United States
Environmental Protection
Agency

CASE STUDY

Wellington, New Zealand Asset Management Program

New Zealand with inset of Australia, courtesy of Maps.com.

Wellington, New Zealand Fast Facts

Established: 1840
Population: 163,824

Treatment Plants
- Moa Point
- Western Treatment Plant (Karori)
- Southern Landfill Sludge Treatment Plant

Sewer Collection System Facts
- 625 miles of sewer line
- 16 miles of force main
- 62 pump stations

Asset Management Facts
- Adopted asset management approach in 1995
- 2002 Asset Management Program is a 10-year planning period

Wellington, New Zealand is using an asset management approach in redeveloping its aged sewer system into a modern, properly-functioning network with adequate capacity for collection and treatment. Currently, the separate sanitary sewer system has numerous illegal cross connections with the storm water system. In addition, many of the components are aging and in poor condition, as evidenced by the collapse of the main interceptor in 1995, and problems with excessive inflow and infiltration (I/I) in some older catchments. Over the next several decades, Wellington's challenge is to disconnect illegal cross connections to the sewer system, replace failing sewer pipes, reduce I/I, and improve operations and maintenance planning. The asset management approach, adopted in 1995, has helped Wellington jump start its progress toward these goals, primarily through implementation of wide-ranging capital improvements and I/I reduction programs that have already shown marked improvements in system performance and water quality.

Overview

New Zealand consists of two main islands, the North Island and the South Island. Wellington is New Zealand's capital city, and is located on the southern tip of the North Island. The town of Wellington was established in 1840 and became the national capital in 1862. About 160,000 people live within the 28-square-mile sewer collection system service area. The area draws visitors with its urban and outdoor recreational resources, including coastal beaches, estuaries, and freshwater streams.

The City developed outward from a narrow coastal plain around Wellington Harbor to the east and the southern sea coast, up steeply sloping hills to the west and north, which now form the borders of the metropolitan area. The regional climate is temperate, typically ranging from 52–68°F. Historic average annual rainfall is about 47 inches per year, although rainfall totals have been declining since the mid 1970s. Wellington experiences several severe storms per year and is subject to infrequent seismic activity that has led to landslides and line ruptures.

The original sewer system–comprising 46 percent of the current network–was installed between 1895 and 1940. The original pipe materials were earthenware, ceramic, or brick; a shift to asbestos cement and reinforced concrete occurred after 1940. Since the 1970s, primary pipe materials have included earthquake-resistant high density polyethylene (HDPE) and polyvinylchloride (PVC). The system now totals 641 miles of sewer line (including 16 miles of force main), 62 pump stations, and three municipal wastewater treatment facilities. Wellington also operates a 372-mile storm sewer network. Currently, illegal cross-connections, especially in the dense urban core area, cause occasional discharges of sewage to the storm water system during wet and dry weather.

New Zealand Regulatory Framework

Environmental Requirements: Resource Management Act of 1991

Outcome-Based Regulation
New Zealand's environmental regulations are structured to avoid and mitigate impacts, rather than to strictly regulate discharges. Rather than effluent limits, sewer utilities have maximum contaminant loads and specific requirements for monitoring receiving waters in the area of each discharge.

Decentralized Implementation and Enforcement
Water quality requirements for Wellington's freshwater streams and coastal areas are established by the Wellington Regional Council, based on national criteria and refined for local conditions and resource management priorities through a stakeholder consultation process. For most of the Region, receiving waters are classified for swimming, fisheries production and harvest, and drinking source water. In some areas, the standards are set higher to protect shellfish beds. The standards prohibit release of floatables, suspended solids, or materials that would render the water or fish unsuitable for consumption or have adverse impacts on aquatic life.

Moa Point in the 1980s before sewage treatment (top) and in 1998 after treatement plant was commissioned (below).
Photos courtesy of Grant Sheehan and Mark Coote, respectively.

