Corporation, 2007.*
[11] *Wastewater Treatment Master Plan, McCormick Rankin Corporation, 2007.*
[12] *Report to Chair and Members of Administration and Finance Committee, St. Jacobs/Elmira Inflow and Infiltration Projects – Revision, June 21, 2006*
[13] *Wastewater Treatment Master Plan, McCormick Rankin Corporation, 2007.*
[14] *2009 Water and Wastewater Monitoring Report, April 2009.*

Waterloo: The City of Waterloo undertook a Waterloo Master Drainage Study in 2005[15]. The purpose of the Drainage Study was to provide Waterloo with a comprehensive understanding of the existing drainage system and loading to Laurel Creek, and provide a framework for future storm water management policies associated with urban development and intensification. The report consisted of the following recommendations:

- Implement water quality controls in the existing urban areas.
- Upgrade spill prevention and control programs.
- Remove sanitary cross-connections to storm sewers.
- Review existing storm sewer capacity in identified areas, and upgrade and construct storm sewers as required.
- Complete a detailed survey of all stormwater ponds, as well as Clair Lake and Silver Lake.
- Consider incentives, such as a reduction in on-site storm water management measures, with the objective of encouraging the construction of Green Roofs in areas where

Figure 14 Region of Niagara

Niagara operates under a split jurisdiction, where wastewater services are provided through a two-tier arrangement.

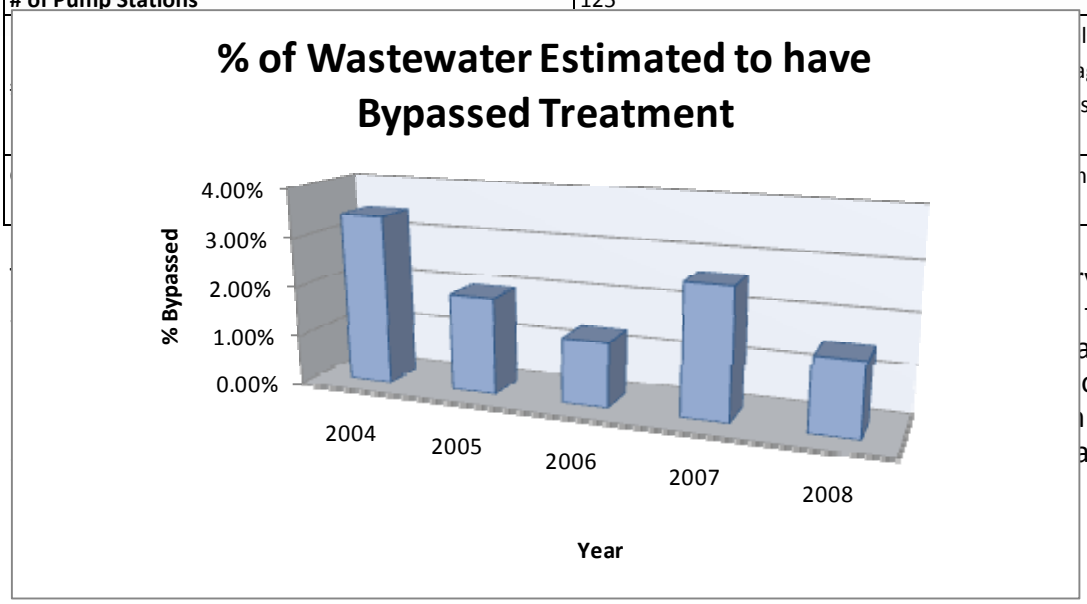
The Region provides treatment and major conveyance, operating 11 wastewater treatment plants and approximately 270 km of trunk sewers. The local area municipalities are responsible for the local collection system, and customer billing. Table 18 provides an overview of the Region.

Table 20 Region of Niagara Profile

Niagara Region Profile	
Population Served	427,421
Service Area	1,852 km2
# of Agencies / Satellite Communities	12 local municipalities

[16] *2009 Water and Wastewater Monitoring Report, April 2009.*

Length of Regional System	270 km
# of Pump Stations	125
	l which include 9 mechanical agoon and 1 facultative lagoon se area facilities range from 2.3
	nade up of 30 representatives



y and combined
to overflows during
are subject to high
of inflow and
the range of 1.32% to
atment, and excludes

Figure 15 Niagara Region % of Wastewater Estimated to have Bypassed Treatment

Six of the Region's wastewater treatment facilities also discharge in to the Niagara River Drainage Basin which has been designated an Area of Concern (AOC). The Niagara River Area of Concern is being addressed by two Remedial Action Plans (RAPs) - one for Ontario and one for New York State. The Niagara River (Ontario) RAP is coordinated by a team of technical and scientific experts from Canadian and Ontario government agencies, and is advised by the Niagara River Public Advisory Committee (PAC) which consists of volunteers representing academia, industry, environmental groups, local agencies, municipalities and the public at large.[19] The focus is to control loadings of contaminants from sewers to the environment.

For over a decade now, the Region has continued to work to mitigate the release of untreated or partially treated sewage, through both individual investments as well as collaboratively with the area municipalities. The Region has undertaken works such as storage facilities, high rate treatment (HRT) and increased capacities at pumping stations and treatment facilities which mitigate the volume of untreated sewage released into the environment[20].

As documented in an OMBI/OCMBP best practice summary report, "For the Region, the most important aspect of inflow and infiltration initiatives is to gain the trust, free sharing of information and understanding of the local municipalities. As such, the Region has offered to contribute funds for hydraulic models for interested municipalities, included municipalities in the master servicing plan, participated in various cost sharing initiatives, and has made joint efforts on pollution control planning…the catalyst for implementing inflow and infiltration reduction strategies for the Region of Niagara and the local municipalities has been the occurrences of combined sewer overflows, basement flooding, and pumping station capacity (eliminating bypasses)[21]."

[17] *Report to Co-Chairs and Members of the Integrated Community Planning and Public Works Committee, 2008 Municipal Performance Measurement Program (MPMP) Report, September 23, 2009.*
[18] *Report to Co-Chairs and Members of the Integrated Community Planning and Public Works Committee, 2008 Municipal Performance Measurement Program (MPMP) Report, September 23, 2009.*
[19] *Options for the Remediation of the Environmental Problems in the Niagara River (Ontario) Area of Concern, May 1994.*
[20] *Report to Co-Chairs and Members of the Integrated Community Planning and Public Works Committee, 2008 Municipal Performance Measurement Program (MPMP) Report, September 23, 2009.*
[21] *OMBI, OMBP, Best Practice Summary Report, Increasing Knowledge Through Flow Monitoring, February, 2008.*

Combined Sewer Overflow

A CSO policy which recognizes the joint responsibility of the Region and Area Municipalities was established in 2007. The policy outlines that 50% of the contributions for studies, flow monitoring, and conform facilities and measures shall be provided by the Region and the remaining from the Area Municipalities[22.] There are 283 CSO locations throughout Niagara. The 283 locations include both municipal and regional infrastructure.

While the CSO's help to prevent basement flooding, but do not address Inflow and Infiltration reduction directly. They also do not eliminate the health and environmental concerns associated with the release of untreated wastewater. Recognizing this, the Region no longer installs combined sewers. Projects to upgrades older pipes, and disconnecting downspouts that run directly into the sewers are some of the improvements being made to address inflow and infiltration as well as reduce the need for overflows.

Flow Monitoring

The Region also has a Flow Monitoring Team which gathers data from the Region's sanitary trunk network; data has been collected since 1987.The team in responsible for 13 rain gauges, flow monitoring and pump station performance testing, and also occasionally supports the efforts of the Area Municipalities'. The resulting data enables a better understanding and quantification of the components of the flow itself, including the portion of extraneous flow resulting from inflow and infiltration.

Pollution Prevention and Control Planning in the Niagara River AOC

As described above, the priority issues for the Niagara River RAP is to reduce the loadings of contaminants from sewers to the environment from CSO's. As such both the Region and the local municipalities have taken steps to reduce the impacts CSO's have on the Niagara River Drainage Basin some of which also relate directly and indirectly to the reduction and control of inflow and infiltration as summarized below[23]:

- Pollution Control Plan (PCP) studies have been completed in Fort Erie (1990), Niagara on the Lake (1990), Niagara Falls (1996), and Welland (2001).
- The City of Welland has partially separated many of their combined sewers over the past 30 years, completed 90% of their downspout disconnections as of 2006, and conducted computer modelling of the flow in their system.
- The City of Welland and Niagara Region are undertaking a sewer separation program.
- The Town of Fort Erie, while, serviced by a separate system, has foundation drains and roof leaders connected to their system. By 2006, 90% of residential downspout disconnections were complete, and commencement of the disconnection of residential foundation drains began.
- The City of Niagara Falls completed construction of a new joint Central Pump Station – High Rate Treatment (HRT) Facility in co-operation with Environment Canada, Niagara Region and the Ministry of the Environment to reduce the amount of pollution from sewer overflows and stormwater discharges into the Niagara River. The project also included reconstruction of a pumping station, forcemains for both pumping stations, decommissioning of three pumping stations and the construction of sanitary and storm sewers to allow for the separation of combined sewers and redirection to new outlets.
- The City of Niagara Falls also has been conducting residential foundation drain disconnections for a number of years, covering 100% of the cost to do so.
- The Town of Niagara-on-the-Lake is working with Niagara Region to undertake flow monitoring before and after works such as disconnection roof leaders, lateral repairs, and other infrastructure deficiencies.

