# Catawba-Wateree Water Management Group
# Phase 2 Workshop



**CWWMG Water Loss Program
Phase 2 Workshop**

2/21/2017



**Agenda**

Brief refresher on M36 auditing
Training & exercise on Level 1 Validation (4639)
Discussion/launch of Data Request



AWWA M36 Methodology
State of the Art Water Auditing & Loss Control

# Catawba-Wateree Water Management Group
# Phase 2 Workshop

## AWWA M36
## Economic Optimum



**Aggressive Intervention is Over-Spending**
*Example: replacement of pipes and meters before their optimal useful life*

**Economic Optimum** Loss & Intervention
*Economic target from benefit-cost design (M36)*

**Reactive Intervention is Over-Spending**
*Example: fixing only leaks that surface, replacing meters only when they stop*

New Supply — Total Loss Cost

New $M — The GAP — The target of the Basin-Wide Water Loss Program

Cost of Water Loss

Cost of Intervention

COST ($M)

Water Loss (Volume)

## CWWMG Member Reflections



## Water Auditing

1. Systematically account for known water volumes to estimate volumes of **Water Loss**.

2. Evaluate **data source reliability**.

3. **Communicate** water distribution efficiency.

## Water Auditing

**1. Account for volumes…**

| WATER SUPPLIED | AUTHORIZED CONSUMPTION | BILLED AUTHORIZED CONSUMPTION | BILLED METERED CONSUMPTION | REVENUE WATER |
| --- | --- | --- | --- | --- |
| | | | BILLED UNMETERED CONSUMPTION | |
| | | UNBILLED AUTHORIZED CONSUMPTION | UNBILLED METERED CONSUMPTION | NONREVENUE WATER |
| | | | UNBILLED UNMETERED CONSUMPTION | |
| | WATER LOSSES | APPARENT LOSSES $$$ | CUSTOMER METER INACCURACIES | |
| | | | UNAUTHORIZED CONSUMPTION | |
| | | $$$ | DATA HANDLING ERRORS | |
| | | REAL LOSSES | | |

- *Mass balance – process of elimination*
- *Account for all water*
- *Accuracy matters!*

## Water Auditing

**1. ...Estimate volumes of Water Loss!**

Apparent Losses      Real Losses



## Water Auditing

**2. Evaluate data reliability**

Complete?    Consistent?    Accurate?



*Does the data story make sense?*

## Water Auditing
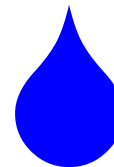
**3. Communicate water distribution efficiency**

customized performance indicators

**financial value** of Water Losses

$ $ $

## Water Auditing

volumes      values      validity

## Types of Water Loss

Apparent Losses      Real Losses



## Apparent Losses

water volume that reaches customers

**but is not registered or properly tracked**

(and so you're not paid)



## Apparent Losses

often referred to as "paper losses"

focus on **revenue optimization**

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reducing Apparent Losses *increases revenue*

but creates *no new water*

## Real Losses

often referred to as "physical losses"

leaks      seeps      breaks

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## Real Losses



reducing Real Losses *creates an additional resource*

can reduce operating costs

can defer capital expenditure

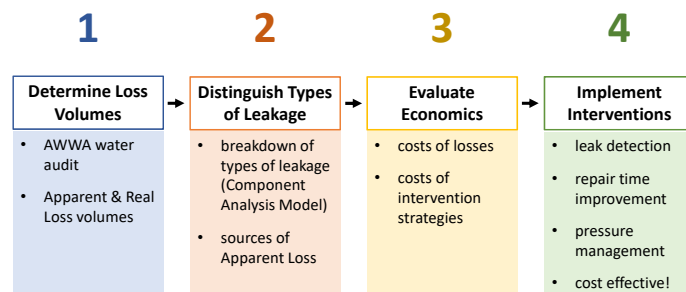## Benefits of Water Loss Control

save water     reduce costs

be proactive

- identify what you don't know
- understand your system
- reduce O&M and CIP costs
- better manage assets
- optimize meter replacement

- conserve water
- improve sustainability
- be ahead of regulation
- lessen liability
- build credibility with stakeholders

better information  →  better system management

## Water Loss Control

**1**

**Determine Loss Volumes**
- AWWA water audit
- Apparent & Real Loss volumes

**2**

**Distinguish Types of Leakage**
- breakdown of types of leakage (Component Analysis Model)
- sources of Apparent Loss

**3**

**Evaluate Economics**
- costs of losses
- costs of intervention strategies

**4**

**Implement Interventions**
- leak detection
- repair time improvement
- pressure management
- cost effective!

## AWWA Free Water Audit Software

Water Audit Jeopardy!

