METROPOLITAN NORTH GEORGIA WATER PLANNING DISTRICT
WATER SYSTEM AUDIT DATA COLLECTION AND INPUT GUIDANCE
FOR THE AWWA FREE WATER AUDIT SOFTWARE©
SEPTEMBER 2010

INTRODUCTION

All water systems in the Metropolitan North Georgia Water Planning District (Metro Water District) are required to annually assess water system losses and develop programs to identify and reduce local water system loss. This requirement is described in the Metro Water District's 2009 Water Supply and Water Conservation Plan (Plan) in Conservation Action Item 5.6. In addition, the 2010 Georgia General Assembly passed the Water Stewardship Act which includes a requirement to assess and reduce water system loss.

Both the Metro Water District Plan and the State Water Stewardship Act require the International Water Association/American Water Works Association water audit method to assess system water loss. The American Water Works Association (AWWA) Water Loss Control Committee provides the free Excel workbook based AWWA Free Water Audit Software© on their website at www.awwa.org.

The intent of this document is to provide guidance on the methods of collecting and adjusting data for input into the AWWA Free Water Audit Software© (herein after referred to as "the software"). The basis of terminology and some methodology used in this document is referenced from the AWWA Manual M36 – *Water Audits and Loss Control Programs*, 2009 and in the software. Additional information is given herein to provide uniformity in data collection methods and data analysis among utilities within the Metro Water District.

This report is organized to follow the sequence of data entry in the Reporting Worksheet tab of the *software*. The data input workflow is broken down into the following sections:

1. Water Supplied
2. Authorized Consumption
3. Water Losses
4. System Data
5. Cost Data

This breakdown is not inclusive of all components of *the software* Reporting Worksheet, only portions that require data entry. Additional information for other modules and calculations within *the software* can be found in AWWA Manual M36.

In addition to the water volume inputs described in this document, a grading score is associated with each input (white box under column E on the Reporting Worksheet) to indicate the relative confidence or validity of the data. Data validity is rated on a scale of 1-10 with 1 being the least reliable and 10 being most reliable. The user can move their cursor over any of these boxes in column E of the Reporting Worksheet and a note with detailed descriptions of the rating scale will appear.

General notes before beginning your audit:

- Do not anticipate a water loss of zero, as it is not achievable. For our purposes, the primary goal is to reduce real losses as represented by the Infrastructure Leakage Index (ILI), and the normalized real loss indicator in gallons/service connection/day or gallons/mile/day, calculated by the spreadsheet. Remember that apparent losses must be quantified in order to reliably quantify real losses.
- The ILI value should not be singularly compared from year to year but rather viewed in combination with the data integrity score overtime. Often, as data integrity improves, the ILI value may increase as system leakage conditions are more reliably portrayed. The goal is to improve the validity of data in order to improve the understanding of both real and apparent losses.
- Documentation is important, especially as the results are subject to EPD audit. It is recommended that the user create a separate excel workbook to store input data with notes describing the data and its sources. This workbook could be referenced to complete the software for subsequent years.
- The water audit should consistently cover the same 12 month period for each annual audit. The period does not necessarily need to match the calendar year. It may be the fiscal year or another 12 month reporting period.
- Specific dates for the start and end period of the audit should be recorded and those months/days should be used consistently each year. Volumes measured or estimated should fall within the dates of the audit period.

SECTION 1 – WATER SUPPLIED

The water supplied section documents the total volume of treated water that leaves the water treatment plant or other treated water sources and enters the distribution system, also referred to as “water pumped to town”.

Volume from Own Sources

This is the amount of water leaving the water treatment plant recorded by the production master meter(s). This number can be obtained from monthly operating reports submitted to EPD.

Make a list of the treated water sources to ensure none are forgotten. Groundwater that directly enters the distribution system should be added; groundwater that is treated at a water treatment plant will be counted by the production meter.

The “master meter” in this section refers only to the production master meter(s) or the last meter(s) measuring flow into the distribution system and does not refer to any large meters that may casually be referred to as master meters.