[22] *OMBI, OMBP, Best Practice Summary Report, Increasing Knowledge Through Flow Monitoring, February, 2008.*
[23] *Niagara Remedial Action Plan Stage 2 Update, October 2009.*

- Fort Erie staff checks the condition of the lateral during a house transaction (Town By-Law No. 90-87). If the connection is not found to be proper, then the existing owner must pay to have it corrected.

5.1.3 *International*

5.1.3.1 United Kingdom Experience

Governance Structure

In the UK, water services are provided by a number of private companies whose actions are regulated by the Office for Water Services (OFWAT). Since privatisation in 1989, investment has been delivered in five-year cycles, known as Asset Management Plan (AMP) periods. Major improvements to sewage treatment, combined sewer overflows and property flooding have been achieved. However, the programme constraints imposed by the AMP process, combined with the scale of the workload, are such that the majority of capital works have been designed to deal with existing levels of inflow/infiltration.

I/I Reduction

A questionnaire survey of infiltration problems in the UK was described in the report *Control of Infiltration to Sewers (CIRIA, 1996)*. Of the 1,646 catchments included in the survey, 28% were reported to have greater than 25% infiltration and 9% to have more than 50% infiltration. A subsequent report, *Dry weather flow in sewers (CIRIA, 1998)*, presented an analysis of long term dry weather flow data from 95 sites in England and Wales. Infiltration ranged from 0% to 89% of total measured dry weather flow, with a mean of 45%. For purely domestic catchments, the 45% level is equivalent to 155-120 litres/capita/day.

Definition of Excessive I/I

Sewers for Adoption (Water UK/WRc, 5th Edition, 2001) is a design and construction guide for developers who what their new sewers to be taken in charge by the water company post-development. The guide requires a design flow of 4000 litres/unit dwelling/day for gravity sewers serving new residential development. The figure effectively allows for 10% infiltration, which equates to 120 litres/capita/day.

Program Funding

The benefits of long-term flow monitoring data were demonstrated by an investigation carried out prior to award of a Private Finance Initiative (PFI)[24] contract for a wastewater treatment facility in Edinburgh, Scotland *(Friend and Hill, WaPUG Spring Meeting, 2001)*. On average, infiltration amounted to some 60% of the dry weather flow and seasonal variations were noted. The PFI payment system was based on flows receiving full treatment at the treatment facility and for the total payment over the 25 years concession period, approximately half is infiltration based. Infiltration value on dry days over a 12-month period were plotted against both the number of preceding dry days and the Antecedent Precipitation Index Values (API30 is a factored total of the rainfall that fell during the 30 days prior to the dry day). The analysis found that the lowest infiltration did not necessarily occur after the largest number of dry days or when the API30 value was lowest.

Understanding rainfall-induced infiltration and representing it correctly in hydraulic models has been highlighted by the considerable investment is CSO improvements in the UK in recent years. Where storage is proposed as a solution for reducing CSO spill frequency, the required volume may be underestimated if the model does not adequately represent the increase in flows after a rainfall event. The typical five to ten week flow survey carried out to verify a sanitary model has been found, in many cases, to be insufficient for understanding infiltration variation to the extent needed for design.

[24] *In Scotland the Private Finance Initiative (PFI) is presently the most common type of Public Private Partnership in Scotland and is used in the main to deliver large infrastructure projects. Its main feature is that the private sector, as well as designing, building and operating the facility, also funds the construction. Once operational, the public sector pays an annual charge to the contractor for the facility and the associated services under a long-term contract of typically between 25 and 30 years.*

5.1.3.2 Greater Dublin

Greater Dublin Strategic Drainage Study Regional Drainage Policies - Volume 4: Inflow, Infiltration & Exfiltration

The Greater Dublin Strategic Drainage Study (GDSDS) was created to provide the recommendation of policies for the future provision and management of drainage services in the Greater Dublin Area (GDA). The GDA includes the Local Authorities in Dublin City, Fingal, South Dublin, Dun Laoghaire Rathdown, Meath, Wicklow and Kildare. These drainage policies are meant to assist Local Authorities in complying with their legal responsibilities, their planning and development objectives and are to, in so far practicable, conform to good international practice. A particular requirement from the study is that Drainage Policies adopted across the region should facilitate a uniform and consistent approach to urban drainage infrastructure planning, design, construction and operation. The Overall Policy Document, entitled "Regional Drainage Policies" summarises the drainage policies for the GDA. The background and details of the drainage policies are contained in separate Technical documents, which are;

- Volume 2 – New Development
- Volume 3 – Environmental Management
- Volume 4 – Inflow, Infiltration and Exfiltration
- Volume 5 – Climate Change
- Volume 6 - Basements

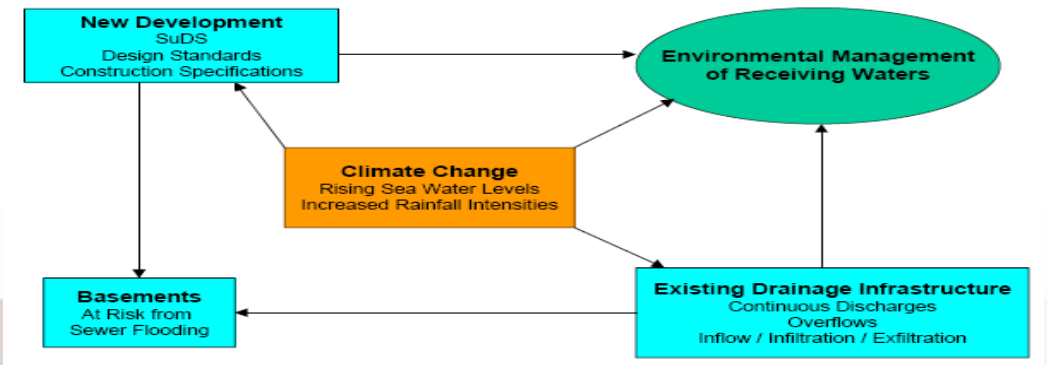
Governance Structure

The major existing drainage infrastructure is interconnected, with the greater part of the sanitary sewer network catering for Dublin City, South Dublin and parts of Fingal, Meathe, and Dun Laoghaire Rathdown, draining to a common wastewater treatment facility (Ringsend WWTP). The management of this interconnected system requires each Local Authority (LA) to have consideration of the needs and drainage requirements of the other local authorities. It is therefore a necessity that the future management of all drainage in the GDA is integrated across the seven local authorities in the region and across various disciplines within those authorities, in order to bring conformity of approach in drainage matters to Councils across the region.

The policies are intrinsically linked and cover a number of key areas, including:

- Existing Drainage Infrastructure; or how to best utilize the existing assets and minimize their impact on the regions watercourses;
- New Development; or how to minimize the impact of future development on the environment, particularly its watercourses;
- Basements; or how to protect basements from sewer flooding;
- Climate Change; or what, if anything, should be done to prepare for higher sea levels and greater rainfall intensities – the predicted outcome of climate change.
- The following figure depicts the interrelationship of these key areas.

Figure 136 Relationship between Regional Drainage Policies (Greater Dublin)



Inflow, Infiltration and Exfiltration Policy

There is limited literature available relating to infiltration studies or removal programmes in Ireland. Drainage area studies (undertaken as part of the design process for new sewage transfer/treatment schemes or to address deficiencies such as flooding) have often identified I/I as a problem and local authorities have followed up with works to locate sources and reduce flows.

The 2001 to 2004 Greater Dublin Strategic Drainage Study covered 18 sanitary/combined sewerage catchments with a combined population of 1.4 million (about 1/3 of the total state population). A major programme of flow measurement (480 flow monitors and 270 rain gauges) and sewerage modelling in these catchments provided an opportunity for an initial assessment of infiltration, albeit on a "snapshot" basis due to the short-term sewer flow surveys. Monitoring was undertaken in both summer and winter conditions.

