NATIONAL WATER QUALITY MONITORING COUNCIL

Working Together for Clean Water

NWQMC

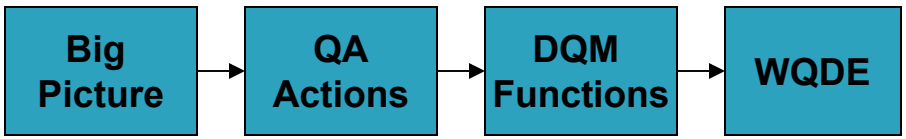
From Quality Assurance to Data Elements: Making the Connections for Sensors

Revital Katznelson and Daniel J. Sullivan

NWQMC 2012, Portland, OR

Today's Topics

- The Big Picture, and how the ASW products fit in
- Actions to assure, document, and share data quality information
- Data Quality Management (DQM) Functions Time Line
- The language of records and communication
- Sensors Data Elements

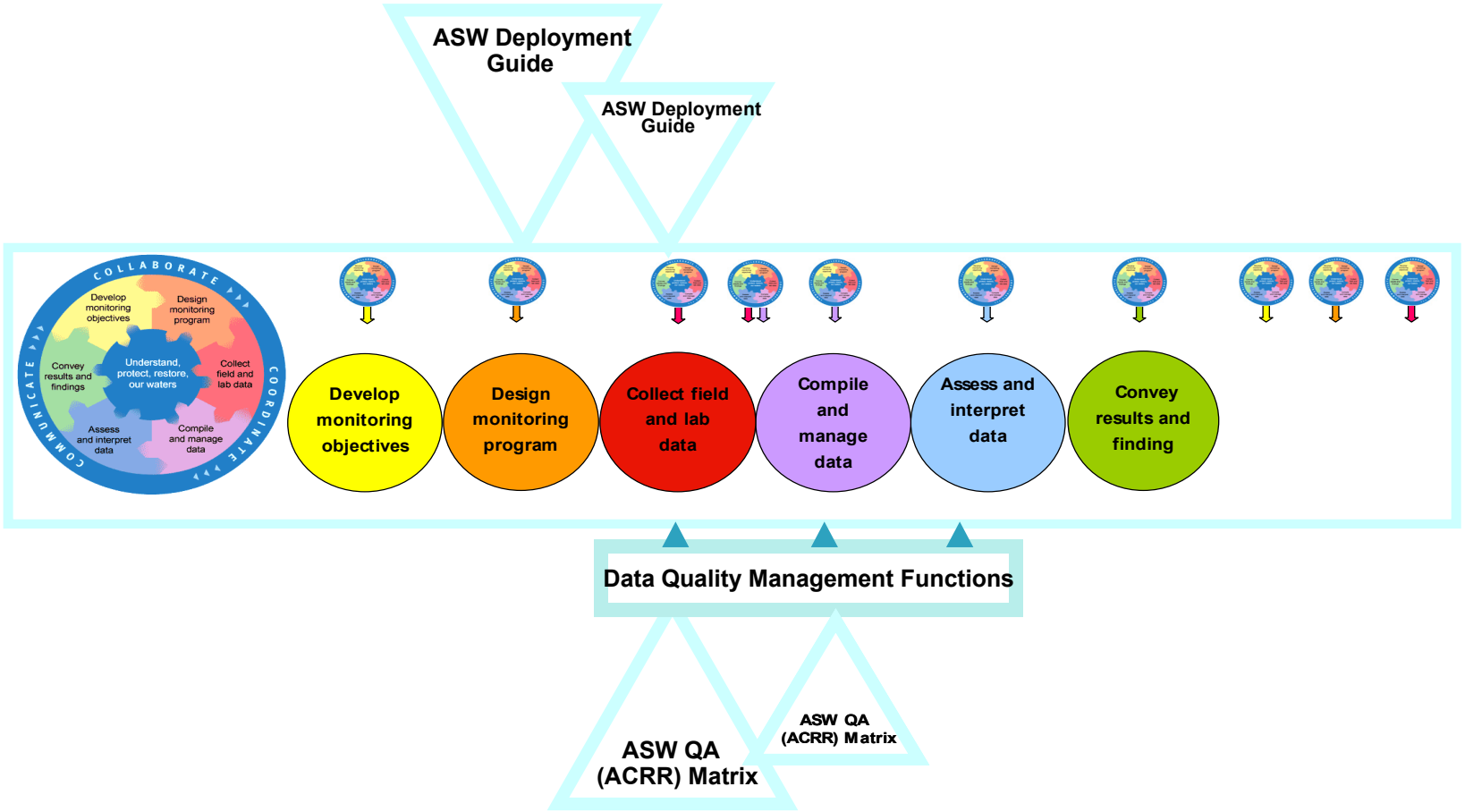


NWQMC

The Monitoring Framework, NWQMC 2002

Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

