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# 2023 Water Audit

**Final Report**
**December 3, 2025**
**KWL Project No. 0566.108**

**Prepared for:**

CITY OF NANAIMO
THE HARBOUR CITY

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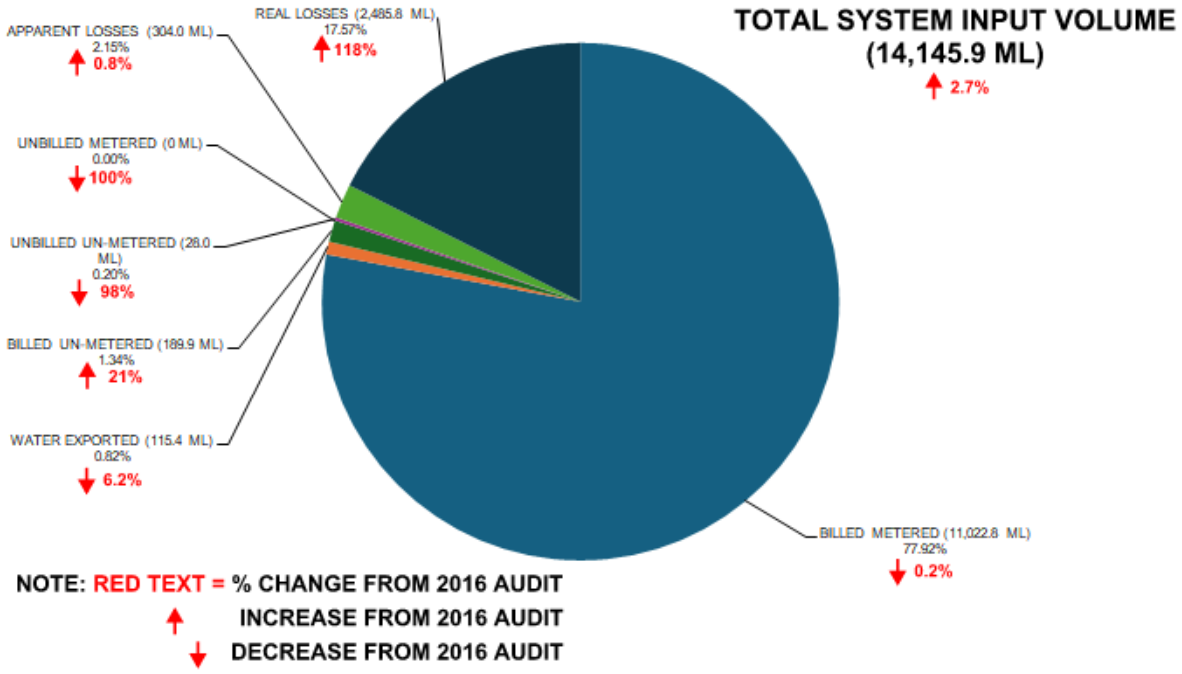
# Executive Summary

KWL completed a top down AWWA M36 water audit on one year of data starting from September 1, 2022 and ending on August 31, 2023. The start and end dates of the audit represent the most current and complete one year period of customer meter reading data as of August 2024.

The results of the audit are presented on the figure below together with how each component has changed from the 2016 audit:




The total water produced during the audit period was 14,146 ML, up 2.7% from 2016.

80.1% of the water produced is billed to customers (revenue water = billed metered + billed un-metered + water exported). As a percentage of water produced each year, revenue water is up 0.9% from 79.2% in 2016, and up 7.5% from 72.6% in 2011. This is largely a result of increased billing of un-metered connections.

The audit revealed an increase to real losses to 2,486 ML corresponding to an infrastructure leakage index (ILI) of 2.23. This represents a 118% increase in the level of real losses estimated for 2016 and indicates room for improvement (assumes that the Duke Point Reservoir Blowoff is no longer active and real losses are happening elsewhere in the water system). The real loses costs the City approximately $93,693/year, and could be reduced with additional leak reduction effort. The majority of this leakage is likely attributed to numerous very small leaks on service connections.

