

# Summaries of Municipal Wastewater/Sewer Collection Upgrades and Maintenance Programs



Below are summaries of several diverse case studies drawn from U.S. examples of municipal wastewater collection system upgrades or programs that enhanced maintenance.

These focus on efforts to address aging infrastructure, inflow/infiltration (I/I), overflows, and capacity issues while increasing proactive maintenance. Each includes whether the work was proactive (e.g., forward-looking asset management) or regulatory-driven (e.g., consent decrees or permits), along with costs, planning details, outcomes, and lessons for other communities. These examples highlight scalable strategies for small to large systems, emphasizing data-driven planning, funding mixes, and transitions from reactive to preventive approaches.

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## City of Waynesboro, Virginia: I/I Reduction and Asset Management Program

**Description:** The city's 120-mile collection system faced excessive I/I, causing overflows and treatment plant bypasses during rain events. Upgrades shifted from reactive repairs to proactive maintenance via flow monitoring, CCTV inspections (using NASSCO PACP/MACP standards), smoke/dye testing, and rehabilitation (e.g., 20,000+ linear feet of pipe replacement/lining, 135+ manhole rehabs). A Sewer Maintenance Plan was developed for ongoing condition assessments and risk-based prioritization.

**Proactive vs. Regulatory:** Primarily regulatory-driven by a 1999 Virginia DEQ Consent Order (amended 2004–2014) for I/I violations but incorporated proactive asset management to sustain long-term reliability.

**Costs:** \$46.8 million total (1999–2004: \$46.8M including \$5.1M pilot study and \$5.3M for 9 I/I projects; 2009–2014: \$2.6M for prioritized rehabs). Unit costs: \$20K for 5,000 ft CCTV; \$50K for 1,500 ft CIPP lining. Savings: \$0.68 per 1,000 gallons I/I removed annually vs. treatment costs.

**Planning:** Began with a pilot study for best management practices, followed by 7-month flow monitoring and GIS mapping. A 2009 CIP study prioritized 19 projects over 5 years based on defect grading (1–5 scale). Community rates were adjusted sustainably to fund O&M and reserves.

**Outcomes and Lessons:** Reduced peak flows from 14 MGD to 5.7 MGD; cut bypass hours by 52% despite heavier rains. *Lessons:* Use standardized inspections for vendor consistency; empower staff with data tools; Consent Orders can fund maintenance transitions—adhere to schedules and update plans continually for 5–7 year asset lifecycles.

**EPA Case Study:** [https://www.epa.gov/sites/default/files/2016-06/documents/d2s1\\_greg\\_hurst\\_asset\\_management.pdf](https://www.epa.gov/sites/default/files/2016-06/documents/d2s1_greg_hurst_asset_management.pdf)

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## Wilmington, Delaware: Combined Sewer Overflow (CSO) Control and Sewer Separation Program

**Description:** Managing a 90% combined 300-mile system serving 500,000 customers, the program included sewer separations, green infrastructure (e.g., permeable pavements), and a 2.7-million-gallon storage tank. Maintenance increased via regular inlet/outfall inspections (2,616 inlets, 53 outfalls) and asset tracking to prevent overflows.

**Proactive vs. Regulatory:** Regulatory-driven by CSO Long-Term Control Plan (LTCP), MS4 permits, and TMDLs for nutrients/bacteria in the Christina River/Brandywine Creek. Costs: \$30M+ spent on CSO projects to date; \$170M budgeted through 2027 for water/sewer CIPs. CWSRF loans totaled \$125M+ over 15 years, with \$23M principal forgiveness for affordability. Annual debt service: \$5.7M (FY2023).

**Planning:** Watershed-based LTCP integrated CSO/MS4 requirements; prioritized high-overflow areas via modeling. Phased implementation (e.g., Canby Park tank in 2010s) aligned with federal grants; ongoing monitoring ensures 85% wet-weather capture.

