**Subject**: Inspection of Regional Water Infrastructure

**Report to:** Public Works Committee

**Report date:** Tuesday, April 5, 2022

1. That staff **BE DIRECTED** to consult with the area municipalities to review options for reinstating a water loss committee to collectively review strategies for targeted investigation and reduction of water loss, with a goal of providing an update to the 2007 Regional Water Loss report; and
2. That this Report **BE CIRCULATED** to the Local Area Municipalities.

## Key Facts

- In 2021, Niagara Region delivered 56,065 ML of treated water through six water treatment plants and 313 km of watermain across 11 municipalities.
- Operations staff monitor variations in flow and pressure throughout the system, and immediately report suspected main breaks to Regional and Area Municipal staff as observations warrant. Breaks on transmission mains are repaired immediately.
- Distribution flow is monitored using 25 flow meters across Niagara, which are verified and calibrated on a semi-annual basis by a third party contractor. These flows are used not only for billing calculations, but also long-term planning associated with servicing, development planning and capital project design.
- Between 2004 and 2007 a Water Loss Reduction Task Force comprised of Regional and Area Municipal representatives was formed to share experiences regarding water loss levels and strategies for reduction.
- Niagara's water transmission system is comprised of large diameter water mains of various pipe material. Approximately 89 per cent of these transmission mains are non-metallic, which is not favourable to acoustic leak detection. Leak detection involving invasive technologies or system shutdowns will potentially impact thousands of customers and may not be feasible on trunk systems.

## Financial Considerations

Watermains are designed for a useful service life greater than 80 years and appurtenances such as valves are designed for a useful service life of 25 years. Access chambers are designed for a useful service life of 50 to 100 years. Asset service life and condition are influenced by various factors such as material, quality, location, use, and

the environment that it is installed in. As thresholds for these criteria are met, watermains are selected for replacement through Capital funds.

The annual cost of calibration, for flow meters used for billing, is approximately $18,000. A breakdown of these costs is provided in Table 2 below (Analysis: Calibration and Verification).

A comprehensive review of water loss along all of Niagara Region's transmission mains would be approximately $3,000 to $25,000 per km of main depending on the diameter of main and the water loss technology used. This estimate is based on the Region's previous work regarding water loss strategies, and is contingent on watermain material, location and configuration of the transmission system. A summary of leak detection strategies is presented in the Analysis section below.

## Analysis

Niagara Region owns and maintains 313 km of watermain and 973 underground enclosures across 11 municipalities. Appendix 1 contains a detailed summary by municipality.

Table 1 below identifies the total length of pipe in the Regional network, by pipe material.

**Table 1: KM of Watermain by Pipe Material**

| Material | KMs of Watermain | Percent of System | Life Expectancy (Years) | Average Age (Years) |
|---|---|---|---|---|
| Concrete Pressure Pipe | 137 | 44 | 70-80 | 43 |
| PVC Plastic Pipe | 108 | 35 | 75 | 17 |
| Asbestos Cement Pipe | 32 | 10 | 60-70 | 49 |
| Ductile Iron | 14 | 4 | 60-70 | 29 |
| Cast Iron | 10 | 3 | 60-70 | 58 |
| Other | 11 | 4 | 60-70 | 37 |

Operational Monitoring and Break Response

Niagara operates six (6) water treatment plants. Operators at these facilities monitor variations in flow and pressure throughout the system and immediately report suspected main breaks to Regional and Area Municipal staff as observations warrant. As breaks

are suspected, Niagara Region initiates the resources to investigate. Region staff often support Area Municipalities in locating and confirming breaks on Local infrastructure. To troubleshoot these events, Regional staff rely on trends from a variety of online instruments which measure flow, pressure, level etc. In the event that a failure is on Region infrastructure, Niagara Region maintenance staff use contractors for immediate repair of the main from a preapproved list of external parties detailed in the Water and Wastewater Emergency Response Procedure.

**Inspection and Maintenance**

Underground enclosures (valve chambers) are routinely inspected by internal maintenance personnel through routine preventative maintenance programs, such as the valve turning program. As required, maintenance personnel inspect and report on valve chamber condition and general operation to support troubleshooting of operational or distribution issues. For example, in January 2022, maintenance personnel inspected chambers along transmission watermains in the City of Port Colborne to provide feedback to the City on concerns related to main breaks in the local distribution system. At the time of inspection, all visible piping and valves were in good working order.

**Investigations Completed to Date**

Through Capital Project scoping and design, many studies and condition assessments have been completed to evaluate the integrity of transmission mains, valves and appurtenances. In addition to these studies, the following specific water loss investigations have occurred:

**2004 to 2007: Water Loss Reduction Task Force and Regional Water Loss Assessment Project**

In 2004 the “Water Loss Reduction Task Force” comprised of Regional and Area Municipal representatives was formed. The purpose of this group was to share experiences regarding water loss levels and strategies for reduction. Through the “Water Loss Assessment Project” water balances were completed based on the data provided by the Region and Area Municipalities. The study was completed by Veritec Consulting Inc. and was finalized in 2007. The Regional Water Loss Assessment Project report is included in Appendix 2.

**2011 - 2015: City of Port Colborne – Integration of Water Loss Analysis Tools into a SCADA System**

Between 2011 and 2014 a study was developed and conducted in the City of Port Colborne to develop off-line and real time tools to integrate the City's water usage data with flow data from four district metered areas (DMAs). Niagara Region provided in-kind (SCADA) support for this project, which was also funded through the Showcasing Water Innovation Program. The goal of this project was to provide the City with flow monitoring to aid in locating and remediating unaccounted for water.

**2020: Niagara Region Billing Meter Verification Demonstration to Town of Fort Erie**

In response to questions from the Town of Fort Erie, the Region invited Town staff to witness a third party calibration process at the Rosehill Water Treatment Plant for the billing meters impacting the Town. Following this demonstration, Niagara Region shared verification certificates with Town staff.

**2021 – 2022; Niagara Region – Water and Wastewater Billing Flowmeter Audit**

This project is currently underway to review, confirm and make recommendations for improvements for all processes that contribute to the volumes used for billing. This work includes an audit of the accuracy and suitability of the Region's billing flow meters and a comparison of current methods, including meter type and installation against best practices.

**Calibration and Verification**

Water meters are essential for process automation and are calibrated on a semi-annual basis. The cost for these calibrations is shown in Table 2 below.

**Table 2: Calibration of Flow Meters**

| Program Name | Frequency | Cost |
|---|---|---|
| Calibration of Non Mechanical Flow Meters | Semi-annual | ≈ $15,200 |
| Calibration of Mechanical Flow Meters | Semi-annual | ≈ $2,200 |

When establishing the frequency of calibration required, Niagara Region takes into account whether or not the meter is used to meet legal requirements, industry standards for calibration, manufacturer recommendations and the conditions of use such as importance of collected data for use in other processes such as billing. There are 25 water meters used for billing, all of which are calibrated on a semi-annual frequency.

**Water QMS Risk Assessment**

An internal risk assessment is required every 36 months for each of Niagara Region's water systems, with complementary risk assessment reviews to be completed at 12 and 24 months between the assessments. A full risk assessment for the Water QMS was completed in 2021, with reviews to follow in 2022 and 2023.

Through the risk assessment exercise, the Water-Wastewater Asset Management group assesses risk associated with watermains using the risk scoring criteria outlined in the Corporate Asset Management Risk Assessment (CAMRA) model. Criteria for consideration includes factors such as; likelihood of failure, impact on users and the environment, financial risks and risks associated with compliance or social reputation of Niagara Region. There were no high-scoring risks identified during the 2021 full risk assessment. Any previously identified high-scoring risks have been mitigated through capital projects, operational adjustments, or through continual improvement initiatives.

**Leak Detection Technologies for Transmission Mains**

The three (3) most common methods of leak detection for transmission systems are in-line acoustic monitoring, non invasive acoustic monitoring and district metering. Costs associated with these methods vary depending on diameter and type of technology used and are detailed under the Financial Considerations section of this report.

For both in-line and non invasive acoustic monitoring, sensors discern the acoustic activity associated with leaks by sending acoustic pulses to receivers attached to pipe appurtenances. Leak location is estimated by the arrival time of the pulses. When in-line acoustic monitoring is used, condition and configuration of the pipe i.e. tubercles, valves, bends and pipe appurtenances may obstruct equipment, and terrain changes may make installation and removal of equipment difficult. In-line monitoring can be disruptive to operations. While non-invasive installations pose less disruption to service and flow, this type of installation is sensitive to interferences. With increasing pipe diameter, there is less accuracy of the sensors to detect leakage. All acoustic leak detection is sensitive to pipe material and diameter. Acoustic methods work best with

smaller diameter metallic pipes, and are less accurate with large diameter transmission mains. Approximately 89 per cent of Niagara Region's transmission mains are non-metallic, and all are large diameter.

District metering is an audit of the meters within a portion of the distribution system. Meters are installed to measure flow into and throughout a defined portion of the system, and flows are monitored to determine if leakage may be an issue. The installation of meters that detect bidirectional flow can also aid in locating leaks.

Due to the size and configuration of Niagara Region watermains it may not be economically feasible to conduct a complete inspection of the entire transmission system. Regional infrastructure valves for shutting down sections of main are often located a considerable distance apart, and isolation and draining of sections at a time can put a significant number of residents and businesses out of service. In addition to these concerns, pressure transients caused by putting a main back into service could cause breaks within the Area Municipal system.

Currently staff focus on areas where mains are known to be aged, have a higher occurrence of failure or the pipe material is most conducive to water loss investigation. Both infrastructure age and failure are well documented through the QMS Risk Assessment Process.

## Alternatives Reviewed

The alternatives to reinstating a water loss committee to collectively review strategies for targeted investigation and reduction of water loss are:

1. Do nothing. Niagara Region could continue with current practices but this may be less effective in addressing the opportunities to further reduce any water loss.

2. Council could direct staff to procure external resources to undertake a comprehensive water loss assessment. This is not recommended without first re-establishing the water loss committee with Local Area Municipal staff participation to ensure that any assessment is comprehensive and has access to all available information.

## Relationship to Council Strategic Priorities

Recommendations presented in this report relate directly to Council's Strategic Priority 4.1 of committing to "high quality, efficient and coordinated core services". Through coordinated efforts, the Region and Area Municipalities can collaborate on water loss reduction strategies.

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Commissioner of Public Works (Interim)
Public Works Department

**Submitted by:**
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This report was prepared in consultation with John Brunet, Associate Director, Water Operations and Maintenance, and reviewed by Joe Tonellato, Director, W-WW Services.

## Appendices

Appendix 1 Niagara Region – Watermain Statistics

Appendix 2 2007 Regional Water Loss Assessment Project

**PW 14-2022 Appendix 1 - Niagara Region Water Main Statistics**

| Water | FE | NOTL | Grimsby | NF | STC | PC | Welland | Thorold | Lincoln | West Lincoln | Pelham | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of connections to local infrastructure | 79 | 109 | 26 | 97 | 144 | 25 | 117 | 50 | 54 | 3 | 35 | 739 |
| Average age of infrastructure (water mains) | 29.26 | 25.36 | 30.80 | 44.00 | 34.00 | 26.00 | 44.50 | 24.60 | 28.74 | 20.04 | 40.50 | 34 |
| Km of Local water main | 275.79 | 200.06 | 135.03 | 483.26 | 593.77 | 111.57 | 273.47 | 117.74 | 112.00 | 34.84 | 85.34 | 2423 |
| KM of Regional water main | 50.90 | 43.14 | 20.46 | 47.13 | 53.90 | 7.80 | 29.22 | 20.28 | 18.38 | 12.58 | 9.56 | 313 |
| KM of water mains replaced over the past 10 years (2011) | 5.50 | 0.06 | 2.50 | 0.08 | 12.77 | 1.41 | 0.74 | 2.57 | 0.06 | 0.52 | 0.00 | 26 |
| KM of mains to be replaced over next 10 years | 10.44 | 3.51 | 1.70 | 0.00 | 0.03 | 1.62 | 0.00 | 0.00 | 3.53 | 7.42 | 0.00 | 28 |
| No. of Regional Underground Enclosures | 129 | 98 | 76 | 133 | 180 | 30 | 149 | 74 | 57 | 32 | 15 | 973 |
| No. of LAM Underground Enclosures | 0 | 0 | 854 | 0 | 101 | 7 | 0 | 1 | 11 | 0 | 1 | 975 |

# Region of Niagara

## Regional Water Loss Assessment Project


***JUNE 2007***

***FINAL REPORT***

VERITEC Consulting Inc.

# *Executive Summary*

With increasing regulatory requirements dealing with water quality, water takings, and full cost recovery the need to understand the performance of water systems has never been more prevalent. Efficient management (and operational control) of water distribution system includes managing real *and* apparent water losses. In November 2004, representatives from both the Region and its area municipalities attended a two day workshop on current industry best practices for dealing with water loss assessment, validation, measurement and control. The group identified that a proper assessment (and validation) of the water loss levels within each AM's water system should be initiated.

The Region contracted Veritec Consulting Inc. to complete water balances for each of the area municipalities. This report highlights the results of the water balances completed for each participating area municipality.

Balances were completed using PIFastCalc for Canada, a licensed software tool incorporating the standard water balance procedure and terminology adopted by both the AWWA and Canadian InfraGuide. PIFastCalc also calculates many benchmarking Performance Indicators (PIs). With respect to validation PIFastCalc for Canada incorporates confidence intervals that highlight data quality.

Non-Revenue Water (NRW) is a "Basic" financial PI. Excluding demands in the City of Welland, the project identifies that collectively, the percentage of NRW in the Region is approximately 14% (i.e, 86% of water sold by the Region is accounted for by billed consumption in the area municipalities). The components of NRW are:

- ✓ Unbilled, Authorized Consumption,
- ✓ Apparent Losses, and
- ✓ Real Losses

Individually the percentage of NRW in the area municipalities ranges from 0% to 37%. Percentages of NRW, however, should not be used to compare and contrast the performance of one system versus another.

The Infrastructure Leakage Index (ILI) is a ratio of the volumes of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). Unavoidable losses vary from system to system based on their characteristics (e.g. kilometers of water main, average system pressures, etc.). Calculated values of ILIs may facilitate the comparison of systems with respect to others as well as benchmark individual performance for annual comparisons.

The World Bank Institute and AWWA have developed general descriptions, guidelines, and recommendations based on the Infrastructure Leakage Index and these may be reviewed by each municipality based on its calculated ILI.

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***Appendices***

## 1.0 INTRODUCTION

With increasing regulatory requirements dealing with water quality, water takings, and full cost recovery the need to understand the performance of water systems has never been more prevalent. Efficient water system(s) management and operational control includes managing real *and* apparent water losses. The now defunct term "unaccounted-for-water" undermined efficiency in so far as the term "unaccounted-for" failed to identify causes or solutions. The term non-revenue water underlines inefficiencies and highlights the real cost(s) of water losses.

Recognizing both costs and regulatory requirements, successful water loss programs must be two-fold; firstly, establishing the level of water losses and secondly, establishing programs to control and/or reduce these losses. The former justifies the investment in water loss reduction and control programs and may be used to track and report on project successes as well as identify program short-comings.

In 2004, the Regional Municipality of Niagara created a working group consisting of Regional staff and representatives of its twelve area municipalities (AMs). The purpose of the *"Water Loss Reduction Task Force"* is to share experiences regarding water loss levels and strategies. In November 2004, a two day workshop on current industry best practices for dealing with water loss assessment, validation, measurement and control was sponsored by the Region.

The task force identified that a proper assessment and validation of the water loss levels within each AM's water system should be initiated. The AWWA and the Canadian InfraGuide have both adopted the International Water Association's (IWA) Standard Water Balance.

Using PIFastCalc for Canada V1, a licensed software package purchased by the Region on behalf of its area municipalities, water balances were completed based on the data provided by the area municipalities themselves.

The following report summarizes the data collected as well as the results of the water balances with respect to the benchmarking performance indicators calculated within the software package. Individual copies of the PIFastCalc outputs are included in the appendices.

## 2.0 PROJECT METHODOLOGY

The goal of the Water Loss Assessment Project is to provide an appreciation of the components of water loss across the region and to identify areas in which losses can be addressed and ultimately reduced. Traditionally many distribution systems describe water losses as the percentage of unaccounted-for-water based on the simple calculation illustrated below:

$$\% \text{ of Unaccounted-For-Water} = \frac{\text{Billed Consumption}}{\text{Water Purchased}}$$

The IWA/AWWA Standard Water Balance (Figure 1) accounts for the total volume of water supplied by identifying the various components[1] of both consumption as well as water losses using either measured or estimated quantities

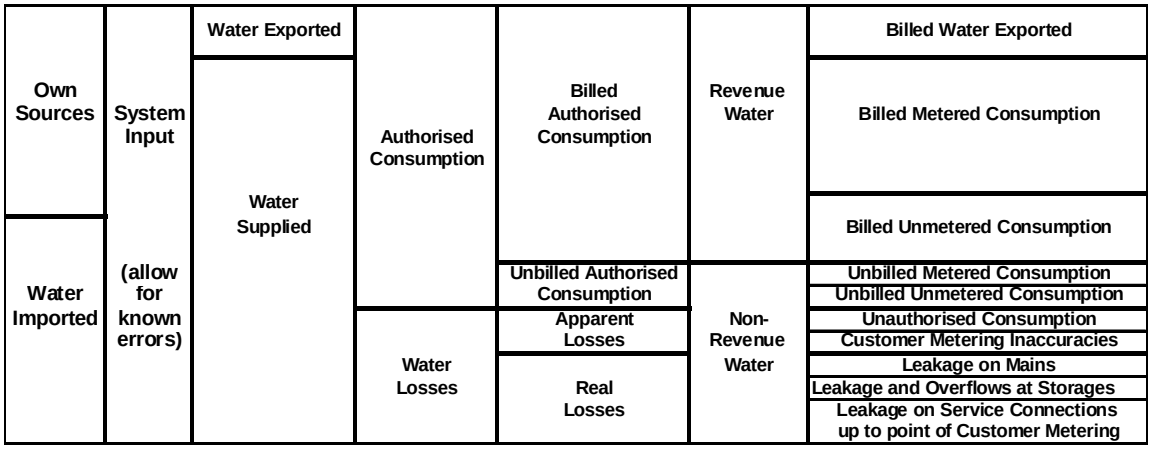



**Figure 1: Overview of the Components of the IWA/AWWA Standard Water Balance**

PIFastCalcs is a licensed software package, purchased by the Region on behalf of its area municipalities, underlying the water loss assessment program. As evidenced in Figure 2 on the following page the standard water balance methodology is incorporated into the software. Based on the water balance, PIFastCalcs automatically calculates "Performance Indicators" (PIs) to assess both real and apparent water losses. And these performance indicators benchmark current losses allowing each area municipality to compare its own performance year-to-year as well as with other systems (locally and internationally).

Tools (e.g., process reliability bands and 95 % confidence limits) highlight the potential need to further evaluate and/or verify data as well as track the overall effect of uncertainty regarding the data used to derive the water balance.

[1] Appendix A includes the standard terminology of each of the balance's components as included in PIFastCalcs.

| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | | | | |
| ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS | | | | | Data entry | Defaults | Calculated Values | | From another Worksheet | | | | |
| Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly | | | | | Currency - | $C | Volume units - | Ml | and | m3 | | | |
| Utility | Enter Licensee's name when issuing software | Bulk supply [BS] or Distribution System [DS]? | DS | | | tm | | - | 365 | days | | | |
| System | | Do most customers have storage tanks? | | | Calculation by | | | Date | | | | | |
| Process Reliability Band | WATER BALANCE CALCULATIONS | | | | Volume in period | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER | | | | | |
| | IWA Terminology | | | | | | | % of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period | | | | |
| | COMPONENTS OF WATER BALANCE | | | | Ml | | | | Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non-Revenue Water | % of cost of running system | | |
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | | | |
| | WI: Water Imported (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 0.0 | 0.0% | 0 | 0.0% | | | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | | | |
| | WS: WATER SUPPLIED - SIV - BACE | | | | 0.0 | 0.0% | 0 | 0.0% | | | | | |
| | BACM1: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | | | |
| | BACM2: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % | | |
| | NRW: NON-REVENUE WATER | | | | 0.0 | 0.0% | 0 | 0.0% | 0.0000 | 0.0 | 0.0% | | |
| | UACM: Unbilled Authorised Consumption: Metered | | | of WS | | | 0 | 0.0% | | 0.0 | 0.0% | | |
| | UACU: Unbilled Authorised Consumption: Unmetere Estimated as | | 1.250% | of WS | 0.0 | 100.0% | 0 | 0.0% | | 0.0 | 0.0% | | |
| | WL WATER LOSSES | | | | 0.0 | 0.0% | 0 | 0.0% | 0.0000 | 0.0 | 0.0% | | |
| | UC: Unauthorised Consumption: | Estimated at | 0.250% | of WS | 0.0 | 100.0% | 0 | 0.0% | | 0.0 | 0.0% | | |
| | ALMUR1: Apparent Loss - meter under-registration | | | of BACM1 | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% | | |
| | ALMUR2: Apparent Loss - meter under-registration | | | of BACM2 | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% | | |
| | ALMUR3: Apparent Loss - meter under-registration | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% | | |
| | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | | 0.0 | 0.0% | | |
| | AL: Sum of APPARENT LOSSES | | | | 0.0 | 0.0% | 0 | 0.0% | 0.0000 | 0.0 | 0.0% | | |
| | RL: REAL LOSSES | | | | 0.0 | 0.0% | 0 | 0.0% | | 0.0 | 0.0% | | |
| | % of period system pressurized - | 100.0% | 365.0 | days | | | Cost of running system in period - | | | | $Cx1000 | | |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 0.00 | Ml/day | | | | | | | |

**Figure 2: Copy of the "Water Balance & PIs" worksheet from PIFastCalc V1a**

## 3.0 RESULTS: PHASE I – DATA COLLECTION

The following section summarizes the data collected with respect to the various components of the standard water balance.

### 3.1.0`Water Supply

The Regional Municipality of Niagara itself is responsible for bulk water supply, treatment, transmission, and storage. Therefore the Region directly provided a monthly summary of metered volumes for each of its thirty-three billing meters. Based on the billing equations provided (Table 1) the data was used to derive the total volume of water supplied to each area municipality per month.

Figure 3 illustrates the breakdown of nearly 74.5 million cubic meters sold in 2005.

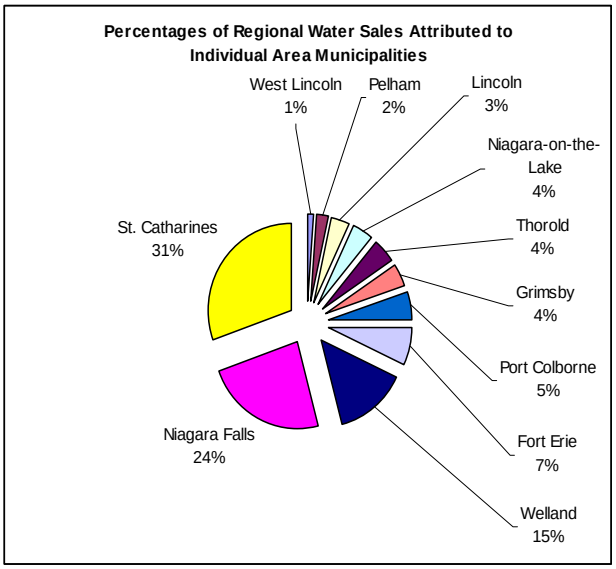



**Figure 3: Water Supply in Niagara Region**

The Region also provided copies of the meter calibration tests completed in 2005 (Appendix B)[2]. Meters for accuracy reports were provided are highlighted in Table 1.

**Table 1**
**Regional Billing Equations**

| Area Municipality | Billing Equation (Accuracy Reports provided for highlighted meters) |
|---|---|
| Fort Erie | 2T1+2T2-2S |
| Grimsby | 6T1-6D1-**6D2** |
| Lincoln | 5D7+5D8+6D1 |
| Niagara Falls | 1T1+1T2-**1D1**-**1D2**-**1D3**-**1D4** |
| Niagara-on-the-Lake | 5D5+5D6+**1D1+1D2+1D3**+5D9 |
| Pelham | 3D1+3D2 |
| Port Colborne | 4T1+4T2 |
| St. Catharines | (5T1+5T2+5T3+5T4+5T5)-**5D1**-**5D2**-**5D3**-5D4-**5D5**-**5D6**-5D7-5D8-5D9 |
| Thorold | 1D4+**5D1-5D2+5D3**+5D4 |
| Welland | 3T1+3T2+3T3-3D1-3D2 |
| West Lincoln | **6D2** |

[2] Veritec distinguished between calibration reports for the meter vs. loop calibration reports.

Table 2 summarizes the results of the meter accuracy tests. Each meter is tested at several flow rates. The range of accuracies recorded for each individual flow rate was between 96.5 and 101.6 percent[3]. Based on this data, and that meter accuracy reports for all the meters were not available, the confidence interval used in the PIFastCalcs software for the Region's meters is +/- 3%.

**Table 2**
**Summary of Supply Meter Accuracy Results**

| Meter ID | Date Tested | % Accuracy | | | | | |
|---|---|---|---|---|---|---|---|
| | | As Found | | | As Left | | |
| | | Avg. | Min. | Max. | Avg. | Min. | Max. |
| 6D2 | 5/24/2005 | 99.7 | 97.0 | 101.0 | | | |
| 1D1 | 5/4/2005 | 97.0 | 94.3 | 101.0 | 99.3 | 96.5 | 101.0 |
| | 10/13/2005 | 99.7 | 99.7 | 101.0 | | | |
| 1D2 | 5/4/2005 | 99.8 | 97.0 | 100.6 | | | |
| 1D3 | 5/20/2005 | 101 | 100.8 | 101.3 | | | |
| 1D4 | 5/4/2005 | 49.8 | 9.8 | 101.3 | 100.2 | 98.2 | 101.1 |
| | 10/13/2005 | 0.0 | 0.0 | 0.0 | 100.4 | 99.9 | 100.9 |
| 5D1 | 5/20/2005 | 100.1 | 99.7 | 100.6 | | | |
| 5D2 | 5/20/2005 | 99.4 | 98.8 | 100.0 | | | |
| 5D3 | 5/24/2005 | 100.7 | 99.3 | 101.6 | | | |
| 5D5 | 5/202005 | 100.0 | 99.7 | 100.4 | | | |
| 5D6 | 5/20/2005 | 99.4 | 97.5 | 101.0 | | | |
| OVERALL [4] | | 70.5 (100.0) | 0.0 (97.0) | 101.6 (101.6) | 100.0 | 96.5 | 101.1 |

Accuracy reports did highlight problems with the Mewburn Road meter. This meter records flows out of the Niagara Falls system and into the Niagara-on-the-Lake system. Figure 4 suggests that the meter was failing to record demands in N-O-T-L prior to being calibrated in May '05 and that it began failing again within weeks of the calibration. The failure of this meter may lead to overestimating supply to Niagara Falls and underestimating supply to N-O-T-L[5].

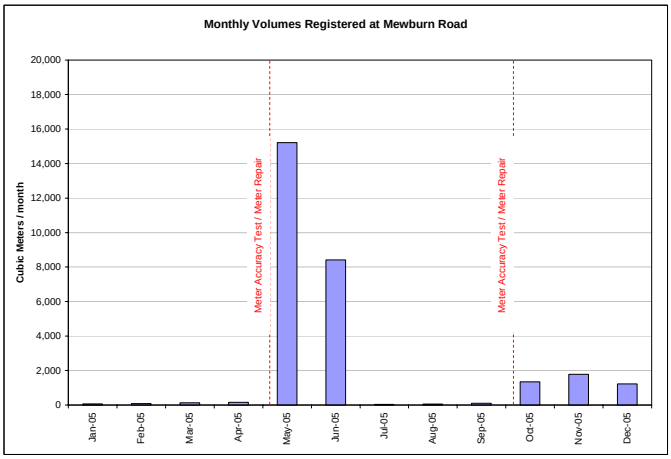



**Figure 4: Monthly Volumes from Mewburn Rd.**

[3] Excludes meters that required calibration.
[4] Overall results for the "As Found" are summarized both with (and without) the meters requiring calibration.
[5] Based on the original billing equations provided it also appears that flows recorded at 1D4 were subtracted from Niagara Falls but were not added to Niagara-on-the-Lake. It is likely that issues

Data for the remainder of the balances were collected from the individual area municipalities. Table No. 3 on the following page summarizes, based on the input parameters of the PIFastCalc software, which area municipalities provided supporting data for each of these parameters.

### 3.2.0 Billed, Authorized Consumption – Metered (BACM)

All municipalities provided at least partial data with respect to BACM[6]. The information provided ranged from complete billing databases to a single figure identified as the annual volume of water sold.

With respect to establishing the water balances, errors introduced into the value of BACM may include the following:

- ✓ Meter Accuracy,
- ✓ Data Handling,
- ✓ Estimated Readings, and
- ✓ Meter Lag Times

Meter accuracy and data handling errors are specifically addressed within the framework of the IWA Standard Water Balance and therefore are not evaluated with respect to the defining confidence in the value of BACM.

Estimated readings and meter lag times may be used to indicate confidence in the value of BACM. The percentage of estimated reads reported by the AMs ranged from none (or, at least, no data was provided) to 16.4 % in St. Catharines. Municipal methods for estimating ranged from using the previous month, an average of the previous six months, or even doubling the previous bill (to get the customer's attention). It is impossible to quantify or address errors due to estimated reads without copies of the billing database.

Meter lag times introduce a difference between *when* water is consumed and *when* it is billed. As an example, in an analysis of the Niagara Falls billing approximately 7.6 % of billing in 2004 relates to water consumed prior to the start of the year, and similarly, 7.3 % of 2004's consumption is derived based on meter readings recorded in 2005 (assuming that water is consumed equally throughout the period between meter readings). On an annual basis, it is often assumed these values will counter balance each other. Where possible, based on the datasets provided, meter lag times were addressed.

surrounding this meter account for N-O-T-L reporting more water sold within the municipality than purchased from Region.

[6] Billing data for Welland contained a limited number of accounts (~530). Much of Welland remains un-metered and customers are billed a flat rate. There was not deemed enough data to complete a water balance for Welland.

**Table 3**
**Summary of Data Collected by PIFastCalc Input Parameters**

| Input Parameters for PIFastCalc (refer to Appendix A for Definition of Terminology) | | Fort Erie | Grimsby | Lincoln | Niagara Falls | N-O-T-L | Pelham | Port Colborne | St. Catharines | Thorold | Wainfleet | Welland | West Lincoln |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WOS | Volume from Own Sources | **All water supplied via the Regional Municipality of Niagara** | | | | | | | | | | | |
| **WI** | **Water Imported** | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| **BACE** | **Billed, Authorized Consumption Exported** | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| **Assessed marginal cost of RL** | | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| BACM | Billed, Authorized Consumption Metered | √ | √ | √ | ‘04 | P | P | √ | ‘04 | P | | | √ |
| BACU | Billed, Authorized Consumption Un-metered | - | √ | | | | | | | | | | - |
| UACM | Unbilled, Authorized Consumption Metered | | | | | | | | | | | | |
| UACU | Unbilled, Authorized Consumption Un-metered | √ | √ | | | | | √ | | | | | |
| UC | Unauthorized Consumption | √ | √ | | | | | √ | | - | | | √ |
| ALMUR | Apparent Loss – meter under-registration | | √ | | | √ | | √ | | | | | |
| ALDCD | Apparent Loss – customer meter data handling errors | | | | | | | | | | | | |
| Lm | Mains Length | √ | √ | √ | √ | √ | √ | √ | √ | √ | | √ | √ |
| Nh | Number of Hydrants | √ | √ | √ | √ | √ | √ | √ | √ | ? | | | √ |
| Nb | Number of Separately Billed Properties | √ | √ | √ | √ | √ | √ | √ | √ | √ | | √ | √ |
| R | Ratio of billed Service Connections to Billed Properties | | | | | | | | | | | | |
| Nu | Number of Unbilled Service Connections | √ | | | | | √ | | | √ | | | √ |
| Lp | Average pipe length, property line to billing meter | √ | √ | | √ | √ | | | √ | √ | | | √ |
| P | Average pressure when system pressurized | √ | √ | | √ | √ | | √ | √ | | | | √ |
| Retail Cost / $m^3$ (excluding base rate) | Assessed marginal cost of UACM | √ | √ | | | | √ | √ | | √ | | | |
| | Assessed marginal cost of UACU | | | | | | | | | | | | |
| | Assessed marginal cost of UC | | | | | | | | | | | | |
| | Assessed marginal cost of ALMUR | | | | | | | | | | | | |
| | Assessed marginal cost of ALDCD | | | | | | | | | | | | |
| Costs of Running system over period (excluding capital projects) | | | √ | √ | | √ | | | | √ | | √ | √ |

### 3.3.0 Billed, Authorized Consumption – Un-metered (BACU)

With the exception of identifying 179 flat rate customers in one specific municipality no details were provided with respect to what the flat rate was or what the estimated consumption was equal to. The remaining AMs provided no details regarding the volume of BACU. There are several flat rate customers in Welland.

### 3.4.0 Unbilled, Authorized Consumption – Metered (UACM)

The Town of Grimsby identified street sweeping and sewer flushing as components of UACM. Assumedly the town provides a mobile hydrant meter but does not invoice the contractors who would be working for the Town.

### 3.5.0 Unbilled, Authorized Consumption – Unmetered (UACU)

Identified sources of Unbilled, Authorized Consumption – Unmetered primarily relate to hydrant usage for the following:

- ✓ Water Main Construction and Repairs (e.g. dewatering & flushing),
- ✓ Water Service Repairs,
- ✓ Fire Fighting & Training, and
- ✓ Street Cleaning & Sewer Flushing (i.e., re-filling equipment)

Figure 3 illustrates calculated estimates provided by Grimsby.