## Water Audit Validation

### Data quality matters!
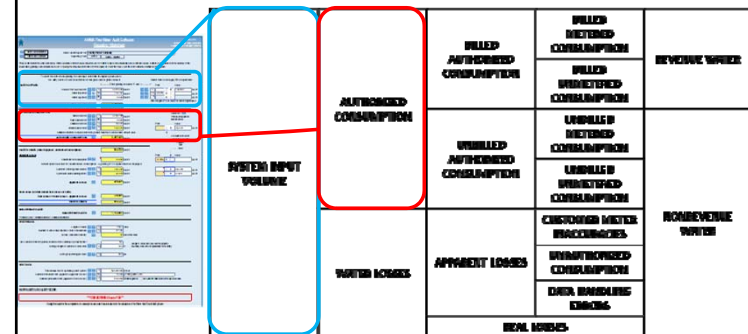
inaccuracy & uncertainty in inputs → inaccuracy & uncertainty in results
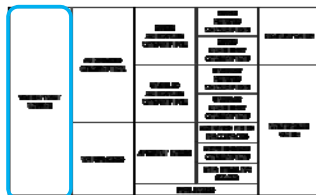
**Sources of error:**
- Instruments
- Databases
- People
- Missing information

## Accuracy in the Water Balance

*the accuracy of our two most important volumes in the water balance makes a big difference!*
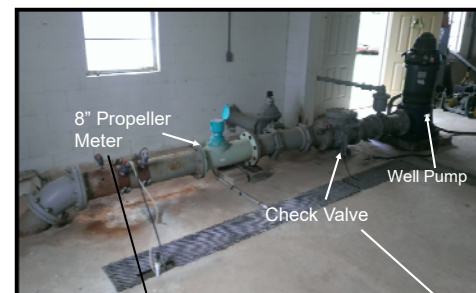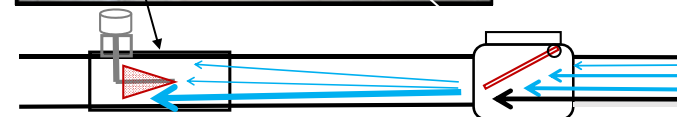


## Accuracy in the Water Balance



#1 – Meter wear

#2 – Meter location

#3 – Meter selection

#4 – Meter programming

#5 – Flow data archiving

## Accuracy in the Water Balance



8" Propeller Meter

Well Pump

Check Valve

Accuracy results from MFR test bench: 99.5%

Accuracy results from in-situ test: 142.2%

Courtesy MESCO

*Prepared by Cavanaugh & Associates, P.A. For reference only. Not for re-distribution/duplication.*
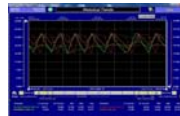
6

## What Constitutes a Meter?

Primary Device:  Measuring Element

*Conducts the measurement*

Secondary Device:  Register, Transmitter

*Converts, communicates the measurement*
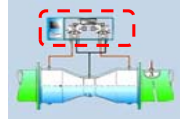
Tertiary Device:  Remote Database
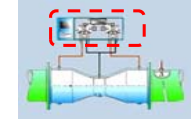
*Records, archives the measurement*
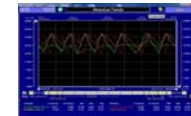
## Accuracy Testing v Calibration