The most significant effect of Inflow and Infiltration for the Dublin Region is that the capacity of the sanitary system and treatment facilities is compromised, resulting in restrictions in their ability to service new developments. The drainage departments in the Dublin Region have long suspected that there are substantial quantities of inflow and infiltration in the sewerage systems of the Region. These suspicions have been confirmed by verification of hydraulic models under the GDSDS.

Existing approximate infiltration flows for the Ringsend WWTP catchments are as follows:[25]:

Table 20 Greater Dublin Infiltration Flows

Catchment	Infiltration Flows in Litres/Second
Grand Canal System	615
City Centre / Docklands	558
Dun Laoghaire	338
Rathmines & Pembroke High Level	500
Total Infiltration Flow	**2011 l/s**

The flow to full treatment at the wastewater treatment plan is 11m^3/s; 2011 l/s comprises 18% of this flow. At a daily sewage discharge per household of 650 litres, 2011 l/s corresponds to 267,300 households. At 2011 l/s, infiltration in the Ringsend WWTP catchments is approximately 50% of dry weather flow.

Policy Objectives

The GDSDS approach requires application of Best Management Practices (BMPs) from international experience, the following objectives are achieved:

- The presence and causes of inflow, infiltration and exfiltration (I/I/E) in the region's sewerage systems are recognized;
- I/I/E in the region's sewerage systems will be identified and flow quantities estimated;
- Survey and reduction works will be carried out with optimum cost-benefit;
- Specifications and practices for sewerage construction will be imposed to minimize I/I/E;
- Asset management systems will be targeted to minimise I/I/E and its adverse effects on the operation of the sewerage system and the overall environment.

Policy Recommendations

Most I/I occurs in relatively small quantifies throughout the extent of the sewerage system, and is hence difficult, time-consuming and expensive to identify. For that reason the recommended policy is

[25] *As of March 2005*

reiterative reduction of flows, based on homing-in from the general area to particular significant sources. The largest sources would be tackled first, then progressing to smaller sources. Where flows are small, or the sources are diffuse through the system, it may be more cost-effective to discontinue the process. The most cost-effective policy is to minimise I/I in the first place. This can best be done by strictly controlling the quality of new and renovated sewerage installations, and by ensuring that best quality materials and construction techniques are used, to provide a long-lasting leak-free system. Connections must also be correctly made, and private drains and abandoned sewers managed to minimise the risk of leakage. Rigorous monitoring by Council Inspectors will ensure that sewerage construction will achieve its maximum life without defects.

Since private drainage systems can cause similar or worse problems due to lake of maintenance, it is recommended that this policy apply to both public and private drainage.

Specific Recommendations

New Water Industry Specification for Ireland, covering materials, installations, construction, testing and inspection to improve the standard of drainage assets.

Strengthened Drainage Inspectorate to ensure that the highest practical standards of drainage assets are achieved. Their remit would include inspection of both public and private drainage systems.

Inflow/Infiltration/Exfiltration Procedure to be adopted to reduce non-legitimate flows in the most cost-effective manner, including strengthening of the current misconnections programme.

Drainage Operation and Maintenance Practices to include particular emphasis on minimising opportunities for non-legitimate flows to enter and leave the systems, through missing manhole covers and faulty flap valves.

Maintenance of Hydraulic Models and Databases to support the above procedures by providing geographically based asset and performance information for the identification of non-legitimate flows.

Register of Water Source Boreholes to enable the interface between water sources and drainage systems to be established and hence allow management of risks of cross-contamination.

Survey and Renovation of Private Drains, as a condition of sale.

The Regional Drainage Policy for New Development has similar objectives in improving the quality of drainage construction, such as new specifications and strengthened inspectorate, so both policies are mutually supportive.

Implementation of GDSDS Policies

The overall policy principles have been adopted by the Local Authority Councils, and included in their current Development Plans. The arrangements to implement the detail of the Policies are shown in Figure17.

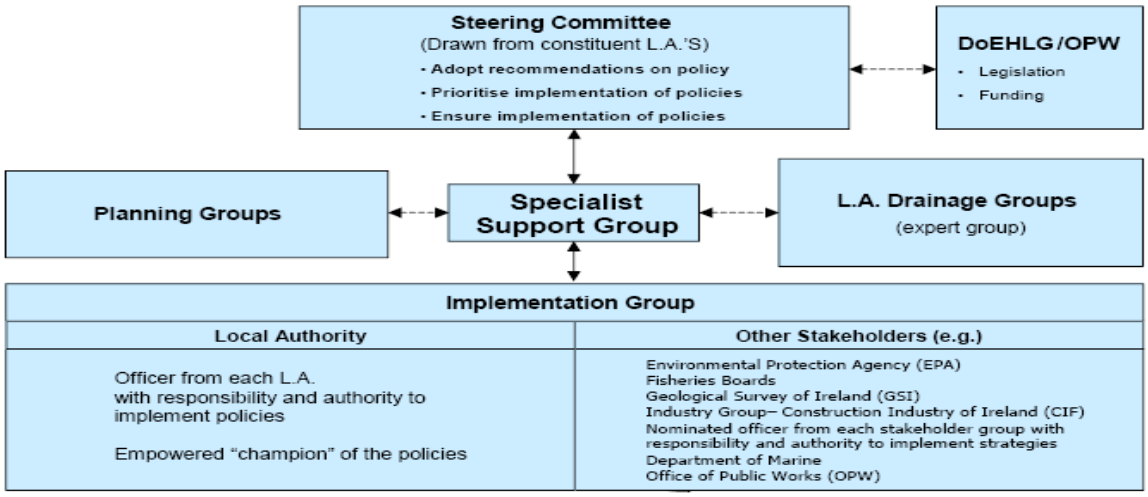


Figure 147 Flow Chart for Implementation of GDSDS Regional Drainage Policies

5.1.3.3 North Shore City, New Zealand

North Shore City offers a lifestyle that's unique in the Auckland region and among the best in New Zealand. There are more than 225,800 residents, spread across the 13,000 hectare region which provides beautiful coastline, rich culture and leading-edge enterprise.

Governance Structure

North Shore City Council is responsible for managing water supply, wastewater and stormwater services in North Shore City. Water supply, wastewater and stormwater are separate services, but form part of the same water cycle.

I/I Reduction

To improve beach water quality, North Shore City Council started the Wastewater Network Strategic Improvement Program (WNSIP) as a part of Project CARE (Council Action in Respect for the Environment) in the year 2000. A key outcome of Project CARE is a Wastewater Network Strategic Improvement Program (WNSIP) to reduce the overflows from the wastewater network caused by the Inflow and Infiltration (I/I) of rainwater into the wastewater network during wet weather events.

Project CARE was launched in 1998 to provide a way of integrating North Shore's planning to work towards resolving the beach pollution problem. After extensive public consultation, a target of two wet weather overflows per year from the wastewater network was adopted. The planning process was completed in 2002 with the adoption of the Wastewater Network Strategic Improvement Program (WNSIP).

	Catchment Name	Existing I/I in 1998	Forecast I/I in 2050 without Rehabilitation	Target for 2050 I/I after Rehabilitation
C07	Constellation East	24.5	30.6	8.5
C06	Windsor	24.6	30.8	8.5
C09_1	Glenfield North/Sunnynook 1	13.2	16.5	7.4
C26_1	Devonport 1	16.7	20.9	8.5
C24A	Hauraki Belmont	12.8	16.0	6.9
C22	Chatswood	10.3	12.9	6.8
C24_2	Bayswater 2	14.6	18.3	8.5
C04_1	Rothesay Bay 1	14.4	18.0	8.5
C17_4	Milford/Takapuna East 4	11.7	14.6	6.8
C25	Narrow Neck	14.6	18.3	7.1
C17_2	Milford/Takapuna East 2	11.7	14.6	7.8
C26_2	Devonport 2	18.4	23.0	12.8
C24_1	Bayswater 1	14.6	18.3	10.8
C02	Mairangi Bay	12.2	15.3	8.5
C05	Castor Bay	9.5	11.9	6.5
C17_1	Milford/Takapuna East 1	11.7	14.6	9.3
C03	Campbells Bay	9.3	11.6	5.5
C12	Beach Haven	10.2	12.8	6.9
C01	Browns Bay South	8.6	10.8	5.0
C21	Old Northcote	7.9	9.9	6.8
C14	Birkdale	8.6	10.8	8.8
C18D	Waiake	4.7	5.9	5.0
C18C	Torbay	3.9	4.9	5.0

Figure 158 North Shore Post-Rehab Reduction Targets

Late 2008 marked the six-yearly review of Project CARE. The main objective of the review was to ensure that the Project CARE target of no more than two wet weather overflows per annum is on track to be met by 2021 in the most cost effective way.

