Shrinking the Box: Utilization of the M36 Audit in Massachusetts to Improve Water Management

Duane LeVangie, Program Chief, MassDEP
Tara E. McManus, PE, Weston & Sampson
Matthew Mostoller, Environmental Manager, Acton Water District

MA Water Resources Commission
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Unaccounted for Water (UAW)

- UAW is a measure of how well a PWS can account for all the water that it pumps into its distribution system.
- It is the percentage of water entering the distribution system not accounted for from service meter readings or from unmetered confidently estimated municipal uses (CEMU) such as fire fighting, street cleaning etc…
- UAW percentages reflect:
  - Leaks;
  - Meter calibration errors or failures;
  - Unmetered uses that are not documented;
  - Billing inaccuracies;
  - Theft; and
  - Systemic data handling errors.

Unaccounted for Water (UAW)

- UAW Performance Standard is 10%.
- Approximately 70-80% of PWSs have the UAW standard in their permit.

PWS Systems UAW Status 2012-2018							
	2012	2013	2014	2015	2016	2017	2018
# PWS with UAW of ≤10% (% meeting)	126 (49%)	119 (44%)	114 (42%)	112 (41%)	128 (47%)	127 (47%)	127 (47%)
UAW > 10%	131	149	161	163	146	141	145
UAW Range (Low/High)	0/52	0/57	1/67	1/66	0/52	0/56	0/52

UAW Compliance Plan

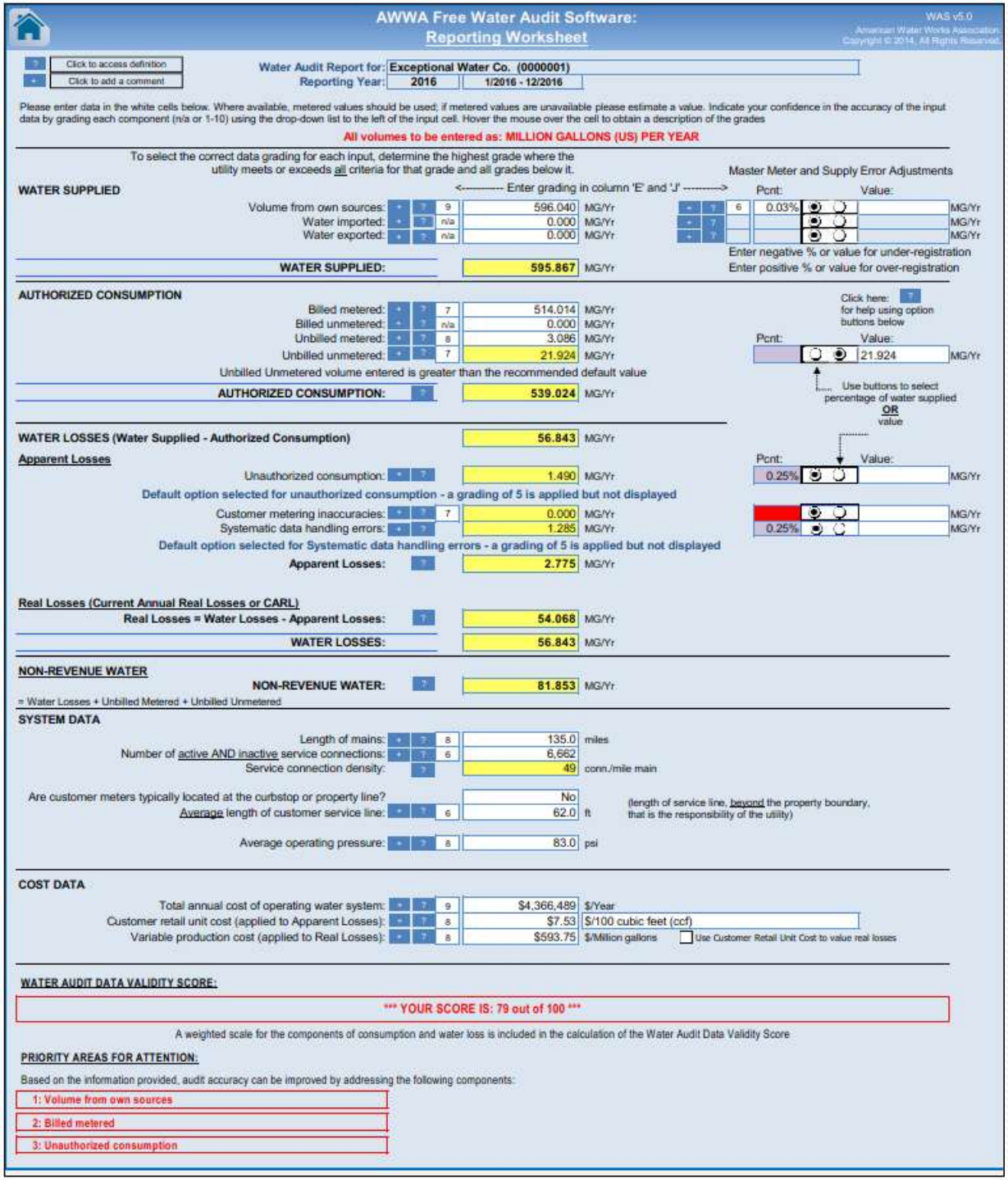
- Historically, PWSs were required to meet 10% UAW within two years of the permit being issued, if not then:
  - Develop an Individual UAW Compliance Plan; or
  - Adopt MassDEPs Functional Equivalence Plan (FEP).
    - Individual Plans had 3 additional years to meet 10%.
    - If 10% not met after 5 full years, implement the MassDEP UAW FEP to be considered functionally equivalent.
- Now, PWSs are required to meet 10% or less for 2 of the 3 most recent years thru the permit period.
  - If not met, then the PWS shall conduct an *AWWA M36 Water Audit* and then proceed based on the validity score.

