Core Parameter QA/QC

for

Stream Water Quality Monitoring

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Northern Colorado Plateau

Inventory and Monitoring

Quality Assurance / Quality Control

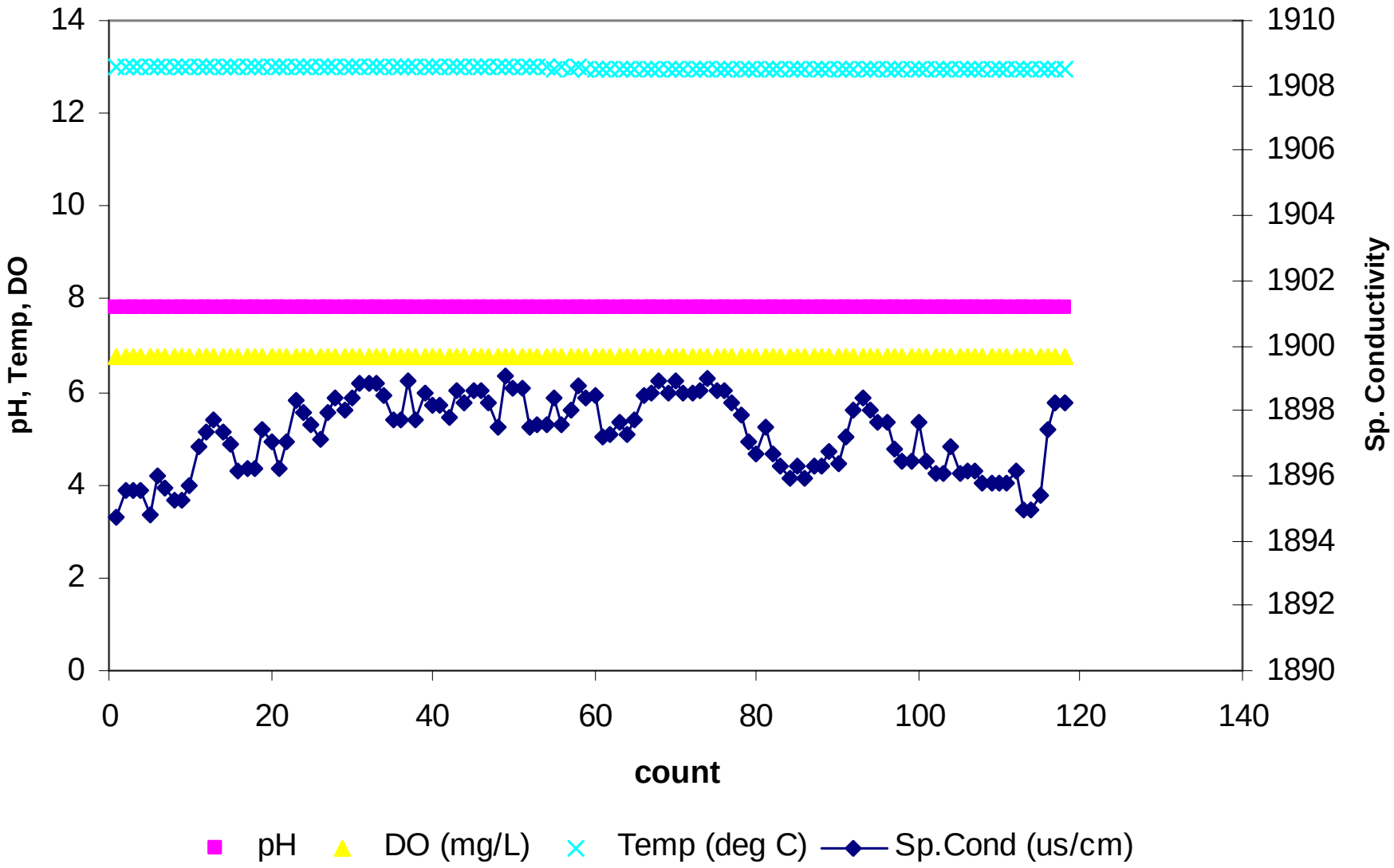
- Target population
- Representativeness
- Completeness
- Data comparability
- Measurement sensitivity
- Measurement systematic error/bias