Good progress has been made to date and many major projects have been completed or are well underway.

Key projects that have been completed include the Browns Bay Storage Tunnel, the Silverfield and Kahika storage tanks, the Oteha Valley trunk sewer, the Northboro storage tunnel, the Wairau trunk sewer upgrade and the Seaview pumping station in Milford.

The total amount of money spent so far has been approximately $124 million and the number of wet weather overflows in areas where these works have been completed have been significantly reduced. Currently around 50% of the beach areas have met the target for overflow numbers.

Overflow frequencies in other areas remain problematic and other activities under Project CARE need to be completed before the overflow targets can be met in these areas

To ensure that the WNSIP program is on-track to reaching its targets, Project CARE includes a review every 6-years. This review includes an assessment of the benefits of the capital-works projects completed to date, and a revision / update of the upcoming WNSIP projects.

As a part of this review process, NSCC has commissioned studies to review the effectiveness of the CARE-catchments that have been rehabilitated as a part of the WNSIP program. Four effectiveness studies have been completed between 2000 and 2007. North Shore City has completed a statistical analysis of the results achieved in the I/I work that they have undertaken thus far and are about to revise their analysis to reflect the last few years of work. Their data allows them to estimate the reductions in PWWF and % rainfall ingress based by the catchment initial leakiness/peak flow characteristics and the % of rain water (Cv) entering the catchment.

In this regard, North Shore City Council (NSCC) commissioned a 2009 study to help them:

Summarize the I/I rehabilitation effectiveness results to date, and extract all that could be learned from these results;
Develop a new model to forecast the expected reduction in RDII and peak wet weather flows in the wastewater network;
Use the newly developed RDII and peak flow reduction models to produce the cost-benefit tables required as input into their wastewater network cost-optimization model;
Develop a toolbox to assist their wastewater planning engineers with planning decisions associated with wastewater network I/I rehabilitation, and;
Advise on how to better the outputs from future I/I effectiveness studies, based on the lessons that have been learned from the I/I effectiveness studies to date.

Their experience has shown that they have not achieved the reductions that their initial strategy expected when they started I/I reduction 10 years ago. This was especially true in catchments which had under 10% rainfall ingress initially, their current practice is that they do not feel that catchments under 15% rainfall ingress are candidates for I/I treatment as flow reductions are not large enough and other solutions would be more economic.

It was determined that there were two main reasons for the Project CARE RDII reduction targets not being achieved. These were:
The RDII I/I rehabilitation effectiveness model developed in 2000 to forecast the potential reduction had over-estimated the potential reduction;
When mini-catchments were selected for rehabilitation, it was assumed that 100% of the mini-catchment would be rehabilitated. However, this was not the case.

Definition of Excessive I/I

Northshore has found that the potential to reduce the RDII and peak wet weather flow reduces for more watertight networks. Any catchments below 15% RDII sees the potential to reduce RDII and peak flow drop off rapidly.

Program Success and Findings

Models were used to forecast the minimum leakage to achieve a net reduction in RDII of 1%, and a net reduction in peak wet weather flow of 1.0L/sec/ha.

RDII: If 65% of the total (public + private) catchment was rehabilitated:

- The initial RDII% must be higher than 10% RDII, to have greater than 84% confidence in reducing the initial RDII by a net 1%
- The initial RDII% must be higher than 5% RDII, to have greater than 50% confidence in reducing the initial RDII by a net 1%;

Peak Flow: If 65% of the total (public + private) catchment is rehabilitated:

- the initial peak flow must be higher than 3.6 L/sec/ha, to have greater than 84% confidence in reducing the initial peak flow by a net 1.0 L/sec/ha
- the initial peak flow must be higher than 2.6 L/sec/ha, to have greater than 50% confidence in reducing the initial peak flow by a net 1.0 L/sec/ha

5.1.3.4 Australia – Mullumbimby

Byron Shire Council – Mullumbimby Sewerage System Inflow & Infiltration Programme Integrated Strategy

Byron Shire Council is a Local Government Area (LGA) in the Northern Rivers region of New South Wales, Australia. It is on the Pacific Ocean and the Pacific Highway and shares boundaries with the Tweed, Lismore and Ballina. Mullumbimby is a town in the Northern Rivers region of Byron Shire.

The Mullumbimby Sewage Reticulation system was constructed in 1962 and consists of 12 pump stations, 418 manholes, 23,281 meters of gravity mains, 23,000 meters of side lines, 7,447 meters of rising mains, 1,138 sewer junctions and approximately 20,000 meters of private lines. Within approximately 10 years of construction problems were identified with respect to inflow / infiltration into the system. The stormwater ingress causes wet weather overflows and can have adverse impacts on the performance of the sewerage system for households in lower lying areas. Stormwater ingress to the sewerage system occurs because of defects like cracked pipes in both the Council sewers and the house service lines on private property. Council has adopted a three year strategy to address the problem of storm water ingress into the Mullumbimby sewerage system and progressively rectify the defects.

In 2003 Council developed the following Inflow and Infiltration Programme:
Measure the levels of Inflow/Infiltration by catchment. Inflow/Infiltration was assessed in 3 categories of background infiltration from groundwater; direct inflow and stormwater infiltration.
Measure the wet weather surcharge flows to the Brunswick River.
Prioritise the Sewage Collection System by catchment according to the measure quantities of Inflow/Infiltration.
Identify the sources of Inflow/Infiltration in the catchments identified as priority by undertaking a complete survey of the catchments from the house to the main.
Prepare and evaluated a cost effective correction plan.
Implement the agreed correction plan.
Re-measure both the level of Inflow/Infiltration in the remedied catchments and the wet weather surcharge flows to the Brunswick River to obtain and "effectiveness Measure" of the corrective action taken.
Continue this process through the prioritised catchments until the level of Inflow/Infiltration is reduced to acceptable levels.

It was proposed to implement the Mullumbimby Inflow and Infiltration Strategy (MIIS) as 6 elements of an overall long term iterative project. The six elements were:

- Data Collection and Analysis

- Public Sewerage Infrastructure Rehabilitation
- Private Sewerage Infrastructure Repairs
- Stormwater Maintenance
- Community Education
- Pump Station Analysis and Upgrade
-

The project focused on 5 catchments which combined, account for over 80% of the entire Mullumbimby system assets and flows.

Data Collection and Analysis
Permanent flow recording technology has been installed at each of the 12 pumps stations complete with rain gauges. The system will record time based flow data and rainfall at each site and allow the data to be viewed through internet access. Also, 2 engineered overflows in the sewerage system have permanent flow recording devices which record all flows and generate alarms advising of overflow events.

The overflow data plus metered inflow into the local sewage treatment plant is used to report total system flows for each event while the pump station data recording device outputs are analysed on a continual basis for feedback into work plans.

Public Sewage Infrastructure
Mullumbimby Water and Sewerage Operations have been rehabilitating the public sewerage infrastructure since late 2003. Mains and sidelines are assessed via CCTV; defects are identified and repairs initiated. The main method of repair has been to excavate and replace using conventional pipe and fittings. Two of the five catchments were completed in the period from late 2003 to early 2005. Since December 2005 virtually all identified repairs in the remaining three catchments have been finished.

Private Sewerage Infrastructure
As of March 2007 private plumbing works had not been fully investigated for leaks and cross connections. However, during investigative and repair works on public infrastructure operations staff had been recording observed anomalies in the private system. Defects noted have ranged from damaged gully traps[26], obstructed traps; non-complying traps i.e. at or below ground level; broken pipes and defective inspection openings.

Moving forward the Council's strategy for this element will be to assess each property for plumbing defects. The assessment will involve above ground and below ground inspections for homes and buildings located within the five prioritized catchments. For identified plumbing defects, the Council will in the first instance, notify the landowner in writing of the defects identified and request they be repaired at the landowner's cost. A time period for repairs will be nominated and follow-up inspections undertaken. If necessary, compliance action will be initiated against the landowner to enforce the repair work to be undertaken.

Stormwater
Byron Shire Council's Asset Management Services department has documented Asset Risk Management Procedures whereby inspections are undertaken routinely on stormwater assets in Mullumbimby. However, there is no funding for maintenance for the vast majority of the underground stormwater assets. Therefore the strategy recommended that through the I/I Program maintenance be performed on those stormwater pipes within the five prioritised catchments.

