Appendix E

EPA Report – Sediment Oxygen Demand

Measurement of Sediment Oxygen Demand (SOD) in the Upper Merrimack River

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March 2010

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INTRODUCTION

The New Hampshire Department of Environmental Services, Watershed Management Bureau and the US Army Corps of Engineers (ACOE), requested EPA's Office of Environmental Measurement and Evaluation assistance in conducting a Sediment Oxygen Demand Study (SOD) on the Upper Merrimack River from Bristol downstream to the New Hampshire and Massachusetts border.

SOD is the total of biological and chemical processes in sediment that utilize oxygen. SOD studies are useful in the development of predictive mathematical models that will determine waste load allocations. They are also useful in measuring the depletion of oxygen in stratified waters when there are concerns about nutrient regeneration and the loss of aquatic life.

NHDES will reassess attainment/ non-attainment status of dissolved oxygen criteria and the trophic status of the Ashuelot River as well as complete the water quality model based on the results of the SOD study and the ongoing water quality survey conducted by NHDES and ACOE in 2009-2010.

This SOD project included monitoring seventeen sites along the Upper Merrimack River. The site selections were determined by NHDES and ACOE to get a representative sediment profile. Sites chosen were behind impoundments and low-gradient areas where there is the best chance to find fine sediment. Site descriptions and locations are shown in Table 1. Sediment analyses included SOD and grain size. The Work/QA Plan in Appendix B provides a detailed account of the methods, procedures and analyses conducted as part of the investigation.

MATERIALS

EPA field crews performed SOD analyses at the EPA Regioinal Laboraty in Chelmsford, Massachusetts. This site provided a controlled environment and somewhat close proximity to the field study location. Crews collected sediment cores with a Wildco KB Corer. An EPA inflatable boat with motor was used to collect samples behind the impoundments. SOD measurements were performed with YSI Model 5100 dissolved oxygen meters. Grain sizes were analyzed at the OEME laboratory in North Chelmsford, MA.

METHODS

Sampling Locations

The seventeen sampling locations selected were based on the presence of fine sediment and proximity to stations used in the NHDES Water Quality Surveys. Three other sample locations were removed due to close proximity to other stations. These stations were: S006, upstream of Franklin Falls Dam 3; S008 , Eastman Falls Dam 2; S018, Amoskeag Dam 2. The stations extend from Bristol downstream to the Massachusetts border as seen on the maps and a table with GPS coordinates in Appendix C.

Table I. Station Descriptions

	NHDES Station
U/S Ayers Island Dam 1	S001
U/S Ayers Island Dam 2	S002
U/S Ayers Island Dam 3	S003
U/S Franklin Falls Dam 1	S004
U/S Franklin Falls Dam 2	S005
U/S Eastman Falls Dam 1	S007
U/S Eastman Falls Dam 3	S009
D/S Winnipesaukee WWTF	S010
U/S Garvins Falls Dam 1	S011
U/S Garvins Falls Dam 2	S012
U/S Garvins Falls Dam 3	S013
U/S Hooksett Dam 1	S014
U/S Hooksett Dam 2	S015
U/S Hooksett Dam 3	S016
U/S Amoskeag Dam 1	S017
U/S Amoskeag Dam 3	S019
Nashua Impairment	S020

Sediment Sampling

Sediment samples for SOD analysis were obtained by using a gravity type Wildco K-B Core Sampler. Five cores were grabbed at each site and capped on the top and bottom with inert rubber stoppers. After SOD measurements were taken, the contents of each core were composited and an aliquot was taken for grain size analysis. These samples were stored on ice in a cooler, then returned to EPA's New England Regional Laboratory and stored prior to analyses. See the Work/QA Plan in Appendix B for the sediment sampling and analytical methods used.

Dissolved Oxygen Ambient Water Collection

Ambient water was collected by a core tube by stoppering at either end to simulate production or respiration in the overlying water in a sediment core tube. The core tube was then analyzed as the same method as the sediment cores. The cores were immersed in a water bath and maintained at 20°C±1° until the end of the test. The results are used in the final SOD rate calculation. IF depths were greater than 25 feet (6.6 meters) then a water bottle would have been used to collect a sample at the depth above the sediment.

Sediment Oxygen Demand Determination

This method involves confining a measurable volume of water overlying a known area of sediment in a core tube and measuring the depletion of dissolved oxygen over a period of time. Procedures were followed based on ECASOP–SODSOP6.0, Sediment Oxygen Demand Determination, Standard Operating Procedure, Rev 6.0, July 18, 2007.

After the five sediment cores are collected, the water column height (h) in each of the five cores is measured in meters and recorded in a logbook. Sediment sample cores are transferred to a temperature controlled water bath and incubated at 20°C±1° for a 3 to 4 hour monitoring period. Often a 30-60 minute stabilization period is required for the core tube temperature to reach equilibrium with the water bath. The dissolved oxygen concentration within these cores is measured every 30 minutes for the test duration. Following the monitoring period, SOD rates are calculated for each core sample and then averaged to produce a mean rate at each site. The standard deviation is also calculated to determine the variability of the sediment. See the Sediment Oxygen Demand calculation sheet in Appendix A for site-specific SOD rates and standard deviations.

The formula for calculating SOD rates is as follows:

$$\text{SOD g } O_2/m^2\text{day} = \frac{\{(O_i - O_f) - (B_i - B_f)\}\ (h)}{(t)}$$

O_i = initial dissolved oxygen (DO) mg/ℓ
O_f = final DO mg/ℓ
B_i = initial DO in bottles mg/ℓ
B_f = final DO in bottles mg/ℓ
h = height of water column in meters
t = time in days

Dissolved oxygen and temperature measurements were recorded in a bound logbook for each station sampled. The meters were calibrated before analysis and a post calibration check was performed at the end of each analysis. In the final calculation of the SOD rate, data is used only where oxygen depletion versus time is a constant.

RESULTS AND DISCUSSION

Sediment Oxygen Demand

SOD station average results ranged from a low of 0.6 g/(m^2day) upstream of the Hooksett Dam (S016) to a high of 3.3 g/(m^2day) at the upstream of the Garvin Falls Dam (S012). Two stations were in the low range of less than 1.0 g/(m^2day). Eleven stations were in the medium range of 1.0 to 2.0 g/(m^2day). Four stations averages were in the high SOD range of greater than 2.0 g/(m^2day). Four of the seventeen stations exhibited high standard deviations. Station S012, upstream of Garvin Falls had the highest standard deviation of 1.5 due to the multiple high numbers. See Appendix C for the map and location of the samples and Appendix A for worksheets with data and results.

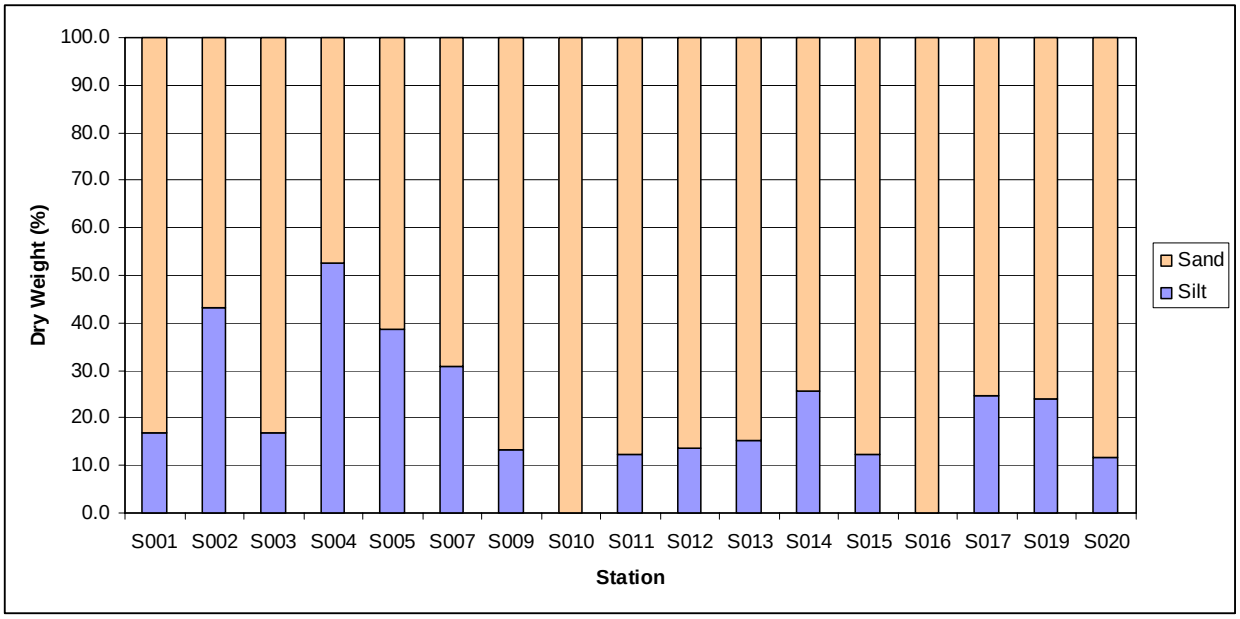
Table II. SOD Results

	NHDES Station	SOD average g/m^2day	Standard Deviation
U/S Ayers Island Dam 1	S001	1.42	0.4
U/S Ayers Island Dam 2	S002	1.85	1.0
U/S Ayers Island Dam 3	S003	2.73	1.3
U/S Franklin Falls Dam 1	S004	1.26	0.6
U/S Franklin Falls Dam 2	S005	1.09	0.2
U/S Eastman Falls Dam 1	S007	1.06	0.3
U/S Eastman Falls Dam 3	S009	1.40	0.7
D/S Winnipesaukee WWTF	S010	1.63	0.6
U/S Garvins Falls Dam 1	S011	1.47	1.6
U/S Garvins Falls Dam 2	S012	3.31	1.5
U/S Garvins Falls Dam 3	S013	1.93	0.3
U/S Hooksett Dam 1	S014	1.81	1.2
U/S Hooksett Dam 2	S015	2.90	2.0
U/S Hooksett Dam 3	S016	0.61	0.3
U/S Amoskeag Dam 1	S017	1.35	0.6
U/S Amoskeag Dam 3	S019	0.85	0.2
Nashua Impairment	S020	1.13	0.2

Grain Size

Grain size analysis was performed to categorize sediment particle size at each of the station locations. In general the grain size distribution indicates a very sandy environment. Stations S010, downstream of Winnipesaukee WWTF, and S016, upstream of the Hooksett Dam, were 100% sand percentage. Station S004 @ Franklin Falls Dam had the highest percentage of silt and clay (53%). Figure 1 below compares the results. Finer sediments were sought for the sediment cores because the small particle size and proportionately greater surface area have a higher affinity for binding contaminants. Grain size results can be found in Appendix D.

Figure 1. Sand and Silt/Clay Distribution Percent by Weight



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EPA OEME, *Measurement of Sediment Oxygen Demand (SOD) in the Piscataquis River @ Dover-Foxcroft, Maine,* April 2002
YSI Inc, *YSI MODEL 5100 Operations Manual,* June 2001

ECASOP–SODSOP6.0, Sediment Oxygen Demand Determination, Standard Operating Procedure, Rev 6.0, July 18, 2007

Upper Merimack River SOD Study

Station # S001 Northern
River Reach: Pemigewasset

AMBIENT WATER

1	0.441
2	0.354
3	0.274
4	0.364
5	0.377

Sample #	S001
Time	14:00
Date	10/8/2009

Grainsize

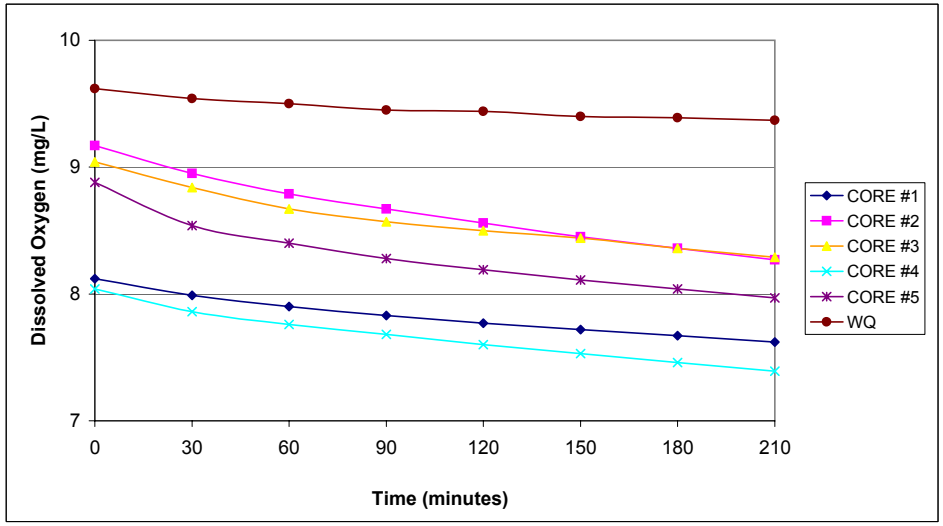
=highest D.O. over steady temp
= lowest D.O. over steady temp

