
Chapter 2

Background

In December 1999, the King County Council approved the development of a Regional Infiltration and Inflow (I/I) Control Program as part of the Regional Wastewater Services Plan (RWSP). The purpose of the I/I control program is to reduce the amount of peak wet-weather flow entering the County’s wastewater conveyance system when it is cost-effective to do so. Reduction of I/I in the system has the potential to lower the risk of sanitary sewer overflows and decrease the costs of conveying and treating wastewater.

In 2000, King County’s Wastewater Treatment Division, in cooperation with the local component agencies that it serves, launched an ambitious 6-year \$41-million I/I control study. The study included efforts to identify sources of I/I, test the effectiveness of various I/I control technologies, and examine the benefits and costs of I/I reduction and control.

This chapter provides background and context for the I/I control study. Subsequent chapters of this report document the findings of the study and the King County Executive’s recommendations for a long-term I/I control program.

2.1 How I/I Enters the Regional System

King County’s regional conveyance and treatment system accepts wastewater flow from 34 component wastewater agencies (see Figure 1-1).

Local agency sewers are either combined or separated sewers (Figure 2-1). Combined sewer systems are designed to carry both stormwater and wastewater. Separated sewer systems are designed to carry wastewater (“base flow”) only. Often, however, separated sewers carry clean groundwater and stormwater in addition to the wastewater (Figure 2-2). Groundwater (**infiltration**) seeps into sewers through holes, breaks, joint failures, defective connections, and other openings. Stormwater (**inflow**) rapidly flows into sewers via roof and foundation drains, catch basins, downspouts, manhole covers, and other sources.

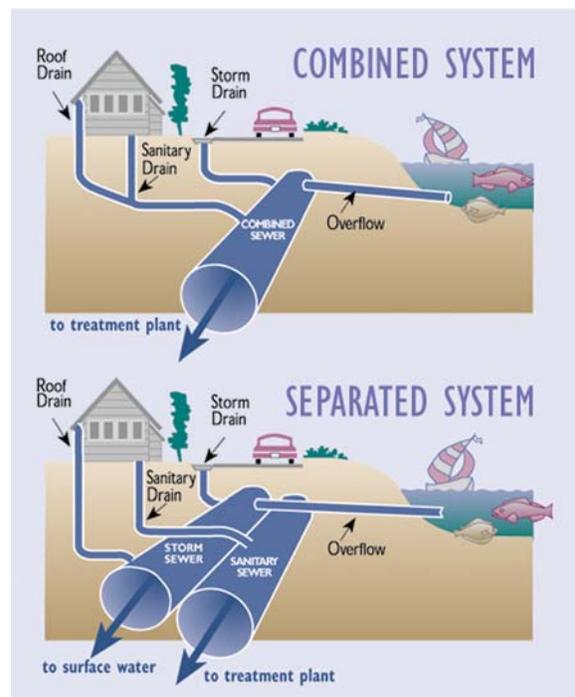


Figure 2-1. Combined Sewer System and Separated Sewer System

Older sewers in parts of the City of Seattle are combined sewers. Most of the flow from the combined sewers is conveyed to the West Point Treatment Plant in Seattle. The remainder of the local agency sewers are separated. Most of the flow from the separated systems is conveyed to the South Treatment Plant in Renton.