Asset Management Requirements: Local Government Act of 1989 and Amendment No. 3 of 1996

All New Zealand local authorities are required to:

- Implement accounting systems and reporting in compliance with generally accepted accounting practices
- Prepare annual plans indicating performance measures developed in consultation with the community
- Prepare annual reports outlining performance against these objectives
- Prepare and adopt long-term financial strategies
- Consider all relevant information, including costs and benefits of each option
- Manage assets prudently, in the interest of the local government and its inhabitants
- Identify clearly significant forecasting assumptions and associated risks
- Account for changes in asset service potential

Asset Management Program Elements

Wellington's 2002 Asset Management Plan covers a 10-year planning period. It is designed with specific activities for the near-term, and more general programs for later years. This allows the City to constantly monitor the effectiveness of its activities, and base its planning on the latest available information. Each year, the City reports on how well it performed during the previous year against the selected performance indicators, and provides detailed plans for the coming year.

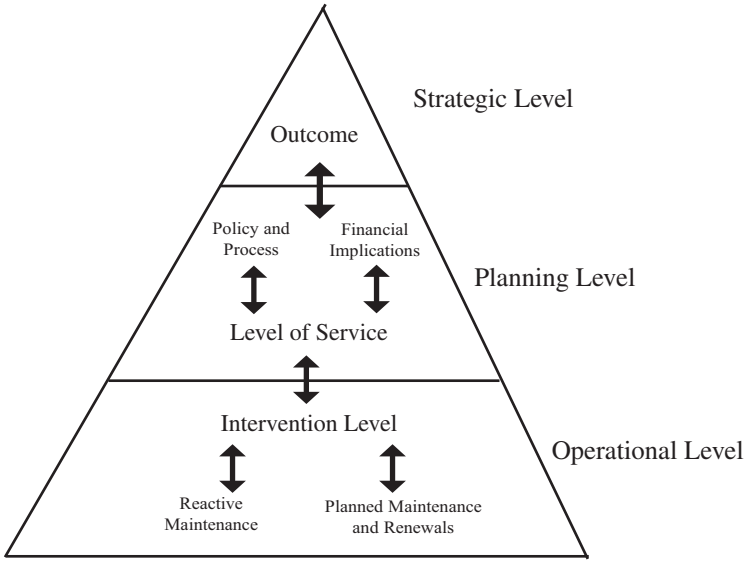
Level of Service Definition

The asset management program strategies and activities are designed to meet Wellington's level of service commitment, which is to:

- Safeguard public health and the environment
- Provide a network with a level of reliability that meets customer and regulatory needs
- Ensure the network has sufficient capacity to serve all customers

In addition to these broad strategic statements, Wellington has established specific goals for the current asset management planning cycle:

- Improve environmental performance of storm water and sewer systems in older parts of the City
- Reduce sewage pollution of the harbor, coastal waters, and streams
- Increase levels of public safety
- Reduce risk of catastrophic failure within the system
- Preserve and/or improve quality of natural streams within the City



The City has a broad approach to sewer system management that shapes the detailed management program and long-term financial and investment decisions. This approach includes an interrelationship between strategic, planning, and operational levels. *Source: Wellington City Council 2002 Sewerage Asset Management Plan.*

Annual Performance Goals

Performance goals provide specific benchmarks against which progress is measured. They fall into three categories: environmental, customer satisfaction, and system capacity and operation.

Environmental Goals

Wellington's environmental goals are based on eliminating sewage pollution in dry and wet weather. Wellington's goals are to achieve full compliance with the following:

- Median annual fecal coliforms of less than 2,000 per 100 mL at at least 50% of monitored storm water outfall sites
- Median annual fecal coliforms of less than 2,000 per 100 mL at at least 50% of monitored freshwater sites
- Median annual enterococci of less than 35 per 100 mL at 100% of monitored bathing beaches

About 70 sites in 12 catchments are monitored on a bi-monthly basis during both wet and dry weather. Storm water effluent and receiving water samples are taken using protocols established by the Wellington Regional Council. In the event of a reported sewage impact at an unmonitored location, that site is added to the monitoring program until the source of the contamination is identified and remedied.

