USING THE IWA PERFORMANCE INDICATORS AND NOISE MAPPING FOR NRW REDUCTION IN HALIFAX, NOVA SCOTIA, CANADA

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Abstract:

The Halifax Regional Water Commission is comprised of three regional systems with diverse NRW performance. Water audit calculations using the standard IWA format were used to determine system performance and set ILI targets.

The paper describes substantial and rapid reduction of NRW using new methodologies of IWA as a focus of reporting, performance, goal setting, and staff motivation to reduce NRW. The revised procedure of system wide noise mapping, standard sounding practice and validation of residual noises in the system resulted in significant reductions to NRW compared to previous leak survey programs.

Introduction:

This presentation will summarize the results of the Halifax Regional Water Commission's first year implementation of a water audit calculation using the standard IWA format in determining system performance and infrastructure leakage indices.

The case study occurred in Halifax Regional Municipality, in the province of Nova Scotia, Canada. The Commission is a newly formed regional water utility comprising of three former water utilities in the Halifax metropolitan area. In 1996 the Provincial Government legislated the amalgamation of four municipal units into the new Halifax Regional Municipality. The three former utilities, Halifax Water Commission, Dartmouth Water Utility, and Halifax County Water Utility were amalgamated into the Halifax Regional Water Commission. These former water utilities operated independently and had varying degrees of leak detection activity, SCADA system development, zone master metering, and system sectorization.

It is interesting to review the infrastructure and history of the water systems under evaluation. The City of Halifax was established in 1749. It was originally serviced with water by the Halifax Water Company, incorporated in 1844, to provide central water services to the Halifax area. Today, the Halifax Regional Water Commission comprises of 1,100 km of distribution water main, 6,500 fire hydrants, 12 storage reservoirs, 11,000 valves, and 120 pressure control / boosting facilities. The system is fully metered with approximately 70,000 metered service laterals, providing service to 300,000 people. The water system has operational pressures varying from 20 psi (138 kpa) up to 140 psi (965 kpa). The infrastructure pipe material is primarily metallic, comprising of approximately 58% ductile iron, 38% cast iron, 2% PVC, and 2% asbestos cement and concrete cylinder pipe. Halifax is in a moderate northerly climate, with winter frost penetration of approximately 5 feet in depth.

In addition to the system make-up, the ground conditions in the Halifax Regional Municipality vary widely, with a high percentage of fractured bedrock in the older portions of the city located near the harbour front, and some of the newer outlying areas. Approximately

60% of the system is installed in bedrock or acidic shale conditions, 20% is installed in red clay, 15% in glacial till, and the balance in a mixture of rock and till conditions. The soil conditions present a further challenge to leakage control in the Halifax Regional Water Commission. It has been our experience that a high percentage of water breaks in rock ground conditions do not surface, and require leak detection to determine their location.

IWA Water Audit Calculations:

The three former utilities used different accounting practices to rationalize apparent water loss. The Commission undertook a review of how to calculate and benchmark system performance related to non-revenue water and leakage. The traditional percentage unaccounted-for approach was inconsistently applied in the past, and gave little indication as to the true performance of each of the systems under consideration. As an example, a variety of standard text book water loss percentages were applied, including 1% for defined water losses repaired, 3% for flushing, fires, and public works, 2% for meter error, 3% for allowable leakage, and 1% for unauthorized (theft) use of water. In effect, 10% was applied, across the board, to rationalize the metered ratio between system input and metered water.

Progressive applications of old and new methods of reducing apparent water loss were well documented in the Central region. The apparent water loss of approximately 45% was reduced over a 16-year period to approximately 10.8%, using a systematic application of new technologies to reduce real water loss. This approach was most effective in reducing water leakage from a top-down, best achieved practice. The attached Fig.1 illustrates the approach to water loss reduction through the application of acoustic leak detection programs, SCADA, and master metering and noise correlator technologies in the Central region from 1982 to 1998.