Grants Background

- State capital fund has provided the money since 2012.
- Approx. $1.5 million/year for several programs:
  - SWMI Mitigation Grants
  - M36 Grants
  - PWS System Mapping
  - Healthy Lawn, Happy Summer Program
- Funding for 2020-2022 is in the current capital budget.
- AWWA M36 Grant 2016-2020
  - Designed to assist permit holders (and now registrants too) reduce their non-revenue water
    - help determine how much water is being lost due to leakage, meter error, or other conditions; and
    - determine the cost of uncaptured revenue from non-revenue water

What is an M36 Water Audit?

- Additional tool to assist PWSs with:
  - Revenue Management
  - Assist with Conservation
  - Provide higher customer confidence
  - Provide higher PWS confidence
  - Set Capital Priorities
  - Respond to Regulations



AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association
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Click to access definition
Click to add a comment

Water Audit Report for: Exceptional Water Co. (0000001)
Reporting Year: 2016 1/2016 - 12/2016

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

<---------- Enter grading in column 'E' and 'J' ----------> Master Meter and Supply Error Adjustments

WATER SUPPLIED

			Pcnt:	Value:	
Volume from own sources:	9	596.040 MG/Yr	0.03%		MG/Yr
Water imported:	n/a	0.000 MG/Yr			MG/Yr
Water exported:	n/a	0.000 MG/Yr			MG/Yr
WATER SUPPLIED:		595.867 MG/Yr			

Enter negative % or value for under-registration
Enter positive % or value for over-registration

AUTHORIZED CONSUMPTION

Click here: for help using option buttons below

			Pcnt:	Value:	
Billed metered:	7	514.014 MG/Yr			
Billed unmetered:	n/a	0.000 MG/Yr			
Unbilled metered:	8	3.086 MG/Yr			
Unbilled unmetered:	7	21.924 MG/Yr		21.924	MG/Yr

Use buttons to select percentage of water supplied OR value

Unbilled Unmetered volume entered is greater than the recommended default value

AUTHORIZED CONSUMPTION: 539.024 MG/Yr

WATER LOSSES (Water Supplied - Authorized Consumption) 56.843 MG/Yr

Apparent Losses

			Pcnt:	Value:	
Unauthorized consumption:		1.490 MG/Yr	0.25%		MG/Yr
Customer metering inaccuracies:	7	0.000 MG/Yr			MG/Yr
Systematic data handling errors:		1.285 MG/Yr	0.25%		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: 2.775 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 54.068 MG/Yr

WATER LOSSES: 56.843 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 81.853 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	8	135.0	miles
Number of active AND inactive service connections:	6	6,662	
Service connection density:		49	conn./mile main
Are customer meters typically located at the curbstop or property line?		No	
Average length of customer service line:	6	62.0	ft
Average operating pressure:	8	83.0	psi

(length of service line, beyond the property boundary, that is the responsibility of the utility)

COST DATA

Total annual cost of operating water system:	9	$4,366,489	$/Year
Customer retail unit cost (applied to Apparent Losses):	8	$7.53	$/100 cubic feet (ccf)
Variable production cost (applied to Real Losses):	8	$593.75	$/Million gallons

Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

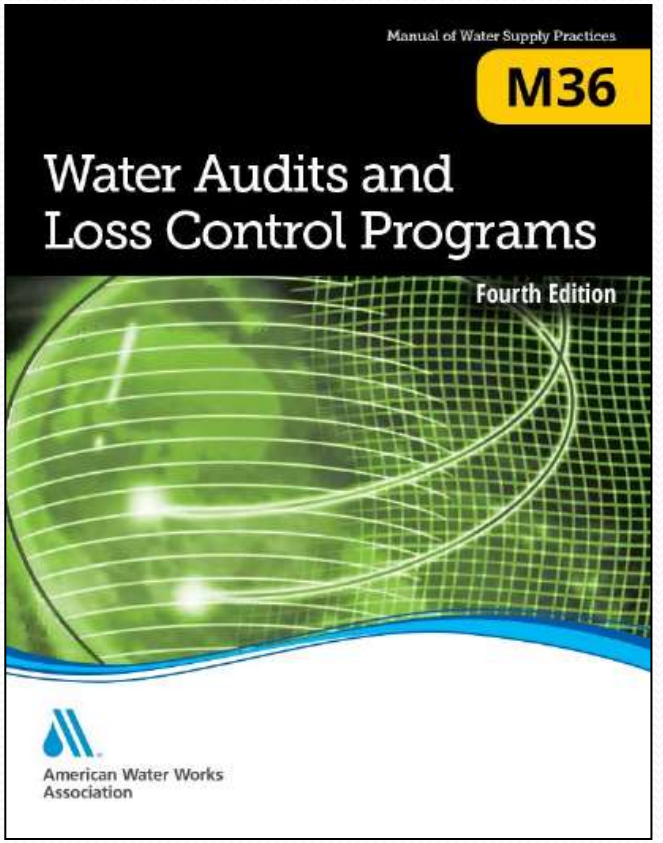
*** YOUR SCORE IS: 79 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