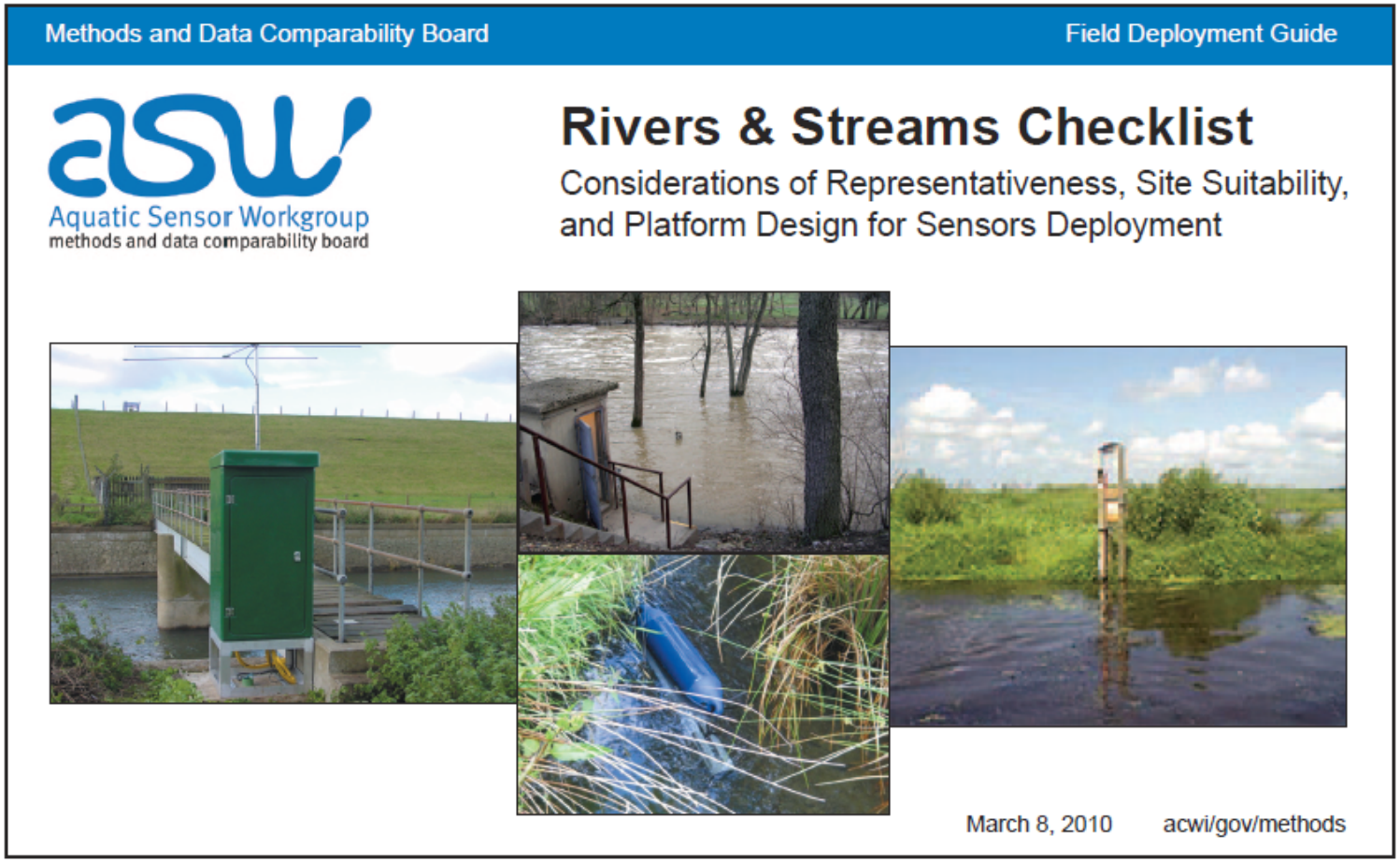


Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

The Field Deployment Guide, ASW 2010

http://watersensors.org

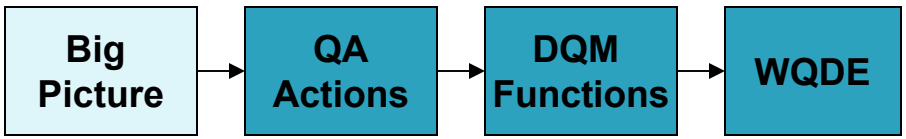


Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

Contents of the Field Deployment Guide

- System selection – the type of monitoring system that will be needed
- Site selection – the factors to consider when choosing the best sampling location
- Installations – platform design, representativeness, safety considerations, maintenance, and requirements for power and telemetry
