



# Colorado Water Loss Initiative

## Stage 1


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### COLORADO WATER LOSS INITIATIVE

Water Loss Technical Assistance Program

Stage 1 Workshop

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*Your Program Management Team*


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## Warm-up!



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## Water Loss Initiative: Overview & Objectives

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

American Water Works Association

M36 1<sup>st</sup> Ed. M36 2<sup>nd</sup> Ed. M36 3<sup>rd</sup> Ed. M36 4<sup>th</sup> Ed.

AWWA adopts Intl standard, abandons Unaccounted For Water

Applying worldwide 80% water loss control

Water Audit and Loss Control Program

WRF study shows audit validity is a widespread challenge

WRF Guidance Manual For Level Validation

1991 1999 2003 2006 2009 2010 2014 2015 2016 2017

AWWA Audit Software v1 AWWA Audit Software v4 AWWA Audit Software v5

~8,500 downloads to date of AWWA Audit Software v5

AWWA Compiler for aggregating multiple audits

WRF Real Loss Component Analysis Model

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### Background

- ✓ Mandatory Water Loss Reporting** - Some water suppliers are required to make single estimates of water losses.
- ✓ Annual Reporting with Standard Terminology** - Reports of water loss using industry definitions are required each year.
- ✓ AWWA Free Water Audit Software** - Utilities are to report water losses in an automated format developed and endorsed by the water utility industry.
- ✓ Validation of Data** - Third party reports or internal evaluations require the information and data sources used by utilities to prepare water loss audit reports (Level 1 validation).
- ✓ Volume-Based Performance Benchmarking** - Goals or targets are being set to reduce water losses by specific volumes.

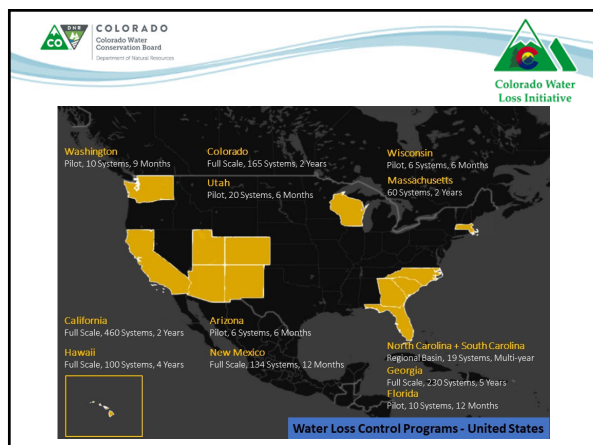
Legend:

- Yellow: No Action
- Yellow: Mandatory Water Loss reporting is required
- Yellow: Annual Water Loss reporting with AWWA standard terminology is required
- Green: Annual use of AWWA Free Water Audit Software is required
- Green: Validation of water loss data is required
- Blue: System specific, volume based performance benchmarking is required

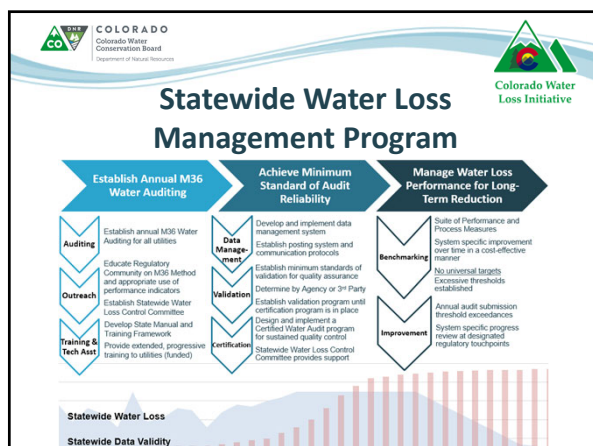
Notes:

- Water loss agencies or other regional organizations where water loss reporting is being specifically addressed.
- Water suppliers for which validated water audits are complete and available.