The cost of apparent losses is valued at $1,439/ML and the cost of real losses is valued at $32/ML.

The volume and cost of losses both real and apparent are provided below.

**Cost of Apparent Losses by Source in 2023**

| Water Loss Type | Yearly Volume (ML) | Yearly Cost ($) |
|---|---|---|
| **Apparent Losses** | | |
| Unauthorized Consumption | 28 | $40,373 |
| Customer Metering Inaccuracies | 248 | $357,587 |
| Systematic Data Handling Errors | 28 | $40,373 |
| **Total Apparent Losses** | **304** | **$438,332** |
| Recoverable Real Losses | 1,372 | $44,107 |
| **Total (recoverable) Real Losses** | **1,372** | **$44,107** |

The cost of customer metering inaccuracies remains the largest yearly water loss cost.

The 98% decrease in un-billed un-metered consumption is attributed to the removal of the treated water blow-off at the Duke Point Reservoir.

Average day demand for single family dwellings could not be determined in 2023 due to issues with the individual meter read data received. The total volume of water used in the individual meter read data was greater than the supplied water indicated an issue in data received.

## Recommendations

We recommend the City continue ongoing efforts and budgets, recommended in the 2011 and 2016 Water Audits, for the replacement of customer meters.

We recommend that the City review individual billing data to identify issue when compared to the summarized billing volumes. This will allow for better tracking of base demand usage by user type.

The ILI increased from 1.1 to 2.23 between 2016 and 2023. An ILI of 2.23 is still considered to be a well-run system. We recommend that the City continue to address major leaks as found.

We recommend the City complete updates to the water audit on a yearly basis. This work is estimated at $10,000/year.

# 1. Introduction

The City of Nanaimo (the City) has retained the services of Kerr Wood Leidal Associates Ltd. (KWL) to complete a 2023 top-down water audit to gain an understanding of where and how water is being used and what level of losses, both apparent and real are occurring. The audit follows the guidelines of the AWWA M36 top down water audit.

This work follows a 2011 and 2016 Water Audits that were completed by KWL.

## 1.1 Abbreviations Used

The following standard water loss management terms and abbreviations used in this Report and the AWWA M36 Water Audits and Loss Control Programs Manual:

ADD = Average Day Demand

BD = Base Demand (Typical Winter Demands)

Ca = Capita (Person)

HGL = Hydraulic Grade Line

ICI = Industrial, Commercial, and Institutional

ILI = Infrastructure Leakage Index

MDD = Maximum Day Demand

MMCD = Master Municipal Contract Documents

OCP = Official Community Plan

PHD = Peak Hour Demand

PRV = Pressure Reducing Valve

SCADA = Supervisory Control and Data Acquisition

SD = Seasonal Demand (Typical Irrigation Demand)

ML/Yr = Unit of measure – Mega Litres of water per year

ML/d = Unit of measure – Mega Litres of water per day

mH = Unit of measure – System pressure expressed in meters (head)

km = Unit of measure – Length of mains in kilometers

## 1.2 Reference Materials, Assumptions and Limitations

### Reference Materials

Preparation of this report has proceeded with the benefit of the following reference materials:

**City of Nanaimo Reference Materials**

1. City of Nanaimo GIS files which include pressure zone boundaries, PRV locations and water main information.
2. Monthly and Daily Bulk water meter readings (from SCADA).
3. Customer meter readings (billed on a 4-month cycle) accessed from the City's Tempest database.
4. City's current tracking sheets characterizing daily consumption, population and system characteristics.

**Other Reference Materials**

1. AWWARF, 2016, M36 Water Audits and Loss Control Programs, Fourth Edition.
2. AWWARF, 2020, AWWA Water Audit Software, v6.0.

# 2. Top-Down Water Audit

The sub-sections included in this section reference the task numbers one (1) through eleven (11) outlined in Chapter 2 of the M36 manual. All references to a particular "Task" is done such that the reader may refer with ease to the appropriate section of the M36 manual.

