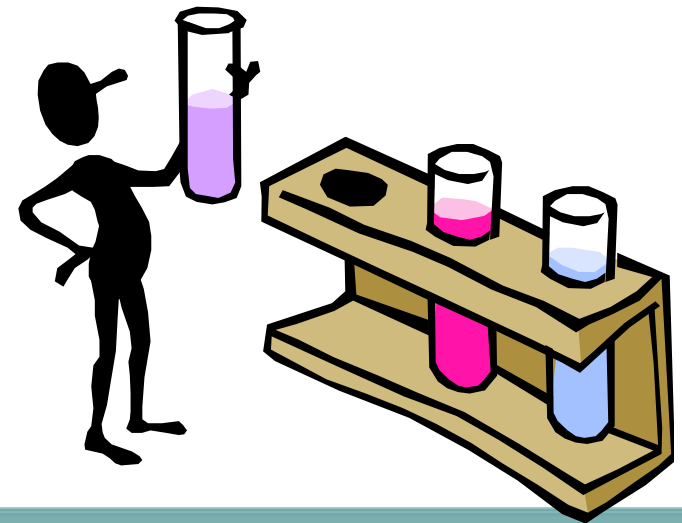




FT 1000 – FT 3000 Field Testing

Collecting data in the field

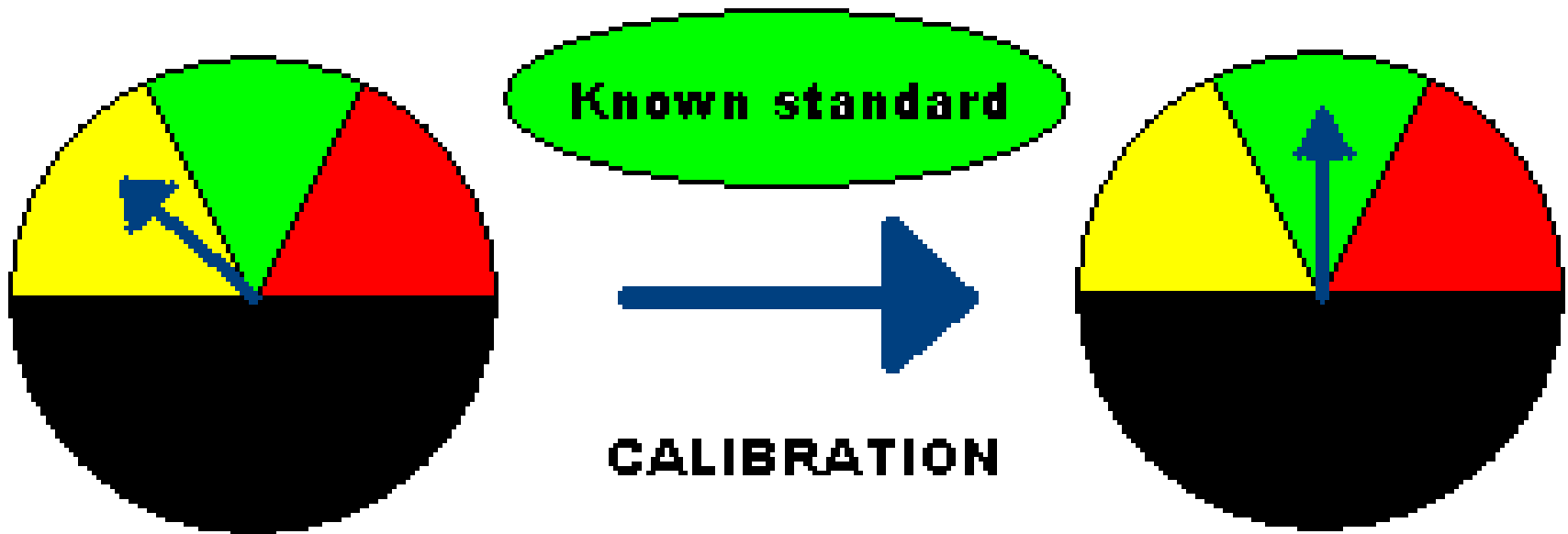
- Calibration of instruments
- Verification of instruments
- Documentation





Calibration:

Changing the reading of an instrument by setting it to a known standard.





Verification:

Reading the instrument with a known standard as if it were a sample.

★ Accept/reject reading based on acceptance criterion.



WHY VERIFY?

- Instrument calibrations are not always reliable or stable due to drift or other errors
- Establishes chronological and quantitative brackets for the sample measurements



Bracketing

- Chronological:

Calibration & verification

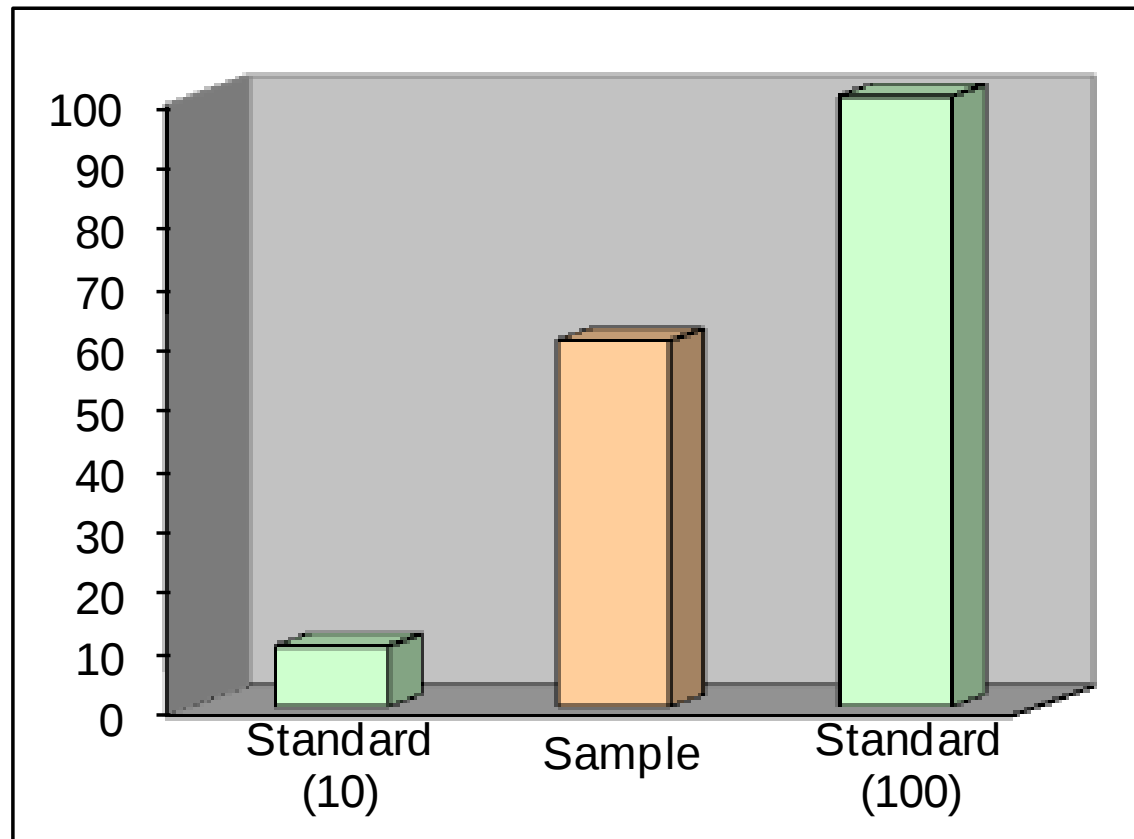
verification





Bracketing

- Quantitative:





FT 1000 – FT 3000 Field Testing SOPs

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen
- Turbidity
- Residual Chlorine
- Salinity
- Transparency
- Continuous Monitoring
- Aquatic Habitat Characterization
- Water Flow





Critical Documentation

- Meter identification code (e.g., DEP property tag number on sonde)
- Date and time of calibration, verification or sample measurement
- Specific data associated with each parameter (pH, SC, DO, turbidity, temp)



Calibration procedure/tips

- Order for calibration/verification:
Conductivity, pH, DO



Calibration procedure/tips

- Conductivity: 1-point calibration
 - 100 μmhos standard sufficient for quantitative bracket if sample values < 100 .
- pH: 2-point calibration
 - Start with 7
- DO
 - Calibrating with 100% humid air
 - Ensure that the temperature is stable



Field Testing Acceptance Criteria per DEP-SOP-001/01

Parameter	Acceptance Criteria
pH	± 0.2 Standard pH Units of calibration buffer
Specific Conductance	$\pm 5\%$ of calibration standard value
Dissolved Oxygen	± 0.3 mg/L of theoretical value
Temperature	± 0.5 °C. of NIST-traceable value (with correction factors) Verification over range of sample values
Turbidity	0.1-10 NTU: $\pm 10\%$ of the calibration standard 11-40 NTU: $\pm 8\%$ of the calibration standard 41-100 NTU: $\pm 6.5\%$ of the calibration standard > 100 NTU: $\pm 5\%$ of the calibration standard
Total Residual Chlorine	0.995 calibration curve correlation coefficient $\pm 10\%$ of primary calibration standard value $\pm 10\%$ of secondary standard value



FT 1100 - pH

- Measure of hydrogen ion activity, based on negative log of hydrogen ion concentration
- pH greatly affects biochemical reactions
- Blackwater and surficial aquifer systems are usually < 6 SU
- Springs and estuaries, 7.5 to 8 SU
- Lakes with algae blooms, >8





FT 1100 pH



Rinse probe with deionized water



FT 1200 - Specific Conductance

- Measures the ability of water to conduct an electric current, from inorganic ions, including Na, Cl, Mg, Ca, SO₄, etc.
- Surface runoff systems < 100 umhos/cm
- Springs, ~250-500 umhos/cm
- Estuaries >1500 umhos/cm
- Urban stormwater increases conductivity
- Many sensitive freshwater organisms decline with increasing conductivity





FT 1200 Specific Conductance

- Ensure stable temperature prior to calibration, verification or sample measurement
- High-conductivity residue from previous sample will affect subsequent sample measurement
- Rinse probe between standards