<https://www.nrdc.org/resources/cutting-our-losses>



- ### Background
- 2010:** HB10-1051 passed
    - Covered entities selling >2,000 Acre Feet per year
    - Requirement for water use and conservation reporting
    - Includes reporting on water loss
  - February 1, 2012:** CWCB adopts Guidelines and reports to legislature regarding the Guidelines.
  - June 30, 2014 :** Annual covered entity reporting for the previous calendar year began.
  - 2015:** Colorado Water Loss Pilot Program



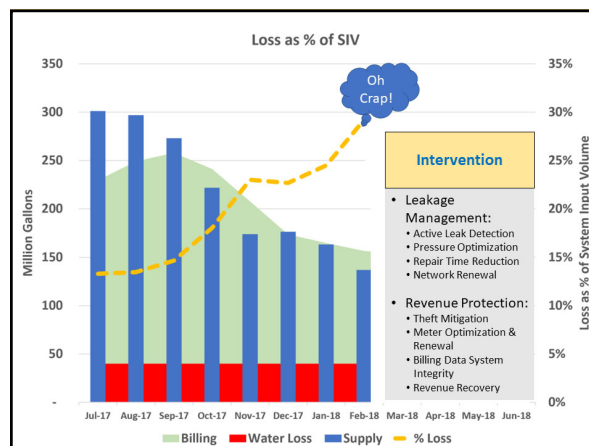
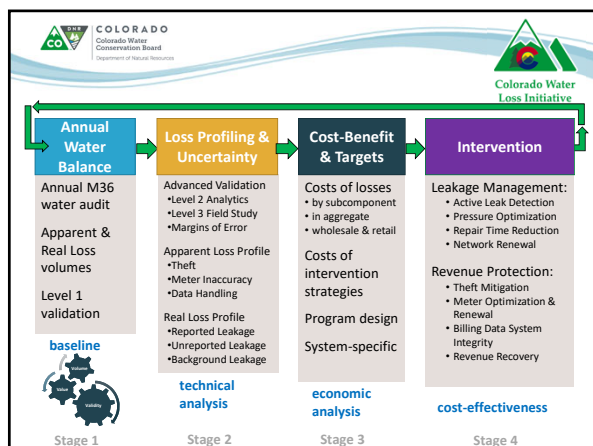
### Why the CWLI?

By participating in the CWLI, you will be demonstrate that your utility has employed the M36 methodology in your annual reporting.

*You will also learn more about your utility's water distribution efficiency and data systems!*

You will be able to start water loss control planning.

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## Water Loss Program Benefits

- Training and assistance to implement the AWWA M36 Methodology
- Contribute to broader conservation efforts
- Provide insight for utility operation & revenue improvement

## Water Loss Program

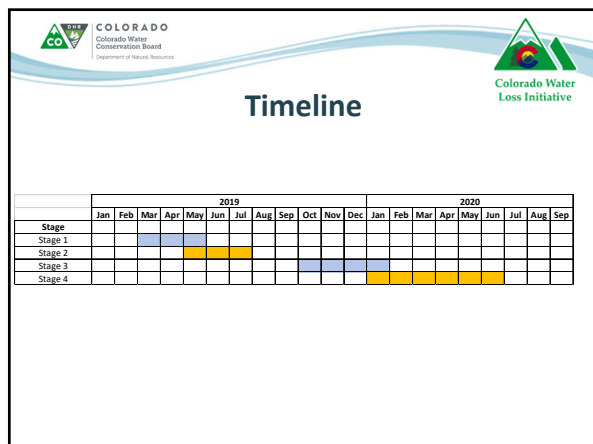
**Goals:**

- Training on AWWA Water Audit Methodology
- Level 1 Validation of Water Audits

**Timeline:** March 2019 to June 2020

**Work Session Types:**

- Webcast + In Person Work Session
- Remote Work Session
- In Person Work Session
- Remote Validation Session



## Your Water Loss Team

Who should participate from your utility?

Supply & Operations

Customer Metering

Billing & Finance

Management

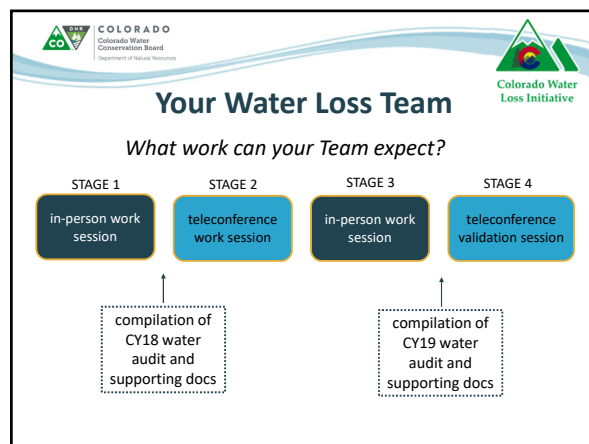
who is responsible for

supplying audit data?      submitting the audit?

coordinating schedules?