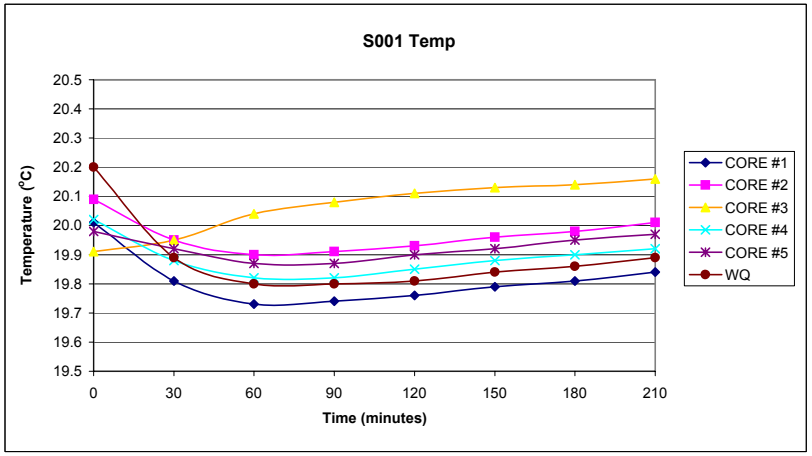
TIME		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1930	0	8.12	9.17	9.04	8.04	8.88	9.62
2000	30	7.99	8.95	8.84	7.86	8.54	9.54
2030	60	7.90	8.79	8.67	7.76	8.40	9.50
2100	90	7.83	8.67	8.57	7.68	8.28	9.45
2130	120	7.77	8.56	8.50	7.60	8.19	9.44
2200	150	7.72	8.45	8.44	7.53	8.11	9.40
2230	180	7.67	8.36	8.36	7.46	8.04	9.39
2300	210	7.62	8.27	8.29	7.39	7.97	9.37

	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
	20.01	20.09	19.91	20.02	19.98	20.20
	19.81	19.95	19.95	19.88	19.92	19.89
	19.73	19.90	20.04	19.82	19.87	19.80
	19.74	19.91	20.08	19.82	19.87	19.80
	19.76	19.93	20.11	19.85	19.90	19.81
	19.79	19.96	20.13	19.88	19.92	19.84
	19.81	19.98	20.14	19.90	19.95	19.86
	19.84	20.01	20.16	19.92	19.97	19.89

SOD Average	1.42	1.19	1.93	1.00	1.37	1.60
Standard Deviation	0.36	SOD				

Analyzed by: Erica Czerepak
Samples collected by: Erica Czerepak, Beth Kelley, Peg Foss





Upper Merimack River SOD Study

Station # S002 Middle Station Upstream of Ayer's Island Dam (Bristol, NH)
River Reach: Pemigewasset

AMBIENT WATER	Water Column Height (meters)
1	0.389
2	0.389
3	0.348
4	0.327
5	0.373

Sample #	S002
Time	15:00
Date	10/8/2009

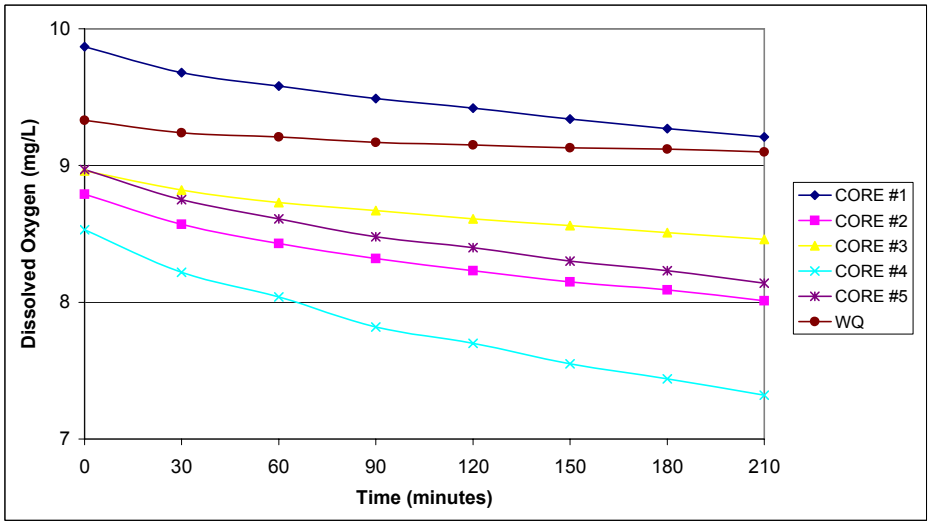
Other Analytes
Grainsize

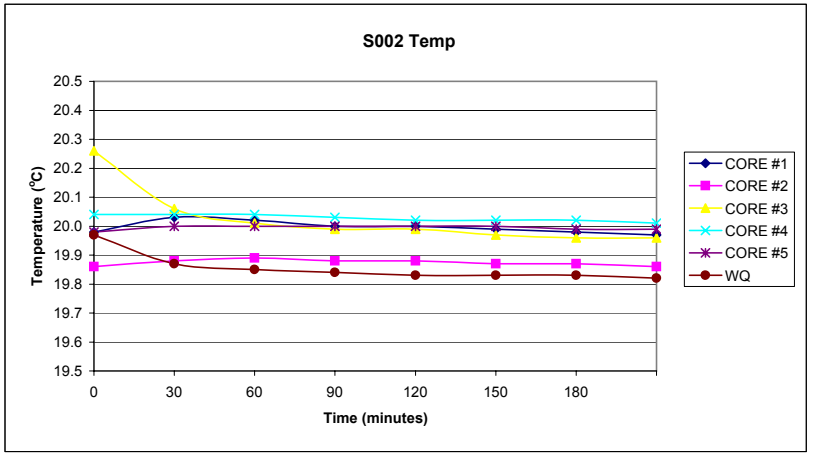
=highest D.O. over steady temp
= lowest D.O. over steady temp

SOD ANALYSIS TIME		Dissolved Oxgen (mg/l) CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	Temperature (C) CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1930	0	9.87	8.79	8.96	8.53	8.97	9.33	19.98	19.86	20.26	20.04	19.98	19.97
2000	30	9.68	8.57	8.82	8.22	8.75	9.24	20.03	19.88	20.06	20.04	20.00	19.87
2030	60	9.58	8.43	8.73	8.04	8.61	9.21	20.02	19.89	20.01	20.04	20.00	19.85
2100	90	9.49	8.32	8.67	7.82	8.48	9.17	20.00	19.88	19.99	20.03	20.00	19.84
2130	120	9.42	8.23	8.61	7.70	8.40	9.15	20.00	19.88	19.99	20.02	20.00	19.83
2200	150	9.34	8.15	8.56	7.55	8.30	9.13	19.99	19.87	19.97	20.02	20.00	19.83
2230	180	9.27	8.09	8.51	7.44	8.23	9.12	19.98	19.87	19.96	20.02	19.99	19.83
2300	210	9.21	8.01	8.46	7.32	8.14	9.10	19.97	19.86	19.96	20.01	19.99	19.82

SOD Average	1.85	1.46	1.57	1.00	3.55	1.69
Standard Deviation	0.98	SOD				

Analyzed by: Erica Czerepak
Samples collected by: Erica Czerepak, Beth Kelley, Peg Foss





Upper Merimack River SOD Study

Station # S003 Station just upstream of Ayer's Island Dam (Bristol, NH)
River Reach: Pemigewasset

AMBIENT WATER

	Water Column Height (meters)
1	0.477
2	0.420
3	0.423
4	0.450
5	0.400

Sample #	S003
Time	15:30
Date	10/15/2009

Other Analytes
Grainsize

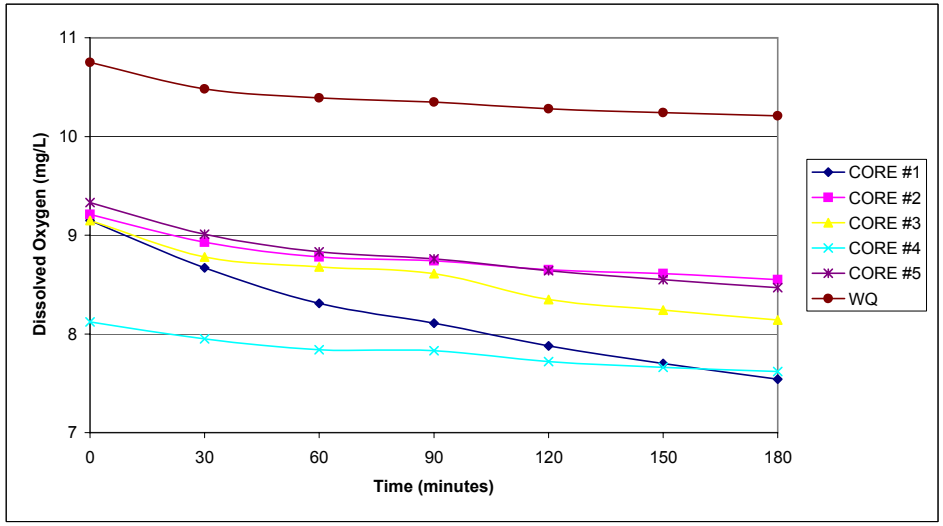
=highest D.O. over steady temp
= lowest D.O. over steady temp

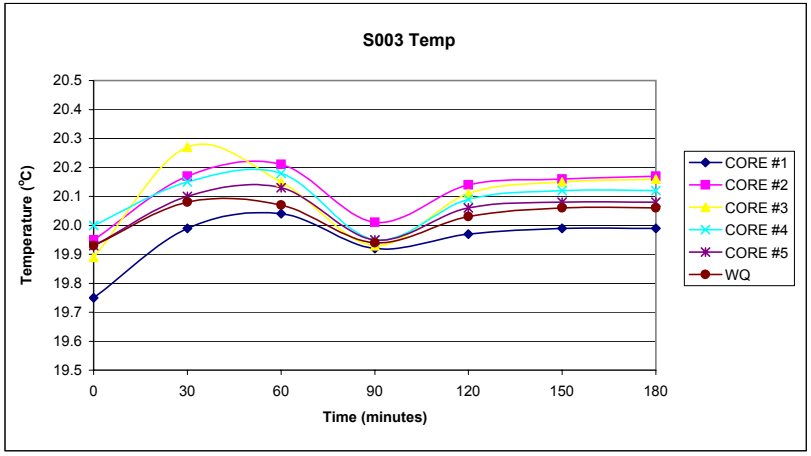
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1930	0	9.15	9.21	9.15	8.12	9.33	10.75	19.75	19.95	19.89	20.00	19.93	19.93
2000	30	8.67	8.93	8.78	7.95	9.01	10.48	19.99	20.17	20.27	20.15	20.10	20.08
2030	60	8.31	8.78	8.68	7.84	8.83	10.39	20.04	20.21	20.15	20.18	20.13	20.07
2100	90	8.11	8.74	8.61	7.83	8.76	10.35	19.92	20.01	19.93	19.95	19.95	19.94
2130	120	7.88	8.65	8.35	7.72	8.64	10.28	19.97	20.14	20.11	20.09	20.06	20.03
2200	150	7.70	8.61	8.24	7.66	8.55	10.24	19.99	20.16	20.15	20.12	20.08	20.06
2230	180	7.54	8.55	8.14	7.62	8.47	10.21	19.99	20.17	20.16	20.12	20.08	20.06

SOD Average	2.73	4.43	1.16	2.60	1.43	2.08
Standard Deviation	1.29	SOD				

Analyzed by: Bethany Kelley
Samples collected by: Erica Czerepak, Peg Foss, Bethany Kelley





Upper Merimack River SOD Study

Station # S004 Furthest Location Upstream of Franklin Falls Dam

AMBIENT WATER

	Water Column Height (meters)
1	0.300
2	0.353
3	0.415
4	0.320
5	0.345

Sample #	S004
Time	13:00
Date	10/12/2009

Other Analytes
Grainsize

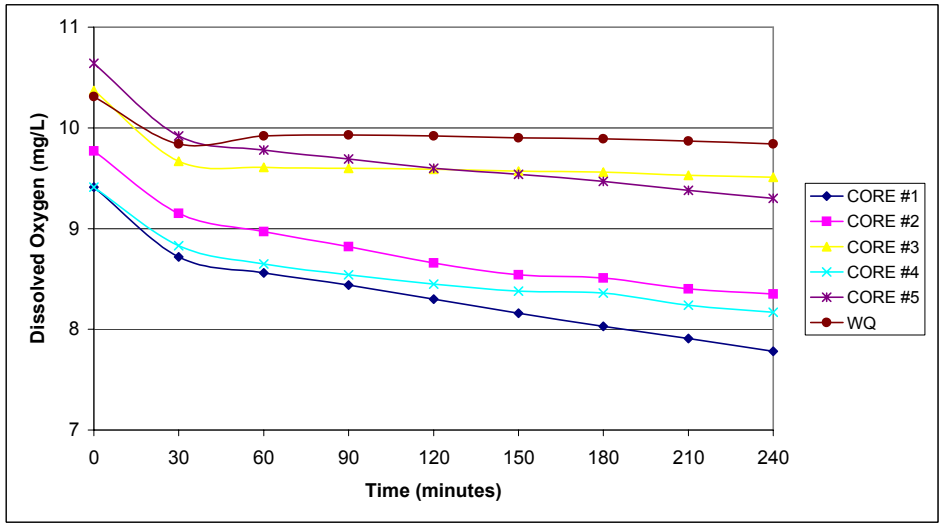
=highest D.O. over steady temp
= lowest D.O. over steady temp