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| Hydrant Usage (mobile meter) | | | 2.12 | | 2.12 | R = Based on recordings, less Avertex |
| New Construction/Rehab | | | | 2.45 | 2.45 | E = estimated; 6 jobs x 3/job x 500 gpm x 1 hr. |
| Fire/Training | | | | 13.64 | 13.64 | E = estimated; 1 fire/yr. 2,000 Imp. Gal; Training 68 hrs/yr @ 1,000 gpm = 3,000,000 Imp. Gal |
| Hydrant Flushing | | | | 18.18 | 18.18 | E = estimated; dead-end 20 locations x 6/yr. x 3,000 Imp Gal + 3,000,000 Imp. Gal |
| Hydroguard | | | | 2.95 | 2.95 | E = estimated; 20 gpm x 6-4 hrs./day (50% of this in winter) |
| Recreation | | | | 0.47 | 0.47 | E = estimated; 3 parks approx. 6 gpm x 2 hrs/day x 5 months |

**Figure 3: Portion of the "Consumption" worksheet extracted from Grimsby's Balance**

Table 4 on the following page illustrates that Grimsby and Port Colborne provided breakdowns of their estimates that equate to 1.17% and 6.7 % of Water Supply, respectively. Thorold, Niagara-on-the-Lake, and Fort Erie identified relevant sources of UACU in their system and the latter provided an overall estimate equal to 5 % of Water Supply. The default estimate in PIFastCalcs is equal to 1.25% of Water Supplied.
In the absence of estimates made by the municipality themselves the balances accept the default estimate. The 95 % confidence limits of +/- 100 % and process reliability band of "D" highlight the uncertainty with regards to this component.

### 3.6.0 Unauthorized Consumption (UC)

Common components of unauthorized consumption are by-pass tampering, unauthorized use of fire services, and unauthorized use of hydrants.

The default estimate in PIFastCalcs is equal to 0.25 % of Water Supply (+/- 100%). Both Grimsby and Fort Erie estimated 1 % whereas West Lincoln estimated 0.02 %. Port

Colborne suggests approximately 5 household per year tamper with the meter by-pass but did not estimate the amount of loss. In the absence of a provided estimate the default value is accepted.

**Table 4**
**Summary of Data Collected Pertaining to UACU**

| | Estimates in ML/year<br>√ indicates the AM recognizes this as a use but did not provide an estimate | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fort Erie | Grimsby | Lincoln | Niagara Falls | N-O-T-L | Pelham | Port Colborne | St. Catharine | Thorold | West Lincoln |
| Water Main Construction & Repairs | | 7.8 | | | | | 1.8 | | | |
| Water Service Repairs | | | | | | | 94.2 | | | |
| Water Quality | √ | | | | | | 86.4 | | √ | |
| Hydrant Flushing | √ | 18.4 | | | | | 13.1 | | | |
| Blow-offs | | | | | √ | | | | √ | |
| Fire Fighting / Training | √ | 13.6 | | | √ | | 44.4 | | √ | |
| Sewer Flushing | √ | | | | | | 14.6 | | √ | |
| Street Cleaning | √ | | | | | | | | √ | |
| Recreation | | 0.6 | | | | | 6.4 | | | |
| TOTAL | 197 | 40.4 | - | - | - | | 260.9 | - | - | - |

### 3.7.0 Apparent Losses – Meter Under-Registration (ALMUR)

As meters deteriorate with age and usage they are more likely to under-register water use. Because of the relative small number of meter accuracy reports provided an aggregated analysis of the tests provided by Grimsby, Niagara-on-the-Lake, and Port Colborne (Appendix C) was completed. The results of this analysis are summarized below.

**Table 5**
**Calculated Values of Meter Under-Registration & 95% Confidence Limits**

| | % Under Registration | 95 % Confidence Limits |
|---|---|---|
| **Meters < 1"** | 0.5 | 7 |
| **Meters > 1"** | 1.0 | 7 |

Most municipalities provided a breakdown of consumption based on accounts for which meters are read based on cycles (e.g., 3 or 4 times per year) and those that are read monthly. In these cases the former group was associated with meters smaller than one inch and the latter with meters larger than one inch. If no breakdown was provided a 70/30 ratio was estimated and an overall value of 0.6% under-registration was assumed (with 95% confidence limits equal to +/- 7 %).

### 3.8.0 Apparent Losses – Customer Data Handling (ALDCD)

Across the Region, numerous methods are employed to retrieve and manage meter readings. Meter reads are collected using customer reading cards, physical meter reads, roll dial remotes, touchpads, and radio-reads. Billing software packages include: Easyroute, USTI Water System, Vadium, Vailtech, and AS400. Niagara Falls maintains a customized database.

Sources of customer data handling errors are numerous and may collectively introduce significant error. Specifically, examples of the data handling errors which were identified included:

- ✓ In Niagara Falls approximately 2% of records in the raw database were duplicates.
- ✓ In Grimsby the summary spreadsheets of 2004 and 2005 contained inconsistent data pertaining to periods where meter reads bridged the calendar year; representing a potential error of approximately 1%.
- ✓ In West Lincoln the original data submitted mismatched data billed monthly in 2004 with data billed quarterly in 2005. The 2005 summary provided included regional billing data from 2004.
- ✓ Simple errors in arithmetic or difference in numbers, depending on the source used

These examples are of errors that have been identified and corrected within the balance but undoubtedly there are errors that remain undetected – either because they are inherent in the data provided or because not all the data was provided

### 3.9.0 Length of Water Mains (Lm)

The total length of water mains in the reporting AMs is equal to approximately 2,000 kilometers.

Age and material are not specifically required in the water balance. Nonetheless most municipalities provided data on materials and Figure 4 provides an overall breakdown of the mains across the Region.

It is assumed that the inventory of water mains is most likely accurate to within +/- 2 %.

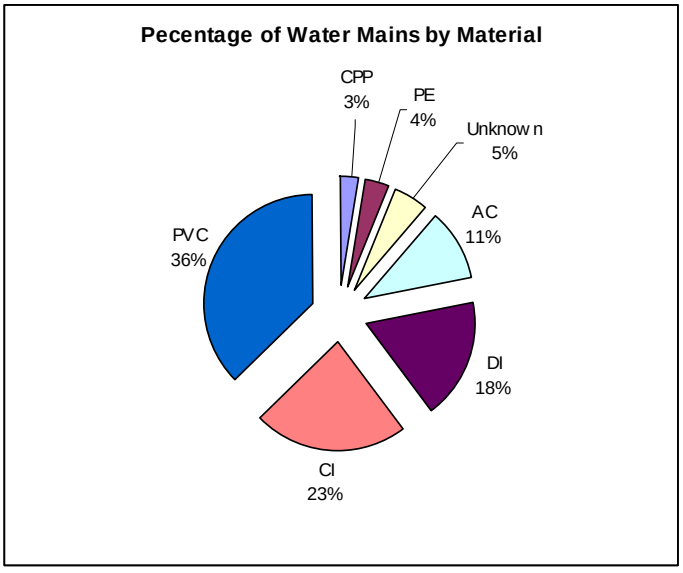



**Figure No. 4 – Water Main Materials**

Some inaccuracies may be as a result of some AM including Regional water mains while others may not. Additionally, databases may be out of date with regards to new construction.

### 3.10.0 Number of Hydrants (Nh)

There are approximately 10,500 hydrants in total. All of the AMs provided this data.

### 3.11.0 Number of Separately Billed Properties (Nb)

PIFastCalc uses two values, the Number of Separately Billed Properties and the Ratio of Service Connections to Billed Properties (R) to calculate the Number of Billed Service Connections (Ns). Most AMs provided the number of billed services directly and a ratio of 1:1 is used. The total number of separately billed properties is equal to 113,228 – equivalent to the number of meters.

### 3.12.0 Number of Unbilled Service Connections (Nu)

Unbilled service connections may include the following:

- ✓ Fire connections, and
- ✓ Un-metered municipal connections

Most AM did not provide any data with regards to the number of unbilled service connections. Table 6 summarizes the data that was provided.

**Table 6**
**Summary of Reported Unbilled Service Connections**

| Area Municipality | Number of Unbilled Service Connections (Nu) |
|---|---|
| Fort Erie | 100 |
| Port Colborne | 28 |
| Thorold | 25 |
| West Lincoln | 6 |

### 3.13.0 Average Pipe Length – Property Line to Meter (Lp)

Private service pipe length is an important consideration in the calculation of the performance indicators assessing real losses. This is because it is generally accepted that the majority of leaks occur on service connections. Table 7 summarizes the reported data.

**Table 7**
**Summary of Reported Lengths (in meters) – Property Line to Meter (Lp)**

| Area Municipality | Lp | Area Municipality | Lp |
|---|---|---|---|
| Fort Erie | 10 | St. Catharines | 7 |
| Grimsby | 10 | Thorold | 10 |
| Niagara Falls | 18 | West Lincoln | 9 |
| N-O-T-L | 8.5 | | |

### 3.14.0 Average System Pressure (P)

The average system pressure entered in PIFastCalc should be a weighted average determined, for example, based on a list of static hydrant pressures many AM record during hydrant inspections. Table 8 summarizes the data provided which in some cases was simply a range of pressures.

**Table 8**
**Summary of Reported Pressures (in PSI)**

| | Pressure(s) |
|---|---|
| Fort Erie | 75 |
| Grimsby | 75 |
| Lincoln | - |
| Port Colborne | 58 |
| Niagara Falls | 94 |
| Niagara-on-the-Lake | |
| *Zone 1* | 44 – 69 |
| *Zone 2* | 56 – 97 |
| *Zone 3* | 45 – 102 |
| *Zone 4* | 66 – 92 |
| St. Catharines | |
| *Zone 1* | 50 – 100 |
| *Zones 2 & 3* | 50 – 80 |
| Thorold | 62 |
| West Lincoln | 62 |

### 3.15.0 Assessed Marginal Costs

Within PIFastCalc several marginal costs are used to attempt to more accurately reflect the actual costs of various components of NRW.

Unbilled, authorized consumption is typically valued at the cost which the AM purchases the water from the Region. Justification of this is that the AM, by not billing the customer, is assuming the costs. The costs of apparent losses is equal to the rate which the AM charges customers because this water is in fact being consumed by customers (sewer surcharges may also be applicable). Unauthorized consumption such as theft may be valued at a rate equal to the retail costs of water without the applicable sewer

surcharge. Real losses are valued at the wholesale costs of water because this water is not consumed or used by anyone – eliminating the real losses eliminates the demand!

Many AM may have never considered assessed marginal costs based on the components of the IWA Water Audit and therefore could not identify costs according to this breakdown.

### 3.15.1 Assessed Marginal Costs of UACM

The rate(s) at which the individual AMs re-sell water vary. If base rates apply it may be difficult to directly distinguish the marginal costs of UACM. Table 9 summarizes the data collected.

**Table 9**
**Summary of Reported Water Rates**

| | Rate(s) |
|---|---|
| Grimsby | $0.73/m$^3$ |
| Port Colborne | $0.756/m$^3$ |
| Thorold | $47.76 for the first 27 m$^3$ ($1.769/m$^3$) |
| | $0.742/m$^3$ in excess |
| West Lincoln | $1.109/m$^3$ |

### 3.15.2 Assessed Marginal Costs of UACU

In most cases the assessed marginal cost of unbilled, authorized consumption will be the same regardless of whether it is metered or un-metered. Possible exceptions may include considerations of sewer surcharges related to water consumption.

### 3.15.3 Assessed Marginal Costs of UC

No data.

### 3.15.4 Assessed Marginal Costs of ULMUR

No data.

### 3.15.5 Assessed Marginal Costs of ALDCD

No data.

### 3.15.6 Assessed Marginal Costs of RL

The assessed marginal cost of real losses is equal to the wholesale water rate at which the AM purchase water from the Region. This rate was equal to $0.40/m$^3$ and $0.446/m$^3$ in 2004 and 2005, respectively.

### 3.16.0 Costs of Running the System Over the Period of the Balance

The costs of running the system should be determined based on the operational costs plus the internal manpower costs minus the capitalized costs of self-constructed assets. Reported costs are summarized in Table 10 on the following page.

**Table 10**
**Summary of Reported Costs ($) of Running Water System(s)**

| | Reported Costs |
|---|---|
| Grimsby | $3,166,740 |
| Lincoln | $3,505,747 |
| Thorold | $2,648,400 |
| West Lincoln | $ 372,750 |

## 4.0 RESULTS: PHASE II – WATER BALANCES

The following sections highlight the results of the individual water balances included in Appendices F through O.

### 4.1.0 Financial Performance Indicators

#### 4.1.1 Non-Revenue Water as a Percentage of System Input Volume

Percentage of Non-Revenue Water by Volume is considered a "Basic Level" Financial Performance Indicator. NRW may be particularly misleading with regards to comparing one system to another.

Region wide the combined volume of BACM reported accounts for approximately 85% of the water purchased from the region by the reporting area municipalities. Individually the percentage of NRW within the area municipalities ranges from -1.3 % to 36.8 %.

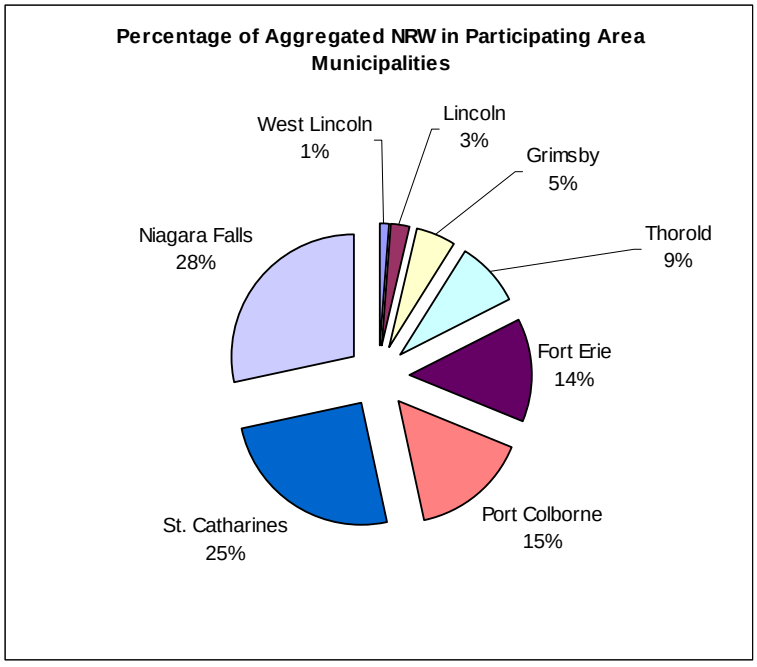



**Figure 5: Percentage of Aggregated NRW in Participating Area Municipalities**

Figure 6 illustrates the values of NRW in each area municipality. Confidence intervals are derived based on the confidence attributed to both the Region's billing and the billing meters. The negative value calculated for Niagara-on-the-Lake may be accounted-for in part due to meter error discussed on page 5 of this report.

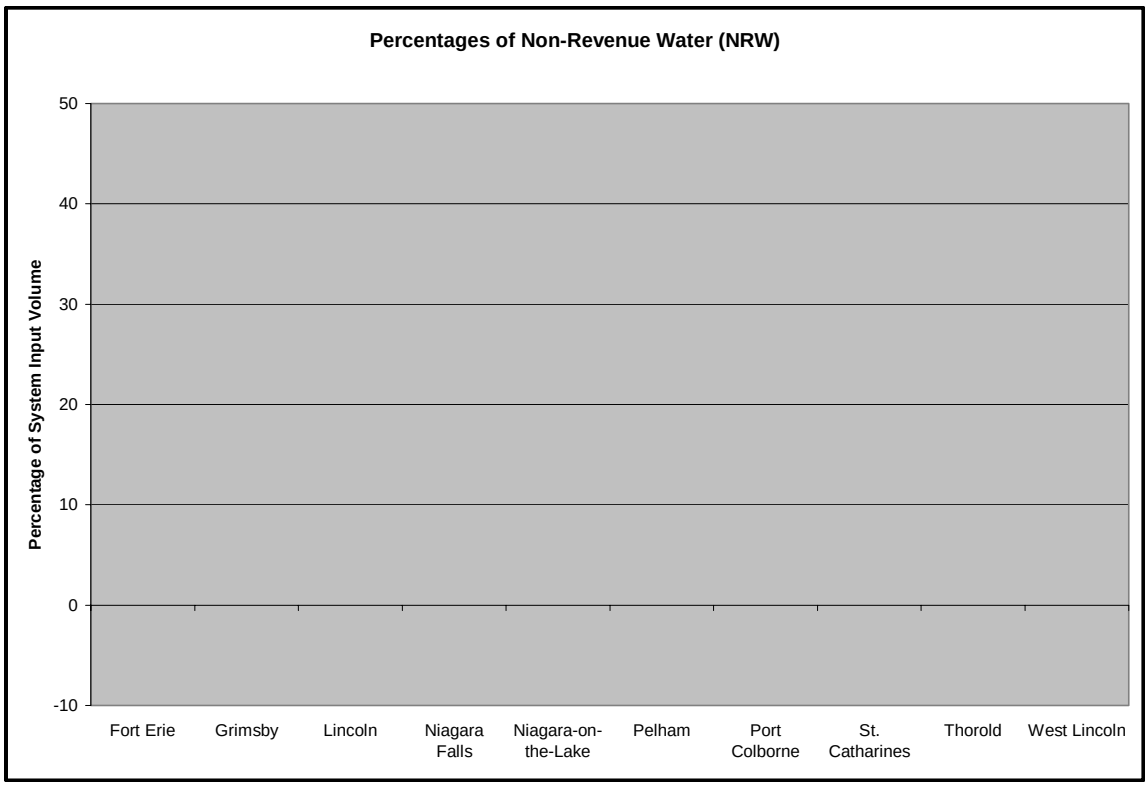
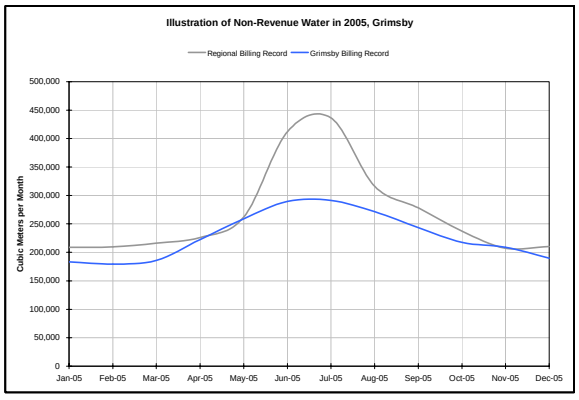
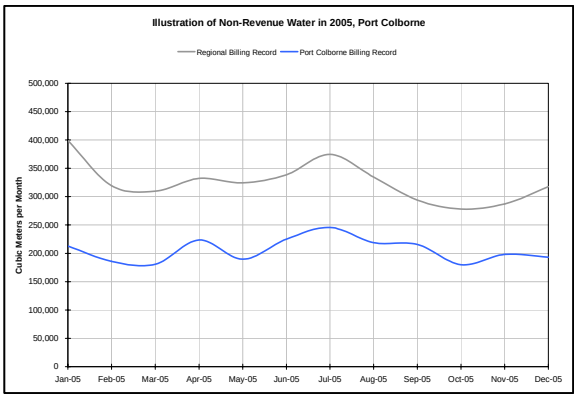



**Figure 6: Non – Revenue Water as a Percentage of System Input Volume**

Insofar as trends in NRW may be more telling than an annual volume, a monthly analysis was completed for those municipalities that provided sufficient data (Appendix D). Figures 7a & 7b illustrate two examples of monthly variations in NRW which suggest different potential causes.




**Figures 7a & b – Trends in Non-Revenue Based on Monthly Volumes Purchased & BACM**

Figure 7a (Grimsby) suggests excessive unbilled water use in the summer period accounting for approximately 5 % of Water Supplied annually. Use of estimated reads, based on average annual consumption, may also account for Grimsby's trend. Figure 7b (Port Colborne) suggests unbilled water use underlying billed consumption throughout the year. This underlying water use may be attributable to several factors including leakage.

### 4.1.2 Non-Revenue Water as % of System Input by Value

As identified any Section 3.16 of this report many municipalities did not provide the costs of running the system during the period of the balance. Table 11 summarizes the results.

**Table 11**
**Non-Revenue Water as % of System Input by Value**

| | % of Non-Revenue Water as % of System Input by Value |
|---|---|
| Fort Erie | 8.4 % (+/- 25.2 %) |
| Grimsby | 3.6 % (+/- 35.6 %) |
| Lincoln | 14.7 % (+/- 12.8 %) |
| Thorold | 13.1 % (+/- 25.0 %) |

## 4.2.0 Operational Performance Indicators

### 4.2.1 Apparent Losses as a % of Water Supply

The recommended Performance Indicator for Apparent Losses is the % of Apparent Losses relative to Water Supply. Apparent losses include meter under-registration, errors in customer data handling, and unauthorized consumption. The values calculated for each of the municipalities are identified below.

**Table 12**
**Summary of Apparent Losses by Area Municipality**

| | % of Apparent Losses | 95 % Confidence Limits |
|---|---|---|
| Fort Erie | 1.4 | 35.1% |
| Grimsby | 2.1 | 36.6% |
| Lincoln | 0.8 | 31.9% |
| Niagara Falls | 0.7 | 36.6% |
| Niagara-on-the-Lake | 0.9 | 30.0% |
| Pelham | 0.8 | 33.6% |
| Port Colborne | 0.7 | 18.7% |
| St. Catharines | 0.8 | 33.5% |
| Thorold | 0.7 | 34.1% |
| West Lincoln | 0.6 | 6.0% |

Differences in apparent losses primarily reflect the estimated percentages of unauthorized consumption (page 9). Values of meter-under registration were assumed equal in all the

municipalities and no municipalities provided any estimates regarding data handling errors. Therefore, because Fort Erie and Grimsby estimated unauthorized consumption to be higher than the default value their apparent losses are greater.

### 4.2.2 Current Annual Real Losses in litres/service connection/day

Figure 8a illustrates the Current Annual Real Losses (CARL) in each of the area municipalities. CARL are calculated by subtracting authorized consumption and apparent losses from the total volume of water supplied. The recommended Performance Indicator for Real Losses (Figure 8b) expresses the value of CARL in litres/service connection/day, when the system is pressurized[7].

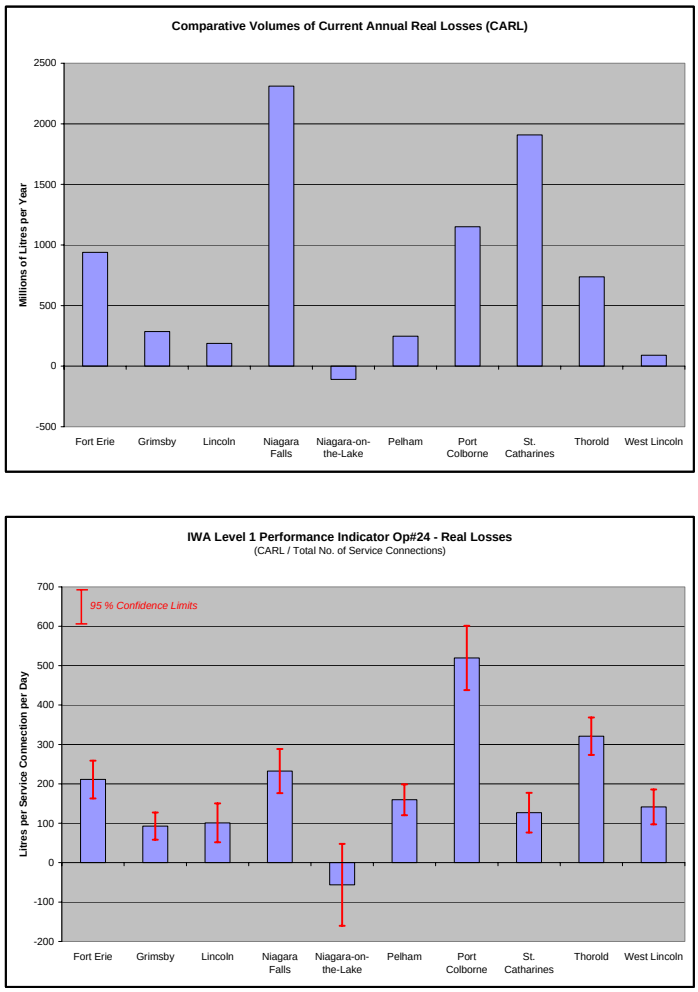



**Figure 8a & b: Comparative, calculated values of Current Annual Real Losses expressed in (a) ML/yr, and (b) litres/service connection/day when pressurized**

As illustrated in Figures 8a and b the volume of real losses in itself may be misleading in comparing area municipalities because it fails to account for the relative size of the

[7] In the case of all these audits the systems are pressurized 100% of the time.

distribution systems. By expressing losses in terms of litres/connection per day when the system is pressurized the volume of losses is put into context. Nonetheless the expression of CARL in these terms is considered a Level 1 (or basic) performance indicator because it does not account for differences in system pressure which significantly influence water losses due to leakage.

### 4.2.3 Infrastructure Leakage Index (ILI)

The advanced (Level 3) operational performance indicator for real losses is the Infrastructure Leakage Index (ILI). The ILI is a ratio of the CARL to Unavoidable Annual Real Losses.

**Unavoidable Annual Real Losses (UARL)**

Some "measure" of water loss due to leakage is unavoidable in all water distribution systems. Background leakage, including small leaks and weeps, is unavoidable in that individual sources are either undetectable and/or the cost-to-benefit does not justify repair/replacement. In addition there are unavoidable losses due to reported/unreported leakage. These losses relate to the time between when leak(s) occurs and is repaired.

Unavoidable losses are controllable through various best-management-practices (e.g., speed and quality of repairs, active leakage control). The calculated values of UARL assume best-management-practices. Appendix E provides a summary of the component analysis for calculating UARL.

Based on the assumptions described in Appendix E, the value of UARL in each area municipality is calculated based on the following:

- total length of water mains
- total number of service connections
- total length of customer supply pipe, and
- the average system pressure

Figure 9, on the following page, illustrates the components of CARL in each of the area municipalities. Potentially recoverable losses represent the difference between CARL and UARL.

The Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure[8].

[8] The ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management.

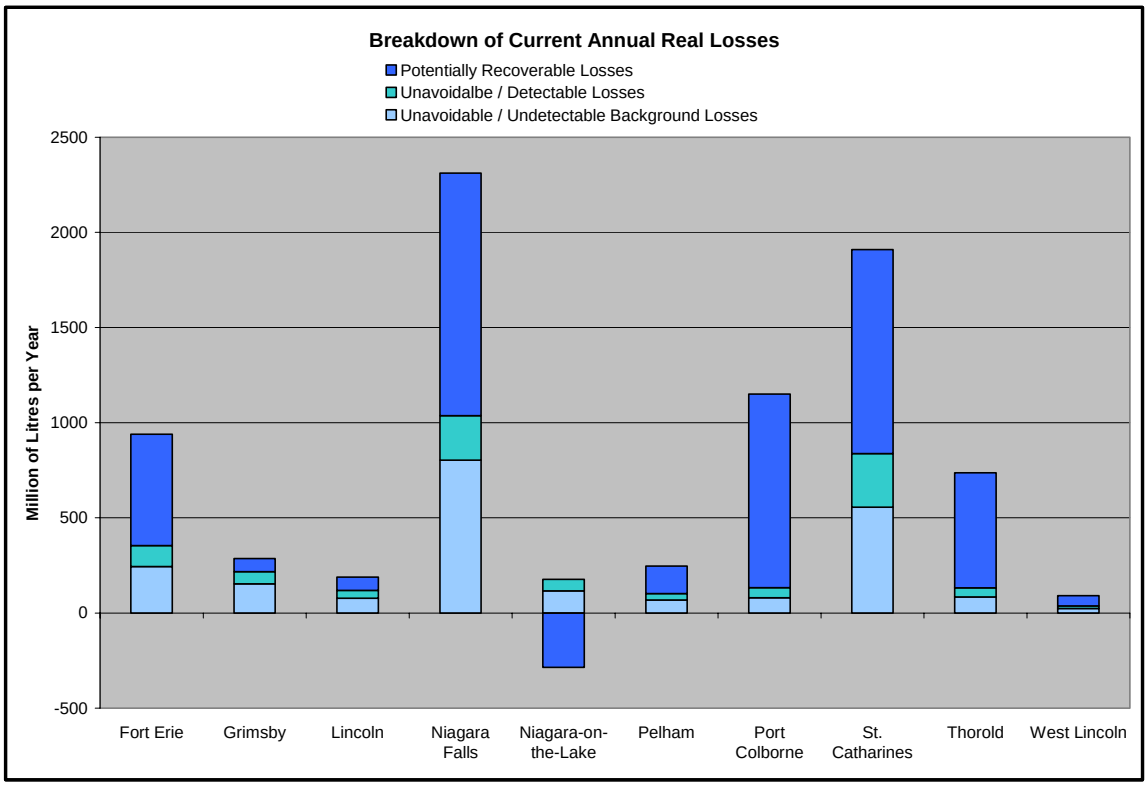



**Figure 9: Illustration of the components making up the Current Annual Real Losses (CARL)**

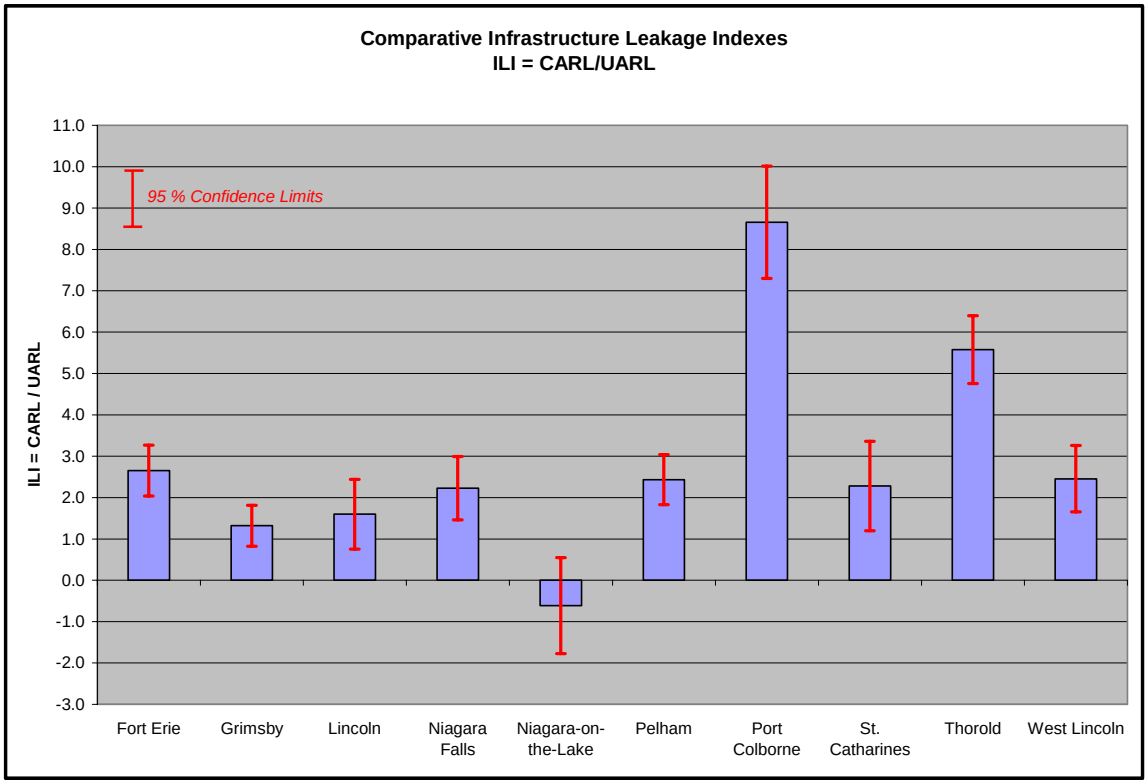



**Figure 10: Illustration of Calculated ILI for each area municipality**

An ILI equal to 2, for example, suggest Current Annual Real Losses (CARL) are two-times greater than the Unavoidable Annual Real Losses (UARL) if best-management-practices were followed. Figure 10 on the preceding page illustrates the calculated ILIs of each of the participating area municipalities.

Based on the calculated ILIs and on the guidelines provided by both the World Bank Institute and the AWWA the following section provides some general discussion of the real losses in the area municipalities.

## 5.0 DISCUSSION

### 5.1.0 World Bank Institute Target Matrix / Banding

PIFastCalc identifies where the calculated ILI fits into a target matrix developed by the World Bank Institute and incorporated into its NRW training modules. These guidelines are included in the individual reports in Appendices F through O and summarized in the following table. In the WBI's target matrix, general descriptions are made which describe a system's performance in real loss management based on its calculated ILI.

**Table 13**
**General Description of Real Loss Management Performance**

| ILI Range | Band | Area Municipality | ILI | General description of Real Loss Management Performance |
|---|---|---|---|---|
| < 2 | A | Niagara-on-the-Lake | -0.6 | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| | | Grimsby | 1.3 | |
| | | Lincoln | 1.6 | |
| 2 to 4 | B | Niagara Falls | 2.2 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| | | St. Catharines | 2.3 | |
| | | Pelham | 2.4 | |
| | | West Lincoln | 2.5 | |
| | | Fort Erie | 2.7 | |
| 4 to 8 | C | Thorold | 5.6 | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| >8 | D | Port Colborne | 8.7 | Very inefficient use of resources; leakage reduction programs imperative and high priority |

### 5.2.0 AWWA General Guidelines

Table 14, on the following page, summarizes the general guidelines developed by AWWA's Water Loss Committee which again categorize system based on the calculated ILI.