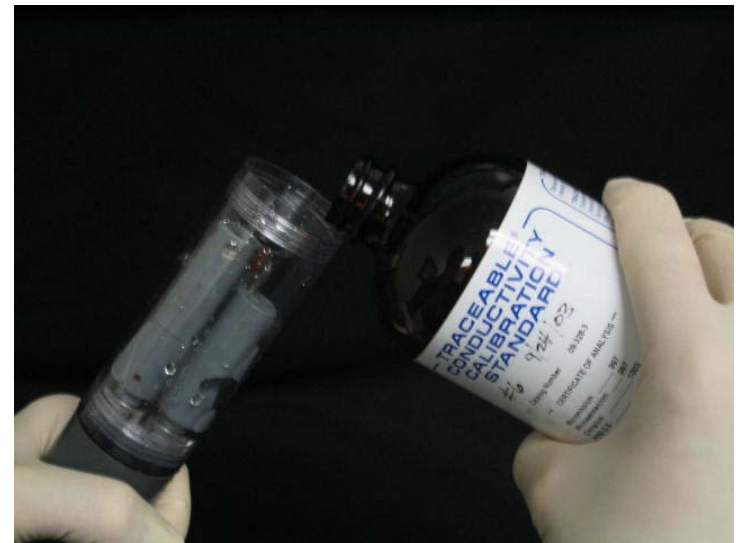
FT 1200 Specific Conductance



Rinse probe with deionized water

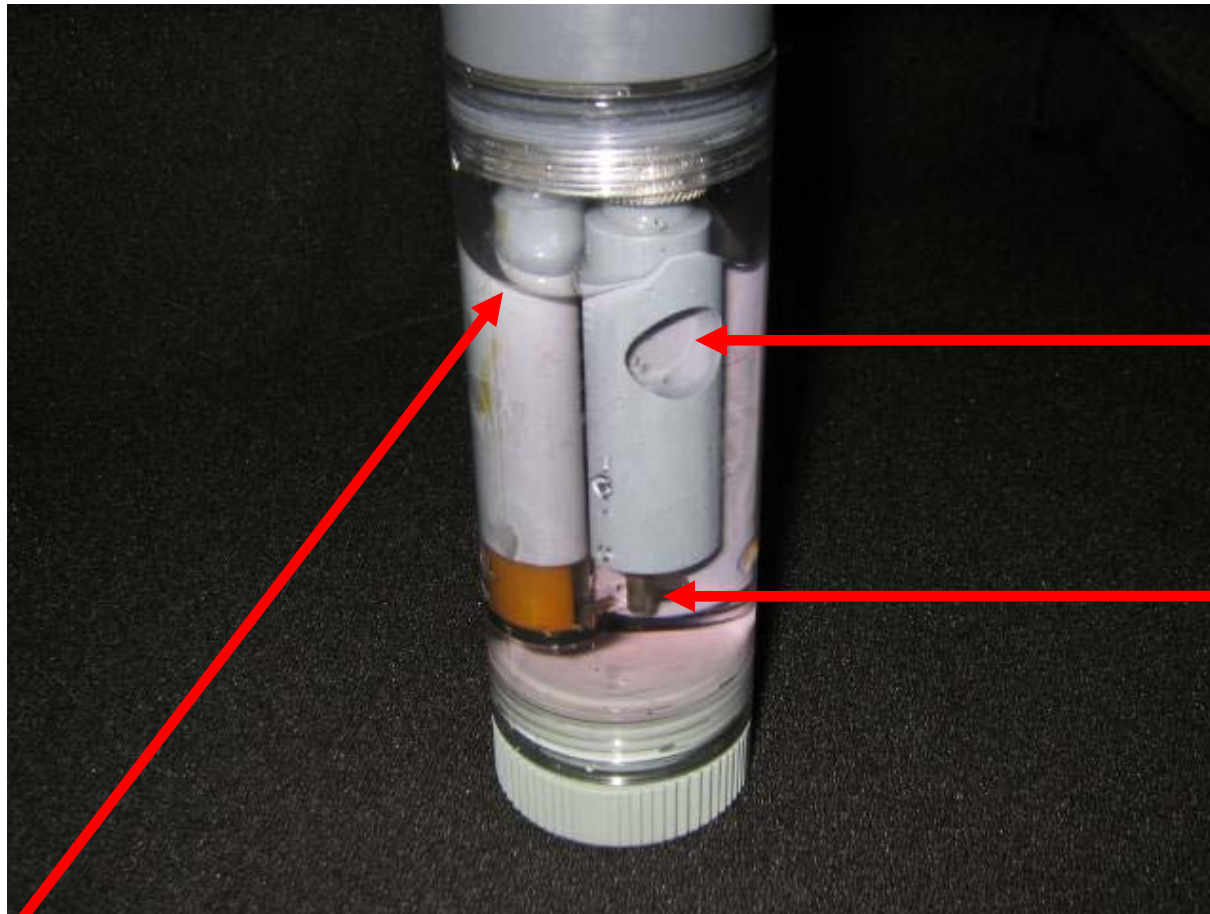


Ensure stable temperature



Rinse probe with aliquot of standard and discard

FT 1200 Specific Conductance



**Vent
hole**

**Ensure
thermometer
is submersed**

Ensure probe is completely submersed with sample or standard



FT 1400 - Temperature

- Verify field-temperature devices against NIST-traceable thermometer
- Bracket sample measurements with appropriate verification temperatures
- Verify at demonstrated time intervals
- Document all deviations from NIST thermometer verification values
- Measure samples *in situ*

