

Table 3a. Quality objectives for commonly measured stream assessment parameters under the umbrella of the VRMP.

See Table 3b for an explanation of frequency of precision measurements. Accuracy assessments will be made at the annual volunteer certification workshops. Laboratories will be responsible for providing accuracy and precision information to volunteer organizations. Refer to Appendix 1 for background information about various quality assurance criteria such as "precision" (including RPD), "accuracy", etc. Also see footnotes at bottom of table.

Priority	Parameter	Parameter Subgroup	Sampling & Analysis Method	Analysis Location	Measurement Range (Detection Limits)		Duplicate Precision	Accuracy	Resolution	Notes
		[or additional parameter information]			Minimum*	Maximum*	[Relative % Difference (RPD)] ⁴	(Assessed at annual trainings and in field (after calibration), or in lab via % recovery [spiked samples].)	**	(In addition to the notes in this table, most water quality meters require calibration at least at the beginning of each sampling day if not more. Refer to appropriate SAP.)
VVVVV INSTANTANEOUS MEASUREMENTS VVVVV										
1	Dissolved Oxygen (D. O.)	Instantaneous	field meter or Winkler-style test (See footnote *** for guidance regarding time-of-day for dissolved oxygen measurements.)	field or field & lab	1 mg/L	15 mg/L (20 mg/L is recommended)	Field dup.: ± 0.3 mg/L	Annual certification by VRMP ± 0.3 mg/L Tier 1: measured against DEP's lab-grade Winkler titration set-up in Augusta Tier 2: measured against VRMP "benchmark" optical D. O. meter (Kits require sodium thiosulfate check once a month.)	0.2 mg/L	• Simultaneous temperature measurement is mandatory. • D. O. meter <u>membranes</u> should be inspected for problems prior to use. • Most meters require continuous movement of water across their membranes in order to function properly. • VRMP "benchmark" D. O. meter <u>accuracy</u> must be ± 0.2 mg/L against DEP's lab-grade Winkler titration set-up in Augusta. • Volunteers using meters also perform "zero oxygen" standard (<u>accuracy</u>) check at beginning of field season and each sampling month using the same accuracy criteria. • See Table 4a of VRMP QAPP for guidance regarding depth profiles of D. O. and temperature for Tier 1.
1	Temperature	Instantaneous	field thermometer or meter	field	0° C	35° C	Field dup.: ± 1° C	Annual certification by VRMP ± 1° C	0.5° C	• <u>Thermometers</u> (or <u>meters</u> with ability to record temp.) will have their accuracy checked against an NIST-certified thermometer at annual VRMP certification workshop. (VRMP will purchase thermometers for groups not using meters, if they do not have thermometers having a resolution of 0.5 °C. Any NIST-certificates which accompany thermometers will be archived at VRMP headquarters.)
1	Specific Conductance	Specific Conductance	field meter	field	1 µS/cm	2000 µS/cm	Field dup.: ± 15% (0 - 499 µS/cm); ± 10% (≥ 500 µS/cm)	Annual certification by VRMP ± 10% (against VRMP "benchmark": either 47 or 84 µS/cm ⁵ standard set)	1 µS/cm	• Make sure that data are expressed in units of µS/cm and not mS/cm. (1000 µS = 1 mS) • Make sure to measure & report specific conductance (which is conductance that has been corrected / adjusted to a temperature of 25 °C). Most modern meters can do this automatically -- refer to your owner's manual.

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1	Bacteria	<i>E. coli</i>	field: grab sample lab: glass millipore filter method	Must use a VRMP approved lab.	0/ 100 mL	2400/ 100mL	Field dup.: ± 30% [for log 10 transformed duplicate data]	Prior to each day of lab analyses "Blank" (see notes)	1/ 100mL	• [Accuracy] A lab blank, using distilled water, must be performed (run) for each batch of samples and result in "0/100 mL" for the sample batch to be valid.
1	Bacteria	<i>E. coli</i>	field: grab sample lab: IDEXX Colilert method	lab	0 MPN (MPN = Most Probable Number)	TNTC (TNTC = Too Numerous To Count)	Field dup.: ± 30% [for log 10 transformed duplicate data]	Prior to each day of lab analyses Use either method "1" or "2": 1) "Blank" (see notes); 2) Need to be TNTC on positive control.	1/ 100mL	• [Accuracy method # 1] A lab blank, using distilled water, must be performed (run) for each batch of samples and result in "0 MPN" for the sample batch to be valid. • [Accuracy method # 2] TNTC on positive control (a spiked sample {e.g., raw sewage sample from wastewater treatment plant}. -- > NOT a recommended method for safety reasons.
2	pH	pH	field meter	field	1	14	Field dup.: ± 0.4 pH units	Annual Certification by VRMP ± 0.2 pH units against two buffers of (4 and 7) or (7 and 10)	0.1	• Buffer solutions should be brought to stream water temperature before performing calibration or determining accuracy.
2	Turbidity	Turbidity (tier 1)	field: grab sample field or lab: meter	field	0	1000 NTUs	Field dup.: ± 20%	Annual Certification by VRMP ± 2 NTUs (checked against VRMP "benchmark" standards)	1 NTU	Checked against turbidity standards.
2	Turbidity	Turbidity (tier 1)	field: grab sample lab: 2130 B (APHA, 1995)	VRMP certified lab	0	1000 NTUs	Field dup.: ± 20% Lab split: ± 10%	N/A	1 NTU	Checked against turbidity standards.
2	Suspended Sediment Concentration (SSC)	SSC	field: grab sample lab: ASTM ¹ Method D 3977-97	VRMP certified lab	5 mg/L	200 mg/L	Field dup.: ± 30% Lab split: ± 20%	N/A	1 mg/L	Due to the sub-sampling procedures that typically are used with the TSS method, and associated error problems ² , MDEP recommends that SSC be measured instead of total suspended solids (TSS). The reason that TSS is included in this table at all is because some groups may have historical TSS data.