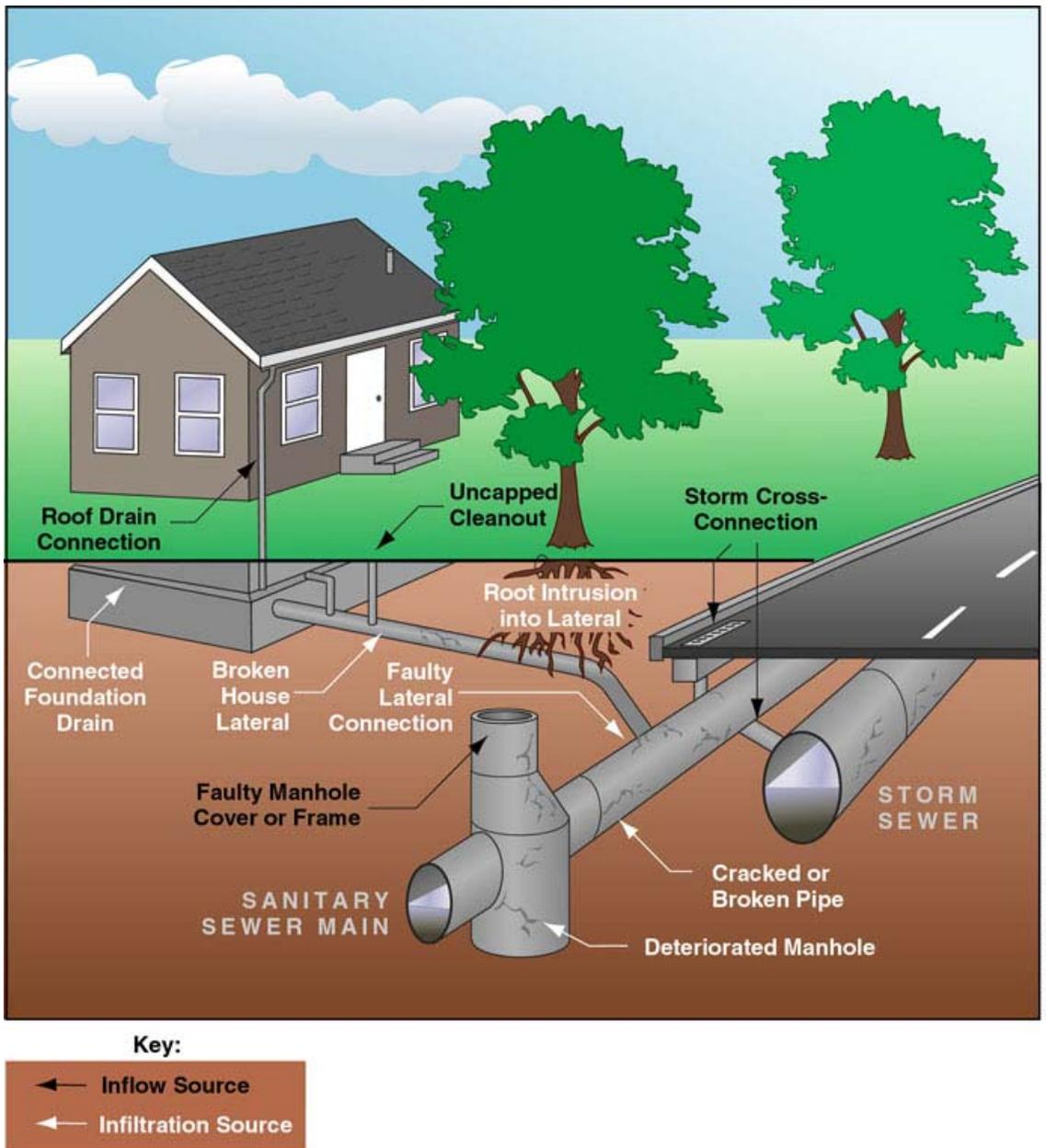


Figure 2-2. Sources of Infiltration and Inflow

2.2 Why I/I Control Is Important

If the amount of I/I entering the separated local agency sewers could be reduced, the risk of sanitary sewer overflows and the costs of conveying and treating wastewater could also be reduced. This reduction can be achieved through both direct I/I reduction and long-term I/I control. Reduction and control involve different approaches and strategies that work together to provide both near-term and ongoing elements of an effective I/I management program.

Direct I/I reduction refers to sewer system rehabilitation or replacement projects that can be done in a basin to reduce I/I flows and alleviate immediate downstream capacity constraints.

Long-term I/I control refers to policy, administrative, financial, and technical measures aimed at limiting future increases in I/I flow. Keeping the system in good repair minimizes future increases of I/I in the system. Long-term I/I control measures include public education, design standards for new construction or rehabilitation, requirements for inspection and/or permitting, and regulations or policies for new development.

Emerging and current federal and state regulations, King County Code, and agreements between King County and local agencies recognize the importance of controlling I/I in wastewater systems. Other agencies around the country share King County's challenges and have implemented I/I control programs—either through regulatory actions or voluntarily. Their experiences were similar to those accumulated during the County's 6-year I/I control study.

Definitions of I/I Terms

Base flow. Wastewater that enters sewers during dry weather in the absence of I/I.

Combined sewer. A pipe designed to carry both stormwater and wastewater.

Infiltration. Groundwater that seeps into sewers through holes, breaks, joint failures, defective connections, and other openings.

Inflow. Stormwater that rapidly flows into sewers via roof and foundation drains, catch basins, downspouts, manhole covers, and other sources.

I/I control. Policy, administrative, financial, and technical measures aimed at limiting future increases in I/I flow.