Target Population

Depends on monitoring objectives

47 Sites in 11 parks

Representativeness



Completeness

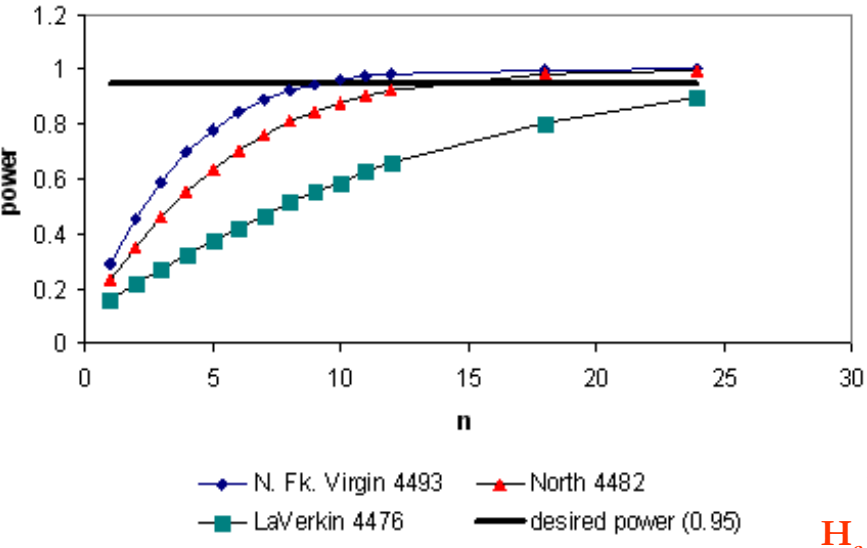
- Depends on objectives
  - Compliance
    - In UT parks 10 of 12 months required for beneficial use assessment
  - Trend assessment
    - 10-20 site visits to detect a 30% change in mean
    - The more you miss the longer it takes!

Power for Trend related to completeness, detectable differences, and magnitude of change

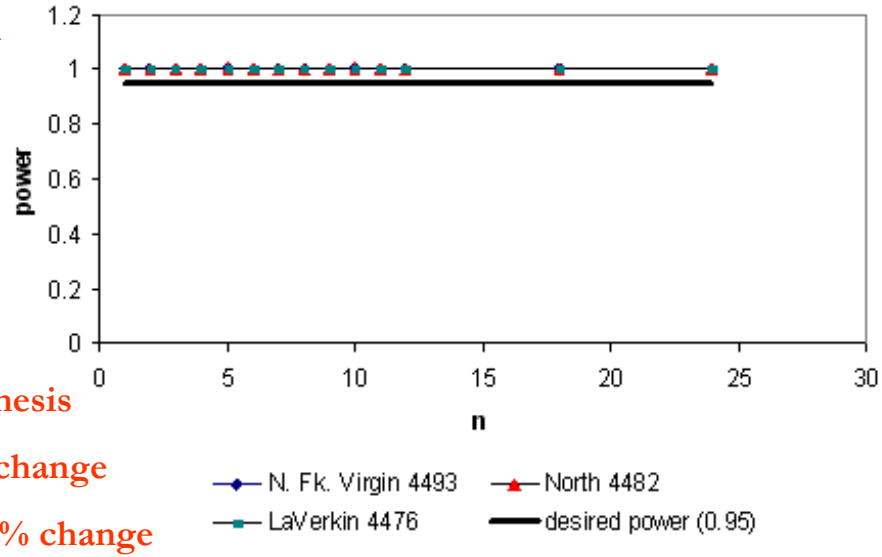
Will we be able to state with confidence that change is occurring and if so how much?

