The California Nevada Section

of the

American Water Works Association

presents the

Water Audit Validator Certificate Course Training Manual

developed by

Water Systems Optimization, Inc. and Cavanaugh & Associates

The Water Audit Certificate Course Training Manual benefitted greatly from the research and materials of recent water loss projects. The California Nevada Section and the Water Audit Validator Certificate program developers thank the following organizations for their recent work and commitment to water loss management education.

THE Water Research FOUNDATION

The Water Research Foundation published "Level 1 Water Audit Validation: Guidance Manual" in early 2017. This research delineated the standards of Level 1 Validation of water audits and is foundational to this publication.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA

The California Water Loss Technical Assistance Program (the "Water Loss TAP") was funded by the California State Water Resources Control Board and the Environmental Project Agency. In conducting hundreds of level 1 validations for the Water Loss TAP the project team developed many of the resources, standardizations, and insights presented in this Training Manual.

The Training Manual also frequently references the California Water Audit Manual – published by the California Department of Water Resources – which translates the main tenets of the American Water Works Association's Manual M36 into an accessible guide for California water suppliers compiling a water audit.

Contents

Introduction: Validation Basics

What is Level 1 Validation?

Level 1 Validation is a process of reviewing a water supplier's American Water Works Association ("AWWA") Water Audit Software inputs. It is defined by The Water Research Foundation's "Level 1 Water Audit Validation: Guidance Manual" ("WRF Guidance Manual"), whose central standards are highlighted here.

Level 1 Validation has the following objectives and outcomes:

Objectives	Outcomes
• Confirm the accurate application of AWWA Manual M36 water audit methodology and terminology to the specific situation of the water supplier • Identify evident inaccuracies and correct inaccuracies, where realistic • Verify the consistent selection of correct data validity grades	• Data Validity Grades that reflect a water supplier's practices • Identification of macroscopic inaccuracies • Recommendations for advanced validation activities where warranted

Level 1 Validation has its limitations. Level 1 validation **does not:**

- correct inaccuracies in raw data that may affect summary data and audit inputs
- investigate data processing and handling to identify and correct inaccuracies
- study instrument accuracy through field tests to improve the certainty of the water audit
- corroborate the volume of Real Losses with bottom-up or field investigations of leakage

Role & Responsibilities of a Validator

A water audit validator must:

- Be proficient in current AWWA Manual M36 best practices for water audit preparation and validation (see Section II on Pre-Requisites and Reference Material). This requires that the validator:
    - Critically review supporting documentation to verify input derivation
    - Consistently assign the appropriate Data Validity Grade
- Have access to the data and people that informed the water audit
- Be gently skeptical of water audit data and data validity grades, as initially submitted
- Ask open-ended questions and listen to the answers
- Document the process and outcomes of water audit validation

A water audit validator should be:

- **objective** to appreciate the interplay between instrumentation, data management systems, and utility staff as it affects the water audit
- **transparent** so that validation findings to improve the quality of the water audit
- **diplomatic** to appreciate the work that went into compiling the water audit but still uncover inaccuracies
- **methodical** to catch all potential inaccuracies or sources of uncertainty through the validation process
- **forward-thinking** so that the recommendations resulting from validation improve the water audit and water loss control in subsequent years

California Requirements for Level 1 Validation

In October 2015 amidst mandatory water use reductions and a historic drought, California Governor Jerry Brown signed Senate Bill 555 into law to improve water auditing throughout the state. SB555 requires that all Retail Urban Water Suppliers submit level 1 validated water audits.

The rules on Water Loss Audits and Water Loss Control Reporting[1] ("the water audit rules"), published by the Department of Water Resources, further specify the requirements of the level 1 validation process. The most important highlights are summarized here, but each water audit validator should be well versed in the rulemaking.

Who: Regulated Water Suppliers and Validator Qualifications

All Retail Urban Water Suppliers must comply with the water audit rules. Retail Urban Water Suppliers are water distribution systems that either serve more than 3,000 service connections or produce more than 3,000 acre-feet annually.

Water Audit Validators must have received a WAV certificate by the California-Nevada Section of the American Water Works Association ("the CA-NV Section).[2] A water audit validator cannot have participated in the compilation of the water audit.

What: Required Level 1 Validation Process and Documentation

The water audit rules specify the required steps of level 1 validation, derived from the WRF Guidance Manual. Each validation must include:

(1) An interview between the water audit validator and the person or persons who prepared the water loss audit, and any member of the utility staff with information that the water audit validator believes is necessary to complete the Level 1 audit validation.

(2) A review and evaluation of required supporting documentation (see Section III: Pre-Interview Guidance).

(3) A review and evaluation of the accuracy of performance indicators included in the AWWA Free Audit Software.

(4) A review of audit inputs and data grading values to confirm a correct application of methodology, and follow-up reviews (if indicated).

(5) A summary of the validation (see Section V: Summary Reporting Requirements).

The Urban Retail Water Supplier – equipped with documentation from the water audit validator – will submit two files to the Department of Water Resources annually:

(1) A level 1 validated water audit, completed on the AWWA Free Water Audit Software.

(2) A summary document that verifies level 1 validation occurred and describes recent water loss control efforts, as outlined in Section V. Summary Reporting Requirements.

When: Reporting Deadlines

Urban Retail Water Suppliers must submit the required reporting to the Department of Water Resources on or before **October 1 each year.**

[1] California Code of Regulations. Title 23. Division 2. Chapter 7. §638

[2] Before June 30, 2019 there are two exceptions to the CA-NV certificate requirement: 1) contractors working for the CA-NV AWWA Technical Assistance Program and 2) any individual who can demonstrate having conducted a minimum of 10 level 1 audit validations in accordance to the WRF Guidance Manual.

II. Pre-Requisites & Reference Material

Pre-Requisites

The WAV curriculum assumes that all participants are fluent in water auditing methodology and are proficient with the AWWA Free Water Audit Software, including the Data Validity Grade criteria. The WAV curriculum builds on knowledge in the following resources; strong understanding of the content here is critical for a validator's success.

References

American Water Works Association Manual M36: Water Audits and Water Loss Control Programs

Available here: https://www.awwa.org/store/productdetail.aspx?productid=51439782

The AWWA M36 manual describes the industry standard for conducting water audits and developing water loss control programs. It attends to all water audit terminology, instructs on use of the Free AWWA Water Audit Software, and outlines best practices in designing and implementing water loss reduction strategies. At the time of this training manual's publication, the most up-to-date version of AWWA M36 is the fourth edition.

Department of Water Resources: California Water Audit Manual

Available here:
https://www.water.ca.gov/LegacyFiles/urbanwatermanagement/docs/2015/DWR%20Water%20Audit%20Manual%20FINAL.pdf

The California Water Audit Manual aims to synthesize the methodology outlined in the AWWA M36 manual for California water suppliers compiling a water audit. The California Water Audit Manual highlights the most important derivations and double checks for thorough water audit compilation.

The Water Research Foundation: Level 1 Water Audit Validation, Guidance Manual, Project 4639

Available here: http://www.waterrf.org/Pages/Projects.aspx?PID=4639

The Water Research Foundation's recent publications on Level 1 Validation describe the principles and standards that inform the Water Audit Validator Certificate program. Though not designated as a pre-requisite, the Level 1 Water Audit Validation Guidance Manual outlines essential knowledge for validators. It describes the purpose, limitations, and detailed approach for the level 1 validation process.