- Documentation – recommendations for photo and written site and installation documentation



NWQMC

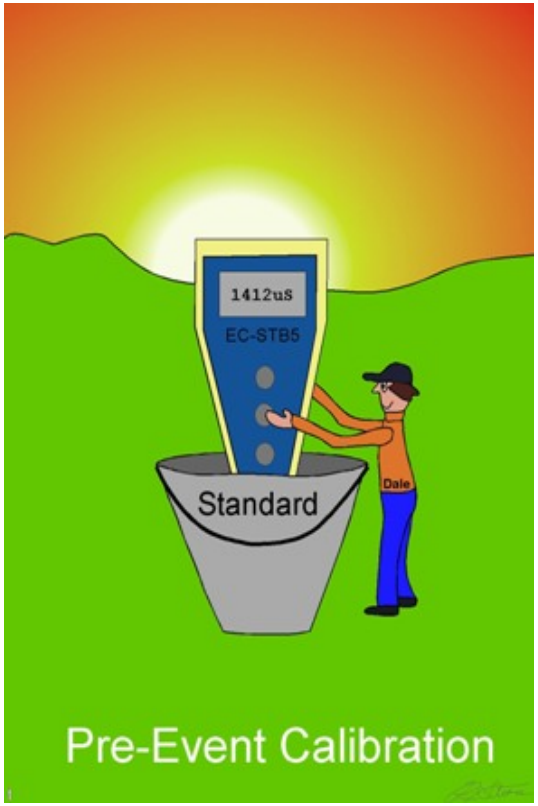
The QA (ACRR) Matrix, ASW 2010

http://watersensors.org

NWQMC

Big Picture → QA Actions → DQM Functions → WQDE

Actions to Affect, Check, Record, and Report the quality of monitoring data (ACRR)



AFFECT **CHECK**

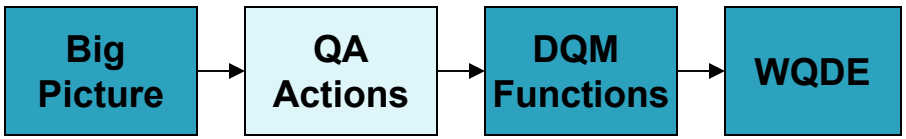
Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

ACRR for accuracy (generic)

- AFFECT – Calibrate
- CHECK – Conduct accuracy check (compare to Standard)
- RECORD – instrument reading +"true" value of Standard
- REPORT – diff. from "true" value, or % accuracy