Ability to detect a 30% change in mean

Historic
Specific Conductivity



Historic
pH



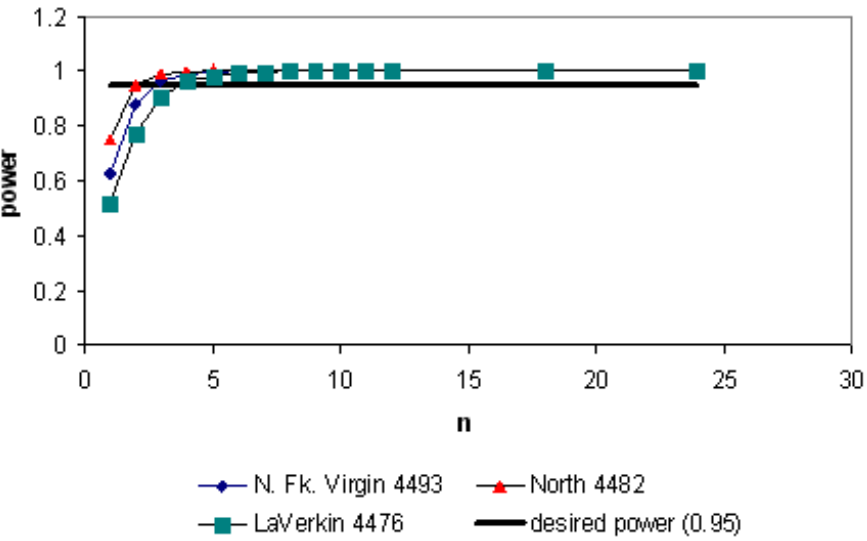
Hypothesis

H_o = no change

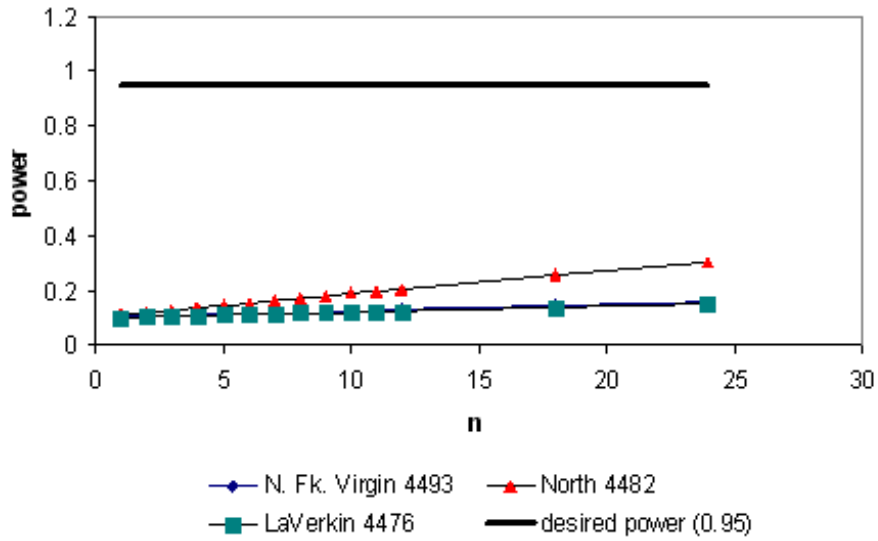
H_a = +/- 30% change

Power = probability of rejecting H_o when H_a is true

Historic
DO



Historic
Ortho P



Comparability

- Internal
  - Staff, equipment, methods change over time
  - Follow guidelines in protocols to minimize bias
  - Careful calibration
  - Assess bias formally
- External
  - Use NIST traceable standards
  - WRD / USGS calibration error checks

Comparability - WRD Error Check for Core Parameters

CORE PARAMETER	Sensor Measurement (acceptance/rejection criteria)	Optimum Goal/Target (Range) (USGS criteria)
Temperature	± 0.3 º C	± 0.2 º C
Specific Conductance	± 5 µS/cm or ± 3%	± 5 µS/cm or ±3%
pH	± 0.3 S.U.	± 0.2 S.U.
Dissolved Oxygen	± 0.4 mg/L, ± 5% saturation	± 0.3 mg/L, ± 3% saturation