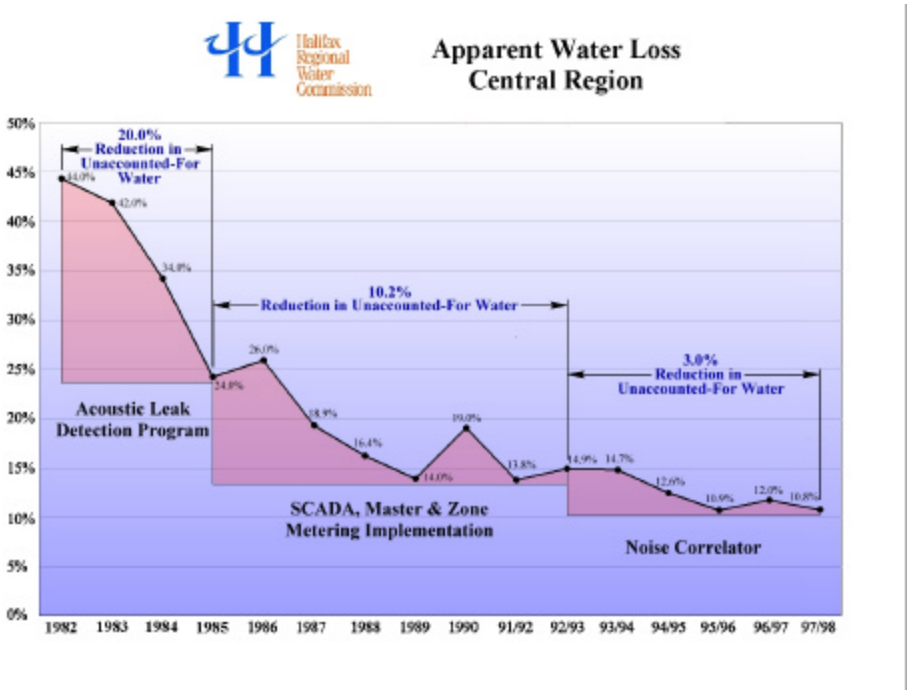


Fig. 1 Apparent Water Loss Reduction, Central Region, 1982 – 1998

In April 2000, the Commission undertook a utility wide water audit for each of the three former utilities to determine performance indicators and infrastructure leakage indices. The standard IWA format was selected as the basis to determine system performance. The Commission anticipated differences in the ILI performance in each of the regions, but not to such a wide variance in the indices among the three regions.

Tab. 1 Infrastructure Features

Region	Average Pressure	Density of Connections per km of Mains	Customer Meter Location from Street	Initial ILI Calculation
Central	70 psi / 483 kpa	69	7.5 m	1.6
East	78 psi / 538 kpa	83	7.5 m	4.8
West	70 psi / 483 kpa	63	7.5 m	12.2

The Central region performance, within world-class parameters, has a well-developed SCADA monitoring system, comprehensive sectorization and master metering, and leak detection program. Comprehensive SCADA system interrogation of nighttime flow rates, on a sector-by-sector basis, significantly contributed to this level of performance.

The East region has recently installed a SCADA system and sector master metering. Traditional leak detection surveys were conducted on a bi-annual basis, along with ad-hoc response as required.

The West region has a functional SCADA monitoring system for reservoir control and system pressures, several sector master meters, and a leak detection program, which is applied on an as-needed basis.

In light of the diverse ILI indices arising from the IWA water audit, senior department staff concluded that non-revenue water identification and reduction was a first priority for the Commission.

The Commission established five ad-hoc committees to review the IWA system input parameters. These committees undertook a comprehensive review of the existing policies, procedures and work programs to fully account for all water arising from system input, as supported through the standard IWA format. Separate task groups were established for authorized metered, authorized unmetered, sectorization and master metering, leak detection, and an oversight committee to provide project management and coordinated results measurement. A full cross section of utility staff are involved in the process.

Real Water Loss Identification:

The Leak Detection Committee decided to undertake a survey in each region. At the outset of the study, trained utility staff undertook the traditional leak detection approach, utilizing electronic acoustic detection equipment, supplemented with noise correlator equipment for pinpointing. Each system was surveyed in April 2000, with a total of 32 system leaks discovered. The East region located 7 leaks, the West region located 17 leaks, and 8 leaks were located in the Central region. Leak repairs were completed and moderate reductions in system input were measured.