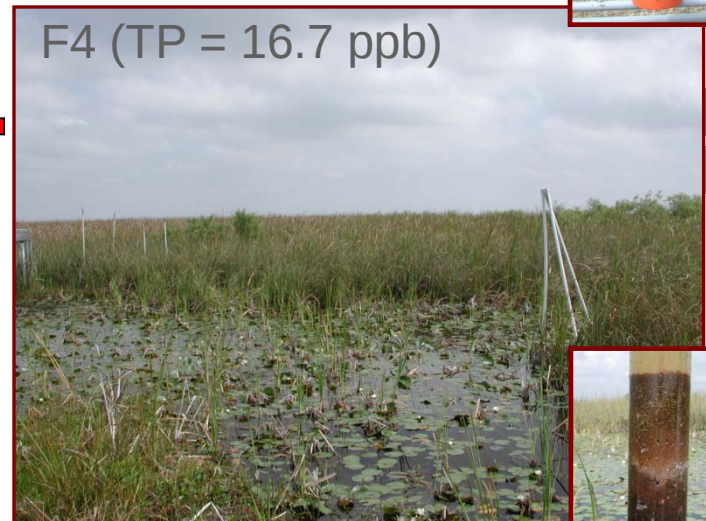
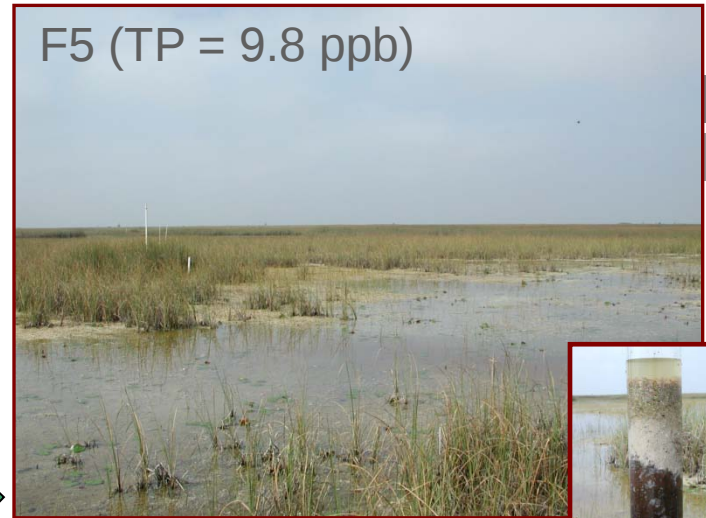
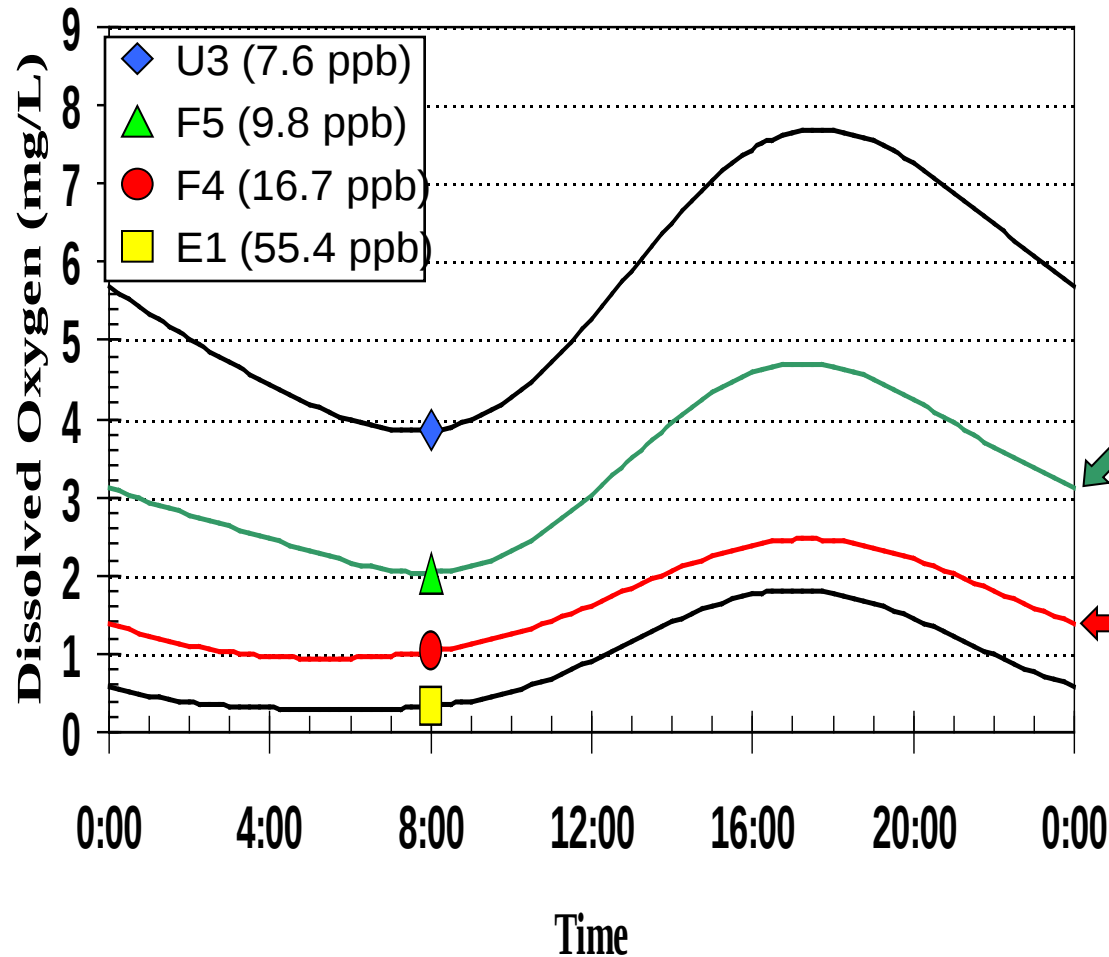