Customer Satisfaction
Currently, Wellington's customers have high levels of satisfaction. In 1998-1999, the rating of the satisfactory operation of the sewage network was 94%. The asset management plan establishes a goal of maintaining or improving the satisfaction level in key areas of customer response:

- Rapid and effective response to service requests
- Network reliability
- Network capacity

System Capacity and Operations
The expenditures Wellington devotes to capital improvements and maintenance are designed to improve the system's capacity to collect and treat sewage. The primary performance measures are:

- Maintain capacity sufficient to collect and treat the sewer system's design flow--up to 4.5 times the average dry weather flow
- Allow no more than an average of fewer than 1.2 sewer line defects per mile (based on current estimates, this may be reduced to fewer than 0.8 defects once better defect tracking systems are established)

Clearwater at Moa Point Treatment Plant. *Photo courtesy of Neil Price, Wellington City Council.*

Information System

Wellington's primary asset information system, CONFIRM, is integrated across the sewage maintenance, storm water, transportation, property, and parks departments. A software extension allows CONFIRM to communicate with the geographic information system (GIS), so that asset information entered in the GIS is routinely uploaded to the CONFIRM asset registry. A wireless auto track and dispatch system allows the City's central call center to route trouble calls directly to field crews and on-call contractor staff.

The GIS was created in the early 1990s, using as-built data and contractor records. About 40 percent of the pipes in the system–the oldest sections–had no as-built information. Missing pipe information, which varied from section to section, included date of installation, size, construction material, length, burial depth, and slope. Some one percent of these pipes are repaired, rehabilitated, or replaced each year, allowing Wellington to fill in the gaps. In the past 12 years, Wellington has undertaken manhole identification, pipeline inspection, and rehabilitation programs in the worst polluted catchments. These programs help locate many of the unmapped pipe segments. As future inspections and rehabilitation is carried out, the information held in GIS and the database is improved.

CONFIRM was purchased by Wellington in 1998. CONFIRM is designed to manage transportation networks and other above-ground assets, and needed some modification to meet the needs of the Sewage Maintenance Department. It did, however, meet the City's larger goal of providing an integrated platform for its interdepartmental asset management planning and reporting needs. The centralized system ensures data is organized in common database structures and formats, which streamlines the consolidated reporting and planning the City is required to do each year.

Each department maintains its own asset registry and program-specific GIS data coverages. Data coverages for the sewer network include catchment boundaries, sewer lines, pump stations, treatment plants, streets, and buildings. Technicians returning from the field enter data into the GIS, and the data is uploaded electronically into CONFIRM.

The Sewer Maintenance Division's local CONFIRM system includes:

- ***Asset Register -*** Detailed asset information (age, location, function, material, condition, and value)
- ***Customer Service -*** Tools for logging customer calls (dispatched from the central call center) and progressing them to closure
- ***Maintenance Management -*** Planning, scheduling and recording maintenance activities, and associated costs
- ***Capital Works Planning and Management Tools -*** Planning capital improvement projects, as well as issuing contracts and managing contracts
- ***Condition Assessment -*** Provides a method for recording the overall condition rating of each pipe segment, as well as a method of tracking individual defects

Asset Identification and Valuation

Identification
Wellington's asset identification program began with the development of the GIS system in the early 1990s, and was refined and enhanced when the CONFIRM system was added in 1998. The classes of identified assets include pipes, pump stations, tunnels, fittings and ancillary items, and flow monitoring equipment. Numbering systems are used to identify each asset component by type and location within the system. As the asset identification process nears completion, Wellington is performing data quality control audits and developing more rigorous data management procedures.

Valuation
Asset values are updated every three years, based on current unit replacement costs, minus depreciation, plus any capital improvements added since the last valuation. In 2002, Wellington's sewer network was valued at $310 million (US $), with a depreciated value of $160 million (US $). There is an additional $92.7 million (US $) of sewarage treatment assets with a depreciated value of $86.5 million (US $).