Community Education

[26] *Wastewater from kitchens and bathrooms is piped to a gully trap before emptying into the sewer. A gully trap is a basin in the group with a water seal to prevent foul odours of the sewer reaching the surface. Gully traps are buried in the ground with the top or surround raised above group level to prevent ground water entering into the sewer.*

Community education of the issues and consequences of asset maintenance, stormwater flows; sewerage system collection and sewage overflows into the environment is an important element of the Council's Inflow and Infiltration Project. The strategy proposed that education of the community is to be driven by the Sewer Rehabilitation project crews as they undertook both public and private asset inspection and repairs. This was to take the form of conversations with the customers and the issuing of appropriate literature in the main garnered from the internet.

Pump Station Analysis and Upgrade

This project element involved a comprehensive review of the Mullumbimby Sewerage Collection and Transfer system. Of particular importance was the analysis of assets within the prioritised catchments. Any identified deficiencies and upgrades were to be addressed in companion capital projects.

Measures of Success

The Mullumbimby Sewerage System Inflow and Infiltration Programme must necessarily have an iterative approach with ongoing data collection and assessment. It is expected that each project element will contribute to an improvement in the system performance. It should be noted however, that as the magnitude of inflow and infiltration is dependent on many factors (rainfall intensity, duration, location, size, time; time of the year) it is not possible to draw conclusions from system performance on one event therefore; project success must be reviewed on data collected over time.

The Council proposed therefore to have the following data collated with the aim of assessing a measure of success:

- Ratio Wet Weather Flow (Daily) / Dry Weather flow (Daily) < 7 – 8
- Number of Overflow events per year < 3
- Total System Flow per Rainfall Event

Data collection is to be continuous with a major review to occur annually to assess actual data against targets and make an assessment of the success or otherwise of the strategy.

5.1.3.5 Auckland New Zealand (Metrowater - Watercare Services Limited)

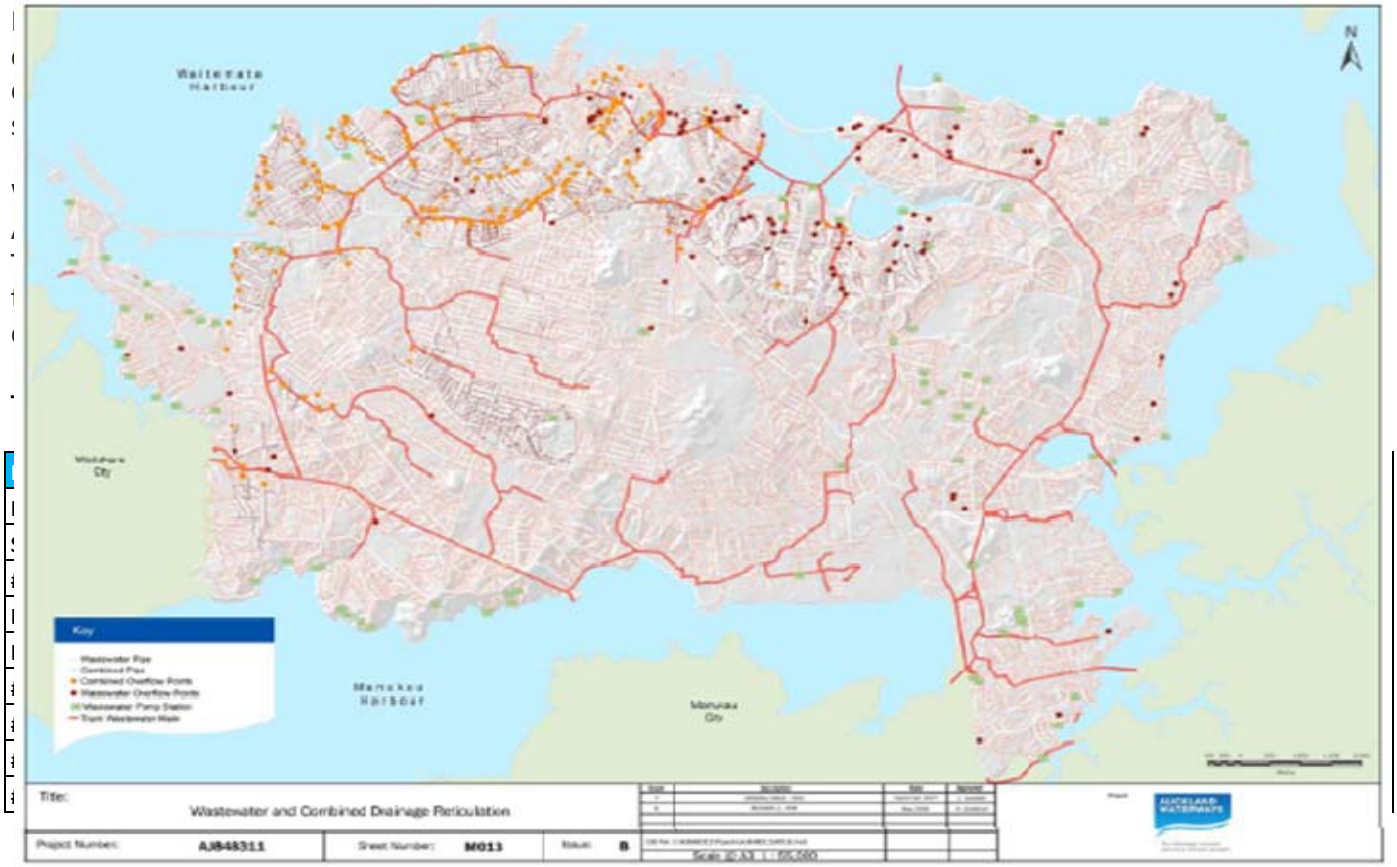


Figure 19 Metrowater Geographic Area

Governance Structure

The Council owns the combined drainage network, although Metrowater is responsible for the maintenance and operating costs. They have prioritized sewer separation as an interim means of reducing wastewater overflow into the harbour.

The role of the Directors of Metrowater is defined in Section 58 of the Local Government Act as follows:

"The role of a director of a Council-Controlled Organization is to assist the organization to meet its objectives and any other requirements in its Statement of Intent."

The Board is responsible for the preparation of the Statement of Intent (SoI), which must receive approval from the Company's Shareholder, Auckland City Council.

In addition to the obligations imposed by the form of the Company, Metrowater Limited is also covered by the Companies Act 1993 and governed by the Directors according to law and best practice.

The Auckland Region is currently set up such that there are 7 local network operators (LNO) and a bulk network/trunk sewer operator. Each LNO tends to have different operating strategies with differing levels of success. Each operator provides Council an update on success. A key public driver is to reduce spills to the environment from overflows during wet weather caused mainly by I/I.

I/I Program

Generally, the I/I reduction targets are based on a combination of overflow mitigation and percentage peak wet weather flow reduction. Auckland is a very diverse city in demographics. The LNO's have different cultures and levels of service that have been developed through community consultation. For example in the South of Auckland which is less affluent, spills are considered to be less of a nuisance than in the more affluent North area. There is also the Maori[27] cultural aspect of 'zero contact with human faecal matter' ever. This means that Metrowater works on very tight spill frequency criteria (2 spills per annum).

The reduction in dry weather overflows of polluted water caused by blockages in Metrowater's wastewater networks and the progress made in separating more properties from the combined wastewater and stormwater networks have both been important factors in improving the environmental impact of the company's wastewater system.

In 2005, Metrowater committed to a 35% reduction in the volume, a goal that was met two years ahead of schedule, of polluted water entering the environment from its networks over the period from 2005 to 2011. The company is on track to achieve this goal through progress made in the sewer separation program. A significant proportion of this work is being carried out by Clear Harbor Alliance.

Enabling significant progress in reducing wet weather overflow spills from the combined and separated sewer systems has been the Clear Harbor Alliance project. This is an alliance which was set up in 2007 between Metrowater, Downer EDI Works, Opus International and GHD Consultants. The alliance operates under an agreement where risks and opportunities are shared for a range of performance targets, incentivizing innovation. Clear Harbor Alliance's success has enabled Metrowater to effectively accelerate progress in reducing pollution and has now achieved 650 property separations against a target for this stage of the project of 489.

Private Sewerage Infrastructure

West Auckland implemented a scheme that linked house valuations to damaged lateral connections. The house owner was issued a time limit to correct a damaged lateral. Three months later an assessment was carried out using smoke testing. If the lateral connection was still deemed to be a problem, then a 'final warning' letter is issued and a secondary check carried out three months hence. If the lateral connection is still inappropriate, the fault is reported on the house survey that can affect house price. Success rate has been apparently excellent.