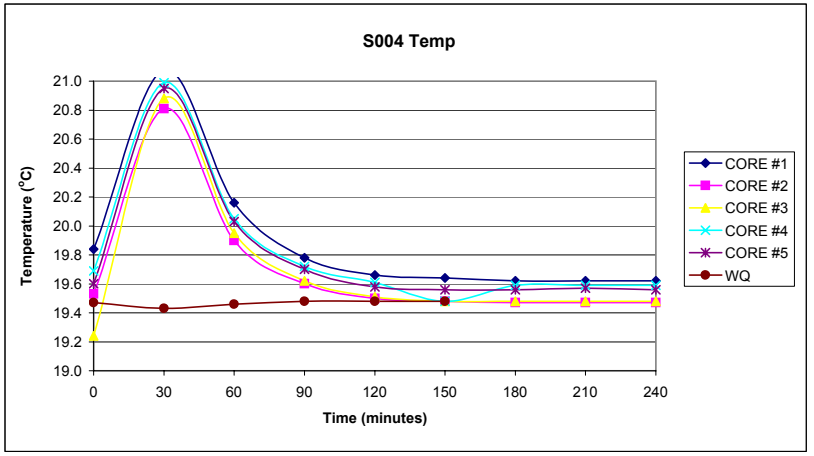
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1600	0	9.41	9.77	10.37	9.41	10.64	10.31	19.84	19.53	19.24	19.69	19.60	20.40
1630	30	8.72	9.15	9.67	8.83	9.92	9.84	21.08	20.81	20.88	20.99	20.95	20.87
1700	60	8.56	8.97	9.61	8.65	9.78	9.92	20.16	19.90	19.95	20.05	20.03	19.68
1730	90	8.44	8.82	9.60	8.54	9.69	9.93	19.78	19.60	19.62	19.72	19.70	19.47
1800	120	8.30	8.66	9.59	8.45	9.60	9.92	19.66	19.50	19.51	19.61	19.58	19.43
1830	150	8.16	8.54	9.57	8.38	9.54	9.90	19.64	19.48	19.48	19.48	19.56	19.46
1900	180	8.03	8.51	9.56	8.36	9.47	9.89	19.62	19.47	19.48	19.59	19.56	19.48
1930	210	7.91	8.40	9.53	8.24	9.38	9.87	19.62	19.47	19.48	19.59	19.57	19.48
2000	240	7.78	8.35	9.51	8.17	9.30	9.84	19.62	19.47	19.48	19.59	19.56	19.48

SOD Average	1.26	1.93	1.60	0.45	1.23	1.08
Standard Deviation	0.56	SOD				

Analyzed by: Erica Czerepak
Samples collected by: Erica Czerepak, Beth Kelley, Mike Ferrier





Upper Merimack River SOD Study

Station # S005 Middle station upstream of Franklin Falls Dam
River Reach: Pemigewasset

AMBIENT WATER	Water Column Height (meters)
1	0.340
2	0.342
3	0.360
4	0.305
5	0.315

Sample #	S005
Time	12:00
Date	10/12/2009

Other Analytes
Grainsize

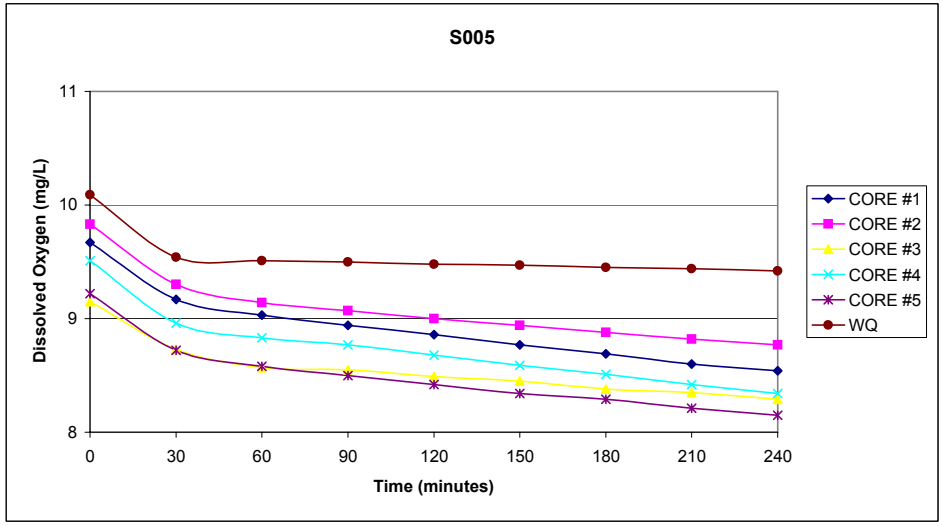
=highest D.O. over steady temp
= lowest D.O. over steady temp

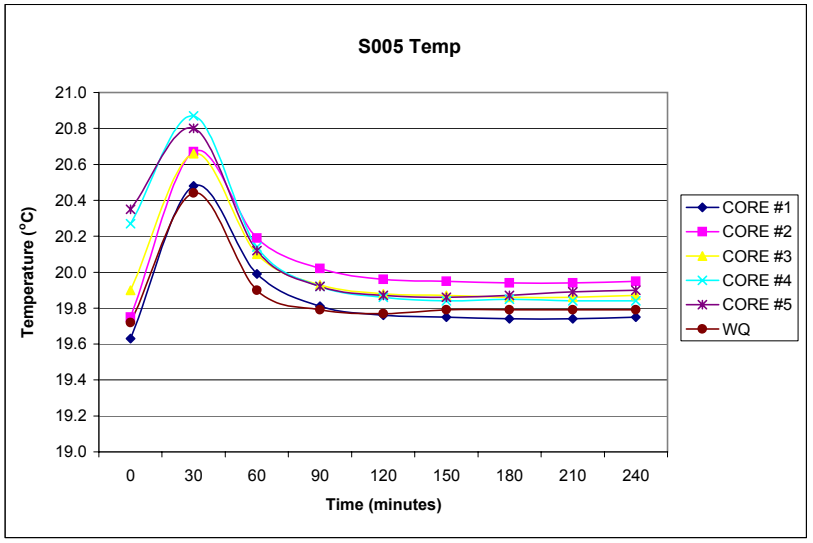
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1600	0	9.67	9.83	9.15	9.51	9.22	10.09	19.63	19.75	19.90	20.27	20.35	19.72
1630	30	9.17	9.30	8.73	8.96	8.72	9.54	20.48	20.67	20.66	20.87	20.80	20.44
1700	60	9.03	9.14	8.57	8.83	8.58	9.51	19.99	20.19	20.10	20.14	20.12	19.90
1730	90	8.94	9.07	8.55	8.77	8.50	9.50	19.81	20.02	19.93	19.92	19.92	19.79
1800	120	8.86	9.00	8.49	8.68	8.42	9.48	19.76	19.96	19.88	19.86	19.87	19.77
1830	150	8.77	8.94	8.45	8.59	8.34	9.47	19.75	19.95	19.87	19.84	19.86	19.79
1900	180	8.69	8.88	8.38	8.51	8.29	9.45	19.74	19.94	19.86	19.85	19.87	19.79
1930	210	8.60	8.82	8.35	8.42	8.21	9.44	19.74	19.94	19.86	19.84	19.89	19.79
2000	240	8.54	8.77	8.29	8.34	8.15	9.42	19.75	19.95	19.87	19.84	19.90	19.79

SOD Average	1.09	1.33	1.01	0.81	1.20	1.08
Standard Deviation	0.20	SOD				

Analyzed by: Erica Czerepak
Samples collected by: Erica Czerepak, Beth Kelley, Mike Ferrier





Upper Merimack River SOD Study

Station # S007 Station furthest upstream of Eastman Falls Dam
River Reach: Pemigewasset

AMBIENT WATER

	Water Column Height (meters)
1	0.435
2	0.402
3	0.343
4	0.390
5	0.433

Sample #	S007
Time	11:15
Date	10/9/2009

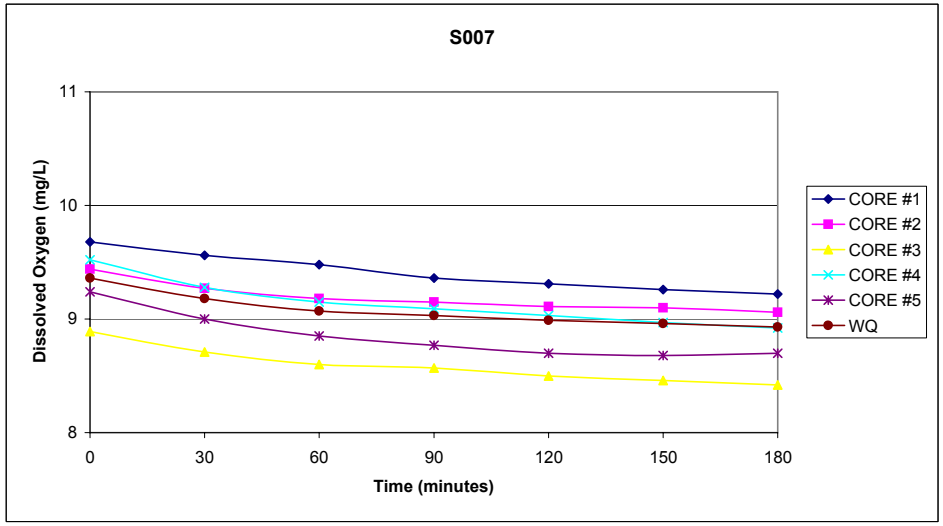
Other Analytes
Grainsize

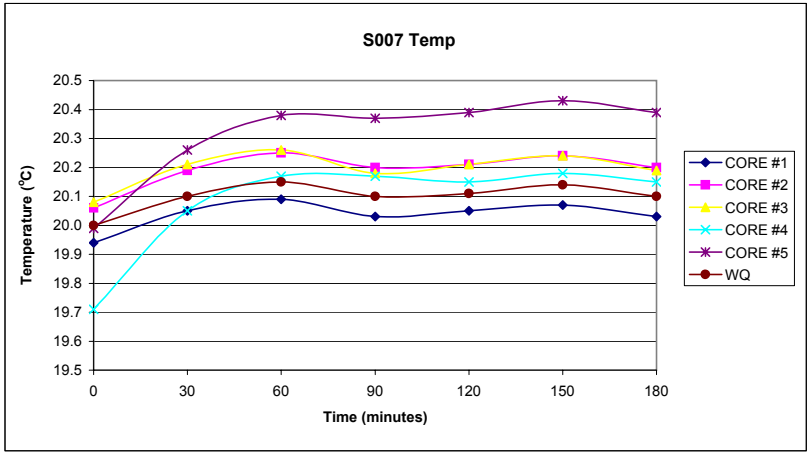
=highest D.O. over steady temp
= lowest D.O. over steady temp

SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1600	0	9.68	9.44	8.89	9.52	9.24	9.36	19.94	20.06	20.08	19.71	19.99	20.00
1630	30	9.56	9.27	8.71	9.28	9.00	9.18	20.05	20.19	20.21	20.05	20.26	20.10
1700	60	9.48	9.18	8.60	9.15	8.85	9.07	20.09	20.25	20.26	20.17	20.38	20.15
1730	90	9.36	9.15	8.57	9.09	8.77	9.03	20.03	20.20	20.18	20.17	20.37	20.10
1800	120	9.31	9.11	8.50	9.03	8.70	8.99	20.05	20.21	20.21	20.15	20.39	20.11
1830	150	9.26	9.10	8.46	8.97	8.68	8.96	20.07	20.24	20.24	20.18	20.43	20.14
1900	180	9.22	9.06	8.42	8.92	8.70	8.93	20.03	20.20	20.19	20.15	20.39	20.10
SOD Average	1.06	1.42	0.81	0.96	1.35	0.78							
Standard Deviation	0.30	SOD											

Analyzed by: Mike Ferrier
Samples collected by: Beth Kelley, Carol Elliot, Tim Bridges





Upper Merimack River SOD Study

Station # S009 Station just upstream of Eastman Falls Dam
River Reach: Pemigewasset

AMBIENT WATER

	Water Column Height (meters)
1	0.420
2	0.345
3	0.470
4	0.382
5	0.380

Sample #	S009
Time	10:30
Date	10/9/2009

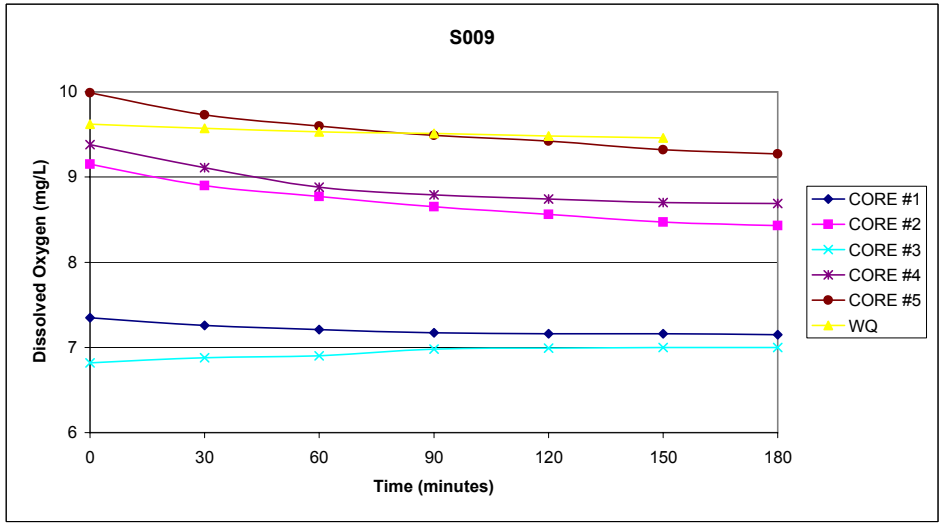
Other Analytes
Grainsize

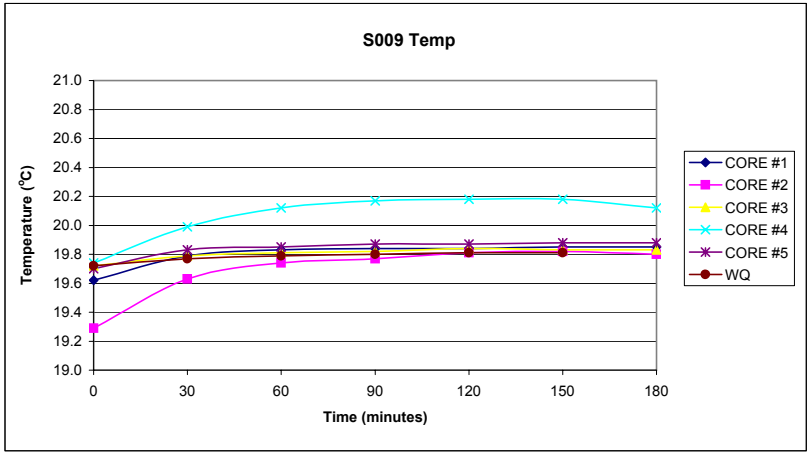
=highest D.O. over steady temp
= lowest D.O. over steady temp

SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1600	0	7.35	9.15	6.82	9.38	9.99	9.76	19.62	19.29	19.72	19.74	19.7	19.51
1630	30	7.26	8.90	6.88	9.11	9.73	9.62	19.79	19.63	19.79	19.99	19.83	19.72
1700	60	7.21	8.77	6.90	8.88	9.60	9.57	19.83	19.74	19.81	20.12	19.85	19.77
1730	90	7.17	8.65	6.98	8.79	9.49	9.53	19.84	19.77	19.82	20.17	19.87	19.79
1800	120	7.16	8.56	6.99	8.74	9.42	9.51	19.84	19.81	19.84	20.18	19.87	19.80
1830	150	7.16	8.47	7.00	8.70	9.32	9.48	19.85	19.82	19.83	20.18	19.88	19.81
1900	180	7.15	8.43	7.00	8.69	9.27	9.46	19.85	19.80	19.83	20.12	19.88	19.81
SOD Average	1.40	0.44	1.56	NA	1.93	1.68							
Standard Deviation	0.66	SOD											

Analyzed by: Mike Ferrier
Samples collected by: Beth Kelley, Carol Elliot, Tim Bridges





Upper Merimack River SOD Study

Station # S010 Downstream of Winnepesaukee WWTF [Walk-in located past Fife's Farm behind Webster Place Rehab Center (Franklin, NH)]
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.447
2	0.440
3	0.418
4	0.430
5	0.412

Sample #	S010
Time	14:30
Date	10/14/2009

Other Analytes
Grainsize

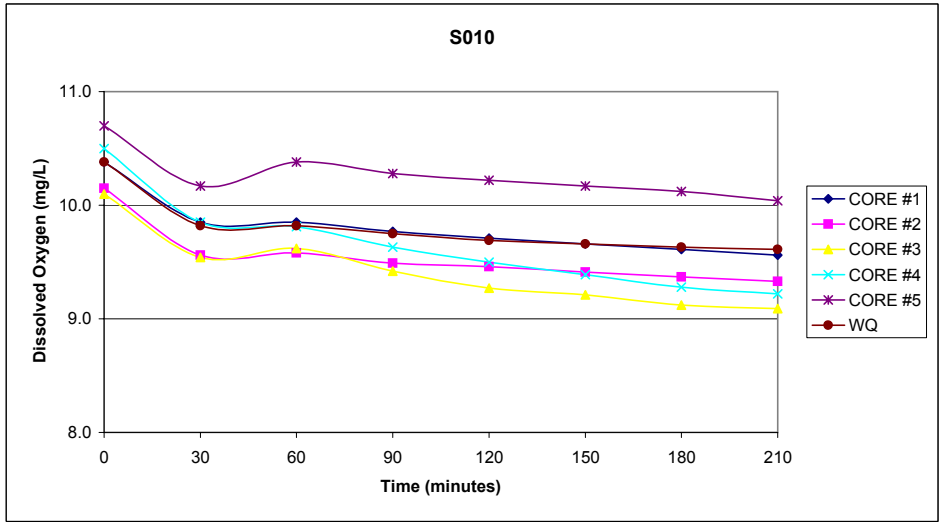
=highest D.O. over steady temp
= lowest D.O. over steady temp

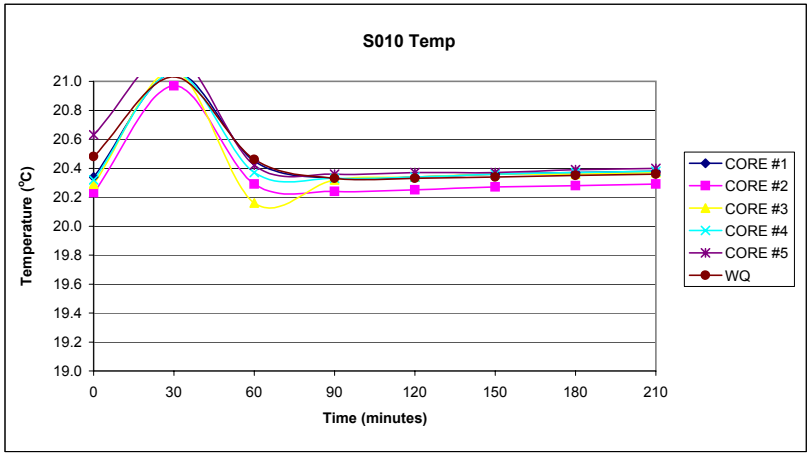
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1830	0	10.38	10.15	10.10	10.50	10.70	10.38	20.34	20.23	20.29	20.32	20.63	20.48
1900	30	9.85	9.56	9.54	9.85	10.17	9.82	21.06	20.97	21.07	21.06	21.19	21.03
1930	60	9.85	9.58	9.62	9.81	10.38	9.82	20.45	20.29	20.16	20.37	20.42	20.46
2000	90	9.77	9.49	9.42	9.63	10.28	9.75	20.33	20.24	20.32	20.33	20.36	20.33
2030	120	9.71	9.46	9.27	9.50	10.22	9.69	20.34	20.25	20.34	20.34	20.37	20.33
2100	150	9.66	9.41	9.21	9.39	10.17	9.66	20.36	20.27	20.36	20.36	20.37	20.34
2130	180	9.61	9.37	9.12	9.28	10.12	9.63	20.37	20.28	20.36	20.37	20.39	20.35
2200	210	9.56	9.33	9.09	9.22	10.04	9.61	20.38	20.29	20.37	20.38	20.40	20.36

SOD Average	1.63	1.25	1.06	2.13	2.36	1.35
Standard Deviation	0.58	SOD				

Analyzed by: Mike Ferrier
Samples collected by: Tim Bridges, Beth Kelley, Carol Elliot





Upper Merimack River SOD Study

Station # S011 Station furthest upstream of Garvins Falls Dam (Put-in by hockey rink: C
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.305
2	0.315
3	0.315
4	0.328
5	0.335

Sample #	S0011
Time	13:00
Date	10/15/2009

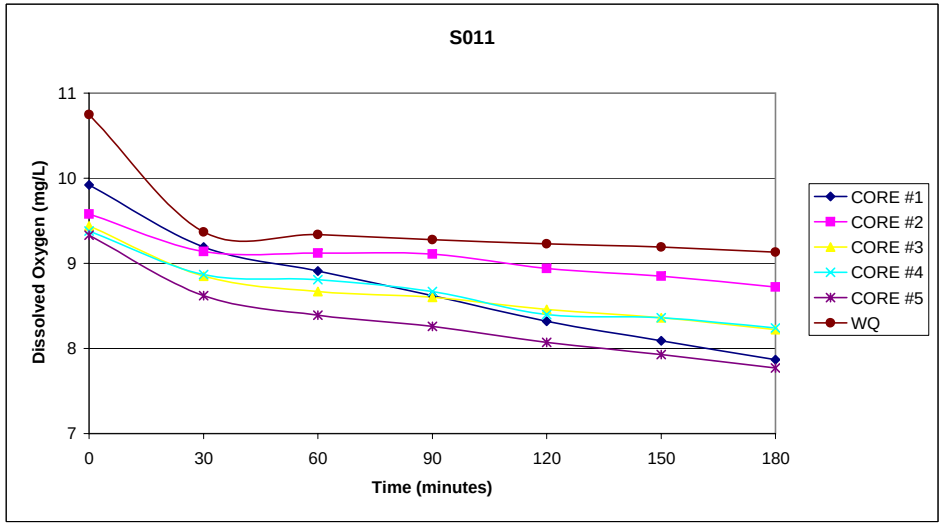
Other Analytes
Grainsize

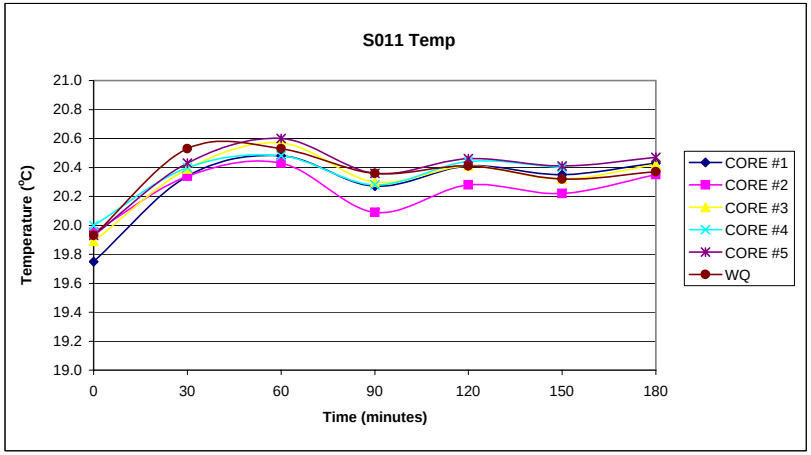
=highest D.O. over steady temp
= lowest D.O. over steady temp

SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1930	0	9.92	9.58	9.44	9.38	9.33	10.75	19.75	19.95	19.89	20.00	19.93	19.93
2000	30	9.19	9.14	8.85	8.87	8.62	9.37	20.34	20.34	20.39	20.40	20.43	20.53
2030	60	8.91	9.12	8.67	8.81	8.39	9.34	20.48	20.43	20.57	20.48	20.60	20.53
2100	90	8.62	9.11	8.60	8.67	8.26	9.28	20.27	20.09	20.30	20.28	20.36	20.36
2130	120	8.32	8.94	8.46	8.40	8.07	9.23	20.41	20.28	20.41	20.44	20.46	20.41
2200	150	8.09	8.85	8.36	8.36	7.93	9.19	20.35	20.22	20.32	20.40	20.41	20.32
2230	180	7.87	8.72	8.22	8.24	7.77	9.13	20.43	20.35	20.42	20.44	20.47	20.37
SOD Average	2.40	3.87	1.52	1.91	1.99	2.74							
Standard Deviation	0.93	SOD											

Analyzed by: Beth Kelley, Tim Bridges
Samples collected by: Erica Czerepak, Tim Bridges, Peg Foss (DES)





Upper Merimack River SOD Study

Station # S012 Middle station above Garvins Falls Dam by Blue Seal Feeds (Concord, NH)
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.365
2	0.442
3	0.375
4	0.343
5	0.383

Sample #	S012
Time	11:45
Date	10/15/2009

Other Analytes
Grainsize

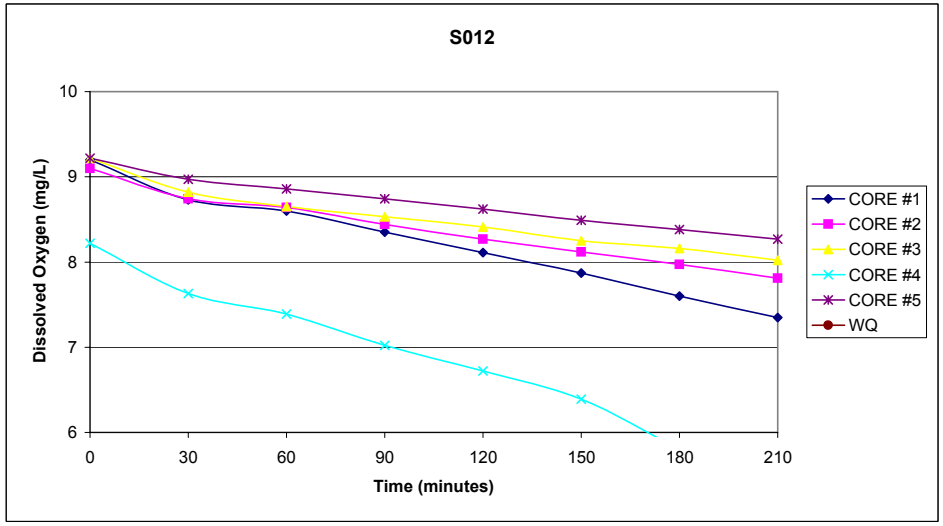
=highest D.O. over steady temp
= lowest D.O. over steady temp