FT 1500 - Dissolved Oxygen

- A measure of ecosystem function (P/R ratio)
- Necessary to support aquatic life
- Amount of DO saturated in water depends on temperature and conductivity/salinity
- 5 mg/L is freshwater WQ standard, but some natural systems (*e.g.*, springs, swamps) are lower

Nutrient Enrichment Depresses Diel Fluctuations





FT 1500 DO Sample Measurement

- Select representative sampling point
- Ensure flow of refreshed sample around probe
- Stabilize reading before recording
- Unstable readings indicate temperature fluctuation or malfunction
- Low readings may indicate anoxic water column near sediments
- Hydrogen sulfide damages electrode



FT 1500 DO Calibration

Enclose probe in water-saturated air chamber



Set atmospheric pressure value (760 mm Hg) to calibrate



Measure air chamber to perform calibration





FT 1500 DO Verification

Enclose probe in water-saturated air chamber

Measure air chamber to perform verification

Look up display reading in
saturation table (or calculate) to
determine acceptable verification
(0.3 mg/L)

Measure samples

Perform next verification



Table FS 2200-2
Dissolved Oxygen Saturation

TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%
15.0	10.084	2.017	19.0	9.276	1.855	23.0	8.578	1.716	27.0	7.968	1.594
15.1	10.062	2.012	19.1	9.258	1.852	23.1	8.562	1.712	27.1	7.954	1.591
15.2	10.040	2.008	19.2	9.239	1.848	23.2	8.546	1.709	27.2	7.940	1.588
15.3	10.019	2.004	19.3	9.220	1.844	23.3	8.530	1.706	27.3	7.926	1.585
15.4	9.997	1.999	19.4	9.202	1.840	23.4	8.514	1.703	27.4	7.912	1.582
15.5	9.976	1.995	19.5	9.184	1.837	23.5	8.498	1.700	27.5	7.898	1.580
15.6	9.955	1.991	19.6	9.165	1.833	23.6	8.482	1.696	27.6	7.884	1.577
15.7	9.934	1.987	19.7	9.147	1.829	23.7	8.466	1.693	27.7	7.870	1.574
15.8	9.912	1.982	19.8	9.129	1.826	23.8	8.450	1.690	27.8	7.856	1.571
15.9	9.891	1.978	19.9	9.111	1.822	23.9	8.434	1.687	27.9	7.842	1.568
16.0	9.870	1.974	20.0	9.092	1.818	24.0	8.418	1.684	28.0	7.828	1.566
16.1	9.849	1.970	20.1	9.074	1.815	24.1	8.403	1.681	28.1	7.814	1.563
16.2	9.829	1.966	20.2	9.056	1.811	24.2	8.387	1.677	28.2	7.800	1.560
16.3	9.808	1.962	20.3	9.039	1.808	24.3	8.371	1.674	28.3	7.786	1.557
16.4	9.787	1.957	20.4	9.021	1.804	24.4	8.356	1.671	28.4	7.773	1.555
16.5	9.767	1.953	20.5	9.003	1.801	24.5	8.340	1.668	28.5	7.759	1.552
16.6	9.746	1.949	20.6	8.985	1.797	24.6	8.325	1.665	28.6	7.745	1.549
16.7	9.726	1.945	20.7	8.968	1.794	24.7	8.309	1.662	28.7	7.732	1.546
16.8	9.705	1.941	20.8	8.950	1.790	24.8	8.294	1.659	28.8	7.718	1.544
16.9	9.685	1.937	20.9	8.932	1.786	24.9	8.279	1.656	28.9	7.705	1.541
17.0	9.665	1.933	21.0	8.915	1.783	25.0	8.263	1.653	29.0	7.691	1.538
17.1	9.645	1.929	21.1	8.898	1.780	25.1	8.248	1.650	29.1	7.678	1.536
17.2	9.625	1.925	21.2	8.880	1.776	25.2	8.233	1.647	29.2	7.664	1.533
17.3	9.605	1.921	21.3	8.863	1.773	25.3	8.218	1.644	29.3	7.651	1.530
17.4	9.585	1.917	21.4	8.846	1.769	25.4	8.203	1.641	29.4	7.638	1.528
17.5	9.565	1.913	21.5	8.829	1.766	25.5	8.188	1.638	29.5	7.625	1.525
17.6	9.545	1.909	21.6	8.812	1.762	25.6	8.173	1.635	29.6	7.611	1.522
17.7	9.526	1.905	21.7	8.794	1.759	25.7	8.158	1.632	29.7	7.598	1.520
17.8	9.506	1.901	21.8	8.777	1.755	25.8	8.143	1.629	29.8	7.585	1.517
17.9	9.486	1.897	21.9	8.761	1.752	25.9	8.128	1.626	29.9	7.572	1.514
18.0	9.467	1.893	22.0	8.744	1.749	26.0	8.114	1.623	30.0	7.559	1.512
18.1	9.448	1.890	22.1	8.727	1.745	26.1	8.099	1.620	30.1	7.546	1.509
18.2	9.428	1.886	22.2	8.710	1.742	26.2	8.084	1.617	30.2	7.533	1.507
18.3	9.409	1.882	22.3	8.693	1.739	26.3	8.070	1.614	30.3	7.520	1.504
18.4	9.390	1.878	22.4	8.677	1.735	26.4	8.055	1.611	30.4	7.507	1.501
18.5	9.371	1.874	22.5	8.660	1.732	26.5	8.040	1.608	30.5	7.494	1.499
18.6	9.352	1.870	22.6	8.644	1.729	26.6	8.026	1.605	30.6	7.481	1.496
18.7	9.333	1.867	22.7	8.627	1.725	26.7	8.012	1.602	30.7	7.468	1.494
18.8	9.314	1.863	22.8	8.611	1.722	26.8	7.997	1.599	30.8	7.456	1.491
18.9	9.295	1.859	22.9	8.595	1.719	26.9	7.983	1.597	30.9	7.443	1.489