Central and Northern Auckland undertook the rehabilitation of public and lateral connections. Success was measured through analysis of pre and post flow monitoring. Challenges are comparing storm with similar antecedent conditions, rainfall volumes and peak intensities. Also some errors have been made in pre and post surveys being undertaken during different seasons

[27] *The **Māori** are the indigenous Polynesian people of New Zealand, They arrived from East Polynesia in several waves at some time before the year 1300,[6] settled and developed a distinct culture.*

Flow monitoring is undertaken on a 'catchment need basis' that is usually linked to wet weather issues such as flooding or developer enquiries. For example, there are parts of Auckland that are delaying development because the sewers have no capacity – this can be attributed to high I&I levels, but a more strategic approach is being considered rather than looking to reduce I&I over the short term

6. Local Regional Programs

6.1 Regional Municipality of Halton [28]

Halton Region has been exploring options and developing various strategies to deal with I & I issues since the early 1990s.

Specifically, Halton has developed standards and procedures in the following areas.

Acquire knowledge of the existing system
Gathering detailed information on the physical aspects of the sewer system (pipes, manholes, laterals, etc), as well as related data that can be used in assessing how the system is performing (flow records, sewer operation and maintenance records, population history, meteorological data, etc).
Understanding the performance of the system through theoretical modeling. This tool is used to compare how the system is actually performing against how it was designed to perform. In addition, modeling can be used to predict potential problem areas.

Implement wastewater flow monitoring equipment.
Gathering data through actual flow meters to assess the sewer flow.
Using over 39 temporary and permanent flow monitoring sites located at strategic areas throughout the Region. Given the age and size of the system and the information gathered to date, there has been more focus on the older infrastructure of Halton, primarily south Oakville and Burlington. In addition to analyzing flows within the system, a great deal of flow information is collected from the seven wastewater treatment facilities and numerous wastewater pumping stations.
Analyzing rain events and their effects on the system at established crucial sites and installed meteorological stations.
In project areas, groundwater monitoring is taken into account.

Assess the physical condition of the sewer system.
Determine and quantify sources of I & I in numerous areas of the system by:
Smoke testing
Manhole inspection
Mainline and lateral closed circuit television (CCTV) inspection
Dye testing
Household Drainage Surveys (HHDS)

Develop and implement a remediation plan for the system.
Establishing priorities in rehabilitation, repair, or replacement works. Halton has completed numerous pilot studies to identify problematic areas and is continually working to improve the performance and condition of the wastewater system. The work includes hydraulic improvements, facilities upgrades, and sewer repairs/replacement
Numerous I & I related projects have been completed including:
The installation of a 6,600m3 tank in the Rebecca Street area of Oakville for the temporary storage of excessive flows into the sanitary sewer system
Various manhole rehabilitation projects
Wastewater main replacements and rehabilitations

[28] *Region of Halton, http://www.halton.ca/cms/One.aspx?portalId=8310&pageId=39617#Q4.*

Improvements to operational practices
A private side lateral lining pilot project was identified in 2005. This pilot project has provided valuable information on the relative impact of aging wastewater laterals and will assist in determining the future steps that Halton can take in working towards reducing/eliminating I & I issues

6.1.1 *The Region of Halton's Household Drainage Survey Program and Downspout Disconnection Program*[29]

The Region of Halton has been conducting household drainage surveys based on a prioritized list; homes within the key flooding areas that have experienced flooding as well as some that have not for comparative purposes have initially been targeted.

The survey incorporates a review of the lot grading, lateral inspections, roof leader and weeping tile connection assessments, and the determination as to whether homes have backflow prevention devices and sump pumps installed. The second component of the Household Drainage Survey Program is to conduct surveys in a number of homes that have not experienced basement flooding to allow the Region to compare results for similar homes and determine the factors that are leading up to basement flooding. The desired outcome of the surveys include the following:

Identify potential sources of stormwater entering the sanitary sewer.
Assess the site drainage of each home.
Collect data regarding the home including history and basement drain elevation.
Assess the condition of the lateral which is the pipe carrying wastewater out of the home.

6.1.2 *The Region of Halton's Pilot Programs*[30][31]

In addition to the Household Drainage Survey, the Region has also undertaken a Regional Disconnection and Lateral Lining Program. The pilot program is serving two purposes:

To address homes that have been the most impacted by multiple basement flooding occurrences since July 2006 and,
To gather critical information required to develop a comprehensive strategy to address basement flooding relating to inflow and infiltration across the Region.

The objectives of the pilot project were as follows:
Identify representative candidates for foundation drain disconnection
Assess the suitability for longer term monitoring
Quantification of diverted storm flows after disconnection
Complete a cost-benefit analysis
Transfer results
Develop a long term management strategy

As described above, the household drainage surveys conducted assessed the condition of the lateral and the installation year as well as established the main layout of the drainage connections in the basement with elevations. With this information, the following outlines the steps of the foundation drain pilot project:

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[29] *Ontario Municipal CAO's Benchmarking Initiative and Ontario Centre for Municipal Best Practices, Best Practice Summary Report, "Customer Outreach"*

[30] *Illija Stetic, Halton Region, Presentation made at the National Water and Wastewater Benchmarking Initiative Inflow and Infiltration Task Force Workshop "Foundation Drain Disconnection and Flow Monitoring Pilot Project," October 29th, 2009.*

[31] *Ontario Municipal CAO's Benchmarking Initiative and Ontario Centre for Municipal Best Practices, Best Practice Summary Report, "Customer Outreach"*

Disconnect roof and foundation drains, construct sump pit, install sump pump with back-up power, and install backwater valve.
Conduct flow monitoring and data analysis
Assess diverted volumes

Halton funded the costs for the pilot program in hopes of having a better idea of the private side costs for rehabilitation and to potentially implement a subsidy program. The information and outcomes of the pilot project provide valuable information and understanding of the private side issues which, for Halton, are the biggest contributor to inflow and infiltration and which have proven difficult to address. Based on the information obtained from the pilot study, Halton conducted a cost benefit analysis:
It is estimated that 51,870 foundation drains are connected
It is estimated that 2,126,670m^3 is diverted from the sanitary system
It is estimated that the resulting reduction in annual treatment costs is $0.5M
The cost of the subsidy program would be $140M

The Region concluded that residential foundation drain disconnection is not financially justified, and that it would be more economical to address foundation drains in areas with chronic basement flooding.

Similarly, the information from the household drainage surveys helped identify activities for the lateral lining pilot study. The following outline the steps of the lateral lining pilot project:

Collect pre-rehabilitation flow monitoring to collect baseline data
Conduct rehabilitation/replacement of sanitary sewers and conduct pros construction flow monitoring
Conduct lateral lining and post construction flow monitoring

In total 52 lateral sewers were lined, 31 lateral sewers were lined to the property line due to lateral configurations issues beyond the property line, and 21 lateral sewers were lined to within 1 m of the house. The results of the pilot study were as follows:
Cost or the project was $267,000
Lateral lining reduced I&I treatment costs by 6% over sanitary sewer replacement, which is a long payback period based on treatment cost reduction
The cost of the program would be more cost effective in areas with chronic basement flooding.

6.1.3 *The Region of Halton's Customer Outreach and Subsidy Program*[32] [33]

While the pilot projects were related to determining the causes for inflow and infiltration, and the development of strategies to address these causes is ongoing, the Region also initiated a customer outreach program to inform homeowners of ways to prevent basement flooding. A pamphlet was developed to educate homeowners on inflow and infiltration and the measures they can take to avoid directing excessive stormwater to the sanitary sewer system. This information has played an important role in public education meetings in educating customers on wastewater collection, how to reduce the risk of basement flooding and how to respond to basement flooding events.

The Region has also implemented a Basement Flood Prevention Subsidy Program, as follows:
Disconnection of downspouts from the sanitary sewer system – ½ of all costs up to a maximum of $250.00.

[32] *Illija Stetic, Halton Region, Presentation made at the National Water and Wastewater Benchmarking Initiative Inflow and Infiltration Task Force Workshop "Foundation Drain Disconnection and Flow Monitoring Pilot Project," October 29th, 2009.*
[33] *Ontario Municipal CAO's Benchmarking Initiative and Ontario Centre for Municipal Best Practices, Best Practice Summary Report, "Customer Outreach"*

Disconnection of weeping tiles from the sanitary sewer system and installation of a sump pump system – ½ of the invoiced total up to a maximum of $1800.00
Installation of a backwater valve – ½ of the total up to a maximum of $675.00

6.2 Region of Peel Inflow and Infiltration Program[34]

The Region of Peel's inflow and infiltration strategy includes the use of real-time flow monitoring strategically placed throughout the Region's sanitary trunk system and local sanitary sewer mains. In the 1990's, the Region had developed a ten year inflow and infiltration strategic plan. The strategy involved a "plan, do, check" approach, defining hotspots in the system that had greater than ten times the design flow in conjunction with other high priority areas in the first year. Smoke and dye testing for problem isolation was conducted in the second year, capital improvements were performed in the third year, and flow monitoring was again performed to test improvements in the fourth year. The existing inflow and infiltration strategy is currently evolving as there has been significant growth in the Region.