AFFECT [Control] *(act to influence the outcome)*	**CHECK** *(test to evaluate or verify)*	**RECORD** *(keep everything documented)*	**REPORT** *(communicate the data quality indicator)*
Quality Assurance Actions		**Documentation Actions**	
calibrate (adjustable-reading instruments)	conduct accuracy check (all instruments)	instrument reading and "true" value of Standard	Accuracy (bias): Instrument's difference from "true" value, in measurement units or as a percentage of Standard's value

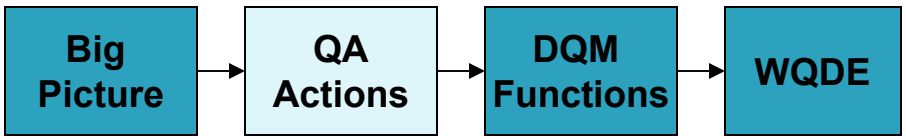


NWQMC

ACRR for precision (generic)

- AFFECT – Use consistent procedures
- CHECK – Conduct precision checks
- RECORD – results of repeated measurements
- REPORT – Rel. % diff, SD, CV

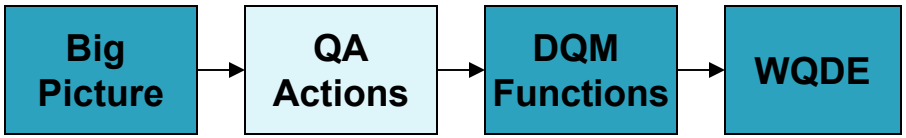
AFFECT [Control] *(act to influence the outcome)*	CHECK *(test to evaluate or verify)*	RECORD *(keep everything documented)*	REPORT *(communicate the data quality indicator)*
Quality Assurance Actions		Documentation Actions	
use consistent procedures under same conditions	conduct precision checks (repeat measurements of same)	results of repeated measurements	Relative Percent Difference, Standard Deviation, or Coefficient of Variation



NWQMC

(Matrix screenshot)

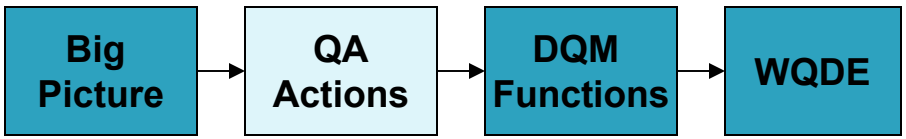
Technology	data quality aspect	Mode	**AFFECT [Control]** *(act to influence the outcome)*	**Check** *(test to evaluate or verify)*	**Record** *(keep everything documented)*	**Report** *(communicate the data quality indicator)*
			Quality Assurance Actions		**Documentation Actions**	
conductivity cell	**Accuracy /Bias**	Attended	Conduct one-point calibration in the lab, at a value in the middle of anticipated environmental range, at room temperature **[sp1-3]**, before each Trip. Conduct two point calibration in the field, at values that bracket expected range, at stream temperature, before first use of the day. Make sure the probe is properly hydrated before calibration and before each use; assure sufficient voltage	**C**onduct a one-point accuracy check in the lab, at a mid-range value, at room temperature **[sp2]**, within 24 hrs of Trip's end	**T**emperature of Standard, Instrument conductivity reading, temperature compensation factor (if needed), and "true" value of Standard	Report bias: Instrument drift, i.e., difference from known ("true") value of Standard, expressed either in measurement units or as percent of Standard's "true" value, whichever is higher.
	Accuracy/Bias	**Unattended**	Conduct two-point calibration in the lab, at zero and at value higher than expected range, at room temperature, before deployment and at every maintenance event (if needed)	Conduct three-point accuracy check, w Standards at min/mid/max values of expected range, plus a zero check in air, at room or field temperature, within 24 hrs of retrieval and at every maintenance event, before and after cleaning.	**T**emperature of Standard, Instrument conductivity reading, temperature compensation factor (if needed), and "true" value of Standard	Report bias: Instrument drift, i.e., difference from known ("true") value of Standard, expressed either in measurement units or as percent of Standard's "true" value, whichever is higher.
	Precision	Attended	use consistent procedures under same conditions	Repeat measurements 3-5 times after the reading has stabilized, under controlled (non-changing) environment in the lab, during every calibration or accuracy check event.	Results of the 3-5 measurements after stabilization;	Compute the Standard Deviation of the 3-5 values and report in measurement units **[a4]**
	Precision	**Unattended**	Use consistent procedures under same conditions	Repeat measurements 3-5 times after the reading has stabilized, under controlled (non-changing) environment in the lab, during every calibration or accuracy check event.	Results of the 3-5 measurements after stabilization;	Compute the Standard Deviation of the 3-5 values and report in measurement units **[a4]**
	Lack of interference or contamination	Attended	clean probes			
	Lack/Extent of interference or contamination	**Unattended**	clean probes, treat with anti-fouling agents, adjust deployment duration or maintenance intervals to local conditions	Run fouling comparison test: Measure stream water (in situ or in bucket) before and after cleaning the probe.	Pre-cleaning inspection and photographic records of fouling, Instrument readings before and after probe fouling removal	



