### Principles of Water Loss Management

In 2010 Water New Zealand assembled the water loss guidelines (WLG) for water loss management based on International Water Association (IWA) methodology.

The purpose of these guidelines is to abstract the right approach to measuring water loss for water suppliers, from the WLG in order to report on this specific mandatory measure. It is recommended however that water suppliers obtain and use the full comprehensive set of guidelines to managing water loss for their water supplies.

The WLG can be downloaded free of charge from the Water New Zealand website.  

### What Is Water Loss

In any water supply system the infrastructure will deteriorate with age whatever its nature. Water losses will increase over time if nothing is done, due to increased leakage from pipes, meter under-registration or failure, and data handling errors (customer and network systems). Network efficiency is a combination of the natural deterioration of the infrastructure and monitoring equipment and the processes that have been put into place by the water suppliers to mitigate against this. This is illustrated in the ’standard’ annual water balance shown in Figure 1 below.
The standard IWA terminology for assessing water losses can be abbreviated as follows:

- **System Input Value** is the annual volume input to the water supply/system;

- **Authorised Consumption** is the annual volume of metered and/or non-metered water taken by registered customers, the water supplier and others that are implicitly or explicitly authorised to do so;

- **Non-Revenue Water (NRW)** is the difference between System Input Volume and Billed Authorised Consumption;

- **Water Losses** is the difference between System Input Volume and Authorised Consumption and consists of Apparent Losses and Real Losses;

- **Apparent Losses** consist of Unauthorised Consumption and all types of meter inaccuracies;

- **Real Losses** are the annual volumes lost through all types of leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of the customer meter.

**Methods to Measure Water Loss**

To measure the water being lost in a distribution system the first approach is to conduct a water balance or night flow measurement. This enables the water supplier to determine the water supplied, consumed and lost in the distribution system.

It is recommended that users refer to the WLG and in particular Section 7 as it details the requirements at both basic and advanced levels.

Measuring leakage should be approached in the following way:

1. Categorise the size of water supply system as large, medium or small as outlined in the table below:
Table 1: Approaches for Assessing Real Losses Based on Size of System

<table>
<thead>
<tr>
<th>System</th>
<th>Number of Service Connections</th>
<th>Residential Customers Metered i.e. Universal metering</th>
<th>Recommended Method for Assessing Real Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>&gt; 10,000</td>
<td>Yes</td>
<td>Annual water balance with confidence limits – BenchlossNZ or CheckCalcsNZ software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Annual water balance with confidence limits / Minimum night flow (MNF) Analysis – BenchlossNZ or CheckCalcsNZ software</td>
</tr>
<tr>
<td>Medium</td>
<td>2,500 to 10,000</td>
<td>Yes</td>
<td>Annual water balance with confidence limits – BenchlossNZ or CheckCalcsNZ software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Minimum night flow (MNF) Analysis – verify against water balance</td>
</tr>
<tr>
<td>Small</td>
<td>&lt; 2,500</td>
<td>Yes</td>
<td>Annual water balance with confidence limits – BenchlossNZ or CheckCalcsNZ software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Minimum night flow (MNF) Analysis</td>
</tr>
</tbody>
</table>

2. Estimating the level of losses in the network should use one of the recommended methods from Table 1:

a. Method option 1: Water Balance – refer WLG Section 2.3

The Water Losses Benchloss Marking Software (Benchloss NZ and CheckCalc NZ) was developed for Water NZ, (NZ Water and Wastes Association) refer to WLG Section 2.2 and is available free from Water NZ direct.

The first step in using the water balance components of the software is to determine the Unavoidable Annual Real Losses (UARL) using the following for each system:

- Length of mains = Total length of transmission and distribution mains;
- Number of service connections = Total number of metered accounts minus the total number of sub-meters plus the estimate number of unmetered service connections;
- Average Operating Pressure = System operating pressure i.e. estimate from weighted average ground levels and average pressure at zone inlets (reservoir, WTP);
- Number of Properties – Broken into residential/non-residential, metered and unmetered;
- Residential Population – Total population supplied from the system.

The next stage is to enter the detailed consumption data for authorised consumption as follows, which feeds directly into the ‘WaterBal’ Worksheet:
- Start and finish dates = Period for which the water balance and consumption data is calculated over, typically annually;
- Billed Water Exported = Volume of water extracted to a different system, if any;
- Billed Metered = number of residential and non-residential properties and billed volume;
- Billed Unmetered Consumption = number of residential / non-residential properties and estimated average usage (Litres/connection/day);
- Unbilled Metered Consumption = specify customer and recorded volume i.e. Council depot.
- Unbilled Unmetered Consumption = For example hydrant flushing; an estimate is given and confidence limits used accordingly.

For the systems with 'unmetered residential properties', the largest single component of error is likely to be assumed consumption 'per property per day', and most effort should be spent on assessing that component rather than the minor components.

System data previously input is brought forward into the ‘WaterBal’ sheet. The next set of data required is the system inputs (own sources and water imported), as follows:

- System input = Source input + water imported. This is the total annual volume (or period) of water input to a system from the water supplier's treatment works and/or, where no treatment is provided, the volume of water input from other water suppliers.

The water losses volume is then calculated by subtracting the volume of authorised consumption from the system input volume. The apparent losses are then presented and then deducted from the water losses to determine the annual volume of real losses.

The next step is to assess the apparent losses consisting of unauthorised consumption and customer metering under-registration. Unauthorised consumption such as illegal connections or meter by-pass are then specified for each system. For customer meter under-registration a percentage is specified for the number of meters that are estimated to be under-registration for residential, non-residential and other meters. The estimated 95% confidence limits should be entered accordingly.

The Current Annual Real Losses (CARL) is calculated based on the difference between water losses and apparent losses, with the calculated 95% confidence limits shown in the lower and upper bands.

The ‘PICalcs’ sheet is used to calculate basic and detailed system operational performance indicators for real losses. The calculation provides a breakdown of the components of Non-Revenue Water expressed as a percentage of volume of system input. The components are:

- Unbilled Consumption
- Apparent Losses
- Real Losses – This value is to be reported as one of the Non-Financial Performance Measures for Water Supply.

b. Method option 2: Minimum Night Flow Analysis – refer WLG Sections 3.3, 4.4 and Appendix A

To use the minimum night flow (MNF) analysis method the following steps should be adopted:

- Arrange to measure night flow into the system or zone i.e. permanent/temporary meter, reservoir drop test;
- Record or estimate the average zonal night pressure (AZNP);
- Identify the time of year and days of the weeks when night consumption is likely to be at a minimum, typically during winter when there is less likely to be outside water use e.g. irrigation;
- Identify any 24-hour consumers and measure through data logging or meter reading during the night flow analysis time period;
- Measure the MNF over 1-hour between the hours of 01:00 to 03:00, together with the AZNP, preferably over a week period;
- The legitimate customer night consumption allowance is to be estimated and deducted from the MNF. For unmetered residential customers a value between 2.0 and 2.5 Litres/conn/hr is recommended. However, it is also recommended that further analysis is carried out to improve confidence;
- The real losses can be calculated from the MNF minus the customer night consumption allowances and any measured night consumption;
- The real losses, expressed as a percentage of total annual system input, is to be reported as one of the Non-Financial Performance Measures for Water Supply.