Comparability - premobilization instrument check

Microsoft Excel - 25Field_forms_08_jan.xls

File Edit View Insert Format Tools Data Window S-PLUS Help Adobe PDF

V19

	A	B	C	D	E	F	G	H	I	J	K	L
1	**Pre-Mobilization MP Instrument (Calibration) Log Book:**											
2	Customized for version 4.57.0.0 pocket situ for Troll 9500											
3	**Date**											
4	**Start time**	13:25	**End time**	11:47	**Port**	**Sensor**		**Sensor ID**			**mfg date**	**port**
5	**Operator**		Thoma			Temperature		platinum resistance thermistor				
6	**Inst. Mfr.**		Insitu		4	Conductivity		LC04780	Low	range	1/5/2007	4
7	**Sonde serial number**		45770		1,2, or 3	pH		PH03343			11/7/2006	1
8	**Model**		Troll 9500		2	Diss. Ox.		DX04308			7/21/2005	2
9	**Display**		Rugged Reader			Barometric Press.		Piezoresistive silicon pressure sensor				
10	**Display voltage (%)**		100.00			poly vented cable		207858				
11	**Sonde (v)**		3.02									
12	**Sondepower (%)**		100									
13	**Notes:**											
14		Insitu programmers didn't update the sonde model to 9500 reported in pocket situ										
15	**Error Check Solution: Sink water with aquarium bubbler**											
16												
17	**Pre-Cal. Measurements**							**Post-Cal. Measurements**				
18	MP temp °F			61.65				MP temp °F		61.64		
19	NIST Thermometer °C			16.5				NIST Thermometer °C		16.5		
20												
21												
22	Actual SC (us/cm)			159.56				Actual SC (us/cm)		84.3266		
23	pH			8.05				pH		8.19		
24	DO (mg/L)			8.683				DO (mg/L)		7.118		
25	BP (mmHg)			660.3432				BP (mmHg)		658.647		
26												
27				**%Error**	**Allowable?**				**%Error**	**Allowable?**		
28	**Temperature error check**		**precal**	0.0450572	yes			**post cal**	0.0540774	yes		
29												
30	**pre-mob_pre file name**		1-15-08-pre2					**pre_mob_post file name**		1-15-08-post		
31												
32	**Specific Conductance Calibration (1413 µS/cm std.) & Error Check @ 100 and 10,000 µS/cm**											
33	**Pre-Cal. Reading (us/cm)**											
34	**Standard**	**reading**	**lot #**	**Exp**	**maker**	**Cat #**		**Post-Cal. Readi**	**%Error**	**Allowable?**		
35	**147**	161	7040210	Apr-08	qua Solution	5836-32		155	-5.44	no		
36	**1413**	[illegible]	[illegible]	[illegible]	qua Solution	[illegible]		[illegible]	[illegible]	yes		
37	**12,880**	12336	7010377	Jan-08	qua Solution	5834-32		12397	3.75	no		
38												
39	**post calibration cell constant**											
40	**Kcell**	0.323348				**Post calibration error check on solutions used in field last month**						
41	acceptable low range conductivity Kcell between		0.34 and 0.4			**Standard**	**reading**	**%Error**	**Allowable?**			
42	acceptable high range conductivity Kcell between		5.1 and 5.7			**1413**	1413	0.00	yes			
43	**maintenance needed?**		yes									
44												
45	notes:											
46												
47												
48												

Two functions

1) Error check

2) AMS = 3.708 * $Stdev_7$

where 3.708 = the 99% confidence middle t value for sample size 7

Measurement Sensitivity

	Manufacturer Specs	Long-run 2yr average (AMS)
Temp (°C)	± 0.1	± 0.02 °C
SC (us/cm)	± 0.5% or 2 µS/cm	± 2.69 µS/cm
pH	± 0.09 pH units	± 0.02 pH
DO (mg/L)	± 0.2 mg/L	± 0.29 mg/L