III. Pre-Interview Guidance

Required Supporting Documentation

To inform a complete review, a validator needs more than the water audit software. The water supplier must provide documentation of its derivation of certain key water audit inputs. Review of the following supporting documentation is required, as outlined by the water audit rules:

1. The reported water **volume from its own sources**, as documented by the supply meter(s) or other means, as applicable. These volumes should be broken down by month for the audit period.
2. The **reported volume of water imported and exported** each month *by connection*.
3. The documentation of the **customer meter and supply meter accuracy testing and calibration,** if conducted.
4. The reported volume of **authorized consumption** each month broken down by water rate, if different rates are applied to water users.

Before interviewing the water supplier about its water audit and data source maintenance practices, the validator must request and review the above material.

If any of the above material is relevant to the water supplier's operations and practices, it must be provided for level 1 validation. For example, if a water supplier exports water to a neighboring agency but does not provide a monthly summary of volume exported by connection, *the level 1 validation process cannot be completed.*

Supplemental Documentation

Although not required to complete level 1 validation, the following documentation should be requested if available:

- **System Schematic** showing locations of supply and export meters
- Customer Meter Inaccuracy derivation
- Average Operating Pressure derivation
- Customer Retail Unit Cost derivation
- Variable Production Cost derivation

These items will expedite the interview, providing background and calculations that the validator will otherwise inquire about without direction.

Supporting Documentation Review Guidance

The validator should review all items of supporting documentation submitted in preparation for the interview. For each supporting document, complete the following steps:

1. Trace how the water supplier calculated the volume of interest and compare the summary volume on the supporting document to the water audit input to verify alignment.
2. Confirm that calculation is appropriate given the utility's setup and water audit methodology.

   Some basic checks include:

   a. Is any non-potable water included?

   b. Are all the volumes included appropriate for the audit input, given the audit boundary and timeframe?

   c. Is the tabulation done correctly?
3. Inventory any questions or discrepancies to address in the interview where necessary.

IV. Interview Guidance

The validator will acquire most of the information needed through an interview with the audit compilers. During the validation interview, the validator needs to ask detailed questions, decipher relevant information and document findings. To facilitate open and efficient inquiry and exchange of information, the validator should endeavor to set and maintain a professional, comfortable tone in the interview.

The audit team put in a great deal of work to prepare the audit and supporting documents, so the validator should prepare adequately for the interview. During the interview, the validator should lead with open-ended questions and target more specific items in the follow-on questions. This approach sometimes brings up valuable discussion items and avoids introducing any bias from the validator.

If conducting the session remotely, the validator should consider using a conference call with share screen functionality: walking through supporting documentation while looking at the same material is very useful.

For each audit input, this manual offers key points of discussion and tips for successful validation, presented in the following format.

Example Input

For each input, the definition of the volume or entry is described here.

Input Derivation

This section highlights the definition of the Audit input and outlines important checks that the Validator should pursue to confirm derivation.

This section draws directly from 1) AWWA Manual M36[3] and 2) the California Water Audit Manual[4] published by DWR, alongside water audit terminology clarifications offered by Alegre et al.[5]

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

This section summarizes questions for the Validator to pursue to understand the data collection and instrument maintenance practices that inform each Audit input. The Validator should identify the source of information for each Audit Input and understand the context of its accuracy.

Additional DVG Assignment Guidance

This section offers clarification on the DVG assignment process, beyond the definitions of the DVG criteria. These clarifications are important for consistent DVG assignment and are considered an extension of the AWWA Software's grading matrix.

This section draws on the materials developed in the Water Loss TAP: "Additional Guidance", which is available on the TAP Resources website.

This section draws from the Water Research Foundation's "Level 1 Validation: Guidance Manual (Project #4639A)[6]

[3] AWWA (American Water Works Association). 2016. *M36 Water Audits and Loss Control Programs*. Fourth Edition. Denver, Colo.: American Water Works Association.
[4] California Department of Water Resources. 2016. *Water Audit Manual.* Sacramento, Cali.: Department of Water Resources.
[5] Alegre, H., H. Hirner, J.M. Baptista, and R. Parena. 2000. *Performance Indicators for Water Supply Services – IWA Manual of Best Practice.* London, UK: IWA Publishing.
[6] Andrews, L. Gasner, K., Sturm, R., Kunkel G., Jernigan W., Cavanaugh S. 2016. *Level 1 Validation: Guidance Manual, Project #4639A. Denver, Colo.: Water Research Foundation.*

Documentation Template

This section outlines the minimum documentation necessary for each Audit input, describing prompts for the Input Derivation documentation and the DVG basis documentation.

This section draws from the materials developed in the Water Loss TAP: “Follow Up Documentation”

Special Case Notes

This section outlines common scenarios that are not obviously addressed in the DVG criteria. Notes in this section provide guidance for consistent handling and DVG assignment.

Volume from Own Sources

Volume from Own Sources (VoS) is the volume of water withdrawn from water resources (rivers, lakes, wells, etc.) controlled by the water utility and then treated for potable water distribution.

Input Derivation

Consider the following when verifying the input derivation:

- Does the VoS volume account for all water sources owned and operated by the supplier?
- Was any volume double-counted?
- Was all non-potable water excluded?
- Does the VoS volume capture the whole audit period?
- Is the best fit data used for the audit input (closest to distribution, most accurate given meter history)?
- Were changes in storage calculated and properly accounted for?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How many distinct own-source distribution inputs are there?
  - How many inputs are metered?
  - Are any of the meters in series?
  - Do the meters capture raw water or potable water?
- How are unmetered inputs estimated?
- Which own-source meters are calibrated? How often are calibrations performed?
  - What were the results of the calibrations closest to the audit period?
- Which own-source meters are volumetrically tested? How often are tests conducted?
  - What were the results of the volumetric accuracy tests closest to the audit period?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

	"Accuracy testing" refers to the study of a meter's primary measuring mechanism. In volumetric accuracy testing, a meter's registered volume is compared to precise and independent volumetric measurement in-situ.
	"Electronic calibration" refers to a check on the meter's secondary instrumentation. Electronic calibration ensures the accurate communication and conversion of electronic signals.
	"% of water production" refers to percentage by volume (not by count).
4+	Manufacturer testing certificate for newly installed meter *does not qualify* as accuracy testing
4	"Occasional meter accuracy testing or electronic calibration conducted" requires that either maintenance activity occurred within the last 5 years but less than annually.
6	Accuracy testing OR electronic calibration occurs annually for at least 90% of the source flow by volume. Supporting documentation showing the most recent maintenance results required.
8+	Accuracy testing AND electronic calibration occurs for at least 90% of the source flow by volume.
10	Testing and calibration practices are closely scrutinized for adherence with the M36 Manual

Documentation Template

Input Derivation	**Data Validity Grade Basis**
Supply meter profile: describe water sources, metering setup, type of meters VoS Input Data Source: describe source of input data Comments:	Percent of VoS metered: Signal calibration frequency: Volumetric testing frequency: Volumetric testing method: Percent of VoS tested and/or calibrated: Comments:

Special Case Notes

Raw Water Meters

For water suppliers that only have raw water meters (i.e. an influent meter at a treatment plant), the raw water meters can be used in place of finished water meters for grade selection. Where possible, finished water meters are the preferred data source.

Accuracy Testing

"Accuracy testing" mentioned in the DVG criteria should feature precise, independent measurements of flow or volume. Accuracy tests include a comparison with a calibrated insertion or strap-on meter, reservoir drop testing, or pitot tube testing. In most cases, pump run-time checks and redundant metering configurations do not provide sufficient insight to be considered accuracy tests.