I/I reduction. Sewer system rehabilitation or replacement projects that are constructed to reduce I/I flows and alleviate immediate downstream capacity constraints.

Lateral sewer. The portion of a building's sewer pipe that is in the public right-of-way.

Separated sewer. A pipe designed to transport household, industrial, and commercial wastewater and to exclude stormwater sources.

Side sewer. The portion of the sewer pipe that extends from a building to the public right-of-way.

Peak flow. The highest combination of base flow and I/I expected to enter a wastewater system during wet weather at a given frequency that treatment and conveyance facilities are designed to accommodate.

2.2.1 Increased Capital and Operating Costs

The King County Wastewater Treatment Division (WTD) must provide adequate capacity to convey and treat all of the flows sent by the agencies through their collection systems. I/I in the separated sewer system takes up capacity that could otherwise be used for wastewater alone and generates the need to build added conveyance and treatment capacity. The extra capacity required to convey and treat I/I results in higher capital and operating costs to the regional system that are born uniformly by all agencies and passed onto ratepayers in each jurisdiction.

The regional wastewater conveyance system has developed over the last 40-plus years. Most of the system has the necessary capacity to transmit wastewater flows today and in the future. However, some portions of the system are at or near capacity during periods of peak flow. As the region’s population and employment base grow over time, these portions of the system and others will not have adequate capacity to transmit peak wastewater flows to treatment plants. Inadequate capacity increases the risk of wastewater backups and overflows.

While there are multiple reasons why portions of the conveyance system are at or near capacity, a major contributing factor is the capacity taken up by I/I flows in the system. Several capacity related capital improvements are needed in the regional system that are directly related to excessive I/I entering the system upstream of the needed improvements. Figure 2-3 demonstrates how peak I/I flows can far exceed base flows.

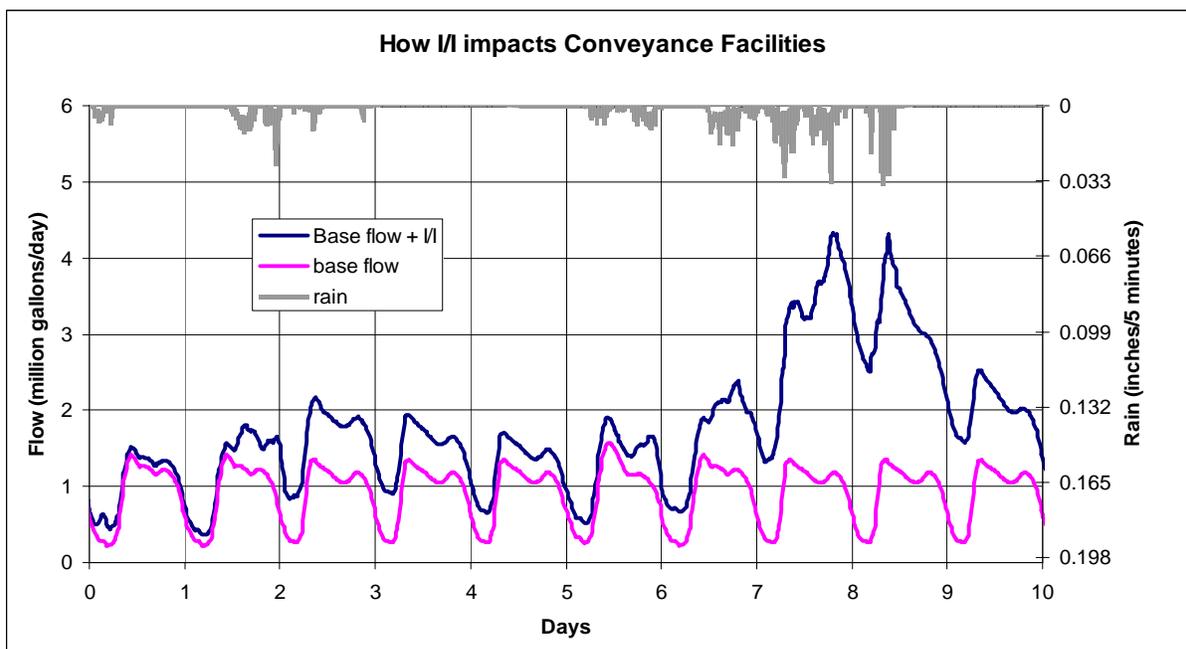


Figure 2-3. Impacts of Peak I/I on Wastewater Flows

I/I that enters the collection and treatment system also triggers higher operating costs for the region. Operating costs for conveyance facilities such as pump stations are proportional to flow volumes passing through the facilities. I/I also increases treatment costs because more chemicals and electricity are used during peak flows at the treatment plants.¹

¹ The operating costs related to I/I were not included in the benefit-cost analysis because they are marginal when compared to the high capital costs. See Chapter 4 for details.