NWQMC

The QA (ACRR) Matrix, ASW 2010

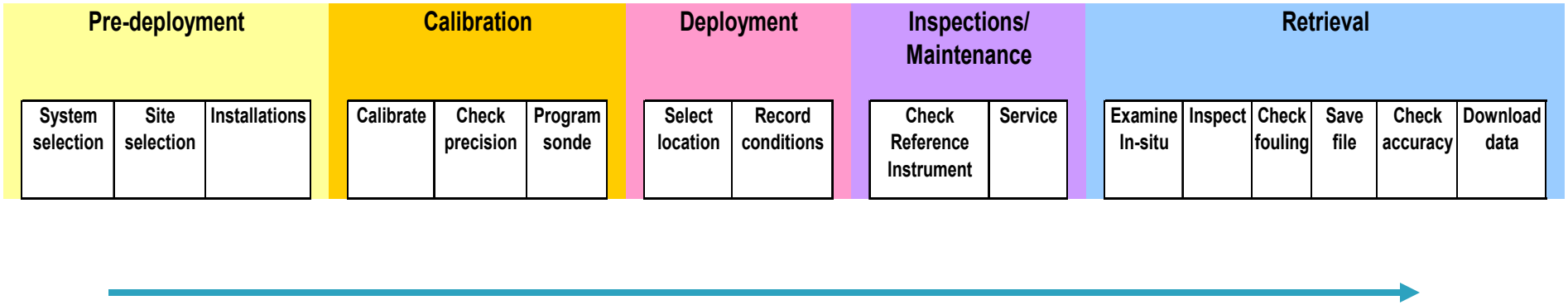
- ASW and Review Panel recommended the minimum actions required for generation of data of known and documented quality
  - Calibration/accuracy check frequency and number of points
  - Repeated measurements
  - Fouling checks
- Various aspects of data quality: accuracy, precision, lack/extent of fouling, etc.
- Attended and unattended modes
- A page for each WQ characteristic, and a general sensors page
- Notes and monitoring tips