Production Master Meter Error Adjustment

The adjustments made to the production master meter(s) based on meter calibration that accounts for errors in measurement, calibration, or other random errors.

A negative number for meter error cannot be entered. Select “under-registered” or “over-registered” from the drop down menu depending on the meter’s reading prior to calibration.

Production master meters should be calibrated annually at a minimum, per EPD requirements. Calibration records should document the existing meter reading as well as the adjustment made to the meter to calculate the over/under calibration difference as a percentage. Adjustments to the production master meter based on the calibration report are entered in this field following Example 1.

If the meter is calibrated more frequently (i.e. quarterly), calculate a flow-weighted average following Example 2.

If there are multiple master meters, sum the error for each meter to determine the total master meter error adjustment.

It is very unlikely that a utility will enter a grading value of 10 in column E and enter an error adjustment of zero. Even with very good data, a meter adjustment is likely and therefore a volume associated with this adjustment should be entered. While storing calibration data results as a new tab in a companion workbook is always recommended, a copy of the independent meter calibration results are strongly recommended if the calibration results show that the meter was reading perfectly.

Example 1 - Meter calibrated annually:

Calibration Date	Current Meter Accuracy	Calibrated Meter Accuracy	Calibration Difference	Water Produced in Year	Annual Master Meter Error Adjustment
Jan-1-09	98.5%	100%	1.5%	100 billion	1.50 billion
Total Master Meter Error Adjustment					1.50 billion

Note: For this example, select “under-register” from the drop-down box because the meter under-registered the volume by 1.5 billion gallons

Example 2 – Meter Calibrated quarterly:

Calibration Date	Current Meter Accuracy	Calibrated Meter Accuracy	Calibration Difference	Water Produced in Quarter	Quarterly Master Meter Error Adjustment
Jan-1-09	98.5%	100%	1.5%	20 billion	- 0.3 billion
Apr-1-09	99.0%	100%	1.0%	30 billion	- 0.3 billion
Jul-1-09	99.0%	100%	1.0%	40 billion	- 0.4 billion
Oct-1-09	101.5%	100%	1.5%	10 billion	0.15 billion
Total Master Meter Error Adjustment					-0.85 billion

Note: For this example, select “under-register” from the drop-down box because the meter under-registered usage by 0.85 billion gallons over the year.

Water Imported

Water purchased from neighboring utility or regional water authority.

Meters that measure this volume are typically calibrated by the seller and therefore reflected in the bill received from the seller. As the purchaser – especially if a majority of the utility supply is imported – the accuracy of this meter(s) should be regularly verified.

Water Exported

Water sold to neighboring utility or regional water authority.

Adjustments to water export meters should be reflected in the water bill sent to the customer and included in the water exported number.

SECTION 2 – AUTHORIZED CONSUMPTION

Authorized consumption refers to the volume of water that is used by an authorized customer. This category does not include water sold to other utilities, which is considered water exported in Section 1. The general categories with basic descriptions of authorized consumption are listed below. More specific sources of data within each category are provided in **Table 1**. The sources listed in Table 1 are not all inclusive and provided only as a guide on potential sources of data.

Billed Metered

This category includes water that is metered and billed for domestic, commercial, industrial or institutional customers. Table 1 includes a more comprehensive list.

It is recommended that water providers periodically check meter readings on inactive accounts to identify billed metered usage that would not be identified during normal meter reading routes because the meter is considered inactive.

This number does not include wholesale water sent to neighboring water systems; these wholesale customers are entered in the “Water Exported” section of the Reporting Worksheet.

Use care when considering estimated bills. Estimated bills and bill adjustments during the same time period are considered billed metered if there is a meter. If estimated consumption is reduced based on better available data, these negative adjustments are considered an Apparent Loss.

Billed Unmetered

This category includes water that is not metered but is billed and may include customers who are not metered but charged a fixed fee or other method, or customers with estimated usage. See Table 1 which includes a more comprehensive list.

- For long term or permanent unmetered customers, installing a permanent meter is recommended to obtain actual consumption.