2.2.2 Federal Regulations

Currently, there are no federal sanitary sewer overflow (SSO) or I/I reduction policies. In 2001, the U.S. Environmental Protection Agency (EPA) proposed a draft SSO control policy.² The proposed SSO rule allowed for zero overflow occurrences. For the first time, municipal satellite wastewater collection agencies were to be placed under the enforcement of the Clean Water Act through adoption of new Capacity Management, Operations and Maintenance (CMOM) programs. The agencies would be required to obtain National Pollutant Discharge Elimination System (NPDES) permits and to control excessive I/I in their collection systems through specific monitoring, maintenance, and rehabilitation programs.³

During the current administration, the SSO rule and its accompanying CMOM requirements were placed on hold. As of July 2005, the rule has been withdrawn from publication in the Federal Register. The most recent federal activity on SSO policy was an EPA report to Congress in August 2004 titled *Impacts and Control of CSOs and SSOs*.⁴ This report details the public health and environmental impacts of combined sewer overflows (CSOs) and SSOs and the costs and technologies used by municipalities to reduce these impacts. According to the report, CSOs and SSOs are a threat to public health and the environment. It proposes strategies for municipalities and regulatory agencies to adopt to reduce adverse impacts but does not make any specific policy recommendations.

Although there are no federal SSO or I/I reduction policies, several states have begun to implement their own policies and it is anticipated that federal regulations may be implemented in the future. If implemented, SSO and CMOM policies would directly affect the King County I/I control program and the local agencies served by the County wastewater system.

In the meantime, recipients of EPA grants for design and construction of wastewater treatment facilities, including expansion and modification projects, must comply with I/I analysis requirements for project certification and must reduce excessive I/I when it is cost-effective to do so.⁵ Section 35.2005 of the Code of Federal Regulations, Title 40: Protection of Environment, includes EPA definitions for excessive I/I:⁶

(16) *Excessive infiltration/inflow*. The quantities of infiltration/inflow which can be economically eliminated from a sewer system as determined in a cost-effectiveness analysis that compares the costs for correcting the infiltration/inflow conditions to the total costs for transportation and treatment of the infiltration/inflow. (See §§35.2005(b)(28) and (29) and 35.2120.)

² EPA. January 2001. *Proposed Rule to Protect Communities from Overflowing Sewers*. EPA number 833F01001.

³ Currently, only wastewater treatment plants that discharge their effluent are required to comply with NPDES permits. The permits require recordkeeping, reporting of overflows, and maintenance of collection systems.

⁴ EPA. August 2004. *Report to Congress: Impacts and Control of CSOs and SSOs*. Available online: http://cfpub.epa.gov/npdes/cso/cpolicy_report2004.cfm

⁵ EPA. May 1985. *Infiltration/Inflow: I/I Analysis and Project Certification*. Available online: <http://www.ecy.wa.gov/biblio/9703.html>

⁶ http://www.epa.gov/e_pahome/cfr40.htm

(28) *Nonexcessive infiltration*. The quantity of flow which is less than 120 gallons per capita per day (domestic base flow and infiltration) or the quantity of infiltration which cannot be economically and effectively eliminated from a sewer system as determined in a cost-effectiveness analysis. (See §§35.2005(b)(16) and 35.2120.)

(29) *Nonexcessive inflow*. The maximum total flow rate during storm events which does not result in chronic operational problems related to hydraulic overloading of the treatment works or which does not result in a total flow of more than 275 gallons per capita per day (domestic base flow plus infiltration plus inflow). Chronic operational problems may include surcharging, backups, bypasses, and overflows. (See §§35.2005(b)(16) and 35.2120).

2.2.3 State Regulations

The Washington State Department of Ecology (Ecology) enforces federal Clean Water Act provisions, including NPDES permitting and water quality regulation, in Washington State.

NPDES permits require that King County immediately report to Ecology any sewer overflow, whether from the combined or separated part of the collection system. Each overflow is considered an unauthorized discharge in violation of the permits and is subject to enforcement and possible monetary penalties at the discretion of Ecology. Because I/I contributes significantly to SSO occurrences during wet weather, ongoing problems with I/I that result in overflows could be subject to Ecology or EPA Region 10 enforcement activities.