As part of the current initiative, real time flow monitors equipped with alarms have been strategically installed through sanitary sewer trunk lines and local sanitary sewer mains to support three components of the Region's inflow and infiltration strategy:

Identification and quantification of areas in the system that are significantly impacted by inflow and infiltration
Generation of additional flow data for Peel's sanitary sewer model
Augmentation of Peel's operations "flood patrols" in areas with a history of basement flooding during rainstorms

Peel Region's existing sanitary sewer system model is also currently utilized for design analysis, with the flow monitoring data, the model is being upgraded and calibrated into a dynamic hydraulic model that will support inflow and infiltration and storm response analysis. Alarmed real-time flow monitoring tools include rain-derived inflow and infiltration (RDII) analysis. Dry Weather flow is used to establish baseline flow and baseline infiltration. Wet Weather flow can then be analyzed to quantify RDII.

The Region utilizes depth velocity flow monitors with a real-time alarming capability for their inflow and infiltration study. With a history of basement flooding in some areas of the Region, the 'alarming' feature is supporting the Region's efforts to eliminate occurrences of basement flooding. A 'sewer alarm' phone was set up at the 24/7 customer call center and an alarm response protocol was established. Alarm notifications are received by phone and by email at the customer call centre when monitored sewer pipe depths reach 75% capacity and again at 100% capacity. The notifications are then received by various operations personnel who coordinate a response. Alarms are transmitted immediately from the monitor units as they are triggered by electronic float mechanisms. Through the internet, real time data recorded from the alarmed real-time flow monitors can be accessed and reviewed by staff. This alarming feature has alleviated staff storm response requirements. Prior to the alarm system, staff would automatically patrol areas with a history of basement flooding to inspect levels in the manholes to prevent basement flooding during precipitation events. Flow monitors with alarms allow the Region to electronically observe pipe depths during storm events in areas of the system that have flow monitors installed.

The Region of Peel has also conducted some investigation as part of their inflow and infiltration remediation program. Flooding has occurred in numerous homes within the Region, and to address flooding issues, the Region of Peel has initiated the following actions:
Conduct Household Drainage Surveys
Provide a subsidy program for backwater valves

[34] *Ontario Municipal CAO's Benchmarking Initiative and Ontario Centre for Municipal Best Practices, Best Practice Summary Report, "Increasing System Knowledge through Flow Monitoring"*

Manhole sealing
Smoke testing
Investigations concerning Wye connections
Review and analysis of available historical data
Closed Circuit Television Inspections

Peel is continuing to work towards resolving and elimination direct inflow connections to the sanitary sewer system to reduce the likelihood of basement flooding.

6.3 Region of Durham Inflow and Infiltration Program

The Region of Durham has undertaken an Inflow and Infiltration (I/I) Study for three local area municipalities: the Village of Beaverton, the Village of Port Perry, and the City of Oshawa. The need for this study was primarily driven by the growing concern for basement flooding occurrences caused by heavy wet weather events. On August 19th, 2005, an event that exceeded a 100-year return period for three hours in some areas of the Greater Toronto Area, resulted in five basement floodings in the City of Oshawa. Although no basement floodings were reported in Beaverton or Port Perry, operations staff have noted increased flows at pumping stations and treatment plants during wet weather events.

This inflow and infiltration study was intended to:
Identify and quantify the sources of inflow and infiltration entering the sanitary sewer systems servicing Beaverton, Port Perry, and Oshawa
Identify feasible short and long term mitigation measures
Develop a long term plan for reducing I/I flows, including a long term separation program for foundation drain connections
Provide a summary of inflow and infiltration mitigation measures employed by other municipalities

In addition to the flow and rainfall monitoring program, a significant amount of other data was also collected and reviewed as part of this study, including:
Previous I/I studies (1986 Basement Flooding Study and 1991 Port Perry Water Distribution System Needs Study)
Basement flooding complaint records
Pumping station operator records and plant flow data
Groundwater level data
Ground surface topography
Regional Design Standards
Other municipal I/I reduction initiatives

This information was utilized to help support the selection of monitoring sites, the interpretation of the flow monitoring data, the I/I analysis, and the review of alternative I/I reduction measures. Based on the results of the study, the following measures were suggested as potential measures for mitigating inflow and infiltration flow in the sanitary sewer system:

Direct Disconnection (private property)
Roof leaders
Foundation drains
Site drains or other connections
System Tightening (public property)
Manhole covers
Target potential or known cross-connections
System Upgrades (public property)
Replace sanitary sewers and manholes to address aging, deteriorating sewers and capacity

Replace storm sewers and manholes to address aging, deteriorating sewers and increase depth to facilitate foundation drain connections
Replace laterals to address aging, deteriorating laterals and evaluate ability to separate and connect to storm and sanitary sewers
Storage
Provide storage capacity to address peak flow rates
Standards & By-Laws
Ensure compliance with Region standards
Target potential or known cross-connections
Target potential or know high contributors

An evaluation of the above alternative I/I mitigation measures and recommended short term and long term mitigation measures were also provided.

7. Supplemental Public Education and Outreach Information

Public education is a vital tool placed on the understanding and strategies used in the process of the Inflow and Infiltration elimination program made to the public. They also provide an effective way of receiving and obtaining compliance in terms of codes and regulations that seeks to deter and prohibit "clear" water from entering the sanitary sewer system. A comprehensive practice scan on the Public Awareness and Education on the Inflow/Infiltration Reduction program into the sanitary sewer system has indicated that generally most agencies/organizations currently involved in the I/I program have developed similar objectives in their outreach programs.

Objectives
To provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solution
To obtain public feedback on analysis/alternatives and or decisions
To work directly with the public to ensure that public issues are understood and considered
To partner with the public in each aspect of the decision including development of alternatives and the identification of preferred solution
To place final decision making process in the hands of the public

Promise to the Public
To listen and keep them informed,
To acknowledge concerns and provide feedback
To continue to work with them to ensure that their advice are taken in formulating alternatives

Tools used in Public education outreach
Mailers, Websites, E-news, e-mails, Youtube, Twitter, Blogs, Facebook,
Focus Groups, house to house surveys and online surveys, public meetings, open house
Workshops, deliberate polling, community service projects, virtual meetings
Citizen advisory committee, task force, community panel
Ballots, delegated decisions

By communicating through this process, the public is made aware of the issues involved, be updated on current studies and notified and advised of certain projects in their area. By being notified the public is expected to give their compliance into the program and the benefits derived by participating in the Inflow and Infiltration program.

Communications and Outreach Programs of Interest

The United States Environmental Protection Agency (US-EPA) New England is working with partners to develop outreach, workshops and tools to assist those working to prevent sewage overflows and improve the management of water/wastewater systems, they have ongoing programs on CMOM (Capacity, Management, Operation and Maintenance), Asset Management and energy management. Communities across the United States are working to find cost-effective, long-term approaches to managing their aging wastewater infrastructure and preventing the problems that lead to sanitary sewer overflows. The Toolbox is an effort by EPA New England to provide examples of programs and educational efforts from New England and beyond showing the approaches being used to:
Communicate with and educate citizens and local officials
Address financial and regulatory needs
Develop and conduct preventive maintenance programs
Better manage infrastructure assets
Use information systems, including GIS
Improve system capacity and address system overflows
The goal is to develop the Toolbox over time and is not to provide an exhaustive listing or endorse any particular approach, but to direct managers, local officials, and other decision-makers to a range of fact sheets, case studies, ordinances, and other information that shows how things are getting done, these of which vary in nature depending on the what is directly applicable to the situation, source of information: http://www.epa.gov/boston/sso/toolbox.html

Delaware County has provided an excellent public outreach program to local communities to "buy in" into their "lateral I/I elimination program" by first educating and then allowing for active participation in the program. A website on this program can be found at www.DELCORA.org http://delcora.org/UploadedDocuments/G__DelcoraPublications_Lateral_I&I_Report_-_Final_June_30.2010_6292010.pdf. In addition, Delaware County has also a youtube video presentation on their I/I program.