## 2.1 Compiling the Top-Down Water Audit Data

An AWWA M36 water audit is an effective tool for quantifying consumption and losses that occur in the distribution system as well as apparent losses that occur within the management processes related to customer metering and billing practices.

The water balance summary sheet that summarizes the audit results is shown in Figure 2-1. The balance sheet shows the sources of non-revenue water, such that large sources of non-revenue water, including water losses, can be identified and managed.

<table>
<tr><td rowspan="10">System Input Volume</td><td rowspan="5">Authorized Consumption</td><td rowspan="3">Billed Authorized Consumption</td><td>Billed Water Exported</td><td rowspan="3">Revenue Water</td></tr>
<tr><td>Billed Metered Consumption</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="8">Non-revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Systematic Data Handling Errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

**Figure 2-1: AWWA M36 Water Balance**

The accuracy of the top-down water audit on assessing water losses relies on accurate source data, good record keeping, and a high percentage of metered customers in the network. The audit gathers all available records and places data in a water audit worksheet.

### System Boundaries

The water audit was performed for the treated water transmission and distribution system as bounded by the City's source and customer meters. For the purpose of an AWWA water audit, source refers to the point where treated water enters the distribution system. The source water is metered at the Water Treatment Plant that is supplied by the South Fork Reservoir.

Raw water transmission mains from the South Forks reservoir are not included in the water audit as they are upstream of the metering location.

### Time Period

A one-year period is recommended for completing the audit as this allows for seasonal variations in demand and reduces the effects of lag time in customer meter reading. The audit period used was from **September 1, 2022 to August 31, 2023.** This period reflects the most recent complete dataset collected by meter readers as of January 2024. This data period includes 365 days given.

### Units of Measure

The units of measure used in the water audit are **metric.** Water volume is given in mega-litres per year (ML/Yr), average operating pressures are given in metres head (mH) and length of water mains is expressed in kilometers (km).

## 2.2 Task 1 – Collect Distribution System Description Information

The physical characteristics of the water system are required in order to calculate key performance indicators. Pertinent characteristics of the City of Nanaimo's water system are listed below:

- 666.2 km of water mains (excluding hydrant connections).
- 26,898 customer meters (*Note: some customers have multiple meters*).
- 3,333 City owned fire hydrants.
- 596 Privately owned fire hydrants.
- 26 pressure zones.
- 7 reservoirs.
- 9 active (online) pump stations.

The city has a service connection density of 42.9 connections per km of mains.

The system is operated at an average pressure of 71.5 meters head. This statistic was taken from the 2011 Water Audit.

## 2.3 Task 2 – Measure Water Supplied to the Distribution System (Source Flow Data)

### Compile Source Volume Raw Data

Water supplied into the system is measured at the City's water treatment plant that was commissioned December 4, 2015. The plant has three raw water inlet pipes that are metered by 20" Endress Hauser magnetic flow meters. The plant consists of seven primary membrane cells that are all individually metered by seven 16" Endress Hauser magnetic flow meters and four secondary membrane cells that are individually metered by four 6" Endress Hauser magnetic flow meters.

Table 2-1 displays the 2023 source flow totals as provided by the City.

**Table 2-1: 2023 Monthly Source Flow Volumes**

| Month | Volume (ML) |
|---|---|
| September 2022 | 1,469 |
| October 2022 | 1,222 |
| November 2022 | 873 |
| December 2022 | 889 |
| January 2023 | 871 |
| February 2023 | 778 |
| March 2023 | 884 |
| April 2023 | 857 |
| May 2023 | 1,273 |
| June 2023 | 1,592 |
| July 2023 | 1,729 |
| August 2023 | 1,639 |
| **Total** | **14,076** |

The total metered source volume for the audit period was 14,076 ML.

### Source Adjustments

Once the source volumes are established (raw data), the measured amounts need to be reviewed and corrected for known systematic or random errors that exist in the data. Factors to be considered in this adjustment include:

1. Meter inaccuracies
2. Changes in reservoir and storage levels
3. Other adjustment such as losses occurring before water reaches the distribution system

Given the duration of the audit and the diurnal fluctuations in tank volumes, changes in storage are considered negligible.