The NPDES permit for the South Treatment Plant requires biennial I/I reports that summarize progress made toward measuring I/I and toward removing I/I from the system. The permit also requires that the County institute an adequate operation and maintenance program for the entire wastewater system. The provisions are broad enough that an operation and maintenance program could be interpreted to include I/I reduction and control, and permit renewals in the future may specifically require such activities.

Finally, NPDES permits require the County to “strictly enforce their sewer ordinances and not allow the connection of inflow (roof drains, foundation drains, etc.) to the sanitary sewer system.”

2.2.4 King County Code

King County Code (KCC), Section 28.84.050, stipulates wastewater disposal rules and regulations for local agencies discharging to the King County conveyance system. Subsection 28.84.050 K.3 states the following: “An additional charge will be made for quantities of water other than sewage and industrial waste hereafter entering those sewers constructed after January 1, 1961, in excess of the volume established for design purposes in this section.” In addition to base wastewater flows, the established volume includes an I/I allowance of 3.06 cubic feet per acre multiplied by the sewered area in acres. Flow volumes for any 30-minute period that exceed

this allowance are considered excess flow. This I/I allowance translates to 1,100 gallons per acre per day (gpad).

Regional monitoring and modeling indicate that the I/I allowance may be unrealistically low. Most basins in the local collection systems exceed this volume. The pilot projects described in Chapter 3 could not achieve I/I reductions below approximately 3,500 gpad. Regardless of whether the 1,100-gpad flow threshold is realistic, no surcharge has yet been devised or assessed.

In addition to the I/I threshold and surcharge provisions, KCC Section 28.84.050 contains design, construction, inspection, and reporting standards for local agencies connecting to King County's conveyance system. Construction of new local public sewers and side sewers must be reported to the County and are subject to unannounced inspections by County inspectors. Further, the code prohibits direct discharge of clean groundwater or surface water to local public sewers and private sewers via roof drains, downspouts, sump pumps, or any other source.

Although the code provisions state that they are applicable to private side sewers and owners of private side sewers, in practice the local agencies have jurisdiction over private side sewer connections to the local public sewers and King County does not inspect new side sewer construction.

2.2.5 I/I Provisions in Local Agency Agreements

King County's wastewater disposal agreements with the 34 agencies that it serves address I/I control through references to Section 28.84.050 of the King County Code. These references effectively 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)."

So far, 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. Enforcing the provisions is difficult because the agreements approach the threshold and surcharge in different ways. The language in 25 of the agreements exempt pipes constructed prior to 1961 from the threshold or surcharge:

An additional charge may be made for quantities of storm or ground waters entering those Local Sewerage Facilities which are constructed after January 1, 1961 in excess of the minimum standard established by the general rules and regulations of Metro.

The agreements with the remaining nine agencies do not contain a pre-1961 pipe exemption. They 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 water" 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." The language pertaining to thresholds and surcharges in these nine contracts is as follows:

In the event the City/District fails to comply with the rehabilitation and replacement expenditure requirements described in this section, the City/District shall pay such charge as may be determined by Metro for quantities of storm or ground water entering its Local Sewage Facilities in excess of the minimum standard established by the general Rules and Regulations of Metro.

Further complicating enforcement is the high cost of monitoring flows to measure compliance. In order to enforce the provisions, continuous flow monitoring would be required at locations where flows from each local agency enter the regional system. Monitoring is impossible at connection sites where there is no nearby metering manhole. In addition, many agencies connect to the King County system at multiple locations, which would require installation of additional flow meters to isolate their flows. At a minimum, a total of 167 flow meters would be required, representing an average annual equipment and labor cost of approximately \$2 million.

2.2.6 I/I Reduction Programs in Other Agencies

King County is not alone in its need to examine ways to control I/I. Wastewater agencies around the country have been facing I/I problems as their collection systems age and deteriorate and the agencies try to accommodate further growth and system expansion. In 2001, King County conducted a survey of nine regional wastewater agencies that were similar in size to WTD. The survey found that regulatory and court actions were major drivers for implementation of I/I control programs. Another major driver was the need to provide additional capacity to accommodate flows from component agencies.