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		[or additional parameter information]			Minimum*	Maximum*	[Relative % Difference (RPD)] ⁴	(Assessed at annual trainings and in field (after calibration), or in lab via % recovery [spiked samples].)	**	(In addition to the notes in this table, most water quality meters require calibration at least at the beginning of each sampling day if not more. Refer to appropriate SAP.)
3	Turbidity	Turbidity (tier 2)	field: turbidity tube	field	0 cm	60 cm	Field dup.: ± 5 cm	Annual Certification by VRMP ± 5 cm between experienced staff and trainees	1 cm	If turbidity is to be monitored primarily under stormflow conditions, then a 60 cm tube may be adequate. If turbidity is to be monitored primarily under low flow conditions, then a 120 cm tube is recommended.
3	Total Dissolved Solids (TDS)	TDS	field: meter -or- field: grab sample with laboratory analysis; Method 2540C (APHA et al., 1995)	field or VRMP certified lab	1 mg/L	2000 mg/L	Field dup.: ± 15% Lab split: ± 10%	Annual certification by VRMP ± 10% (against VRMP "benchmark" 30 ppm ⁵ standard set)	1 mg/L	• (The TDS concentration in mg/L is approximately 65 % [range 55 - 75%] of the specific conductivity value in µS/cm. {Allan and Castillo 2007} ³)
3	Chloride	Chloride	field: grab sample: lab: Method 4500 CL ⁻ (B or C) (APHA et al, 1995)	VRMP certified lab	3 mg/L	300 mg/L	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses Lab ±10%	1 mg/L	
3	Phosphorus	Total Phosphorus	field: grab sample lab: EPA 365.1; Lachat 10-115-01-1-F	Only HETL or SECRL labs	1 ppb	200 ppb (> 200 ppb by dilution)	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses Lab ±30%	1 ppb	HETL = State of Maine Health & Environmental Testing Laboratory (Augusta) SECRL = Sawyer Environmental Chemistry Research Laboratory (University of Maine)
4	Phosphorus	Ortho Phosphate	field: grab sample lab: EPA 365.1; Lachat 10-115-01-1-B	Only HETL or SECRL labs	1 ppb	200 ppb (> 200 ppb by dilution)	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses Lab ±30%	1 ppb	HETL = State of Maine Health & Environmental Testing Laboratory (Augusta) SECRL = Sawyer Environmental Chemistry Research Laboratory (University of Maine)
4	Nitrogen	Nitrate (NO ₃) and Nitrite (NO ₂)	field: grab sample lab: EPA 353.2; Lachat 10-107-04-1-C	VRMP certified lab	1 ppb	2000 ppb	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses Lab ±10%	1 ppb	
4	Nitrogen	Total Kjeldahl Nitrogen (TKN)	field: grab sample lab: EPA 351.2; Lachat 10-107-06-2-E	VRMP certified lab	40 ppb	5000 ppb	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses Lab ±30%	10 ppb	