Primary Device:  Accuracy Testing

*Independent measurement for comparison*

Secondary Device:  Calibration

*Checks alignment of primary measurement to register and signal output*

Tertiary Device:  Calibration

*Checks alignment of secondary signal to SCADA output*

## Gremlins in the Data Chain

### Flow Data Archiving

- Production flow data should be reviewed every business day for data gaps
- Gaps occur due to:
  - Unplanned interruption: lightning strike, power failure
  - Planned interruption: instrumentation calibration
- Gaps in water flow data should be quantified and added back to the daily total

(Source: AWWA M36 Publication, 4th Ed.)

| 8/15/2012, hrs | High Service Pumping Rate, mgd actual flow | High Service Pumping Rate, mgd raw recorded data |
|---|---|---|
| | Example of Water Pumping Data Gaps an | |
| 0:00 | 8.69 | 8.69 |
| 1:00 | 8.65 | 8.65 |
| 2:00 | 8.32 | 8.32 |
| 3:00 | 8.11 | 8.11 |
| 4:00 | 7.94 | 0 |
| 5:00 | 8.02 | 0 |
| 6:00 | 8.44 | 0 |
| 7:00 | 8.98 | 0 |
| 8:00 | 9.34 | 0 |
| 9:00 | 9.25 | 0 |
| 10:00 | 9.17 | 0 |
| 11:00 | 9.12 | 9.12 |
| 12:00 | 9.27 | 9.27 |
| 13:00 | 9.22 | 9.22 |
| 14:00 | 9.08 | 9.08 |
| 15:00 | 8.99 | 8.99 |
| 16:00 | 9.14 | 9.14 |
| 17:00 | 9.18 | 9.18 |
| 18:00 | 9.25 | 9.25 |
| 19:00 | 9.22 | 9.22 |
| 20:00 | 8.82 | 8.82 |
| 21:00 | 8.78 | 8.78 |
| 22:00 | 8.75 | 8.75 |
| 23:00 | 8.71 | 8.71 |
| 0:00 | 8.68 | 8.68 |
| Total | 212.43 | 151.29 |
| Average | 8.85 | 6.30 |
| Difference | | 2.55 |

## Accuracy in the Water Balance
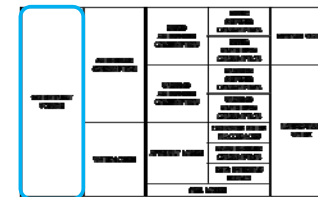
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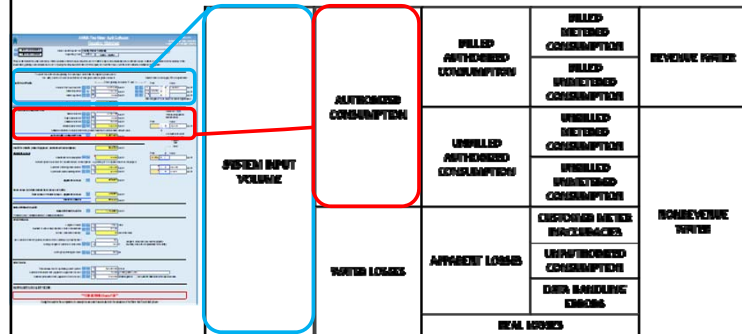


## Accuracy in the Water Balance
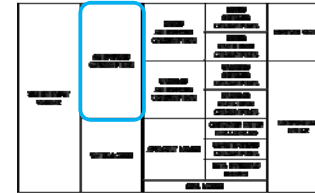


#6 – Redundant volumes          #8 – Missing volumes

#7 – Non-potable volumes          #9 – Mismatched timeframes



Executive Summary

Research Team:

**Level 1 Water Audit Validation**

Quick Facts — Project Number: 4639 • Date Available: November 2016

- Water audit validation is the process of examining water audit inputs to improve the water audit's accuracy and document the uncertainty associated with water audit data.
- Level 1 water audit validation confirms that American Water Works Association M36 water audit methodology was correctly applied to a utility's specific situation, identifies evident inaccuracies in summary water audit data, and verifies that data validity grades accurately reflect utility practices.
- While some uncertainty may persist in the water audit, the water audit is more reliable for having been Level 1 validated.

## Water Audit Validation

Data validation can be performed at distinct levels.