**Table 14**
**AWWA General Guidelines Pertaining to Infrastructure Leakage Index**

| ILI Range | Band | Area Municipality | ILI | Water Resource Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|---|---|
| < 2 | A | Niagara-on-the-Lake | -0.6 | Available resources are greatly limited and are very difficult / environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| | | Grimsby | 1.3 | | | |
| | | Lincoln | 1.6 | | | |
| 2 to 4 | B | Niagara Falls | 2.2 | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| | | St. Catharines | 2.3 | | | |
| | | Pelham | 2.4 | | | |
| | | West Lincoln | 2.5 | | | |
| | | Fort Erie | 2.7 | | | |
| 4 to 8 | C | Thorold | 5.6 | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| >8 | D | Port Colborne | 8.7 | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than as an incremental goal to a smaller long-term target – is discouraged | | |

## 6.0 RECOMMENDATIONS

The water balances have been completed based on the data provided. In all cases it is advisable to update and complete the data.

With regards to managing real losses (leakage and overflows from systems up to the point of customer metering or consumption) best management practices recognize the following:

- ✓ Pressure Management
- ✓ Speed and Quality of Repairs
- ✓ Active Leakage Control, and
- ✓ Pipeline and Assets Management

PIFastCalc's recommendations are based on the World Bank Institute's ILI Bands. Individual municipalities are grouped in these bands in Tables 13 and 14. Table 15 is reproduced from the ILI Guidelines worksheet within the software.

**Table 15**
**WBI Recommendations**

| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

# Appendix A

# IWA Water Balance Terminology

| | |
|---|---|
| **Volume from Own Sources:** | The volume of water input to a system from the Water Supplier's own sources |
| **Water Imported or Exported:** | The volume(s) of bulk transfers across operational boundaries |
| **System Input Volume:** | The volume input to that part of the water supply system to which the water balance calculation relates, corrected for known errors. Equal to VOLUME FROM OWN SOURCES plus WATER IMPORTED |
| **Water Supplied:** | Equal to the SYSTEM INPUT VOLUME minus WATER EXPORTED |
| **Authorized Consumption:** | Volume of metered and/or un-metered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial and industrial purposes. Authorized consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or un-metered. |
| **Water Losses:** | The difference between SYSTEM INPUT and AUTHORISED CONSUMPTION. Water losses can be considered as a total volume for the whole system, or for partial systems such as raw water mains, transmission or distribution systems, or individual zones. In the above definition of Water Losses, 'Authorized Consumption' includes bulk exports of water across operational boundaries. When doing the Water Balance calculation, a convenient alternative method of calculating Water Losses is 'Water Supplied - (Authorized Consumption - Water Exported)' |
| **Apparent Losses:** | Includes all types of inaccuracies associated with customer metering, plus unauthorized consumption (theft or illegal use). Over-registration of customer meters, leads to under-estimation of REAL LOSSES. Under-registration of customer meters, leads to over-estimation of REAL LOSSES. |
| **Real Losses:** | Physical water losses from the pressurized system, up to the point of measurement of customer use. The annual volume lost through all types of leaks, breaks and overflows depends on frequencies, flow rates, and average duration of individual leaks, breaks and overflows. Although physical losses after the point of customer flow measurement or assumed consumption are excluded from the assessment of REAL LOSSES, |

| | |
|---|---|
| | this does not necessarily mean that they are not significant or worthy of attention for demand management purposes. |
| **Revenue Water:** | Those components of SYSTEM INPUT which are billed and produce revenue (also known as BILLED AUTHORISED CONSUMPTION). Equal to BILLED WATER EXPORTED, BILLED METERED CONSUMPTION and BILLED UNMETERED CONSUMPTION |
| **Non- Revenue Water:** | Those components of SYSTEM INPUT which are not billed and do not produce revenue. Equal to UNBILLED AUTHORISED CONSUMPTION, APPARENT LOSSES and REAL LOSSES |
| **Unbilled, Authorized Consumption:** | Those components of AUTHORISED CONSUMPTION which are not billed and do not produce revenue. Equal to UNBILLED METERED CONSUMPTION and UNBILLED UNMETERED CONSUMPTION |

# Appendix B

# Supply Meter Accuracy Test Reports

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301678 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/24/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** PARK ROAD @ MUD STREET
**Acct No** METER #15
**Occupant** AREA #3
**Contact** PAUL COLEMAN 905-684-5353
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 4" W-1000
**Reg Unit** D/R 1M3
**Serial No** 1243994

**Location** MODULE TESTED IN-SHOP
**Test Fittings** MODULE EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 932213 | 932222 |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 500 GPM | 4110.00 | 4105.00 | 0.00 | 4105.00 | 99.88 |
| 150 GPM | 2004.50 | 2020.00 | 0.00 | 2020.00 | 100.77 |
| 50 GPM | 1010.00 | 1020.00 | 0.00 | 1020.00 | 100.99 |
| 10 GPM | 1010.00 | 980.00 | 0.00 | 980.00 | 97.03 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: $247.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301743 **Old P.O.** 303511 **Invoice No** 28793 **REGNIA** ***Service Date*** 5/4/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Service Provided By:** S. PATE / D. JONES

**Job Address** BEVAN HEIGHTS
**Acct No** METER #3
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Meter Mfg** INVENSYS
**Size Type** 6" F/S
**Reg Unit** ECR 5M3
**Serial No** 16436770

**Location** CORNER OF BEVAN & MELROSE
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☑
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**Mtr Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 000825 | 000834 |
| LF OUT | | |
| LF IN | 056290 | 256296 |

**Static PSI** 100 **Residual PSI** 20 **At** 200 **Rate Of Flow** 8 **At** 12:00 PM

### TEST RESULTS

| As Found | | | | | | After Service | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R.O.F. | QTY | HIGH | LOW | TOTAL | % | R.O.F. | QTY | HIGH | LOW | TOTAL | % |
| 8 GPM | 1000.00 | 0.00 | 1010.00 | 1010.00 | 101.00 | 8 GPM | 1000.00 | 0.00 | 1010.00 | 1010.00 | 101.00 |
| 200 GPM | 3000.00 | 2049.00 | 780.00 | 2829.00 | 94.30 | 200 GPM | 3000.00 | 2140.00 | 830.00 | 2970.00 | 99.00 |
| 100 GPM | 1000.00 | 431.00 | 535.00 | 966.00 | 96.60 | 100 GPM | 1000.00 | 485.00 | 520.00 | 1005.00 | 100.50 |
| 60 GPM | 1000.00 | 200.00 | 760.00 | 960.00 | 96.00 | 60 GPM | 1000.00 | 240.00 | 725.00 | 965.00 | 96.50 |

**Meter Runs At Min. Flow** ☑ **Meter Runs At Min. Flow** ☑

**Comments** PRETESTED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C703 FOR FIRE SERVICE TYPE METERS.

SERVICING: $420.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 303511 **Old P.O.** 303511 **Invoice No** 29175 **REGNIA** ***Service Date*** 10/13/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** BEVAN HEIGHTS
**Acct No** METER #3
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** PARSONS / OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 6" F/S
**Reg Unit** ECR 5M3
**Serial No** 16436770

**Location** CORNER OF BEVAN & MELROSE
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☑
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**'r Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 001065 | 001070 |
| LF OUT | | |
| LF IN | 073001 | 073004 |

**Static PSI** 100 **Residual PSI** 20 **At** 443 **Rate Of Flow** 40 **At** 1:15 PM

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| .51 LPS | 1000.40 | 0.00 | 1010.00 | 1010.00 | 100.96 |
| 28 LPS | 4210.00 | 3560.00 | 600.00 | 4160.00 | 98.81 |
| 12.6 LPS | 2007.00 | 1400.00 | 590.00 | 1990.00 | 99.15 |
| 2.8 LPS | 1003.00 | 40.00 | 960.00 | 1000.00 | 99.70 |

**Meter Runs At Min. Flow** ☑

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN SPECIFICATIONS,

SERVICING: $420.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301743 **Old P.O.** 303511 **Invoice No** 28793 **REGNIA** ***Service Date*** 5/4/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** PORT ROBINSON TRANSFER STATION
**Acct No** METER #2
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** S. PATE / D. JONES

**Meter Mfg** INVENSYS
**Size Type** 6" F/S
**Reg Unit** HSPU 1M3
**Serial No** 1413619

**Location** 1795 THOROLD TOWN LINE
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☑
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**Mtr Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 061815 | 061825 |
| LF OUT | | |
| LF IN | 20612.3 | 20615.0 |

**Static PSI** 100 **Residual PSI** 30 **At** 450 **Rate Of Flow** 40 **At** 5:30 PM

### TEST RESULTS

| As Found | | | | | | After Service | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R.O.F. | QTY | HIGH | LOW | TOTAL | % | R.O.F. | QTY | HIGH | LOW | TOTAL | % |
| 8 GPM | 100.00 | 0.00 | 100.50 | 100.50 | 100.50 | | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| 450 GPM | 5000.00 | 4415.00 | 638.00 | 5053.00 | 101.06 | | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| 200 GPM | 3000.00 | 2220.00 | 798.00 | 3018.00 | 100.60 | | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| 55 GPM | 1000.00 | 275.00 | 695.00 | 970.00 | 97.00 | | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☑ **Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C703 FOR FIRE SERVICE TYPE METERS.

SERVICING: $420.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 303511 **Old P.O.** 303511 **Invoice No** 29175 REGNIA ***Service Date*** 10/13/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** PORT ROBINSON TRANSFER STATION
**Acct No** METER #2
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** PARSONS / OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 6" F/S
**Reg Unit** HSPU 1M3
**Serial No** 1413619

**Location** 1795 THOROLD TOWN LINE
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☑
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**r Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 072485 | 72491 |
| LF OUT | | |
| LF IN | 17476.1 | 17478.7 |

**Static PSI** 100 **Residual PSI** 25 **At** 570 **Rate Of Flow** 65 **At** 11:15 PM

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| .32 LPS | 100.20 | 0.00 | 99.00 | 99.00 | 98.80 |
| 36 LPS | 5503.00 | 4875.00 | 642.50 | 5517.50 | 100.26 |
| 12.6 LPS | 2625.00 | 1875.00 | 780.50 | 2655.50 | 101.16 |
| 2.8 LPS | 1005.00 | 35.00 | 963.50 | 998.50 | 99.35 |

**Meter Runs At Min. Flow** ☑

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN SPECIFICATIONS.

SERVICING: $420.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301678 **Old P.O.** 303511 **Invoice No** 28793 **REGNIA** ***Service Date*** 5/4/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Service Provided By:** S. PATE / D. JONES

**Job Address** MEWBURN ROAD
**Acct No** METER #4
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Meter Mfg** INVENSYS
**Size Type** 4" SRH
**Reg Unit** ECR 5M3
**Serial No** 1502170

**Location** MEWBURN RD SOUTH OF QEW
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☑
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**Mtr Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 130104 | 130113 |
| LF OUT | | |
| LF IN | | |

**Static PSI** 100 **Residual PSI** 80 **At** 100 **Rate Of Flow** 30 **At** 2:30 PM

### TEST RESULTS

| As Found | | | | | | After Service | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| R.O.F. | QTY | HIGH | LOW | TOTAL | % | R.O.F. | QTY | HIGH | LOW | TOTAL | % |
| 4 GPM | 100.00 | 0.00 | 78.00 | 78.00 | 78.00 | 4 GPM | 100.00 | 0.00 | 101.00 | 101.00 | 101.00 |
| 100 GPM | 1000.00 | 101.00 | 0.00 | 101.00 | 10.10 | 100 GPM | 1000.00 | 1005.00 | 0.00 | 1005.00 | 100.50 |
| 50 GPM | 1000.00 | 1013.00 | 0.00 | 1013.00 | 101.30 | 50 GPM | 1000.00 | 1011.00 | 0.00 | 1011.00 | 101.10 |
| 24 GPM | 1000.00 | 98.00 | 0.00 | 98.00 | 9.80 | 24 GPM | 1000.00 | 982.00 | 0.00 | 982.00 | 98.20 |

**Meter Runs At Min. Flow** ☐ **Meter Runs At Min. Flow** ☑

**Comments** PRETESTED, REPAIRED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C702 FOR COMPOUND METERS. SMALL SIDE COORDINATOR GEAR CLUSTER WORN. REPLACED COORDINATOR.

PARTS AND REPAIR TIME TO BE INVOICED SEPARATE.

SERVICING: $394.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 303511 **Old P.O.** 303511 **Invoice No** 29175 **REGNIA** ***Service Date*** 10/13/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** MEWBURN ROAD
**Acct No** METER #4
**Occupant** AREA #1
**Contact** HERB MARACLE 905-295-4831
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** PARSONS / OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 4" SRH
**Reg Unit** ECR 5M3
**Serial No** 1502170

**Location** MEWBURN RD SOUTH OF QEW
**Test Fittings** 2" TEST PORT
**Chamber** Y
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☑
**Bypass Sealed On Arrival** ☑
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☑
**r Valves Sealed On Departure** ☑
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | 146765 | 146770 |
| HF IN | 146767 | 146770 |
| LF OUT | | |
| LF IN | | |

**Static PSI** 110 **Residual PSI** 100 **At** 100 **Rate Of Flow** 65 **At** 3:15 PM

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| .25 LPS | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6.3 LPS | 1000.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3.2 LPS | 1000.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.3 LPS | 1000.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| .25 LPS | 100.30 | 0.00 | 100.70 | 100.70 | 100.40 |
| 6.3 LPS | 1001.00 | 1000.00 | 0.00 | 1000.00 | 99.90 |
| 3.2 LPS | 1001.00 | 1010.00 | 0.00 | 1010.00 | 100.90 |
| 1.3 LPS | 1005.00 | 1010.00 | 0.00 | 1010.00 | 100.50 |

**Meter Runs At Min. Flow** ☑

**Comments** PRETESTED, REPAIRED AND CALIBRATED METER TO WITHIN SPECIFICATIONS.

SEE SEPARATE INVOICE FOR PARTS AND REPAIR TIME.

SERVICING: $394.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 302638 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/20/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** SCHMON PKWY @ ST. DAVIDS ROAD
**Acct No** METER #10
**Occupant** AREA #3
**Contact** PAUL COLEMAN 905-684-5353
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 10" W-5500
**Reg Unit** HSPU 10M3
**Serial No** 1194818

**Location** MODULE TESTED IN SHOP
**Test Fittings** MODULE EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 663420X | 663424X |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 600 GPM | 10128.00 | 10150.00 | 0.00 | 10150.00 | 100.22 |
| 200 GPM | 10039.00 | 10010.00 | 0.00 | 10010.00 | 99.71 |
| 100 GPM | 10981.00 | 11050.00 | 0.00 | 11050.00 | 100.63 |
| 50 GPM | 5003.00 | 5000.00 | 0.00 | 5000.00 | 99.94 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: $341.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301678 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/20/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** TUPPER DRIVE REVERSE
**Acct No** METER #10
**Occupant** AREA #3
**Contact** PAUL COLEMAN
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 10" W-5500
**Reg Unit** HSPU 10M3
**Serial No** 1111559

**Location** MODULE TESTED IN-SHOP
**Test Fittings** MODULE EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 008335X | 008338X |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 600 GPM | 12199.00 | 12050.00 | 0.00 | 12050.00 | 98.78 |
| 200 GPM | 10003.00 | 10000.00 | 0.00 | 10000.00 | 99.97 |
| 100 GPM | 10402.00 | 10300.00 | 0.00 | 10300.00 | 99.02 |
| 50 GPM | 5001.00 | 5000.00 | 0.00 | 5000.00 | 99.98 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: $341.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301678 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/24/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** FRONT ST THOROLD FLUORIDE
**Acct No** METER #9
**Occupant** AREA #3
**Contact** PAUL COLEMAN 905-684-5353
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 6" W-2000
**Reg Unit** HSPU 1M3
**Serial No** 28871662

**Location** MODULE TESTED IN-SHOP
**Test Fittings** MODULE EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**.tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 507107 | 507127 |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 600 GPM | 5053.00 | 5135.00 | 0.00 | 5135.00 | 101.62 |
| 200 GPM | 2133.00 | 2155.00 | 0.00 | 2155.00 | 101.03 |
| 100 GPM | 1008.00 | 1015.00 | 0.00 | 1015.00 | 100.69 |
| 20 GPM | 1002.00 | 995.00 | 0.00 | 995.00 | 99.30 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 600 GPM | 5042.00 | 5105.00 | 0.00 | 5105.00 | 101.25 |
| 200 GPM | 2024.00 | 2035.00 | 0.00 | 2035.00 | 100.54 |
| 100 GPM | 1007.00 | 1010.00 | 0.00 | 1010.00 | 100.30 |
| 20 GPM | 1001.00 | 985.00 | 0.00 | 985.00 | 98.40 |

**Meter Runs At Min. Flow** ☐

**Comments** PRETESTED AND CALIBRATED METER TO WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: $341.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 302638 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/20/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** GLENDALE AVENUE @ COON ROAD
**Acct No** METER #7
**Occupant** AREA #3
**Contact** PAUL COLEMAN 905-684-5353
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWALKER

**Meter Mfg** INVENSYS
**Size Type** 10" W-5500
**Reg Unit** HSPU 10M3
**Serial No** 1182334

**Location** MODULE TESTED IN-SHOP
**Test Fittings** MODULE EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 939682X | 939686X |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 600 GPM | 10125.00 | 10100.00 | 0.00 | 10100.00 | 99.75 |
| 200 GPM | 10006.00 | 10000.00 | 0.00 | 10000.00 | 99.94 |
| 100 GPM | 10006.00 | 10050.00 | 0.00 | 10050.00 | 100.44 |
| 50 GPM | 5820.00 | 5800.00 | 0.00 | 5800.00 | 99.66 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C701 FOR CLASS II TURBINE METERS.

SERVICING: $341.00

# Coulter Water Meter Service Inc.

P.O. Box 216, Strathroy, Ontario N7G 3J2 (519) 245-5860

## Service Order/Report

**New P.O.** 301678 **Old P.O.** 30513 **Invoice No** 28792 **REGNIA** ***Service Date*** 5/20/2005

**Invoiced To** REG. MUNICIPALITY OF NIAGARA
2201 ST. DAVIDS ROAD
P.O. BOX 1042
THOROLD ONTARIO
L2V 4T7 CANADA

**Job Address** SUNNY'S GAS BAR
**Acct No** METER #8
**Occupant** AREA #3
**Contact** PAUL COLEMAN 905-684-5353
**Cust Contact** TONY ACCETTOLA

**Service Provided By:** J. OSTROWLAKER

**Meter Mfg** NEPTUNE
**Size Type** 2" T10
**Reg Unit** D/R IG
**Serial No** 4745830

**Location** FULL METER TESTED IN-SHOP
**Test Fittings** FULL METER EXCHANGE
**Chamber** N
**Job Completed** ☑

**Meter Running On Arrival** ☐
**Meter Sealed On Arrival** ☐
**Bypass Sealed On Arrival** ☐
**If NO, Was It Open** ☐
**Mtr Running On Departure** ☐
**tr Valves Sealed On Departure** ☐
**Broken Valves Tagged** ☐

### Meter Reading

| | As Found | After Service |
|---|---|---|
| HF OUT | | |
| HF IN | 000888 | 000893 |
| LF OUT | | |
| LF IN | | |

**Static PSI** 0 **Residual PSI** 0 **At** 0 **Rate Of Flow** 0 **At**

### TEST RESULTS

**As Found**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| 100 GPM | 1000.00 | 990.00 | 0.00 | 990.00 | 99.00 |
| 50 GPM | 1000.00 | 1010.00 | 0.00 | 1010.00 | 101.00 |
| 25 GPM | 1000.00 | 1000.00 | 0.00 | 1000.00 | 100.00 |
| 2 GPM | 1000.00 | 975.00 | 0.00 | 975.00 | 97.50 |

**Meter Runs At Min. Flow** ☐

**After Service**

| R.O.F. | QTY | HIGH | LOW | TOTAL | % |
|---|---|---|---|---|---|
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |
| | 0.00 | 0.00 | 0.00 | 0.00 | #Num! |

**Meter Runs At Min. Flow** ☐

**Comments** METER PRETESTED WITHIN AWWA SPECIFICATION C700 FOR DISPLACEMENT TYPE METERS.

SERVICING: $105.00

# Appendix C

# Draft Customer Meter Accuracy Report

## *Analysis background*

Customer meters are the cash register of the utility and are responsible for ensuring an equitable distribution of water volume and income throughout various different customer classes within a utility and as such it is extremely important to analyze the accuracy of the meters on a regular basis and where necessary make repairs or replace groups of meters. In addition to being the cash register meters are responsible for a large amount of consumption data which can be used for other engineering functions such as hydraulic models and in this case the annual water balance which is used to disaggregate components of consumption, apparent loss and real loss in order to identify appropriate and efficient intervention programs for each loss type and volume.

## *Using AWWA test flows and volumetric participation to identify weighted average accuracy for water balance purposes*

Data has been imported into our analysis programs and analyzed using the volume weighted percentages suggested in AWWA manual M36 table 2-7 for small meters and table 2-10 for large meters. It should be noted that further improvements to this analysis could be made by data logging samples of meter consumption profiles and applying them to the weighted average calculations as opposed to using the suggested values in M36[1] and M6[2].

AWWARF Project No. 418 Residential Water Use Patterns of 1993 states; *"Standards for domestic 5/8in. and 3/4in. water meters are based on a flow range of 0.25gpm to 20gpm. The range is assumed to be typical of the average domestic consumer. However, limited surveys of these domestic water use rates have not, until now, adequately substantiated this range."* Although the project concluded that *"overall patterns of water use across the range of hours and flow rates were remarkably stable across geographic regions"*

Based on AWWA published data the following weighted % volumes have been used for the 5/8 inch and ¾ inch meter weighted accuracy calculations. There were no 1 inch meters in the test sample so these have not been considered. In order to check if the volumes used in the M36 report are representative Veritec has undertaken a detailed analysis of 1200 data logged residential consumption profiles consisting of meters 5/8 to 1 inch in diameter, which were undertaken as part of the national AWWARF REUWS study in 1999[3].

---

[1] *"Water audits and leak detection" American water works association (AWWA) manual of water supply practices M36 second edition 1999 page 20 table 2-7 (5/8 inch meters)*

[2] *"Water meters-selection installation testing and maintenance" AWWA manual of water supply practices M6 fourth edition 1999 page 60*

[3] *"Residential end uses of water" American Water Works Association Research Foundation 1999*

| Percent of Time | Range (gpm) | | Average (gpm) | Percent of Volume |
|---|---|---|---|---|
| 15% | Low | 0.50 to 1 | 0.75 | 2% |
| 70% | Medium | 1 to 10 | 5.00 | 63.8% |
| 15% | High | 10 to 15 | 12.50 | 34.2% |

*Table 1 percent of volume calculations used for small meters taken from AWWA M6 and M36 table 2-7*

The results shown below in *Table* **2** clearly indicate that the M36 results are in the right order of magnitude and that the volumes actually passed at the flow rates used to generate the low flow test results are very small compared to those volumes which pass at the medium and high test flow rates. It is important to note that this data set included 100 profiles from an Eastern Ontario utility.

| Flow range GPM | Volume | % |
|---|---|---|
| 0 – 0.25 | 4,978.79 | 0.05 |
| 0.26 – 0.50 | 63,756.66 | 0.59 |
| 0.51 – 0.75 | 121,274.58 | 1.13 |
| 0.76 – 1.0 | 192,455.03 | 1.79 |
| 1.01 – 10.0 | 7,835,760.04 | 72.77 |
| > 10 | 2,549,331.51 | 23.68 |
| *Total* | 10,767,556.61 | 100.00 |

*Table 2 volumes consumed at different flow ranges from AWWARF REUS*

The percent of volume at each flow rate changes for larger meter sizes and based on the same AWWA publication material available the following percent of volume were used for the estimations of weighted meter accuracy for large meters;

- Low 10%
- Medium 65%
- High 25%

It should be noted that larger customer meters are generally subject to a wider variation of flow profile as the nature of demand can differ – Veritec therefore reiterates the need to check a sample of flow profiles for the larger meter class.

### *Statistics of the sample set and the meter population*

Customer meter test data ranging from 5/8 inch to 6 inch was made available from 3 cities within the Niagara Region as shown below:

- Town of Grimsby
- Niagara on the Lake
- Port Colborne

No information was provided as to whether or not the test samples were representative of random samples so for Veritec analysis we have assumed they are. Veritec recommends stratified random sampling of various meter sizes for future more detailed analysis of economic meter maintenance.

Data supplied broken into small and large meter classes was as follows:

- Small meters are classed as 1 inch and less – 11 samples
- Large meters classed as 1.5 inch and more – 26 samples

The total meter population for the Niagara Region is as follows:

- Small meters - 104,848
- Large meters - 8,380

### *Results*

The tables below show the first look at the weighted meter accuracy by volume for small meters in *Table* **3** and for large meters *Table* **4**.

Both sets of meters have an overall meter accuracy which is within the AWWA recommended range. However upon review of the low flow accuracy it can be seen that on average it is significantly below the recommended AWWA range however using the volume weighted % contribution the lower flows have little impact on the overall average.

| Test Flow Rate | Test High | Test Medium | Test Low |
|---|---|---|---|
| No. of Test Results | 11 | 11 | 11 |
| Average Accuracy | 98.46% | 99.84% | 84.28% |
| Variance | 0.001 | 0.000 | 0.089 |
| Standard Dev | 2.47% | 1.80% | 29.78% |
| 95% Confidence | 1.46% | 1.06% | 17.60% |
| Average Meter Error at each flow rate | -1.54% | -0.16% | -15.72% |
| % of Consumption Volume Passed at Test Flow | 34.2% | 63.8% | 2.0% |
| Contribution to Overall Average Meter Error | -0.53% | -0.10% | -0.31% |

| | |
|---|---|
| Overall Meter Error | -0.94% |
| Overall Meter Accuracy | 99.06% |

*Table* 3 *First look meter accuracy for small meters*

Veritec would suggest that the cities continue to review meter accuracy using this component based approach paying particular attention to the medium flow range which has most impact on the overall meter accuracy.

Once this starts to deteriorate then it is time to consider meter replacement in the case of the smaller meters and meter replacement or repair in the case of the larger meters.

| Test Flow Rate | Test High | Test Medium | Test Low |
|---|---|---|---|
| No. of Test Results | 26 | 26 | 26 |
| Average Accuracy | 100.10% | 99.50% | 92.54% |
| Variance | 0.001 | 0.001 | 0.035 |
| Standard Dev | 2.25% | 2.47% | 18.59% |
| 95% Confidence | 0.87% | 0.95% | 7.15% |
| Average Meter Error at each flow rate | 0.10% | -0.50% | -7.46% |
| % of Consumption Volume Passed at Test Flow | 25.0% | 65.0% | 10.0% |
| Contribution to Overall Average Meter Error | 0.03% | -0.32% | -0.75% |
| Overall Meter Error | -1.04% | | |
| Overall Meter Accuracy | 98.96% | | |

*Table 4 First look meter accuracy for large meters*

### *Confidence*

Confidence in the test results has been calculated first for each of the test flow rates used in this analysis and then secondly confidence in the overall meter accuracy has been calculated for use in the annual water balance.

Both small and large meter tests sets display a small variance around the mean for the medium and high flow rates and a larger variance around the mean for the low flow results.

The small meter test sample has one stuck meter at the low flow rate which makes a big difference to the small test set. ***Table 5*** below shows the difference in confidence if this meter is removed from the sample.

| Test Flow Rate | Test High | Test Med | Test Low |
|---|---|---|---|
| No. of Test Results | 10 | 10 | 10 |
| Average Accuracy | 98.48% | 100.24% | 92.71% |
| Variance | 0.001 | 0.000 | 0.012 |
| Standard Dev | 2.60% | 1.31% | 10.83% |
| 95% Confidence | 1.61% | 0.81% | 6.71% |
| Average Meter Error at each flow rate | -1.52% | 0.24% | -7.30% |
| % of Consumption Volume Passed at Test Flow Rate | 34.2% | 63.8% | 2.0% |
| Contribution to Overall Average Meter Error | -0.52% | 0.15% | -0.15% |
| Overall Meter Error | -0.51% | | |
| Overall Meter Accuracy | 99.49% | | |

*Table 5 Confidence is increased in low flow tests if the stuck meter is removed*

Confidence in that range of tests improves from 17.6% as shown in *Table* **3** to 6.7% as shown in ***Table 5***.

This example indicates the influence that one stuck meter can have on a sample test set, particularly when the test sample is small. Veritec would recommend that a larger set of data is used for future more detailed analysis and that stuck meters are removed from the test sets and the issue of stuck meters is dealt with as a separate component of the water balance. Further details can be supplied upon request.

| Analysis by percentage meter error | |
|---|---|
| Total pop (N) | 104,848 |
| Sample count (n) | 10 |
| Average registration % (AWWA method) | 99.49% |
| Average meter error % | 0.51% |
| Sample variance off % under-reg | 0.0126 |
| N-n | 104,838 |
| n-1 | 9 |
| Var(Ybar) | 0.001396929 |
| Sqrt(Var(Ybar)) | 0.037375507 |
| Zstat for 95% | 1.96 |
| CI limits +/- of meter error % | 7.33% |

*Table 6 Confidence in overall meter accuracy for small meters for annual water balance*

As there has been no analysis of stuck meter frequency or response time to replace stuck meters the stuck meter has been removed from the test set and overall confidence increases from +/-17 to +/-7.3%. However this is still a large range and could be improved by a larger test sample.

| Analysis by percentage meter error | |
|---|---|
| Total pop (N) | 8,380 |
| Sample count (n) | 26 |
| Average registration % (AWWA method) | 98.96% |
| Average meter error % | 1.04% |
| Sample variance off % under-reg | 0.0357 |
| N-n | 8,354 |
| n-1 | 25 |
| Var(Ybar) | 0.001423053 |
| Sqrt(Var(Ybar)) | 0.037723377 |
| Zstat for 95% | 1.96 |
| CI limits +/- of meter error % | 7.39% |

*Table 7 Confidence in overall meter accuracy for large meters for annual water balance*

There were no stuck meters in the large meter test sample and therefore the overall average accuracy and the confidence have been taken at face value.

