

Corrective Actions: Identifying, Investigating, and Resolving Field Sampling Nonconformities

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PORTLAND WATER BUREAU

FROM FOREST TO FAUCET



Presentation Outline

1. Introduction
2. Corrective Actions
3. Case Study
4. Summary/Conclusions

About the Portland Water Bureau



Water System

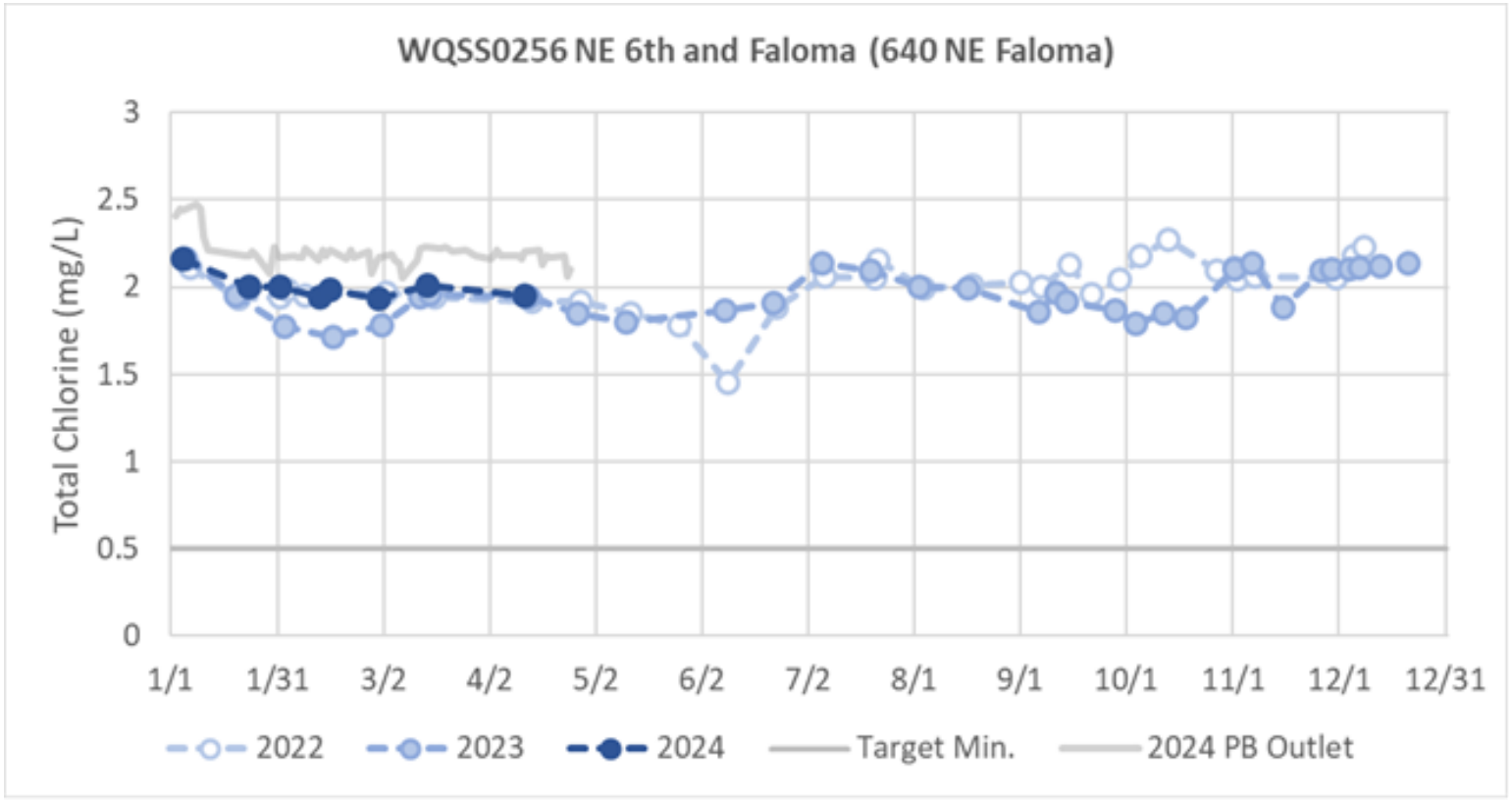
- 187,000 connections
- 19 wholesale systems
- 101 million gallons per day

Staff:

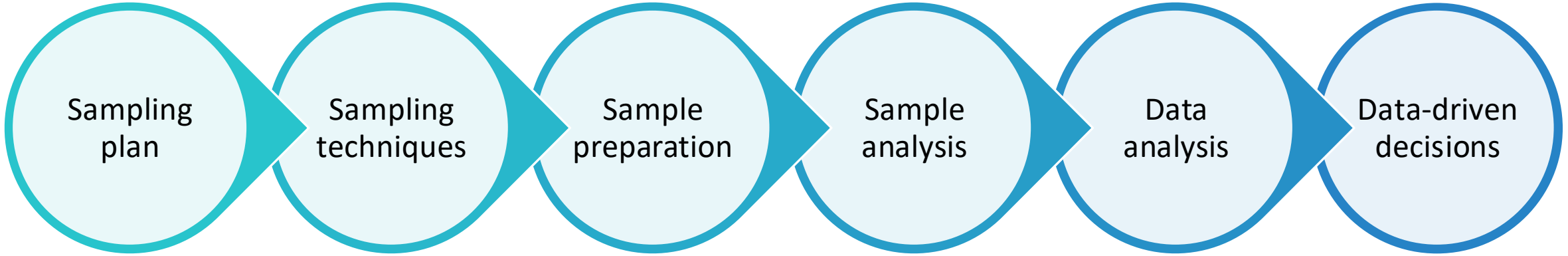
- 600 total
- 21 Water Quality staff
- 7 WQ Monitoring staff
- 11 Laboratory staff

Turning Water Into Data





Bad data can cost you money



Economic decisions are based upon environmental data

“The quality of the data can only be as good as the quality of the sample” - TNI

Field Sampling & Measurement Quality Management System

- Standard policies and procedures
- Calibration and field documentation
- File and record management
- Reviews, audits, and corrective actions



Corrective Actions

- Investigation
- Analysis
- Solution
- Review

Corrective Actions - Definition

"An action initiated in response to an identified nonconformance, in order to define a problem, attempt to identify the root cause, and determine how to prevent the problem from recurring."

- USEPA Corrective Action Operating Procedure

Corrective Actions - Benefits



PERMANENT FIX TO A PROCEDURAL PROBLEM



PREVENT REPEAT FINDINGS AND INCONSISTENCY



LONG-TERM CONTINUOUS IMPROVEMENT INSTEAD OF DISCIPLINE



PROMOTES A CULTURE OF SELF-ACCOUNTABILITY



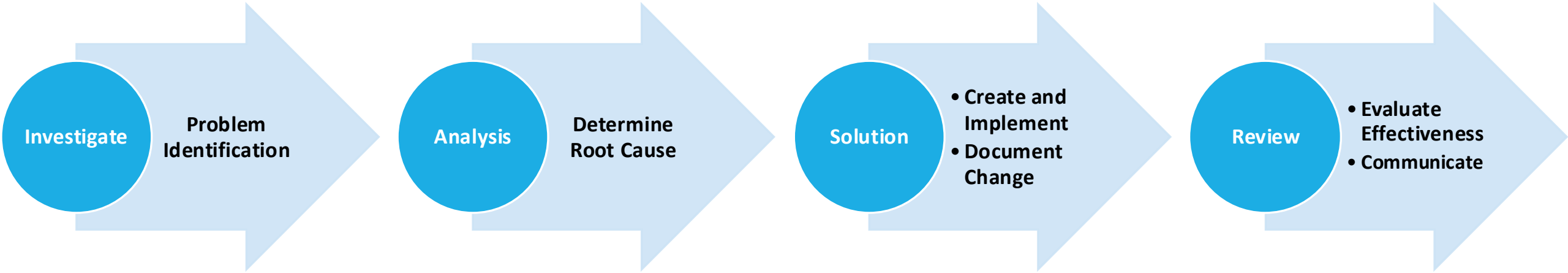
OPPORTUNITY TO IMPROVE

Corrective Actions

Common Causes

- Issues with communication
- Standard Operating Procedures not effectively documented
- Equipment or instrument failure
- Ineffective training
- Lack of oversight or indifference to procedures

Steps for an Effective Corrective Action



Investigating a Correct Action

- Identify the need for a corrective action
- Assign a unique number to the corrective action
- Investigate the issue to determine the root cause
- Write a summary of the issue and root cause



Analysis

- Determine how to correct the issue and prevent it from recurring
- Symptoms vs Root Cause
- Fix the system, not just the symptom
- Is this a procedure, documentation, or training issue?



Root Cause Analysis

Questions to Ask

- Why?
- How?
- Has this happened before?
- Failure of previous solutions?
- More than one cause of the issue?