For the purpose of the audit, the meters are assumed to have an accuracy of ±0.5% and sized to minimize low flow inaccuracies. A 0.5% under-registration is assumed. The yearly average metering inaccuracy due to low flow under-registration is therefore estimated to be to 70.7 ML/year.

### Source Meter Adjustments for the Water Audit

**The adjusted source volume for the audit is 14,146 ML** given the assumed 0.5% source meter under-registration.

## 2.4 Tasks 3 and 5 – Quantify Authorized Consumption

Authorized consumption comprises:

**Task 3 – Quantify Billed Authorized Consumption**

- Billed Water Exported
- Billed Metered Consumption
- Billed Unmetered Consumption

**Task 5 – Quantify Unbilled Authorized Consumption**

- Unbilled Metered
- Unbilled Unmetered

For the audit period:

- **Authorized consumption was calculated as 11,349.3 ML**
- **Billed Authorized Consumption was calculated as 11,356.1 ML**
- **Unbilled Authorized Consumption was calculated as 28.0 ML**

The components of these values are expanded upon below.

### Billed Water Exported

In addition to its residents, the City also supplies water to the Village of Southwest Extension, District of Lantzville, and Snuneymuxw Reserve No 1.

The City of Nanaimo has been supplying the Village of Southwest Extension with bulk water since 1998. Water is metered through a 50 mm Sensus touch read meter for low flow installed in 2008 and a 150 mm Sensus radio read meter for high flow installed in 2010. The total water exported to the village during the audit period was 26.2 ML.

The City of Nanaimo supplies the District of Lantzville with bulk water based on the Lantzville/Nanaimo Water Agreement from September 8, 2014. Water is metered through a 200 mm manual read meter. The total water exported to the District during the audit period was 25.5 ML.

The Snuneymuxw First Nation is supplied and billed for bulk water through four touch read Sensus meters. In 2009, a 200 mm meter and a 75 mm meter were installed. A 150 mm meter was installed in 2012 and a 200 mm Sensus touch read was installed in 2013. The total water exported to the Snuneymuxw Reserve No. 1 was 63.7 ML over the audit period.

**The total water exported was therefore 115.4 ML over the audit period.**

## Billed Metered Consumption

The city has had near universal metering of service connections since 1983. Currently 94.2% of customers are metered. It manages customer billing and meter reading using billing management software that stores meter readings and meter data including meter installation date, size, and manufacturer.

There are 26,907 active billing meters in the network (excluding bulk water export customers). Table 2-2 gives a summary of customer account types as defined in the meter database. It is noted that the account type listed in the database contains limited information for defining Industrial, Commercial and Institutional (ICI) customers however the level of detailed data is still very informative.

**Table 2-2: Metered Customers by Account Type**

| Account Type | # of Meters | Percent of Total Meters |
|---|---|---|
| Commercial/Residential (Mixed Use) | 152 | 0.6% |
| Government | 85 | 0.3% |
| Municipal | 161 | 0.6% |
| Other | 945 | 3.5% |
| Residential – Multi-Family Dwelling | 528 | 2.0% |
| Residential – Single Family Dwelling | 25,036 | 93.0% |
| **Total** | **26,907** | **100.0%** |

**The total billed-metered consumption over the audit period was 11,022.8 ML.**

## Billed Un-metered Consumption

A list of billed un-metered accounts was provided for the audit including 1,706 domestic connections, 2 municipal connections, and 3 commercial connection (Imperial Oil Limited and 2 warehouses).

Table 2-3 provides a summary of the billed un-metered customers and assumed average day consumption rates from the 2016 audit.

**Table 2-3: Billed Un-Metered Customers and Assumed Average Day Consumption**

| Customer Description | Number of Customer Accounts | Assumed Average Day Consumption (L/day/cust.) | Estimated Yearly Volume (ML) |
|---|---|---|---|
| Single Family Dwelling | 54 | 495 | 9.8 |
| Single Family Dwelling w Suite | 34 | 650 | 8.1 |
| Mobile Home (assumes 50% occupancy) | 1,618 | 190 | 112.2 |
| Municipal/Govt. | 2 | 1,000 | 0.7 |
| Commercial | 3 | 1,000 | 1.1 |
| **Total** | **1,711** | **NA** | **131.9** |

1. 2 accounts have 2 single family dwellings attached to the account. The actual total number of customer accounts is 1,664 and not 1,666.