Most agencies have found that I/I control efforts in the publicly owned portions of their collection systems, such as sewer mains, manholes, and the public portions of laterals, have failed to significantly reduce I/I flows. Many agencies have therefore begun to look at private side sewers and connections to the public system as significant sources of I/I control. King County and the local agencies that it serves estimate that over 50 percent of I/I originates on private property in the region. Although the agencies surveyed varied in their levels of certainty about how much I/I originates in private property sources, the contribution of I/I from private property sources is considered significant enough that agencies have been investigating possible corrective actions that would be financially, legally, and politically feasible.

Implementing I/I reduction projects on private property carries a number of challenges. The challenges include the legality of entering private property for inspection and repairs, the use of public funds to pay for the repairs, and the high costs and potential liabilities of locating I/I sources and repairing problems on multiple properties. In response to some of these challenges, many agencies have passed ordinances allowing them to access private property for inspections and repairs.⁷ The ordinances have held up in several state supreme court rulings as being fair and reasonable and not in violation of the Fourth Amendment. Still, most agencies rely on voluntary homeowner participation for inspections and repairs. Many states, including Washington, prohibit the use of public funds for any private purpose. However, reducing peak I/I flows from

⁷ Michael H. Simpson. July 2005. It Can Be Done: Some Legal Issues to Consider When Managing Infiltration and Inflow from Laterals. *Water Environment & Technology*, 17 (7), 26-31.

private property sources can have a clear public benefit. Benefits include promoting public health by protecting water bodies; reducing SSOs, basement backups, and other problems; and serving as cost-effective alternatives to spending more on treatment and conveyance capacity expansions.⁸ Chapter 5 of this report discusses legal issues and presents recommendations regarding the use of public funds for reducing I/I on private property.

Even with all the challenges, I/I control projects on private property have been deemed successful and cost-effective by several agencies. Agencies participating in the 2001 survey reported I/I reduction rates of 17–84 percent from projects that included repair of private laterals and side sewers. These results are similar to reduction rates achieved during King County’s pilot projects, ranging from 28–87 percent I/I reduction.⁹ Approaches to measuring cost-effectiveness vary. Many agencies calculate a cost per gallon to treat and compare this cost with a cost per gallon to remove I/I.

2.3 King County’s I/I Control Program

In recognition of the need to explore the feasibility of I/I reduction and control, the King County Council approved three I/I control policies as part of the RWSP. The RWSP was adopted in 1999 under Ordinance 13680. The policies establish the framework and process for development of a long-term regional I/I control program in collaboration with local wastewater agencies.

2.3.1 Policy Direction for I/I Control

The RWSP policies that set forth development of a King County I/I control program are as follows:

I/IP-1: 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).

I/IP-2: King County shall work with component agencies to reduce I/I in local conveyance systems by the following:

1. By July 1, 2001, the King County Executive shall propose for County Council review and approval an initial list of pilot rehabilitation projects dealing with the most serious and readily identified I/I problem areas in local sewer systems.

⁸ Michael H. Simpson. July 2005. It Can Be Done: Some Legal Issues to Consider When Managing Infiltration and Inflow from Laterals. *Water Environment & Technology*, 17 (7), 26-31.

⁹ Three of the 10 pilot projects showed no measurable I/I reduction. See Chapter 3 for details.

2. By July 1, 2002, the King County Executive shall propose an additional list of pilot projects. The pilot rehabilitation projects shall be used to demonstrate the effectiveness of I/I controls in local sewer systems tributary to the regional system.
3. By December 31, 2002, the County, in coordination with component agencies, shall develop model local conveyance system design standards, including inspection and enforcement standards, for use by component agencies to reduce I/I within their systems.
4. By December 31, 2003 (March 2005),¹⁰ the King County Executive shall submit to the County Council a report defining I/I levels in each of the local sewer systems, based on assessments of those systems, and identifying options and the associated cost of removing I/I and preventing future increases. The options should be informed by the results of the pilot rehabilitation projects described in I/IP-2.1. The report shall present an analysis of options on cost-effectiveness and environmental costs and benefits, including, but not limited to those related to water quality, groundwater interception, stream flows and wetlands, and habitat of species listed under the ESA.

The report shall include information on public opinion, obtained through surveys and other appropriate methods, on the role of individual property owners in implementing solutions to reducing I/I, voluntary and mandatory property owner actions, willingness to pay for reducing I/I, and acceptable community options for reducing I/I.