Accuracy Testing and/or Electronic Calibration Supporting Documentation

Some water suppliers conduct accuracy tests and/or electronic calibrations but cannot furnish documentation of results. Anecdotal description of testing practices is sufficient for a DVG of 5 or below. However, a DVG of 6 or higher requires annual testing and/or calibration alongside a specific range of results. To confirm these details, a 6 or higher requires documentation of the most recent maintenance records. Those records should include: the test or calibration method, flowrate(s) tested if applicable, test duration, result(s) per flowrate(s), test date

Electronic Calibration Inapplicability

Electronic calibration is not relevant to some water suppliers' meter reading processes. If a water supplier manually reads mechanical meters, there is no electronic signal to calibrate or verify. For these setups, electronic calibration is not relevant; the Validator should document the setup and disregarded electronic calibration in the assignment of a DVG.

Initiation of Accuracy Testing and/or Electronic Calibration

Some water suppliers will have just begun an accuracy testing and/or electronic calibration program. If the water supplier explains that the test results are relevant to the audit period, the results can be used for an MMEA entry. However, the DVG should only reflect the practices that occurred within the audit period timeframe.

Volume from Own Sources – Master Meter Error Adjustment

Volume from Own Sources – Master Meter Error Adjustment (VoS MMEA) accounts for any known errors in master meters. Sources of error include meter inaccuracy (under- or over-registration) and data gaps caused by outages of the meter instrumentation.

Input Derivation

Consider the following when verifying the input derivation:

- How is the adjustment provided justified?
- Does the input reflect a correction for all sources or a subset? Is it calculated accordingly?
- Is the adjustment correctly assigned as negative or positive?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How are own-source production volumes sampled and recorded?
- How often is own-source production data reviewed?
- Under what conditions is own-source production data adjusted?
- Are changes in stored volume incorporated? If so, how?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

4+	Tank levels are monitored and reviewed daily, and the net change in storage for the year is included in the MMSEA input. Daily calculations on tank storage unnecessary.

Documentation Template

Input Derivation

Adjustment Basis: describe type of testing or calibration, specifics of derivation calculation

Net Storage Change Included: Yes/No

Comments:

Data Validity Grade Basis

Supply meter read frequency:
Supply meter read method:
Frequency of data review:
Storage level monitoring frequency:
Comments:

Special Case Notes

Old Meter Accuracy and/or Electronic Calibration Results

Outdated accuracy or calibration results should not inform the VoS MMEA input. Accuracy or calibration results older than two years are not relevant to VoS MMEA derivation.

Water Imported

Water Imported (WI) is the volume of bulk water purchased to supply the distribution system. Typically, Water Imported is purchased from a neighboring water utility or regional water authority and is metered at a point of interconnection between the two utilities.

Input Derivation

Consider the following when verifying the input derivation:

- Does the WI volume account for all water sources purchased by the supplier?
- Was any volume mistakenly double-counted?
- Was all non-potable water excluded?
- Does the WI volume capture the whole audit period?
- Is the best fit data used for the audit input (closest to distribution, most accurate given maintenance history)?
- Does the WI data source feature any financial adjustments?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How many distinct import connections are there?
  - How many import connections are metered?
  - Are any of the meters in series?
  - Do the meters capture raw water or potable water?
  - How are unmetered imports estimated?
- How often are import meters calibrated? Which meters are calibrated?
  - What were the results of the calibrations closest to the audit period?
- How often are import meters tested for volumetric accuracy? Which meters are volumetrically tested?
  - What were the results of the volumetric accuracy tests closest to the audit period?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

	"Accuracy testing" refers to the study of a meter's primary measuring mechanism. In volumetric accuracy testing, a meter's registered volume is compared to precise and independent volumetric measurement in-situ.
	"Electronic calibration" refers to a check on the meter's secondary instrumentation. Electronic calibration ensures the accurate communication and conversion of electronic signals.
	"% of water production" refers to percentage by volume (not by count).
4+	Manufacturer testing certificate for newly installed meter *does not qualify* as accuracy testing
4	"Occasional meter accuracy testing or electronic calibration conducted" requires that either maintenance activity occurred within the last 5 years but less than annually.
6	Accuracy testing OR electronic calibration occurs annually for at least 90% of the source flow by volume. Supporting documentation showing the most recent maintenance results required.
8+	Accuracy testing AND electronic calibration occurs for at least 90% of the source flow by volume.

Documentation Template

Input Derivation

Import meter profile: describe water sources, %, metering setup, type of meters, frequency of interconnection use

WI Data Source: describe source of input data

Comments:

Data Validity Grade Basis

Percent of WI metered:
Signal calibration frequency:
Volumetric testing frequency:
Volumetric testing method:
Percent of WI tested and/or calibrated:
Comments:

Special Case Notes

Emergency Import Connections

Double check and document the existence and use of emergency import connections. If no volume was exchanged at emergency import connections, their reading and maintenance can be disregarded for DVG assignment.

Accuracy Testing

"Accuracy testing" mentioned in the DVG criteria should feature precise, independent measurements of flow or volume. Accuracy tests include a comparison with a calibrated insertion or strap-on meter, reservoir drop testing, or pitot tube testing. In most cases, pump run-time checks and redundant metering configurations do not provide sufficient insight to be considered accuracy tests.

Accuracy Testing and/or Electronic Calibration Supporting Documentation

Some wholesalers conduct accuracy tests and/or electronic calibrations but cannot furnish documentation of results. Anecdotal description of testing practices is sufficient for a DVG of 5 or below. However, a DVG of 6 or higher requires annual testing and/or calibration alongside a specific range of results. To confirm these details, a 6 or higher requires documentation of the most recent maintenance records. Those records should include: the test or calibration method, flowrate(s) tested if applicable, test duration, result(s) per flowrate(s), test date

Electronic Calibration Inapplicability

Electronic calibration is not relevant to some wholesalers' meter reading processes. If a wholesaler manually reads mechanical meters, there is no electronic signal to calibrate or verify. For these setups, electronic calibration is not relevant; the Validator should document the setup and disregarded electronic calibration in the assignment of a DVG.

Initiation of Accuracy Testing and/or Electronic Calibration

Some water suppliers will have just begun an accuracy testing and/or electronic calibration program. If the water supplier explains that the test results are relevant to the audit period, the results can be used for an MMEA entry. However, the DVG should only reflect the practices that occurred within the audit period timeframe.

Water Imported – Master Meter Error Adjustment

Water Imported – Master Meter Error Adjustment (WI MMEA) accounts for any known errors in Water Imported master meters. Sources of error include meter inaccuracy (under- or over-registration) and data gaps caused by outages of the meter instrumentation.

Input Derivation

Consider the following when verifying the input derivation:

- How is the adjustment provided justified?
- Does the input reflect a correction for all sources or a subset? Is it calculated accordingly?
- Is the adjustment correctly assigned as negative or positive?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How are Water Imported volumes recorded?
- How often are Water Imported volumes captured?
- How often is Water Imported data reviewed?
- Under what conditions is Water Imported data adjusted?
- What documentation is available to describe the interagency import-export agreement?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

4+	Processes of data review by Importer can stand in for data review by Exporter

Documentation Template

Input Derivation

Adjustment Basis: describe type of testing or calibration, specifics of derivation calculation

Comments:

Data Validity Grade Basis

Import meter read frequency:
Import meter read method:
Frequency of data review:
Comments:

Special Case Notes

Old Meter Accuracy and/or Electronic Calibration Results

Outdated accuracy or calibration results should not inform the WI MMEA input. Accuracy or calibration results older than two years are not relevant to WI MMEA derivation.