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## AWWA M36 Foundations, Data Sources & Developing the Inputs

CAVANAUGH WSO

## AWWA Water Audit :

- What is a water audit?
- What are water audit volumes?

## Water Audit

1. Systematically account for known water volumes to estimate volumes of **Water Loss**.
2. Evaluate **data source reliability**.
3. **Communicate** water distribution efficiency.

## The Water Balance

### 1. Account for volumes...

WATER SUPPLIED	AUTHORIZED CONSUMPTION	BILLED AUTHORIZED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
		UNBILLED AUTHORIZED CONSUMPTION	UNBILLED METERED CONSUMPTION	
		\$\$\$	CUSTOMER METER INACCURACIES	NONREVENUE WATER
		\$\$\$	UNAUTHORIZED CONSUMPTION	
		\$\$\$	DATA HANDLING ERRORS	
		REAL LOSSES		

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

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### Water Losses


1. ...Estimate volumes of Water Loss!

Apparent Losses




Real Losses





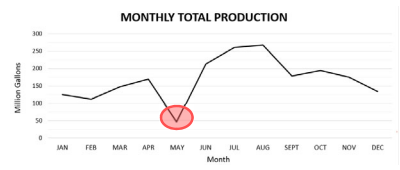
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### Water Audit

2. Evaluate data reliability

Complete?      Consistent?      Accurate?




MONTHLY TOTAL PRODUCTION

Does the data story make sense?



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### Water Audit

3. Communicate water distribution efficiency


customized performance indicators

**financial value** of Water Losses

**\$ \$ \$**







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### Water Audit

volumes      values      validity



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### Water Audit Volumes


The big volumes...

Water Supplied


Authorized Consumption

Water Losses

*each volume is composed of sub-volumes*



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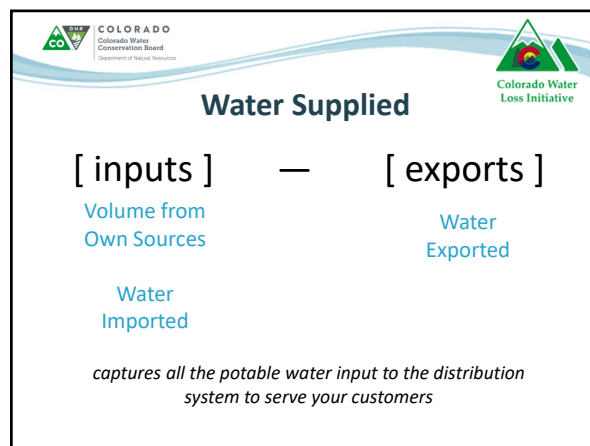
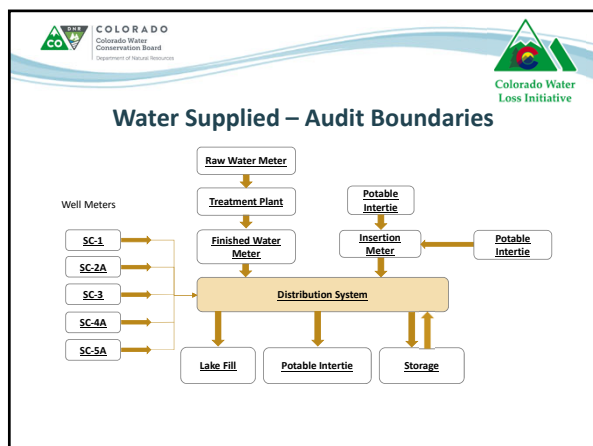


### Water Supplied

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

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**Water Supplied**

*Volume from Own Sources*

groundwater  
surface water

Which meters?

Where are the meters?

**Water Supplied**

*Water Imported*

Which meters?

How is Water Imported tracked?

**Water Supplied**

*Water Exported*

bulk water sales  
supplements to raw/reclaimed systems

Which meters?

How is Water Exported tracked?