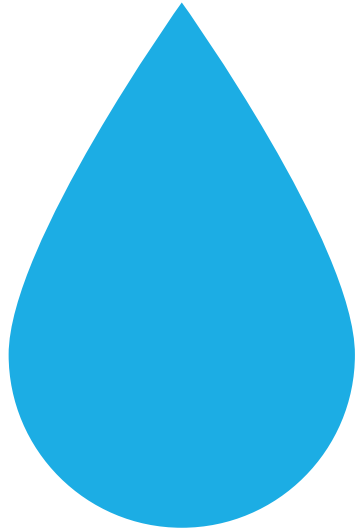
Root Cause Analysis

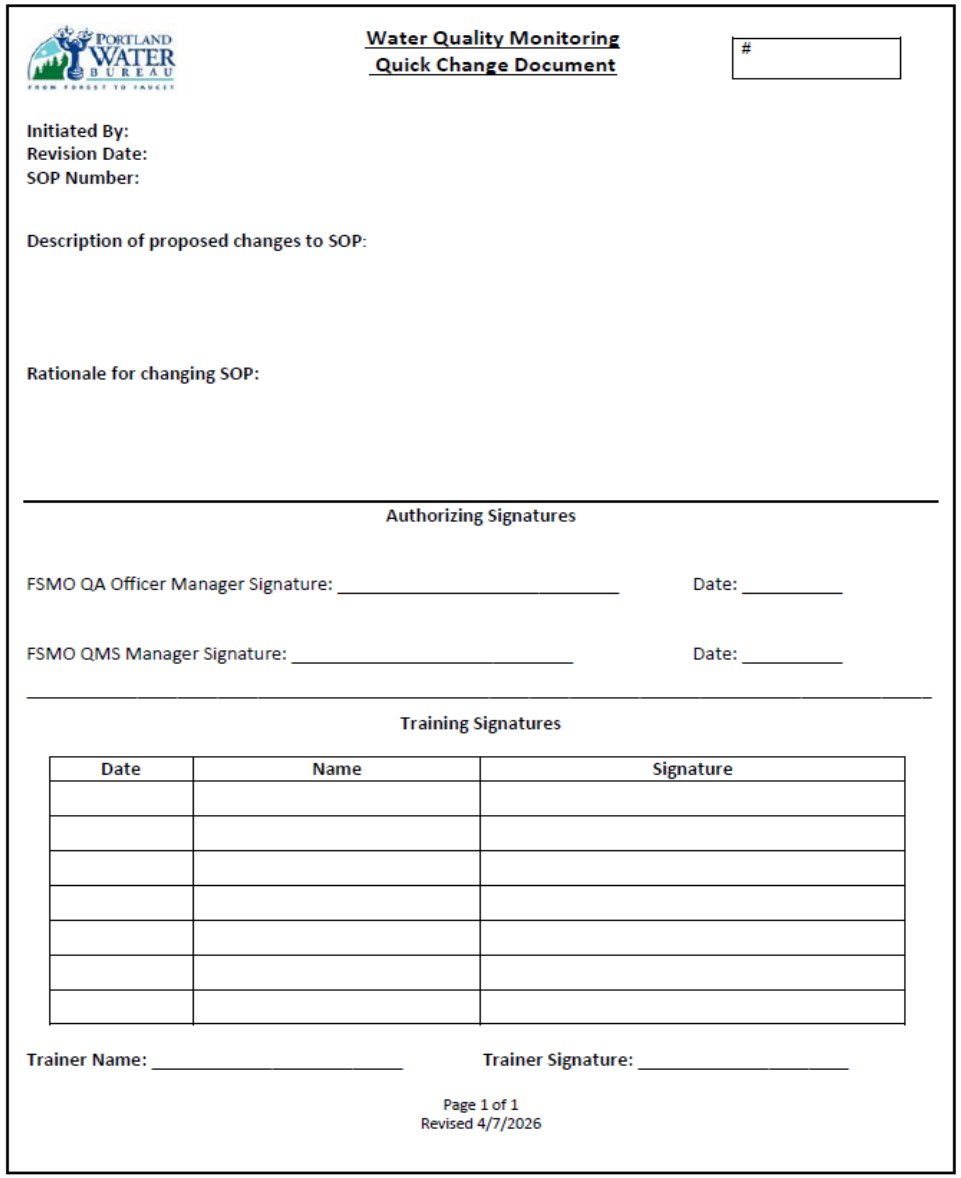
Fix the System – Not Just the Symptoms

- Research the standard methods
- Ask staff questions to clarify the issue
- Assign roles and responsibilities
- Create a timeline for corrective action

Solution

- Present the solution to the affected management and field staff for approval
- Retrain staff if necessary
- Initiation of corrective action





Water Quality Monitoring
Quick Change Document

#

Initiated By:
Revision Date:
SOP Number:

Description of proposed changes to SOP:

Rationale for changing SOP:

Authorizing Signatures

FSMO QA Officer Manager Signature: _____ Date: _____

FSMO QMS Manager Signature: _____ Date: _____

Training Signatures

Date	Name	Signature

Trainer Name: _____ Trainer Signature: _____

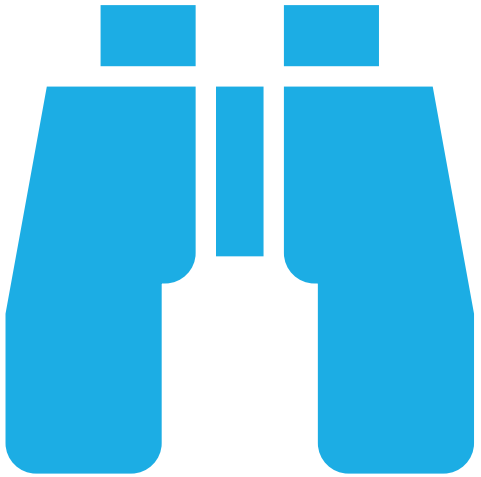
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Revised 4/7/2026

Quick Change Document

- SOP number
- Document Control number
- Revision Date
- Proposed SOP Changes
- Rationale for SOP Changes
- Signatures of Authorizing Personnel
- Training Signatures

Reviewing a Corrective Action

- Monitor effectiveness for 30 - 45 days
- Verify implementation effectiveness
- Update policies and procedures
- Communicate changes with stakeholders



Preventive Actions - Definition

"Preventive action is a proactive process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints."

-ISO/IEC 17025:2005(E)

Preventive Actions – Continuous Program Improvement

- Preventing problems is generally cheaper and easier than fixing problems
- Will help others in the future
- Define roles and responsibilities for initiating and assessing corrective actions
- Identify and address trends to prevent future problems

Preventive Actions – QMS Internal Audits

- Review documentation of field sampling activities
- Assess operation and develop action plans
- Identify non-conforming issues that could affect data quality
- Confronts the **Appeal to Tradition** logical fallacy



Case Study

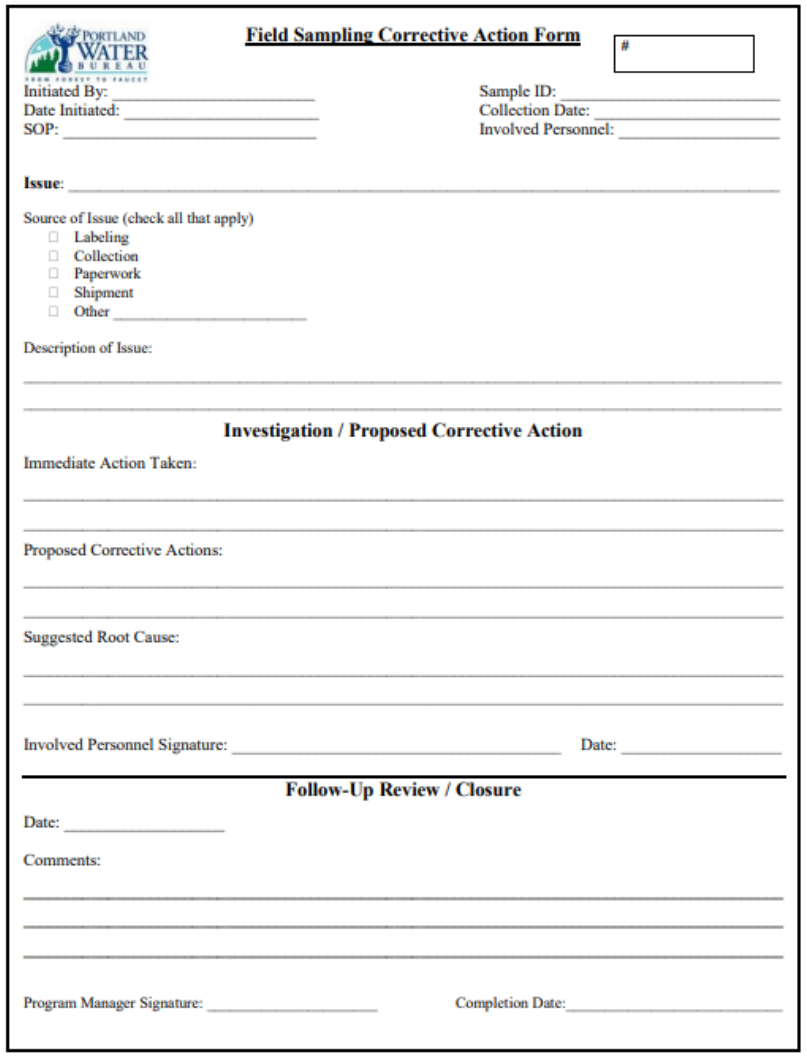
- Investigation
- Analysis
- Solution
- Review

Case Study: Background

- pH is a critical measurement for understanding corrosion, nitrification, and general water quality
- Low-ionic-strength drinking water is difficult to measure in the PWB DS
- WQM measures pH in the DS as a routine operational measurement
  - Included on 240+ monthly TCR samples

Case Study: Background

- Non-Regulated pH measurements collected by seasonal or limited-term employees
- Did not have extensive knowledge or experience of instrumentation or field procedures
- New pH electrode out-of-range slope calibration failure overlooked by field staff was discovered during data review