AMS = 3.708 * $Stdev_7$
99% confidence
interval around mean

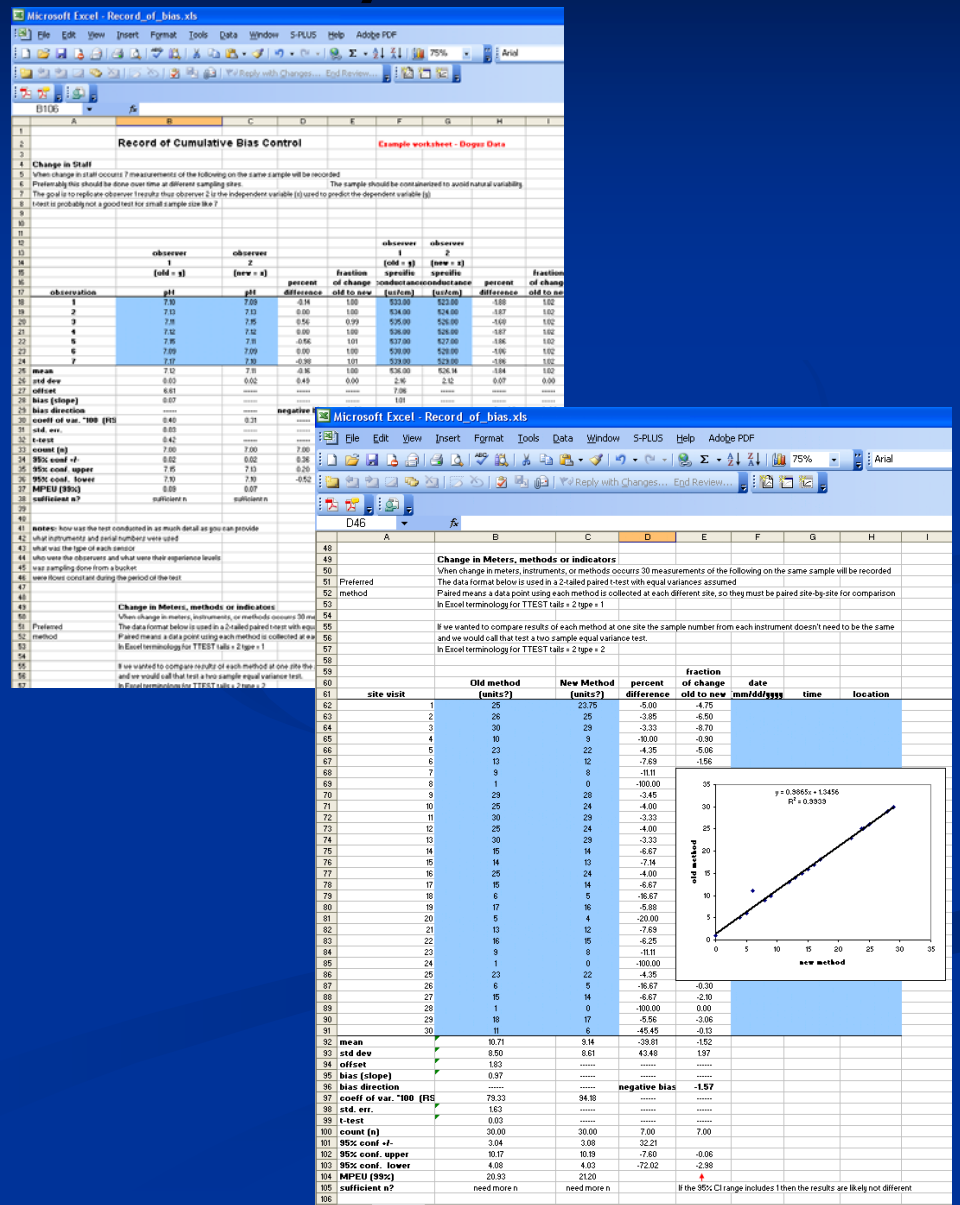
		Example AMS calculation			
	DO	Baro. Press.	Spc. Cond	Water	pH
Reading #	(mg/L)	(mm Hg)	(uS/cm@25 °C)	temp °C	unitless
1	4.75	573.02	525.43	19.46	7.61
2	4.75	573.05	525.59	19.46	7.61
3	4.75	573.05	525.92	19.46	7.61
4	4.75	573.05	525.75	19.46	7.61
5	4.74	573.05	526.03	19.46	7.61
6	4.74	573.02	525.79	19.47	7.61
7	4.74	573.05	525.79	19.48	7.61
AMS	0.018	0.046	0.740	0.026	0.000