*Level 1 – data validity grading and analysis of summary records*

*Level 2 – desktop analysis of existing raw data behind summary records*

*Level 3 – new data collection in field – testing, calibration, flow/pressure, etc.*

Data validation doesn't necessarily fix all errors in data.

After all, *auditing is retrospective*.

## Water Audit Validation

Each level of validation is defined by distinct

**goals**

**outcomes**

**limitations**

Scale of validation effort should match desired results.

## Level 1 Validation – "DVS"

*focus:*      *accurate assignment of data validity grades*
     *correct application of methodology*
     *identify macroscopic errors if present*

**GOALS:**      confirm interpretation of methodology
     identify macroscopic errors
     assign correct data validity grades

**OUTCOMES:**    correct data validity grades
     recommendations for higher-level validation activity

**LIMITATIONS:**   does not correct errors in raw data
     does not study instrument performance

## Level 2 Validation – "Raw Data"

*focus:*      *full interrogation of water audit data sources*
     *assessment of data chain fidelity*

**GOALS:**      study data transfer from instrument to water audit
     correct for raw data gaps, anomalies, and redundancies
     confirm correct application of test results, pressure data

**OUTCOMES:**    identification of best data sources
     documentation of problems in raw data
     recommendations for level 3 validation activity

**LIMITATIONS:**   time intensive!
     does not measure instrument performance

## Level 3 Validation – "Instruments"

*focus:*      *corroboration of water audit results*
     *assessment of instrument performance*

**GOALS:**      measure supply meter and 4-20 mA accuracy
     study accuracy of customer meter population
     corroborate water audit results (estimate of Real Loss)

**OUTCOMES:**    understanding of master meter error
     verification of leakage volume
     water loss management insight

**LIMITATIONS:**   time and resource intensive!
     does not always uncover water audit data issues

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## The Validator

The **validator** is essential to the process of validation!

The validator should be…
- knowledgeable
- objective
- transparent
- methodical
- diplomatic

The validator should NOT be…
*…the auditor!*

## Level 1 Validation

*correct interpretation of methodology*
*accurate assignment of data validity scores*

primary validation tool: **engaged interview**

1. Collect audit and request supporting documents.
2. Examine initial performance indicators
3. Validate audit input.
4. Re-examine performance indicators.
5. Document results.

## 1. Collect documents

| REQUIRED | SUPPLEMENTAL |
|---|---|
| ❑ Volume from Own Sources *broken down by month and meter* | ❑ Customer Meter Inaccuracy *derivation* |
| ❑ Water Imported *broken down by month and meter* | ❑ Average Operating Pressure *derivation* |
| ❑ Water Exported *broken down by month and meter* | ❑ Customer Retail Unit Cost *derivation* |
| ❑ Supply Meter Testing | ❑ Variable Production Cost *derivation* |
| ❑ Volume of Water Sold *broken down by month and charge code* | ❑ System Schematic *showing locations of Supply and Export Meters* |

## 2. Look at PIs

| FINANCIAL INDICATORS | CHECK |
|---|---|
| **NRW volume** as % of Water Supplied | > 0% |
| **NRW value** as % of operating cost | < 100% |

| OPERATIONAL EFFICIENCY INDICATORS | CHECK |
|---|---|
| **Apparent Losses** per Service Connection per Day | > 0 |
| **Real Losses** per Service Connection per Day | > 0 |
| **Real Losses** per Service Connection per Day per PSI | > 0 |
| **Infrastructure Leakage Index** | > 1.0 |

*Anything funky going on?*

## 3. Validate inputs.

How did the auditor **arrive at the water audit input**?

How did the auditor **interpret general methodology and definitions** to apply to the specifics of his or her system?

How did the auditor **select a data validity grade**?

How does the audit input **compare to previous years** (if applicable)?

## 3. Validate inputs.

Is the data validity score defensible?

*ALL criteria must be met for a given score and all scores below it for that score to apply.*

Does anything need to be changed to make the audit more accurate?

## 4. Look at PIs again.

Any changes?

Do the PIs make more sense?
Or not?