## *Recommendations*

This analysis serves as a first look at the impact of weighted overall meter accuracy by small and large meter category and allows volumes of apparent loss to be calculated in the annual water balance along with the confidence in

those volumes. Should the Region wish to refine this analysis in order to improve confidence in the apparent loss volumes and also to build a stronger business case for the correct meter accuracy intervention plan then Veritec would suggest that ongoing analysis include the following tasks:

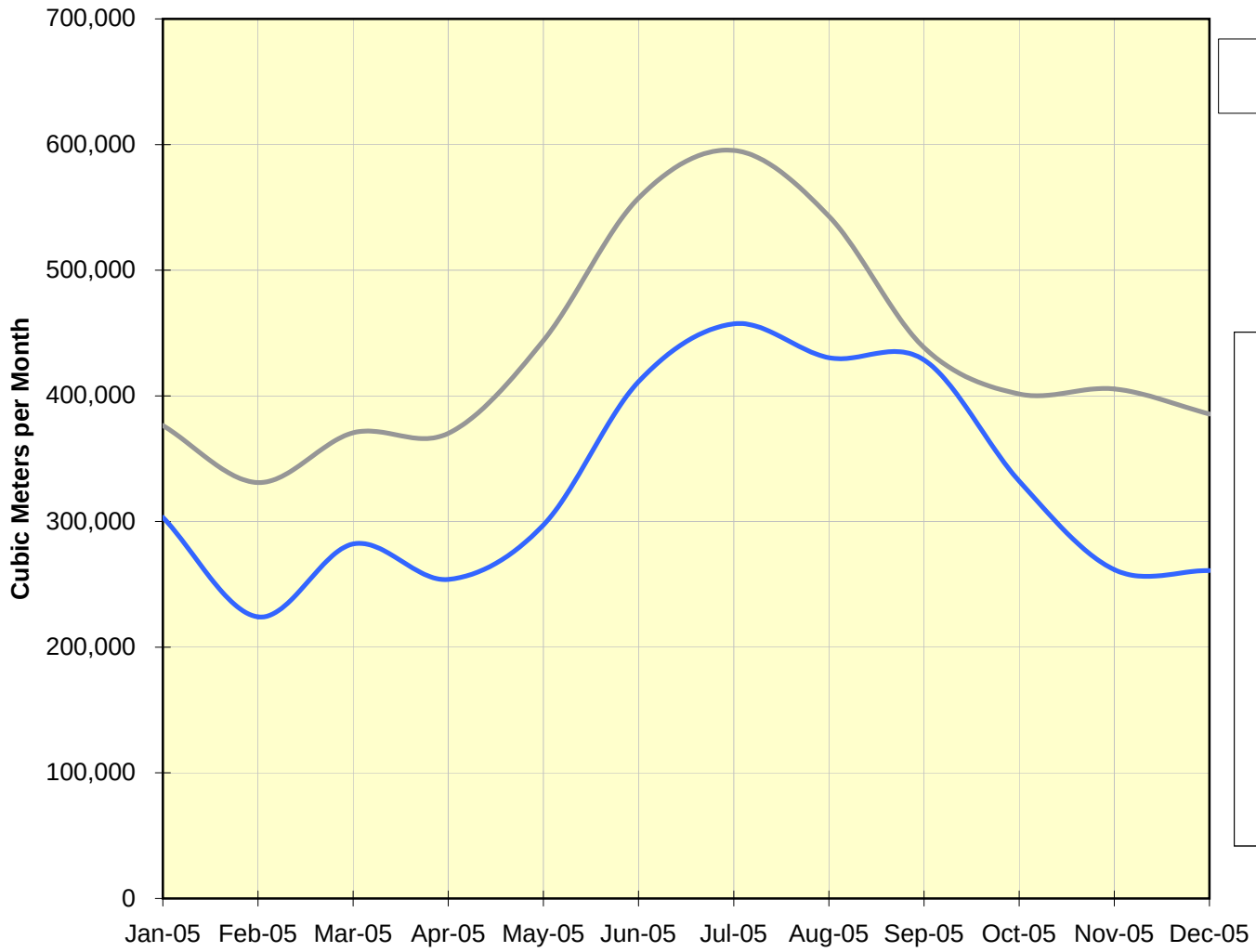
- Undertake flow profiling of key meter sizes and classes to determine weighted volume components for low, medium and high flow rates
- Undertake stratified random sampling and analysis of key meter sizes
- Increase sample size to in excess of 30 for each class to be analyzed
- Treat stuck meters separately and look at utility response time to change out to calculate volume for annual water balance

# Appendix D

# Non-Revenue Water Trends

**Illustration of Non-Revenue Water in 2005 *, Fort Erie**

(* All meters appear to be read monthly)



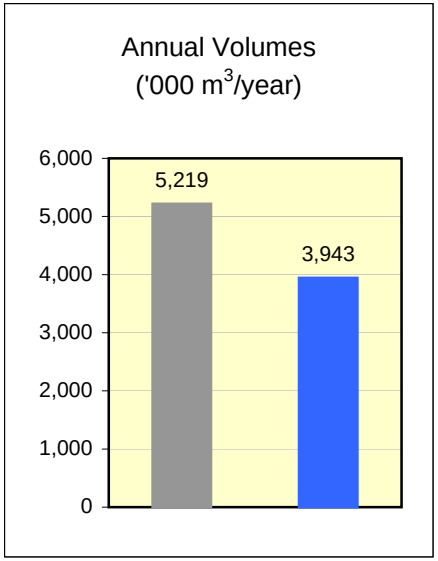



**Illustration of Non-Revenue Water in 2005 * , Grimsby**

(* Monthly Billing for Grimsby based on a combination of monthly reads and 3 times annually reads)

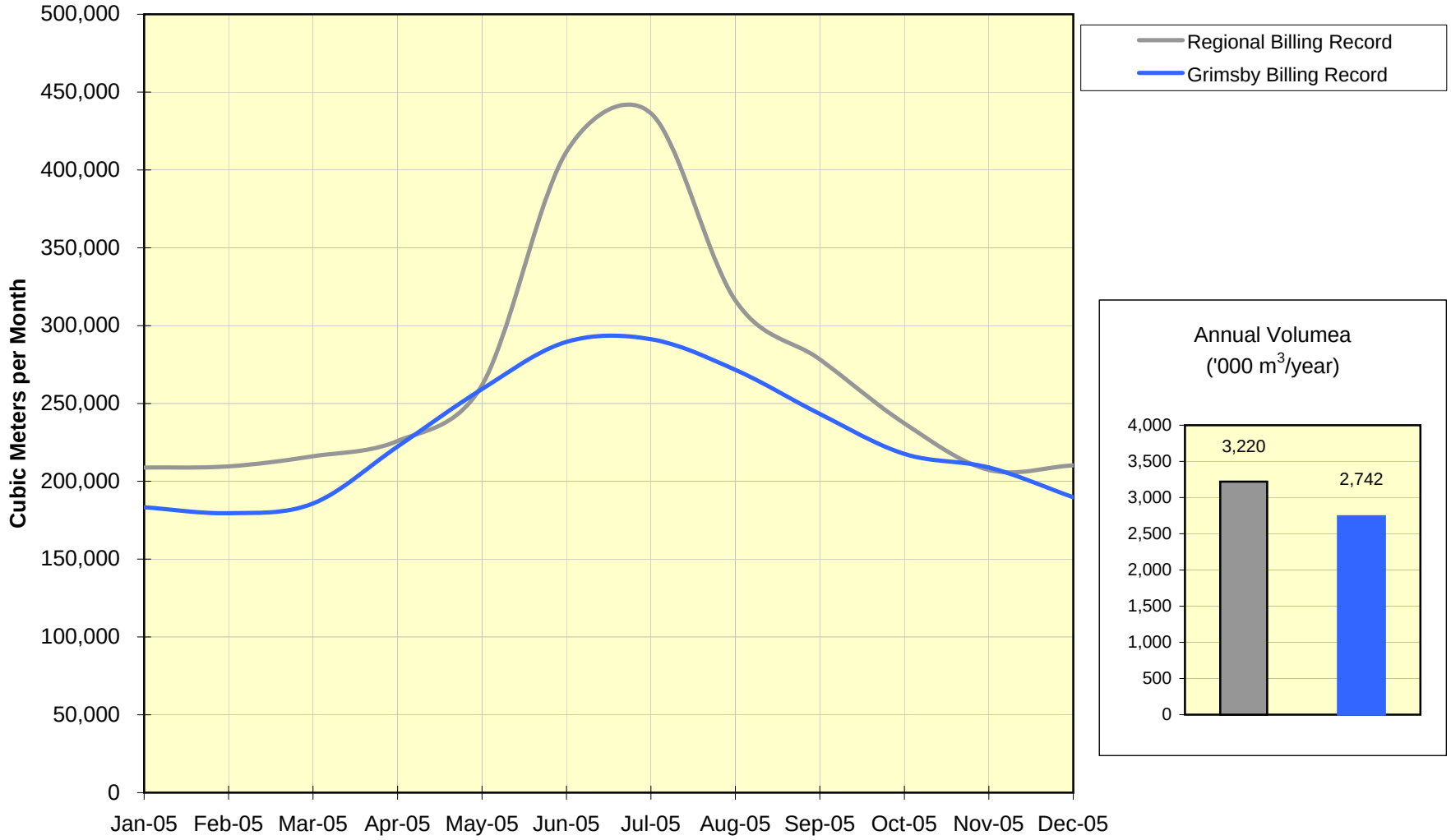
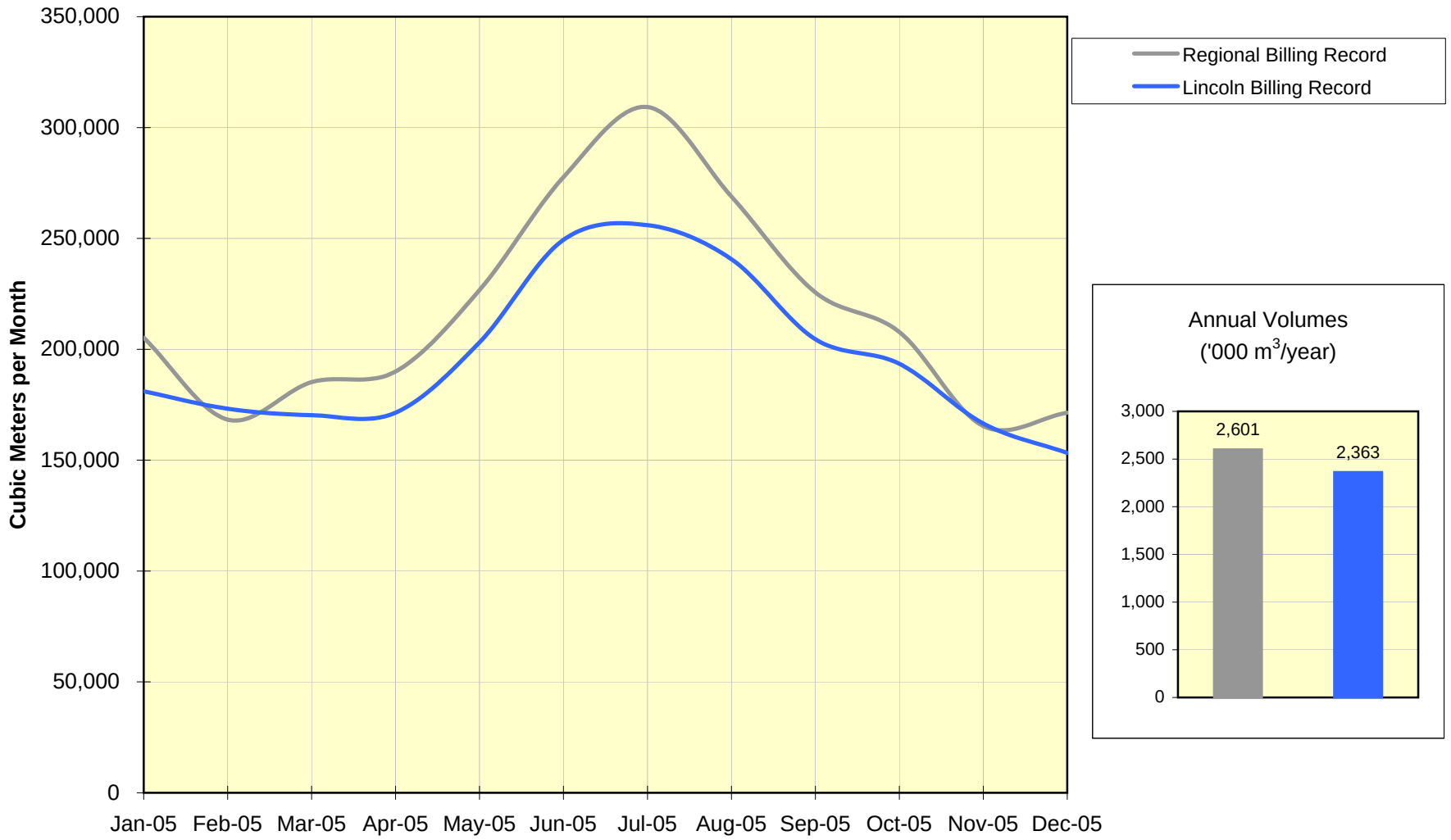


**Illustration of Non-Revenue Water in 2005 *, Lincoln**

(* All meters appear to be read monthly)



## Illustration of Non-Revenue Water in 2004 *, Niagara Falls

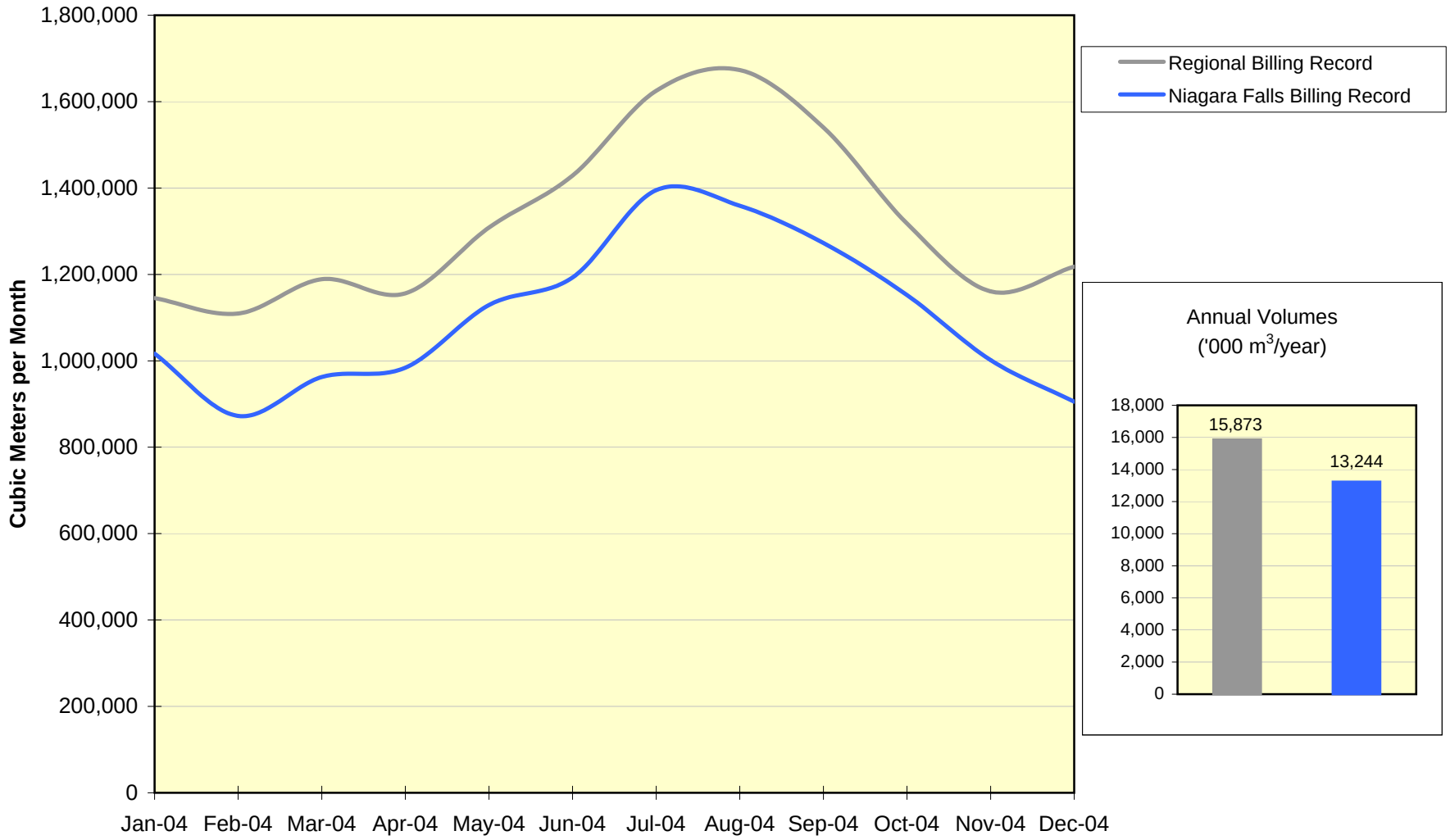


**Illustration of Non-Revenue Water in 2005 *, Niagara-on-the-Lake**
(No metering data beyond annual value provided)

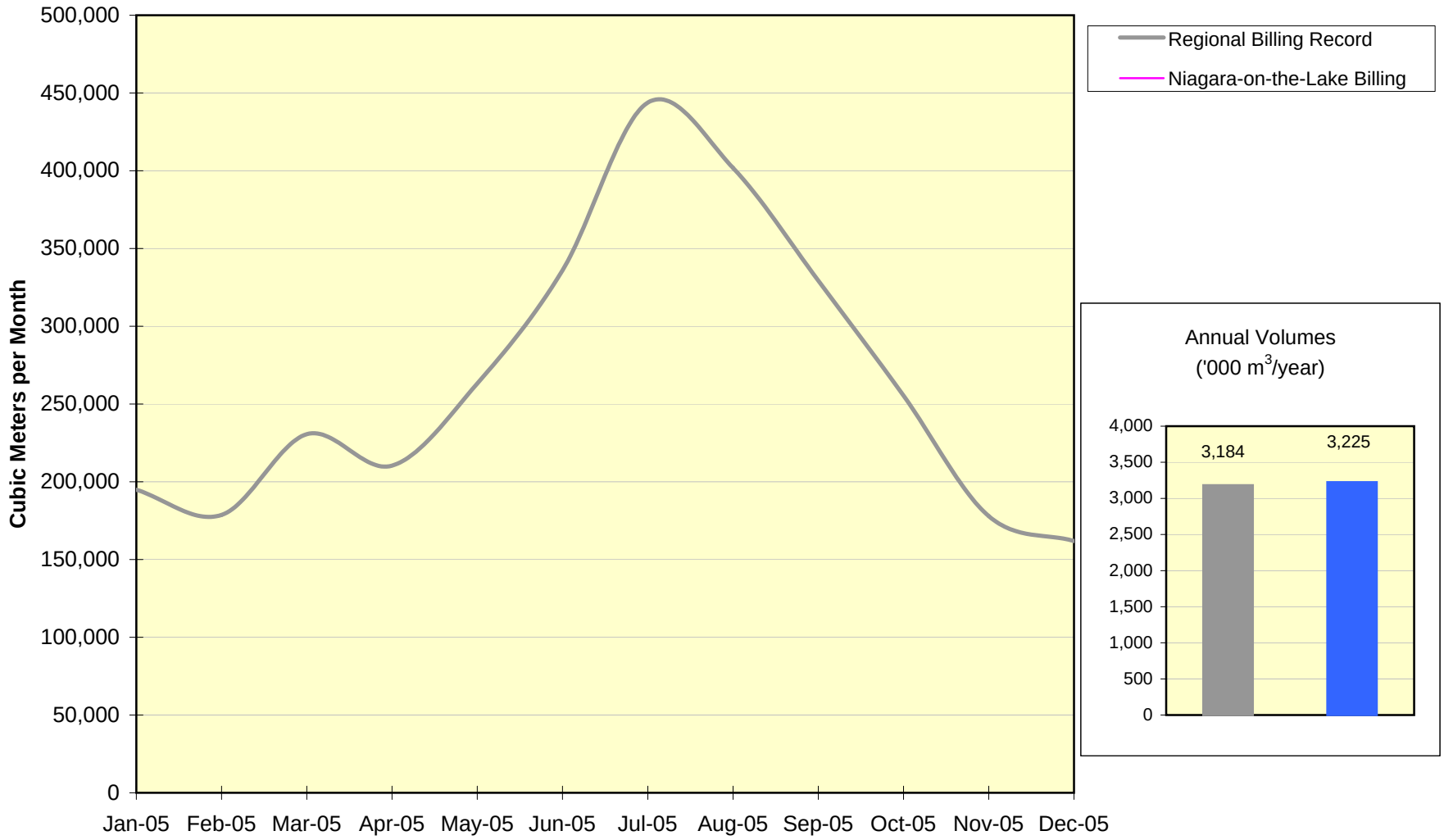


**Illustration of Non-Revenue Water in 2005 *, Pelham**

(* No metering data beyond annual value provided)

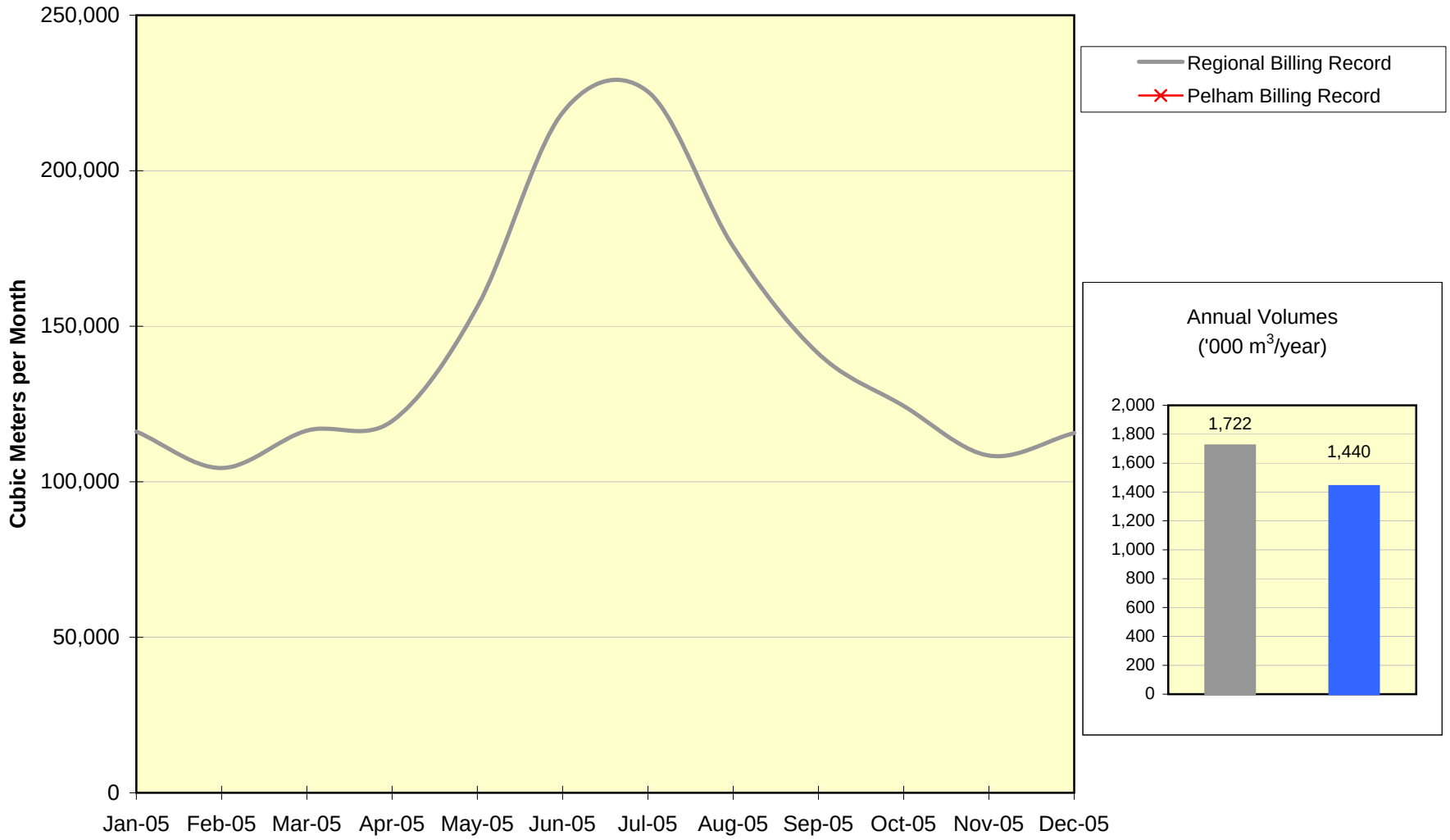
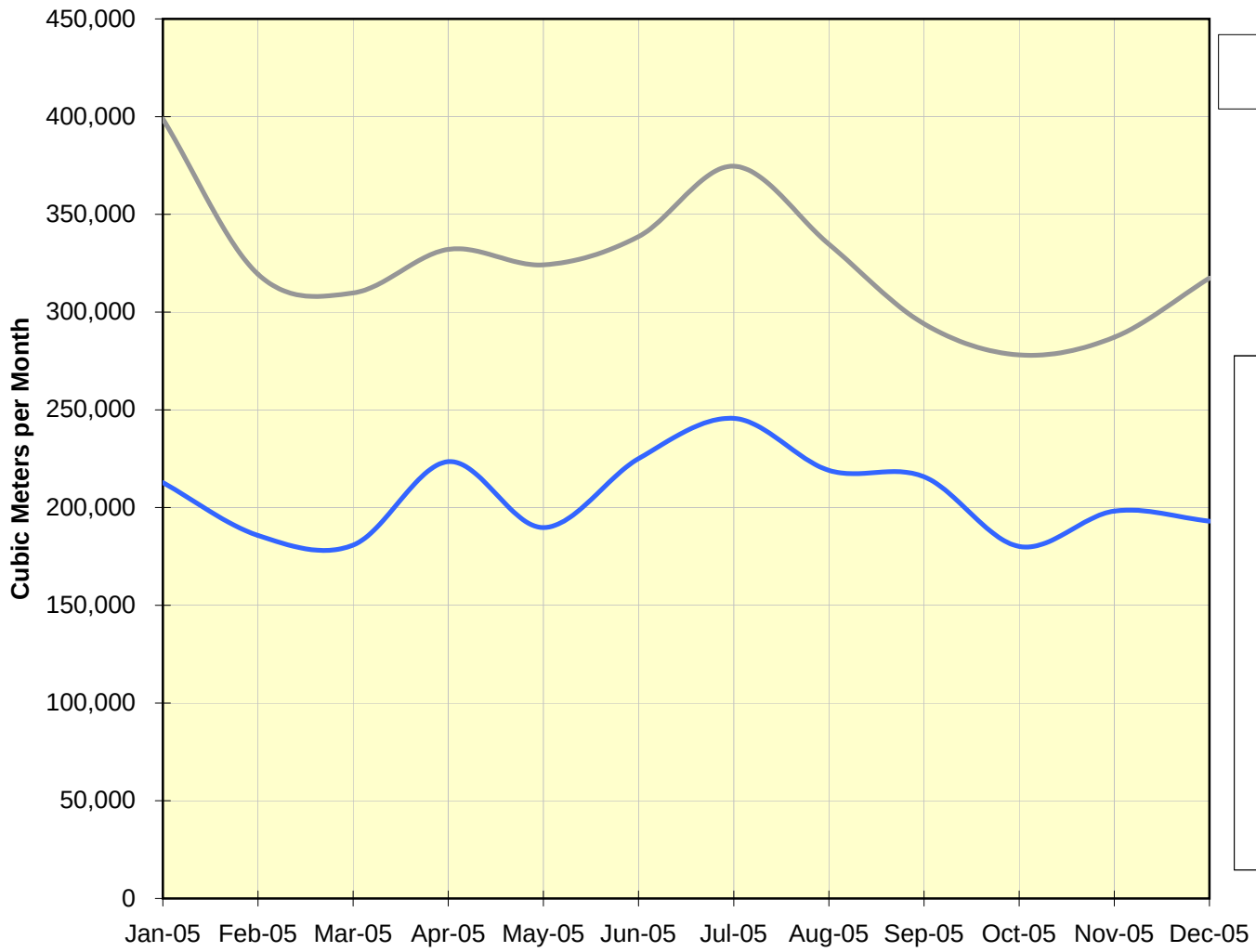


**Illustration of Non-Revenue Water in 2005 *, Port Colborne**

(* Monthly Billing for Port Colborne based on a combination of monthly reads and quarterly reads)



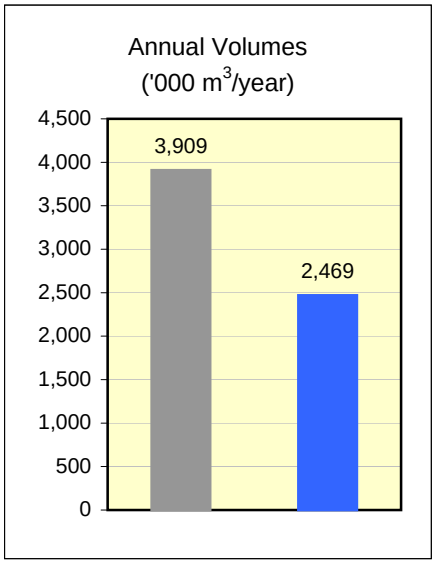



**Illustration of Non-Revenue Water in 2004*, St. Catharines**

(* Monthly Billing for West Lincoln based on a combination of monthly reads and quarterly reads)