5. No later than December 31, 2004 (now December 31, 2005), utilizing the report described in I/IP-2.3, the King County Executive shall recommend target levels for I/I reduction in local collection systems and propose long-term measures to meet the targets. These measures shall include, but not be limited to, establishing new local conveyance system design standards, implementing an enforcement program, developing an incentive-based cost-sharing program, and establishing a surcharge program. The overall goal for peak I/I reduction in the service area should be 30 percent from the 20-year level identified in the report. The County shall pay 100 percent of the cost of the assessments and pilot projects.

I/IP-3: King County shall consider an I/I surcharge, no later than June 30, 2005 (now June 30, 2006),¹¹ on component agencies that do not meet the adopted target levels for I/I reduction in local collection systems. The I/I surcharge should be specifically designed to ensure the component agencies' compliance with the adopted target levels. King County shall pursue changes to component agency contracts if necessary or implement other strategies in order to levy an I/I surcharge.

¹⁰ Completion dates for elements in the regional I/I control program deviated from the original RWSP schedule because regional flow monitoring took place over two winter seasons, rather than the one season assumed in the policies. See Chapter 3 for details.

¹¹ Because of the 1-year delay that resulted from an additional year of flow monitoring, the date for considering a surcharge was adjusted by a year in order to provide adequate time for the King County Council to take action on the overall I/I program recommendation and then to consider a surcharge.

2.3.2 Implementation of the Policies

In response to the RWSP policies, WTD staff, working in a consensus-based approach with local agencies, conducted a comprehensive 6-year I/I control study. The study began in 2000 and culminates with this Executive's recommendation for a regional I/I control program. It includes the following components (Figure 2-4):

- Define current levels of I/I for each local agency tributary to the regional system.
- Select and construct pilot projects to demonstrate the cost-effectiveness of collection system rehabilitation projects.
- Develop model standards, procedures, policies, and guidelines for use by local agencies to reduce I/I in their systems.
- Identify cost-effective options to remove up to 30 percent of I/I expected to occur in local agency systems during a 20-year peak flow condition.
- Develop a long-term regional I/I control plan for review and approval by the King County Council.

Major reports that have contributed to the contents of this recommendation report include the *2000/2001 Wet Weather Flow Monitoring Technical Memorandum*, *2001/2002 Wet Weather Flow Monitoring Technical Memorandum*, *Pilot Project Report*, *Alternatives/Options Report*, *Regional Needs Assessment Report*, and *Benefit-Cost Analysis Report*. These reports and other information produced during the I/I control study can be found on the CD included with this recommendation report and on the I/I program Web site at <http://dnr.metrokc.gov/wtd/i-i>.

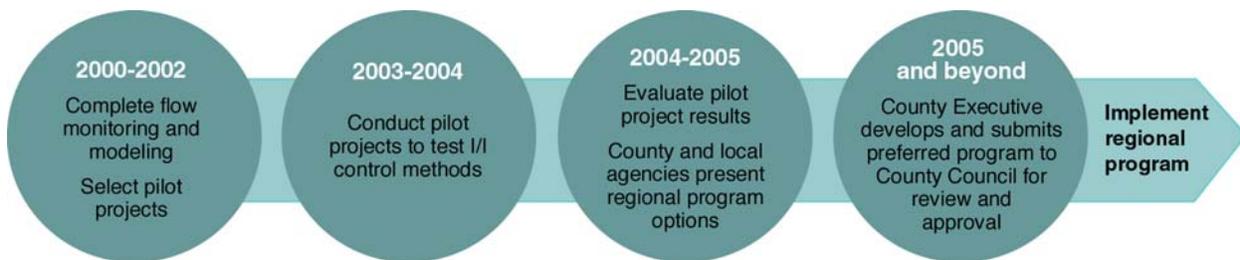


Figure 2-4. I/I Control Program Elements and Schedule

2.3.3 Consensus-Based Approach

The King County Council set forth a cooperative process for the County and local agencies to work together to develop a long-term regional I/I control program. To this end, County staff have involved local agency representatives via the Metropolitan Water Pollution Abatement Advisory Committee (MWPAAC) in key decisions throughout the 6-year study.

MWPAAC, created by state law (RCW 35.58.210), advises the King County Executive and Council on matters related to regional wastewater services and water pollution abatement. It consists of representatives from the cities and sewer districts that operate sewer systems in King County. Most of these cities and sewer districts deliver their wastewater to King County for treatment and disposal. MWPAAC's Engineering and Planning (E&P) Subcommittee worked closely with King County staff and consultants to develop this program recommendation.