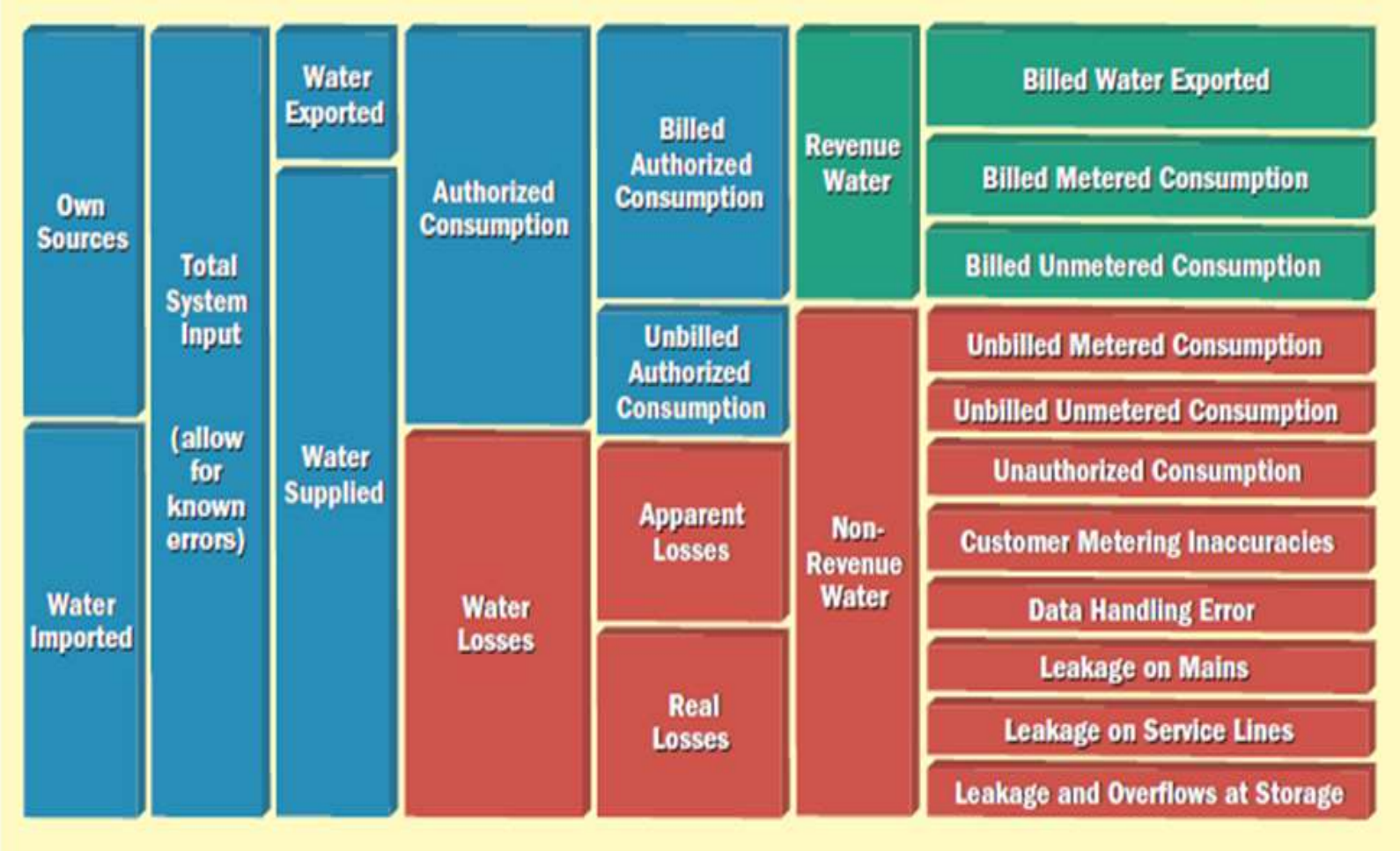
Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Billed metered
3: Unauthorized consumption



- No more "un-accounted for water" – M36 accounts for all water
- Water Losses are broken down into Apparent and Real Losses