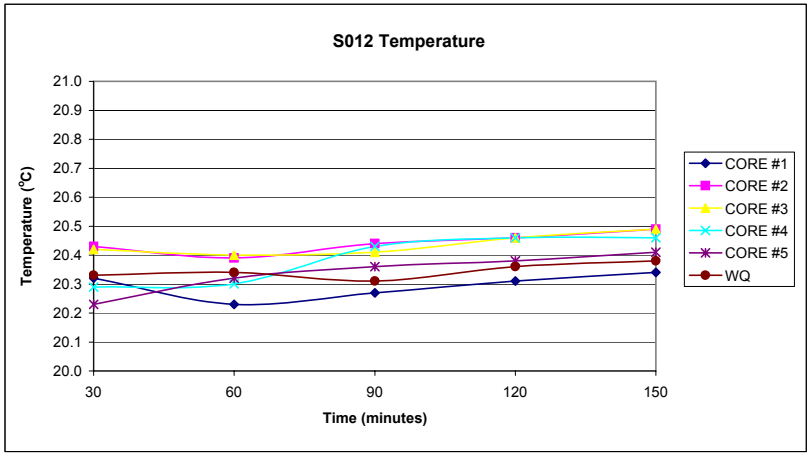
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1510	0	9.20	9.10	9.22	8.22	9.22	10.63	20.12	20.23	20.23	19.92	19.79	20.19
1540	30	8.73	8.74	8.82	7.63	8.97	10.48	20.32	20.43	20.42	20.29	20.23	20.33
1610	60	8.60	8.64	8.65	7.39	8.86	10.44	20.23	20.39	20.40	20.30	20.32	20.34
1640	90	8.35	8.44	8.53	7.02	8.74	10.47	20.27	20.44	20.41	20.43	20.36	20.31
1710	120	8.11	8.27	8.41	6.72	8.62	10.44	20.31	20.46	20.46	20.46	20.38	20.36
1740	150	7.87	8.12	8.25	6.39	8.49	10.42	20.34	20.49	20.49	20.46	20.41	20.38
1810	180	7.60	7.97	8.16	5.81	8.38	10.40	20.44	20.51	20.51	20.47	20.42	20.40
1840	210	7.35	7.81	8.02	5.27	8.27	10.37	20.53	20.40	20.55	20.50	20.45	20.43

SOD Average	3.31	4.39	3.29	2.27	5.12	1.47
Standard Deviation	1.49	SOD				

Analyzed by: Beth Kelley
Samples collected by: Beth Kelley, Erica Czerepak, Peg Foss (DES)





Upper Merimack River SOD Study

Station # S013 Station just upstream of Garvins Falls Dam (Concord, NH)
River Reach: Upper Merrimack

=highest D.O. over steady temp
= lowest D.O. over steady temp

AMBIENT WATER	Water Column Height (meters)
1	0.350
2	0.385
3	0.360
4	0.365
5	0.420

Sample #	S013
Time	11:15
Date	10/15/2009

Other Analytes
Grainsize

	Adjusted SOD w/DO
CORE #1	0.37
CORE #2	1.14
CORE #3	0.63
CORE #4	1.46
CORE #5	0.28

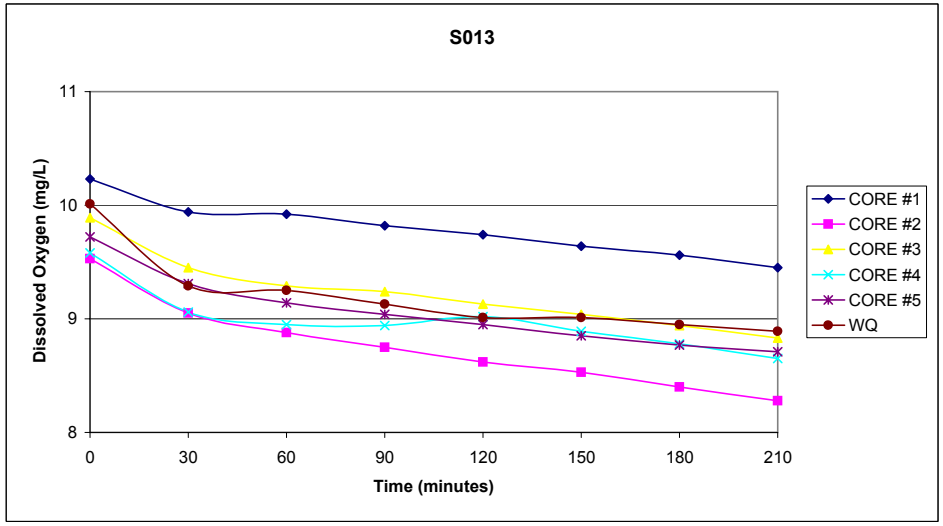
SOD Average	0.78
Std Dev	0.51

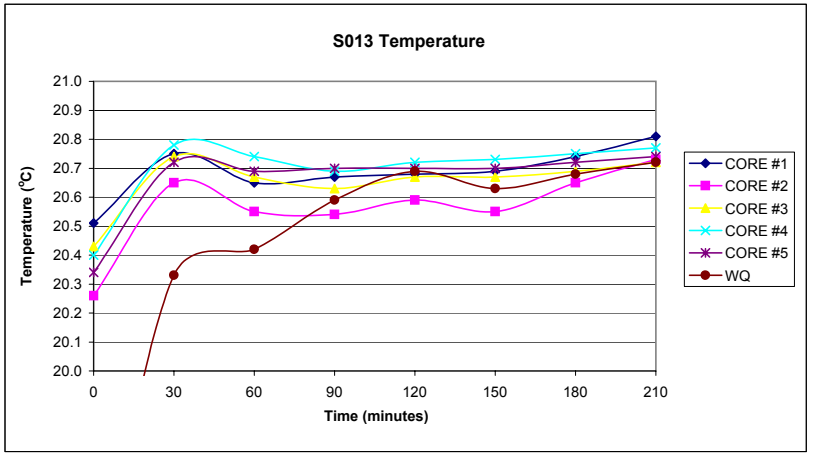
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1510	0	10.23	9.53	9.89	9.58	9.72	10.01	20.51	20.26	20.43	20.40	20.34	19.20
1540	30	9.94	9.05	9.45	9.06	9.31	9.29	20.75	20.65	20.74	20.78	20.72	20.33
1610	60	9.92	8.88	9.29	8.95	9.14	9.25	20.65	20.55	20.67	20.74	20.69	20.42
1640	90	9.82	8.75	9.24	8.94	9.04	9.13	20.67	20.54	20.63	20.69	20.70	20.59
1710	120	9.74	8.62	9.13	9.02	8.95	9.01	20.68	20.59	20.67	20.72	20.70	20.69
1740	150	9.64	8.53	9.04	8.89	8.85	9.01	20.69	20.55	20.67	20.73	20.70	20.63
1810	180	9.56	8.40	8.94	8.78	8.77	8.95	20.74	20.65	20.69	20.75	20.72	20.68
1840	210	9.45	8.28	8.83	8.65	8.71	8.89	20.81	20.73	20.72	20.77	20.74	20.72

SOD Average	1.93	1.58	2.37	1.79	2.16	1.74
Standard Deviation	0.33	SOD				

Analyzed by: Beth Kelley
Samples collected by: Beth Kelley, Erica Czerepak, Peg Foss





Upper Merimack River SOD Study

Station # S014 Station upstream of the Hooksett Dam and PSNH (Bow, NH)
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.372
2	0.384
3	0.452
4	0.412
5	0.445

Sample #	S014
Time	11:00
Date	10/8/2009

Other Analytes
Grainsize

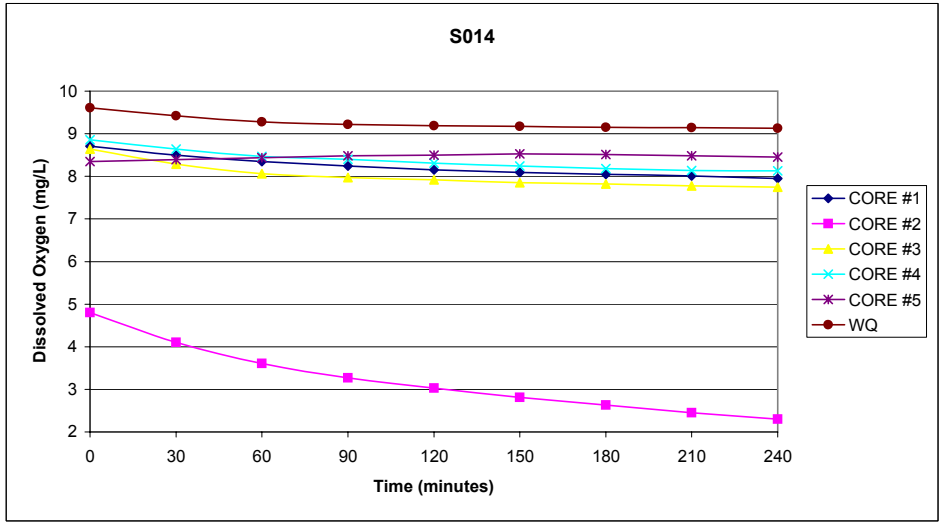
=highest D.O. over steady temp
= lowest D.O. over steady temp

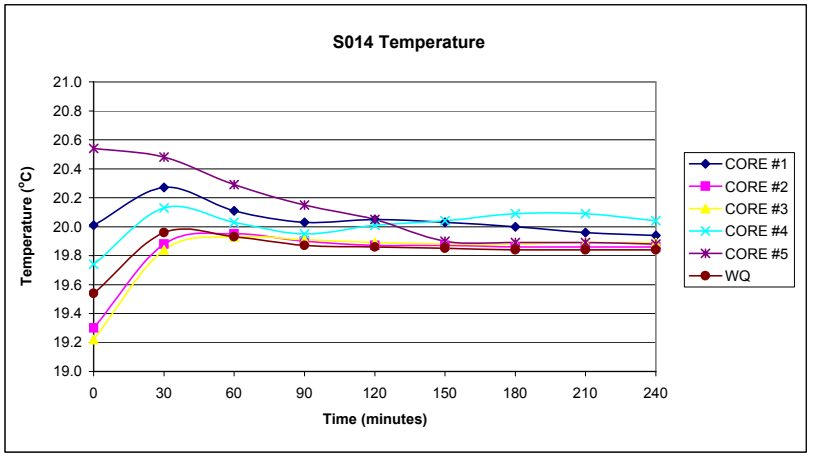
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1400	0	8.71	4.80	8.64	8.86	8.35	9.61	20.01	19.30	19.22	19.74	20.54	19.54
1430	30	8.50	4.10	8.29	8.64	8.39	9.42	20.27	19.88	19.84	20.13	20.48	19.96
1500	60	8.35	3.61	8.06	8.47	8.44	9.28	20.11	19.95	19.93	20.03	20.29	19.93
1530	90	8.24	3.27	7.97	8.40	8.48	9.22	20.03	19.90	19.91	19.95	20.15	19.87
1600	120	8.15	3.03	7.92	8.31	8.50	9.19	20.05	19.87	19.89	20.01	20.05	19.86
1630	150	8.09	2.81	7.85	8.24	8.53	9.17	20.03	19.87	19.88	20.04	19.90	19.85
1700	180	8.05	2.63	7.82	8.18	8.51	9.15	20.00	19.86	19.88	20.09	19.89	19.84
1730	210	8.01	2.45	7.78	8.14	8.48	9.14	19.96	19.86	19.89	20.09	19.89	19.84
1800	240	7.95	2.30	7.75	8.13	8.45	9.13	19.94	19.86	19.89	20.04	19.88	19.84

SOD Average	1.81	1.22	3.58	1.12	1.31	0.57
Standard Deviation	1.17	SOD				

Analyzed by: Mike Ferrier
Samples collected by: Erica Czerepak, Beth Kelley, Tim Bridges





Upper Merimack River SOD Study

Station # S015 Middle Station downstream of ?Dam Suncook? Below Power Lines (Hooksett/Bow, NH)
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.477
2	0.424
3	0.405
4	0.458
5	0.463

Sample #	S015
Time	10:00
Date	10/8/2009

Other Analytes
Grainsize

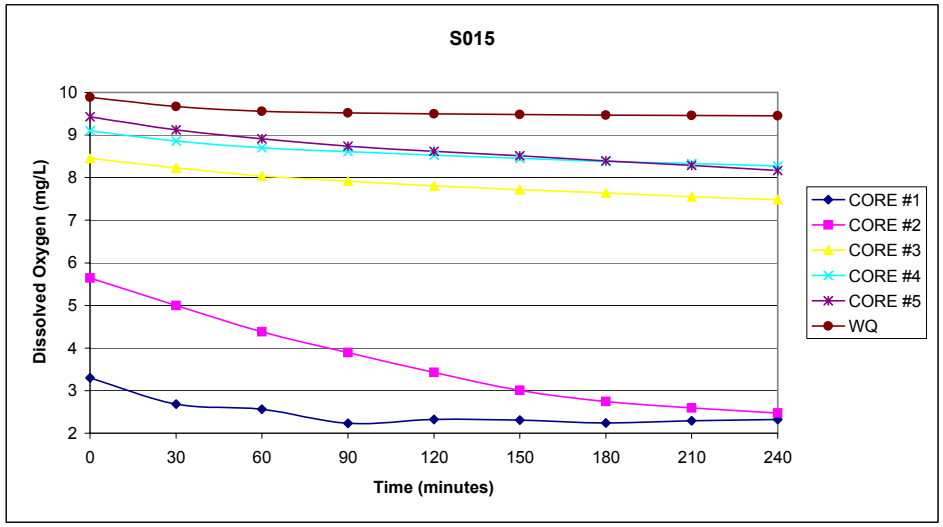
=highest D.O. over steady temp
= lowest D.O. over steady temp