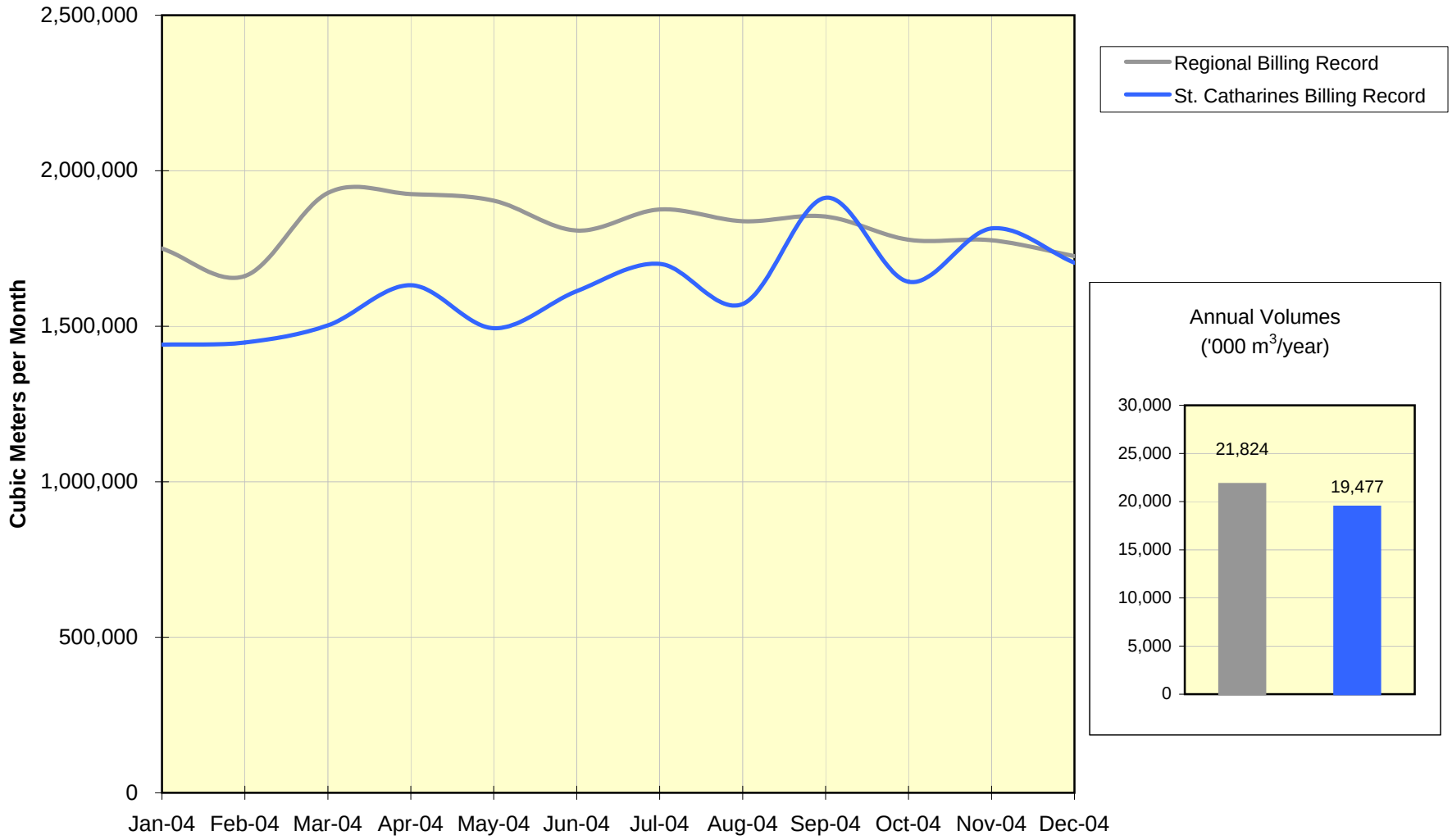


**Illustration of Non-Revenue Water in 2005 *, Thorold**
(No metering data beyond annual value provided)

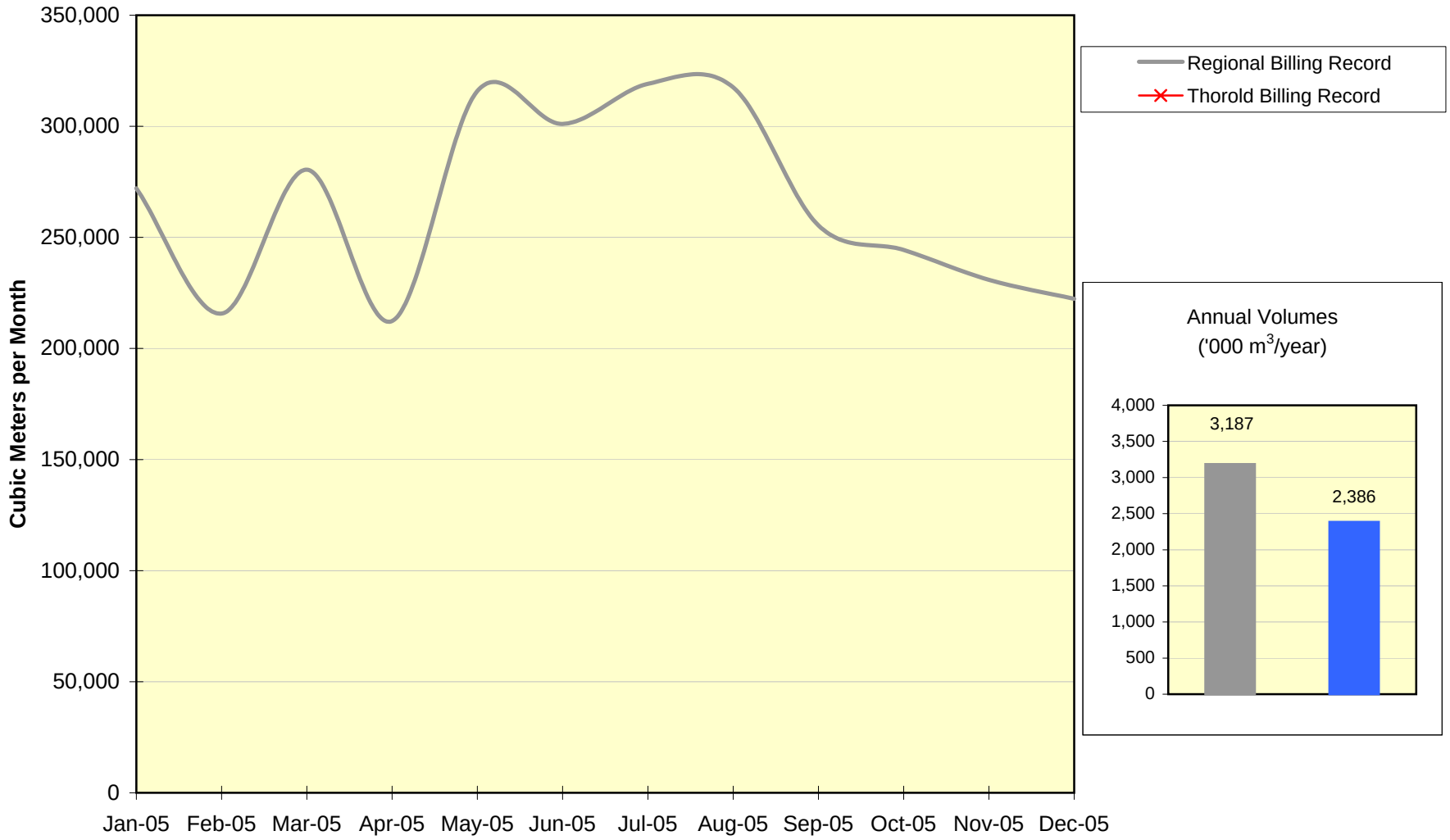


**Illustration of Non-Revenue Water in 2005 *, Welland**
(No data provided for 2005 / partial data for 2004)

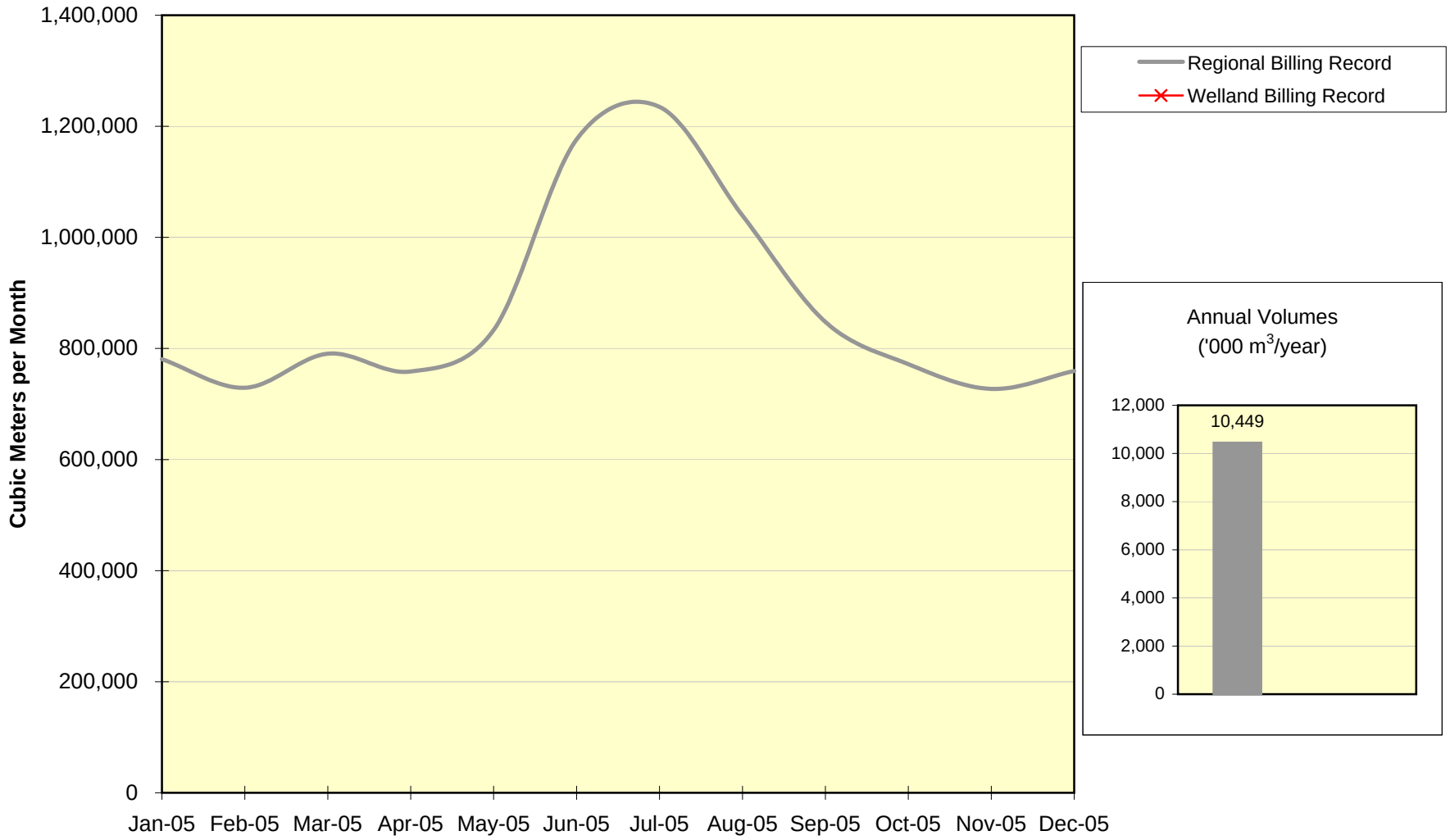
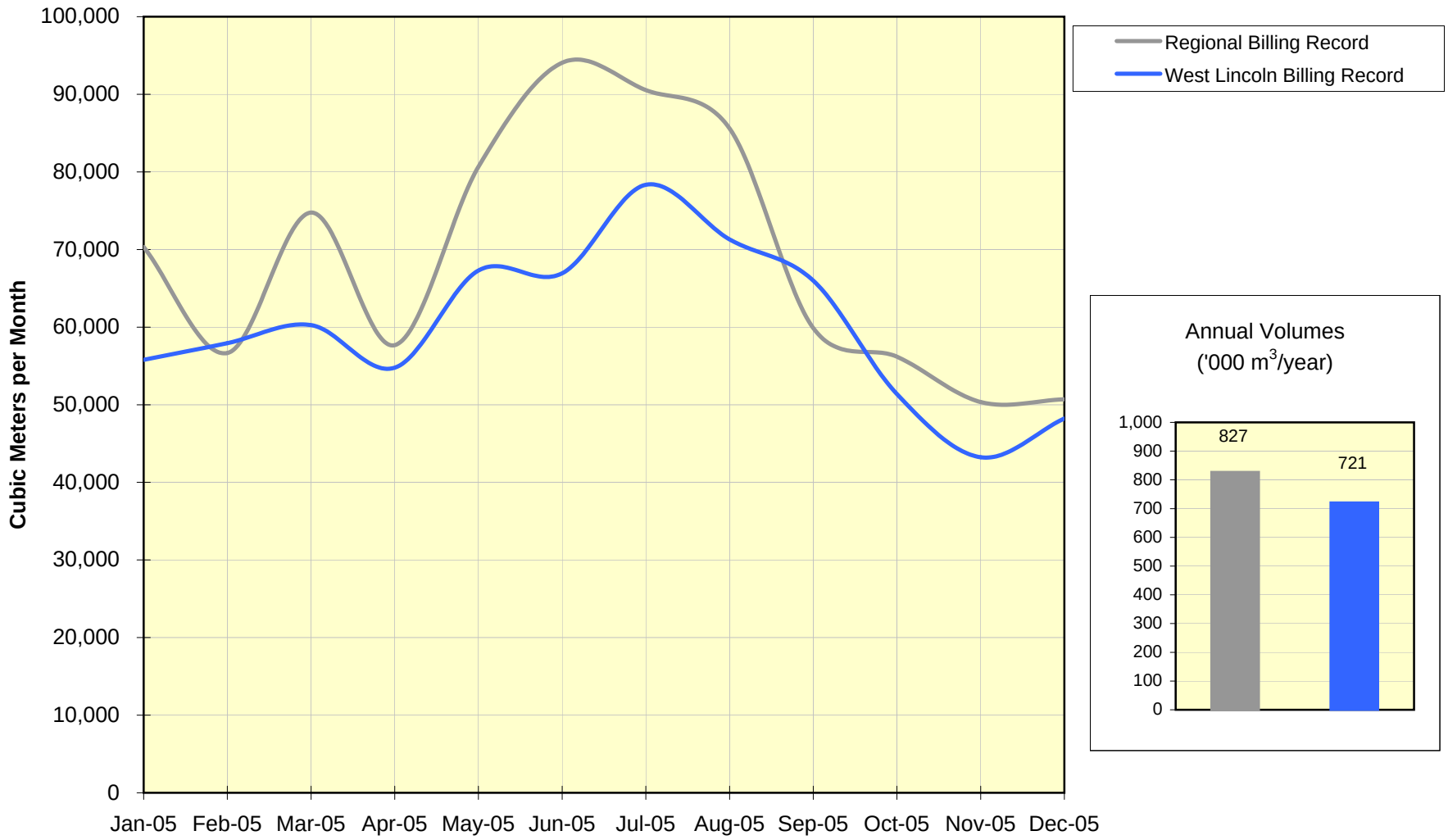


**Illustration of Non-Revenue Water in 2005 *, West Lincoln**

(* Monthly Billing for West Lincoln based on a combination of monthly reads and quarterly reads)



# Appendix E

# Component Analysis to Calculate UARL

**Appendix D: Component Analysis to Calculate Unavoidable Annual Real Losses**

**Mains**: assumed new burst frequency 13/100 km mains/year at 50m pressure

- 95% of events reported, 5% unreported
- Reported mains leaks average 864 $m^3$ loss each (12 $m^3$/hr for 3 days, or equivalent)
- So loss/km/year from reported mains leaks = 864 x 13 x 0.95/100 = **107** $m^3$/km/year
- Unreported mains leaks average 7200 $m^3$ loss each (6 $m^3$/hr for 50 days, or equivalent)
- So loss/km/year from unreported mains leaks = 7200x 13 x 0.05/100 = **47** $m^3$/km/year
- Background leakage: 20 l/km/hour for 365 days = **175** $m^3$/km/year

Total for mains at 50m pressure = **329** $m^3$/km/year

**Service Connections**: assumed new leak frequency 5/1000 connections/year at 50m pressure

- Data split into 'main to property line' (3/1000 conns/year at 50m pressure) and 'after property line' (2/1000 conns/year, for 15m average length of unmetered underground private pipe)
- 75% of events reported, 25% unreported
- Assumed flow rate for all new leaks is 1.6 m3/hr at 50m pressure

**Service Connections, Main to property line**

- Reported leaks (main to property line) average 307 $m^3$ loss each (1.6 $m^3$/hr for 8 days)
- So loss/conn/year from these reported leaks = (307 x 3 x 0.75)/1000 = **0.7** $m^3$/conn/year
- Unreported leaks (main to property line) average 3840 $m^3$ loss each (1.6 $m^3$/hr for 100 days)
- So loss/conn/year from these unreported leaks = (3840 x 3 x 0.25)/1000 = **2.9** $m^3$/conn/year
- Background leakage (main to property line) =1.25 l/conn/hr for 365 days = **11.0** $m^3$/conn/year

Total for service connections, main to property line = **14.6** $m^3$/conn/year

**Service Connections, private underground pipe between property line and meter**

- Reported leaks (15m private pipe) average 346 $m^3$ loss each (1.6 $m^3$/hr for 9 days)
- So loss/conn/year from these reported leaks = (346 x 2 x 0.75)/15 = **35** $m^3$/km/year
- Unreported leaks (15m private pipe) average 3878 $m^3$ loss each (1.6 $m^3$/hr for 101 days)
- So loss/conn/year from these unreported leaks = (3878 x 2 x 0.25)/15 = **129** $m^3$/km/year
- Background leakage = 0.5 l/conn/hr for 15m/connection for 365 days = **292** $m^3$/km/year

Total for 15m private pipe, property line to customer meters = **456** $m^3$/km/year

Table A1: Summary of Unavoidable Annual Real Losses Component Analysis at 50m pressure

| Infrastructure Component | Background Leakage | Reported Leaks | Unreported Leaks | Total | Units |
|---|---|---|---|---|---|
| Mains | 175 | 107 | 47 | 329 | $M^3$/km mains/yr |
| Service Connections, mains to property line | 11.0 | 0.7 | 2.9 | 14.6 | M3/service connection /yr |
| Underground pipe, where customer meter is located after property line | 292 | 35 | 129 | 456 | M3/km of pipe/ year |

In Table 4 of Lambert et al (1999), the above figures were multiplied by 1000 (to convert to litres), divided by 365 (to convert to average daily values) and divided by 50 metres (to present the figures 'per litre per day per metre of pressure', assuming a linear pressure:leakage relationship). These are shown Table A2 below.

Table A2: Summary of Unavoidable Annual Real Losses Components in AQUA Paper Format

| Infrastructure Component | Background Leakage | Reported Leaks | Unreported Leaks | Total | Units |
|---|---|---|---|---|---|
| Mains | 9.6 | 5.8 | 2.6 | 18.0 | l/km mains/day/ metre of pressure |
| Service Connections, mains to property line | 0.60 | 0.04 | 0.16 | 0.80 | l/service conn/ day/m. pressure |
| Underground pipe, where customer meter is located after property line | 16.0 | 1.9 | 7.1 | 25.0 | l/km of pipe/ day/ metre of pressure |

# Appendix F

# PIFastCalc Output Fort Erie

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

Currency = $C | Volume units = Ml | and m³

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Utility | Town of Fort Erie | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 5218.8 | 3.0% | 6381 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 5218.8 | 3.0% | 6381 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 5218.8 | 3.0% | 6381 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Residential | | | 3404.8 | 1.5% | 679 | 65.2% | | | |
| A | BACM2: Billed Authorised Consumption: Metered | Large Commercial | | | 538.3 | 1.5% | 17 | 10.3% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 1275.7 | 12.9% | 7077 | 24.4% | 0.4771 | 608.7 | 0.0% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| C/D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 5.000% | of WS | 260.9 | 50.0% | 4431 | 5.0% | 0.4460 | 116.4 | 0.0% |
| | WL WATER LOSSES | | | | 1014.7 | 20.7% | 11508 | 19.4% | 0.4851 | 492.3 | 0.0% |
| C/D | UC: Unauthorised Consumption: | Estimated as | 1.000% | of WS | 52.2 | 50.0% | 177 | 1.0% | 0.7300 | 38.1 | 0.0% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Residential | 0.50% | of BACM1 | 17.1 | 7.0% | 0 | 0.3% | 1.5500 | 26.5 | 0.0% |
| B/C | ALMUR2: Apparent Loss - meter under-registration: | Large Commercial | 1.00% | of BACM2 | 5.4 | 7.0% | 0 | 0.1% | 1.5500 | 8.4 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 1.5500 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 1.5500 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 74.7 | 35.0% | 178 | 1.4% | 0.9774 | 73.0 | 0.0% |
| | RL: REAL LOSSES | | | | 940.0 | 22.5% | 11685 | 18.0% | 0.4460 | 419.2 | 0.0% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | | Cost of running system in period = | | | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 2.58 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 303.10 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 1475 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 12098 | | 2.0% |
| A/B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 12098 | | 2.8% |
| B | Nu: Number of Unbilled Service Connections | 101 | | 10.0% |
| | Nl: Total Number of Service Conns (= Ns + Nu), mains to property line | 12199 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 40.2 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 123.40 | | 3.7% |
| B | P: Average pressure when system pressurised (psi) | 75.0 | Yes | 5.0% |
| | P: Average pressure when system pressurised (m) | 53.0 | | 5.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nl + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nl + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.67 | 243 | 108.5 | 7.7% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.97 | 354 | 158.0 | 5.3% |
| CARL: CURRENT ANNUAL REAL LOSSES | 2.58 | 940 | 419.2 | 22.5% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 1.61 | 586 | 261.3 | 36.3% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 24.4 | 13.3% | 21.2 | 27.7 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | | 13.3% | | |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 1.4 | 35.1% | 0.9 | 1.9 |
| | | % of System Input Volume (Bulk Supply Systems) | 1.4 | 35.1% | 0.9 | 1.9 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 211 | 22.7% | 163 | 259 |
| | | m3/km of mains/day, when system pressurised | 8.5 | 22.6% | 6.6 | 10.4 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 2.65 | 23.1% | 2.04 | 3.27 |

**Comments:**

Region Billing Equation = 2T1 + 2T2 -2S (Accuracy ranges between 97 and 101.6 percent)

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No costs for operating the system provided.

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: Town of Fort Erie

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by: Steve Genser

Date: 04/12/2006

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| Residential | 3404.80 | | | | 3404.80 | (R) From billing records |
| Commercial | 538.32 | | | | 538.32 | (R) From billing records |
| | | | | | 0.00 | |
| Fire Fighting | | | | | 260.94 | |
| Street Cleaning | | | | | 0.00 | |
| Hydrant Usage | | | | | 0.00 | |
| Sewer Flushing | | | | 260.94 | 0.00 | (E) 5% of WS |
| W/M Cleaning | | | | | 0.00 | |
| Flushing | | | | | 0.00 | |
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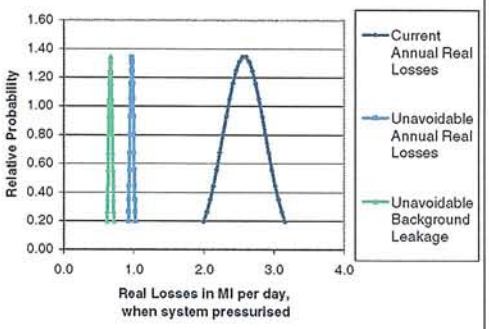
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 3943.11 | 0.00 | 0.00 | 260.94 | 4204.05 | Ml |
| Authorised Unbilled Unmetered Consumption = | | | | 5.000% | of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet | |

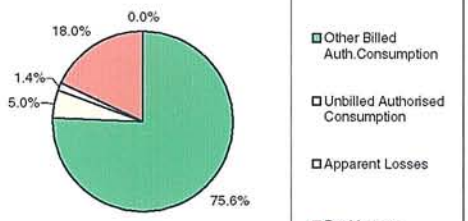
| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| By-pass tampering | 26.09 | (E) 0.5% of WS |
| Hydrant Usage | 26.09 | (E) 0.5% of WS |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 52.19 | Ml |
| Unauthorised consumption = | 1.000% | of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet |

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Fort Erie | 01/01/2005 | to 01/01/2006 | 365 | days |
| System | Whole System | | | | |

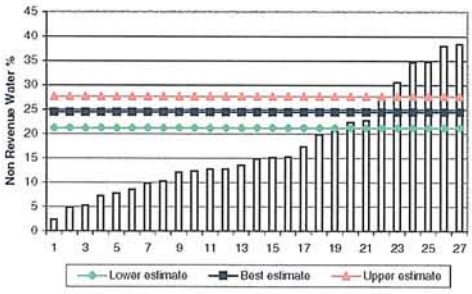
**Real Losses and 95% Confidence Limits**



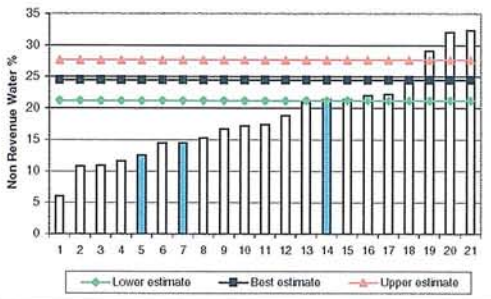

**Water Balance Components as % of System Input Volume**



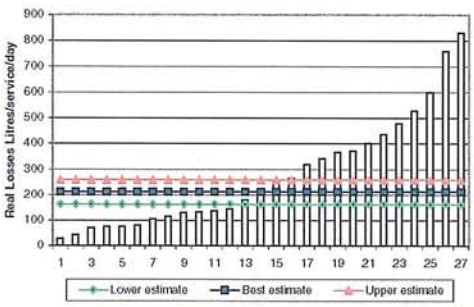

**NRW % by Volume; Comparison with International Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**Non-Revenue Water as % of System Input Volume**



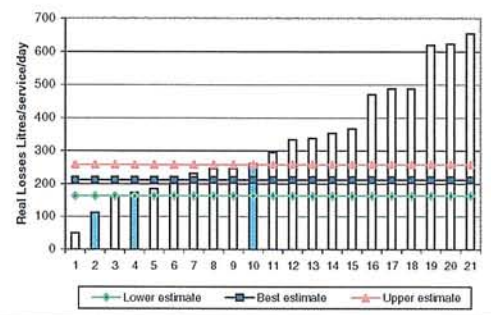

**NRW % by Volume; Comparison with North American Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**NRW as % of System Input Volume: Canadian data in blue**



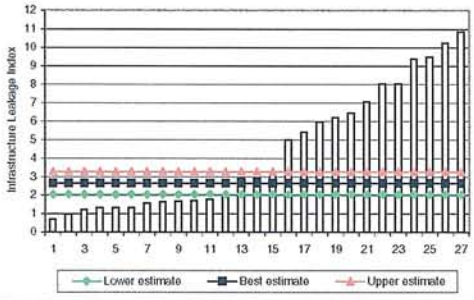

**Real Losses in litres/service connection/day**
**(when system is pressurised)**
**Compared with International data set**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



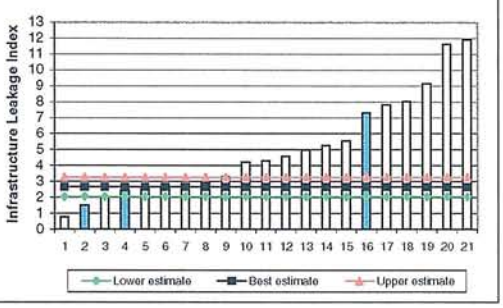

**Real Losses in litres/service connection/day**
**when system is pressurised**
**Compared with North American data set, Canadian data in blue**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with International data set**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with North American data set, Canadian data in blue**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**



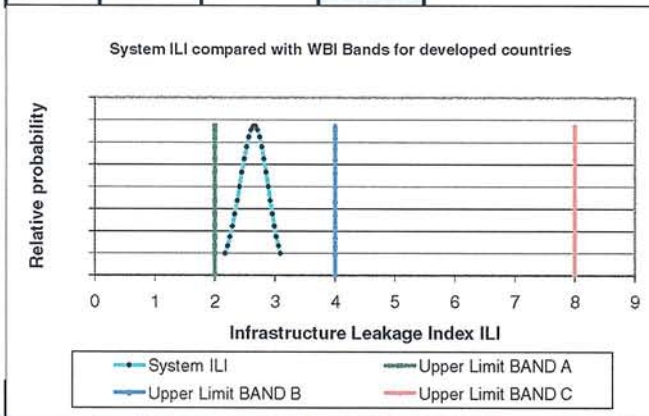
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Enter Licensee's name when issuing software |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | 2.7 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 2.7 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | Data entry | Calculated Values | From another Worksheet | |

| Utility | Town of Fort Erie | 01/01/2005 | to | 1/1/2006 | Number of Days in Period | 365 | days |
|---|---|---|---|---|---|---|---|
| System | Whole System | Calculation by | | Steve Genser | Date of calculation = | 7-Sep-06 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix G

# PIFastCalc Output Grimsby

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS | Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly | Currency = $C | Volume units = Ml | and m³

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Utility | Town of Grimsby | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 3219.6 | 3.0% | 2429 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 3219.6 | 3.0% | 2429 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 3219.6 | 3.0% | 2429 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Residential | | | 2092.2 | 1.5% | 256 | 65.0% | | | |
| B | BACM2: Billed Authorised Consumption: Metered | ICI | | | 735.1 | 1.5% | 32 | 22.9% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 392.3 | 26.0% | 2717 | 12.2% | 0.6811 | 267.2 | 8.4% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.07% | of WS | 2.1 | | 0 | 0.1% | 0.4460 | 0.9 | 0.0% |
| C | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.170% | of WS | 37.7 | 50.0% | 92 | 1.2% | 0.4460 | 16.8 | 0.5% |
| | WL WATER LOSSES | | | | 352.5 | 29.5% | 2809 | 10.9% | 0.7077 | 249.5 | 7.9% |
| | UC: Unauthorised Consumption: | Estimated as | 1.500% | of WS | 48.3 | 50.0% | 152 | 1.5% | 1.6600 | 80.2 | 2.5% |
| B | ALMUR1: Apparent Loss - meter under-registration: | Residential | 0.50% | of BACM1 | 10.5 | 7.0% | 0 | 0.3% | 2.3200 | 24.4 | 0.8% |
| B | ALMUR2: Apparent Loss - meter under-registration: | ICI | 1.00% | of BACM2 | 7.4 | 7.0% | 0 | 0.2% | 2.3200 | 17.2 | 0.5% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 66.2 | 36.5% | 152 | 2.1% | 1.8388 | 121.8 | 3.8% |
| | RL: REAL LOSSES | | | | 286.3 | 37.3% | 2961 | 8.9% | 0.4460 | 127.7 | 4.0% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | 3166.7 | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 0.78 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 128.30 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 841 | | 1.0% |
| B | Nb: Number of Separately Billed Properties | 8449 | | 2.0% |
| B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 8449 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | | | |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 8449 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 65.9 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 86.18 | | 3.7% |
| B | P: Average pressure when system pressurised (psi) | 75.0 | Yes | 5.0% |
| | P: Average pressure when system pressurised (m) | 53.0 | | 5.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.42 | 153 | 68.3 | 7.7% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.60 | 217 | 96.9 | 5.3% |
| CARL: CURRENT ANNUAL REAL LOSSES | 0.78 | 286 | 127.7 | 37.3% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 0.19 | 69 | 30.8 | 155.3% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 12.2 | 26.2% | 9.0 | 15.4 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | 8.4 | 26.2% | 6.2 | 10.6 |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 2.1 | 36.6% | 1.3 | 2.8 |
| | | % of System Input Volume (Bulk Supply Systems) | 2.1 | 36.6% | 1.3 | 2.8 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 93 | 37.4% | 58 | 128 |
| | | m3/km of mains/day, when system pressurised | 6.1 | 37.3% | 3.8 | 8.4 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 1.32 | 37.6% | 0.82 | 1.81 |

**Comments:**

Region supplied calculated based on three meters, i.e., 6T1 - 6D1 - 6D2 with meter calibration reports dated as follows:
6T1 - August 15 and Nov. 2, 2005
6D1 - no calibation provided
6D2 - May 24, 2005

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Water Rates: $70.42 for the first 30.3 cubic meters; $3.28 per 4.55 cubic meters in excess of 30.3 cubic meters
Purchase water from the region at $.0446 per cubic meter
In 2004 ILI Survey quoted as $1.54 per cubic meter applied to apparent losses therefore increase suggests $1.67 per cubic meter.

Total length of watermain allow for 3 m per hydrant (i.e., 841 hydrants x 3m = 2.523 km)

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

**DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION**

Data entry | Calculated Values | From another Worksheet

Utility: Town of Grimsby

01/01/2005 to 01/01/2006 = 365 days

System: Whole System

Calculation by: Steve Genser

Date: 04/12/2006

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | 80% have remotes, 65% roll dial remote, 14 touch pad remote, 1% radio |
| | | | | | 0.00 | 20% old imp gall with no remote |
| | | | | | 0.00 | 7.44% of billing by cards |
| | | | | | 0.00 | 4.2% of bills estimated |
| Residential | 2092.22 | | | | 2092.22 | R = Based on recordings |
| Commercial | 320.53 | | | | 320.53 | R = Based on recordings |
| Industrial | 109.80 | | | | 109.80 | R = Based on recordings |
| Institutional | 110.31 | | | | 110.31 | R = Based on recordings |
| Irrigation | 6.36 | | | | 6.36 | R = Based on recordings |
| Region | 34.13 | | | | 34.13 | R = Based on recordings |
| Town | 22.78 | | | | 22.78 | R = Based on recordings |
| Hamilton-Wentworth | 45.91 | | | | 45.91 | R = Based on recordings |
| via invoice | 85.31 | | | | 85.31 | R = Based on recordings |
| | | | | | 0.00 | |
| Hydrant Usage (mobile meter) | | | 2.12 | | 2.12 | R = Based on recordings, less Avertex |
| New Construction/Rehab | | | | 2.45 | 2.45 | E = estimated; 6 jobs x 3/job x 500 gpm x 1 hr. |
| Fire/Training | | | | 13.64 | 13.64 | E = estimated; 1 fire/yr. 2,000 Imp. Gal; Training 68 hrs/yr @ 1,000 gpm = 3,000,000 Imp. Gal |
| Hydrant Flushing | | | | 18.18 | 18.18 | E = estimated; dead-end 20 locations x 6/yr. x 3,000 Imp Gal + 3,000,000 Imp. Gal |
| Hydroguard | | | | 2.95 | 2.95 | E = estimated; 20 gpm x 6-4 hrs./day (50% of this in winter) |
| Recreation | | | | 0.47 | 0.47 | E = estimated; 3 parks approx. 6 gpm x 2 hrs/day x 5 months |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
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| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 2827.33 | 0.00 | 2.12 | 37.70 | 2867.14 | Ml |

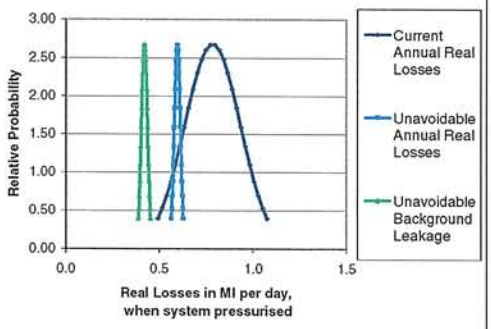
Authorised Unbilled Unmetered Consumption = 1.171% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| Hydrant Usage | 16.10 | Estimated as 0.5% of overall usage |
| By-passes | 16.10 | Estimated as 0.5% of overall usage |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 32.20 | Ml |

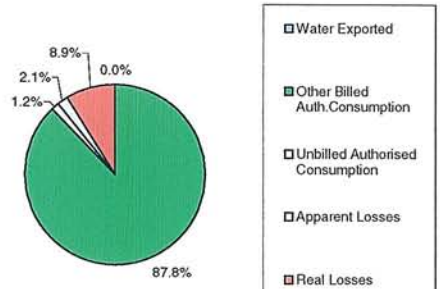
Unauthorised consumption = 1.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Grimsby | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | |

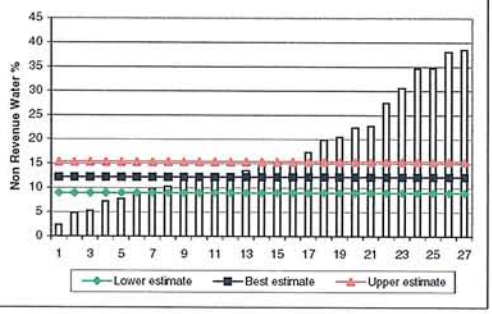
## Real Losses and 95% Confidence Limits



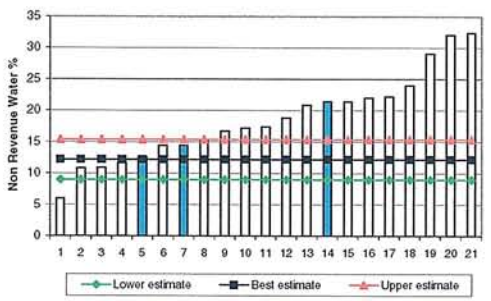

## Water Balance Components as % of System Input Volume



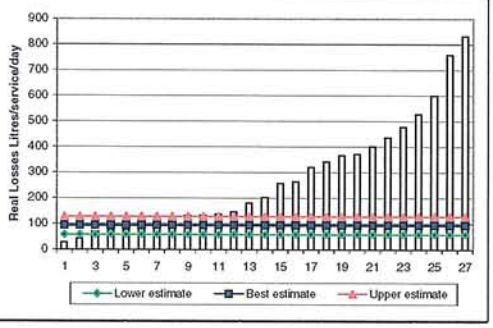

## NRW % by Volume; Comparison with International Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### Non-Revenue Water as % of System Input Volume



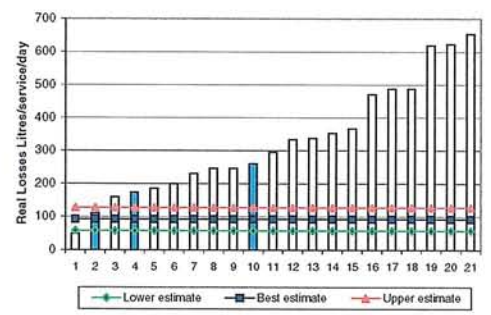

## NRW % by Volume; Comparison with North American Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### NRW as % of System Input Volume: Canadian data in blue



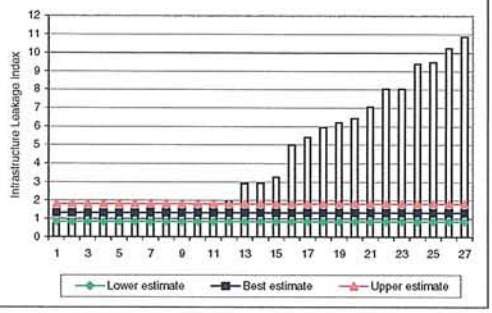

## Real Losses in litres/service connection/day
### (when system is pressurised)
### Compared with International data set
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



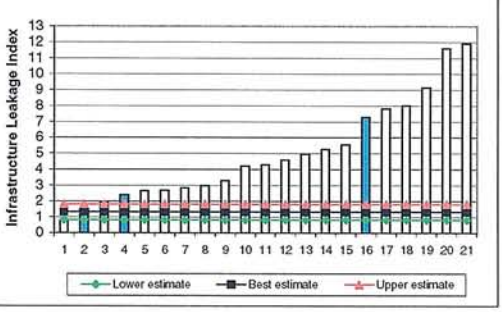

## Real Losses in litres/service connection/day
### when system is pressurised
### Compared with North American data set, Canadian data in blue
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




## Infrastructure Leakage Index ILI for Real Losses
### Compared with International data set
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)




## Infrastructure Leakage Index ILI for Real Losses
### Compared with North American data set, Canadian data in blue
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)



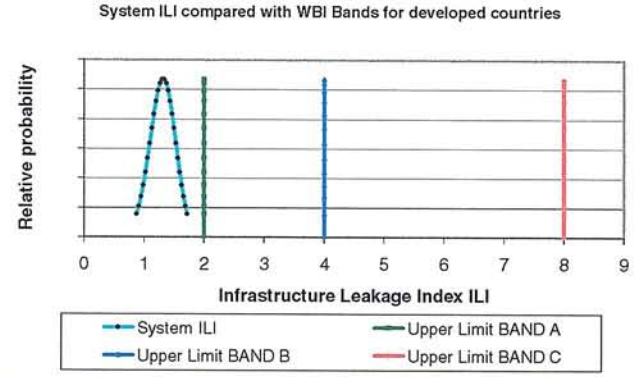
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Grimsby |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | 1.3 | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 1.3 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | Master.0000 |
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | | | Data entry | | Calculated Values | | From another Worksheet | |
| Utility | Town of Grimsby | 01/01/2005 | to | 1/1/2006 | | Number of Days in Period | 365 | days | |
| System | Whole System | Calculation by | | A.N. Other | | Date of calculation = | | | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix H

# PIFastCalc Output Lincoln

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | |
| | | | | | Data entry | Defaults | Calculated Values | | From another Worksheet | |
| | | | | | Currency = | $C | Volume units = | Ml | and | $m^3$ |
| Utility | Town of Lincoln | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 2604.7 | 3.0% | 1589 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 2604.7 | 3.0% | 1589 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 2604.7 | 3.0% | 1589 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Total | | | 2362.9 | 1.5% | 327 | 90.7% | | | |
| | BACM2: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | 0.0 | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 241.8 | 35.5% | 1916 | 9.3% | 0.5216 | 126.1 | 3.6% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 32.6 | 100.0% | 276 | 1.3% | 0.4460 | 14.5 | 0.4% |
| | WL WATER LOSSES | | | | 209.2 | 43.9% | 2192 | 8.0% | 0.5334 | 111.6 | 3.2% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 6.5 | 100.0% | 11 | 0.3% | 1.3260 | 8.6 | 0.2% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Total | 0.60% | of BACM1 | 14.3 | 7.0% | 0 | 0.5% | 1.3260 | 18.9 | 0.5% |
| | ALMUR2: Apparent Loss - meter under-registration: | | | of BACM2 | 0.0 | | 0 | 0.0% | 1.3260 | 0.0 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 1.3260 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 1.3260 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 20.8 | 31.7% | 11 | 0.8% | 1.3260 | 27.5 | 0.8% |
| | RL: REAL LOSSES | | | | 188.5 | 48.8% | 2204 | 7.2% | 0.4460 | 84.0 | 2.4% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | 3505.7 | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 0.52 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 91.50 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 532 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 5110 | | 2.0% |
| A/B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 5110 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | 0 | | |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 5110 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 55.8 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 52.12 | | 3.7% |
| C | P: Average pressure when system pressurised (psi) | 65.0 | Yes | 20.0% |
| | P: Average pressure when system pressurised (m) | 46.0 | | 20.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.21 | 77 | 34.3 | 30.1% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.32 | 118 | 52.7 | 20.1% |
| CARL: CURRENT ANNUAL REAL LOSSES | 0.52 | 188 | 84.0 | 48.8% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 0.19 | 70 | 31.4 | 135.0% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 9.3 | 35.6% | 6.0 | 12.6 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | 3.6 | 35.6% | 2.3 | 4.9 |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.8 | 31.9% | 0.5 | 1.1 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.8 | 31.9% | 0.5 | 1.1 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 101 | 48.9% | 52 | 150 |
| | | m3/km of mains/day, when system pressurised | 5.6 | 48.9% | 2.9 | 8.4 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 1.60 | 52.8% | 0.75 | 2.44 |

Comments:

Supply via Regional Municipality of Niagara meters 5D7 (Vineland), 5D8 (Vineland Service), and 6D1 (Beamsville). Calibration reports dated:

5D7; August 15 / November 2, 2005
5D8; August 15 / November 2, 2005
6D1; no report

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No breakdown of consumption provided by the Town of Lincoln, i.e., quoted single value of billed authorized consumption for the year. Confidence reflects lack of information and possibilty of lag time, etc.