**Water Supplied**

*Master Meter Error Adjustment*

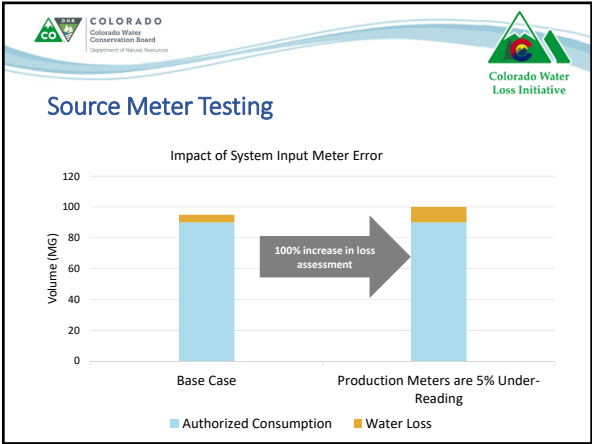
How accurate are Water Supplied meters?

electronic calibration  
volumetric accuracy testing



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**Authorized Consumption**

WATER SUPPLIED	AUTHORIZED CONSUMPTION	BILLED AUTHORIZED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
		UNBILLED AUTHORIZED CONSUMPTION	BILLED UNMETERED CONSUMPTION	
			UNBILLED METERED CONSUMPTION	
			UNBILLED UNMETERED CONSUMPTION	
	WATER LOSSES	APPARENT LOSSES	CUSTOMER METER INACCURACIES	NONREVENUE WATER
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		REAL LOSSES		

**Authorized Consumption**

Billed Metered Consumption

Billed Unmetered Consumption

Unbilled Metered Consumption

Unbilled Unmetered Consumption

How much water is used for all intended purposes?  
How accurate are tracking mechanisms?

**Billed Metered Authorized Consumption**

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

**Billed Metered Authorized Consumption**

Duplicates

Missing Data

Negative Reads

Adjustments

Zero Reads

Outliers

A lot of data


One summary number

**Other Authorized Consumption**


SYSTEM INPUT VOLUME	AUTHORIZED CONSUMPTION	BILLED AUTHORIZED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
		UNBILLED AUTHORIZED CONSUMPTION	BILLED UNMETERED CONSUMPTION	
			UNBILLED METERED CONSUMPTION	
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### Other Authorized Consumption

Billed Unmetered

Unbilled Metered


Unbilled Unmetered


District use?

City use?


Special customers?

Exemptions?






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### Now we know Water Losses!

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




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### Water Losses


[ Water Supplied ] — [ Authorized Consumption ] =

### Water Losses




Real Losses

Apparent Losses



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### Apparent Losses

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



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### Apparent Losses

water volume that reaches an end user


**but is not registered or properly tracked**

(and so you're not paid)



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### Apparent Losses

often referred to as “paper losses”

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reducing Apparent Losses **increases revenue**

but creates **no new water**

**\$\$\$**




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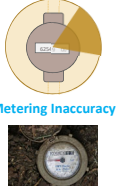
**Apparent Loss – Categories**

*How much water is delivered but not registered (or paid for)?*




Unauthorized Consumption

Theft!



Metering Inaccuracy

Customer meter under registration

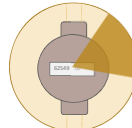


Data Handling Errors

Reporting or other clerical errors during the handling of meter reading data

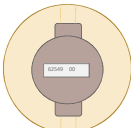
**Apparent Loss – Value**

90% Customer Meter Accuracy



Service Charge: \$20  
Volume of Use: 9 CCF  
Variable Charge:  $\$3.00 \times 9 = \$27.00$

100% Customer Meter Accuracy



Service Charge: \$20  
Volume of Use: 10 CCF  
Variable Charge:  $\$3.00 \times 10 = \$30.00$

**Real Losses**

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

**Real Losses**

often referred to as “physical losses”

leaks

seeps

breaks



**Real Losses**



reducing Real Losses *creates an additional resource*

can reduce operating costs


can defer capital expenditure


**Let's walk through it again...**

System Input Volume  (allow for known errors)	Authorized Consumption	Billed Authorized Consumption	Revenue Water	Billed Water Exported
		Unbilled Authorized Consumption		Billed Metered Consumption
				Billed Unmetered Consumption
	Water Losses	Apparent Losses	Unbilled Metered Consumption	Unbilled Metered Consumption
			Unbilled Unmetered Consumption	Unbilled Unmetered Consumption
		Real Losses	Unauthorized Consumption	Unauthorized Consumption
			Customer Metering Inaccuracies	Customer Metering Inaccuracies
			Systematic Data Handling Errors	Systematic Data Handling Errors
			Reported Leakage	Reported Leakage
			Unreported Leakage	Unreported Leakage
		Background Leakage	Background Leakage	


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### QUIZ!