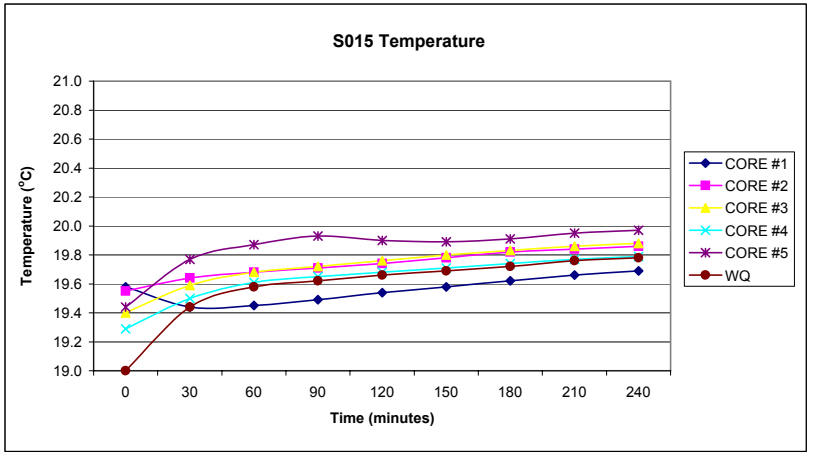
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1400	0	3.30	5.64	8.45	9.10	9.43	9.89	19.58	19.55	19.40	19.29	19.44	19.00
1430	30	2.68	5.00	8.23	8.86	9.12	9.67	19.44	19.64	19.59	19.50	19.77	19.44
1500	60	2.56	4.38	8.04	8.70	8.91	9.56	19.45	19.68	19.68	19.61	19.87	19.58
1530	90	2.23	3.89	7.92	8.61	8.74	9.52	19.49	19.71	19.72	19.65	19.93	19.62
1600	120	2.32	3.43	7.81	8.53	8.62	9.50	19.54	19.74	19.76	19.68	19.90	19.66
1630	150	2.31	3.01	7.72	8.45	8.51	9.48	19.58	19.78	19.80	19.71	19.89	19.69
1700	180	2.24	2.74	7.64	8.38	8.39	9.47	19.62	19.82	19.83	19.74	19.91	19.72
1730	210	2.29	2.59	7.55	8.33	8.29	9.46	19.66	19.84	19.86	19.77	19.95	19.76
1800	240	2.32	2.47	7.48	8.27	8.17	9.45	19.69	19.86	19.88	19.79	19.97	19.78

SOD Average	2.90	2.02	6.48	1.52	1.94	2.54
Standard Deviation	2.03	SOD				

Analyzed by: Mike Ferrier
Samples collected by: Erica Czerepak, Beth Kelley, Tim Bridges





Upper Merimack River SOD Study

Station # S016 Just upstream of Hooksett Dam (Hooksett, NH)
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.418
2	0.351
3	0.403
4	0.456
5	0.411

Sample #	S016
Time	11:00
Date	10/6/2009

Other Analytes
Grainsize

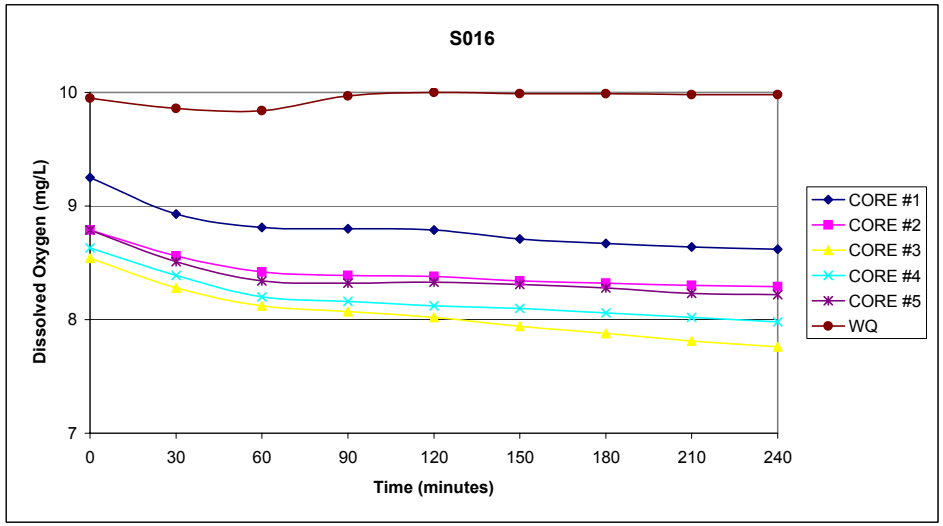
=highest D.O. over steady temp
= lowest D.O. over steady temp

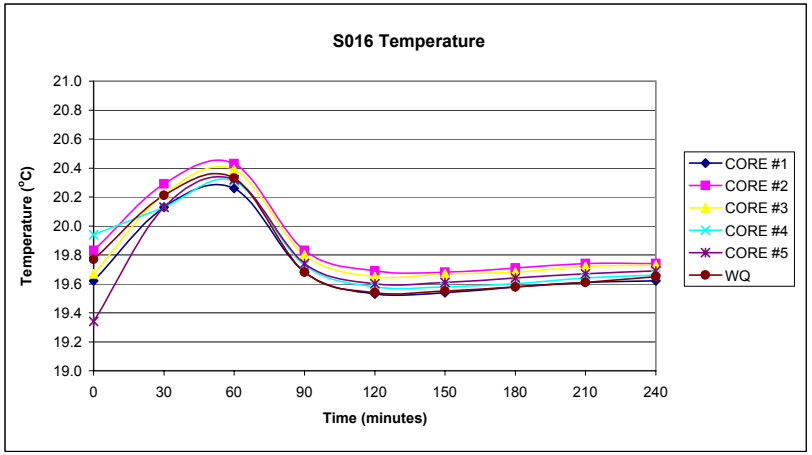
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1400	0	9.25	8.79	8.54	8.63	8.79	9.95	19.62	19.83	19.67	19.94	19.34	19.77
1430	30	8.93	8.56	8.28	8.39	8.51	9.86	20.13	20.29	20.22	20.13	20.13	20.21
1500	60	8.81	8.42	8.12	8.20	8.34	9.84	20.26	20.43	20.39	20.31	20.32	20.33
1530	90	8.80	8.39	8.07	8.16	8.32	9.97	19.68	19.83	19.80	19.73	19.74	19.68
1600	120	8.79	8.38	8.02	8.12	8.33	10.00	19.53	19.69	19.65	19.58	19.60	19.54
1630	150	8.71	8.34	7.94	8.10	8.31	9.99	19.54	19.68	19.67	19.58	19.61	19.55
1700	180	8.67	8.32	7.88	8.06	8.28	9.99	19.58	19.71	19.68	19.60	19.64	19.58
1730	210	8.64	8.30	7.81	8.02	8.23	9.98	19.61	19.74	19.72	19.64	19.67	19.61
1800	240	8.62	8.29	7.76	7.98	8.22	9.98	19.62	19.74	19.73	19.66	19.69	19.65

SOD Average	0.61	0.64	0.37	1.16	0.51	0.36
Standard Deviation	0.33	SOD				

Analyzed by: Mike Ferrier, Tim Bridges?
Samples collected by: Tim Bridges, Mike Ferrier, Beth Kelley





Upper Merimack River SOD Study

Station # S017 Station furthest upstream of Amoskeag Dam (Hooksett/Manchester)
River Reach: Upper Merrimack

AMBIENT WATER

	Water Column Height (meters)
1	0.363
2	0.284
3	0.343
4	0.309
5	0.364

Sample #	S017
Time	10:30
Date	10/14/2009

Other Analytes
Grainsize

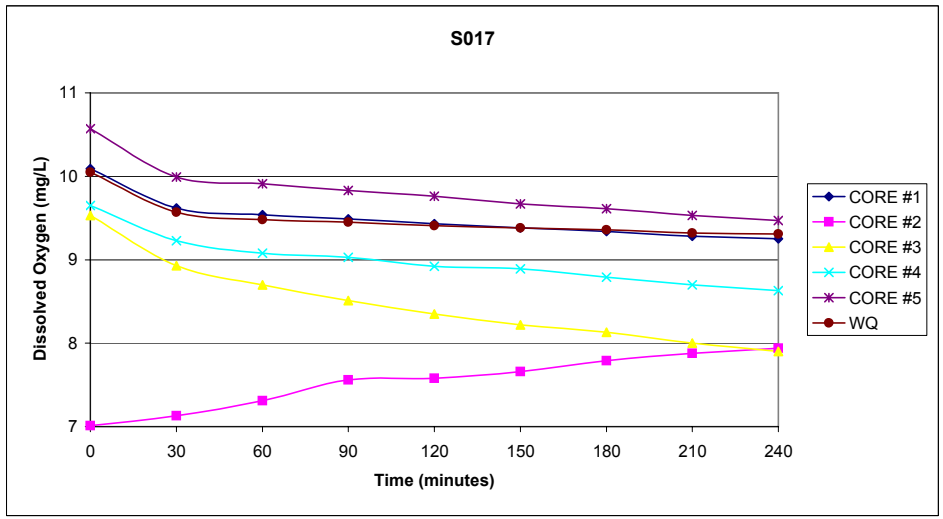
=highest D.O. over steady temp
= lowest D.O. over steady temp

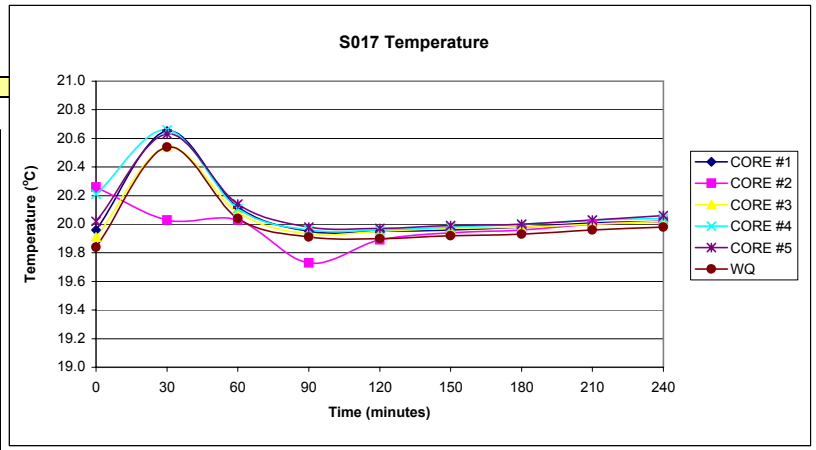
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1335	0	10.09	7.01	9.53	9.65	10.57	10.05	19.96	20.26	19.91	20.21	20.02	19.84
1405	30	9.62	7.13	8.93	9.23	9.99	9.57	20.65	20.03	20.54	20.66	20.63	20.54
1435	60	9.54	7.31	8.70	9.08	9.91	9.48	20.12	20.03	20.08	20.11	20.14	20.04
1505	90	9.49	7.56	8.51	9.03	9.83	9.45	19.95	19.73	19.93	19.96	19.98	19.91
1535	120	9.43	7.58	8.35	8.92	9.76	9.41	19.95	19.89	19.95	19.96	19.97	19.90
1605	150	9.38	7.66	8.22	8.89	9.67	9.38	19.96	19.94	19.97	19.98	19.99	19.92
1635	180	9.34	7.79	8.13	8.79	9.61	9.36	19.98	19.96	19.98	20.00	20.00	19.93
1705	210	9.28	7.88	8.00	8.70	9.53	9.32	20.01	20.00	20.00	20.03	20.03	19.96
1735	240	9.25	7.94	7.90	8.63	9.47	9.31	20.02	20.02	20.02	20.04	20.06	19.98
SOD Average	1.35	0.99	NA	2.20	1.11	1.10							
Standard Deviation	0.57	SOD											

Analyzed by: Erica Czerepak, Mike Ferrier
Samples collected by: Beth Kelley, Tim Bridges, Carol Elliot

Note: Core 2 was cracked at the top and bubbling





Upper Merimack River SOD Study

Station # S019 Station just upstream of Amoskeag Dam (Manchester, NH)
River Reach: Upper Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.381
2	0.390
3	0.373
4	0.343
5	0.381

Sample #	S019
Time	12:00
Date	10/14/2009

Other Analytes
Grainsize

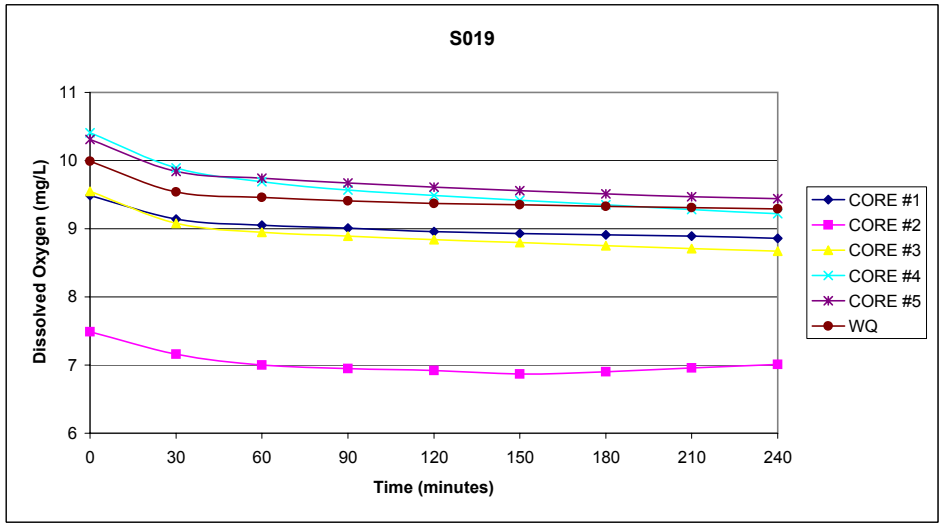
=highest D.O. over steady temp
= lowest D.O. over steady temp