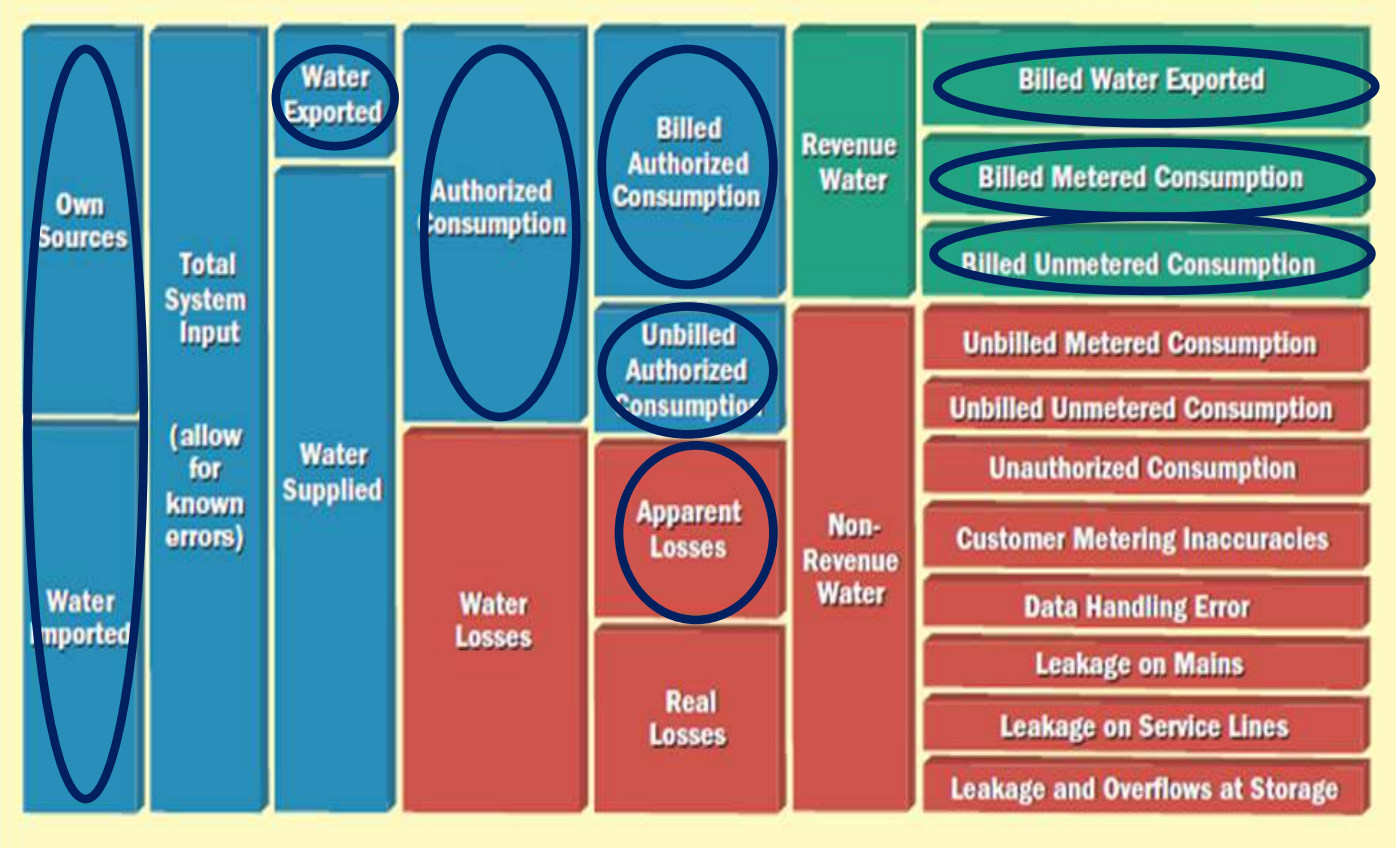
The Water Balance



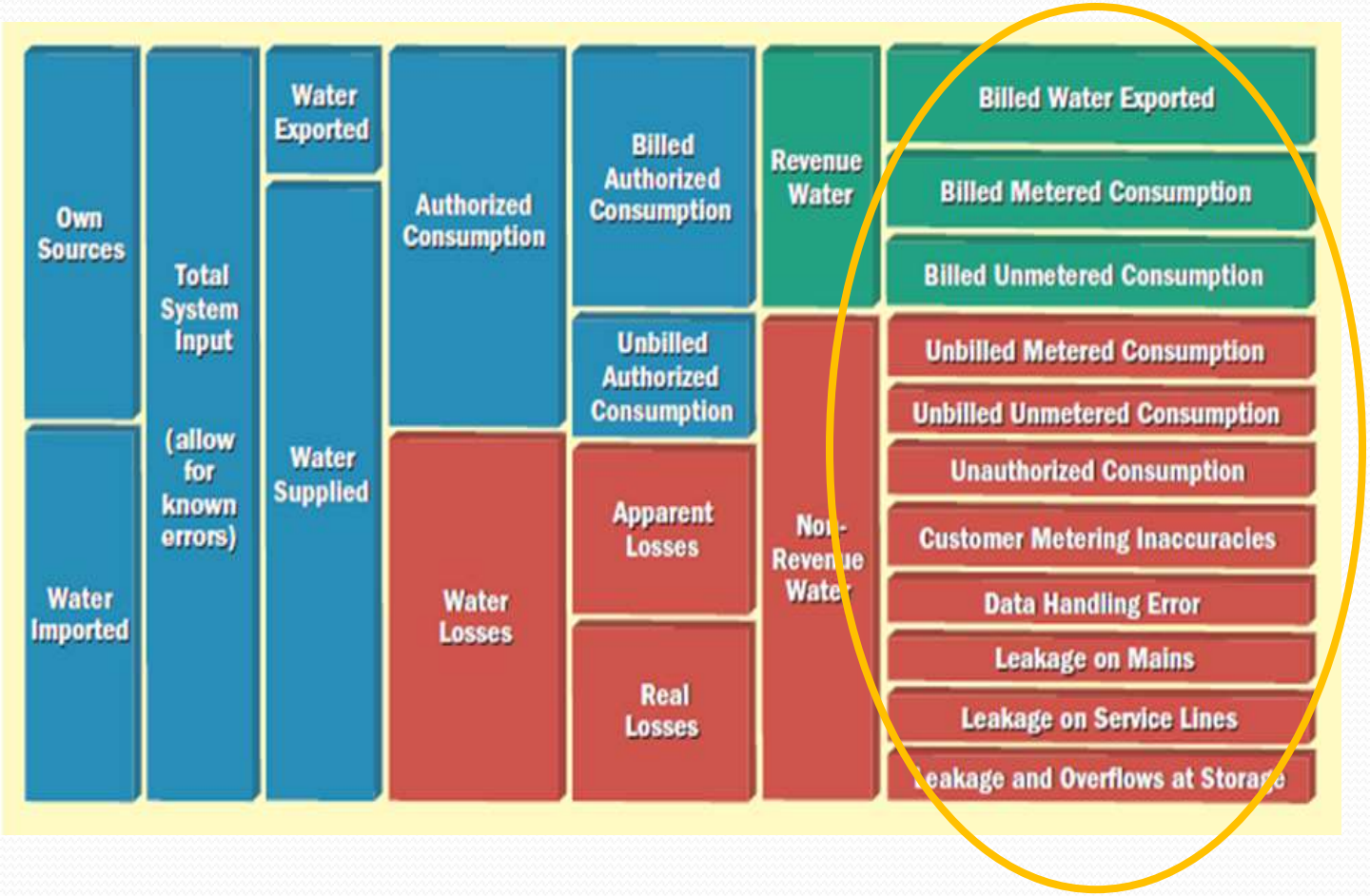
Style of M36 Audits Funded

1. "Top Down" approach
   Water balance….in vs out
   - Quantifies losses
   - Assigns value to losses
2. "Bottom Up" approach
   - Searches out causes of losses
   - Includes WRF Component Analysis
3. Both go through a level of validation