Unbilled Metered

This category includes water that is metered but not billed, such as water provided free of charge for municipal purposes (unbilled public facilities, unbilled public irrigation, etc.). Table 1 includes a more comprehensive list.

Unbilled Unmetered

This category includes unmetered water that is unbilled for authorized uses such as; fire fighting, flushing of mains or sewers, street cleaning, etc. Table 1 includes a more comprehensive list.

- All utilities should select the default number of 1.25% of the volume from own sources unless they can compile accurate data to justify a different number. Supporting data should be saved in a companion workbook.

- It is recommended that water providers focus on billed metered and billed unmetered data before focusing on unbilled unmetered as it is typically a small percentage of use.

- It is recommended that water providers install meters on all permanent structures regardless of whether it is billed or unbilled to improve data quality.

Table 1: Sources of Data for Authorized Consumption			
Billed Metered	**Billed Unmetered**	**Unbilled Metered**	**Unbilled Unmetered**
Any location with a meter and receiving a bill	**Any location receiving a bill and does not have a meter**	**Any metered account that does not have a bill**	**Any consumer that does not have a meter or bill and is AUTHORIZED to use the water**
Industrial customers	Unmetered systems or areas	Institutional customers	Fire fighting and other fire dept uses (testing and training)
Commercial customers	Flat Rates	Government irrigation meters	Line Flushing (automatic and manual)
Residential customers	County/City construction projects including free water		
Institutional customers		Line Disinfection	Line Disinfection
Irrigation meters		Vactors (pipeline cleaning, street cleaning, dust control, etc.)	Vactors (pipeline cleaning, street cleaning, dust control, etc.)
Fire Hydrant Meters			
Private Fire Lines	Private Fire Lines		
Volume sales to tanks/trailers within service area using a meter	Volume sales to tanks/trailers within service area using container volume or other calculation		Repair efforts by others (private utility services)
Water Authority / Government	Water Authority / Government	Water Authority / Government	Water Authority / Government
Schools	Schools	Schools	Schools
Religious/charity institutions	Religious/charity institutions	Religious/charity institutions	Religious/charity institutions
Special Events	Special Event (set fee for service)	Special Events	Special Events
Infrastructure Cleaning (streets, bus stops, etc.)	Infrastructure Cleaning (streets, bus stops, etc.)	Infrastructure Cleaning (streets, bus stops, etc.)	Infrastructure Cleaning (streets, bus stops, etc.)
Pools (filling and maintenance)	Pools (filling and maintenance)	Pools (filling and maintenance)	Pools (filling and maintenance)
Water Fountains/features	Water Fountains/features	Water Fountains/features	Water Fountains/features
Special Contract sales for cash or in-kind services	Special Contract sales for cash or in-kind services	Special Contract sales for cash or in-kind services	Special Contract sales for cash or in-kind services

Notes:

1. Several water uses may apply to several categories based on the system.
2. This list is not all inclusive, but rather a guide for collecting system data.

SECTION 3 – WATER LOSSES

Apparent losses account for errors generated while collecting customer consumption data. The three categories of apparent losses include Unauthorized Consumption, Customer Metering Inaccuracies, and Systematic Data Handling Errors. The following provides descriptions of each type of loss and methods of measuring these losses. Real Losses are calculated by the software. The general categories with basic descriptions of water losses are listed below. More specific sources of data within each category are provided in **Table 2**. The sources listed in Table 2 are not all inclusive and provided only as a guide on potential sources of data.

Unauthorized Consumption

This category includes theft of water such as illegal connections, unauthorized use of fire hydrants, meter tampering, etc. Table 2 includes a more comprehensive list.

- Water providers should use the default number of 0.25% of volume from own sources provided in the software unless they can compile accurate data to demonstrate why their number is different. Supporting data should be saved in a companion workbook.

Customer Metering Inaccuracies

These are inaccuracies that result from wear, improper sizing or maintenance of meters. Table 2 includes a more comprehensive list.