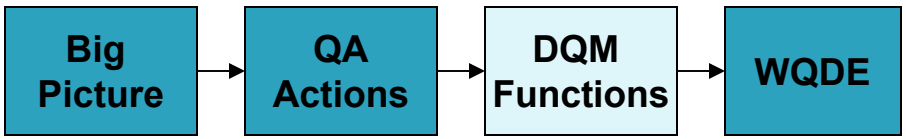


Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

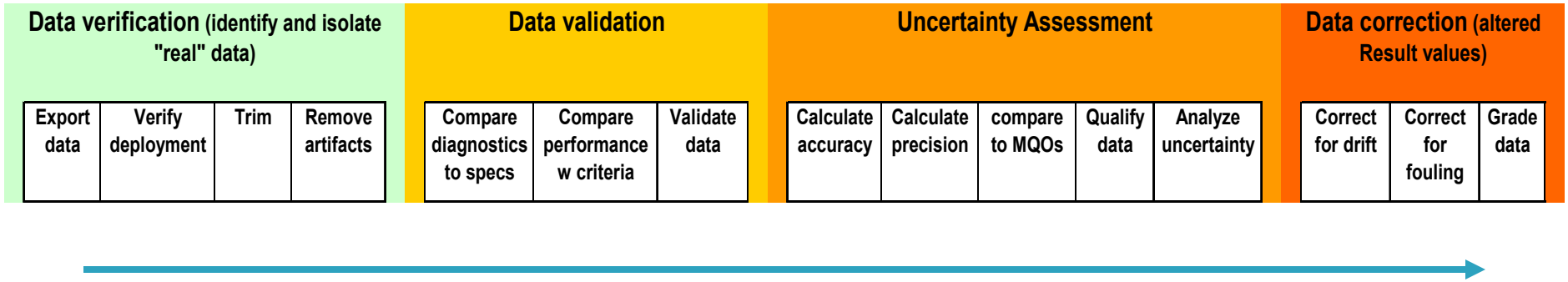
The Sensors Data Quality Management (DQM) Functions Timeline, Part1





NWQMC

The Sensors Data Quality Management (DQM) Functions Timeline, Part 2



Essential post-event accuracy check records: examples

Instrument ID	Character-istic	Units	Standard	"True" Value	Reading in Standard	Differen-tial	Percent Accuracy
DOP-STB01	DO	% sat	humid air	100	97.3	-2.7	-2.7
DOP-STB01	DO	% sat	saturated water	100	95	-5	-5.0
ECP-STB01	Sp.Cond	uS	STB-EC10y	1412	1410	-2	-0.1
PHP-STB01	pH	pH	STB-PH20f	7	7.05	0.05	0.7
PHP-STB01	pH	pH	STB-PH29b	9	8.98	-0.02	-0.2
TTP-STB01	Temp	C	TR-STB43	21.5	21.19	-0.31	-1.4
TTP-STB01	Temp	C	TR-STB43	21	21.21	0.21	1.0

$$\text{Differential} = (\text{Reading in Standard}) - (\text{True value})$$

$$\text{Percent accuracy} = \frac{((\text{Reading in Standard}) - (\text{True value})) \times 100}{(\text{True value})}$$

NWQMC

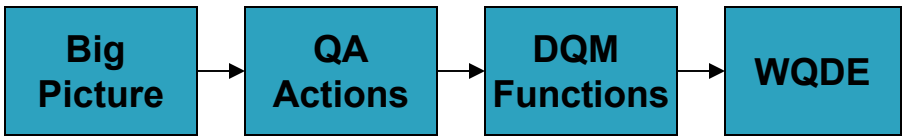
Big Picture → QA Actions → DQM Functions → WQDE

… and here is how you can report accuracy and precision

Instrument ID	Characteristic (Parameter)	Results Units	Result	Accuracy	Precision
TTP-STB01	Temperature, water	C	14.57	-1.4 %	0.06 %, RPD
ECP-STB01	Specific conductivity	uS/cm	758.7	-0.14 %	0.40 %, RPD
PHST-STB03j	pH	pH	8	0.5 Res.	0.5 Resolution
PHP-STB01	pH	pH	8.34	0.7%	0.12 %, RPD

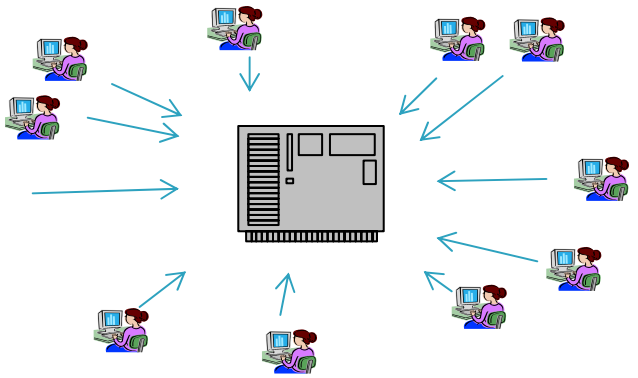
When planning for monitoring, consider:

- Which protocol should be followed??
- Who will performs which functions?
  - Field Operator
  - Data manager
  - Other
- What electronic platform are they using?
- What software tools do they have?