Water Exported

Water Exported (WE) is the volume of bulk water conveyed and sold by a water utility to a neighboring system(s) that exists outside the utility's service area. Typically, Water Exported is metered at a point of interconnection between the two water utilities, and usually the meter(s) is owned by the utility that sells the water.

Input Derivation

Consider the following when verifying the input derivation:

- Does the WE volume account for all water sold to neighboring agencies by the supplier?
- Was any volume mistakenly double-counted?
- Is the WE volume excluded from the Billed Metered Authorized Consumption volume?
- Was all non-potable water excluded?
- Does the WE volume capture the whole audit period?
- Is the best fit data used for the audit input (closest to distribution, most accurate given maintenance history)?
- Does the WE data source feature any financial adjustments?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How many distinct export connections are there?
  - How many export connections are metered?
  - Are any of the meters in series?
  - Do the meters capture raw water or potable water?
  - How are unmetered exports estimated?
- How often are export meters calibrated? Which meters are calibrated?
  - What were the results of the calibrations closest to the audit period?
- How often are export meters tested for volumetric accuracy? Which meters are volumetrically tested?
  - What were the results of the volumetric accuracy tests closest to the audit period?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

	"Accuracy testing" refers to the study of a meter's primary measuring mechanism. In volumetric accuracy testing, a meter's registered volume is compared to precise and independent volumetric measurement in-situ.
	"Electronic calibration" refers to a check on the meter's secondary instrumentation. Electronic calibration ensures the accurate communication and conversion of electronic signals.
	"% of water production" refers to percentage by volume (not by count).
4+	Manufacturer testing certificate for newly installed meter *does not qualify* as accuracy testing
4	"Occasional meter accuracy testing or electronic calibration conducted" requires that maintenance activity occurred within the last 5 years but less than annually.
6	Accuracy testing OR electronic calibration occurs annually for at least 90% of the source flow by volume. Supporting documentation showing the most recent maintenance results required.
8+	Accuracy testing AND electronic calibration occurs for at least 90% of the source flow by volume.

Documentation Template

Input Derivation

Export meter profile: describe water sources, %, metering setup, type of meters, frequency of interconnection use

WE Data Source: describe source of input data

Comments:

Data Validity Grade Basis

Percent of WE metered:
Signal calibration frequency:
Volumetric testing frequency:
Volumetric testing method:
Percent of WE tested and/or calibrated:
Comments:

Special Case Notes

Emergency Import Connections

Double check and document the existence and use of emergency export connections. If no volume was exchanged at emergency export connections, their reading and maintenance can be disregarded for DVG assignment.

Accuracy Testing

"Accuracy testing" mentioned in the DVG criteria should feature precise, independent measurements of flow or volume. Accuracy tests include a comparison with a calibrated insertion or strap-on meter, reservoir drop testing, or pitot tube testing. In most cases, pump run-time checks and redundant metering configurations do not provide sufficient insight to be considered accuracy tests.

Accuracy Testing and/or Electronic Calibration Supporting Documentation

Some water suppliers conduct accuracy tests and/or electronic calibrations but cannot furnish documentation of results. Anecdotal description of testing practices is sufficient for a DVG of 5 or below. However, a DVG of 6 or higher requires annual testing and/or calibration alongside a specific range of results. To confirm these details, a 6 or higher requires documentation of the most recent maintenance records. Those records should include: the test or calibration method, flowrate(s) tested if applicable, test duration, result(s) per flowrate(s), test date

Electronic Calibration Inapplicability

Electronic calibration is not relevant to some water suppliers' meter reading processes. If a water supplier manually reads mechanical meters, there is no electronic signal to calibrate or verify. For these setups, electronic calibration is not relevant; the Validator should document the setup and disregarded electronic calibration in the assignment of a DVG.

Initiation of Accuracy Testing and/or Electronic Calibration

Some water suppliers will have just begun an accuracy testing and/or electronic calibration program. If the water supplier explains that the test results are relevant to the audit period, the results can be used for an MMEA entry. However, the DVG should only reflect the practices that occurred within the audit period timeframe.

Water Exported – Master Meter Error Adjustment

Water Exported – Master Meter Error Adjustment (WE MMEA) accounts for any known errors in Water Exported master meters. Sources of error include meter inaccuracy (under- or over-registration) and data gaps caused by outages of the meter instrumentation.

Input Derivation

Consider the following when verifying the input derivation:

- How is the adjustment provided justified?
- Does the input reflect a correction for all sources or a subset? Is it calculated accordingly?
- Is the adjustment correctly assigned as negative or positive?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How are Water Exported volumes recorded?
- How often are Water Exported volumes captured?
- How often is Water Exported data reviewed?
- Under what conditions is Water Exported data adjusted?
- What documentation is available to describe the interagency import-export agreement?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

N/A

Documentation Template

Input Derivation

Adjustment Basis: describe type of testing or calibration, specifics of derivation calculation

Comments:

Data Validity Grade Basis

Export meter read frequency:
Export meter read method:
Frequency of data review:
Comments:

Special Case Notes

Old Meter Accuracy and/or Electronic Calibration Results

Outdated accuracy or calibration results should not inform the WE MMEA input. Accuracy or calibration results older than two years are not relevant to WE MMEA derivation.

Billed Metered Authorized Consumption

Billed Metered Authorized Consumption (BMAC) is water delivered to metered customers who receive a bill and generate revenue for a utility. All billed and metered customer groups are incorporated in the total Billed Metered Authorized Consumption volume, including domestic, commercial, industrial, potable irrigation, and agricultural users.

Input Derivation

Consider the following when verifying the input derivation:

- Are all customer classes appropriately included in the total BMAC volume?
- Is all recycled or raw water consumption excluded?
- Is unbilled metered consumption excluded, such as non-paying municipal accounts?
- Are wholesale exports to other agencies excluded from BMAC (these volumes should be categorized as Water Exported)?
- How are financial adjustments handled? Confirm that the consumption total reflects actual volumetric use and solely financial changes are disregarded.
- Is the data pro-rated to align with the audit period?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What portion of customers are metered?
- How are customer meter reads collected?
  - What is the success rate of meter read collection?
- When are customer meters replaced?
- How many customer meters are tested annually? Why?
- How are customer bill records maintained?
  - How often are customer bill records audited? By whom?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

4	"Very limited meter accuracy testing" describes a reactive testing program wherein only complaint based or consumption flag triggered accuracy testing occurs. "Sporadic" describes testing that occurs less than annually.
6	"Limited meter accuracy testing" describes a proactive testing program wherein subsets of meters (i.e. old meters, large meters) are targeted but a representative sample of the full meter population is not involved. Annual auditing of "summary statistics" describes monthly or annual total volumes are reviewed annually.
8	"Regular meter accuracy testing" describes a proactive testing program wherein subsets of meters (i.e. old meters, large meters) are targeted but a representative sample of the full meter population is not involved AND the results directly inform maintenance and replacement activities. Routing auditing of "detailed statistics" involves review of billing data at least down to charge code categories. "Third party verification" involves a sampling review on select billing accounts.