The City operates two bulk filling stations, the Duke Point station and the Public Works station. Bulk water hauling spreadsheets were provided for the period of January 2020 through March 2024. The monthly totals during the audit period are summarized in Table 2-4.

**Table 2-4: 2022-23 Bulk Filling Stations Monthly Volume Totals**

| Month | Volume (ML) |
|---|---|
| September 2022 | 6.0 |
| October 2022 | 5.3 |
| November 2022 | 2.6 |
| December 2022 | 2.6 |
| January 2023 | 2.0 |
| February 2023 | 2.0 |
| March 2023 | 2.6 |
| April 2023 | 2.8 |
| May 2023 | 6.5 |
| June 2023 | 7.7 |
| July 2023 | 9.5 |
| August 2023 | 8.6 |
| **Total** | **58.0** |

**The total volume of billed unmetered consumption was 189.9 ML.**

### Unbilled Metered Consumption

There are no accounts with meters that are not billed.

**Unbilled metered consumption was 0.0 ML.**

### Unbilled Un-Metered Consumption

Unbilled un-metered consumption includes water used by the City of Nanaimo for operational purposes. Unbilled water consumption for the City of Nanaimo was assumed to be 0.25% of the total authorized consumption.

**The total unbilled un-metered consumption is estimated at 28.0 ML/year.**

## 2.5 Task 4 – Calculate Non-revenue Water

Non-revenue water is the portion of water that the City treats and distributes that is not billed and therefore does not generate revenue for the City. Non-revenue water consists of unbilled authorized consumption (discussed above), apparent losses and real losses. In the top-down audit approach, non-revenue water is calculated as the remaining water into supply that is not accounted for within the billing records. This is shown as:

**Non-Revenue Water =** Adjusted Source Volume (Task 2) – Billed Authorized Consumption (Task 3) = 14,146 ML - (115.4 ML + 11,022.8 ML + 189.9 ML) = **2,817.9 ML**

## 2.6 Task 6 – Quantify Water Losses

Water losses are made up of apparent and real losses. In the AWWA water audit approach, water losses are determined as the adjusted source volume minus authorized consumption. Put in another way, water losses are non-revenue water minus unbilled authorized consumption. **Water losses are estimated as 2789.9 ML (including both apparent and real losses)**. This is given as:

Water Losses = Non-revenue water (Task 4) – Unbilled Authorized Consumption (Task 5) = 2,817.9 ML – (0.0 ML + 28.0 ML) = 2,789.9 ML

## 2.7 Task 7 – Quantify Apparent Losses

Apparent losses are those that are caused by incorrect meter reads, data handling errors, billing system accounting practices, meter under-registration and water taken without permission. **Apparent losses were calculated to be 304.0 ML**.

Apparent losses consist of three main components:

1. Customer metering inaccuracies
2. Data-handling errors
3. Unauthorized consumption

The components of apparent losses and calculation assumptions are given below.

### Customer Metering Inaccuracies

The extent of customer metering inaccuracy was estimated in the 2011 Water Audit by performing testing on a representative sample of meters. We assume customer meter inaccuracies have not changed since the 2011 Water Audit.

The following meter accuracies were estimated in the 2011 Water Audit:

- 98% for the 19 mm meter population
- 97.2% for the large meter population (25 mm - 250 mm)
- 97.8% overall meter accuracy

**Apparent losses due to metering inaccuracies were therefore estimated at 248.0 ML/year.**

### Systematic Data Handling Errors

Systematic data handling errors are apparent losses associated with the handling of retail water meter billing system. Errors are associated with estimates due to missed meter reads, errors in meter reads, and customer billing disputes and leak credit adjustments that make their way into the meter read database.