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District facility use  
 Tank overflow  
 AMR Device transmission failure  
 Well water lubrication  
 Firefighting  
 Main breaks  
 Flat-rate condominiums  
 Parks department irrigation  
 Single-family indoor use  
 Under-registered customer meters






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## AWWA Free Water Audit Software


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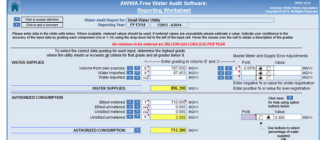

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## AWWA Free Water Audit Software


A value to be entered by the user  
 A calculated value based on data from other cells  
 Contains a recommended default value

### Functions of the AWWA Software:

- Complete a water balance
- Document data validity grades
- Calculate performance indicators
- Identify areas for improvement




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## AWWA Free Water Audit Software

**Sheets that require data entry:**

**the rest are references, results, and diagrams**


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## AWWA Free Water Audit Software

Start with your name!


Name of Contact Person:   
 Email Address:   
 Telephone (incl Ext.):   
 Name of City / Utility:   
 City/Town/Municipality:   
 State / Province:   
 Country:   
 Year:  Calendar Year  
 Audit Preparation Date:   
 Volume Reporting Units:

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### AWWA Free Water Audit Software

for each input into the audit software...

**COMMENTS**

Volume from own sources: + ? 3 1,464.676 acre-ft/yr

Water imported: + ? 7 283.570 acre-ft/yr


Water exported: + ? 7 283.570 acre-ft/yr

**DEFINITIONS**


**WATER SUPPLIED:** 1,748.246 acre-ft/yr

DATA  
VALIDITY  
GRADES

VOLUMES

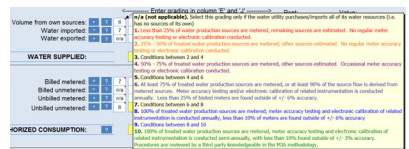



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### Data Validity Grades

- qualitative but specific
- 1 through 10
- capture utility practices






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### Filling out the Software

1. **Gather** data and supporting documents
2. **Review** data for each input:
  - complete? consistent? accurate?
3. Enter the input.
4. **Comment** on source of data, quality of data, etc.
5. **Select** a data validity grade for each input




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### Volumetric Inputs → Water Balance

Water Exported	4,289,276			Billed Water Exported	
Own Sources (Adjusted for known errors)	41,832,197	Authorized Consumption 86,000,123	Unbilled Authorized Consumption 62,634	Billed Authorized Consumption	85,937,499
				Billed Unmetered Consumption	85,937,499
				Unbilled Metered Consumption	0.000
				Unbilled Unmetered Consumption	29,765
Water Supplied		82,046,462		Apparent Losses 712,884	
Water Imported		52,832,741		Water Losses 7,046,529	
				Real Losses 6,333,646	
				Leakage on Transmission and/or Distribution Mains Not broken down Leakage and Overflows at Utility's Storage Tanks Not broken down Leakage on Service Connections Not broken down	



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### System Data

Infrastructure information

- Length of Mains (includes hydrants laterals)
- Count of service connections (active and inactive)

Operating Pressure

used to calculate a technical minimum volume of leakage



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### Cost Data

**Total Annual Operating Cost**

How much are Apparent Losses worth?

**Customer Retail Unit Cost**

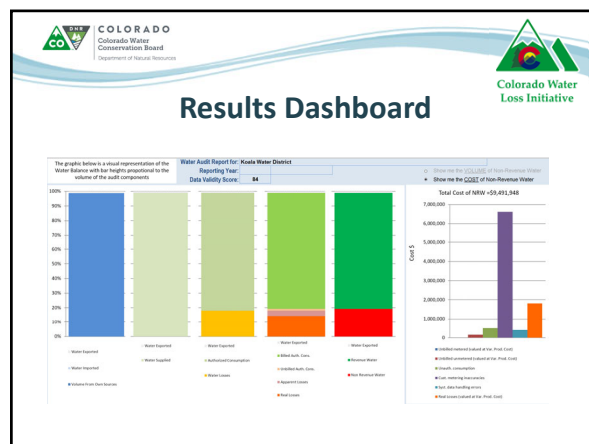
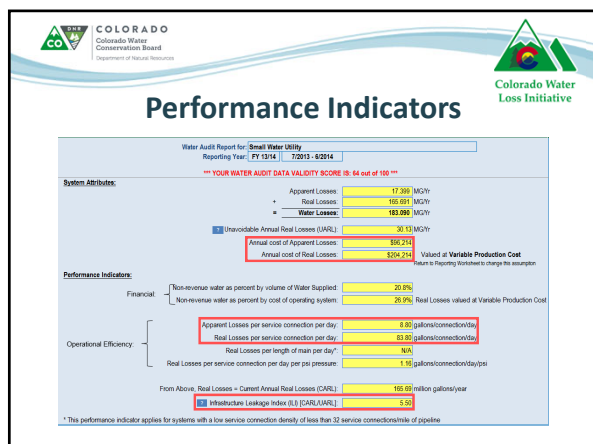
How much are Real Losses worth?