- If a utility has a meter testing/calibration/replacement program, the average calibration difference for the old meters is entered in this category. Water providers may choose to develop an average calibration difference based on the size of the meter.
- If a utility does not yet have a meter testing/calibration/replacement program, the manufacturers' default (typically 2%) may be used for this entry. Typically, customer meters under-register, particularly if they have served a long life or passed a high cumulative flow volume.

Systematic Data Handling Error

These are errors occurring between the meter readings and billing systems.

- Errors include billing system entry errors, account adjustments, skewed estimates, poor accounting, etc. Table 2 includes a more comprehensive list.
- Automatic Meter Reading (AMR) systems can reduce systematic data handling errors compared to manual meter reading systems.

Use care when considering estimated bills. If estimated consumption is reduced based on better available data, these negative adjustments are considered an Apparent Loss. If estimated consumption is increased, the difference is considered billed metered. All other estimates or adjustments should be included in the appropriate Authorized Consumption category; either billed metered or billed unmetered.

Table 2: Sources of Data for Apparent Losses			
Unauthorized Consumption	**Customer Metering Inaccuracies**	**Systematic Data Handling Errors**	
Entities that are NOT AUTHORIZED to use water	**Field Measurement / Calibration Issues**	**Internal Data Handling /Transfer Errors**	**Data Analysis / Billing Program Errors**
Unauthorized fire hydrant usage	Calibration Errors	Manual adjustments to usage (hand)	Improper or erroneous multipliers
Connection to unmetered fire line	Meter installation errors	Adjustments that replace original data	Manual adjustments to bills but not volumes (changed entry)
Customer installed bypass (residential or commercial)	Open/leaking bypass valve	Long term "no reads"	Usage adjustments based on short term estimates
Unauthorized connections to other systems (border areas)	Under or over sized meters or improper type of meter	Improperly recorded meter data from crossed meters	Adjustments due to known leakages
Fire Sprinkler system testing (private)	Improper repair of meter reading equipment	Estimated readings from malfunction or exchange of meters (excludes temporary inclement weather issues)	Adjustments that do not leave original data in place and change it to a new reading
Internal connection to fire line by entity staff	Untimely meter installations	Procedural/data entry errors for change outs and new meters	Adjustments to prior year volumes (entry update)
Meter or reading equipment vandalism (internal or external)	Buried/"lost" meters	Improper programming of AMR equipment	Long term "no reads" are not flagged
Water Fountains/features	Meter failure	Non-billed status where meter is in place and not being read (rental, vacancy, abandoned, sale property)	Computer / Billing Software issues (malfunctions, programming errors, etc.)
Special Events		Customer meters left unread due to account setup problems	Inconsistent policy interpretations by staff
Pools and operations of		Untimely final reads	Customer lost in system
Infrastructure Cleaning (streets, bus stops, etc.)		Using a combined large/small meter calibration error	Improper programming of AMR equipment
Line Disinfection (contractors)		Customer lost in system	Political "adjustments"
Repair efforts by others with unreported system damage		AMR equipment failure	

SECTION 4 - SYSTEM DATA

The System Data portion of the worksheet describes the physical characteristics of the distribution system. Components are broken down as follows:

Length of Mains

Total length of distribution pipelines, including fire hydrant leads, ending at the customer curb stop or meter.

Length does not include service lines, which are included in the average length of customer service line value.

Number of Active and Inactive Service Connections

These include all physical connections, not just the number of accounts in the system because one account could have multiple connections.

Average Length of Customer Service Line

This number should be zero for all water utilities unless the meter is located within the house (which is typically only done in cold weather climates).

A diagram with corresponding description is provided in *the software* on the tab “Service Connection Diagram”.

Average Operating Pressure

The average system pressure is a very important parameter in calculating the unavoidable annual real losses (UARL). All systems are unique and the pressure will vary based on the extent of the system, the elevation changes, the demand patterns, and other local considerations. To limit the variability in pressure measurements that might skew the IWA/AWWA water loss results, the following standards for pressure measurements are recommended.

Tank Elevations – It is recommended that the tanks be at the midpoint of normal daily operations. For example if the tanks fluctuate between 60% full and 100% full, then the measurement should be at 80% full. If the tanks operate between 0% full and 100% full, then 50% full represents the midpoint.