Field Sampling Corrective Action Form

#

Initiated By: _____
Date Initiated: _____
SOP: _____

Sample ID: _____
Collection Date: _____
Involved Personnel: _____

Issue: _____

Source of Issue (check all that apply)
- ☐ Labeling
- ☐ Collection
- ☐ Paperwork
- ☐ Shipment
- ☐ Other _____

Description of Issue:

_____

_____

Investigation / Proposed Corrective Action

Immediate Action Taken:

_____

_____

Proposed Corrective Actions:

_____

_____

Suggested Root Cause:

_____

_____

Involved Personnel Signature: _____ Date: _____

Follow-Up Review / Closure

Date: _____

Comments:

_____

_____

_____

Program Manager Signature: _____ Completion Date: _____

Corrective Actions - Form

- Corrective Action Number
- Issue
- Description
- Investigation/Proposal
- Root Cause
- Solution
- Follow-Up Review

Investigating the Issue

- Began a corrective action document and assigned a unique document control number
- Removed pH electrode from field service
  - Reviewed pH electrode calibration test certificate
- Method Review
  - Standard Method 4500B
  - USEPA Method 150.3
  - Hach Method 10076
- SOP Review
  - PWB Lab pH SOP
  - PWB Field pH SOP
  - Calibration one-sheet



Investigating the Issue

- Two test calibrations performed
- Internal pH electrode thermometer tested and verified
- pH electrode reconditioned and recalibrated
- Side-by-side field testing



Analyzing the Issue

- Communication
  - Communication channels not clearly defined in SOP
  - Field staff v lab responsibilities on QC review missing from SOP
- New pH electrode procedure
  - Inconsistent with the manufacturer’s recommendations



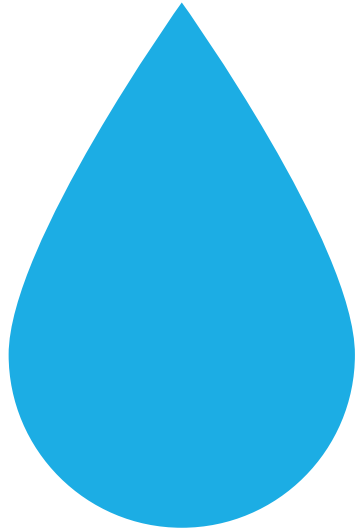
Analyzing the Issue

- Calibration Booklets
  - Missing regular review intervals
  - Slope Range documentation causing mistakes
- Instrumentation
  - Available programming capabilities not being utilized
- Training
  - Key improvements identified



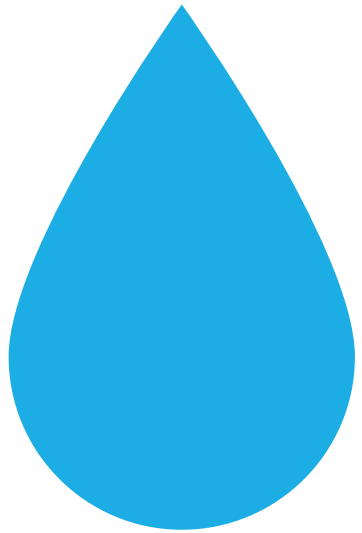
Creating Solutions

- Communication
  - Added clarifying language to SOP that defines roles and responsibilities
  - Display contact information in the field room
- Calibration Booklets
  - monthly checks
  - Added contact information
  - Updated SOP and calibration booklets to slope efficiency percentage and CCV instead of slope mV range



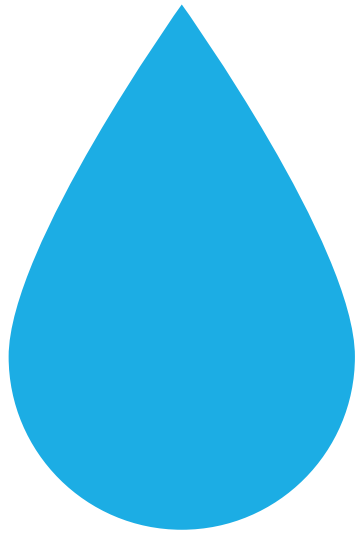
Creating Solutions

- Instrumentation
  - Programmed instrument calibration acceptance range
- Training
  - Create calibration training presentation
  - Can be added to the one-sheet as a QR code linked to a training video
  - Increase field staff awareness of procedures and policies



pH Side-by-Side Testing

- Before placing a new pH probe into service:
  - condition and calibrate pH probe
  - compare >15 side-by-side pH measurements with an established pH probe
  - Absolute Difference <0.1 pH units
- Ongoing quarterly pH electrode side-by-side testing to maintain adherence to SOP