*Remember: level 1 validation doesn't fix most errors in data and instrumentation.*

## 5. Document!

- Any data validity grade changes
- Any audit input changes

- Outstanding questions or actions needed
- Evaluation of audit metrics v reasonable ranges and expectation for the system
- Recommendations for advanced validation as warranted

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## Now what?

*Level 2 validation* – raw data, data transfer

*Level 3 validation* – results confirmation, instruments

**More audits**! Best when performed annually.

deeper water loss analysis → water loss control program

## Water Loss Control

The end goal:

cost-effective

informed

### Water Loss Control Program

*auditing and validation alone do not save money and water*

## Exercise
### Your turn!

You will receive an example water audit and some supporting data for you to review. Your instructions are:

1.  Identify and correct any errors in the inputs

2. Determine the appropriate data grades where sufficient information is provided.  Otherwise notate what further  information is needed to assign remaining data grades.   Keep notes – we will discuss!

3. Evaluated the performance indicators and determine where advanced validation should focus, if warranted.

## Recap

### How'd it go?

What were the results of your level 1 validation?

What questions remain about the water audit?

What info did you determine to be missing to assess the data validity grades?

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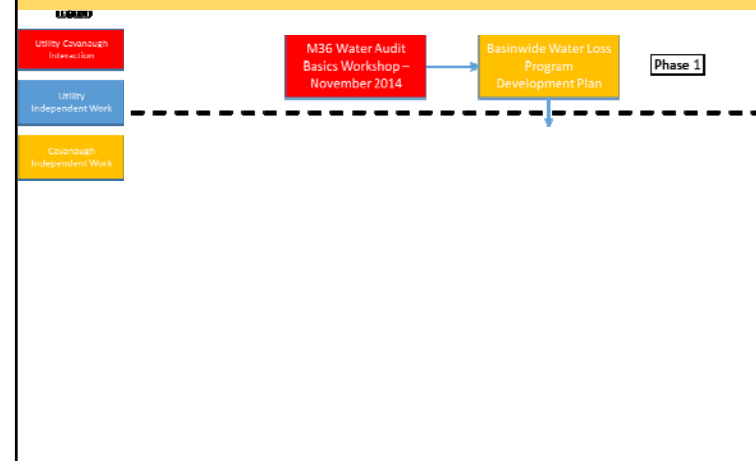## Phase 2 Workshop

### Review

Validation improves water audits.

Validation can be conducted at varying levels of rigor, each with distinct goals, outcomes, and limitations.
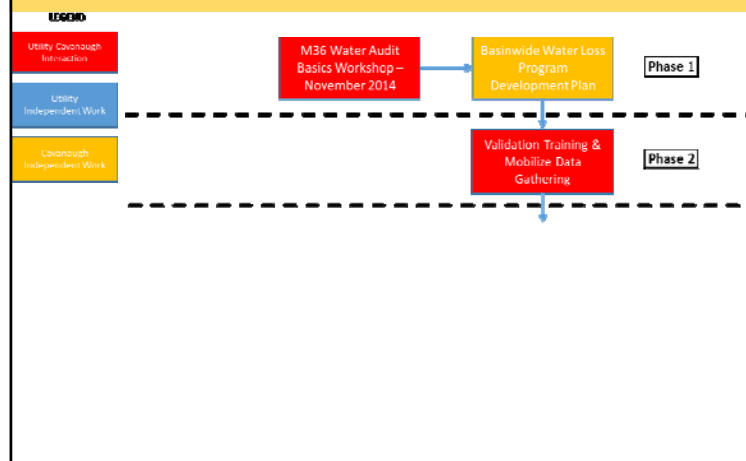
Level 1 validation aims to confirm application of methodology and assignment of data validity grades.