The customer billing data was reviewed and no clear errors were found. The AWWA recommends a minimum default value of 0.25% of billed authorized consumption be attributed to data handling errors.

**Systematic data handling errors were therefore estimated at 28.0 ML/year.**

### Unauthorized Consumption

The main causes of unauthorized consumption are:

1. Illegal connections
2. Misuse of fire hydrants and firefighting systems
3. Vandalized or bypassed consumption meters

Improper use of fire hydrants, such as unauthorized filling of tanker trucks is difficult to account for and control. AWWA recommends that unauthorized consumption be estimated as 0.25% of source flows.

**Un-authorized consumption is therefore estimated to be 28.0 ML/year.**

## 2.8 Task 8 – Quantify Real Losses

Real losses include water that has been extracted from a water source, treated, and transported a distance before being lost from the distribution system.

Real losses are calculated as the system input volume minus authorized consumption and apparent losses. **Real losses are therefore estimated to be 2,485.8 ML/year.**

### Components of Real Losses

The last component of the water audit is to estimate the distribution of real losses from transmission mains, service connection, and reservoirs. No field data on reservoir leakage has been completed and no historical reports of uncontrolled reservoir leakage. Reservoir leakage is therefore assumed to be negligible.

The distribution of real losses between transmission mains and service connections is assumed to be equal to that of reported leakage. Service connection leakage is estimated as 67% of reported leakage and therefore the total leakage from service connection is estimated as 1,655.5 ML/year. Transmission main leakage is therefore estimated at 820.3 ML/year.

## 2.9 Task 9 – Assign Costs of Apparent and Real Losses

Determining the cost impacts associated with apparent and real losses is equally as important as the tracing of the volume of each component of the water balance.

The unit cost implications of apparent and real losses are not equal. Apparent losses are losses associated with real consumption that would otherwise produce revenue, whereas, real losses, due to such things as main breaks, do not affect customer revenues but do affect operational costs such as the costs to chlorinate water and pump it as required. Apparent losses are therefore valued at the retail cost that is charged to the customer, and real losses are valued at the variable production costs to treat and deliver water.

### The Cost of Apparent Losses

In 2023, the city utilizes a fixed daily charge plus a daily volumetric inclining block rate structure for water billing. The average daily volumetric charge represents the cost of apparent losses and excludes the daily base charge.

The average rate charged by cubic meter of water ($/ML) can be calculated from the City's 2023 water rate structure.

The average 2023 daily customer demand across single family customer types (assuming 30.9% of total usage reported in 2018 has not significantly changed) was 97.8 gallon/account/day. Applying the City's inclining block structure, the average unit rate charged for water calculated as follows:

First 110 gallons/day @ $0.00212/gallon/day = $0.21

DAILY TOTAL PER ACCOUNT = $0.21

ANNUAL TOTAL (365 days x ACCOUNTS x DAILY TOTAL PER ACCOUNT) = $4,982,992

Cost per gallon (ANNUAL TOTAL/SF WATER USE) = $0.00250/gallon

The average 2023 daily customer demand across all other customer types was charged at the City's unit rate of $0.00835/gallon.

The average unit rate charged for all water use calculated as follows:

% SF Water Use = 30.7%[1] @ $0.00250/gallon

% Other Water Use = 69.3% @ $0.00835/gallon

Combined cost per gallon = $0.00654/gallon

**The cost of apparent losses is $0.00654/gallon or $1,439.18/ML**

Table 2-5 provides the costs of apparent losses in 2023.

**Table 2-5: Cost of Apparent Losses by Source in 2023**

| Source of Apparent Loss | Yearly Volume (ML) | Yearly Cost ($) |
|---|---|---|
| Unauthorized Consumption | 28 | $40,373 |
| Customer Metering Inaccuracies | 248 | $357,587 |
| Systematic Data Handling Errors | 28 | $40,373 |
| **Total** | **304** | **$438,332** |

## The Cost of Real Losses

The cost of real losses includes all costs attributed to delivering the water to the leak location. Specifically, this includes the unit cost for treatment (chemicals, power) and delivery to the leak (pumping power costs).