Derived using the formula in Standard Methods for the Examination of Water and Wastewater, Page 4-101, 18th Edition, 1992



FT 1500 Dissolved Oxygen



Inspect membrane



Ensure stable temperature

Vent to atmosphere



Enclose with saturated air



FT 1500 - Critical Documentation

- Verification reading (mg/L)
- Verification temperature
- Expected saturation value (mg/L)
- Calculated deviation from expected saturation value

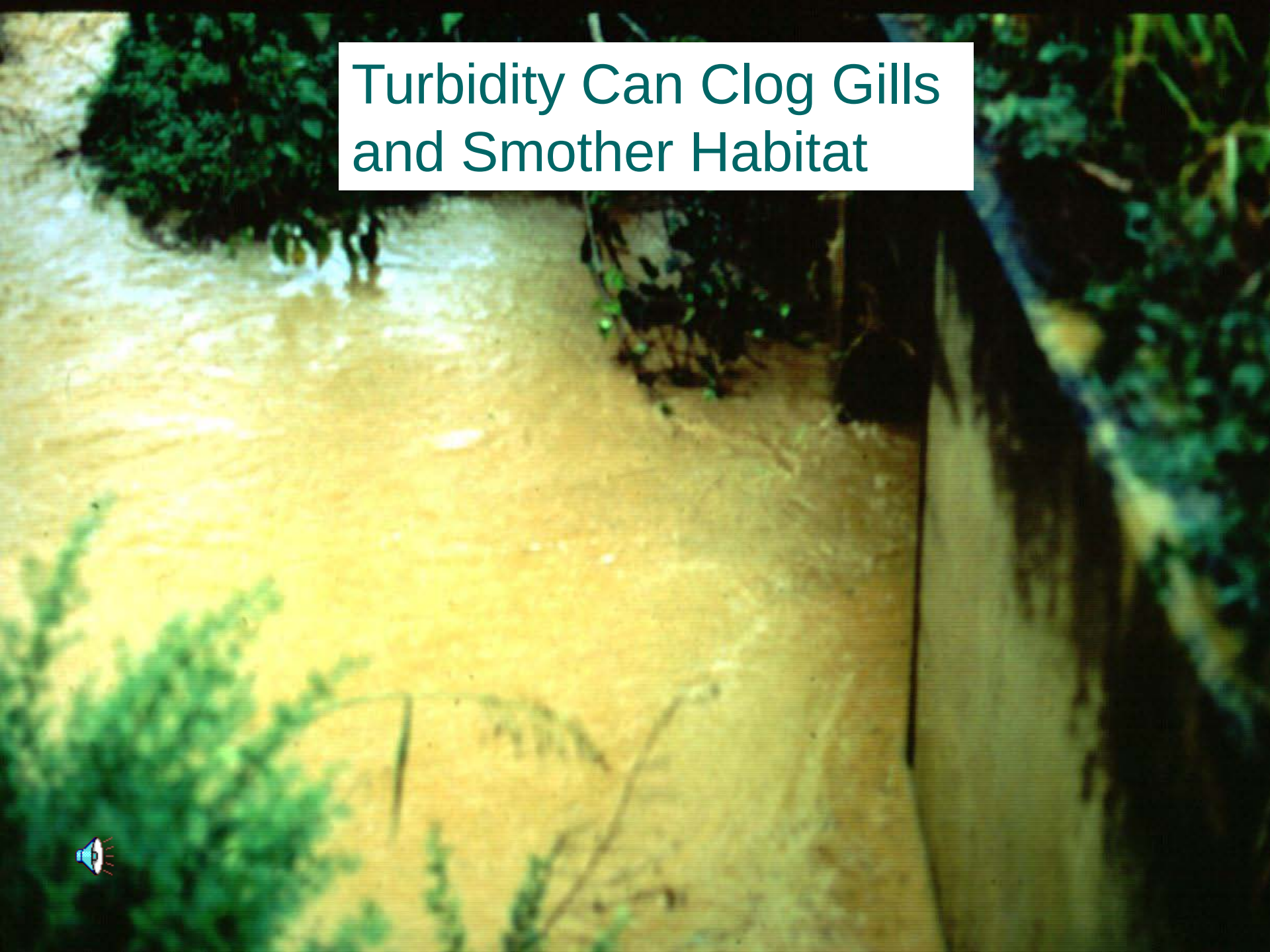


FT 1600 - Turbidity

- Measures light dispersion caused by suspended particulates in water column
- Turbidity can reduce light penetration and clog gills of fish and invertebrates
- As turbid particles settle, they smother habitat, reducing substrate quality and preventing fish spawning
- 29 NTU above background is WQ standard



Turbidity Can Clog Gills and Smother Habitat





FT 1600 - Turbidity

- Hand-held turbidimeter typically used
- Primary standards for initial calibration
- Secondary standards for everyday use



Settled formazin



**Gel standard
(Use for field verification)**



Secondary Turbidity Standards

- ***Secondary verification*** standards only
- Typically manufacturer-specific
- Field-rugged for routine use
- Assign values using calibrated meter
- Verify against manufacturer tolerances
- Discard when no longer verifiable



FT 1000 & FT 1600





FT 2000 – Residual Chlorine

- Typically done with hand-held meter
- Secondary standards for everyday use



Secondary Standards

★ For chlorine and turbidity





What is this?