A standard approach to level 1 validation relies primarily on an interview with the auditor or audit team.
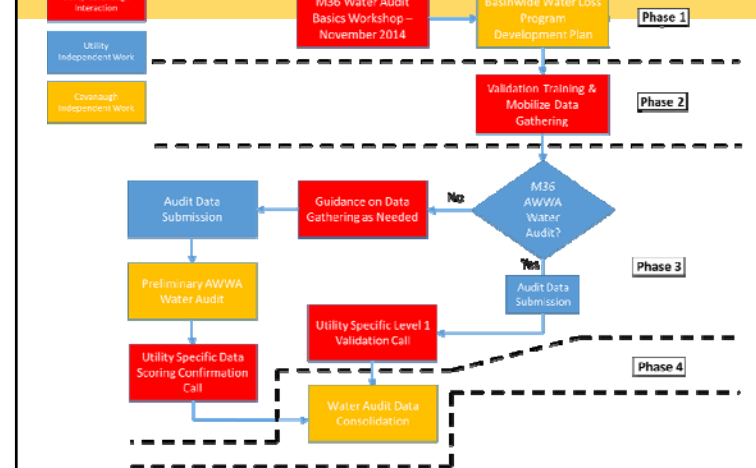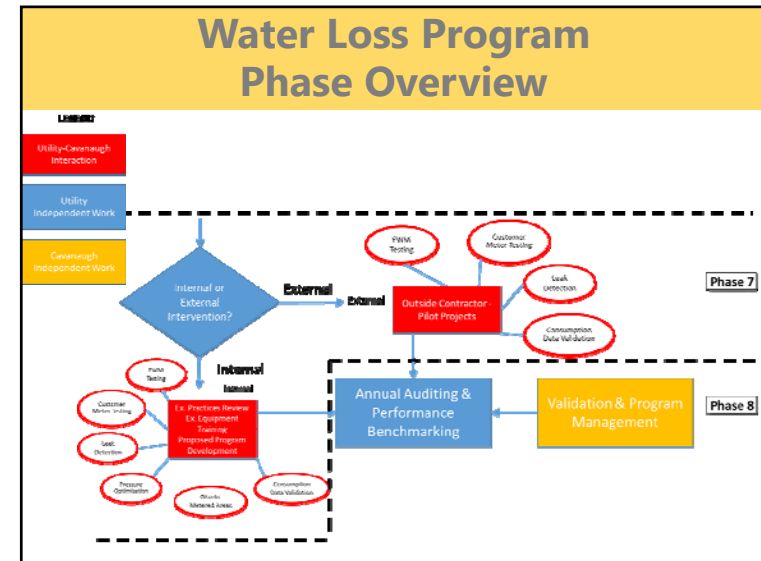
### Water Loss Program Phase Overview

LEGEND
- Utility Cavanaugh Interaction
- Utility Independent Work
- Cavanaugh Independent Work

M36 Water Audit Basics Workshop – November 2014 → Basinwide Water Loss Program Development Plan — Phase 1

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Validation Training & Mobilize Data Gathering — Phase 2

### Water Loss Program Phase Overview

LEGEND
- Utility-Cavanaugh Interaction
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M36 Water Audit Basics Workshop – November 2014 → Basinwide Water Loss Program Development Plan — Phase 1

Validation Training & Mobilize Data Gathering — Phase 2

M36 AWWA Water Audit?