Alternative Meas. Sensitivity (AMS)

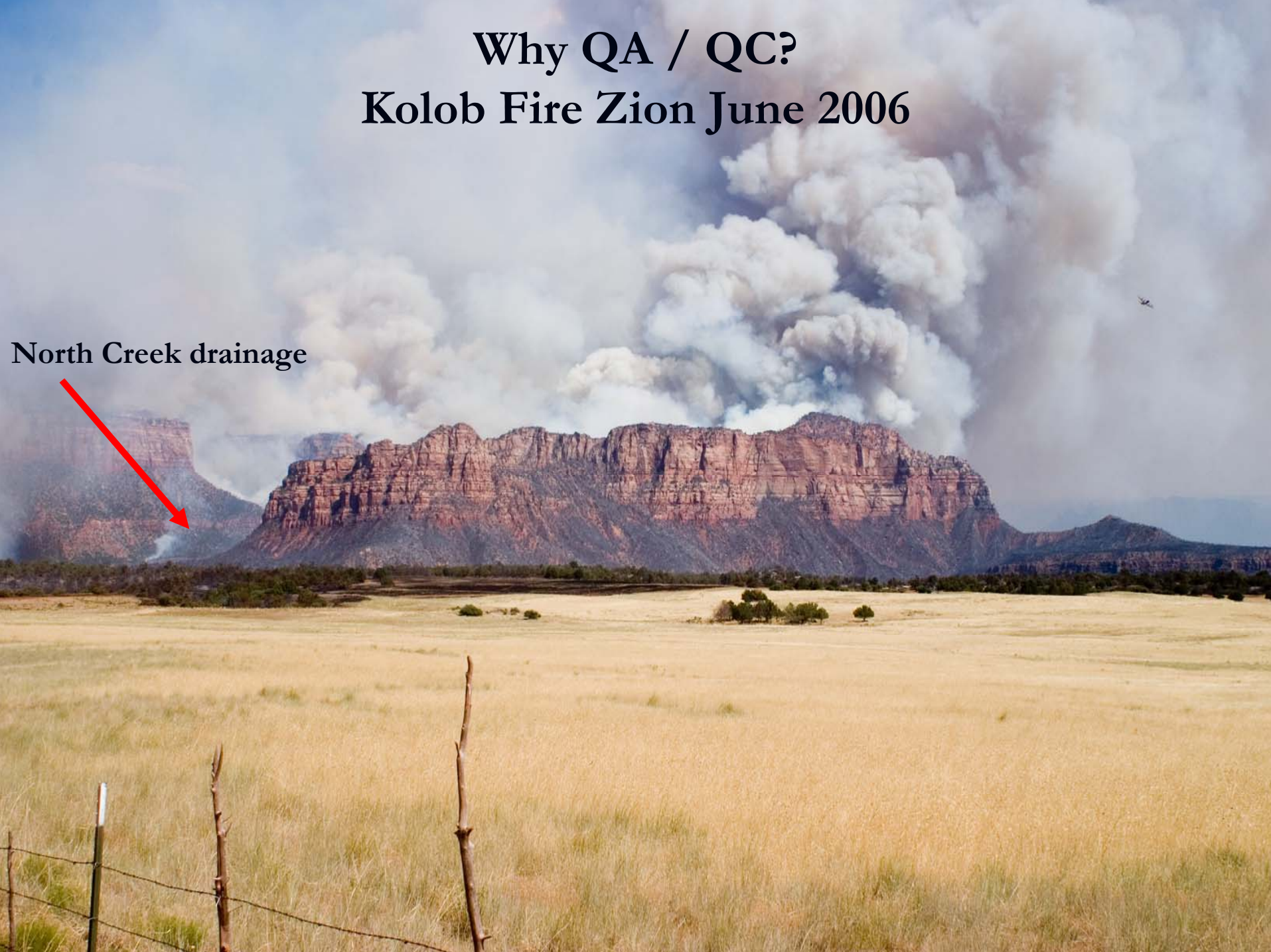
Alternative Meas. Sensitivity (AMS+)