	10 "Statistically significant testing and replacement" describes a proactive meter testing program that features: 1) large meter testing informed by revenue considerations and 2) small meter testing of a random and representative sample. The accuracy test results inform maintenance and replacement activities, and testing program margins of error have been analyzed. Third party audit describes a full billing database inquiry and analysis of raw data to rebuild a corroboration of the summary volumes.

Documentation Template

Input Derivation Customer Meters & Reads Profile: - Age Profile: - Reading System: - Read Frequency: Billing Data Pro-rated? Comments:	**Data Validity Grade Basis** Percent of customers metered: Small meter testing policy: Number of small meters testing/year: Large meter testing policy: Number of large meter tested/year: Meter replacement policy: Number of replacements/year: Billing data auditing practice: Comments:

Special Case Notes

Meter Change Out Underway

If presently in a meter changeout or conversion project, new meter installations can stand in as 'testing' for the audit year of installation + 1 (2-year horizon), assuming new meters are supplied with proof of calibration. Be sure to note whether a subset of meters are targeted for replacement or the whole meter population is under conversion. The "pace" of meter stock conversion must be at least 10% per year to qualify for this exception.

Testing Upon Retirement

If meters are only tested upon retirement, this qualifies as a testing program for a subset of the meter population. Whether the test results inform maintenance and replacement activities distinguishes between a 6 and an 8.

Billed Unmetered Authorized Consumption

Billed Unmetered Authorized Consumption (BUAC) is water delivered to unmetered customers who nonetheless receive a bill and generate revenue for the utility. BUAC is most often an estimated volume for flat rate customers.

Input Derivation

Consider the following when verifying the input derivation:

- How does the supplier generate revenue for the estimated consumption in BUAC?
- Is the consumption summarized in BUAC exclusively flat rate customers? Why are these customers unmetered?
- What other billed unmetered uses are included?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What are the utilities policies regarding which customers must be metered?
  - Are metering policies clear?
  - Are metering policies consistently implemented?
- How is billed unmetered consumption estimated?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the BUAC DVG assignment.

Documentation Template

Input Derivation
Billed Unmetered Profile:
Input Derivation:
Comments:

Data Validity Grade Basis
Policy for metering exemptions:
Comments:

Special Case Notes

Flat Rate Metered Customers

Some water suppliers have a customer group that is billed a flat charge despite having meters. As such, the supplier receives revenue though it is not volumetrically determined, and the supplier can turn to metered volumes for a reference of consumption. It is recommended that the metered volume for this customer group is used for the BUAC input in the audit. This way there is more transparency about which meters are charged volumetrically, which are charged a flat fee.

Unbilled Metered Authorized Consumption

Unbilled Metered Authorized Consumption (UMAC) includes all uses that are metered but do not generate revenue for the utility. In California, such use is typically associated with metered operational uses by the water utility, such as flushing programs that utilize temporary meters to track usage or metered water provided to a civic institution free of charge.

Input Derivation

Consider the following when verifying the input derivation:

- What uses are included in the UMAC input?
- What is the source of information for the UMAC input?
- If UMAC records are included in a billing database, were these volumes excluded from the BMAC total?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What are utility policies regarding which customers are metered but unbilled?
  - Are billing exemption policies clear?
  - Are billing exemption policies consistently implemented?
- How often are unbilled meters read?
  - How is unbilled metered consumption estimated in the absence of a recent meter read?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the UMAC DVG assignment.

Documentation Template

Input Derivation
Unbilled Metered profile:
Input derivation:
Comments:

Data Validity Grade Basis
Policy for billing exemptions:
Comments:

Unbilled Unmetered Authorized Consumption

Unbilled unmetered consumption consists of those uses that are neither metered nor revenue-generating. Most often, this includes operational uses by the water utility.

Input Derivation

Consider the following when verifying the input derivation:

- Has the supplier provided an estimate of UUAC, selected the default, or applied the California adjusted default of 0.25% of Water Supplied?
- If a customized estimate is provided, what UUAC categories are included? Is it comprehensive of all the UUAC uses?
- Are any estimates of leakage included? Leakage is not an authorized use and should be excluded from UUAC.

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What uses are unmetered and unbilled?
  - Are utility policies on unmetered and unbilled use clear?
- How are unmetered, unbilled uses documented?
  - How is consumption for each use estimated?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the UUAC DVG assignment.

Documentation Template

Input Derivation
Unbilled Unmetered Profile:
Input Derivation if Estimated:
Comments:

Data Validity Grade Basis
Default or Adjusted Default Applied:
Completeness of Documentation:
Comments:

Unauthorized Consumption

Unauthorized Consumption (UC) is not explicitly or implicitly authorized by the utility, commonly known as water theft.

Input Derivation

Consider the following when verifying the input derivation:

- Has the supplier selected the default? If not, how is the customized UC volume derived?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What instances of UC have been documented?
  - What information is capture in records of UC?
- Are documented volumes of UC through enough to replace the default estimate?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the UC DVG assignment.

Documentation Template

Input Derivation
Default Applied?
Input Derivation if Customized:

Data Validity Grade Basis
Instances and extent of UC documented:
Comments:

Customer Metering Inaccuracies

Customer Metering Inaccuracies (CMI) are a form of Apparent Loss that results from collective meter under-registration. This input acknowledges that overall, customer meters register volumes smaller than the volumes that pass through them.

Input Derivation

Consider the following when verifying the input derivation:

- Has the supplier acknowledged customer meter inaccuracy with a non-zero input for CMI?
- What informed the CMI input?
- Was small meter inaccuracy considered separately from large meter inaccuracy?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How are customer meter records managed?
- What is the make-up of the customer meter population? Is it homogeneous or varied?
  - How many meters are replaced annually?
- How are meters selected for replacement?
  - How many meters are tested annually?
- Why are they tested?
  - Were the test results used for CMI calculation? How?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

2	Meter accuracy tests are only conducted upon customer request. CMI is estimated.
4	Meter accuracy tests are triggered by customer requests *and* consumption flags. The inaccuracy volume is *inferred* from test data. Replacement program targets old meters upon failure.
6	"Routine, but limited meter accuracy testing" describes a *proactive* customer meter testing program. The sample can be targeted (large meters, oldest meters). The input must be *calculated* for the full meter population based on this data.
8	"Ongoing meter replacement and accuracy testing" describes an annual proactive customer meter testing program. The test sample must be representative of the whole meter population, not just a sub-population of concern. The input must be *calculated* for the full meter population based on this data.
9	"Statistically significant" describes a testing program wherein the margins of error have been analyzed.
10	"Targeted and justified" meter replacement describes a program of thorough, proactive customer meter testing. Large meter testing is prioritized by revenue and a random, representative sample of small meters is tested. Test results inform maintenance and replacement activities. Testing program and input calculations have been closely scrutinized for M36 alignment.

Documentation Template

Input Derivation	***Data Validity Grade Basis***
Input Derivation: Comments:	Characterization of meter testing: Characterization of meter replacement:

Special Case Notes

Meter Stock Conversion

If a supplier has a significant meter replacement effort underway, the CMI grade will depend on 1) whether or not the supplier is testing any of the meters as they are replaced and 2) whether or not those tests informed a calculation of the CMI input.

Data Unavailable for Review

The CMI derivation is not a required supporting document. If the CMI is described as calculated without data or calculation available for review, pursue enough details of calculation to thoroughly document approach.

Systematic Data Handling Errors

Systematic Data Handling Errors can cause Apparent Losses through accounting omissions, errant computer programming, gaps in policy and procedure, and other data lapses that result in understated customer consumption.