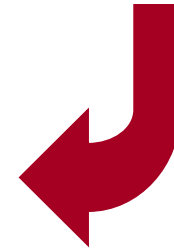
“READ”



DPD-CHLORINE
CERTIFICATE OF ANALYSIS

	Lot	Test Value/Tolerance	Instrument Reading
BLANK	96	Zero Instrument	Zero
STD 1	82	0.18 ± 0.02 mg/l Chlorine	
STD 2	82	0.81 ± 0.10 mg/l Chlorine	
STD 3	82	1.42 ± 0.11 mg/l Chlorine	

User Instrument Identification: _____
Reported by: _____





FT 1900 Continuous Monitoring

- Same calibration, verification, and bracketing rules apply
- Calibration prior to installation
- Daily verification can be done with grab sample
- Maximum period between verifications – 1 month



FT 1900 Continuous Monitoring

- If verification fails-
 - Perform instrument maintenance and reduce time interval.
 - Perform initial calibration when instrument is taken off-line, after preventative maintenance, immediately after criteria verifications are not met.
- DO probes most problematic
 - e.g., Clark Cell holds 4 days, optical hold 1 month



CALIBRATION LOG (FDEP SOP FT 1000-FT 1500, FD 1000-FD 4000)

11-10-05 version

Boldly "X" this box if there is qualified data on this page.

Project/Site: _____ Date: _____ Meter # _____

Temperature (Quarterly) For Date of Last Temperature Verification see _____ in log book

Dissolved Oxygen	DEP SOP FT 1500	Initials	Date	Time	Probe Charge	Probe Gain	mg/L	Temp °C	% DO	Saturation mg/L (from chart)	Pass or Fail
Acceptance Criteria: +/- 0.3mg/l											
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F

Specific Conductance	DEP SOP FT 1200	Initials	Date	Time	Standard µmhos/cm	Exp. Date	Lot #	Bottle #	Cell Constant	Reading µmhos/cm	Pass or Fail
Acceptance Criteria: +/- 5%											
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F

pH	DEP SOP FT 1100	Initials	Date	Time	Standard SU	Exp. Date	Lot #	Bottle #	Slope	Reading SU	Pass or Fail
Acceptance Criteria: +/- 0.2 SU											
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F
CAL ICV CCV											P F

Maintenance: Weekly pH Slope: _____ Specific Conductance Probe Cleaned? Yes No Dissolved Oxygen Membrane Changed: Yes

Notes:

Sample measurements: TREEO pond						
Date	Time	Depth (m)	Temp. (°C)	pH (SU)	Cond. (UMHO/CM)	DO (mg/L)

Perform only in Calibrate Mode: **CAL** - Calibrate -
 Perform only in Run Mode: **ICV** - Initial Calibration Verification
 Perform only in Run Mode: **CCV** - Continuing Calibration Verification

Test Your Knowledge

CALIBRATION LOG (FDEP SOP FT 1000-FT 1500, FD 1000-FD 4000)

11-10-05 version

Project/Site: RQ 2005-05-16-39 Otter and Hiawatha Lake Samples

Date: 5/19/2005

Meter # 7321

Temperature (Quarterly) For Date of Last Temperature Verification see _____ in log book _____											
Dissolved Oxygen	DEP SOP FT 1500	Initials	Date	Time	Probe Charge	Probe Gain	mg/L	Temp °C	% DO	Saturation mg/L (from chart)	Pass or Fail
Acceptance Criteria: ± 0.3 mg/L											
CAL	ICV	CCV	OJT	5/19/2005	1310	41.0	0.782	8.05	24.0	95.6	8.418 P F
CAL	ICV	CCV	OJT	5/19/2005	1312	41.0	0.782	8.39	23.8	99.3	8.450 P F
CAL	ICV	CCV	OJT	5/20/2005	0715	41.0	0.782	8.32	24.6	99.9	8.325 P F
CAL	ICV	CCV	OJT	5/21/2005	0842	40.4	0.723	8.62	22.4	99.3	8.677 P F
CAL	ICV	CCV									P F
CAL	ICV	CCV									P F
CAL	ICV	CCV									P F
Specific Conductance	DEP SOP FT 1200	Initials	Date	Time	Standard μ mhos/cm	Exp. Date	Lot #	Bottle #	Cell Constant	Reading μ mhos/cm	Pass or Fail
Acceptance Criteria: $\pm 5\%$											
CAL	ICV	CCV	OJT	5/19/2005	1325	1425.0	7/4/2006	3346	3	4.93	1424 P F
CAL	ICV	CCV	OJT	5/20/2005	1327	1425.0	7/4/2006	3346	3	4.93	1404 P F
CAL	ICV	CCV	OJT	5/21/2005	1340	1425.0	7/4/2006	3346	3	4.93	1410 P F
CAL	ICV	CCV									P F
CAL	ICV	CCV									P F
CAL	ICV	CCV									P F
CAL	ICV	CCV									P F
pH	DEP SOP FT 1100	Initials	Date	Time	Standard SU	Exp. Date	Lot #	Bottle #	Slope	Reading SU	Pass or Fail
Acceptance Criteria: ± 0.2 SU											
CAL	ICV	CCV	OJT	5/19/2005	1357	7.00	2/2007	050540-24	2	7.00	P F
CAL	ICV	CCV	OJT	5/19/2005	1401	4.00	5/2006	041616-24	5	3.99	P F
CAL	ICV	CCV	OJT	5/20/2005	1500	10.00	2/2007	050539-24	6	10.02	P F
CAL	ICV	CCV	OJT	5/21/2005	0915	7.00	5/2006	041616-24	5	3.92	P F