It was clear that the traditional approach and leak detection activities were not yielding the desired NRW reductions in the East and West regions as indicated from the IWA standard water audit. Operations Department staff collaborated and re-engineered the leak detection process. The following methods and techniques were standardized to ensure consistency and thoroughness:

- A review of system mapping and standardized information, zones, scale, acronyms, and map legend.
- Consistent leak equipment performance, setup, intensity settings, volume, and operation.
- Creation of new leak detection teams through regional staff rotation.
- Standardized documentation of noise mapping on map plans and corresponding spreadsheets.
- Noise validation checklist developed, describing leak location, date, description, validation result, and recheck date.
- System noise field validation process to confirm leakage or customer "use".
- SCADA monitoring and NRW quantification from repaired leaks.
- System recheck after completed repairs.

This revised approach of noise mapping and a corresponding validation process resulted in a significant documentation of system-generated noises and resulting leaks. Tab. 2 is a sample of the survey results in the East region.

Tab. 2 Sample Leak Survey Documentation Sheet

HALIFAX REGIONAL WATER COMMISSION EAST REGION
POSSIBLE LEAKS – NOISE MAPPING SURVEY

	Noises to Check		Leaks Repaired	
	Leaks to be Repaired		Noises Eliminated	

No.	Date	Location	Description	Re-Check Date	By	Result
1	Apr 25	1770 Shore Road	Small noise - 5	Apr 25	MH	**Service line repaired May 1**
2	Apr 25	Redoubt Way – near 27	Transformer - 18	May 15	MH/GM	Noise gone
3	Apr 25	37 Rosewood Lane	Draw - 9	Apr 25	MH	Small meter noise
4	Apr 25	Lowrey Court	Transformer noise	Apr 25	MH	Transformer noise
5	Apr 25	E.P. Education Centre	Small noise – 10	Apr 26	JL	Mechanical noise
6	Apr 25	Jeep Cresc – near 221	Transformer - 15	Apr 27	MH	**Curb stop was on at empty lot**
7	Apr 25	47 Melrose Cres	Transformer - 15	Apr 25	MH	Transformer noise
8	Apr 25	386 Cow Bay Rd	Meter noise	Apr 25	MH	Gone
9	Apr 25	Shore Rd – near 1530	Sewer P Stn – 10	Apr 25	MH	Noise
10	Apr 25	Main Rd – near 1494	Sewer P Stn	Apr 25	MH	Small noise
11	Apr 26	Howard Ave @ Main Rd	3 noisy hyds – 20, 10, 7	May 15	MH & GM	Very small noise hyd Howard Ave
12	Apr 26	Hines Rd @ Main Rd	2 noisy hyds – 10, 10	Apr 27	MH	Noise gone
13	Apr 26	Belmont & Carlton – 6 hyds	Noises 20 - 100	Apr 26	MH	**Leak in 4 inch Esso Line**

Leak technicians were reassigned to different regions, and with alternate team members. The new teams acoustically surveyed the Central, East, and West regional systems. All system acoustic "soundings" on valves and fire hydrants were conducted between 10 pm and 6 am. The activity took place in late April and was completed by early June 2000.

The concept of noise mapping is somewhat different than the usual North American approach to leak detection. The noise mapping process is intended to capture and document all of the noises generated in the water system through acoustic sounding of valves, hydrants, and service boxes. The noises are categorized by type of noise (mechanical, leak, transformer, etc.), and intensity. Comprehensive documentation was required on the system mapping, which typically shows the water mains, hydrants and valves. The corresponding spreadsheet provides a more detailed documentation of the date, location, noise description, intensity, and the result of the investigation, with rechecks as required. This change in methodology was intended to provide the most thorough determination of system noises and corresponding acoustic documentation on maps and spreadsheets. The field validation process was needed to determine the specific generation of the noise and provide the noise source in the comment section. The Commission realized outstanding results from this process and determined a significant number of leaks in all three systems.

Tab. 3 outlines the summary of noises and leaks determined during this noise mapping process.