Some classes of assets, such as pump stations, are valued using actual data and depreciated using the straight line method. This is possible because the actual age and rehabilitation records of all pump stations are known, and the economic life of 20 years can be reasonably applied to each one. Since Wellington fully rehabilitates its pump stations on a rotating 20-year schedule, there are typically several pump stations on every point along the depreciation curve, so that the total value of all pump stations tends to depreciate less than the other components.

Pipe valuation is more complicated. The depreciated replacement value of a sewer line segment is equal to its replacement cost (using current construction methods and materials), minus its elapsed economic life. Each type of pipe material has an assumed economic life, or adopted base life; for instance, 60 years for asbestos cement, 80 years for reinforced concrete, or 140 years for ceramic. Because there are so many variables, Wellington uses a deterioration model to perform valuations of pipes. Condition data is being improved and for a particular pipe material, size, and ground condition, collated information will be used to determine a more accurate economic life for future valuations.

Failure Impact Evaluation and Risk Management

Level of risk considered acceptable for people to live with over the long term
The acceptable level of risk is established under the Resource Management Act, the Local Government Act, and laws regulating flood control, soil conservation, building standards, and human health and safety. Wellington has passed municipal ordinances as set by the Building Act establishing standards and procedures governing private lateral design and construction,

residential drainage and plumbing, construction over drains, earthworks, commercial and industrial wastewater ("tradewaste") that impact the sewer system.

Risk management systems needed to manage operational and management failures

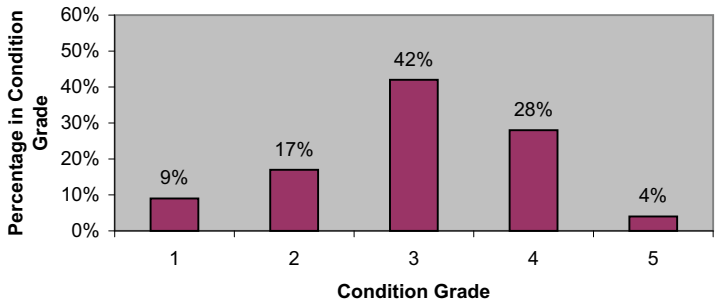
Wellington developed and implemented an Operational Risk Management Plan in 2002. The centerpiece of this plan is the Critical Drains Strategy. Approximately 15 percent of the pipes in the system are classified as critical, based on importance to the sewer network and/or the impact of failure on the environment, public health, or property. These pipes are given higher priority for inspection that may result in rehabilitation or replacement if they are at risk of failure.

Staff and contractor crews are available 24 hours a day to ensure prompt response to customer service calls. Written procedures guide responses to the range of customer problems, from reports of blocked drains to system failures or civil emergencies; calls are prioritized according to the severity of the problem. All emergency technicians receive emergency response training and are provided with appropriate equipment. Emergency calls, diagnostic assessments, and maintenance and repair actions are logged into the CONFIRM system by the field crew performing the work.

Wellington also maintains an inventory of critical parts to ensure that failed pump station equipment and sewer lines can be replaced within 48 hours. Skilled pipefitters and electricians are on call 24 hours a day.

Condition Assessment

The first condition analysis of the sewer system was performed in 2000. Prior to that, Wellington's sewer rehabilitation and replacement planning was based on identified needs and historical expenditures. The condition assessment included statistical methods and computer modeling to extrapolate available information to areas of the system that had not been inspected. This approach is widely used in Australia and New Zealand to develop a long-range forecast of capital funding needs at far less cost than a complete system inspection and condition assessment.



A key task of the "top-down" 2000 expenditure forecast study was the assessment of condition grade profiles to various material types and pipe diameters. *Source: Wellington City Council 2002 Sewerage Asset Management Plan.*

The condition analysis focused on evaluating the need for pipe replacement due to loss of structural integrity. It was based on the assumption that only pipes in very poor condition would be replaced. The resulting forecast provided a good idea of how much pipe Wellington can expect to replace per year through 2080.