Systematic Error / Bias

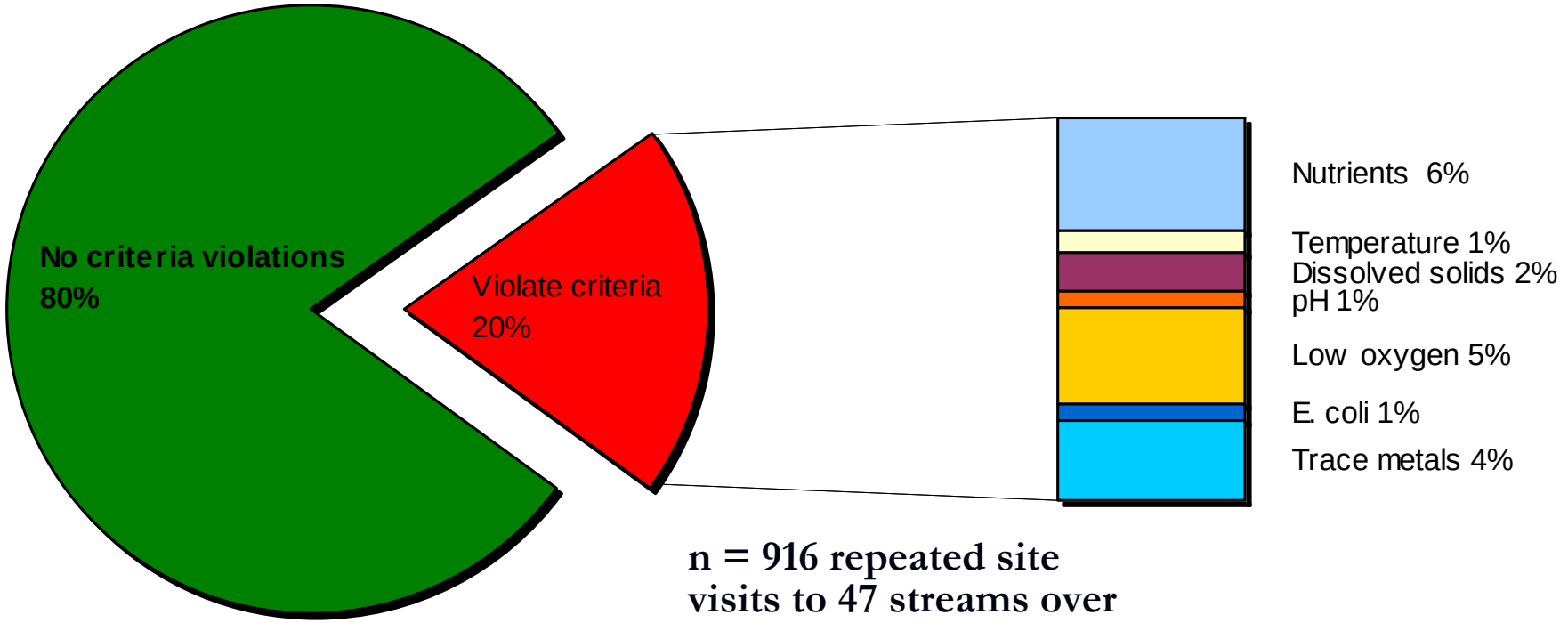
- Assess effect of change
  - Staff
  - Meters
  - Methods
  - Indicators
- Part B Lite
  - Lots of guidance programmed into this spreadsheet