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: Town of Lincoln

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by: Steve Genser

Date: 2nd July 2005

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | |
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| | | | | | 0.00 | |
| Authorised consumption sub-totals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ml |

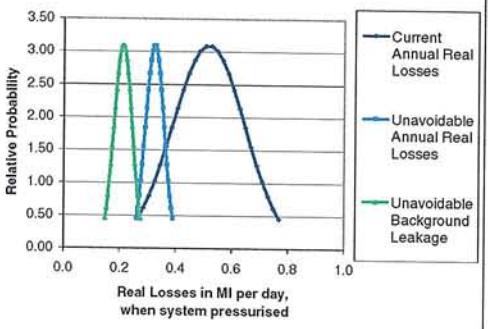
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |

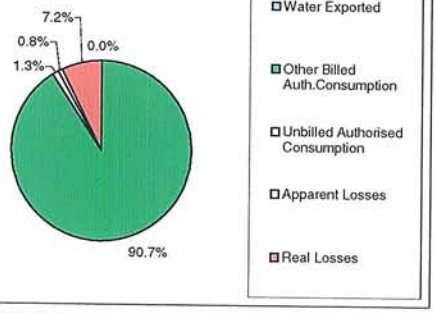
Unauthorised consumption = 0.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Lincoln | 01/01/2005 | to 01/01/2006 | 365 | days |
| System | Whole System | | | | |

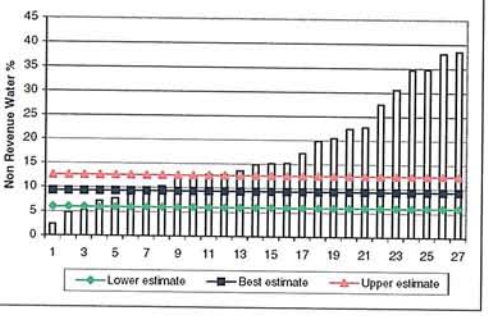
## Real Losses and 95% Confidence Limits



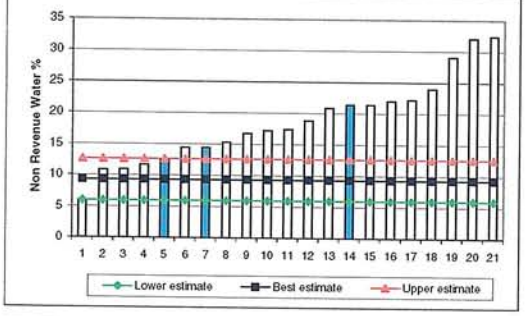

## Water Balance Components as % of System Input Volume



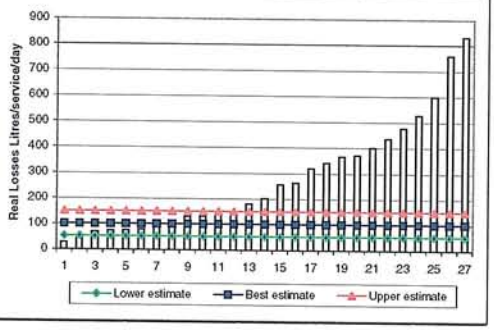

## NRW % by Volume; Comparison with International Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### Non-Revenue Water as % of System Input Volume



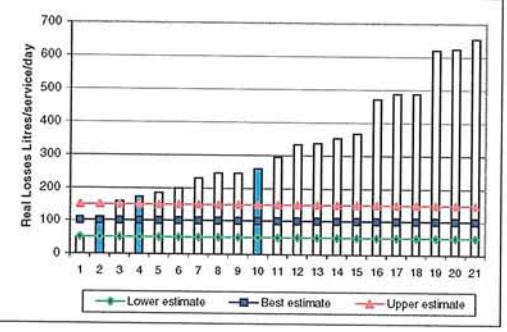

## NRW % by Volume; Comparison with North American Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### NRW as % of System Input Volume: Canadian data in blue



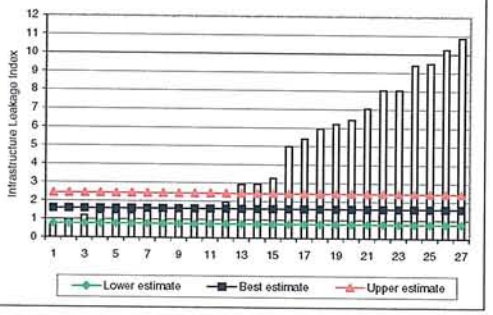

## Real Losses in litres/service connection/day
### (when system is pressurised)
### Compared with International data set
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



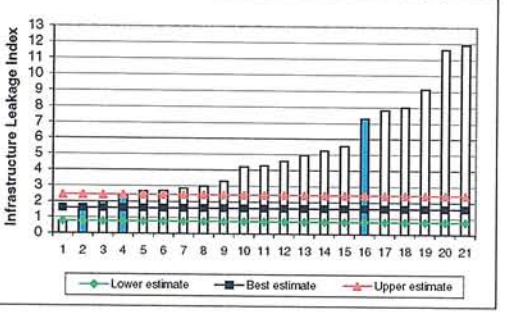

## Real Losses in litres/service connection/day
### when system is pressurised
### Compared with North American data set, Canadian data in blue
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




## Infrastructure Leakage Index ILI for Real Losses
### Compared with International data set
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)




## Infrastructure Leakage Index ILI for Real Losses
### Compared with North American data set, Canadian data in blue
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)



| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Lincoln |

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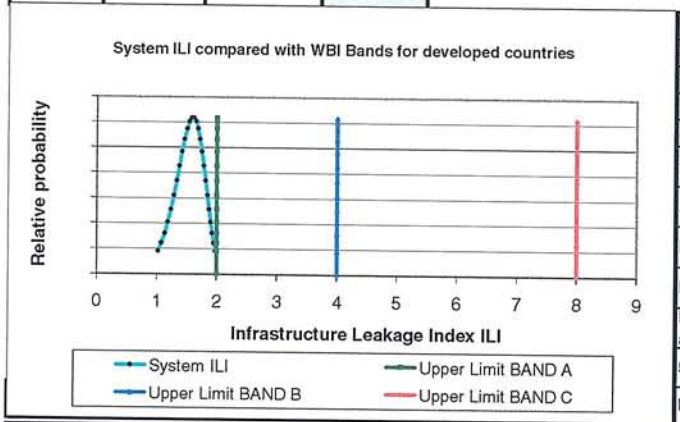
| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | 1.6 | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 1.6 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | Data entry | Calculated Values | From another Worksheet | |
| Utility: Town of Lincoln | 01/01/2005 | to 1/1/2006 | Number of Days in Period | 365 | days |
| System: Whole System | Calculation by | Steve Genser | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix I

# PIFastCalc Output
# Niagara Falls

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS | Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly | Currency = | $C | Volume units = | Ml | and | $m^3$

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Utility | City of Niagara Falls | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2004 | to | 01/01/2005 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water<br>$C/m3 | Assessed Unit Value of individual components of Non Revenue Water<br>$Cx1000 | % of cost of running system<br>% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 15872.7 | 3.0% | 59025 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 15872.7 | 3.0% | 59025 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 15872.7 | 3.0% | 59025 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Total | | | 13243.6 | 1.5% | 10273 | 83.4% | | | |
| | BACM2: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| A | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 2629.1 | 19.6% | 69297 | 16.6% | 0.0000 | 0.0 | 0.0% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 198.4 | 100.0% | 10247 | 1.3% | | 0.0 | 0.0% |
| | WL WATER LOSSES | | | | 2430.7 | 22.7% | 79545 | 15.3% | 0.0000 | 0.0 | 0.0% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 39.7 | 100.0% | 410 | 0.3% | | 0.0 | 0.0% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Total | 0.60% | of BACM1 | 79.9 | 7.0% | 8 | 0.5% | | 0.0 | 0.0% |
| | ALMUR2: Apparent Loss - meter under-registration: | | | of BACM2 | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 119.6 | 33.5% | 418 | 0.8% | 0.0000 | 0.0 | 0.0% |
| | RL: REAL LOSSES | | | | 2311.1 | 24.0% | 79963 | 14.6% | | 0.0 | 0.0% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 6.33 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 498.00 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 2775 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 27224 | | 2.0% |
| A/B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 27224 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | | | |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 27224 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 54.7 | | 3.0% |
| B/C | Lp: Average pipe length, property line to meter (m) | 18.0 | | 50.0% |
| | Lp: Total pipe length, property line to meter (km) | 490.03 | | 50.1% |
| B | P: Average pressure when system pressurised (psi) | 93.5 | Yes | 20.0% |
| | P: Average pressure when system pressurised (m) | 65.1 | | 20.0% |

### ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 2.20 | 803 | | 34.5% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 2.84 | 1037 | | 24.6% |
| CARL: CURRENT ANNUAL REAL LOSSES | 6.33 | 2311 | | 24.0% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 3.49 | 1274 | | 47.9% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 16.6 | 19.9% | 13.3 | 19.9 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | | 19.9% | | |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.8 | 33.6% | 0.5 | 1.0 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.8 | 33.6% | 0.5 | 1.0 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 233 | 24.1% | 176 | 289 |
| | | m3/km of mains/day, when system pressurised | 12.7 | 24.0% | 9.7 | 15.8 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 2.23 | 34.4% | 1.46 | 2.99 |

Comments:

Suppy via Regional Municipality of Niagara meters 1T1, 1T2, 1D1, 1D2, 1D3, and 1D4.

Accuracy reports provided for:

1D1 - May 4, 2005 and October 13, 2005
1D2 - May 4, 2005
1D3 - May 20, 2005
1D4 - May 4, 2005 tested and repaired: then replaced on October 13, 2005

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No costs for operating the system provided.

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: City of Niagara Falls

System: Whole System

01/01/2004 to 01/01/2005 = 365 days

Calculation by:

Date:

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | |
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| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ml |

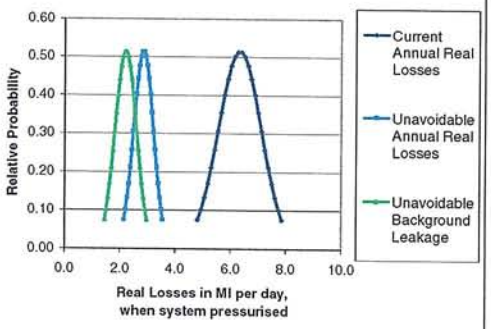
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |

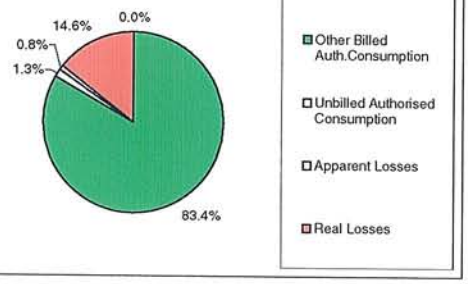
Unauthorised consumption = 0.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | City of Niagara Falls | 01/01/2004 to 01/01/2005 | 365 | days | |
| System | Whole System | | | | |

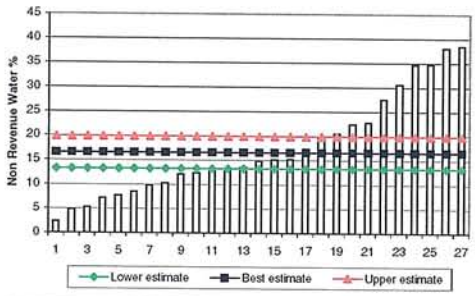
**Real Losses and 95% Confidence Limits**



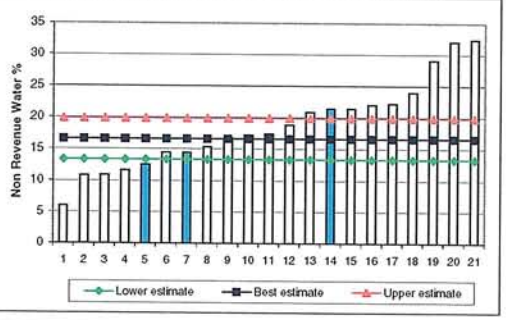

**Water Balance Components as % of System Input Volume**



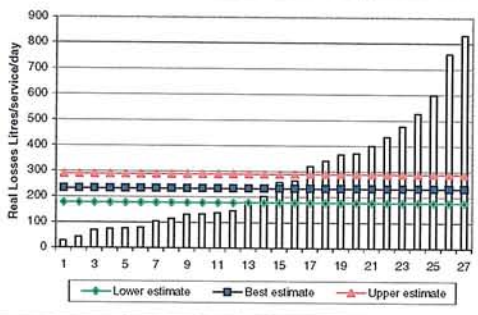

**NRW % by Volume; Comparison with International Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**Non-Revenue Water as % of System Input Volume**



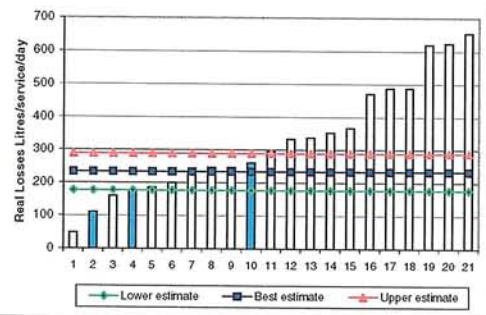

**NRW % by Volume; Comparison with North American Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**NRW as % of System Input Volume: Canadian data in blue**



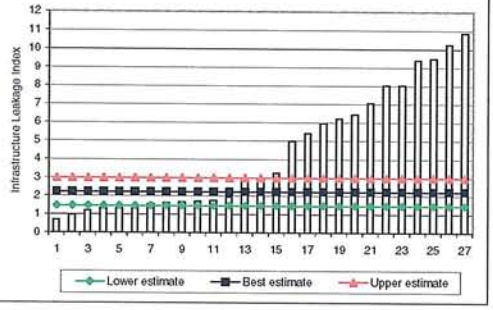

**Real Losses in litres/service connection/day**
**(when system is pressurised)**
**Compared with International data set**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



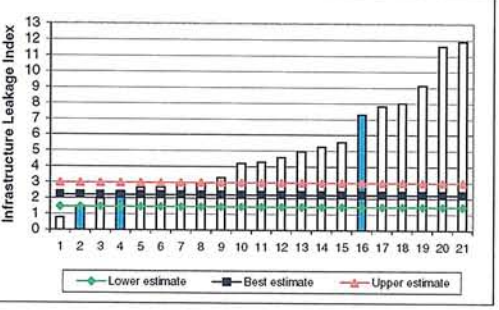

**Real Losses in litres/service connection/day**
**when system is pressurised**
**Compared with North American data set, Canadian data in blue**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with International data set**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with North American data set, Canadian data in blue**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**



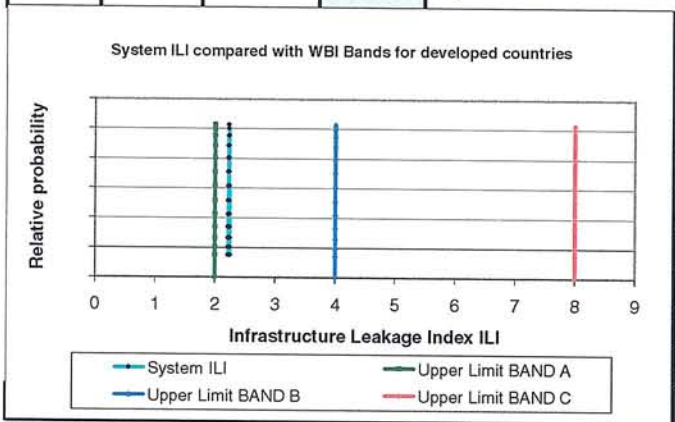
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of Niagara Falls |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | 2.2 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 2.2 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | Data entry | Calculated Values | From another Worksheet | |
| Utility: City of Niagara Falls | 01/01/2004 | to 1/1/2005 | Number of Days in Period | 365 | days |
| System: Whole System | Calculation by | Steve Genser | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix J

# PIFastCalc Output
# Niagara-on-the-Lake

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | |
| | | | | | Data entry | Defaults | Calculated Values | | From another Worksheet | |
| | | | | | Currency = | $C | Volume units = | Ml | and | $m^3$ |
| Utility | Town of Niagara-on-the-Lake | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water<br>$C/m3 | Assessed Unit Value of individual components of Non Revenue Water<br>$Cx1000 | % of cost of running system<br>% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 3183.6 | 6.0% | 9498 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 3183.6 | 6.0% | 9498 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 3183.6 | 6.0% | 9498 | 100.0% | | | |
| B/C | BACM1: Billed Authorised Consumption: Metered | Total | | | 3225.0 | 1.5% | 609 | 101.3% | | | |
| | BACM2: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| D | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | | | |
| | NRW: NON-REVENUE WATER | | | | -41.5 | -475.2% | 10107 | -1.3% | 0.0000 | 0.0 | 0.0% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 39.8 | 100.0% | 412 | 1.3% | | 0.0 | 0.0% |
| | WL WATER LOSSES | | | | -81.3 | -247.4% | 10519 | -2.6% | 0.0000 | 0.0 | 0.0% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 8.0 | 100.0% | 16 | 0.3% | | 0.0 | 0.0% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Total | 0.60% | of BACM1 | 19.5 | 7.0% | 0 | 0.6% | | 0.0 | 0.0% |
| | ALMUR2: Apparent Loss - meter under-registration: | | | of BACM2 | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 27.4 | 29.4% | 17 | 0.9% | 0.0000 | 0.0 | 0.0% |
| | RL: REAL LOSSES | | | | -108.7 | -185.1% | 10536 | -3.4% | | 0.0 | 0.0% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | -0.30 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 224.24 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 1080 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 5306 | | 2.0% |
| B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 5306 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | 0 | | |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 5306 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 23.7 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 8.5 | | 25.0% |
| | Lp: Total pipe length, property line to meter (km) | 45.10 | | 25.2% |
| C | P: Average pressure when system pressurised (psi) | 73.0 | Yes | 40.0% |
| | P: Average pressure when system pressurised (m) | 51.6 | | 40.0% |

### ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.32 | 116 | | 60.1% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.49 | 177 | | 40.1% |
| CARL: CURRENT ANNUAL REAL LOSSES | -0.30 | -109 | | -185.1% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | -0.78 | -286 | | -74.6% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | -1.3 | 475.2% | 4.9 | -7.5 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | | 475.2% | | |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.9 | 30.0% | 0.6 | 1.1 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.9 | 30.0% | 0.6 | 1.1 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | -56 | 185.1% | 48 | -160 |
| | | m3/km of mains/day, when system pressurised | -1.3 | 185.1% | 1.1 | -3.8 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | -0.61 | 189.4% | 0.55 | -1.77 |

**Comments:**

Water Supplied by Niagara Region from both Decew Falls system (5D5, 5D6 & 5D9) as well as Niagara Falls WTP (1D1, 1D2, 1D3, 1D4). Calibration reports provided as follows:

5D5, 5D6 - May 20, 2005
5D9 - no report
1D1, 1D2 - May 4, and October 13, 2005
1D3 - August 10, and November 1, 2005
1D4 - May 4 and October 13, 2005 - problematic meter at its highest accounted for 6% of overall supply.

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

No costs for operating the system provided.

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: Town of Niagara-on-the-Lake

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by

Date

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | |
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| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ml |

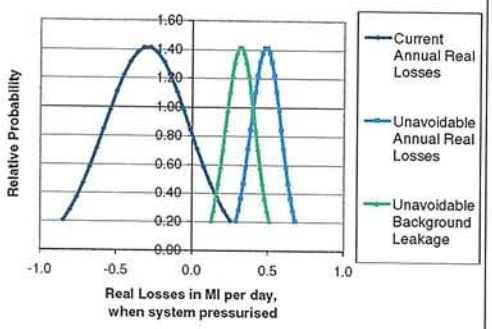
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |

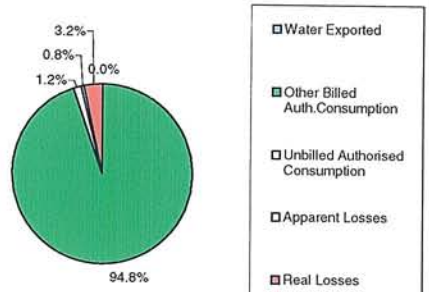
Unauthorised consumption = 0.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Niagara-on-the-Lake | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | |

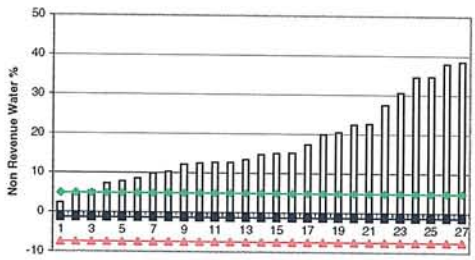
**Real Losses and 95% Confidence Limits**



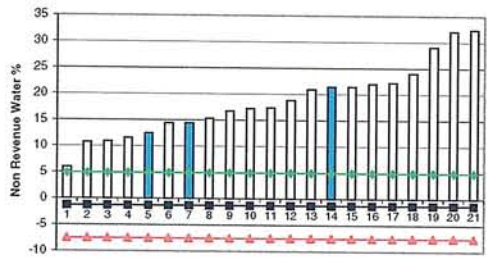

**Water Balance Components as % of System Input Volume**



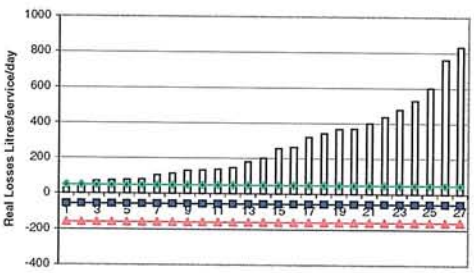

**NRW % by Volume; Comparison with International Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**Non-Revenue Water as % of System Input Volume**



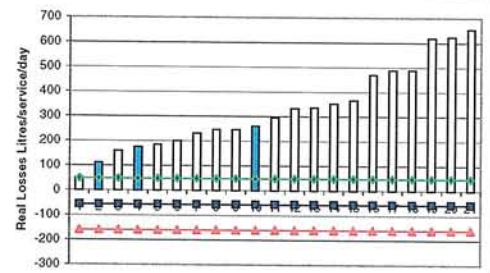

**NRW % by Volume; Comparison with North American Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**NRW as % of System Input Volume: Canadian data in blue**



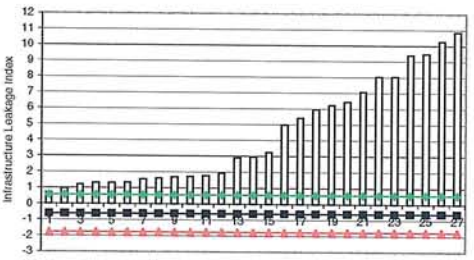

**Real Losses in litres/service connection/day**
**(when system is pressurised)**
**Compared with International data set**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



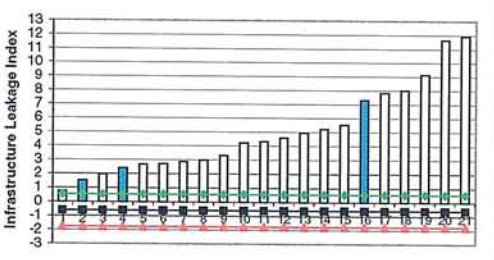

**Real Losses in litres/service connection/day**
**when system is pressurised**
**Compared with North American data set, Canadian data in blue**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with International data set**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with North American data set, Canadian data in blue**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**



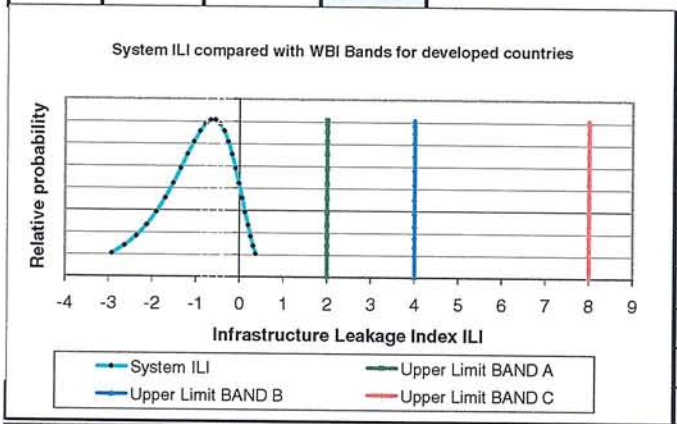
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Niagara-on-the-Lake |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | -0.6 | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | -0.6 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | Data entry | Calculated Values | From another Worksheet | |
| Utility: Town of Niagara-on-the-Lake | 01/01/2005 | to 1/1/2006 | Number of Days in Period | 365 | days |
| System: Whole System | Calculation by | Steve Genser | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | **0.0** | |
| **Internal manpower costs** | Employment costs | | **0.0** | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | **0.0** | |

**Comments:**

# Appendix K

# PIFastCalc Output Pelham

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

Currency = $C | Volume units = Ml | and m³

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Utility | Town of Pelham | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 8-Feb-07 |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | Calculated Value of NRW as % of System Running Costs in Period<br>% of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 1722.2 | 3.0% | 695 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 1722.2 | 3.0% | 695 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 1722.2 | 3.0% | 695 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Total Billed | | | 1440.4 | 1.5% | 122 | 83.6% | | | |
| | BACM2: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| A | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 281.8 | 19.9% | 816 | 16.4% | 0.4637 | 130.7 | 12.7% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 21.5 | 100.0% | 121 | 1.3% | 0.4460 | 9.6 | 0.9% |
| | WL WATER LOSSES | | | | 260.3 | 23.1% | 937 | 15.1% | 0.4652 | 121.1 | 11.7% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 4.3 | 100.0% | 5 | 0.3% | 0.8300 | 3.6 | 0.3% |
| | ALMUR1: Apparent Loss - meter under-registration: | Total Billed | 0.60% | of BACM1 | 8.7 | 7.0% | 0 | 0.5% | 0.8300 | 7.2 | 0.7% |
| | ALMUR2: Apparent Loss - meter under-registration: | | | of BACM2 | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | | 0.0 | 0.0% |
| | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 0.8300 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 13.0 | 33.4% | 5 | 0.8% | 0.8300 | 10.8 | 1.0% |
| | RL: REAL LOSSES | | | | 247.3 | 24.3% | 942 | 14.4% | 0.4460 | 110.3 | 10.7% |
| | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | 1031.7 | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 0.68 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 68.66 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 438 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 4237 | | 2.0% |
| A/B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 4237 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | 4 | | 25.0% |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 4241 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Nc/Lm | 61.8 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 43.22 | | 3.7% |
| A/B | P: Average pressure when system pressurised (psi) | 69.0 | Yes | 5.0% |
| | P: Average pressure when system pressurised (m) | 48.8 | | 5.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.19 | 68 | 30.5 | 7.7% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.28 | 102 | 45.3 | 5.3% |
| CARL: CURRENT ANNUAL REAL LOSSES | 0.68 | 247 | 110.3 | 24.3% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 0.40 | 146 | 65.0 | 41.5% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 16.4 | 20.1% | 13.1 | 19.7 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | 12.7 | 20.1% | 10.1 | 15.2 |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.8 | 33.6% | 0.5 | 1.0 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.8 | 33.6% | 0.5 | 1.0 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 160 | 24.5% | 121 | 199 |
| | | m3/km of mains/day, when system pressurised | 9.9 | 24.3% | 7.5 | 12.3 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 2.43 | 24.9% | 1.83 | 3.04 |

Comments:

Region billing equation = 3D1 + 3D2

No Calibration Reports.