The methodology used to develop the baseline condition assessment included:

- *Asset Database* - Information on pipe materials, diameters, age, and ground conditions
- *Identification of Zones* - Confirming catchment areas and subdividing them into zones based on predominant pipe material, soil type, and average asset age
- *Identification of Strata* - Statistically grouping zones with similar characteristics or attributes
- *Sampling and Interviews* - Selecting sample zones from each stratum at random and conducting structured interviews of key staff who have a good working knowledge of the asset
- *Extrapolation of the Results* - Analyzing all relevant information for the sample areas and

extending findings to the other areas of the network.

A computer model was used to project the rate of deterioration for the pipes to arrive at the year when each pipe is expected to degrade to "very poor condition". Unit replacement costs for each pipe diameter allow Wellington to assess the anticipated cost of replacements per year.

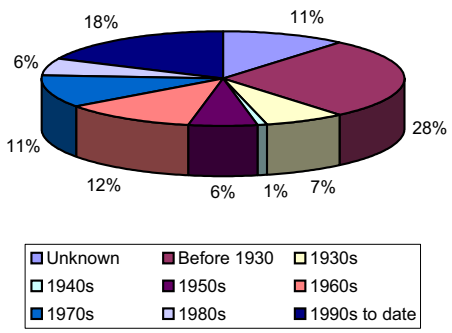
To improve on the forecast, Wellington plans to add more condition assessment activities to its next Asset Management Program. These would include extending CCTV inspection to parts of the system that have not yet been inspected, modifying CONFIRM to better track maintenance histories and sanitary sewer overflow (SSO) reports, and streamlining procedures for adding baseline condition data to the CONFIRM system as pipes are replaced or new pipes are added.

Pipe Rehabilitation and Replacement Planning

Pipe rehabilitation is planned based on a three-tiered priority system:

- First priority is given to any critical drain pipes that are in imminent danger of collapse.
- Second priority goes to areas where homes have been flooded by sewage more than twice in 10 years.
- Third priority goes to areas where unoccupied buildings, yards and streets are flooded by sewage more frequently than once every five years.

Age Distribution



According to the 2002 Sewerage Asset Management Plan, 89 percent of the City of Wellington's system age has been determined. By 2020, more than 30 percent of the system pipes will have reached "very poor condition". *Source: Wellington City Council 2002 Sewerage Asset Management Plan.*

The long-term goal of Wellington's replacement planning program is to replace assets at the point where the cost to maintain the asset equals or exceeds the cost to replace it. Currently most of the system is maintained reactively, it is difficult to project when that point will occur. Therefore, Wellington has adopted the approach of replacing pipes that are rated as being in "very poor condition." More than 30 percent of the pipes in the system will have reached that condition by 2020, with another 15 percent expected to need replacement by 2040. After 2040, the rate of replacements is expected to gradually decline to a nearly stable rate by 2060.

Local Government Act Amendment No. 3 prohibits Wellington from delaying needed replacements to avoid rate increases for current users, thereby passing the infrastructure crisis on to future residents. Replacements are scheduled to occur within one to two years of the identified need. Urgent replacements are accommodated by reprioritizing the works program.

Both new and replacement pipes are designed and built according to standards specified in Wellington's local land development and drainage specification ordinances. These standards call for assets to be conservatively sized for ultimate development potential, using the best available construction technology and best available earthquake-tolerant materials. Pipes between 6 inches and 10 inches are generally constructed of HDPE. Larger pipes are specified on a case-by-case basis. All replacements are performed by approved contractors and inspected by City engineers prior to acceptance.

Faced with a seasonal shortage of local contractors, Wellington plans pipe replacements well in advance of the anticipated project start date, and incorporates demand-based pricing into its financial management planning. The shortage and resulting lack of competition can occasionally

add up to 30 percent to the cost of construction.