Why QA / QC?
Kolob Fire Zion June 2006

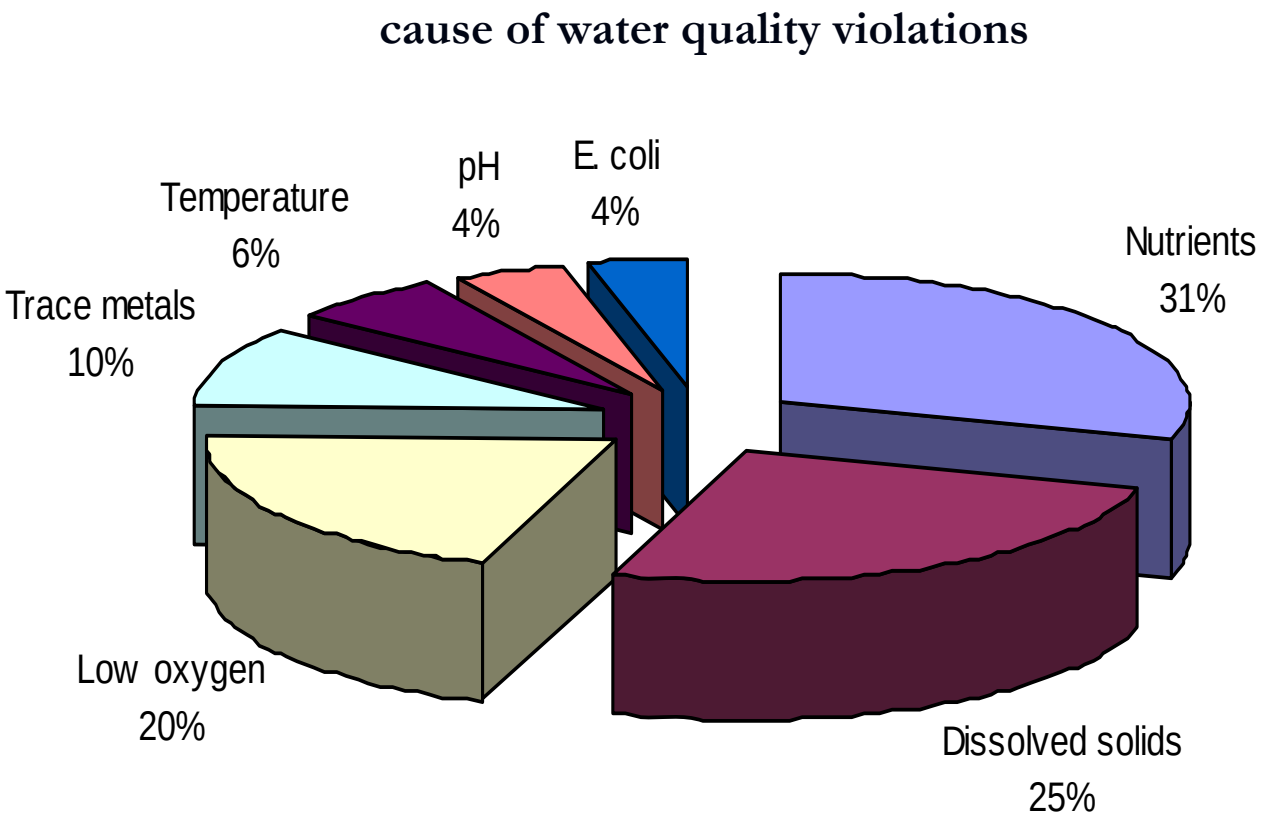


Resource Assessment cont.
Network-wide frequency of impairment



n = 916 repeated site visits to 47 streams over a 2 year period

Resource Assessment cont.
NCPN-wide cause of impairment



n = 181 criteria violations over a 2 year period

Conclusions

- Assure data quality by…
  - Selecting target population and sticking with it
  - Sampling representatively and completely
  - Sampling with calibrated equipment
    - Know how and when to maintain equipment
  - Calculating measurement sensitivity
    - Allows reporting with known levels of confidence
  - Guarding against bias
    - Almost any change can introduce bias
- Feel free to borrow spreadsheet templates for
  - Premobilization error check
  - AMS (+) calculations
  - Bias assessment

http://www.nature.nps.gov/im/units/ncpn