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: Town of Pelham

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by

Date

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | |
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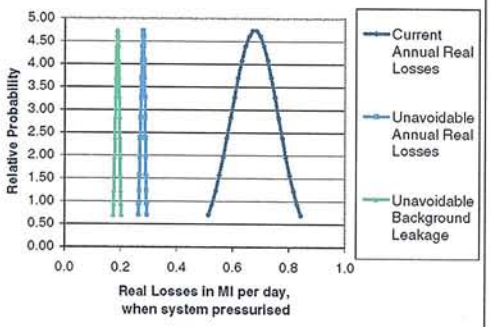
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ml |

Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

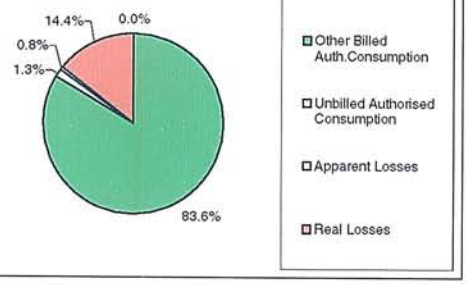
| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |
| Unauthorised consumption = | 0.000% | of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet |

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Pelham | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | |

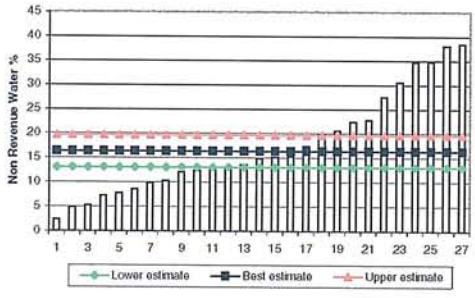
## Real Losses and 95% Confidence Limits



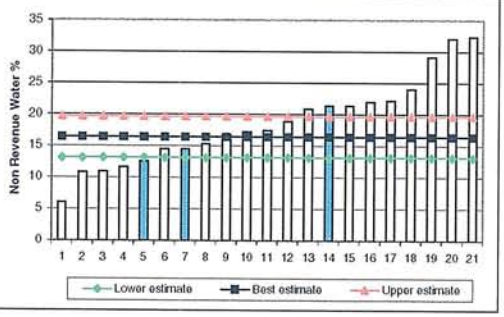

## Water Balance Components as % of System Input Volume



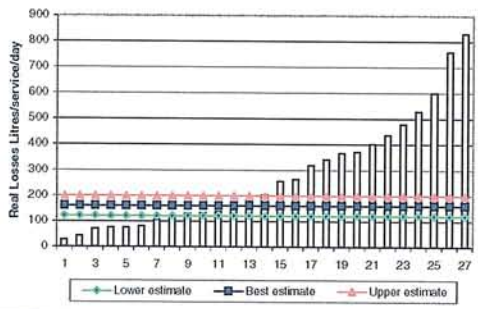

## NRW % by Volume; Comparison with International Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### Non-Revenue Water as % of System Input Volume



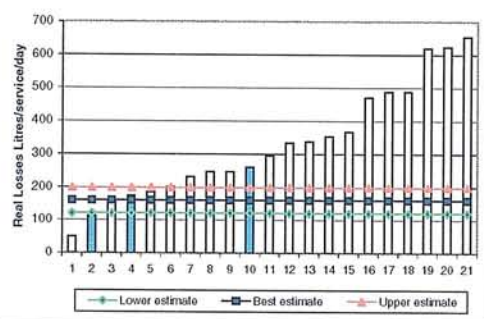

## NRW % by Volume; Comparison with North American Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### NRW as % of System Input Volume: Canadian data in blue



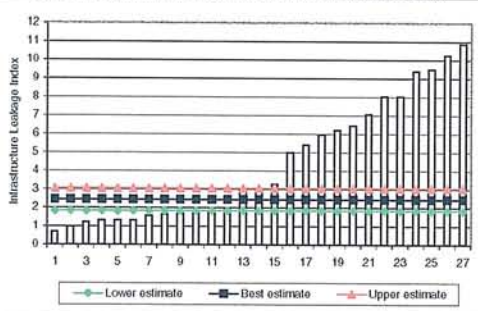

## Real Losses in litres/service connection/day
### (when system is pressurised)
### Compared with International data set
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



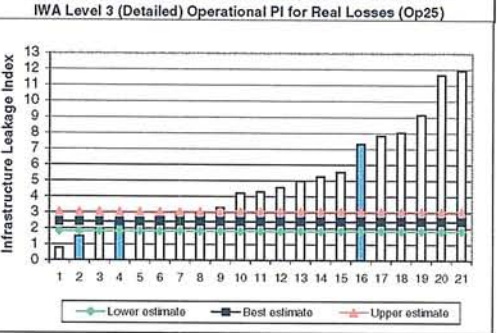

## Real Losses in litres/service connection/day
### when system is pressurised
### Compared with North American data set, Canadian data in blue
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




## Infrastructure Leakage Index ILI for Real Losses
### Compared with International data set
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)




## Infrastructure Leakage Index ILI for Real Losses
### Compared with North American data set, Canadian data in blue
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)



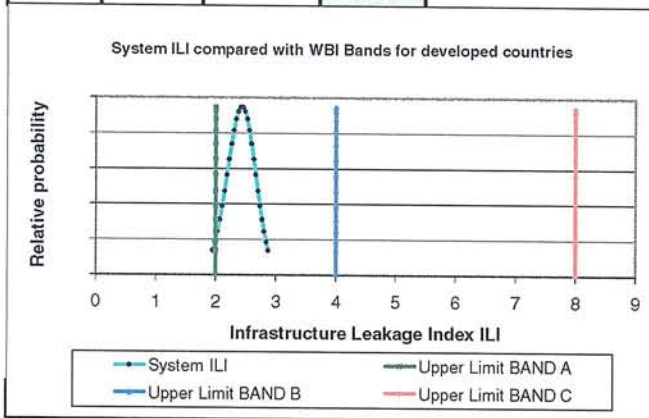
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Pelham |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | 2.4 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 2.4 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | Master.0000 |
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | | | Data entry | | Calculated Values | | From another Worksheet | |
| Utility | Town of Pelham | 01/01/2005 | to | 1/1/2006 | | Number of Days in Period | 365 | days | |
| System | Whole System | Calculation by | | Steve Genser | | Date of calculation = | 7-Sep-06 | | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix L

# PIFastCalc Output Port Colborne

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard: Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Data entry: Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

Currency = $C | Volume units = Ml | and $m^3$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Utility | Town of Port Colborne | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 3909.0 | 3.0% | 3580 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 3909.0 | 3.0% | 3580 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 3909.0 | 3.0% | 3580 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Residential | | | 1546.9 | 1.5% | 140 | 39.6% | | | |
| A | BACM2: Billed Authorised Consumption: Metered | Large Users | | | 922.9 | 1.5% | 50 | 23.6% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 1439.2 | 8.4% | 3770 | 36.8% | 0.4616 | 664.3 | 0.0% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| B | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 6.700% | of WS | 261.9 | 50.0% | 4464 | 6.7% | 0.4460 | 116.8 | 0.0% |
| | WL WATER LOSSES | | | | 1177.3 | 15.1% | 8234 | 30.1% | 0.4651 | 547.5 | 0.0% |
| C | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 9.8 | 50.0% | 6 | 0.3% | 0.7560 | 7.4 | 0.0% |
| B | ALMUR1: Apparent Loss - meter under-registration: | Residential | 0.50% | of BACM1 | 7.8 | 7.0% | 0 | 0.2% | 1.5810 | 12.3 | 0.0% |
| B | ALMUR2: Apparent Loss - meter under-registration: | Large Users | 1.00% | of BACM2 | 9.3 | 7.0% | 0 | 0.2% | 1.5810 | 14.7 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 1.5810 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 1.5810 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 26.9 | 18.5% | 6 | 0.7% | 1.2809 | 34.4 | 0.0% |
| | RL: REAL LOSSES | | | | 1150.4 | 15.5% | 8240 | 29.4% | 0.4460 | 513.1 | 0.0% |
| | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 3.15 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 138.00 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 591 | | 1.0% |
| A/B | Nb: Number of Separately Billed Properties | 5807 | | 2.0% |
| A/B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.040 | | 2.0% |
| | Ns: No. of billed Service Connections | 6039 | | 2.9% |
| B | Nu: Number of Unbilled Service Connections | 28 | | 10.0% |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 6067 | Yes | 2.9% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 44.0 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 61.60 | | 3.7% |
| A | P: Average pressure when system pressurised (psi) | 58.0 | Yes | 2.0% |
| | P: Average pressure when system pressurised (m) | 41.0 | | 2.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = $(20 \times Lm + 1.25 \times Nt + 33 \times Lp) \times (P/50)^{1.5}$

UARL in litres/day = $(18 \times Lm + 0.8 \times Nt + 25 \times Lp) \times P$

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.22 | 81 | 36.0 | 3.4% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.36 | 133 | 59.3 | 2.6% |
| CARL: CURRENT ANNUAL REAL LOSSES | 3.15 | 1150 | 513.1 | 15.5% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 2.79 | 1018 | 453.8 | 17.5% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 36.8 | 8.9% | 33.5 | 40.1 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | | 8.9% | | |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.7 | 18.7% | 0.6 | 0.8 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.7 | 18.7% | 0.6 | 0.8 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 519 | 15.7% | 438 | 601 |
| | | m3/km of mains/day, when system pressurised | 22.8 | 15.5% | 19.3 | 26.4 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 8.66 | 15.7% | 7.30 | 10.02 |

Comments:

Region billing equation = 4T1 + 4T2

Loop Calibration Reports dated October 28, 2005 highlight the following errors:

22.9 % of full scale = +26.7% error
45.8 % of full scale = + 0.1% error
76.4 % of full scale = no error
91.6 % of full scale = no error

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant (i.e., 591 hydrants x 3m = 1.773 km)

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

**DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION**

Data entry | Calculated Values | From another Worksheet

Utility: Town of Port Colborne

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by: Steve Genser

Date: 04/12/2006

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| **Residential** | 1546.89 | | | | 1546.89 | R = 4 month billing cycle |
| **Large Users** | | | | | | |
| PC General #52598 | 22.78 | | | | 22.78 | R = monthly meter reads |
| PC General #52605 | 5.85 | | | | 5.85 | R = monthly meter reads |
| PC General #52613 | 2.27 | | | | 2.27 | R = monthly meter reads |
| Riocan Holdings #53679 | 1.41 | | | | 1.41 | R = monthly meter reads |
| Riocan Holdings #53695 | 0.54 | | | | 0.54 | R = monthly meter reads |
| City of PC #54396 | 1.00 | | | | 1.00 | R = monthly meter reads |
| City of PC #54403 | 5.40 | | | | 5.40 | R = monthly meter reads |
| City of PC #54586 | 0.64 | | | | 0.64 | R = monthly meter reads |
| City of PC #54635 | 5.04 | | | | 5.04 | R = monthly meter reads |
| Inco #54734 | 23.63 | | | | 23.63 | R = monthly meter reads |
| Inco #54768 | 19.42 | | | | 19.42 | R = monthly meter reads |
| Inco #63545 | 26.64 | | | | 26.64 | R = monthly meter reads |
| Region #57291 | 1.02 | | | | 0.00 | R = monthly meter reads |
| Region #64816 | 10.43 | | | | 10.43 | R = monthly meter reads |
| Region #64874 | 2.16 | | | | 2.16 | R = monthly meter reads |
| Robin Hood | 36.08 | | | | 36.08 | R = monthly meter reads |
| Mermaid Ent | 52.10 | | | | 52.10 | R = monthly meter reads |
| PC Poultry | 284.53 | | | | 284.53 | R = monthly meter reads |
| H2O #55435 | 0.11 | | | | 0.11 | R = monthly meter reads |
| H2O #64501 | 0.11 | | | | 0.11 | R = monthly meter reads |
| John Boys #55443 | 9.20 | | | | 9.20 | R = monthly meter reads |
| John Boys #64501 | 3.81 | | | | 3.81 | R = monthly meter reads |
| Sunshine Trucking #55451 | 7.62 | | | | 7.62 | R = monthly meter reads |
| Sunshine Trucking #5500 | 22.27 | | | | 22.27 | R = monthly meter reads |
| KNT Water Haulage #55477 | 36.64 | | | | 36.64 | R = monthly meter reads |
| KNT Water Haulage | 1.29 | | | | 1.29 | R = monthly meter reads |
| Canada Starch #63694 | 38.60 | | | | 38.60 | R = monthly meter reads |
| Canada Starch #63701 | 242.40 | | | | 242.40 | R = monthly meter reads |
| Jim Buccione #64056 | 16.70 | | | | 16.70 | R = monthly meter reads |
| Jim Buccione #64155 | 2.40 | | | | 2.40 | R = monthly meter reads |
| Chamber Water Haul #64072 | 8.78 | | | | 8.78 | R = monthly meter reads |
| Chamber Water Haul #64121 | 1.83 | | | | 1.83 | R = monthly meter reads |
| JBL #64139 | 0.06 | | | | 0.06 | R = monthly meter reads |
| JBL #64147 | 9.64 | | | | 9.64 | R = monthly meter reads |
| Aqualine Water #64866 | 20.26 | | | | 20.26 | R = monthly meter reads |
| Aqualine Water #65517 | 0.27 | | | | 0.27 | R = monthly meter reads |
| | | | | | 0.00 | |
| **Unbilled, Authorized, Consumption** | | | | | 0.00 | |
| Hydrant Flushing | | | | 0.01 | 0.01 | E = estimated |
| Fire Fighting | | | | 0.04 | 0.04 | E = estimated |
| Watermain Breaks | | | | 0.77 | 0.77 | E = estimated |
| Frozen Services | | | | 0.03 | 0.03 | E = estimated |
| Water Quality | | | | 0.09 | 0.09 | E = estimated |
| Public Works | | | | 0.00 | 0.00 | E = estimated |
| Fares St. Water main | | | | 0.00 | 0.00 | E = estimated |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sports Complex | | | | 0.01 | 0.01 | E = estimated |
| Water main repairs | | | | 0.06 | 0.06 | E = estimated |
| Bulk Water Station | | | | 0.01 | 0.01 | E = estimated |
| | | | | | 0.00 | |
| **Authorised consumption sub-totals** | 2469.81 | 0.00 | 0.00 | 1.04 | 2470.84 | Ml |

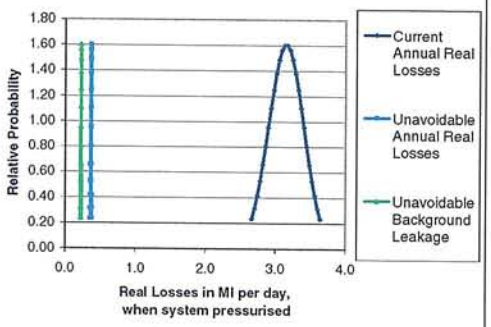
| | | |
|---|---|---|
| **Authorised Unbilled Unmetered Consumption =** | 0.026% | **of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet** |

| **Components of Unauthorised Consumption** | **Ml** | **Method of estimation** |
|---|---|---|
| By-pass tampering | | Estimated based on five houshold per year |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| **Unauthorised consumption sub-total** | 0.00 | Ml |

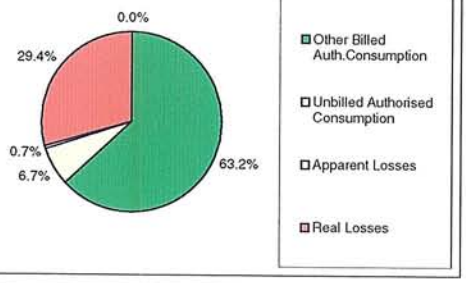
| | | |
|---|---|---|
| **Unauthorised consumption =** | 0.000% | **of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet** |

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | Town of Port Colborne | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | |

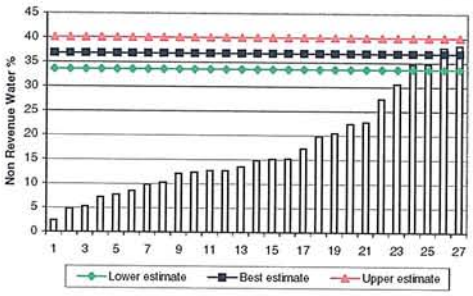
## Real Losses and 95% Confidence Limits



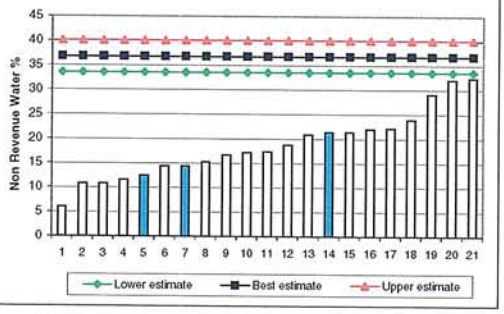

## Water Balance Components as % of System Input Volume




## NRW % by Volume; Comparison with International Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### Non-Revenue Water as % of System Input Volume

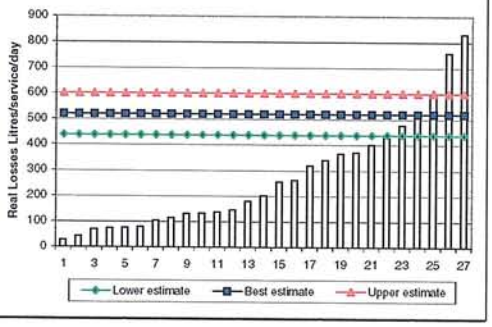



## NRW % by Volume; Comparison with North American Data Set
### IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)
### NRW as % of System Input Volume: Canadian data in blue



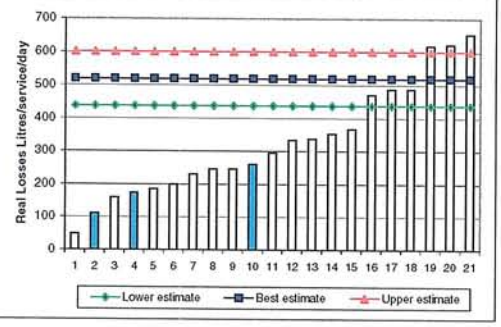

## Real Losses in litres/service connection/day
### (when system is pressurised)
### Compared with International data set
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)

Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains

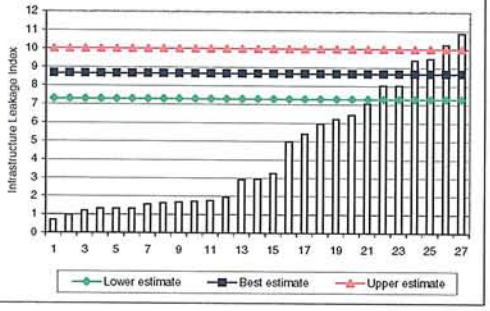



## Real Losses in litres/service connection/day
### when system is pressurised
### Compared with North American data set, Canadian data in blue
### IWA Level 1 (Basic) Operational PI for Real Losses (Op24)

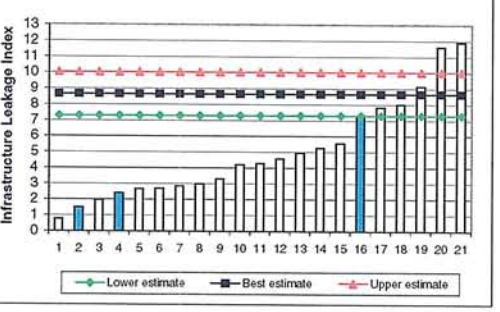
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




## Infrastructure Leakage Index ILI for Real Losses
### Compared with International data set
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)




## Infrastructure Leakage Index ILI for Real Losses
### Compared with North American data set, Canadian data in blue
### IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)



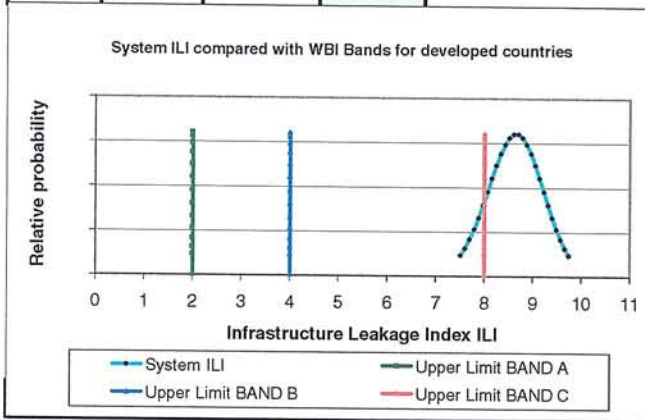
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Town of Port Colborne |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | 8.7 | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | 8.7 | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | | Data entry | | Calculated Values | From another Worksheet | |
| Utility | Town of Port Colborne | 01/01/2005 to | 1/1/2006 | | Number of Days in Period | 365 | days |
| System | Whole System | Calculation by | Steve Genser | | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| Sum of Operational Costs | All the above operational costs | | 0.0 | |
| Internal manpower costs | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| Capitalised cost of self-constructed assets | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| Total Running Costs | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

Comments:

# Appendix M

# PIFastCalc Output
# St. Catharines

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

Currency = $C | Volume units = Ml | and m³

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Utility | City of St. Catharines | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2004 | to | 01/01/2005 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS | | | | Volume in period | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | IWA Terminology | | | | | | | % of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period | | |
| | COMPONENTS OF WATER BALANCE | | | | Ml | | | | Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 21823.7 | 3.0% | 111580 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 21823.7 | 3.0% | 111580 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 21823.7 | 3.0% | 111580 | 100.0% | | | |
| A | BACM1: Billed Authorised Consumption: Metered | Cycles | | | 17067.9 | 1.5% | 17062 | 78.2% | | | |
| A | BACM2: Billed Authorised Consumption: Metered | Bulk Metering & Industrial | | | 2409.6 | 1.5% | 340 | 11.0% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 2346.2 | 30.0% | 128982 | 10.8% | 0.4626 | 1085.4 | 0.0% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | 0.0 | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 272.8 | 100.0% | 19372 | 1.3% | 0.4460 | 121.7 | 0.0% |
| | WL WATER LOSSES | | | | 2073.4 | 36.4% | 148353 | 9.5% | 0.4648 | 963.7 | 0.0% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 54.6 | 100.0% | 775 | 0.3% | 0.4460 | 24.3 | 0.0% |
| B | ALMUR1: Apparent Loss - meter under-registration: | Cycles | 0.50% | of BACM1 | 85.8 | 7.0% | 9 | 0.4% | 0.8000 | 68.6 | 0.0% |
| B | ALMUR2: Apparent Loss - meter under-registration: | Bulk Metering & Industrial | 1.00% | of BACM2 | 24.3 | 7.0% | 1 | 0.1% | 0.8000 | 19.5 | 0.0% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 0.8000 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 0.8000 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 164.7 | 33.3% | 785 | 0.9% | 0.6827 | 112.4 | 0.0% |
| | RL: REAL LOSSES | | | | 1908.7 | 39.7% | 149138 | 8.7% | 0.4460 | 851.3 | 0.0% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 5.23 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 541.40 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 3803 | | 1.0% |
| B | Nb: Number of Separately Billed Properties | 41210 | | 2.0% |
| B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 41210 | | 2.8% |
| C | Nu: Number of Unbilled Service Connections | 0 | | |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 41210 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 76.1 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 7.0 | | 50.0% |
| | Lp: Total pipe length, property line to meter (km) | 288.47 | | 50.1% |
| C | P: Average pressure when system pressurised (psi) | 65.0 | Yes | 25.0% |
| | P: Average pressure when system pressurised (m) | 46.0 | | 25.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 1.52 | 555 | 247.7 | 38.6% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 2.29 | 837 | 373.5 | 26.1% |
| CARL: CURRENT ANNUAL REAL LOSSES | 5.23 | 1909 | 851.3 | 39.7% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 2.94 | 1071 | 477.8 | 73.5% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 10.8 | 30.2% | 7.5 | 14.0 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | | 30.2% | | |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.8 | 33.5% | 0.5 | 1.0 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.8 | 33.5% | 0.5 | 1.0 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 127 | 39.8% | 76 | 177 |
| | | m3/km of mains/day, when system pressurised | 9.7 | 39.7% | 5.8 | 13.5 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 2.28 | 47.5% | 1.20 | 3.36 |

Comments:

Region Billing Equation = (5T1+5T2+5T3+5T4+5T5)-5D1-5D2-5D3-5D4-5D5-5D6-5D7-5D8-5D9

5T1, 5T2, 5T3 - June 30 & November 1, 2005
5T4 - no report
5T5 - June 30, 2005

5D1, 5D2, 5D5, 5D6 - May 20, 2005
5D3 - May 24, 2005
5D7 & 5D8 - August 15 & November 2, 2005
5D9 no report

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Allowance for 3m hydrant lead for each hydrant built in to kilometers of water main.

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

**DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION**

Data entry | Calculated Values | From another Worksheet

Utility: City of St. Catharines

System: Whole System

01/01/2004 to 01/01/2005 = 365 days

Calculation by: Steve Genser

Date: 04/12/2006

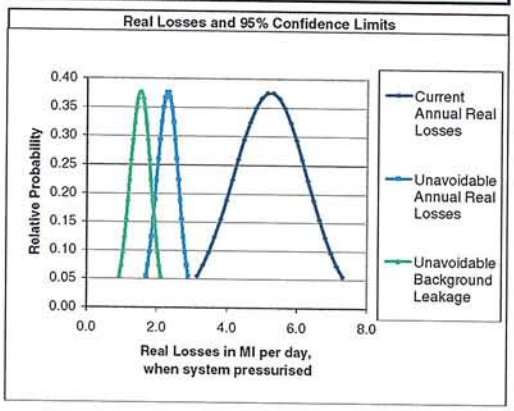
| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| Section A | 3153.17 | | | | 3153.17 | |
| Section B | 1449.65 | | | | 1449.65 | |
| Section C | 1783.46 | | | | 1783.46 | |
| Section D | 1548.20 | | | | 1548.20 | |
| Section E | 2590.82 | | | | 2590.82 | |
| Section F | 2002.50 | | | | 2002.50 | |
| Section G | 1506.47 | | | | 1506.47 | |
| Section H | 1612.77 | | | | 1612.77 | |
| Section I | 358.17 | | | | 358.17 | |
| Section J (Seasonal) | 55.77 | | | | 55.77 | |
| Section K (Bulk Water) | 26.33 | | | | 26.33 | |
| Section L (Large Industrial) | 2222.82 | | | | 2222.82 | |
| Manual Billing Adjustments | 205.70 | | | | 205.70 | |
| | | | | | 0.00 | |
| Year End Accruals | | | | | 0.00 | |
| | | | | | 0.00 | |
| Section D | 843.15 | | | | 843.15 | |
| Section K | 2.51 | | | | 2.51 | |
| Section L | 157.95 | | | | 157.95 | |
| | | | | | 0.00 | |
| partial section accrual | 2637.19 | | | | 2637.19 | |
| reverse opening accrual | -2203.94 | | | | -2203.94 | |
| | | | | | 0.00 | |
| 176 flat rate customers | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 19952.69 | 0.00 | 0.00 | 0.00 | 19952.69 | Ml |

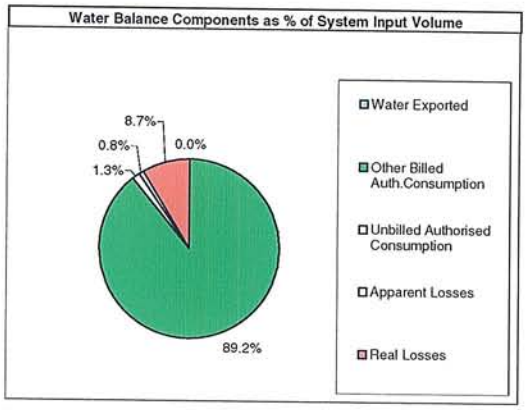
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

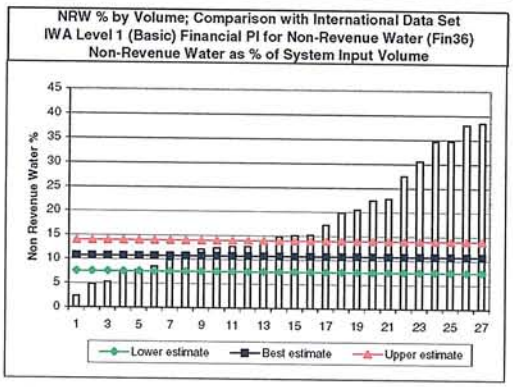
| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |

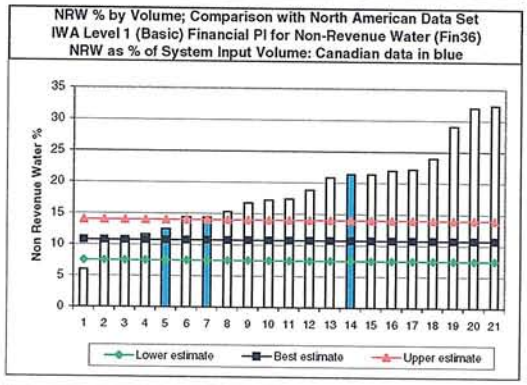
Unauthorised consumption = 0.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

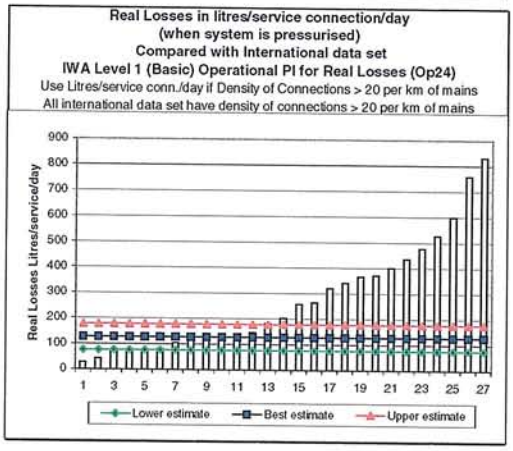
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | City of St. Catharines | 01/01/2004 to 01/01/2005 | 365 | days | |
| System | Whole System | | | | |

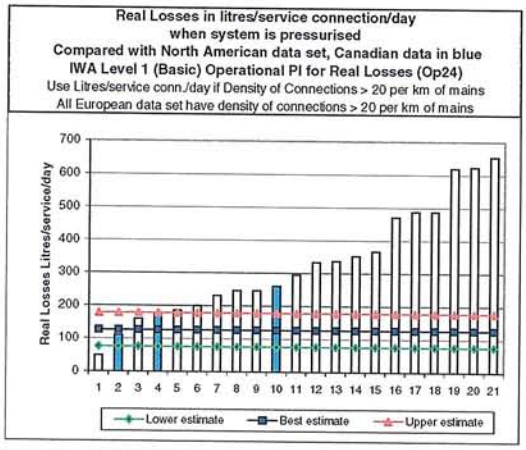


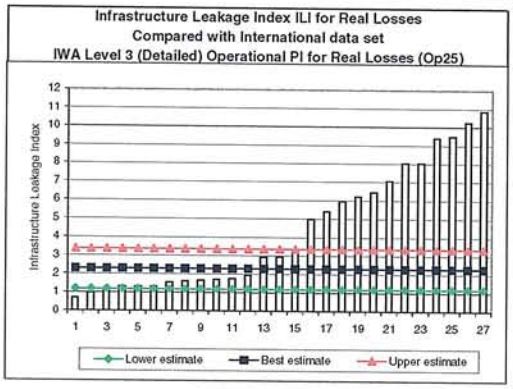



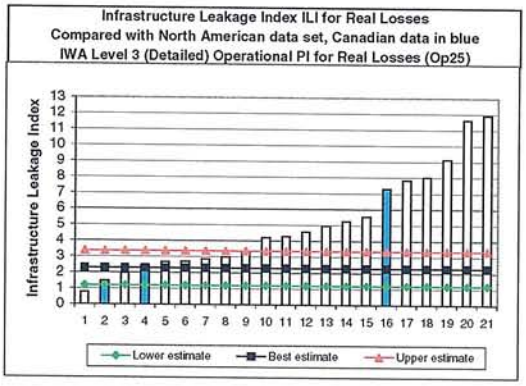



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|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of St. Catharines |

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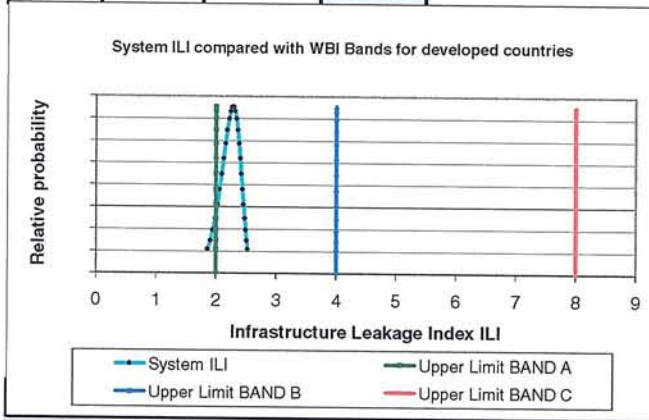
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | 2.3 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 2.3 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | Data entry | | Calculated Values | From another Worksheet | |
| Utility: City of St. Catharines | 01/01/2004 | to 1/1/2005 | Number of Days in Period | 365 | days |
| System: Whole System | Calculation by | Steve Genser | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**

# Appendix N

# PIFastCalc Output Thorold

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

Standard | Version 1a | 2nd Dec 2005 | Canada

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Data entry | Defaults | Calculated Values | From another Worksheet

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

Currency = $C | Volume units = Ml | and m³

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Utility | City of Thorold | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual components of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 3187.3 | 3.0% | 2380 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 3187.3 | 3.0% | 2380 | 100.0% | | | |
| A | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 3187.3 | 3.0% | 2380 | 100.0% | | | |
| B/C | BACM1: Billed Authorised Consumption: Metered | Residential (~ 70%) | | | 1670.5 | 1.5% | 163 | 52.4% | | | |
| B/C | BACM2: Billed Authorised Consumption: Metered | ICI (~ 30%) | | | 715.9 | 1.5% | 30 | 22.5% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $C/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 800.9 | 12.4% | 2573 | 25.1% | 0.4850 | 388.4 | 14.7% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 39.8 | 100.0% | 413 | 1.3% | 0.4460 | 17.8 | 0.7% |
| | WL WATER LOSSES | | | | 761.0 | 14.1% | 2987 | 23.9% | 0.4870 | 370.6 | 14.0% |
| D | UC: Unauthorised Consumption: | Estimated as | 0.250% | of WS | 8.0 | 100.0% | 17 | 0.3% | 1.7690 | 14.1 | 0.5% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Residential (~ 70%) | 0.50% | of BACM1 | 8.4 | 7.0% | 0 | 0.3% | 1.7690 | 14.8 | 0.6% |
| B/C | ALMUR2: Apparent Loss - meter under-registration: | ICI (~ 30%) | 1.00% | of BACM2 | 7.2 | 7.0% | 0 | 0.2% | 1.7690 | 12.8 | 0.5% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 1.7690 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 1.7690 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 23.6 | 33.9% | 17 | 0.7% | 1.7690 | 41.7 | 1.6% |
| | RL: REAL LOSSES | | | | 737.4 | 14.6% | 3003 | 23.1% | 0.4460 | 328.9 | 12.4% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | Cost of running system in period = | | | 2648.4 | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 2.02 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 90.60 | Yes | 1.0% |
| A | Nh: Number of Fire Hydrants | 600 | | 1.0% |
| B | Nb: Number of Separately Billed Properties | 6269 | | 2.0% |
| B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 6269 | | 2.8% |
| B | Nu: Number of Unbilled Service Connections | 25 | | 10.0% |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 6294 | Yes | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 69.5 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 10.2 | | 2.4% |
| | Lp: Total pipe length, property line to meter (km) | 63.94 | | 3.7% |
| A | P: Average pressure when system pressurised (psi) | 62.0 | Yes | 1.0% |
| | P: Average pressure when system pressurised (m) | 43.8 | | 1.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.23 | 85 | 37.9 | 2.4% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.36 | 132 | 59.0 | 2.1% |
| CARL: CURRENT ANNUAL REAL LOSSES | 2.02 | 737 | 328.9 | 14.6% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 1.66 | 605 | 269.9 | 17.8% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 25.1 | 12.8% | 21.9 | 28.3 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | 14.7 | 12.8% | 12.8 | 16.5 |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.7 | 34.1% | 0.5 | 1.0 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.7 | 34.1% | 0.5 | 1.0 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 321 | 14.8% | 273 | 369 |
| | | m3/km of mains/day, when system pressurised | 22.3 | 14.6% | 19.0 | 25.6 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 5.58 | 14.7% | 4.76 | 6.40 |

Comments:

Region billing equation = 1D4+5D1-5D2+5D3+5D4; Calibration reports as follows:

5D1 & 5D2 - May 20
5D3 - May 24
5D4 - No report
1D4 - calibration report for May 4 illustrates the meter was significantly under-registering and was repaired.
- calibration report on Oct. 13 illustrates the meter was again under-registering and was repaired.