Tab. 3 Acoustic Sounding vs. Actual Leaks Located

Region	Noises	Mains	Services	Hydrants	Total Leaks
East	390	35	42	0	77
West	205	28	43	32	103
Central	117	5	23	8	36
Total	**712**	**68**	**108**	**40**	**216**

The re-survey determined 712 acoustic noises in the system. A total of 216 leaks were identified during the acoustic noise mapping process. As a matter of comparison, the Halifax Regional Water Commission repaired a total of 288 leaks in the 1999 calendar year. This best-practice survey resulted in the repair of 68 water mains, 108 services and 40 hydrant leaks over a several month program.

Measurement of System Input Reduction:

The SCADA system in each region was used to track the corresponding reduction in nighttime flow rates and daily system inputs.

For comparison purposes, the 1999 and 2000 system inputs are contrasted in each region on Fig. 2, 3, and 4. Apparent reclaimed water is shown for each system. The ILI calculations at program initiation, as well as other system inputs, are shown for illustration purposes. The trends for each of the system inputs indicate lower projected ILI figures, resulting from the leak identification process undertaken by the Commission.
The Central region (Fig. 2) is performing at levels approaching optimum ILI performance, near 1.0. The East region (Fig. 3) illustrates considerably lower system inputs and a projected 2.7 ILI performance rating. This is substantially down from the initial ILI calculation of 4.8, in April 2000.

The West region (Fig. 4) has achieved modest, but consistent, lower system input since the program initiation. Further reductions in real water loss have been the focus of the Commission's attention through improved SCADA system installation and corresponding sector master metering.