Sample Measured at 1400 on 5/20/2005

pH= 7.31 SU DO= 5.50 mg/L Cond= 87 umhos/cm

Table FS 2200-2
Dissolved Oxygen Saturation

TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%	TEMP deg C	D.O. SAT.	mg/L 20%
15.0	10.084	2.017	19.0	9.276	1.855	23.0	8.578	1.716	27.0	7.968	1.594
15.1	10.062	2.012	19.1	9.258	1.852	23.1	8.562	1.712	27.1	7.954	1.591
15.2	10.040	2.008	19.2	9.239	1.848	23.2	8.546	1.709	27.2	7.940	1.588
15.3	10.019	2.004	19.3	9.220	1.844	23.3	8.530	1.706	27.3	7.926	1.585
15.4	9.997	1.999	19.4	9.202	1.840	23.4	8.514	1.703	27.4	7.912	1.582
15.5	9.976	1.995	19.5	9.184	1.837	23.5	8.498	1.700	27.5	7.898	1.580
15.6	9.955	1.991	19.6	9.165	1.833	23.6	8.482	1.696	27.6	7.884	1.577
15.7	9.934	1.987	19.7	9.147	1.829	23.7	8.466	1.693	27.7	7.870	1.574
15.8	9.912	1.982	19.8	9.129	1.826	23.8	8.450	1.690	27.8	7.856	1.571
15.9	9.891	1.978	19.9	9.111	1.822	23.9	8.434	1.687	27.9	7.842	1.568
16.0	9.870	1.974	20.0	9.092	1.818	24.0	8.418	1.684	28.0	7.828	1.566
16.1	9.849	1.970	20.1	9.074	1.815	24.1	8.403	1.681	28.1	7.814	1.563
16.2	9.829	1.966	20.2	9.056	1.811	24.2	8.387	1.677	28.2	7.800	1.560
16.3	9.808	1.962	20.3	9.039	1.808	24.3	8.371	1.674	28.3	7.786	1.557
16.4	9.787	1.957	20.4	9.021	1.804	24.4	8.356	1.671	28.4	7.773	1.555
16.5	9.767	1.953	20.5	9.003	1.801	24.5	8.340	1.668	28.5	7.759	1.552
16.6	9.746	1.949	20.6	8.985	1.797	24.6	8.325	1.665	28.6	7.745	1.549
16.7	9.726	1.945	20.7	8.968	1.794	24.7	8.309	1.662	28.7	7.732	1.546
16.8	9.705	1.941	20.8	8.950	1.790	24.8	8.294	1.659	28.8	7.718	1.544
16.9	9.685	1.937	20.9	8.932	1.786	24.9	8.279	1.656	28.9	7.705	1.541
17.0	9.665	1.933	21.0	8.915	1.783	25.0	8.263	1.653	29.0	7.691	1.538
17.1	9.645	1.929	21.1	8.898	1.780	25.1	8.248	1.650	29.1	7.678	1.536
17.2	9.625	1.925	21.2	8.880	1.776	25.2	8.233	1.647	29.2	7.664	1.533
17.3	9.605	1.921	21.3	8.863	1.773	25.3	8.218	1.644	29.3	7.651	1.530
17.4	9.585	1.917	21.4	8.846	1.769	25.4	8.203	1.641	29.4	7.638	1.528
17.5	9.565	1.913	21.5	8.829	1.766	25.5	8.188	1.638	29.5	7.625	1.525
17.6	9.545	1.909	21.6	8.812	1.762	25.6	8.173	1.635	29.6	7.611	1.522
17.7	9.526	1.905	21.7	8.794	1.759	25.7	8.158	1.632	29.7	7.598	1.520
17.8	9.506	1.901	21.8	8.777	1.755	25.8	8.143	1.629	29.8	7.585	1.517
17.9	9.486	1.897	21.9	8.761	1.752	25.9	8.128	1.626	29.9	7.572	1.514
18.0	9.467	1.893	22.0	8.744	1.749	26.0	8.114	1.623	30.0	7.559	1.512
18.1	9.448	1.890	22.1	8.727	1.745	26.1	8.099	1.620	30.1	7.546	1.509
18.2	9.428	1.886	22.2	8.710	1.742	26.2	8.084	1.617	30.2	7.533	1.507
18.3	9.409	1.882	22.3	8.693	1.739	26.3	8.070	1.614	30.3	7.520	1.504
18.4	9.390	1.878	22.4	8.677	1.735	26.4	8.055	1.611	30.4	7.507	1.501
18.5	9.371	1.874	22.5	8.660	1.732	26.5	8.040	1.608	30.5	7.494	1.499
18.6	9.352	1.870	22.6	8.644	1.729	26.6	8.026	1.605	30.6	7.481	1.496
18.7	9.333	1.867	22.7	8.627	1.725	26.7	8.012	1.602	30.7	7.468	1.494
18.8	9.314	1.863	22.8	8.611	1.722	26.8	7.997	1.599	30.8	7.456	1.491
18.9	9.295	1.859	22.9	8.595	1.719	26.9	7.983	1.597	30.9	7.443	1.489

Temperature: 21.6
Reading: 9.08
Theoretical: 8.812
Difference: 0.268