Data Inputs for both “Top Down” and “Bottom Up” Audits

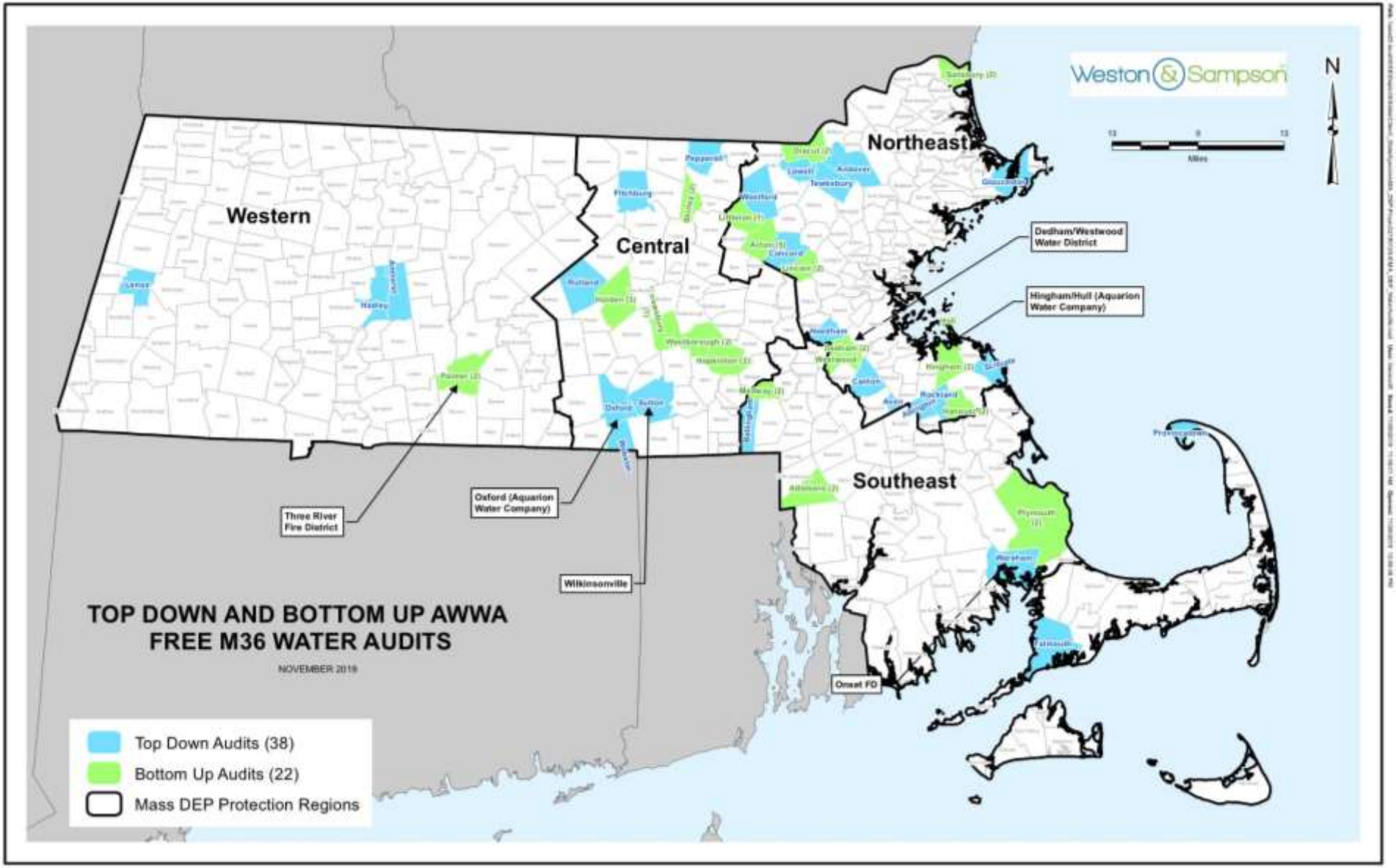


Areas Further Evaluated by "Bottom Up" Audit



Weston & Sampson performed 58 AWWA M36 audits through MassDEP M36 Grant Funding and 2 M36 audits through the 2014 SWMI grant funding (piloted M36 for a small and medium PWS)

- 38 Top Down Audits
- 22 Bottom Up Audits
- Total of 41 different PWSs
- Repeat M36 PWSs include: Acton, Aquarion Hingham/Hull, Attleboro, DWWD, Dracut, Hanover, Holden, Hopkinton, Lincoln, Medway, Plymouth, Salisbury, Shirley, Three Rivers, & Westborough


Weston & Sampson
N
Western
Central
Northeast
Southeast
Dedham/Westwood Water District
Hingham/Hull (Aquarion Water Company)
Three River Fire District
Oxford (Aquarion Water Company)
Wilkinsonville
Onset FD
TOP DOWN AND BOTTOM UP AWWA FREE M36 WATER AUDITS
NOVEMBER 2019
Top Down Audits (38)
Bottom Up Audits (22)
Mass DEP Protection Regions

Massachusetts Water System Characteristics

	City/Town Population*	Service Connections	Water Supplied (MG)	Length of Mains (mi)
Small-sized	8,963	866	77	20
Mid-sized	16,332	5,822	500	112
Large-sized	106,519	30,697	3766	213

*Some residents may be served by private wells or other PWSs
Shortest length of mains: 13 miles
Largest length of mains: 390 miles

Audit Statistics – from the 60 MA Audits

	Max	Min	Median
Data Validity Score (DVS)	87	51	68
Infrastructure Leakage Index (ILI)	5.2	0.2	1.6
Apparent Losses (gallons/connections/day)	9.1	0.8	1.2
Real Losses (gallons/connections/day)	122.5	4.9	35.4
Non-revenue water by % operating cost	14%	1%	3%

15 PWS Repeat Water Audits

13 UAW decreased or stayed the same

14 Data Validity Scores increased

11 Water Loss % decreased

- Up to 17% decrease

Lessons Learned – Audit Results

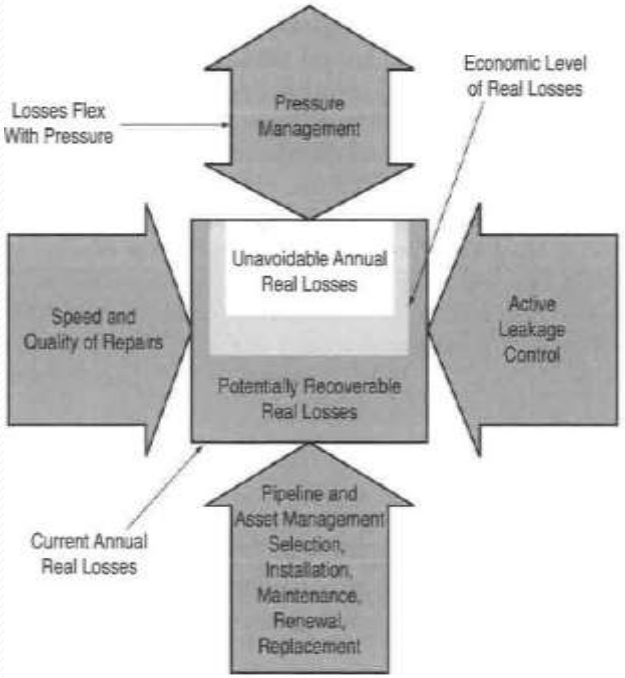
- **Areas where PWSs should focus on:**
  - Volume from own sources – accuracy of master meters
    - Outdated master meters
    - Limited calibration
  - Customer metering inaccuracies
    - QA/QC
    - Reading vs billing databases lead to billing inaccuracies
    - Aging/inaccurate meter populations
  - Systematic data handling errors
    - Data collection
    - Unbilled unmetered usage