Wouldn't it be nice if…

- Sensors protocols are standardized across agencies and groups?
- Everyone validates data, calculates error, and corrects data in the same way, using standardized software packages?
- Everyone reports all relevant bits of information needed for data sharing?



Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

Phase	Calibration			Retrieval					
Task Name	**Calibrate**	**Check precision**	**Program sonde**	**Examine In-situ**	**Inspect**	**Check fouling**	**Save file**	**Check accuracy**	**Download data**
Task content	Calibrate electrode w Standard buffers	Run precision check in situ	Program sonde for deployment	document sonde in situ, pre-retrieval	inspect retrieved sonde	run fouling checks in stream water	save and close sonde file	run accuracy checks w Standard buffers	download sonde file to sonde software on computer
Records	'calibration records' package including diagnostics	repeated measurements	Time, place, initial instrument readings	notes (e.g., buried in sediment), photos	notes (e.g.,covered w biofilm), photos	readings before and after cleaning	file ID etc.	'accuracy check records' package including diagnostics	file ID etc.
Data Elements subject	7.9.3, 7.9.4, 7.9.5	7.10.1, 7.10.2	5.1.1, 6.4.4	6.4.3, 6.4.6, etc.	6.4.3, 6.4.6, etc.	7.10.1, 7.10.2	6.4.4	7.10.1 to 7.10.4	6.4.4

NWQMC

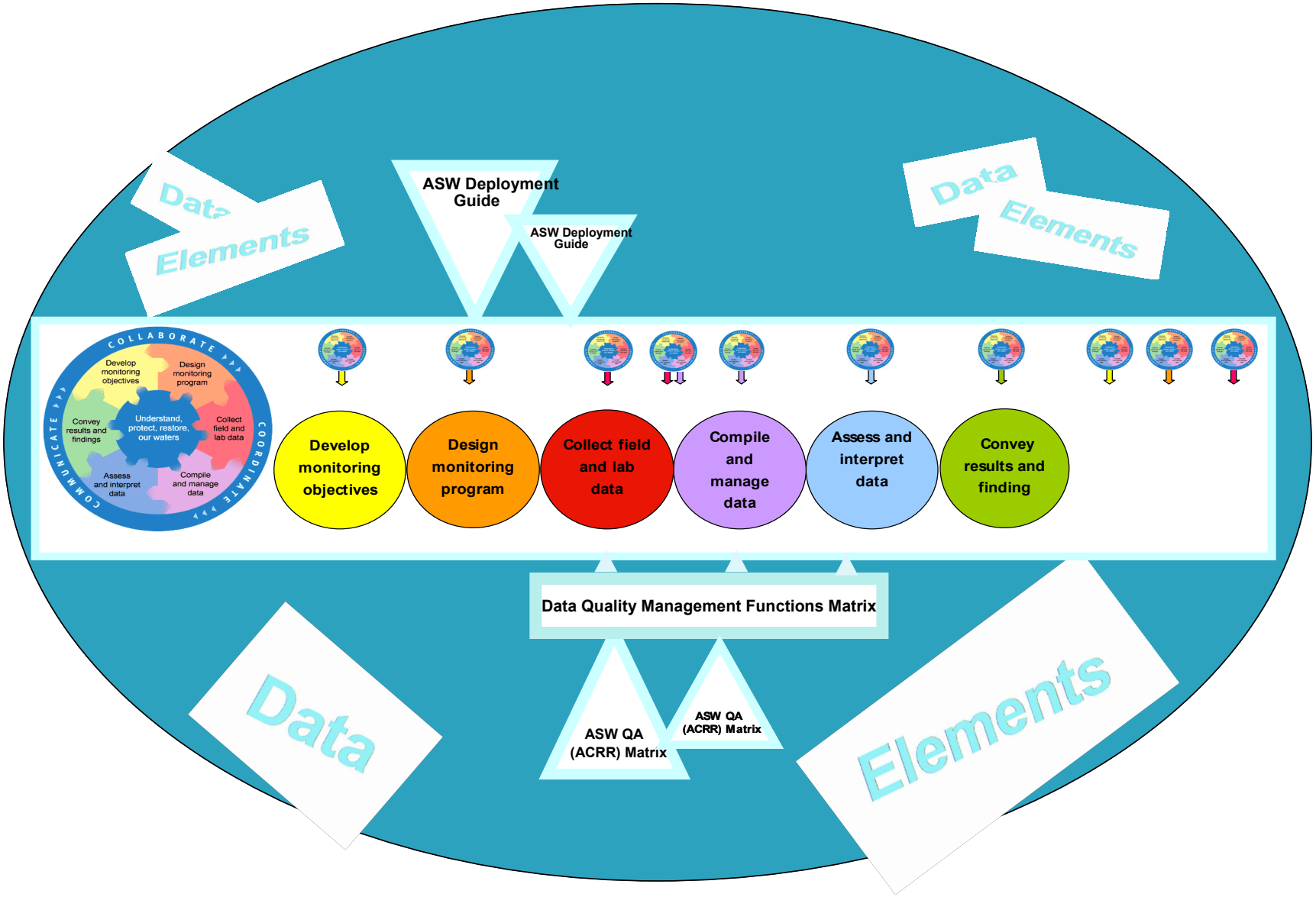
Big Picture → **QA Actions** → **DQM Functions** → **WQDE**