pH Side-by-Side Testing

pH Probe Side-by-Side Field Sheet

Name: M.Holt_____

Probe Deployment Date - Dec 2025				Probe Deployment Date - Jan 2026				Probe Deployment Date - Jan 2026			
pH probe SN:	1008	Calbrated:	Y	pH probe SN:	308	Calbrated:	Y	pH probe SN:	987	Calbrated:	Y
WQSS	Time	Temp	pH	WQSS	Time	Temp	pH	WQSS	Time	Temp	pH
83	0832	6.9	8.90	83	0832	6.9	8.94	83	0832	6.9	8.97
164	0922	8.6	8.84	164	0922	8.6	8.88	164	0922	8.6	8.84
199	0940	9.4	8.66	199	0940	9.4	8.67	199	0940	9.4	8.68
10	0955	8.4	8.85	10	0955	8.4	8.87	10	0955	8.4	8.86
212	1005	9.9	8.85	212	1005	9.9	8.89	212	1005	9.9	8.92
213	1016	9.8	8.83	213	1016	9.8	8.86	213	1016	9.8	8.87
186	1025	7.7	8.91	186	1025	7.7	8.90	186	1025	7.7	8.91
200	1039	10.0	8.50	200	1039	10.0	8.51	200	1039	10.0	8.53
11	1051	10.0	8.85	11	1051	10.0	8.86	11	1051	10.0	8.92
214	1105	9.8	8.75	214	1105	9.8	8.73	214	1105	9.8	8.82
12	1116	10.0	8.83	12	1116	10.0	8.85	12	1116	10.0	8.90
204	1224	10.7	8.65	204	1224	10.7	8.67	204	1224	10.7	8.72
250	1235	9.8	8.51	250	1235	9.8	8.54	250	1235	9.8	8.56
258	1248	9.9	8.58	258	1248	9.9	8.61	258	1248	9.9	8.62
Mid 9.0 QC:	9.14	Post 9.0 QC	9.11	Mid 9.0 QC:	9.15	Post 9.0 QC	9.15	Mid 9.0 QC:	9.15	Post 9.0 QC	9.15

Auto-Filled

Instructions - The tables below are built to use 3 values when calculating differences. If only two probes are being compared copy this formula into the Abs. Diff. box and drag down. ---------->

Absolute Difference of readings at each station	
WQSS	Abs. Diff.
83	0.07
164	0.04
199	0.02
10	0.02
212	0.07
213	0.04
186	0.01
200	0.03
11	0.07
214	0.09
12	0.07
204	0.07
250	0.05
258	0.04
0	0.00
0	0.00

<-- Paste here
drag down
|
|
v

Two Probe Formula
=MAX(D7, I7) - MIN(D7, I7)'

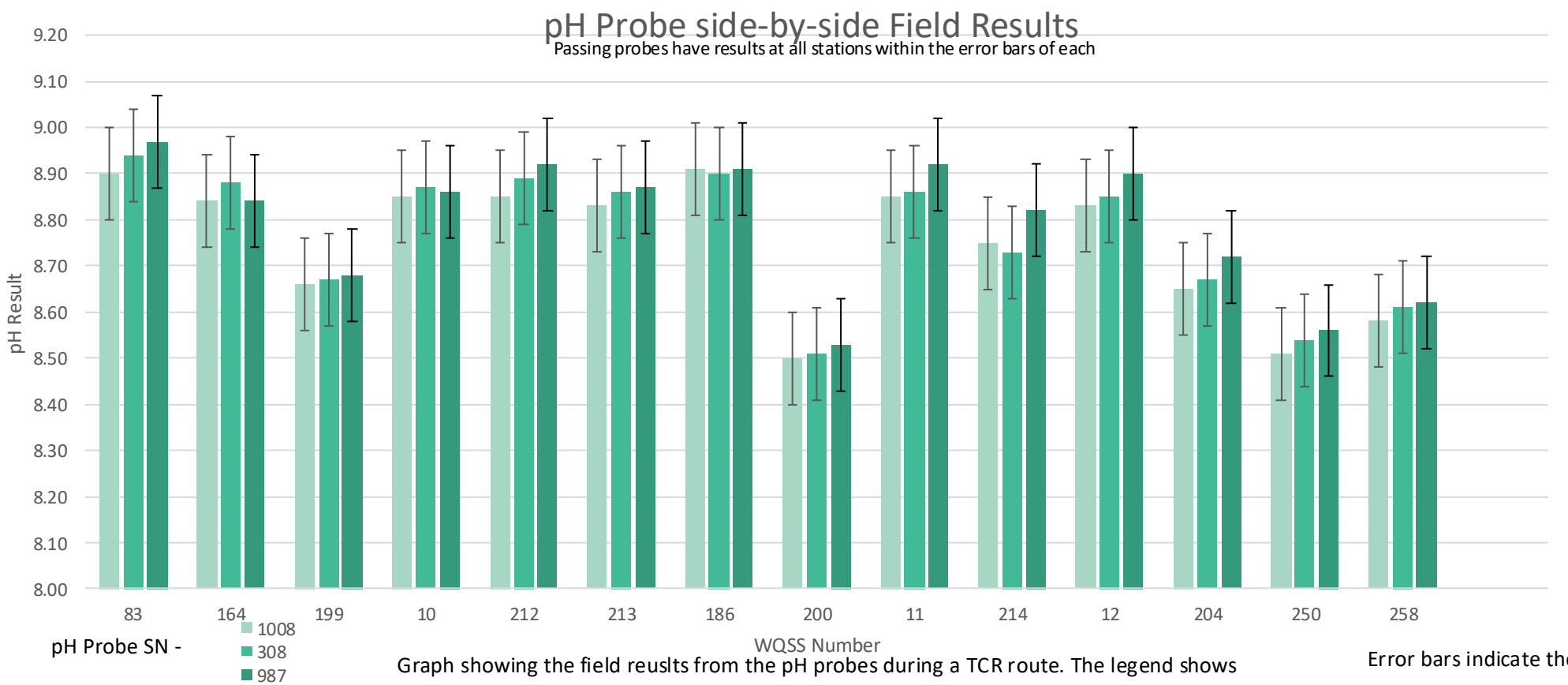
Three Probe Formula
=MAX(D7, I7, N7) - MIN(D7, I7, N7)'