**Variable Production Cost**




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**Common Exercise:**

## Developing the Inputs



**Data Validity Grading**

© HANNA HANSEN

WWW.AUDITDATA.COM

"So things are good, stuff is OK, and I reiterate my request for more specific data."

GET ALL THE INFORMATION YOU CAN, WE'LL THINK OF A USE FOR IT LATER.

**Water Research Foundation**

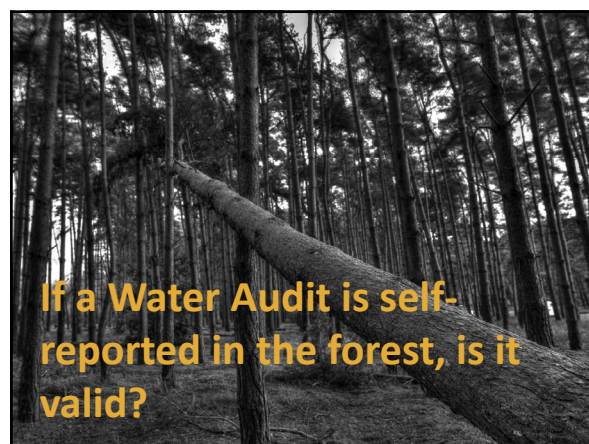
**WRF #4372B:**

**WATER AUDITS IN THE UNITED STATES:**



**A REVIEW OF DATA VALIDITY AND RESULTS**

**WRF #4639:**

**ESTABLISHING WATER UTILITY GUIDANCE AND METHODOLOGY FOR WATER AUDIT VALIDATION**





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## Purpose of Level 1 Validation

- 1) review of audit methodology and volume determination
- 2) review of Data Validity Grade selection

*goals: quality and consistency*






## Purpose of Level 1 Validation

- 1) review of audit methodology and volume determination
- 2) review of Data Validity Grade selection

### Level 1 Validation Tools:

- Discussion with Validator
- Supporting Documentation






## Data quality matters!

inaccuracy & uncertainty in inputs
→
inaccuracy & uncertainty in results

**Sources of error:**

- Instruments
- Databases
- People
- Missing information



## Data Validity Grades

- qualitative but specific
- assess best practice implementation
- 1 through 10

**must meet *all* criteria (and all criteria for lower scores) to select a given score**

Enter grading in column 'E' and 'F'		Grade	Link
Volume from own sources:	1 2 3 4 5 6	6	
Water imported:	1 2 3 4 5 6	7	
Water exported:	1 2 3 4 5 6	na	
<b>WATER SUPPLIED:</b>			
Billed metered:	1 2 3 4 5 6 7	7	
Billed unmetered:	1 2 3 4 5 6	na	
Unbilled metered:	1 2 3 4 5 6	na	
Unbilled unmetered:	1 2 3 4 5 6	6	
<b>HORIZED CONSUMPTION:</b>			
	1 2 3 4 5 6	6	

1. (not applicable). Select this grading only if the water utility purchases/imports all of its water resources (i.e. has no sources of its own).  
2. Less than 25% of treated water production sources are metered; remaining sources are estimated. No regular meter accuracy testing or electronic calibration conducted.  
3. 25% - 50% of treated water production sources are metered; other sources estimated. No regular meter accuracy testing or electronic calibration conducted.  
4. 50% - 75% of treated water production sources are metered; other sources estimated. Occasional meter accuracy testing or electronic calibration conducted.  
5. Conditions between 4 and 6.  
6. At least 75% of treated water production sources are metered, or at least 80% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.  
7. Conditions between 6 and 8.  
8. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy.  
9. Conditions between 8 and 10.  
10. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted semi-annually, with less than 10% found outside of +/- 3% accuracy. Procedures are reviewed by a third party knowledgeable in the KSM methodology.