All costs associated with the treatment and distribution of water are given in Table 2-6.

**Table 2-6: 2023 System Operating Costs (2016 Costs inflated to 2023 Dollars)**

| Cost Elements | Resources Section | Operations Section | |
|---|---|---|---|
| | South Fork Water Treatment Plant | Water Supply | Water Distribution |
| Utilities (Energy) | $103,964 | $109,987 | $5,817 |
| Materials & Supplies | $234,999 | $89,148 | $545,580 |

[1] From 2016 Water Audit

The unit cost of real losses is calculated as the sum of South Forks Water Treatment Plant materials and supplies ($234,999) and sum of all system energy costs ($219,767) divided by the total volume of water supplied (14,146 ML).

The cost of real losses is calculated as:

$454,766/14,146 ML = **$32.15/ML**

**The cost of real losses during the audit period (2,485.8 ML) was approximately $79,913.54.**

The real cost of water losses for the City is more accurately the cost of the potentially recoverable volume of real loss. When this is considered, the cost of real losses to the City is $44,107. See the following section for the calculation of the potentially recoverable volume of real loss.

## 2.10 Task 10 – Calculate Performance Indicators

### Infrastructure Leakage Index

The Infrastructure leakage index is the ratio of current annual real losses (CARL) to unavoidable annual real losses (UARL). The ILI is a highly effective performance indicator for comparing and benchmarking the performance of utilities in operational management of real losses. Table 2-7 presents the components used in the calculation of the ILI. The formula used is presented below.

ILI = CARL/UARL

*UARL (L/day) = (18*Lm + 0.8*Nc + 25 Lp) * P*

*Where;*

*Lm is the length of distribution mains including hydrant leads (in km);*
*Nc is the number of connections;*
*Lp is the length of service connections (in km) assumed as 10 m times # of service connections; and*
*P is the average pressure of the system (in m head).*

**Table 2-7: ILI Calculation**

| Lm (km) | Nc (#) | Lp (km) | P (mHead) | UARL (ML/Year) | CARL (ML) | ILI | Potentially Recoverable Volume of Losses (ML) |
|---|---|---|---|---|---|---|---|
| 705.5 | 28,562 | 285.6 | 71.5 | 1,114.1 | 2,485.8 | 2.23 | 1,372 |

An ILI of 2.23 represents a well-run distribution system with some room for additional leak reduction. As the ILI approaches 1, costs increase to achieve additional loss reductions because of the level of effort to locate smaller and smaller leaks. The 1,372 ML of potentially recoverable leakage costs the City approximately $51,700/year. Some additional effort to locate major leaks has the potential to save the city significant money annually.

## 2.11 Task 11 – Compile the Water Balance

A summary of the water balance results is presented below in Figure 2-2.

<table>
<tr><td rowspan="11">System Input Volume<br>14,145.9 ML</td><td rowspan="4">Authorized Consumption<br>11,356.1 ML</td><td rowspan="3">Billed Authorized Consumption<br>11,328.1 ML</td><td>Billed Water Exported<br>115.4 ML</td><td rowspan="3">Revenue Water<br>11,328.1 ML</td></tr>
<tr><td>Billed Metered Consumption<br>11,022.8 ML</td></tr>
<tr><td>Billed Unmetered Consumption<br>189.9 ML</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption<br>28.0 ML</td><td>Unbilled Metered Consumption<br>0 ML</td><td rowspan="7">Non-revenue Water<br>2,817.9 ML</td></tr>
<tr><td>Unbilled Unmetered Consumption<br>28.0 ML</td></tr>
<tr><td rowspan="7">Water Losses<br>2,789.8 ML</td><td rowspan="3">Apparent Losses<br>304.0 ML</td><td>Unauthorized Consumption<br>28.0 ML</td></tr>
<tr><td>Customer Metering Inaccuracies<br>248.0 ML</td></tr>
<tr><td>Systematic Data Handling Errors<br>28.0 ML</td></tr>
<tr><td rowspan="4">Real Losses<br>2,485.8 ML</td><td>Leakage on Transmission and Distribution Mains<br>820.3 ML</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks<br>0 ML</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering<br>1,665.5ML</td></tr>
</table>

**Figure 2-2: Water Audit Results**

## 2.12 Summary of Results

The results of the 2023 Water Audit are summarized in the chart below along with the percent difference that each component changed from 2016.