pH side-by-side results		
Probe #	*All Results within 0.20 tolerance range?*	*# of sites probe out of range?*
1008	YES	0
308	YES	0
987	YES	0

Absolute difference color legend:

- within tolerance range
- trigger limit - probe needs troubleshooting before deployment
- probe fails - do not deploy probe

pH Side-by-Side Testing

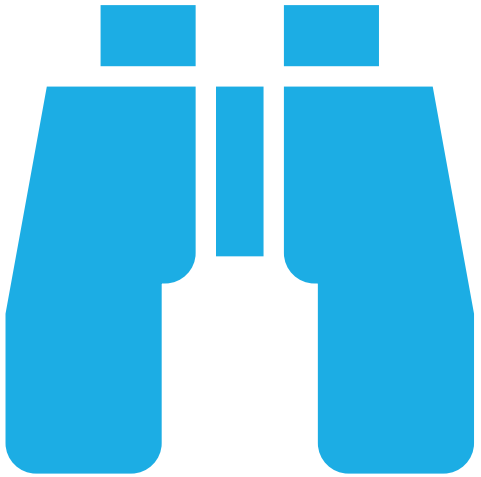


Graph showing the field reuslts from the pH probes during a TCR route. The legend shows

Error bars indicate the 0.20

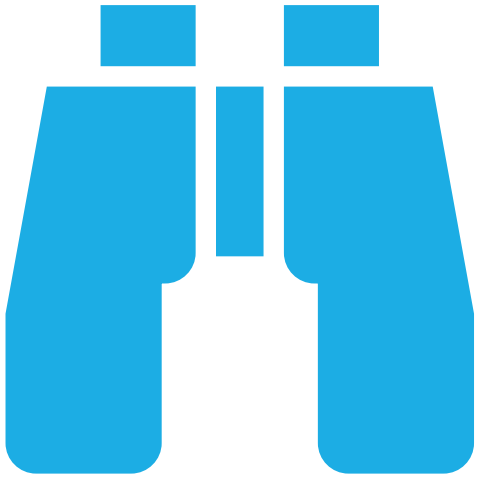
Corrective Action Review

- Monitored the effectiveness of changes for several months
- Discussed impacts of changes with field staff and project managers
- Refined changes for usability and efficiency
- Updated SOPs with approved changes