Input Derivation

Consider the following when verifying the input derivation:

- Is the default value (0.25% of BMAC) used to estimate SDHE?
- If not, how did the supplier derive its estimate of SDHE? What data transmission and billing process review informed the estimate?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What policies govern billing processes and account management?
  - How effectively are these policies implemented?
- What technologies are used in read collection and billing processes?
- How often are billing processes and billing data audited?
  - Who performs the auditing?
  - What checks and functions are built into billing data management to minimize error?
- How was the volume of SDHE estimated?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the SDHE DVG assignment.

Documentation Template

Input Derivation

SDHE Derivation:
Comments:

Data Validity Grade Basis

If custom estimate provided --
Characterization of read collection & billing process:
Characterization of billing process and billing data auditing:

Special Case Notes

No SDHE

If a utility presents a zero value for SDHE, detailed billing process and billing data analysis should be provided to justify the assertion.

Length of Mains

*The length of mains input describes the total length of transmission and distribution pipelines in the potable water system. It **does not include** the length of service connection lines, but it **does include** fire hydrant lateral pipe – the segment of pipe between the water main and the hydrant.*

Input Derivation

Consider the following when verifying the input derivation:

- Does the length of mains only include potable water infrastructure?
- Does the length of mains include hydrant lateral pipe length?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What is the policy for installing and documenting new infrastructure?
  - How effectively are these policies implemented?
- How are pipe assets tracked?
- How often are asset records validation with field data?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

10 "Random field validation" describes an effort of asset information verification that is completed for the specific purposes of asset inventory (not through the double checking that occurs through regular work order processes).

Documentation Template

Input Derivation

Input Derivation:
Hydrant lateral length included:
Comments:

Data Validity Grade Basis

Mapping format:
Asset management database:
Map updates & field validation:
Comments:

Special Case Notes

Total Hydrant Lateral Pipe Length Unknown

If the total length of hydrant lateral pipe is unknown, the water supplier should be encouraged to estimate it by multiplying the total count of hydrants by an average hydrant lateral length.

GIS and Asset Management System are Combined

The validator can acknowledge that GIS sometimes serves to both inventory where infrastructure is and keep track of its condition. If the water supplier's GIS is setup to track condition assessment characteristics (break history, date of installation, etc), the validator can consider the system to be both the GIS and the asset management system referenced in the DVG of 8 and above.

Number of Active and Inactive Service Connections

The Number of Active and Inactive Service Connections is the total count of pressurized customer service connections extended from the water main to supply water to customers. This figure should include the number of distinct pressurized connections, including fire connections, regardless of whether connections are metered or unmetered.

Input Derivation

Consider the following when verifying the input derivation:

- Are all service connections counted in the total, regardless of their status as active or inactive?
- Are fire connections included?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What is the policy for permitting, installing and documenting new service connections?
  - How effectively are these policies implemented?
- How are service connections tracked?
  - How is service connection documentation field verified?
- What margin of error does the auditor assign to the estimate of the Number of Active and Inactive Service Connections?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the Number of Active and Inactive Service Connections DVG assignment.

Documentation Template

Input Derivation

Input Derivation:
Basis for database query:
Comments:

Data Validity Grade Basis

CIS updates & field validation:
Estimated error of total count within:
Comments:

Special Case Notes

Manual Reading Process Verifies Meter Count

If a manual meter reading effort exists and there is intentional double checking that the meters are appropriately inventoried, a validator can consider this to be field verification of the service connections total.

Average Length of Customer Service Line

The Average Length of Customer Service Line is the average length of the customer service line owned and maintained by the customer from the point of ownership transfer to the customer water meter or building line, if the customer is unmetered.

This is a two-part input. If the audit compiler answers "Yes" to the question "Are customer meters typically located at the curbstop or property line?", the average length of customer service line is automatically considered zero and a DVG of 10 is assigned. If the meter is not typically at the curbstop or property line, the average length of customer service line must be entered and a DVG must be selected.

Input Derivation

Consider the following when verifying the input derivation:

- In California, meters are usually located at the curbstop. Is that the case for this water supplier?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

Only necessary if meters are not located at the curbstop.

- Where does the utility policy dictate that ownership transfer occurs?
- Where does utility policy dictate that meters are installed?
- How is meter installation and asset ownership information tracked?
  - How is recorded information field verified?
- How is the average length of service connection pipe estimated?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the Average Length of Customer Service Lines DVG assignment.

Documentation Template

Input Derivation

Are customer meters at the curbstop?
Where are customer meters installed if not at curbstop?
Customer service line derivation:
Comments:

Data Validity Grade Basis

Comments:

Average Operating Pressure

The Average Operating Pressure (AOP) input describes the average pressure in the potable distribution system. It should be calculated as a weighted average where possible, wherein the pressure in areas with more infrastructure have greater weight.

Input Derivation

Consider the following when verifying the input derivation:

- Was the AOP calculated or estimated?
- If calculated, how was the AOP derived? How were pressure zone values weighted?
- What is the range of pressures throughout the system?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How does the utility manage system pressure?
- Does the utility employ pressure zones?
- How are pressure zones defined and separated?
  - Are pressure zones discrete?
- How does pressure vary throughout the system?
- How and where is pressure data collected?
- How was average system pressure determined?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

2	AOP is *estimated.*
4	"Basic coverage" describes a system that has telemetry or pressure logging at boundary points (PRVs, booster pumps, supply locations). Input is *inferred* from the data.
6	"Well-covered" describes telemetry or pressure logging beyond the boundary points, targeted in some portions of the system but not representing the full pressure profile. Input is *calculated* from the data.
8	"Full-scale" describes telemetry or pressure logging that captures data beyond the boundary points, collecting pressure information from throughout the distribution system, representing a full pressure profile. If pressure logging (instead of using telemetry), seasonal variation must also be captured.
10	Telemetry is required that captures data beyond the boundary points, collecting pressure information from throughout the distribution system. A hydraulic model is in place and has been calibrated within the last 5 years to produce a precise average pressure input.

Documentation Template

Input Derivation

Number of zones, general setup:
Typical pressure range:
Input derivation:
Comments:

Data Validity Grade Basis

Extent of static pressure data collection:
Characterization of real-time pressure data collection:
Hydraulic model in place? Calibrated?:
Comments:

Total Annual Cost of Operating Water System

The Total Annual Cost of Operating Water System includes costs for operations, maintenance, and any annually incurred costs for upkeep of the drinking water supply and distribution system. Both daily costs and long-term financing (e.g. capital bond repayment, infrastructure expansion and rehabilitation projects) should be incorporated, in addition to employee salaries and benefits, materials, equipment, insurance, and other administrative costs. Depreciation costs may also be included, depending on utility.

It is important that all costs pertain specifically to the potable water system.

Input Derivation

Consider the following when verifying the input derivation:

- Are all costs relevant to operating the system (both day to day costs and long-term financing)?
- Are all costs included related to the potable water system?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How thoroughly are costs tracked?
  - Are any relevant costs not tracked?
- What technology manages cost, budget, and other financial data?
- How frequently are operating costs audited? By whom?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the TOC DVG assignment.

Documentation Template

Input Derivation

Input Derivation:
Comments:

Data Validity Grade Basis

Frequency of internal auditing:
Frequency of third-party CPA auditing:
Comments:

Special Cases

FY Financial Audit Not Yet Completed

Given the timing of audit compilation and validation, water suppliers may use financial reporting for the calculation of Total Operating Cost that has not yet been audited. The Validator should question the water supplier on the frequency of the financial audit and when it usually occurs. If the water supplier can confirm annual financial auditing, the DVG can grade accordingly even if the input has not yet been reviewed.