No → Guidance on Data Gathering as Needed → Audit Data Submission

Yes → Audit Data Submission

Utility Specific Level 1 Validation Call

Preliminary AWWA Water Audit

Utility Specific Data Scoring Confirmation Call

Water Audit Data Consolidation

Phase 3

Phase 4

### Water Loss Program
### Phase Overview



### Water Loss Program
### Phase Overview
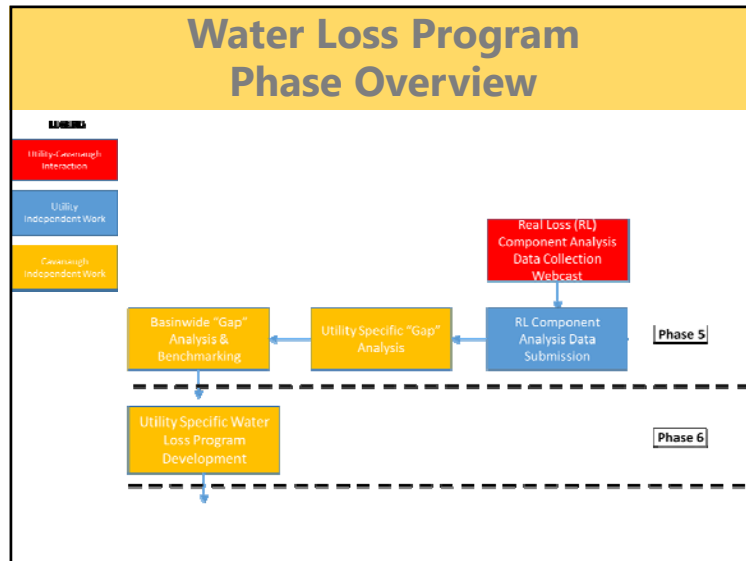


**Your Role in Phases 2-4**

| | |
|---|---|
| Launch workshop | Feb |
| Data gathering | Feb - May |
| Validation teleconference | Summer |

## Phase 3 Data Request

- Timeframe for the data requested unless noted otherwise: Most recent year (either calendar or fiscal) plus 2 months on the front and back end (so 16 months total)

- Format for the data requested: **Excel preferred**, scan or PDF if Excel format not available.

- **Deadline** to provide the requested data: **Monday, May 15th, 2017.**

Most recent year (either calendar or fiscal) water audit, in either
- • AWWA Free Water Audit Software format if you have it or
- • Your own format if you are not using the AWWA software

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### Phase 3 Data Request

Water Supplied
- Basic schematic showing where supply meters are located relative to distribution system, including any export or import meters, and pressure zones if applicable
- Inventory or your finished water meters, import water meters and export water meters – size, type & age.
- Provide your current policy for flow testing and/or signal calibration of these meters, if you have one.
- Provide all available records/reports/data from testing and/or calibration activities for each finished water and/or purchase meter.
- Table of volume produced from own sources, by month, by finished water meter (if applicable)
- Table of volume imported from another system(s), by month, by import water meter (if applicable)
- Table of volume exported to another system(s), by month, by import water meter (if applicable)

### Phase 3 Data Request

Authorized Consumption
- For billed water, provide volumes sold by charge code, by month. Include key for charge codes.
- For unbilled water, provide any available summary of tracking data such as flushing and fire estimates.

Apparent Loss
- Any available customer meter testing results.
- Provide your policy/practice for testing of customer meters, if you have one. Note if you have a different testing policy for large vs small meters.
- Provide your policy/practice for customer meter replacement.

System data – as of today
- Total miles of distribution main, including hydrant laterals
- Number of active and inactive taps.
- General description of operating pressure – how many pressure zones, and what are the ranges of pressure in each zone. Provide any available pressure data.

### Phase 3 Data Request

Cost data – for audit year only
- Total annual operating cost for the water system, including admin (billing, management) and water debt service, excluding any costs associated with non-potable water (sewer, storm, etc).
- Total *commodity* revenue (excluding base charges, consumption only) from water sales and sewer sales.
- Total cost for power (supply & distribution), treatment chemicals, residuals management (if applicable).
- Total cost for water purchases, if applicable.
- Total cost for damages paid on claims resulting from main or service line breaks for the past 5 years.
- Itemized depreciation schedule for water system pumping and treatment assets, if available.

### Phase 3 Data Request

- Transmittal of data by email if that is easiest

- If file sizes are too large, let us know and we will send you a link to upload the data to us

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SAVE THE DATE

December 3 - 5, 2017
Paradise Point Resort · San Diego, CA

NORTH AMERICAN WATER LOSS 2017
SAN DIEGO, CALIFORNIA

Presented by: American Water Works Association California-Nevada Section

In cooperation with the American Water Works Association, the Alliance for Water Efficiency and the NAWL 2017 Conference Planning Committee.

The North American Water Loss Conference (NAWL) will assemble policy and technical experts on non-revenue water management in North America.

Presented by:
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Sponsorships will be available.

www.northamericanwaterloss.org



CAVANAUGH
Stewardship Through Innovation

**CWWMG Water Loss Program**
**Phase 2 Workshop**

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WATER MANAGEMENT GROUP

*2/21/2017*