## How do I find the grading criteria?

- 1 hover over data validity score box to reveal comment box
- 2 select "Grading Matrix Tab"

**Enter grading in column 'E' and 'F' (not applicable). Select if has no sources of its own.**

own sources: 1 2 3 4 5 6

water imported: 1 2 3 4 5 6

water exported: 1 2 3 4 5 6

**WATER SUPPLIED:**

Billed metered: 1 2 3 4 5 6 7

Billed unmetered: 1 2 3 4 5 6

Unbilled metered: 1 2 3 4 5 6

Unbilled unmetered: 1 2 3 4 5 6

**CONSUMPTION:**

1 2 3 4 5 6

**AWWA Free Water Audit Software: Grading Matrix**

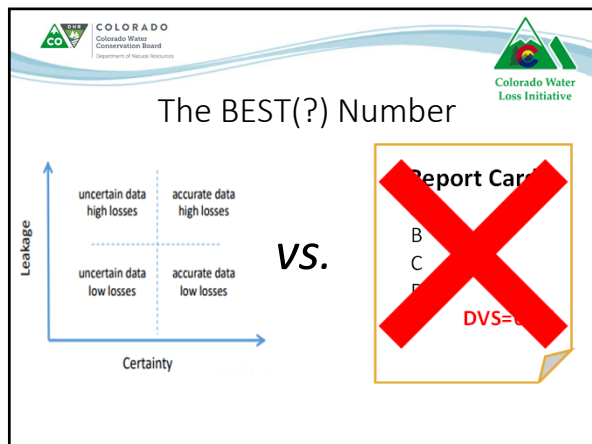
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4. 50% - 75% of treated water production sources are metered; other sources estimated. Occasional meter accuracy testing or electronic calibration conducted.  
5. Conditions between 4 and 6.  
6. At least 75% of treated water production sources are metered, or at least 80% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.  
7. Conditions between 6 and 8.  
8. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy.  
9. Conditions between 8 and 10.  
10. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted semi-annually, with less than 10% found outside of +/- 3% accuracy. Procedures are reviewed by a third party knowledgeable in the KSM methodology.




## The BEST(?) Number

# 100

# Colorado Water Loss Initiative Stage 1



**Common Exercise:  
Data Validity Grades**

**Preparation for  
Stage 2 Work Session**

CAVANAUGH  
Sustainability Strategy Institute

WSO

**Stage 2 Prep**

STAGE 1: in-person work session

STAGE 2: teleconference work session

STAGE 3: in-person work session

STAGE 4: validation session

What to Prepare

1. Water Audit (AWWA Water Audit Software v5.0)
2. Supporting Documentation
3. Questions on Methodology, Inputs, Results

CY 2018

**Supporting Documentation**

**Required**

- ☐ Completed **AWWA Free Water Audit Software** (Excel Spreadsheet)
- ☐ **Volume from Own Sources** broken down by month and finished water supply meter
- ☐ **Water Imported** broken down by month by meter
- ☐ **Water Exported** broken down by month by meter
- ☐ **Supply meter testing** and/or calibration documentation
- ☐ **Authorized Consumption** broken down by month and use type (e.g. charge status, water type, customer class)



**Supporting Documentation**

**Supplemental**

- ☐ **System schematic** showing at least locations of Own Source, Import, and Export meters
- ☐ **Customer Meter Inaccuracy** derivation
- ☐ **Average Operating Pressure** derivation
- ☐ **Customer Retail Unit Cost** derivation
- ☐ **Variable Production Cost** derivation



# Colorado Water Loss Initiative Stage 1





## Scheduling Your Session

- Teleconference will be scheduled between **May and July**
- Primary contact will need to coordinate the time that works for your team members

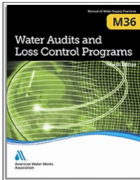


## Scheduling Your Session


Stage 2 Scheduling is now open....GO!



## Some light reading...

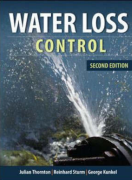


**AWWA M36**




**Water Research Foundation Reports**

2811: Evaluating Water Loss and Planning Loss Reduction Strategies  
2928: Leakage Management Technologies  
4372: Water Audits and Real Loss Component Analysis



**textbooks**



**AWWA WLCC Free Water Audit Software ©**

current version: 5.0



## Save The Date



## Thank You!



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