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: City of Thorold

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by:

Date:

| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| | | | | | 0.00 | |
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| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Ml |

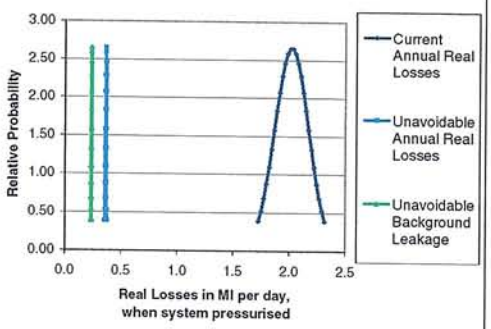
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.00 | Ml |

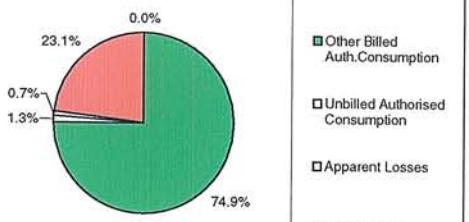
Unauthorised consumption = 0.000% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|
| Utility | City of Thorold | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | |

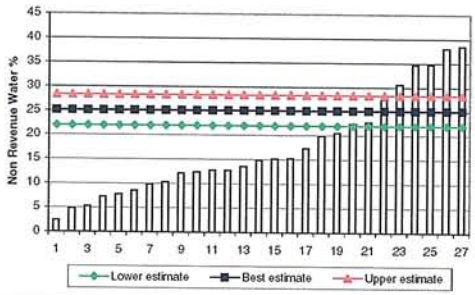
**Real Losses and 95% Confidence Limits**



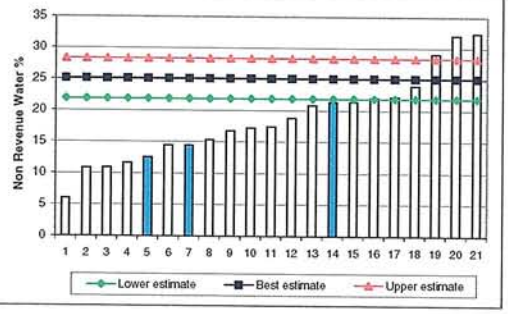

**Water Balance Components as % of System Input Volume**



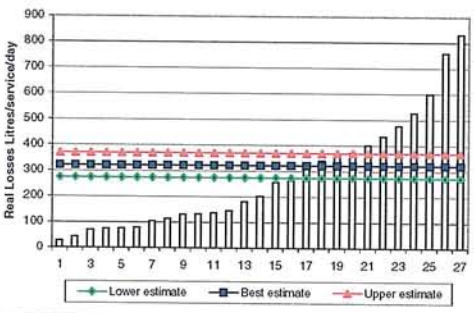

**NRW % by Volume; Comparison with International Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**Non-Revenue Water as % of System Input Volume**



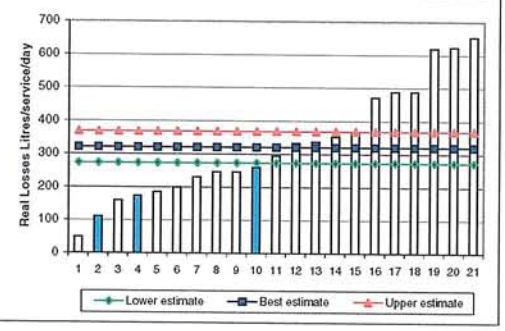

**NRW % by Volume; Comparison with North American Data Set**
**IWA Level 1 (Basic) Financial PI for Non-Revenue Water (Fin36)**
**NRW as % of System Input Volume: Canadian data in blue**



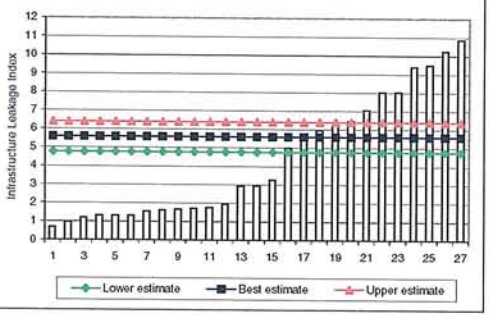

**Real Losses in litres/service connection/day**
**(when system is pressurised)**
**Compared with International data set**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All international data set have density of connections > 20 per km of mains



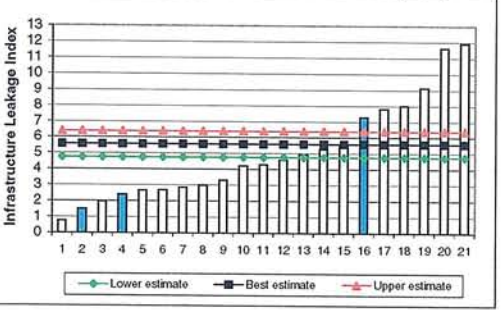

**Real Losses in litres/service connection/day**
**when system is pressurised**
**Compared with North American data set, Canadian data in blue**
**IWA Level 1 (Basic) Operational PI for Real Losses (Op24)**
Use Litres/service conn./day if Density of Connections > 20 per km of mains
All European data set have density of connections > 20 per km of mains




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with International data set**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**




**Infrastructure Leakage Index ILI for Real Losses**
**Compared with North American data set, Canadian data in blue**
**IWA Level 3 (Detailed) Operational PI for Real Losses (Op25)**



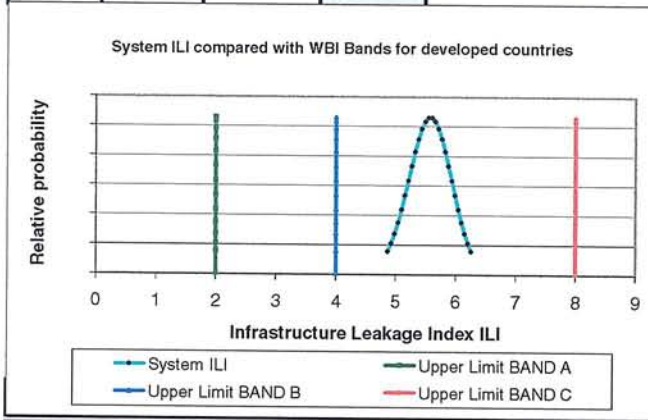
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | City of Thorold |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | 5.6 | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | 5.6 | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | Master.0000 |
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | | | Data entry | | Calculated Values | | From another Worksheet | |
| Utility | City of Thorold | 01/01/2005 | to | 1/1/2006 | | Number of Days in Period | 365 | days | |
| System | Whole System | Calculation by | | Steve Genser | | Date of calculation = | 12/4/2006 | | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| Sum of Operational Costs | All the above operational costs | | 0.0 | |
| Internal manpower costs | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| Capitalised cost of self-constructed assets | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| Total Running Costs | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

Comments:

# Appendix O

# PIFastCalc Output
# West Lincoln

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

ANNUAL WATER BALANCE CALCULATION IN IWA STANDARD FORMAT, WITH 95% CONFIDENCE LIMITS

Note:Calculations should be based on a 12-month period for all aspects of the worksheet to function correctly

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Standard | Version 1a | 2nd Dec 2005 | | Canada | |
| | | | | | Data entry | Defaults | Calculated Values | | From another Worksheet | |
| | | | | | Currency = | $C | Volume units = | Ml | and | $m^3$ |
| Utility | Township of West Lincoln | Bulk supply (BS) or Distribution System (DS)? | DS | | 01/01/2005 | to | 01/01/2006 | = | 365 | days |
| System | Whole System | Do most customers have storage tanks? | No | | Calculation by | Steve Genser | | Date | 4-Dec-06 | |

| Process Reliability Band | WATER BALANCE CALCULATIONS<br>IWA Terminology<br>COMPONENTS OF WATER BALANCE | | | | Volume in period<br>Ml | 95% Confidence Limit as +/- % | Variance | FINANCIAL PERFORMANCE INDICATORS FOR NON-REVENUE WATER<br>% of System Input Volume | Calculated Value of NRW as % of System Running Costs in Period<br>Assessed marginal cost of individual components of Non-Revenue Water | Assessed Unit Value of individual componente of Non Revenue Water | % of cost of running system |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WOS: Volume from Own Sources (corrected for known systematic errors) | | | | | | 0 | 0.0% | | | |
| A | WI: Water Imported (corrected for known systematic errors) | | | | 827.4 | 3.0% | 160 | 100.0% | | | |
| | SIV: SYSTEM INPUT VOLUME | | | | 827.4 | 3.0% | 160 | 100.0% | | | |
| | BACE:Water Exported | | | | | | 0 | 0.0% | | | |
| | WS: WATER SUPPLIED = SIV - BACE | | | | 827.4 | 3.0% | 160 | 100.0% | | | |
| A/B | BACM1: Billed Authorised Consumption: Metered | Residential / ICI | | | 558.8 | 1.5% | 10 | 67.5% | | | |
| A | BACM2: Billed Authorised Consumption: Metered | Bulk metering | | | 162.7 | 1.5% | 2 | 19.7% | | | |
| | BACM3: Billed Authorised Consumption: Metered | | | | | | 0 | 0.0% | | | |
| | BACU: Billed Authorised Consumption:Unmetered | | | | | | 0 | 0.0% | $/m3 | $Cx1000 | % |
| | NRW: NON-REVENUE WATER | | | | 105.9 | 24.8% | 180 | 12.8% | 0.4598 | 48.7 | 13.1% |
| A | UACM: Unbilled Authorised Consumption: Metered | | 0.00% | of WS | | | 0 | 0.0% | 0.4460 | 0.0 | 0.0% |
| D | UACU: Unbilled Authorised Consumption: Unmetered: | Estimated as | 1.250% | of WS | 10.3 | 100.0% | 28 | 1.3% | 0.4460 | 4.6 | 1.2% |
| | WL WATER LOSSES | | | | 95.6 | 29.6% | 208 | 11.6% | 0.4613 | 44.1 | 11.8% |
| C | UC: Unauthorised Consumption: | Estimated as | 0.020% | of WS | 0.2 | 50.0% | 0 | 0.0% | | 0.0 | 0.0% |
| B/C | ALMUR1: Apparent Loss - meter under-registration: | Residential / ICI | 0.50% | of BACM1 | 2.8 | 7.0% | 0 | 0.3% | 0.7919 | 2.2 | 0.6% |
| | ALMUR2: Apparent Loss - meter under-registration: | Bulk metering | 1.00% | of BACM2 | 1.6 | 7.0% | 0 | 0.2% | 0.7919 | 1.3 | 0.3% |
| | ALMUR3: Apparent Loss - meter under-registration: | | | of BACM3 and UACM | 0.0 | | 0 | 0.0% | 0.7919 | 0.0 | 0.0% |
| D | ALDCD Customer meter data handling errors | | | | | | 0 | 0.0% | 0.7919 | 0.0 | 0.0% |
| | AL: Sum of APPARENT LOSSES | | | | 4.6 | 5.2% | 0 | 0.6% | 0.7635 | 3.5 | 0.9% |
| | RL: REAL LOSSES | | | | 91.0 | 31.1% | 208 | 11.0% | 0.4460 | 40.6 | 10.9% |
| A | % of period system pressurized = | 100.0% | 365.0 | days | | | | Cost of running system in period = | | 372.8 | $Cx1000 |
| | CARL: CURRENT ANNUAL REAL LOSSES (when system is pressurized) | | | | 0.25 | Ml/day | | | | | |

| Process Reliability Band | SYSTEM INFRASTRUCTURE AND PRESSURE DATA | | Valid for UARL& ILI calc? | 95% CLs as +/- % |
|---|---|---|---|---|
| A | Lm: Mains Length, km | 28.53 | No | 1.0% |
| A | Nh: Number of Fire Hydrants | 175 | | 1.0% |
| B | Nb: Number of Separately Billed Properties | 1755 | | 2.0% |
| B | R: Ratio of billed Service Connections (Ns, main to property line) to Billed Props (Nb) | 1.000 | | 2.0% |
| | Ns: No. of billed Service Connections | 1755 | | 2.8% |
| B | Nu: Number of Unbilled Service Connections | 6 | | 16.0% |
| | Nt: Total Number of Service Conns (= Ns + Nu), mains to property line | 1761 | No | 2.8% |
| | DC: Density of Connections/ km of mains = Ns/Lm | 61.7 | | 3.0% |
| B | Lp: Average pipe length, property line to meter (m) | 9.0 | | 11.0% |
| | Lp: Total pipe length, property line to meter (km) | 15.80 | | 11.4% |
| B | P: Average pressure when system pressurised (psi) | 62.0 | Yes | 10.0% |
| | P: Average pressure when system pressurised (m) | 43.8 | | 10.0% |

ASSESSMENT OF UNAVOIDABLE REAL LOSSES, AND VOLUME AND COST OF POTENTIALLY RECOVERABLE REAL LOSSES

Notes: If Lm and Lp are in km and pressure P is in metres

UBL in litres/hour = (20 x Lm + 1.25 x Nt + 33 x Lp) x $(P/50)^{1.5}$

UARL in litres/day = (18 x Lm + 0.8 x Nt + 25 x Lp) x P

| COMPONENT OF REAL LOSSES | Ml per day | Ml in period | $Cx1000 in period | 95% CLs as +/- % |
|---|---|---|---|---|
| UBL: UNAVOIDABLE BACKGROUND LEAKAGE | 0.06 | 24 | 10.6 | 15.3% |
| UARL: UNAVOIDABLE ANNUAL REAL LOSSES | 0.10 | 37 | 16.5 | 10.3% |
| CARL: CURRENT ANNUAL REAL LOSSES | 0.25 | 91 | 40.6 | 31.1% |
| POTENTIALLY RECOVERABLE REAL LOSSES = CARL - UARL | 0.15 | 54 | 24.0 | 52.9% |

| IWA BEST PRACTICE PERFORMANCE INDICATOR | | UNITS OF PERFORMANCE INDICATOR | Best estimate | 95% CLs as +/- % | Lowest Estimate | Highest Estimate |
|---|---|---|---|---|---|---|
| Non Revenue Water Basic (IWA Level 1, Fin36) | | % of System Input by Volume | 12.8 | 25.0% | 9.6 | 16.0 |
| Non Revenue Water Basic (IWA Level 1, Fin37) | | % of System Input by Value | 13.1 | 25.0% | 9.8 | 16.3 |
| Apparent Losses (IWA Op23) | Best Op23 PI > | % of Water Supplied (Distribution Systems) | 0.6 | 6.0% | 0.5 | 0.6 |
| | | % of System Input Volume (Bulk Supply Systems) | 0.6 | 6.0% | 0.5 | 0.6 |
| Real Losses Basic (IWA Level 1, Op24) | Best Op24 PI > | Litres/service connection/day, when system pressurised | 142 | 31.2% | 97 | 186 |
| | | m3/km of mains/day, when system pressurised | 8.7 | 31.1% | 6.0 | 11.5 |
| Real Losses Detailed (IWA Level 3, Op 25) | | Infrastructure Leakage Index ILI (non-dimensional) | 2.45 | 32.7% | 1.65 | 3.26 |

Comments:

Water supplied via Regional Municipality of Niagara's Grimsby Water Treatment Plant via Mudstreet.

Meter (ID 6D2). Meter Calibration Report dated May 24, 2005.

AM Billing Data broken into Quantities Metered each month combines monthly reads and quarterly reads. Second catagory is Bulk Metering with monthly record.

Process Reliability Bands:

A - actual data
B - calculated based on actual data
C - calculated estimate
D - no data / default

Combinations, for example, B/C may be used to illustrate a calculated estimate based on partial data

Total length of watermain allow for 3 m per hydrant

## 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

## WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs'

DETAILED CALCULATION OF COMPONENTS OF AUTHORISED AND UNAUTHORISED CONSUMPTION

Data entry | Calculated Values | From another Worksheet

Utility: Township of West Lincoln

System: Whole System

01/01/2005 to 01/01/2006 = 365 days

Calculation by: Steve Genser

Date: 2nd July 2005

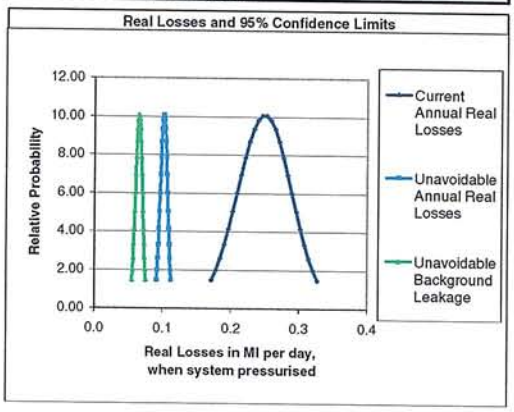
| Components of Authorised Consumption | Components in Ml | | | | Total | Additional information on sources of data and basis of estimates<br>E = estimated<br>R = Based on recordings |
|---|---|---|---|---|---|---|
| | Billed Metered | Billed Unmetered | Unbilled Metered | Unbilled Unmetered | | |
| Quantities Metered | | | | | 0.00 | |
| January | 0.113 | | | | 0.11 | R = Based on recordings |
| February | 0.148 | | | | 0.15 | R = Based on recordings |
| March | 139.669 | | | | 139.67 | R = Based on recordings |
| April | 0.175 | | | | 0.18 | R = Based on recordings |
| May | 0.239 | | | | 0.24 | R = Based on recordings |
| June | 137.622 | | | | 137.62 | R = Based on recordings |
| July | 0.202 | | | | 0.20 | R = Based on recordings |
| August | 0.862 | | | | 0.86 | R = Based on recordings |
| September | 172.256 | | | | 172.26 | R = Based on recordings |
| October | 0.209 | | | | 0.21 | R = Based on recordings |
| November | 0.402 | | | | 0.40 | R = Based on recordings |
| December | 106.889 | | | | 106.89 | R = Based on recordings |
| | | | | | 0.00 | |
| Bulk Metering | | | | | 0.00 | |
| January | 9.118 | | | | 9.12 | R = Based on recordings |
| February | 11.222 | | | | 11.22 | R = Based on recordings |
| March | 13.706 | | | | 13.71 | R = Based on recordings |
| April | 8.730 | | | | 8.73 | R = Based on recordings |
| May | 21.174 | | | | 21.17 | R = Based on recordings |
| June | 21.061 | | | | 21.06 | R = Based on recordings |
| July | 20.726 | | | | 20.73 | R = Based on recordings |
| August | 13.009 | | | | 13.01 | R = Based on recordings |
| September | 8.567 | | | | 8.57 | R = Based on recordings |
| October | 15.538 | | | | 15.54 | R = Based on recordings |
| November | 7.196 | | | | 7.20 | R = Based on recordings |
| December | 12.613 | | | | 12.61 | R = Based on recordings |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| | | | | | 0.00 | |
| Authorised consumption sub-totals | 721.45 | 0.00 | 0.00 | 0.00 | 721.45 | Ml |

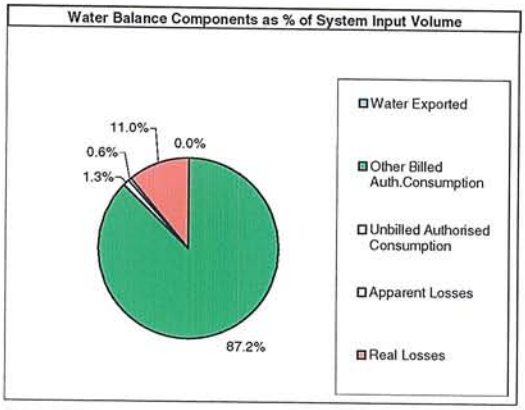
Authorised Unbilled Unmetered Consumption = 0.000% of Water Supplied, transfer this figure to Cell E21 of 'WaterBalance&Pis' Worksheet

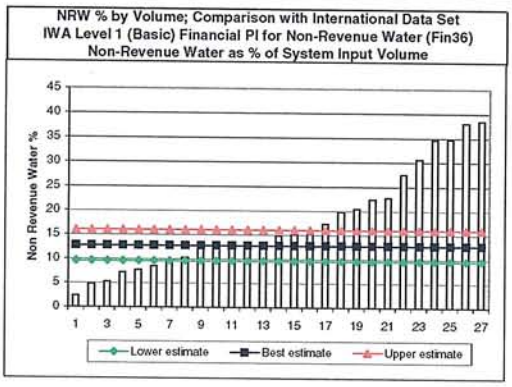
| Components of Unauthorised Consumption | Ml | Method of estimation |
|---|---|---|
| Hydrant (contractors not metered) | 0.08 | Estimated |
| By-passes or theft | 0.08 | Estimated |
| | | |
| | | |
| | | |
| | | |
| | | |
| Unauthorised consumption sub-total | 0.17 | Ml |

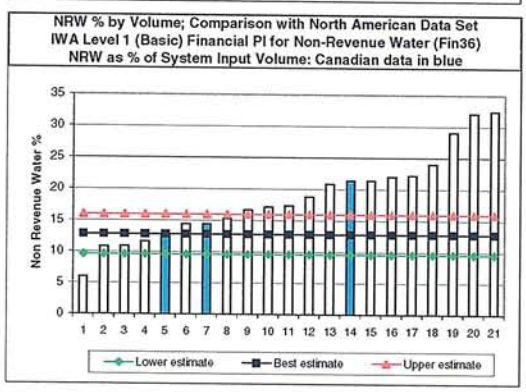
Unauthorised consumption = 0.020% of Water Supplied, transfer this figure to Cell E23 of 'WaterBalance&Pis' Worksheet

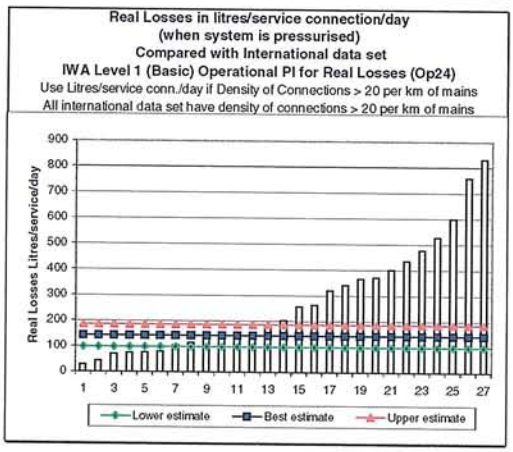
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | Standard | Version 1a | 2nd Dec 2005 | Canada |
|---|---|---|---|---|---|---|
| Utility | Township of West Lincoln | | 01/01/2005 to 01/01/2006 | 365 | days | |
| System | Whole System | | | | | |

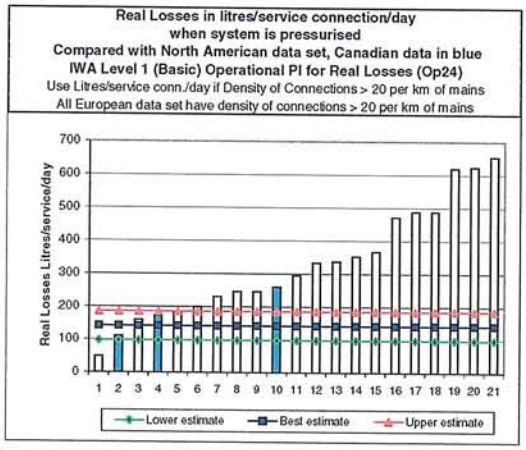


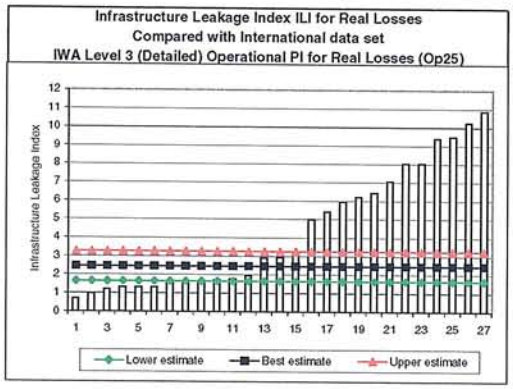



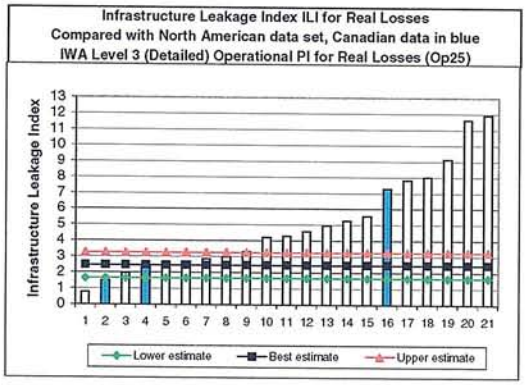



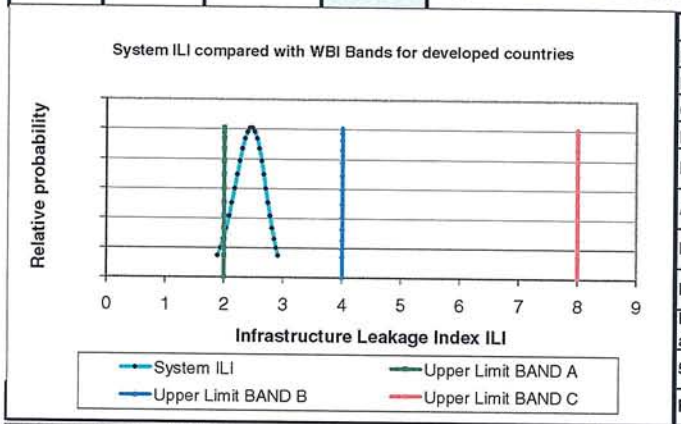
| 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE | | | | | | |
|---|---|---|---|---|---|---|
| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | | | | | | |
| PIFastCalcs | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 | Township of West Lincoln |

**THIS WORKSHEET COMPARES THE CALCULATED SYSTEM ILI WITH WORLD BANK INSTITUTE GUIDELINES**

**World Bank Institute (WBI) Guidelines**

The World Bank Institute has recently introduced, into its NRW Training Modules, a target matrix for Real Losses management performance, based on real losses in volume/service connection/day for a range of average operating pressures, and classified into Bands A to D. The targets assume that customer meters are located at the property boundary, with an average connection density of around 40 per km mains. Bands A to D in the WBI target matrix can also be shown as an equivalent range of ILIs, which can be applied to a wider range of connection densities and customer meter locations, as shown below. Band limits in terms of ILIs, general descriptions of each Band, and appropriate recommended actions are as follows:

| Developing Countries ILI range | Developed Countries ILI range | BAND | Calculated ILI for this System | General description of Real Loss Management Performance Categories for Developed and Developing Countries |
|---|---|---|---|---|
| Less than 4 | Less than 2 | A | | Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement |
| 4 to < 8 | 2 to < 4 | B | 2.5 | Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance |
| 8 to < 16 | 4 to < 8 | C | | Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts |
| 16 or more | 8 or more | D | | Very inefficient use of resources; leakage reduction programs imperative and high priority |




| WBI Recommendations for BANDS | A | B | C | D |
|---|---|---|---|---|
| Investigate pressure management options | Yes | Yes | Yes | |
| Investigate speed and quality of repairs | Yes | Yes | Yes | |
| Check economic intervention frequency | Yes | Yes | | |
| Introduce/improve active leakage control | | Yes | Yes | |
| Identify options for improved maintenance | | Yes | Yes | |
| Assess Economic Leakage Level | Yes | Yes | | |
| Review break frequencies | | Yes | Yes | |
| Review asset management policy | | Yes | Yes | Yes |
| Deal with deficiencies in manpower, training and communications | | | Yes | Yes |
| 5-year plan to achieve next lowest band | | | Yes | Yes |
| Fundamental peer review of all activities | | | | Yes |

**GUIDELINE 2: The AWWA Water Loss Committee general guidelines for setting a target ILI (in lieu of having a determination of a system-specific economic level of leakage). Source of information: Table 7 in the AWWA Water Loss Committee Report in the AWWA Journal, August 2003**

Note: since this table was published, simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the ALCCalc software. This has allowed the development of the ELLCalc software to calculate short-term ELL for an active leakage control policy of regular survey. Data from England & Wales (where many Water Companies are recognised as having achieved ELL) suggests that in developed couintries, the ELL (in terms of ILI) is unlikely to exceed 3.0, even where water is plentiful and inexpensive.

| Target ILI Range | This System ILI | Water Resources Considerations | Operational Considerations | Financial Considerations |
|---|---|---|---|---|
| 1.0 - 3.0 | 2.5 | Available resources are greatly limited and are very difficult and/or environmentally unsound to develop | Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand | Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability |
| 3.0 - 5.0 | | Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management,water conservation) are included in the long-term planning | Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place | Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population |
| 5.0 - 8.0 | | Water resources are plentiful, reliable, and easily abstracted | Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to shortages | Cost to purchase or obtain/treat water is low, as are rates charged to customers |
| Greater than 8.0 | | Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged. | | |

**Note**: Simplified methods of calculating an economic frequency of intervention for active leakage control by regular survey have been been developed and are included in the **ALCCalcs** Standard software. This has allowed the development of the **ELLCalcs** standard software to calculate short-term Economic Leakage Level for an active leakage control policy of regular survey.

**Important Footnote:** the Infrastructure Leakage Index (ILI) provides guidance as to how well real losses are being managed (in terms of repairs, active leakage control and infrastructure management) at the current operating pressure. However, calculation of the ILI does not imply that pressure management in a system is optimal, or economic. If system pressures are excessive, or subject to surges, then pressure management may result in additional benefits for real losses management - in particular, a reduction in new burst frequency and annual repair costs, and a reduction in flow rates of existing leaks. So even if a low ILI is being achieved, there may still be opportunities to reduce annual real losses by improved pressure management. The **PressCalcs** Standard Software provides more detailed information on this topic.

# 'LEAKS' Suite of LEAKAGE EVALUATION and ASSESSMENT KNOW-HOW SOFTWARE

| WATER BALANCE AND PERFORMANCE INDICATORS PROGRAM 'PIFastCalcs' | Standard | Version 1a | 2nd Dec 2005 | Canada | Master.0000 |
|---|---|---|---|---|---|
| OPTIONAL DATA ENTRY SHEET FOR ANNUAL SYSTEM RUNNING COSTS | | Data entry | Calculated Values | From another Worksheet | |
| Utility: Township of West Lincoln | 01/01/2005 | to 1/1/2006 | Number of Days in Period | 365 | days |
| System: Whole System | Calculation by | Steve Genser | Date of calculation = | 12/4/2006 | |

| Total running costs as calculated below = | 0.0 | $Cx1000 | Transfer this figure to Cell L30 of 'WaterBalance&Pis' Worksheet |
|---|---|---|---|

Note: The following definitions of annual system running costs should be considered as guidelines only. They are based on the 'Financial Definitions' in pages 19 and 20 of the IWA 'Manual of Best Practice 'Performance Indicators for Water Supply Services', (Alegre H, Hirner W, Baptista J.M. and Parena R, July 2000, ISBN 1 900222 27 2, IWA Publishing; this report should be consulted for further guidance as necessary.

| Operational Costs | | Sub-total $Cx1000 | Group total $Cx1000 | INCLUDES |
|---|---|---|---|---|
| Imported water | Raw water | | 0.0 | BULK SUPPLY IMPORTS: total payments for imported raw water |
| | Treated water | | | BULK SUPPLY IMPORTS: total payments for imported treated water |
| Energy | Raw water | | 0.0 | POWER: all energy costs for water supply electricity and fuel for motive machinery |
| | Treatment | | | |
| | Transmission | | | |
| | Distribution | | | |
| External services: Outsourcing | Outsourcing | | 0.0 | Outsourcing of technical or administrative services, such as consultants, contractors undertaking operational tasks, meter reading and accounting fees |
| | Software licences and IT support | | | Licence fees on computer software and technical support by software companies |
| | Associated Companies | | | Costs of associated companies that are not included in other items |
| | Third party services | | | Operating costs of providing water services to third parties (other than the regulated water supply function) that are not included in other items |
| Leasing and Rentals | Premises | | 0.0 | Payments for leasing or renting premises |
| | Vehicles | | | Payments for leasing or renting vehicles |
| | Mobile Plant | | | Payments for leasing or renting mobile plant |
| | Fixed Plant | | | Payments for leasing or renting fixed plant |
| | Equipment | | | Payments for leasing or renting equipment |
| Purchases | Water treatment chemicals | | 0.0 | All water treatment chemicals for water supply that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| | Other than chemicals and energy | | | All materials and consumables other than energy and water treatment chemicals for water supply, that are not in HIRED AND CONTRACTED SERVICES and which are required for operation of sources, treatment plants,transmission and distribution systems |
| Taxes, levies and fees | All kinds | | 0.0 | Any operating licences paid to a Government or municipal authority, abstraction charges, local authority rates |
| Exceptional earnings and losses | All kinds | | 0.0 | Any exceptional income or expenditure from donations, investment subsidies, compensations or adjustments related to sales/writing off of fixed assets |
| Other Operating Expenditures | Other direct costs | | 0.0 | Any other operating costs (but excluding interest and taxation, on an aggregated basis) |
| | General and support expenditures | | | The aggregate direct cost of GENERAL AND SUPPORT ACTIVITIES (Manpower costs excluded) |
| | Customer services | | | Costs directly associated with customer services that are not included in previous items, related to customer accounting, reading of meters, debt revovery, costs of disconnections, customers'enquiries and complaints handling. |
| | Scientific services | | | Costs directly associated with scientific and laboratory services and with the monitoring of quality that are not included in previous items |
| | Other business activities | | | Costs directly associated with other business activities that are not included in previous items, except for cost depreciation |
| | Doubtful debts | | | Charge/credit to the profit and loss account for bad and doubtful debts |
| **Sum of Operational Costs** | All the above operational costs | | 0.0 | |
| **Internal manpower costs** | Employment costs | | 0.0 | The sum of the total manpower costs of permanent and temorary personnel, including employment-related social costs and benefits paid by the employer |
| **Capitalised cost of self-constructed assets** | Negative allocation | | 0.0 | The summation of the amounts in each of the above cost categories that have been incurred in the construction of new or rehabilitated assets |
| **Total Running Costs** | Sum of Operational costs and Internal Manpower Costs, minus capitalised cost of self-constructed assets | | 0.0 | |

**Comments:**