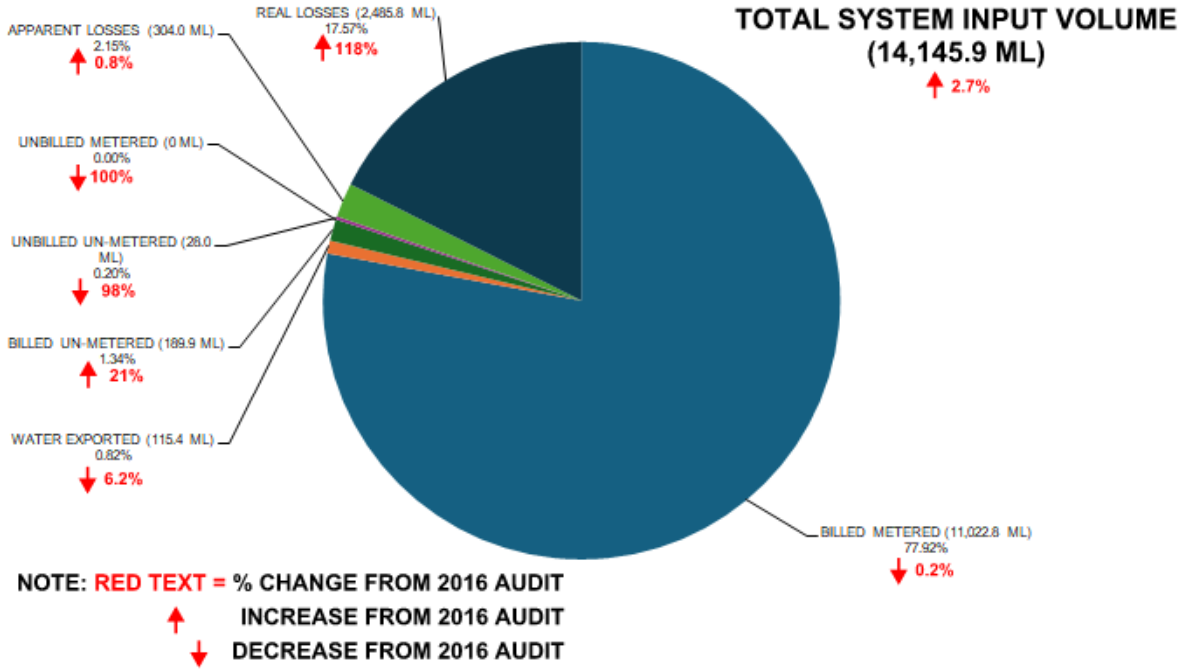



**Figure 2-3: 2023 Water Audit Summary**

## 2.13 Recommendations

We recommend the City continue ongoing efforts and budgets, recommended in the 2011 and 2016 Water Audits, for the replacement of customer meters.

We recommend that the City review individual billing data to identify issue when compared to the summarized billing volumes. This will allow for better tracking of base demand usage by user type.

The ILI increased from 1.1 to 2.23 between 2016 and 2023. An ILI of 2.23 is still considered to be a moderately well-run system. We recommend that the City continue to address major leaks as found.

We recommend the City complete updates to the water audit on a yearly basis. This work is estimated at $10,000/year.

# 3. Report Submission

Prepared by:

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Reviewed by:

Ryan Lesyshen, M.Sc., P.Eng.
Technical Reviewer

## Statement of Limitations

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## Revision History

| Revision # | Date | Status | Revision | Author |
|---|---|---|---|---|
| 0 | December 3, 2025 | Final | | SJR/BLJ |
| A | October 31, 2024 | Draft | 95% Draft Report | SJR/BLJ |