Water Quality Data Elements

Category number	Category (Module) name	Group number	Group name
1	Monitoring Project ("Contact")	1.1	Project Identifiers
		1.2	Organization identifiers
		1.3	Project Contacts
2	Result	2.1	Result (how much?)
		2.2	Characterisitc (of what?)
		2.3	Result descriptors
3	Study Dataset ("Reason")	3.1	Identifiers
		3.2	Intent
		3.3	Design (…more)
4	Site Visit ("Date/time")	4.1	Trip
		4.2	Visit
5	Location		Site identifiers
			Site Description
			Site Location
6	Activity-Field ("sample collection")		Identifiers, type
			Spatial descriptors
			Sample (in a jar)
7	Measurement System - field&lab ("Sample Analysis")		Instruments and lab batches
			Method
			Quality checks

NWQMC

Big Picture → QA Actions → DQM Functions → WQDE

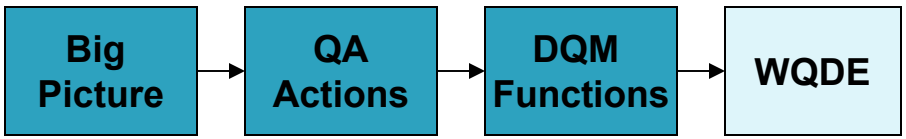


Big Picture → QA Actions → DQM Functions → WQDE

NWQMC

Water Quality Data Elements

- Sensors Data Elements Lists, 2012
  - Comprehensive list of data elements for use at the Project level ("the Long List"), aligned with WQX data dictionary
  - A subset of data elements for data sharing beyond the projects
  - **"Shared"** data elements are categorized as Essential, Recommended, or Conditional per ASW consensus
- Next Steps:
  - Approval of "shared" data elements list for sensors by ACWI
  - Continue work with EPA as they add time series data to WQX
  - Continue dialog with the WaterML team and OGC



Thanks for Listening!

- Revital Katznelson, revitalk@sbcglobal.net
- Dan Sullivan, djsulliv@usgs.gov

Special Thanks to the Sensor Workgroup

- Chuck Dvorsky - TCEQ
- Rick Wagner - USGS
- Pete Penoyer and Dean Tucker – NPS
- Mike Sadar - Hach
- Rob Ellison and others - YSI
- Mary Giorgino – USGS
- Mario Tamburri – ACT
- Janice Fulford - USGS
- Ed Quilty - AI

- And many others since 2008!

NWQMC

Big Picture → QA Actions → DQM Functions → WQDE