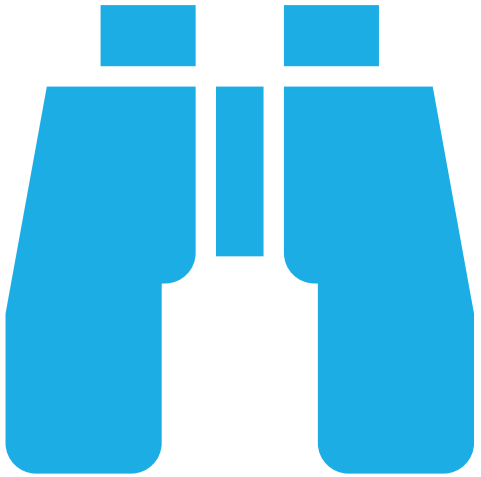
Lessons Learned

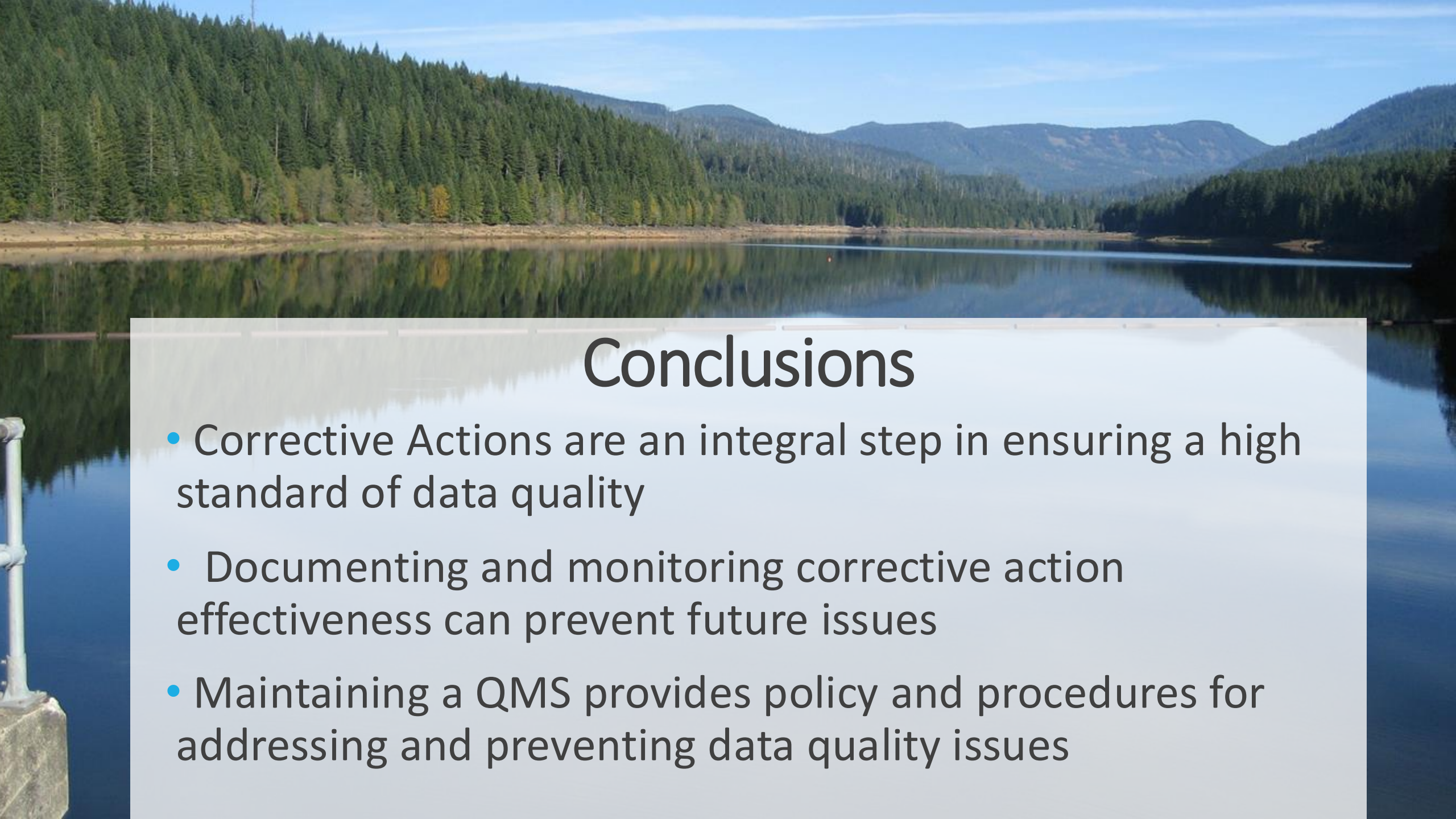
- Found technical improvements while researching a small issue
- Side-by-side testing increased our confidence in field pH measurements
- Reviewing SOPs led to improvements in calibration, measurement, and quality control



Lessons Learned

- Involving field staff helps improve the process and increase buy-in
- An effective corrective action prevents the issue from recurring
- Simplicity increases effectiveness





Conclusions

- Corrective Actions are an integral step in ensuring a high standard of data quality
- Documenting and monitoring corrective action effectiveness can prevent future issues
- Maintaining a QMS provides policy and procedures for addressing and preventing data quality issues

Resources

- TNI Standard Module 2
  - 4.8, 4.9, 4.11, 4.12, 4.14, 4.15
- DOD Quality System Manual Module 2:
  - 4.11.8, 4.2.8.4, 4.14.6 – 4.14.8
- ISO/IEC 17025: 2005(E)
  - 4.8, 4.9, 4.11, 4.12, 4.14, 4.15
- ISO 17025 2017
  - 8.7.1, 8.8.2, 8.9.2, 8.9.3

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- **Water Quality Monitoring Group**

Questions?





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