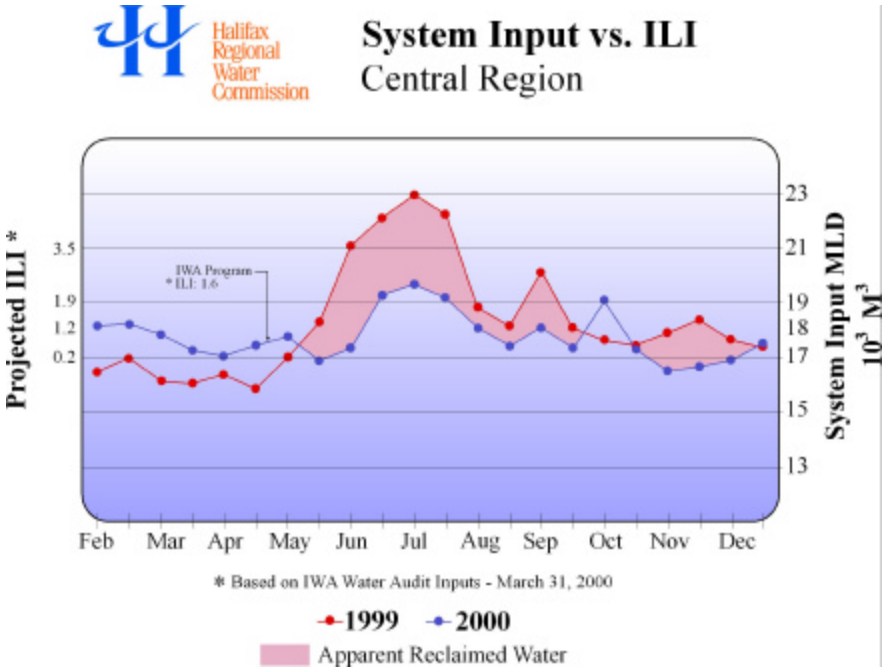


Fig. 2 Apparent Reclaimed Water – Central Region 2000

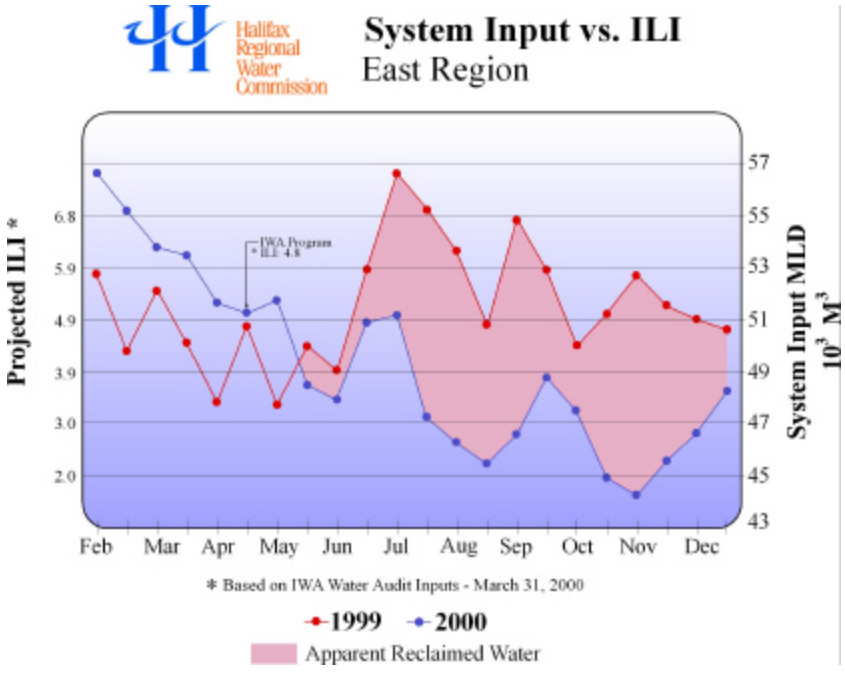


Fig. 3 Apparent Reclaimed Water - East Region 2000

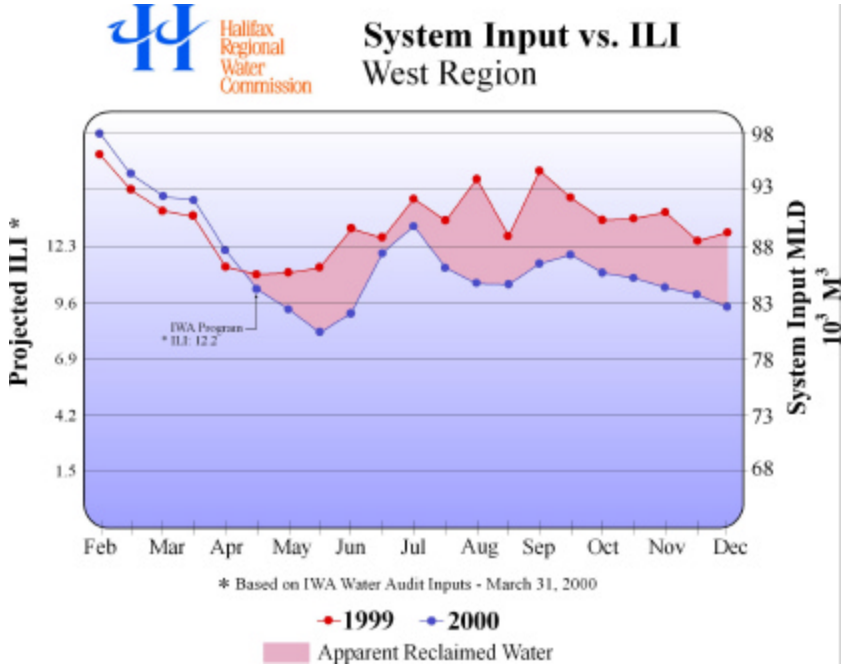


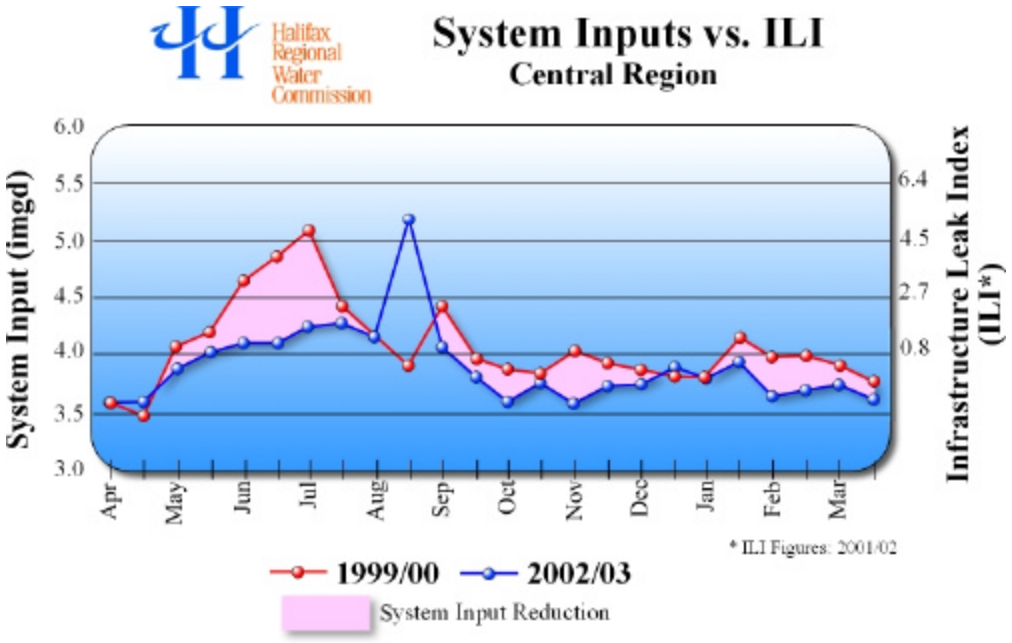
Fig. 4 Apparent Reclaimed Water - West Region 2000