Lessons Learned – 3rd Party Viewpoint

- When conducting a Free Audit it can be difficult to obtain the proper data and schedule meetings with the appropriate personnel
- More accurate data is needed to validate the Component Analysis
- Smaller systems have different challenges than larger systems
  - Possibly more miles of main with less service connections
  - Less personnel and resources
  - More attention to individual accounts
- Group PWS audit review sessions are highly beneficial
- Reiterate to PWS that the process takes time and patience

Ability to Perform Additional Work

- In 2017 and 2019, funds were also provided for 6 free M36 Audit training sessions across the state.
  - Open to all PWSs
  - Walk participants through the M36 spreadsheet, definitions & terminology, and basic data needs
  - Review Water Balance, Performance Indicators, & Water Loss Control Strategies
  - Group Q&A and roundtable discussion
- A detailed instruction manual for the M36 Audit methodology was also created.
  - Found on-line at: https://www.mass.gov/service-details/public-water-supply-tools-resources-performance-standards



Ability to Perform Additional Work 2018

- Source meter evaluations
  - Upstream and downstream lay lengths comply with specifications
  - Installs meet specifications
  - Confirm all usage post-meters are recorded
  - Recommendations included: replacing out-of-date meters and increasing lay lengths when retrofitting the stations

Ability to Perform Additional Work 2018

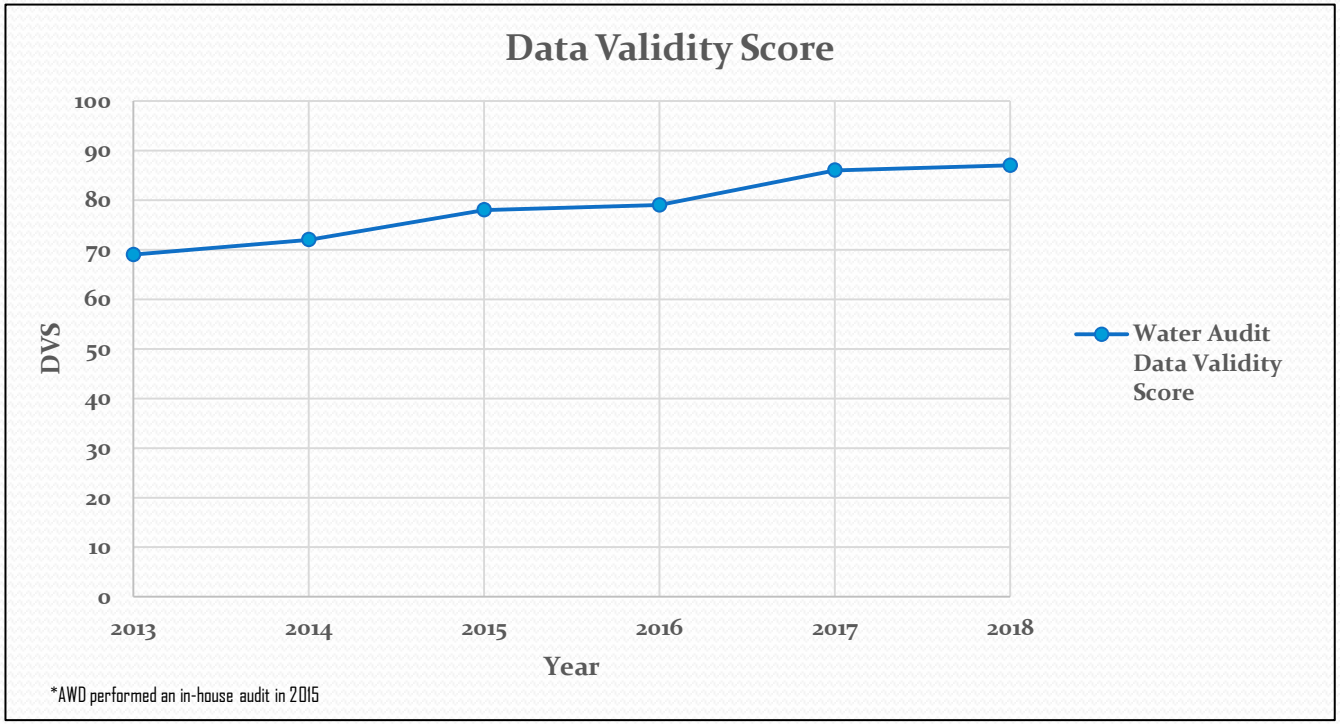
- Top 5 water users review
  - Appropriate type and size for application
  - Meter condition
  - If the usage was typical for account/facility type
  - Recommendations included: downsizing meter, replacing current meter with a compound meter, or collection of more data