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4	Hardness	Hardness	field: grab sample lab: Method 2340 B (APHA et al, 1995)	VRMP certified lab	3 mg/L	400 mg/L	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses ± 10%	1 mg/L	Expressed in terms of CaCO ₃ /L
4	Alkalinity	Alkalinity	field: grab sample lab: EPA 310.1; Method 2320 B (APHA, 1995)	VRMP certified lab	5 mg/L	400 mg/L	Field dup.: ±30% Lab split: ±10%	On each day of lab analyses ± 10%	1 mg/L	Expressed in terms of CaCO ₃ /L
4	Total Suspended Solids (TSS)	TSS	field: grab sample lab: EPA Method 160.2; method 2540 D (APHA et al., 1995)	VRMP certified lab	5 mg/L	200 mg/L	Field dup.: ± 30% Lab split: ± 20%	N/A	1 mg/L	Due to the sub-sampling procedures that typically are used with the TSS method, and associated error problems, MDEP generally recommends that suspended sediment concentration (SSC) be measured instead of TSS. The reason that TSS is included in this table at all is because some groups may have historical TSS data or a specific use for TSS data.
4	Bacteria (in tidal sections of coastal streams))	<i>Enterococcus</i>	field: grab sample lab: glass millipore filter method	Must use a VRMP approved lab.	0/ 100 mL	2400/ 100mL	Field dup.: ± 30% [for log 10 transformed duplicate data]	Prior to each day of lab analyses "Blank" (see notes)	1/ 100mL	• A lab blank, using distilled water, must be performed (run) for each batch of samples and result in "0/100 mL" for the sample batch to be valid. [[Accuracy]]
4	Bacteria (in tidal sections of coastal streams))	Fecal Coliform	field: grab sample lab: glass millipore filter method	Must use a VRMP approved lab.	0/ 100 mL	2400/ 100mL	Field dup.: ± 30% [for log 10 transformed duplicate data]	Prior to each day of lab analyses "Blank" (see notes)	1/ 100mL	• A lab blank, using distilled water, must be performed (run) for each batch of samples and result in "0/100 mL" for the sample batch to be valid. [[Accuracy]]
4	Bacteria (in tidal sections of coastal streams))	Total Coliform	field: grab sample lab: IDEXX Colilert method	lab	0 MPN (MPN = Most Probable Number)	TNTC (TNTC = Too Numerous To Count)	Field dup.: ± 30% [for log 10 transformed duplicate data]	Prior to each day of lab analyses Use either method "1" or "2": 1) "Blank" (see notes); 2) Need to be TNTC on positive control.	1/ 100mL	• [Accuracy method # 1] A lab blank, using distilled water, must be performed (run) for each batch of samples and result in "0 MPN" for the sample batch to be valid. • [Accuracy method # 2] TNTC on positive control (a spiked sample {e.g., raw sewage sample from wastewater treatment plant}.) --> NOT a recommended method for safety reasons.
VVVVV CONTINUOUS MEASUREMENTS (DATA LOGGERS, SONDES, ETC.) VVVVV										

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		[or additional parameter information]			Minimum*	Maximum*	[Relative % Difference (RPD)] ⁴	(Assessed at annual trainings and in field (after calibration), or in lab via % recovery [spiked samples].)	**	(In addition to the notes in this table, most water quality meters require calibration at least at the beginning of each sampling day if not more. Refer to appropriate SAP.)
1	Temperature	continuous	field: thermometer / meter; with datalogger or data sonde	field	0° C	35° C	See notes.	N/A	0.5° C	• <u>Data logger</u> precision checked annually following VRMP-approved SOP. Basically, this consists of placing all of a group's loggers in a fume hood for 2 hours and then comparing to determine whether the mean temperature of any of the loggers falls outside $\pm 0.5^{\circ}\text{C}$ of the grand mean temperature (mean of the means) of all the loggers.

Footnotes

- *: VRMP and VRMP volunteer group equipment must be able to make measurements, for a given parameter, at least down to the minimum detection limit and at least up to the maximum detection limits shown in the "Measurement Range" column for the equipment and data to be considered valid for the program.
- **: Resolution values indicate minimum resolution values [but not necessarily minimum detection limits] that must be attained by field or lab equipment for it to be considered valid by the VRMP. Equipment that has better resolution than required minimum standards is acceptable.
- ***: Dissolved oxygen (D.O.) data collected between dawn and 8:00 AM are important for assessment of attainment of D.O. criteria within Maine's Water Quality Standards. But, except as naturally occurs, D.O. concentrations below the applicable D.O. criteria at any time of day signal non-attainment. If there are no D.O. concentrations below the criteria after 8:00 AM, then data between dawn and 8:00 AM must be collected to assess attainment of the criteria.
- 1: American Society for Testing and Materials (ASTM), 2000, Standard test methods for determining sediment concentration in water samples: Method D 3977-97, vol. 11.02, Water (II), 395-400.
- 2: Gray, J. R, G. D. Glysson, L. M. Turcios, and G. E. Schwarz. 2000. Comparability of Suspended-Sediment Concentration and Total Suspended Solids Data. U. S. Geological Survey. Water-Resources Investigations Report 00-4191. Reston, Virginia. 14 pp.
- 3: Allan, J. D. and M. M. Castillo. 2007. Stream ecology: structure and function of running waters. Springer, Dordrecht, Netherlands, 436 pp., 2nd edition.
- 4: "Field duplicates" are extra samples or monitoring replicates that are collected immediately after the initial sample was collected so that precision can be estimated. For water grab samples, this involves collecting a duplicate grab sample after collecting an initial grab sample for a given parameter. For water quality meters, thermometers, or similar field equipment, the field duplicate consists of lowering the meter's probe back into the water immediately after the initial reading was taken. "Lab split" refers to a precision estimation technique used by laboratories in which they take the initial water grab sample, mix well, and split into two samples. Then analyses are made on the two new samples to see how close they were to each other.
- 5: Some possible standard solutions:
- Myron L Company; Total Dissolved Solids/Conductivity Standard Solution 442™ Standard Solution (30ppm / 46.7µS); (formula 442 is intended for lakes, streams, etc.)
 - Oakton; Conductivity Standard Solution, 84 µS