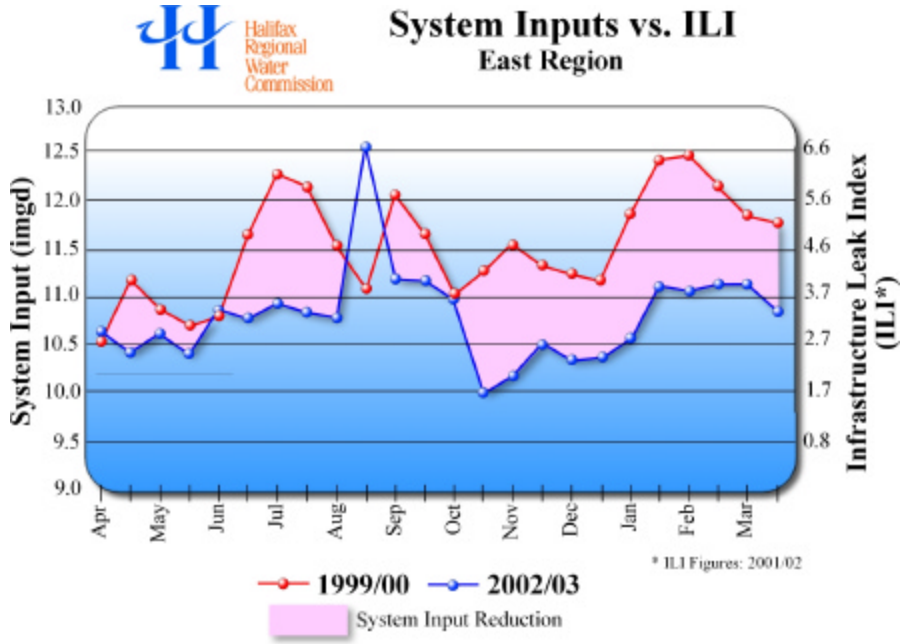
Conclusions:

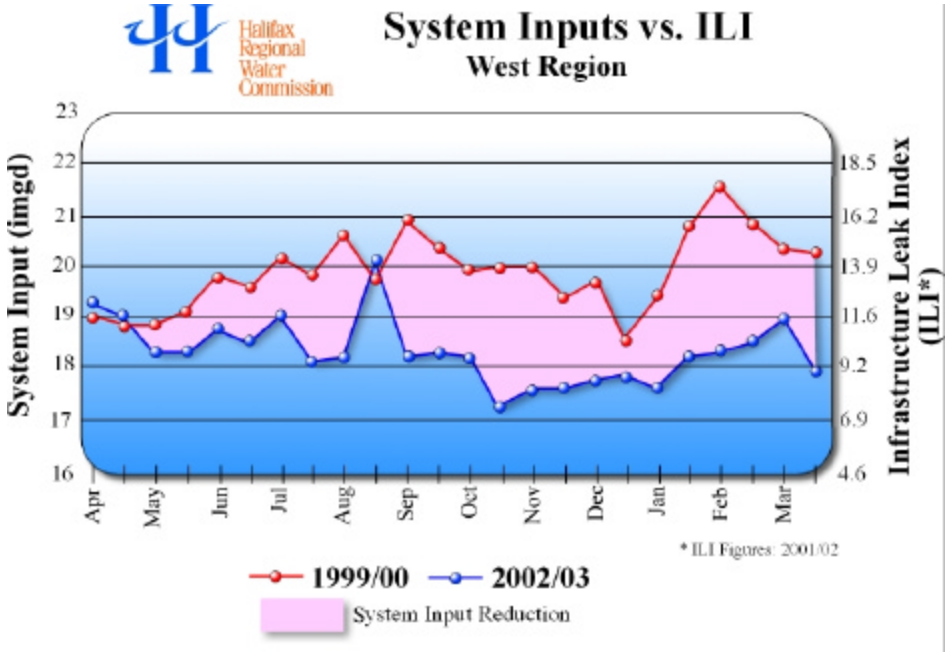
The Standard IWA Format created an environment for change at the Halifax Regional Water Commission. All system input water was reviewed through five standing committees to reconfirm the documentation and water accounting for authorized metered and unmetered water, sectorization master metering, and leak detection practices. The application of IWA water audit information provided a sharp focus and initiative to benchmark and set world-class performance standards for NRW at the Halifax Regional Water Commission.