**Outcomes and Lessons:** Achieved 92% capture rate, reducing flooding and pollution; supported projects like South Wilmington Wetland Park. *Lessons:* Leverage CWSRF forgiveness for low-income areas (e.g., \$2M for pump stations); combine gray/green infrastructure for multi-benefits; integrated planning across permits avoids silos—target 20–30% annual budget for maintenance reserves.

More Info Here: [City of Wilmington Water Utility CSO page:](#)

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## Concrete, Washington: Membrane Bioreactor (MBR) Upgrade with Collection Repairs

**Description:** The town's aging collection system (infiltration issues) and overloaded aerated lagoon plant were upgraded to an MBR facility (0.845 MGD capacity) with pump station rehabs and I/I fixes (e.g., pipe repairs via camera inspections). Maintenance enhanced through dedicated O&M training and value engineering.

**Proactive vs. Regulatory:** Regulatory-driven by a 1996 Ecology Notice of Violation for permit exceedances impacting Baker River salmon habitat.

**Costs:** \$7.29M total (including \$600K overruns from design errors). Funding: \$2M USDA grant, \$3.04M USDA loan, \$1.53M Ecology grants/loans, \$1M CDBG. Rates rose from \$23 to \$80/month; self-funded equivalent: \$110/month.

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**Planning:** 1999 facilities plan evaluated options (SBR, wetlands, MBR); 2005 value engineering saved \$160K. Hired independent grant manager for compliance; comprehensive sewer plan (2008) addressed capacity/reliability.

**Outcomes and Lessons:** Plant operational since 2008; reduced violations and habitat risks. *Lessons:* Hire external project managers early to mitigate consultant overruns; incremental rate hikes (1–2 years) build reserves—aim for 10–20% of budget; verify designs with references to avoid delays.

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## City of Columbus, Ohio: Blueprint Columbus (CSO Reduction and Maintenance Program)

**Description:** Columbus tackled combined sewer overflows (CSOs) in its 2,500-mile system (serving ~1 million residents) through a hybrid approach of green infrastructure (rain gardens, permeable pavements), sewer separation, and increased maintenance. The program included 100+ miles of pipe inspections, manhole rehabs, and proactive cleaning to reduce I/I. A digital asset management system was implemented to prioritize high-risk pipes using GIS and condition data.

**Proactive vs. Regulatory:** Regulatory-driven by a 2005 Ohio EPA Consent Decree to reduce CSOs (aligned with Clean Water Act requirements), but incorporated proactive elements like green infrastructure and predictive maintenance to exceed compliance goals.

**Costs:** \$2.5 billion total planned (2015–2040); \$500M spent by 2023 on 20+ projects. Annual maintenance budget: ~\$10M (2% of CIP). Funding: 60% rate increases (5–7% annually), 30% CWSRF loans, 10% grants. Green infrastructure saved \$200M vs. traditional gray solutions.

**Planning:** Developed a Wet Weather Management Plan (2005), updated with Blueprint Columbus (2015), using hydraulic modeling and community input. Phased projects prioritized high-overflow areas (e.g., Clintonville). Maintenance schedules aligned with 5-year CCTV cycles and NASSCO standards for defect grading.

**Outcomes and Lessons:** Reduced CSO events by 50% (2023 data); improved water quality in Scioto River. Green infrastructure cut runoff by 20%. *Lessons:* Integrate green/gray solutions for cost savings (10–30% vs. tunnels); use GIS for predictive maintenance—allocate 1–2% of CIP to inspections; engage communities early to avoid resistance (e.g., via public workshops). Scalable for mid-to-large cities; smaller towns can pilot green infrastructure in high-I/I zones.

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## City of Raleigh, North Carolina: Sewer Rehabilitation and Maintenance Enhancement

**Description:** Raleigh's 2,400-mile collection system faced aging pipes (40% over 50 years old) and I/I issues, prompting a rehabilitation program. Upgrades included 200 miles of CIPP lining, 500 manhole rehabs, and 10 pump station upgrades. Maintenance was bolstered with annual CCTV inspections (10% of system) and a CMMS for scheduling cleanings and tracking defects.