Time of Day – Midday is recommended because tanks are typically filled at night, when pressure will be the highest. In the morning, the demand is the highest so the pressure will be the lowest. Midday (noon) is a more representative time for pressure in most systems.

There are several basic methods for calculating average operating pressure.

- For water systems with a distribution model, an average pressure can be easily calculated. Systems should calibrate the model with field pressure data to verify model accuracy.
- For water systems with multiple pressure zones, the average pressure should be calculated based on the total length of water mains in each zone using the distribution model.
- Systems that cover a relatively flat terrain <50 ft. variation can sample static pressures at hydrants evenly distributed throughout the system (30 minimum recommended). The arithmetic average of these readings can be used. A sample calculation is provided in Example 3. Data should be adjusted by 1-2 psi to account for elevation difference between hydrant and the distribution line (see sample adjustment in Example 4).
- Systems that have varying terrain (>50ft) can sample static pressures at hydrants distributed throughout the system representative of the terrain (30 minimum recommended). The results can be used to calculate an average elevation and weighted average pressure of the system. A sample calculation is provided in Example 4.

Example 3 – Simple Average

Average Pressure = (P1+P2+P3+P*n*…) / *n*
Assume 4 locations are measured. Simple average would be:
(35 psi + 50psi +42 psi +38psi) / 4 = 41.3 psi average system pressure

Example 4 – Elevation Weighted Average Calculation

Pressure Test Data					
Hydrant #	**Elevation (ft)**	**Static Pressure (psi)**	**Hydrant #**	**Elevation (ft)**	**Static Pressure (psi)**
1	600	85	**6**	605	86
2	623	75	**7**	695	58
3	710	55	**8**	620	75
4	682	60	**9**	630	70
5	640	67	**10**	680	62

1. Consolidate the pressure test data into elevation ranges.
2. Calculate the midpoint for each elevation range.
3. Determine the average elevation following the sample calculation.
4. Locate the hydrant nearest to the average elevation (in this example, hydrant #5 with a pressure of 67 psi).
5. Adjust the pressure reading to account for the elevation difference between the hydrant nozzle and the main. Assume the main is 4-feet below the nozzle. Since 1-foot of water = 0.43 psi, the adjustment is 4-feet * 0.43 psi = 1.72 feet.
6. Therefore, the pressure entered into the spreadsheet equals 67 + 1.7 = 68.7 psi.

Elevation Range (ER)	Average Elevation	# of Hydrants in range	Average Elevation x # Hydrants
600-625	**612.5**	**4**	**2450**
625-650	**637.5**	**2**	**1275**
650-675	**667.5**	**0**	**0**
675-700	**687.5**	**3**	**2062.5**
700-725	**713.5**	**1**	**713.5**

Weighted Average = 6501/10 = 650.1 ft.

SECTION 5 - COST DATA

Total Annual Cost of Operating Water System

These costs should include all the costs for operating just the water system, as stated in its definition in the *software*.

Additional costs to consider include shared equipment, bond paybacks, and wholesale water purchases.

Costs to operate wastewater, biosolids, or other non-potable water operations should not be included.

Customer Retail Unit Cost

As stated in the definition, this is the charge that customers pay for water service and is applied to apparent losses.

Be sure to apply the correct units that match the billing units; for example, if water volumes are in million gallons, the cost should be presented in $/1,000 gallons.

With tiered water rates, a weighted average is recommended. The weighted-average may simply be calculated by dividing the total year end revenue from water sales by the total gallons produced.

While the definition included in the software indicates that the customer retail unit cost should include additional charges for sewer, stormwater, or biosolids processing if these are based on water consumption; this is not recommended. Although these charges are based upon the volume of potable water consumed, they will skew the results for the priority areas for attention.

Variable Production Cost

The current unit cost to treat and distribute water to the system.

Include the costs associated with production of water (including distribution pumping costs) and wholesale water purchases. Divide the total cost by the volume of water produced.