Success Stories – Acton Water District

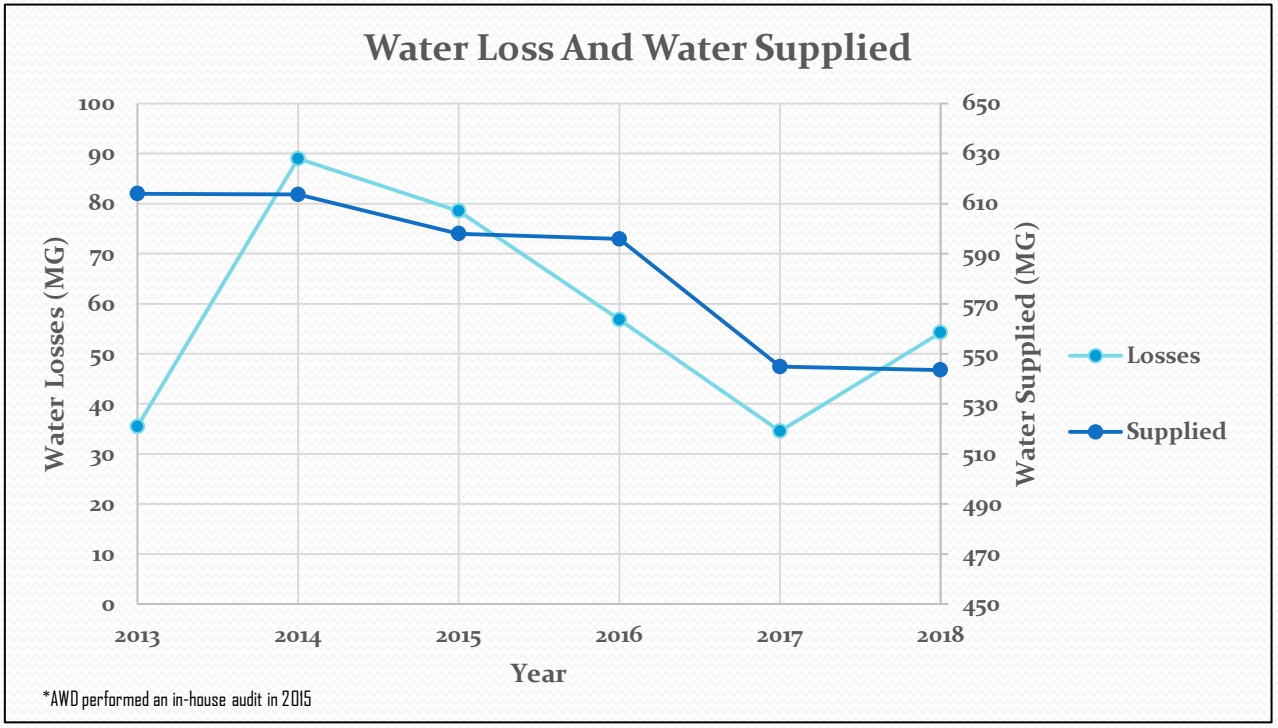
- 6 Water Audits, 5 through MassDEP and W&S
- Population: 21,929
- Number of service connections: 6,745
- Water Supplied: 544 MG
- Miles of Main: 128

	1st Audit (2013)	2018 Audit
Data Validity Score (DVS)	69	87
Infrastructure Leakage Index (ILI)	0.45	0.7
Apparent Losses (gallons/connections/day)	1.72	1.03
Real Losses (gallons/connections/day)	13.01	21.02
Non-revenue water by % operating cost	10.3%	1.7%

Success Stories – Acton Water District



Success Stories – Acton Water District



*AWD performed an in-house audit in 2015

Year	Water Supplied Supplied (MG) (MG)	Water Losses (%) (%)
2013	614	6%
2014	614	14%
2015	598	13%
2016	597	10%
2017	545	6%
2018	545	10%

Acton Water District Adopted Practices

- Replaced source meters
- Completed customer meter replacement project
- Converted to AMR system, where high/low reads are flagged automatically
- Developed a meter replacement program based on customer usage
- Utilized WaterSmart, where customers can view and track their usage
- Implemented use of electronic forms and iPads in the field to track unbilled unmetered usage

Take Away Messages

- Management Tool
- Third Party is Helpful
- M36 Audit is a Process, not a check box!
- Informs Decision making
  - Meter Calibration versus increased leak detection
- Water Theft is Real
- Emphasis on Team Effort
- Component Analysis Offers Insight to Distribution System

Questions?

Duane LeVangie, duane.levangie@mass.gov
Tara E. McManus, mcmanust@wseinc.com
Matthew Mostoller, matt@actonwater.com