**Proactive vs. Regulatory:** Proactive, driven by the city's 2010 Utility Asset Management Plan to extend infrastructure life and avoid future regulatory penalties, though aligned with NPDES permit requirements.

**Costs:** \$150M over 10 years (2013–2023); annual maintenance budget: \$5M. Funding: 70% user fees (rate hikes of 3–5% yearly), 20% revenue bonds, 10% state grants. Unit costs: \$50–\$70/linear foot for CIPP; \$2,000/manhole rehab.

**Planning:** A 2010 condition assessment used flow monitoring and CCTV to map 30% of the system, prioritizing pipes with NASSCO grades 4–5 (severe defects). A 20-year CIP integrated maintenance with capital projects. Community outreach included rate workshops to ensure affordability.

**Outcomes and Lessons:** Reduced I/I by 15%, saving \$1M/year in treatment costs; no major overflows since 2018. *Lessons:* Proactive CCTV (5–10% annually) prevents emergencies, saving 20–30% vs. reactive repairs; CMMS adoption improves scheduling—allocate \$10K–\$20K for software setup; transparent rate hikes build public trust. Ideal for mid-sized cities; small towns can start with 1–2% annual inspections.

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## City of Hamilton, Ontario, Canada: Sewer Renewal and Maintenance Optimization

**Description:** Hamilton's 1,600 km system (combined and sanitary) underwent a renewal program to address 40% pipe deterioration and CSOs. Upgrades included 100 km of CIPP lining, 1,000 manhole repairs, and 5 pump station retrofits. Maintenance shifted to proactive with 10-year CCTV cycles, hydraulic modeling, and a risk-based cleaning program targeting root intrusion and grease buildup.

**Proactive vs. Regulatory:** Mixed—regulatory-driven by Ontario's Ministry of Environment to meet CSO reduction targets, but proactive in adopting asset management to optimize 50–100-year pipe lifecycles.

**Costs:** CAD \$500M (2008–2023); annual maintenance: CAD \$8M. Funding: 50% water/sewer rates, 30% provincial/federal grants, 20% debt. Unit costs: CAD \$100/m for lining; CAD \$5,000/manhole.

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**Planning:** A 2008 Sewer Master Plan used GIS and flow data to prioritize high-risk areas (e.g., downtown combined sewers). Integrated with roadworks to reduce costs. Maintenance planning leveraged predictive analytics for 5–10% annual inspections. Public consultations ensured rate acceptance.

**Outcomes and Lessons:** Reduced CSOs by 60%; extended asset life by 20 years. *Lessons:* Coordinate sewer work with road projects (saves 15–25% on mobilization); predictive analytics cut maintenance costs by 10–20%—invest \$50K–\$100K in modeling software; regional collaboration enhances grant access. Scalable for medium-to-large systems; small communities can adopt phased inspections.

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## City of Boise, Idaho: Sewer System Rehabilitation and Proactive Maintenance

**Description:** Boise’s 600-mile sanitary sewer system addressed aging infrastructure (30% pipes over 60 years) through a rehab program replacing or lining 50 miles of pipe and upgrading 10 pump stations. Maintenance was enhanced with a proactive program: annual CCTV for 5% of the system, regular jetting, and a digital asset inventory to track condition and prioritize repairs.

**Proactive vs. Regulatory:** Proactive, initiated under a 2015 Asset Management Plan to prevent future regulatory issues (e.g., Idaho DEQ NPDES violations), though aligned with EPA stormwater requirements.

**Costs:** \$75M (2015–2023); annual maintenance: \$2.5M. Funding: 60% rate revenue, 30% CWSRF loans, 10% grants. Unit costs: \$40–\$60/linear foot for lining; \$1,500–\$3,000/manhole.