Customer Retail Unit Cost

The Customer Retail Unit Cost (CRUC) is the average rate that customers pay for a unit of water. The CRUC is used to value Apparent Losses, since improvements in customer meter accuracy and billing data handling will result in increased revenues at retail rates. Most utilities bill customers with a tiered rate structure that incorporates ranges of use and/or distinct customer classes. In valuing Apparent Losses, it is recommended that a composite average customer retail rate is used, rather than any single rate tier or customer class rate.

If sewer revenues collected by the water utility are volumetrically linked to potable water use, the Customer Retail Unit Cost can also incorporate sewer rates since improvements in meter accuracy will increase both water revenue and sewer revenue.

Input Derivation

Consider the following when verifying the input derivation:

- How was the CRUC calculated?
- Are sewer charges volumetric? If so, are any sewer charges included in CRUC?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- What is the utility's rate structure?
  - When was the rate structure last studied or updated?
  - How consistently is the rate structure applied?
- How was the Customer Retail Unit Cost determined?
  - Have all rate tiers and account classes been incorporated?
- How frequently is the rate structure reviewed by a party knowledgeable in AWWA water audit methodology?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

No additional guidance developed for the CRUC DVG assignment.

Documentation Template

Input Derivation

Input Derivation:
Sewer Charges Volumetric?
Sewer Charges Included?
Comments:

Data Validity Grade Basis

Characterization of calculation:
Comments:

Special Case Notes

Single Volumetric Rate

If the water supplier has one volumetric rate for all customer classes, but no official third-party review has been conducted, the validator's confirmation of rate structure suffices for a DVG of 10.

Validator as M36 Expert Review

Some water suppliers will ask whether the validation process can stand in for M36 expert review of the CRUC (and VPC) inputs. This decision is at the validator's discretion: if enough information on data sources and derivation are provided, and the validator is comfortable with it, the validator's review can serve as the M36 expert review noted in the DVG criteria.

Variable Production Cost

The audit input for Variable Production Cost (VPC) is used to value Real Losses. Therefore, the auditor may choose to value Real Losses at strict Variable Production Cost (the average cost of producing one unit of water) or use a higher value that incorporates costs relevant to marginal production (the production of the next unit of water), the most expensive source of water, avoided expenditures, or other indirect expenses.

Input Derivation

Consider the following when verifying the input derivation:

- Does the audit input describe a strict Variable Production Cost?
- If not, what other costs are incorporated (marginal costs, indirect expenses)?
- Are fixed costs excluded?

Data Practices & DVG Assignment

Data Practices Inquiry Guidance

- How thoroughly are production costs tracked?
  - Are any relevant production costs not tracked?
- What technology manages production cost tracking?
- How was Variable Production Cost estimated?
- How frequently are production costs audited? By whom?

Additional DVG Assignment Guidance

In addition to the DVG criteria, consider the following when confirming the selection:

4	A DVG of 4/5 is assigned when a strict Variable Product Cost (power, chemicals, and/or purchase water costs) is used.
6	Reference to "pertinent additional costs" describe that some (but not all) secondary costs have been evaluated and incorporated. Secondary costs include – but are not limited to: • wear and tear on dynamic equipment • residuals management • impending expansion of supply • damages paid from claims from line breaks If some of the secondary costs are not applicable, the basis for this should be documented.
8	All secondary costs have been evaluated and incorporated as applicable. For any deemed not applicable, the basis for this should be documented. 3rd party M36 review suggests that the input calculations have been reviewed by a water loss expert**.**

Documentation Template

Input Derivation

Supply profile:
Direct variable costs included:
Secondary costs included:
Comments:

Data Validity Grade Basis

Characterization of calculation: primary costs? secondary costs? Import purchase costs?
Comments:

V. Summary Reporting Requirements

The water audit rules specify two reporting requirements for level 1 validation:

Reporting Item	Water Audit Rules Reference	Purpose	Content	Audience
Level 1 Validation Summary Notes	23 CCR § 638.3 Standardized Conduct for Validation of Water Loss Audits	Document level 1 validation findings and highlight next steps for water audit improvement	• Basis of input derivations and DVG assignments • Consistency of performance indicator notes • Recommendations for further validation or improvement	Water Supplier's water audit team.
Certified Validation Report	23 CCR § 638.5 Audit Reporting Requirements	Summarize SB555 compliance	• Identification of validator qualifications • Description of recent water audit improvements and water loss control efforts • Certification statement from Water Supplier executive staff.	Department of Water Resources.

Level 1 Validation Summary Notes

The first item, Level 1 Validation Summary Notes, documents the findings of level 1 validation and serves as a reference document for the water supplier. Though it is not submitted to the Department of Water Resources, validators should recommend that water suppliers keep this document on hand as proof of the validation process and interview.

The water audit rules specify that the Level 1 Validation Summary Notes must include:

> (A) Name and contact information of the water audit validator.
>
> (B) A summary of the Level 1 validation utility staff interview, including the basis for the input derivations and the DVS selections.
>
> (C) Any recommended changes to the water audit inputs by the water audit validator that were not accepted by the urban retail water supplier, and the rationale for not accepting the recommendations.
>
> (D) A summary of any follow-up performance indicator reviews.
>
> (E) Overall impressions, including the consistency of performance indicators with system conditions and water loss management practices.
>
> (F) Any recommendations for further validation or water loss audit improvements.

A templated report for the Level 1 Validation Summary Notes is provided as Appendix B.

For each water audit, the validator makes a judgement on whether the water audit performance indicators are "consistent" with the system's conditions and practices. To do this the validator should reference the water supplier's experience of leakage and the practices surfaced in the validation interview.

The following table outlines possible explanations if the water audit results are deemed inconsistent. This is an incomplete list, meant to provide a general framework. Each water audit deserves customized recommendations given the validator's observations.

Leakage Performance Indicators are Unexpectedly Low	Leakage Performance Indicators are Unexpectedly High
• Water Supplied Volume is under-estimated. This may be the result of overlooked inputs into the system or under-registering meters. • Authorized Consumption is over-estimated. This may be the result of double counted customer classes, inclusion of non-potable water consumption, error in billing queries, or over-estimation for unmetered volume. • Apparent Losses are over-estimated.	• Water Supplied Volume is over-estimated. This may be the result of a database query error, double-counting of water sources or over-registered meters. • Authorized Consumption is under-estimated. This may be the result of overlooked customer consumption or under-estimated unmetered consumption. • Apparent Losses are under-estimated.

Certified Validation Report

The second reporting item, the Certified Validation Report, is submitted to DWR alongside the level 1 validated water audit software file. This file verifies that validation occurred and outlines the water supplier's recent water audit improvements and water loss control efforts.

The water audit rules specify that the Certified Validation Report must be submitted as a single PDF file. This file must include the following (as numbered in the water audit rules):

> (3) Information identifying steps taken by the urban retail water supplier in the preceding 3 years to increase the validity of data entered into the final audit, reduce the volume of apparent losses, and reduce the volume of real losses, as informed by the annual validated water audit.
>
> (4) A statement confirming the Level 1 validation of the submitted water loss audit, including the validation findings, and documenting the following:
>
> > (A.) Identification of the water audit validator.
> >
> > (B.) Qualification of the water audit validator.
> >
> > (C.) Date of the Level 1 validation review.
>
> (5) The following Water Loss Audit Certification Statement, signed by the chief financial officer, the chief engineer or the general manager of an urban retail water supplier:
>
> > "This water loss audit report meets the requirements of California Code of Regulations Title 23, Division 2, Chapter 7 and California Water Code Section 10608.34 and has been prepared in accordance with the methods prescribed therein."