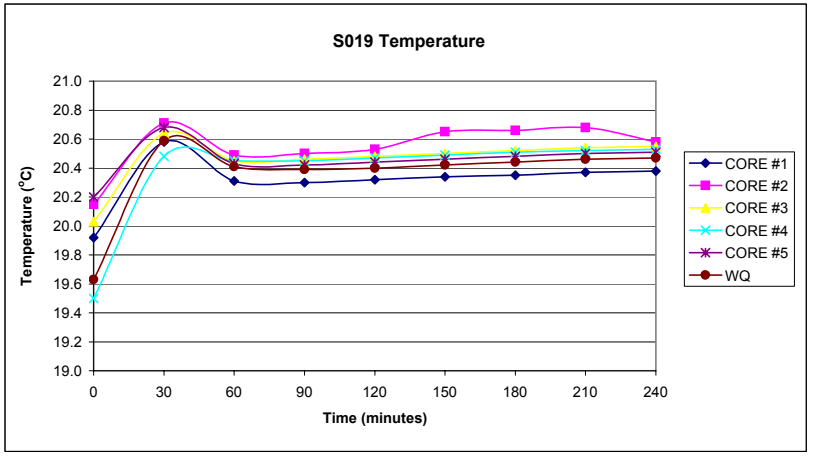
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1335	0	9.49	7.49	9.55	10.41	10.31	9.99	19.92	20.15	20.03	19.50	20.20	19.63
1405	30	9.14	7.16	9.08	9.89	9.84	9.54	20.58	20.71	20.64	20.48	20.68	20.59
1435	60	9.05	7.00	8.95	9.69	9.74	9.46	20.31	20.49	20.45	20.45	20.43	20.41
1505	90	9.01	6.95	8.89	9.57	9.67	9.41	20.30	20.50	20.46	20.45	20.42	20.39
1535	120	8.96	6.92	8.84	9.49	9.61	9.37	20.32	20.53	20.48	20.47	20.44	20.40
1605	150	8.93	6.87	8.80	9.42	9.56	9.35	20.34	20.65	20.50	20.49	20.46	20.42
1635	180	8.91	6.90	8.75	9.35	9.51	9.33	20.35	20.66	20.52	20.51	20.48	20.44
1705	210	8.89	6.96	8.71	9.28	9.47	9.31	20.37	20.68	20.54	20.52	20.50	20.46
1735	240	8.86	7.01	8.67	9.22	9.44	9.29	20.38	20.58	20.55	20.53	20.51	20.47

SOD Average	0.85	0.55	0.81	0.84	1.15	0.91
Standard Deviation	0.22	SOD				

Analyzed by: Erica Czerepak, Mike Ferrier
Samples collected by: Beth Kelley, Tim Bridges, Peg Foss (DES)





Upper Merimack River SOD Study

Station # S020 East site of Merrimack River behind Green Meado Gold Course (Hudson, NH)
River Reach: Lower Merrimack

AMBIENT WATER	Water Column Height (meters)
1	0.425
2	0.425
3	0.445
4	0.454
5	0.430

Sample #	S020
Time	17:00
Date	10/14/2009

Other Analytes
Grainsize

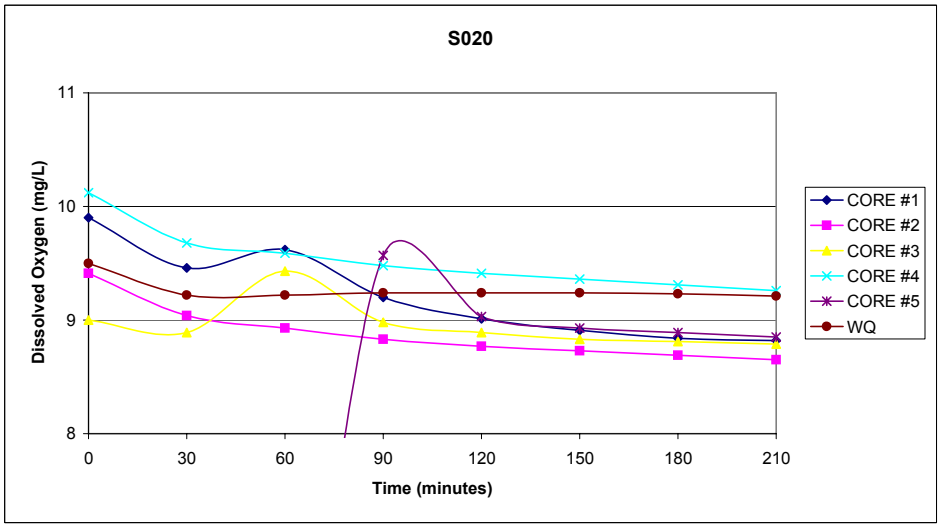
=highest D.O. over steady temp
= lowest D.O. over steady temp

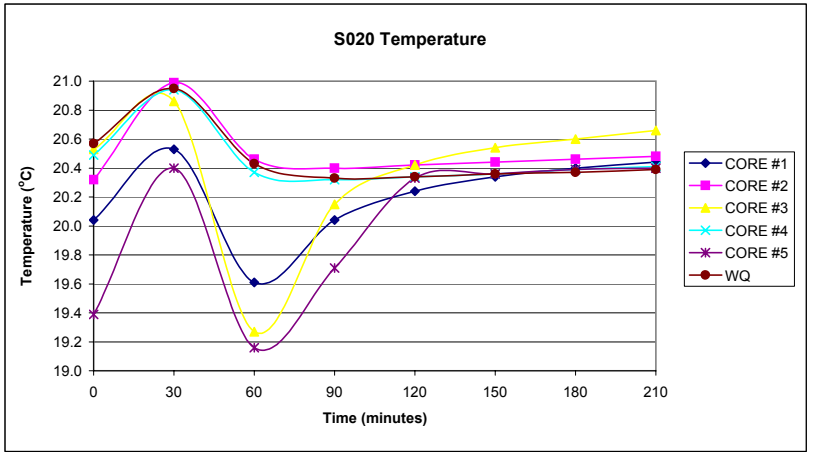
SOD ANALYSIS

TIME		Dissolved Oxgen (mg/l)						Temperature (C)					
		CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ	CORE #1	CORE #2	CORE #3	CORE #4	CORE #5	WQ
1830	0	9.90	9.41	9.00	10.12	5.51	9.50	20.04	20.32	20.53	20.49	19.39	20.57
1900	30	9.46	9.04	8.89	9.68	4.63	9.22	20.53	20.99	20.86	20.94	20.40	20.95
1930	60	9.62	8.93	9.43	9.59	5.04	9.22	19.61	20.46	19.27	20.37	19.16	20.43
2000	90	9.20	8.83	8.98	9.48	**9.57**	9.24	20.04	20.40	20.15	20.32	19.71	20.33
2030	120	9.01	8.77	8.89	9.41	9.03	9.24	20.24	20.42	20.42	20.34	20.33	20.34
2100	150	8.91	8.73	8.83	9.36	8.93	9.24	20.34	20.44	20.54	20.36	20.36	20.36
2130	180	8.84	8.69	8.81	9.31	8.89	9.23	20.40	20.46	20.60	20.39	20.39	20.37
2200	210	8.82	8.65	8.79	9.26	8.85	9.21	20.44	20.48	20.66	20.41	20.40	20.39
SOD Average	1.13	1.29	0.92	1.02	1.20	1.24							
Standard Deviation	0.16	SOD											

Analyzed by: Mike Ferrier
Samples collected by: Tim Bridges, Beth Kelley, Carol Elliot

Note: Core #5 stirrer was off until 2000





Measurement of Sediment Oxygen Demand (SOD) in the Upper Merrimack and Pemigewassett River, New Hampshire

Summer 2008

Project Work/QA Plan

U.S. Environmental Protection Agency
Region 1, New England

Office of Environmental Measurement and Evaluation
Ecosystem Assessment Unit

Project Work/QA Plan Acceptance

EPA QA Officer

Steve DiMattei, EPA/OEME/EQA Date: 07-24-08

EPA Project Officer

Leah Bowe, EPA/OEME/ECA Date: 07-25-08

NH DES

_____ Date:

Paul Currier, Watershed Management Bureau Administrator

1.0 Project Overview

New Hampshire Department of Environmental Services (NH DES), Water Division, has requested the Office of Environmental Measurement and Evaluation (OEME) assistance in evaluating the sediment oxygen demand (SOD) in the Upper Merrimack and Pemigewasset River as well as one site located in the Lower Merrimack River. NH DES is requesting that the SOD testing be performed as an extension of the work that has already been completed on the Lower Merrimack River, from Hooksett, NH downstream to the Atlantic Ocean in Newburyport, MA. The goal of this work is to extend the instream water quality modeling from Hooksett to Lincoln, NH. These investigations will provide the NH DES with measured rates of SOD at stations in the Upper Merrimack and Pemigewasset River. The SOD rates will also be used to identify areas of potential concern.

The site selections are based on known areas of low dissolved oxygen at local impoundments with 3 sample sites per impoundment and 1 sample site downstream of Franklin WWTF and 1 sample site downstream of Nashua WWTF. Sites are in areas where there is the best chance of finding fine sediment with lower dissolved oxygen including behind impoundments. Site descriptions are shown in Table 2 . Sample locations will be displayed on in map in the final report. Each core sampling location will be documented through the use of Global Positioning System (GPS).

A list of key stakeholders for this project is found in Table 1.

Table 1. Key Stakeholders

NH DES	USEPA Quality Assurance	USEPA Project Officer(s)	EPA Laboratory Activities	Field Activities
Paul Currier	Tim Bridges	Leah Bowe	Leah Bowe	USEPA

2.0 SOD Method Summary

This method involves confining a measurable volume of sediment and its overlying water, in a core sample and measuring the depletion of dissolved oxygen over time. Sediment sample cores are taken and transferred to a temperature controlled water bath. The dissolved oxygen concentration within these cores is measured over a specified period of time. Following the monitoring period, the SOD of the sediment is calculated. See Sediment Oxygen Demand Determination SOP 6.0 attached in Appendix A.

SOD is the total of biological and chemical processes in sediment that utilize oxygen. SOD studies are useful in the development of predictive mathematical models that will determine waste load allocations. They are also useful in measuring the depletion of oxygen in stratified waters when there are concerns about nutrient regeneration and the loss of aquatic life.

3.0 Interferences and Potential Problems

Sampling will be conducted at low energy depositional areas behind impoundments. Every effort will be made to collect depositional sediment rather than sand or gravel. Sand and gravel typically do not bind contaminants that may be present. In addition, sediment samples should be collected up-gradient of major bridges and roadways to avoid localized contaminants from road runoff. There are no significant known interferences for this project.

4.0 Sample Handling and Preservation

TOC and grain size samples will be preserved on ice in a cooler until they arrive at the laboratory. Samples will then be refrigerated at 4ºC. Table 4 and 5 list the holding time and preservation necessary for each parameter collected. The sample label will contain the following information: sample number; sample location or identifier; date and time of collection; and sampling personnel. Samples for SOD will have analysis performed within 4 hours of collection. Samples will be warmed to close to 20ºC before analysis. Samples will be collected according to the SOD SOP in Appendix A.

A bound field notebook will be maintained by field personnel to record sample collection information. A chain of custody form will be used to document the types and numbers of samples collected and logged. The sample storage coolers will be taped with signed chain-of-custody tape while the samples are being stored in the mobile laboratory.

5.0 Station Monitoring

Table 2. Sediment Station Descriptions and Locations

Station #	Station Description
S001	*U/S Ayers Island Dam 1*
S002	*U/S Ayers Island Dam 2*
S003	*U/S Ayers Island Dam 3*
S004	*U/S Franklin Falls Dam 1*
S005	*U/S Franklin Falls Dam 2*
S006	*U/S Franklin Falls Dam 3*
S007	*U/S Eastman Falls Dam 1*
S008	*U/S Eastman Falls Dam 2*
S009	*U/S Eastman Falls Dam 3*
S0010	*D/S Franklin WWTF*
S0011	*U/S Garvins Falls Dam 1*
S0012	*U/S Garvins Falls Dam 2*
S0013	*U/S Garvins Falls Dam 3*

S0014	*U/S Hooksett Dam 1*
S0015	*U/S Hooksett Dam 2*
S0016	*U/S Hooksett Dam 3*
S0017	*U/S Amoskeag Dam 1*
S0018	*U/S Amoskeag Dam 2*
S0019	*U/S Amoskeag Dam 3*
S0020	*Nashua Impairment*

6.0 Analytical Parameters

Analyses for SOD and dissolved oxygen will be conducted in the OEME Mobile Biology Trailer on site near the study areas. Grain Size and TOC will be performed at OEME when crews arrive back from the field and after they are logged into the sample custodian. Refer to Appendix A for sample collection procedure.