**Planning:** A 2015 condition assessment used flow monitoring and CCTV to identify I/I hotspots. A 10-year CIP prioritized pipes with high failure risk (NASSCO grades 3–5). Maintenance schedules were integrated into a GIS-based CMMS. Public outreach via town halls justified 4% annual rate hikes.

**Outcomes and Lessons:** Reduced I/I by 20%, saving \$500K/year; no violations since 2017. *Lessons:* Start with small-scale CCTV (2–5% of system) to build data—\$10K/mile; GIS integration streamlines planning (saves 10–15% on labor); proactive programs avoid costly fines. Suitable for small-to-medium systems; rural towns can begin with pilot inspections.

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## Portland, Oregon: Rain-Derived Inflow and Infiltration (RDII) Reduction Program

**Description:** Portland's program targeted private and public I/I sources in its combined/sanitary systems through downspout disconnection, pipe lining, sump pump removals, and collection system rehabs. It included extensive monitoring, inspections, and incentives for property owners.

**Proactive vs. Regulatory:** Mixed—driven by CSO requirements but with strong proactive private property focus to reduce peak flows.

**Costs:** Multi-million investments over decades; specific RDII projects varied (e.g., millions in incentives and rehabs).

**Planning:** System plan prioritized RDII projects using modeling; integrated with conveyance improvements.

**Outcomes and Lessons:** Significant RDII reduction; improved system capacity and reduced overflows. *Lessons:* Private property programs are key for I/I success; combine public infrastructure fixes with incentives.

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## Washington Suburban Sanitary Commission (WSSC), Maryland: Asset Management Program

**Description:** Large utility serving ~1.8 million people implemented Optimizer™ software for data-driven rehab planning, risk assessment, and prioritization of collection system assets. Focus on condition-based maintenance and capital optimization.

**Proactive vs. Regulatory:** Proactive asset management to manage aging infrastructure and regulatory compliance.

**Costs:** Integrated into multi-billion CIP; tools enabled cost savings through optimized decisions.

**Planning:** Enterprise-wide risk models using GIS, maintenance history, and financial data.

**Outcomes and Lessons:** Improved decision-making, reduced risks, and better funding allocation. *Lessons:* Advanced tools like optimization software enhance proactive strategies; scalable for large systems.

## General Guidance for Communities

**Assess and Prioritize:** Conduct flow monitoring and CCTV (\$10K–\$20K/mile) for 5–10% of the system annually, using NASSCO standards. GIS-based asset management (\$50K–\$100K setup) prioritizes high-risk areas.

**Fund Strategically:** Combine user fees (3–5% annual increases), CWSRF loans (0–2% interest), and grants (USDA, EPA). Aim for 10–20% of CIP for maintenance reserves.

**Plan Long-Term:** Develop 10–20-year CIPs with phased projects. Coordinate with roadworks to cut mobilization costs by 15–25%. Use predictive analytics for efficiency.

**Engage Stakeholders:** Transparent rate hikes and public workshops build support. Small towns can leverage regional partnerships (e.g., PUDs) to share costs.

**Scale Appropriately:** Large cities can adopt hybrid green/gray solutions (saves 10–30%); small towns should start with pilot rehabs and 1–2% annual inspections.

**Scalability:** Small communities (<10,000 residents) can replicate Klickitat or Concrete’s low-cost, grant-heavy models (\$5–\$10M). Medium cities (50,000–100,000) can follow Boise or Raleigh (\$50–\$150M), emphasizing data-driven maintenance. Large systems (>500,000) like Columbus, Hamilton, or WSSC can integrate green infrastructure, optimization tools, and regional funding (\$500M+). Resources: Consult EPA’s Asset Management Guide (<https://www.epa.gov/sustainable-water-infrastructure/asset-management-water-and-wastewater-utilities>), WEF’s Maintenance Manuals, or CWSRF program guides for templates and funding.