Capacity Assessment and Assurance

A known capacity constraint within the main sewer interceptor routinely results in discharges of untreated sewage to Wellington Harbor at the Overseas Passenger Terminal. Wellington is currently evaluating options to accommodate peak flow volumes and eliminate the overflows. A hydraulic model of the main sewer interceptor was developed in 1998 and updated in 2002. Recent data on SSOs were added to the model to give a more accurate picture of the capacity constraints and to allow Wellington's system design engineers to evaluate design alternatives for the new interceptor. Anticipated to cost up to $9.7 million (US $), any works are to be completed by 2008.

Activities undertaken under the Storm Water Pollution Elimination Project have already drastically reduced the volume and frequency of water quality violations, allowing Wellington to come very close to meeting its environmental performance goals. These activities have included identification and disconnection of illegal storm water cross connections, private lateral repair programs, and sewer line rehabilitation programs to eliminate exfiltration from and infiltration to sewer pipelines. However, the expected peak flow reductions within the main sewer interceptor were not achieved. Wellington plans to use its modeling and monitoring programs to continue implementing I/I source identification and elimination programs, but recognizes that it may not be economically possible to reduce I/I to acceptable levels in some parts of the system. In these areas, in-line storage may be considered.

Wellington also is evaluating improved demand management schemes as part of its capacity assurance plan. For example, Wellington has a program in place to control the amounts and types of commercial discharges to the system. Currently, flat fees are charged for discharge licenses, based on the type of industry. Flat fees range from approximately $45 to $900 (US $) per annum. Wellington has proposed that the fee structure be changed to volume-based billing, with a system of surcharges for pollutants that cost more to treat. This would provide incentives for industrial wastes to be treated at source or charge polluters for the cost of treating their wastes.

System expansions and upgrades are planned based on demographic data provided by the Central Government Department, Statistics New Zealand. Outward population growth is limited by Wellington's municipal boundary, with the exception of a few areas where sewer mains are being added to accommodate new subdivisions. Infill development is expected in a number of areas, but is not expected to significantly increase system flows.

Maintenance Analysis and Planning

Planned Maintenance

Wellington uses its Critical Drains Strategy to focus its maintenance planning. Risk assessment was used to identify areas where the potential public safety, social disruption, and cost impacts of failures are high enough to justify proactive inspection and maintenance. About 15 percent of the pipes in the system are considered critical drains. Within this category, there are two subclasses:

- *Critical A Drains* - The five percent of system sewers (about 32 miles) that have the most potential for causing excessive expense and disruption. The City works to prevent collapse of these lines by inspecting them every five years and undertaking preemptive repair and rehabilitation as necessary.
- *Critical B Drains* - The 10 percent of drains (about 64 miles) that pose a high enough risk of potential cost and social impacts to justify inspections every 15 years. The City

rehabilitates or replaces these lines when collapse is imminent or has begun to occur.

In practice, the distinctions between these categories are blurred, and Wellington has adopted the approach of rehabilitating any critical drain lines when the cost of continuing maintenance is 40 percent or more of the cost of rehabilitation.

Pump stations also are considered critical assets. They are inspected monthly or more frequently if a maintenance requirement is indicated or the pump station is undergoing scheduled maintenance. Each station has its own operations and maintenance manual and complete repair and rehabilitation history. Pump stations are rehabilitated or replaced approximately every 20 years.

Another system-wide maintenance activity involves ensuring that the 16 miles of force main within the system have adequate isolation valves to allow Wellington crews to bypass sewage when they need to inspect the force mains or work on pump stations. When this activity is completed, crews can then inspect and classify the condition of the force mains.

Reactive Maintenance

Approximately $2.4 million (US $) of the City's $6 million (US $) average annual maintenance budget is devoted to unplanned inspection and maintenance of 85 percent of the system, approximately 545 miles of sewer line. Although Wellington does not regularly inspect all areas of the system, it has several indirect methods for identifying developing problems that will require inspection and maintenance.