The City of Oregon has posted a website which educates the public on their inflow and infiltration reduction and can be viewed at http://www.oregonohio.org/Engineering/inflow-infiltration.html

Global Case Studies on CSO's: A recent public slide presentation and discussion on Global Case studies on combined sewers overflow has been developed and presented with comparisons from a number of countries. The presentation was made to educate and inform the public on the current development of the I/I program. Further details can be viewed on the public website at: http://media.millionbrains.org/ChallengeContent/000/00/414/8db2d31143e3410b85b77816261c0df9.pdf.

8. Observations and Conclusions

The agencies investigated exhibited various stages of evolution in their application of their I/I Reduction Strategy development and decision-making processes. The evolution of each program stemmed from the original goals, objectives or mandates established early on. For example, North Shore has developed their program to address overflow issues and peak flow reduction. However, each agency reviewed has adopted innovative and successful approaches that will allow them to address their I/I issues. Thus, the observations listed below and within this report should be understood in the context that not all agencies

reviewed were at the same stage of development of their respective I/I Programs but each is considered to be progressive within the industry.

Sophisticated agencies tend to have clear reduction targets that are well-defined and understood by all stakeholders.
Most I/I reduction programs focus on the reduction of peak flows, overflows or basement flooding; not on volumetric flow reductions
All progressive agencies reviewed engage their satellite agencies through formal and ongoing working groups although there was no one organizational model for I/I Programs. In some cases, agencies have identified an I/I team or working group, while in others one cannot find I/I on an organization chart. Perhaps the most important organizational characteristic found in the agencies was the use of a team approach in defining and implementing an I/I Strategy.
The majority of multi-tiered agencies reviewed monitor and measure in-coming wastewater flows from their local satellite agencies.
There is no single model for I/I Strategy development. There are consistent processes and components but no discernable template.
Through our discussions with the agencies it is apparent that each of them recognizes that the strategies are working guidance documents that will evolve over time and as such, must be reviewed on a regular basis; including a review of original program reduction goals. As a matter of interest, several agencies that are into their 2nd and 3rd review or iteration of their strategy documents have made a discernable move away from making specific, measurable goals to more over-reaching objectives.
In each reviewed case the participants revealed that the success of I/I reduction programs is reliant on sound asset management principles. I/I reduction can't or shouldn't be treated as a stand-alone initiative.
All agencies have either identified future plans or are currently conducting work on private property. The general consensus is that I/I contributions from private property range from 50-80%; confirming that to effectively address I/I agencies must look at private property issues.
The majority of programs have been adopted to address current system deficiencies and many are just starting to review new development, design and construction issues. Infrastructure and development standards and policies should be reviewed or developed to ensure that new sewer systems are designed and built using materials and techniques that protect against future I/I problems. Design criteria should be reviewed so that new systems are designed with I/I allowances consistent with the materials and construction techniques used. During installation, consistent inspection and verification practices should be instituted and proper operational procedures should be followed after commissioning.
MMSD is the closest comparator to York as far as having a stated volumetric goal reduction. A review of MMSD's program confirms that York's proposed approach is defensible.
Many of the agencies state the overall program including goals. However; reduction programs, including administration, prioritization and implementation are done at the local community level.
For agencies that have done extensive cost-benefit analyses including pre and post construction monitoring, no clear relationship between dollars spent on rehabilitation activities and treatment/storage cost savings has been found.
All reviewed agencies agreed that public education programs should be maintained or introduced to inform the population about the proper separation of sources of waters discharged into sewers and the consequences of diverting excess water to a sanitary sewer system.
The growing pains associated with the development of a comprehensive I/I Strategy in almost all cases, fostered enhanced communication among many different organizational units. Many of the participants agreed that the need to promote cross organizational coordination has led to more effective planning and decision-making in the agency and between the satellite communities.

9. Appendix A - Agency Questionnaire Survey

9.1 Survey Components and Questions

- **Strategy Document**

Does your agency have a documented strategy or an implementation plan to reduce Inflow and Infiltration (I/I) that includes short and long term objectives for:
Establishing reduction goals
Has a schedule been defined to achieve the goals?
Communication, Public Education & Advocacy,
Construction standards, monitoring and analysis standards,
Audit measurement or reporting mechanisms that demonstrate successful flow reduction and progress toward achieving goals,
Funding alternatives and strategies
Was this strategy approved by other regulatory agencies or Council's (i.e. MOE, EPA, Agency Council, and Satellite Council)? If yes, how frequently do you provide status updates or full scale Strategy updates?
Can a copy of this strategy be provided?

- **Governance**

Does your agency have a specific working group (committee, panel, etc.) responsible for development, maintenance and overall stewardship of the I/I Strategy or reduction program(s)?
If so, please provide a brief summary of the stakeholder member(s)/groups and the responsibilities of the committee as it pertains to the administration of the program.
Does the Strategy serve as an overall guidance document for your agency and its member satellite agencies is this a mandatory or collaborative approach program??
Have regulatory/management documents (I.e. Bylaws, sub-division agreements, development standards, etc.) been developed in order to carry out the directions/objectives outlined in the strategy?

- **I &I Reduction Goals & Objectives (Targets)**

Please describe your specific goals related to I/I reduction (E.g. are there volumetric reduction goals, % flow reduction, overflow reduction targets)?
Does your strategy specify I/I reduction goals for satellite agencies?
Does your strategy outline incentives or penalties for your member agencies if they achieve or do not achieve specified reduction goals?
Have you implemented capital projects to reduce I-I and evaluated the success of these projects?
How did you measure success?
Have you implemented a pilot program to study the effectiveness of various rehabilitation techniques?
Have you established a methodology to convert these results to larger geographic areas?

- **Statutory Regulations**

Is your I/I strategy/program a result of existing or anticipated governmental regulations?

- If yes, please define the regulation(s).

- **Sewage System Knowledge (Existing Infrastructure, hydraulics, operational parameters)**

How have you defined catchment (drainage) areas for managing I-I analysis and reduction?
Have allowable I/I rates/flows been defined for your system or sub-systems?
Have actual I/I rates been used to prioritise catchment rehabilitation based on severity of I/I?

- **Data & Information Management**

Do you mandate any specific data requirements, or require the type or frequency of condition assessment activities that your satellite agencies must utilize to reduce I/I flows?
(Such requirements could include flow monitor density, CCTV, smoke testing, physical surveys, or flow data analysis.)

- **Private-Side Management**

Has your agency attempted to address I/I generated on private property, e.g. private-side laterals, foundation drains or downspouts?
Does your agency have a program in place to deal with issues associated with working on private property (I.e. downspout disconnection, lateral inspection/repair, basement flooding, access to property)
If yes – how are these programs:
Funded (subsidies for homeowners, grants, paid for by gov't agency)?
How is construction activity administered?
Enforced (by-laws, condition-of-sale, permit application process)?
Communicated to the public (communication and education for the home owners, PIC, one on one consultation)?
Are private-side I/I issues and reduction adequately addressed in the overall strategy?

- **Construction of New Infrastructure**

Does your strategy address engineering/design standards for sewer main design & construction?
Does the strategy define construction or periodic inspection requirements or define construction standards specific to leakage?
Do you assess or measure leakage in new infrastructure to verify that construction standards as they relate to I/I are being achieved?

- **Program Funding**

How are investigative and rehab/replace programs funded:
At the national/federal government level?
At the state/provincial level?
At the Agency level?
At the local municipal or satellite agency level?
Are there inter-agency funding commitments between your agency and your satellite agencies in place?
Do you have a dedicated funding mechanism for I-I reduction projects?

- **Program Coordination (i.e. Linkages to master plans, operational plans, etc.)**

Is your I/I strategy a stand-alone program or is it embedded as part of another program (I.e. CSO Attenuation, LWMP, Master Plans, etc.)

- **Bylaws & Agreements**

Were bylaws or agreements with your satellite agencies created that address I/I reduction goals or activities? If so, please provide a summary.

- **Public Education & Outreach**

Please describe your education and outreach programs for:

- The general public and property owners – i.e. public meetings, door to door information, advertising, websites
- Other government agencies, industry or the development community – i.e. builders, developers, satellite agency staff

-
- **Technical Information**

Does the strategy address the following items for I/I reduction? If so, please provide a summary
Program level:
Projects prioritization model (i.e. decision making method, optimization model, etc.).
Budget allocation strategy or mathematical costing model(s) for rehab. /replace activities.
Rehab. /replace scheduling constraints (cost, time, whether, etc.).
Project level:
Method(s) of condition assessment (i.e. deterioration point, failure probability, etc.) and what is (are) the basis of the selection method(s).
Method(s) of rehab. /replace activities (i.e. Sliplining, CIIP, etc.) and what is (are) the basis of the selection method(s).
Risk and responses models due to rehab/replace.
Cost/benefit analysis for I/I rehabilitation projects.
Quality assurance and quality control process of rehab./replace activities.