A template for the Certified Validation Report is provided as Appendix C

Documentation Delivery

The validator should send the water supplier a packet of information that facilitates state submission. That should include the following:

- The Water Audit Software as finalized through level 1 validation (the validator should also keep a copy on file).
- The Validation Summary Notes.
- The Certified Validation Report with validator portions complete and direction to complete the supplier portions.

Unit Conversion Help!

Before the Training Manual wraps up, here's a handy reference. Validators need to be equipped with water unit conversion mastery:

Unit Start		Unit Need	Multiply By	Divide By
MG	to	AF	3.0689	0.3259
AF	to	MG	0.3259	3.0689
HCF	to	AF	0.0023	435.5989
AF	to	HCF	435.5989	0.0023
HCF	to	MG	0.0007	1,336.8984
MG	to	HCF	1,336.8984	0.0007

Appendix A: Level 1 Validation Notes Template

Pre-Interview Notes	

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Volume from Own Sources (VOS)	Supply meter profile: VOS Input Data Source: Comments: Confirmed input value:	Percent of VOS metered: Signal calibration frequency: Volumetric testing frequency: Volumetric testing method: Percent of VOS tested and/or calibrated: Comments: Confirmed DVG:
VOS Master Meter Error Adjustment	Adjustment Basis: Net Storage Change Included: Comments: Confirmed input value:	Supply meter read frequency: Supply meter read method: Frequency of data review: Storage level monitoring frequency: Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Water Imported (WI)	Import meter profile: WI Data Source: Comments: Confirmed input value:	Percent of WI metered: Signal calibration frequency: Volumetric testing frequency: Volumetric testing method: Percent of WI tested and/or calibrated: Comments: Confirmed DVG:
WI Master Meter Error Adjustment	Adjustment Basis: Comments: Confirmed input value:	Import meter read frequency: Import meter read method: Frequency of data review: Comments: Confirmed DVG:
Water Exported (WE)	Export meter profile: WE Data Source: Comments: Confirmed input value:	Percent of WE metered: Signal calibration frequency: Volumetric testing frequency: Volumetric testing method: Percent of WE tested and/or calibrated: Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
WE Master Meter Error Adjustment	Adjustment Basis: Comments: Confirmed input value:	Export meter read frequency: Export meter read method: Frequency of data review: Comments: Confirmed DVG:
Billed Metered Authorized Consumption (BMAC)	Customer Meters & Reads Profile: - Age profile: - - Reading system: - - Read frequency: Billing data pro-rated? Comments: Confirmed input value:	Percent of customers metered: Small meter testing policy: Number of small meters testing/year: Large meter testing policy: Number of large meter tested/year: Meter replacement policy: Number of replacements/year: Billing data auditing practice: Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Billed Unmetered Authorized Consumption (BUAC)	Billed Unmetered Profile: Input Derivation: Comments: Confirmed input value:	Policy for metering exemptions: Comments: Confirmed DVG:
Unbilled Metered Authorized Consumption (UMAC)	Unbilled Metered Profile: Input Derivation: Comments: Confirmed input value:	Policy for billing exemptions: Comments: Confirmed DVG:
Unbilled Unmetered Authorized Consumption (UUAC)	Unbilled Unmetered Profile: Input Derivation if Estimated: Comments: Confirmed input value:	Default or Adjusted Default Applied: Completeness of Documentation: Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Unauthorized Consumption (UC)	Default Applied? Input Derivation if Customized: Comments: Confirmed input value:	Instances and extent of UC documented: Comments: Confirmed DVG:
Customer Metering Inaccuracies (CMI)	Input Derivation: Comments: Confirmed input value:	Characterization of meter testing: Characterization of meter replacement: Comments: Confirmed DVG:
Systematic Data Handling Errors (SDHE)	Input Derivation: Comments: Confirmed input value:	If custom estimate provided -- Characterization of read collection & billing process: Characterization of billing process and billing data auditing: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Length of Mains	Input Derivation: Hydrant lateral length included: Comments: Confirmed input value:	Mapping format: Asset management database: Map updates & field validation: Comments: Confirmed DVG:
Number of Active and Inactive Service Connections	Input Derivation: Basis for database query: Comments: Confirmed input value:	CIS updates & field validation: Estimated error of total count within: Comments: Confirmed DVG:
Average Length of Customer Service Line	Are customer meters at the curbstop? Where are customer meters installed if not at curbstop? Customer service line derivation Comments: Confirmed input value:	Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Average Operating Pressure	Number of zones, general setup: Typical pressure range: Input derivation: Comments: Confirmed input value:	Extent of static pressure data collection : Characterization of real-time pressure data collection: Hydraulic model in place? Calibrated?: Comments: Confirmed DVG:
Total Operating Cost (TOC)	Input Derivation: Comments: Confirmed input value:	Frequency of internal auditing: Frequency of third-party CPA auditing: Comments: Confirmed DVG:
Customer Retail Unit Cost (CRUC)	Input Derivation: Sewer Charges Volumetric? Sewer Charges Included? Comments: Confirmed input value:	Characterization of calculation: Comments: Confirmed DVG:

Audit Input	Confirmation of Input Derivation	Confirmation of DVG Assignment
Variable Production Cost (VPC)	Supply profile: Direct variable costs included: Secondary costs included: Comments: Confirmed input value:	Characterization of calculation: Comments: Confirmed DVG:
Pending Items needed to complete the validation		

Appendix C: Certified Validation Report Template

Part A: Provided by Validator

Validator Provided

Audit Information:

Water Supplier Name: PWS ID:

System Type: Potable Audit Period:

Utility Representation:

Validation Date: Call Time: Sufficient Supporting Documents Provided:

Validation Findings & Confirmation Statement:

Key Audit Metrics:

Data Validity Score: Data Validity Band (Level):

ILI: Real Loss: Apparent Loss:

Non-revenue water as percent of cost of operating system:

Certification Statement by Validator:

This water loss audit report has been Level 1 validated per the requirements of California Code of Regulations Title 23, Division 2, Chapter 7 and the California Water Code Section 10608.34.

All recommendations on volume derivation and Data Validity Grades were incorporated into the water audit. ☐

If not, rejected recommendations are included here.

Validator Information:

Water Audit Validator : Qualifications: Water Audit Validator Certificate issued by the CA-NV Section of the AWWA

Certified Validation Report Template

Part B: Provided by Utility

Utility Provided

Water Supplier Name: **Water Supplier ID Number:** **Water Audit Period:**

Water Audit & Water Loss Improvement Steps:

Utility to provide steps taken in preceding year to increase data validity, reduce real loss and apparent loss as informed by the annual validated water audit:

Certification Statement by Utility Executive:

This water loss audit report meets the requirements of California Code of Regulations Title 23, Division 2, Chapter 7 and the California Water Code Section 10608.34 and has been prepared in accordance with the method adopted by the American Water Works Association, as contained in their manual, *Water Audit and Loss Control Programs, Manual M36, Fourth Edition* and in the Free Water Audit Software version 5.

Executive Name (Print)	Executive Position	Signature	Date
_____	_____	_____	_____