The first is analysis of emergency call patterns. CONFIRM and GIS allow emergency calls to be classified according to the type of problem, the response activity (clearing pipe blockage, repairing small collapse, etc.), and location within the system. This allows the City to track trends that indicate a developing problem, and to schedule maintenance, repair, or rehabilitation activities as needed to prevent future failures.

Another mechanism for identifying problems comes from the Storm Water Pollution Elimination Project. Whenever receiving water or storm water outfall monitoring suggests that sewage is present in the storm water system, Wellington undertakes a study of the affected catchment. If the source of the contamination is not immediately detected, a more detailed investigation is implemented. Often, this type of study will involve smoke and dye testing, and/or CCTV inspection of pipes and laterals, working upstream into the system from the outfall location until the source is identified. Problems identified during these inspections are prioritized and resolved.

Financial Management

Expenditure Forecast

Operations costs and capital improvement needs are forecasted for a 10-year period. Wellington's operating budget is expected to average approximately $8.5 million (US $) per year, while capital improvement costs are expected to peak midway through the period, from $4.2 million (US $) in 2002 to nearly $7.3 million (US $) in 2005, before returning to $4.2 million (US $) by 2012.

Each year, the Drainage and Water Supply Department prepares a detailed budget for the coming year and submits it to the City Council for review. The budget includes expected operational costs, proposed capital works, and asset depreciation that must be recaptured through user fees. The budget is published in the City's Annual Plan for public review and comment by ratepayers. Feedback received from the public is considered by the City Council, which may opt to disallow projects that are deemed too expensive or not cost-effective by the public. User rates for the coming year are calculated based on the final approved budget.

Valuations and Depreciation

As noted earlier, Wellington's assets are valued based on current replacement costs, minus depreciation, plus any capital improvements. In 2002, the sewer collection system assets were valued at $310 million (US $) based on optimized replacement value, and $160 million (US $) when fully depreciated. The valuation will be updated in 2005, and at least every three years thereafter.

Confidence Levels

The New Zealand Water and Wastes Association has created Guidelines for Infrastructure Asset Grading Standards, which is used by communities to assess the reliability of their forecasts. Wellington's confidence level is assessed as "B," reliable, since:

- Forecasts are based on the analysis of life-cycle costs
- Operations and capital needs were evaluated separately
- Forecasts are constantly improving as new data become available and analyses become more sophisticated

Funding Policy

User fees and reserve funds are used to cover operational expenses and pipe renewals. Debt financing is used to pay for new works. User fees are collected as part of Wellington's general residential and commercial rates, which are assessed based on property value. Residential customers also pay a $67 (US $) Uniform Annual Charge in addition to their assessed rate. In 2001, the average residential customer paid $124 (US $). Commercial rates were approximately $0.18 (US $) per $100 of assessed value, so that a commercial property valued at $1.2 million (US $) would pay $1,800 (US $) in annual sewer service fees. Rates were raised in 2002 to cover the expected increase in capital improvements, to $1.10 (US $) per $100 of assessed value for commercial customers. Rates are subject to change from year to year, based on the approved final budget.

Continuous Improvement

The asset management plan is subject to internal and external review and independent audit. As a first-generation plan, the elements draw from a combination of current practices and new programs, leaving a great deal of room for growth and improvement. It will be reviewed and updated every two to three years.

As processes are developed, they are added to the Drainage and Water Supply Department's Quality Assurance Manual to allow for future review and audit.

As a result of its most recent audit, Wellington has established the following near-term improvement goals:

- Improve and complete asset data collection and analysis in CONFIRM and GIS
- Expand regular inspection and maintenance planning to non-critical areas of the system, and reduce reactive maintenance costs
- Improve service fault notification tracking and reporting
- Use sewer system and receiving water modeling of main system components to isolate and eliminate sources of I/I
- Reduce uncertainty in renewal/replacement planning

For More Information on Wellington's Asset Management Program

Wellington City Council
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101 Wakefield Street, P.O. Box 2199
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http://www.wcc.govt.nz/services/water/

For Program Information on SSO Abatement

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