A substantial real water loss reduction was achieved through the performance benchmarking from the IWA, ILI calculation. The Commission is striving for world-class performance in all three systems, using the IWA standard. The noise mapping, leak detection, and validation program have demonstrated the process by which the Commission will achieve its performance goals.

CONTINUED RESULTS – 1999/00 – 2002/03:






Halifax Regional Water Commission
System Inputs vs. ILI
West Region
System Input (imgd)
Infrastructure Leak Index (ILI*)
23
22
21
20
19
18
17
16
18.5
16.2
13.9
11.6
9.2
6.9
4.6
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
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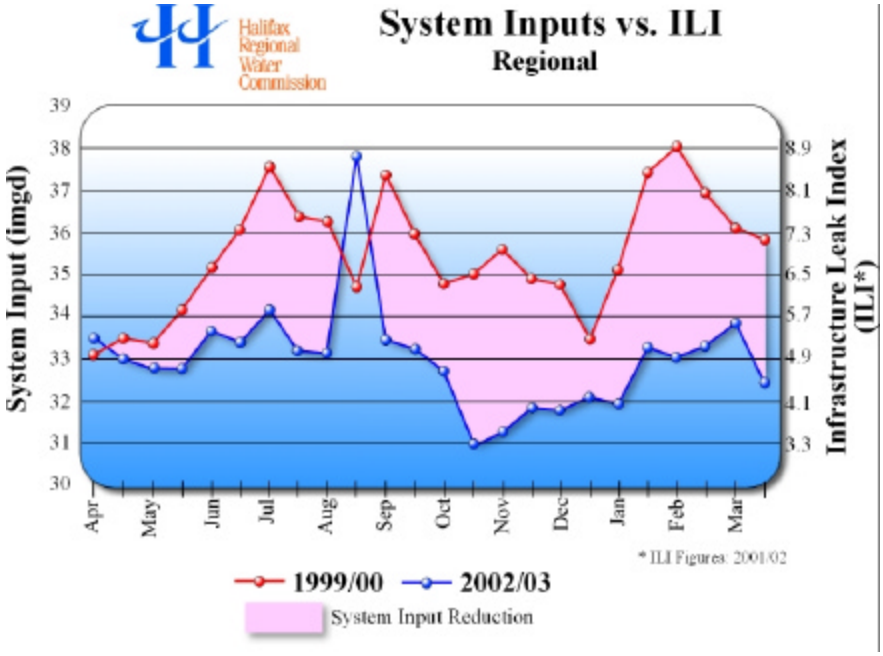
* ILI Figures: 2001/02
1999/00
2002/03
System Input Reduction


Halifax Regional Water Commission
System Inputs vs. ILI
Regional
System Input (imgd)
Infrastructure Leak Index (ILI*)
39
38
37
36
35
34
33
32
31
30
8.9
8.1
7.3
6.5
5.7
4.9
4.1
3.3
Apr
May
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Mar
* ILI Figures: 2001/02
1999/00
2002/03
System Input Reduction