During the I/I control study, the County conducted 10 workshops with local agencies and over 75 work sessions with the E&P Subcommittee. The County will continue to involve the Subcommittee in implementation of the regional I/I control program, including decisions about implementing initial I/I reduction projects.

2.3.3.1 Local Agency Workshops

Local agency workshops began in 2000 and continued through 2005. Both policy makers and technical staff attended the workshops. The purpose of the workshops was to review and reach agreement on key aspects of a regional I/I control program. Workshop topics were as follows:

1. Introduction, approach, and work plan for a regional I/I control program
2. Pilot project selection process and criteria; pilot project reimbursement and funding
3. Introduction to technical concepts
4. Financial concepts; alternatives for cost sharing
5. Modeling I/I flows
6. Design standards and rehabilitation techniques; contract management and language; private property I/I issues
7. MWPAAC RWSP Subcommittee;¹² design standards, procedures, policies, and guidelines
8. Pilot project selection
9. Pilot project update, including sewer system evaluation survey (SSES) results; schedules
10. Policy direction on draft standards, guidelines, procedures, and policies

¹² MWPAAC's RWSP Subcommittee was the precursor to the Engineering and Planning (E&P) Subcommittee. The group was expanded to include other local agency representatives interested in I/I, and in 2003, the name was changed.

2.3.3.2 E&P Subcommittee Work Sessions

In 2004 and 2005, the E&P Subcommittee worked toward reaching consensus on several complex issues related to the program recommendations contained in this report. The E&P Subcommittee's consensus decisions guided the County in developing this program recommendation and, along with input from the workshops, allowed local agencies to shape the parameters of a regional I/I control program.

Issues that were discussed and the products developed in the work sessions are as follows:

- Design standards, guidelines, procedures, and policies for I/I reduction projects
- Policies and intergovernmental agreements to guide I/I reduction projects
- Criteria for assessing the benefits and costs of I/I reduction projects
- Assumptions to be used to model capital facility needs and identify I/I reduction projects
- Assumptions for cost-effectiveness analysis of I/I reduction projects
- Issues related to I/I reduction on private property
- Issues related to financing I/I removal

2.4 Contents of this Report

This *Executive's Recommended Regional I/I Control Program* summarizes the approaches and results of the various efforts conducted since 2000 to study the feasibility of controlling I/I in King County's wastewater service area. The report concludes with a recommended long-term I/I control program.

Chapter 3 describes efforts to measure current I/I levels and to determine the effectiveness of various I/I reduction technologies. During the winter seasons of 2000–2001 and 2001–2002, approximately 800 flow meters were installed in drainage basins throughout the separated sewer system to identify sources and volumes of I/I for each local agency. Between mid 2003 and January 2004, 10 I/I pilot projects were constructed in local agency systems. Computer simulation models were developed and then calibrated using pre- and post-measured flow responses and a continuous 60-year record of storms. The models helped to establish a common basis for determining I/I reduction effectiveness and to project the 20-year peak flow rates in each basin.

Chapter 4 presents the approach and results of the benefit-cost analysis that was conducted in 2005 to identify cost-effective I/I reduction projects in local sewer systems. The benefit-cost analysis relied on information learned from the extensive flow monitoring and modeling program and from the I/I reduction pilot projects. When an I/I reduction project downsizes or eliminates the need for a conveyance facility improvement, the savings achieved (benefit) must be higher than the cost of the I/I reduction project (cost) to arrive at a positive benefit-cost ratio.

A benefit-to-cost ratio was used to measure cost-effectiveness. The ratio compares the cost of I/I repair and rehabilitation projects to the cost of conveyance system improvement and treatment plant capacity projects. The planning assumptions developed from numerous discussions with the MWPAAC E&P Subcommittee played a key role in the analysis. They included assumptions regarding rehabilitation method costs, reduction effectiveness, future conditions, and contingencies. In accordance with a consensus reached with the E&P Subcommittee, the ratio was applied on a project-specific basis rather than to the accumulated benefits of multiple projects regionally. Future analyses will evaluate the merits of allowing local agencies to contribute funding to make an I/I reduction project cost-effective.

Chapter 5 describes the recommended I/I program for King County. The recommendations are presented for I/I reduction, long-term I/I control, and program administration and policy.

Included in Appendix A of this report are references to documents used in the legal analysis of the use of public funds to conduct I/I reduction work on private property. Appendix B contains the set of draft design standards, guidelines, procedures, and policies developed jointly by the County and local agencies for use in long-term I/I control.