Table 3: Analytical Parameters for Water

Parameter	# of Samples	Container	Method	Preservation	Holding Times
Dissolved Oxygen	6	N/A	SM 4550 O G	N/A	Immediate
Temperature	6	N/A	SM 2550 B	N/A	Immediate

Table 4: Sediment Analytical Parameters

Parameter	# of Samples	+Dup.[1]	Total	Container	Method	Preservation	Holding Times
SOD	6	N/A	6	5 Acrylic Cores/site	OEME SOD SOP 7/07 REV 6.0	N/A	none
Grain Size	6	1	7	250 ml WM glass jar	OEME	Ice 4ºC	28 days

[1] **Duplicates samples will be collected in the field.**

Table 5: Water Analytical References and QC Goals

Parameter	# of Samples	Ranges	Precision	Accuracy	Completeness
Dissolved Oxygen	6	0.02 to 10.0 mg/L	± 0.1 mg/L	± 0.1 mg/L	90%
Temperature	6	- 5.0 to + 50.0ºC	N/A	± 0.1°C	95%

Table 6: Sediment Analytical References and QC Goals

Parameter	# of Samples	Range	Precision	Accuracy	Completeness
SOD	6	0.02 - 3.99 (g O_2/M^2/day)	Multi-core, Standard Deviation <50 %	±0.1 (g O_2/M^2/day)	90%

7.0 Project Schedule

1) Scoping Meeting	7/30/08
2) Site Recon	8/7/08
3) Collect water and sediment samples	8/11 -8/22/08
4) Complete sediment oxygen demand analysis and testing	8/22/08
5) Complete all analytical reports and release data	12/30/08
6) Complete assessment report incorporating all data	12/30/08
7) Meet with MDEP to discuss data	by 12/30/08

8.0 Data Quality

The quality of the data is to be within ranges associated with the specific approved protocols. Refer to parameter methods and standard operating procedures for more information.

Data Representativeness:

The sample must be representative of conditions existing at the time of sample collection. Field and laboratory conditions, which may affect sample integrity, are to be documented in the field logbook. At least 80% of the data must be determined to be representative for the project to be considered complete.

Laboratory Data Evaluation:

After data is review by the analyst, it is reviewed and signed off for release by the Field Project Manager and Acting EMT Team Leader.

Corrective Action:

When it is found that data is incomplete or that results are unacceptable, the Project Officer may determine that one or more of the following procedures for corrective action shall be undertaken:

1. Incomplete data:

Omissions from logs, notebooks and worksheets place the entire analysis in question. If data does not meet the 90% data completeness requirement, a meeting will be held with the analyst and QA officer to determine an appropriate response. Incomplete field sampling

data may require re- sampling of the questionable location. Incomplete laboratory data usually calls for reintroduction or re- analysis of the questionable sample if feasible.

2. Conflicting or poor quality data:

When results from duplicates, spikes, blanks, etc. do not meet the described QC goals, the project officer and QA officer will review the available data. Upon examination, all or some of the following actions may be applied:

a. Systems audit for analyte in question.
b. Determination of matrix interference.
c. Re-sampling of the questionable sample.
d. Reconsideration of acceptable limits with statements explaining the results of the action/rationale taken.
e. Rejection of data and exclusion from the report with written explanation.
f. Rejection of the entire sample/site location with recommendation of relocation of sample site or reconsideration of results.

9.0 Final Report

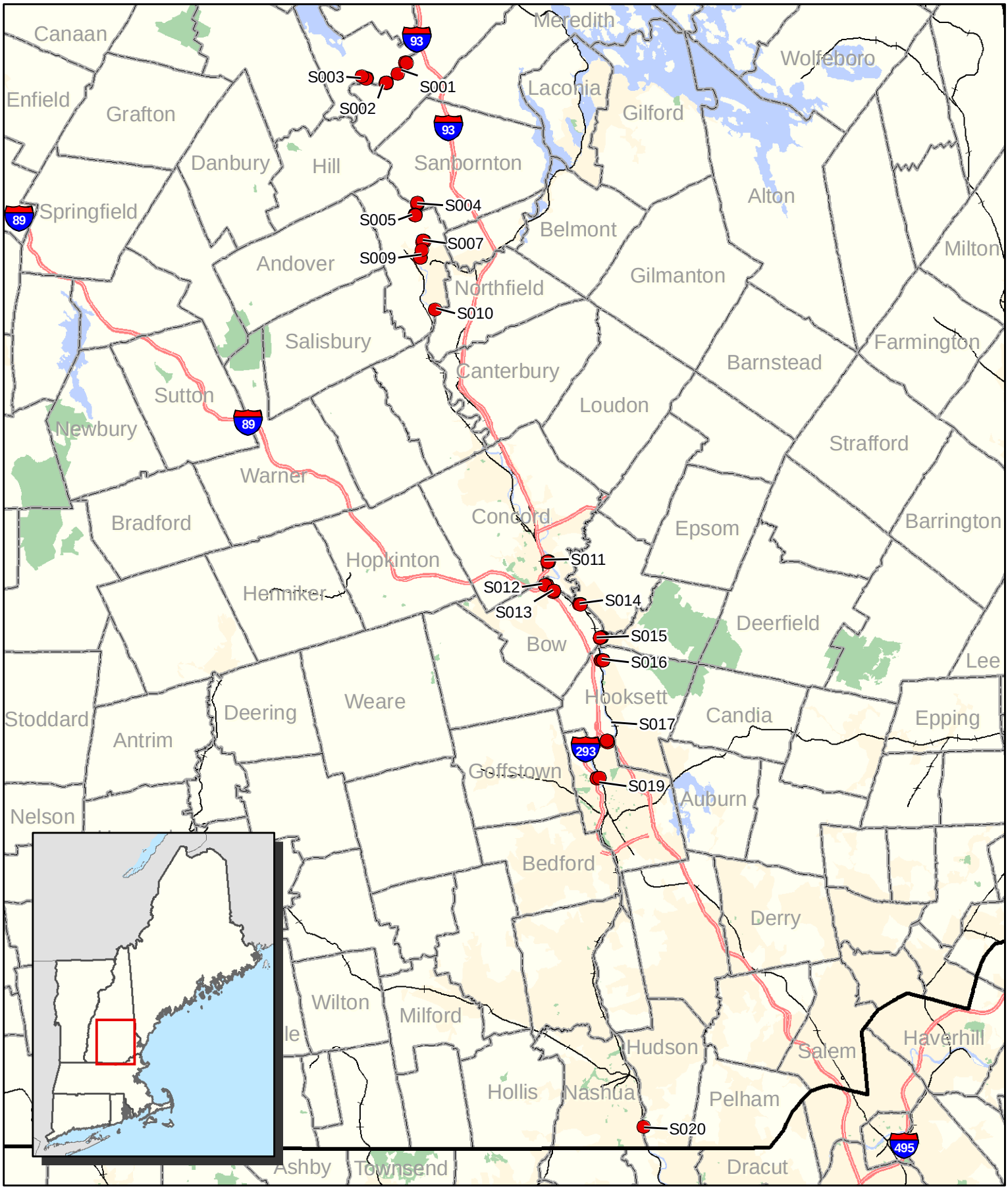
The final report will include all analytical results and water/sediment quality evaluations. The report will be written by Leah Bowe and Tim Bridges, then sent to Paul Currier at NH DES for future decision-making. If necessary, a meeting will be scheduled when the final report is released to discuss the results and future monitoring. A copy will remain in OEME central files. Other copies will be available upon request.

10.0 Reconciliation with Project Objectives

If the project objectives stated in section 1.0 and the QC goals in Tables 5 and 6 are met then the project goals have been met. If the project goals have not been met, project management will meet to determine future work under this QAPP.

11.0 Attachments

1) Sediment Oxygen Demand Determination SOP 6.0
2) Global Positioning System SOP – GEOXM

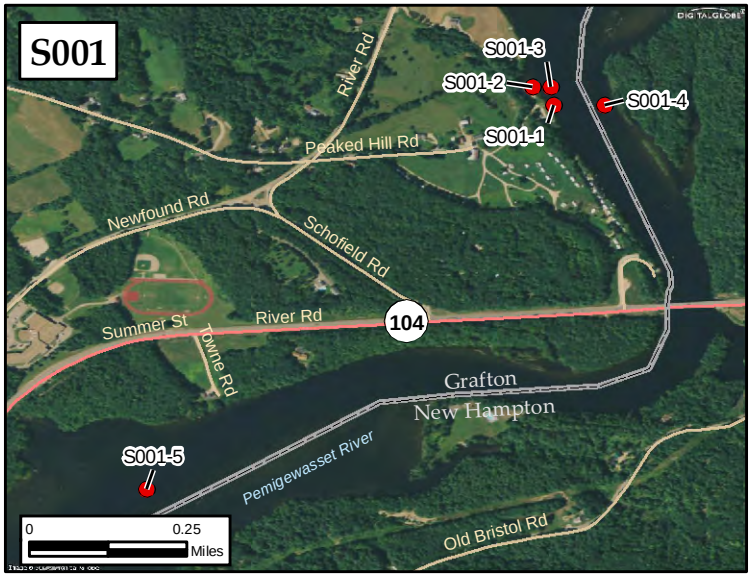


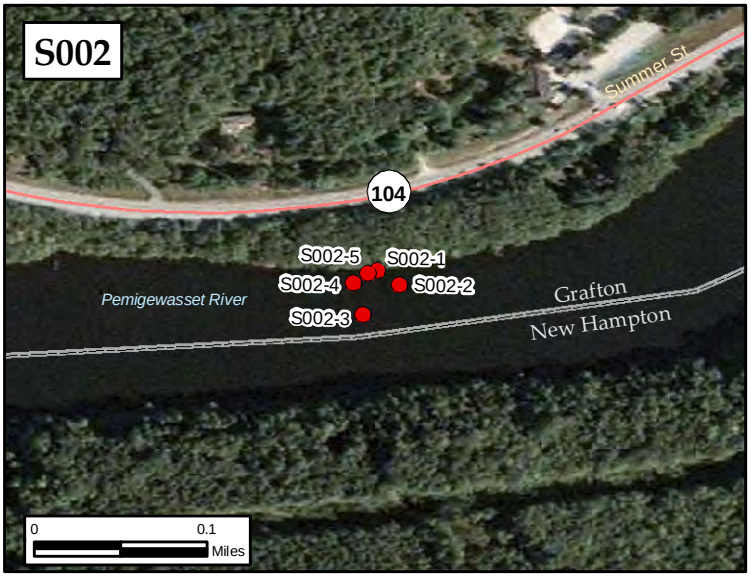
Merrimack River
SOD Sample Locations

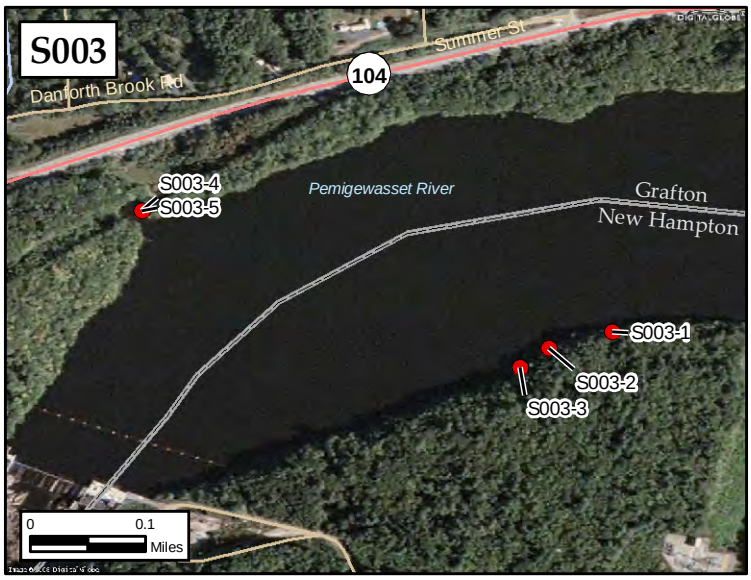
See Insets for Detail

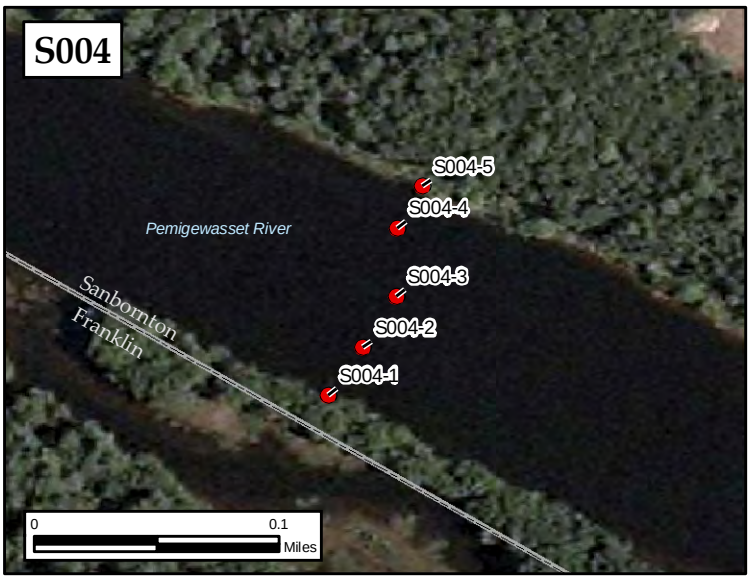
EPA

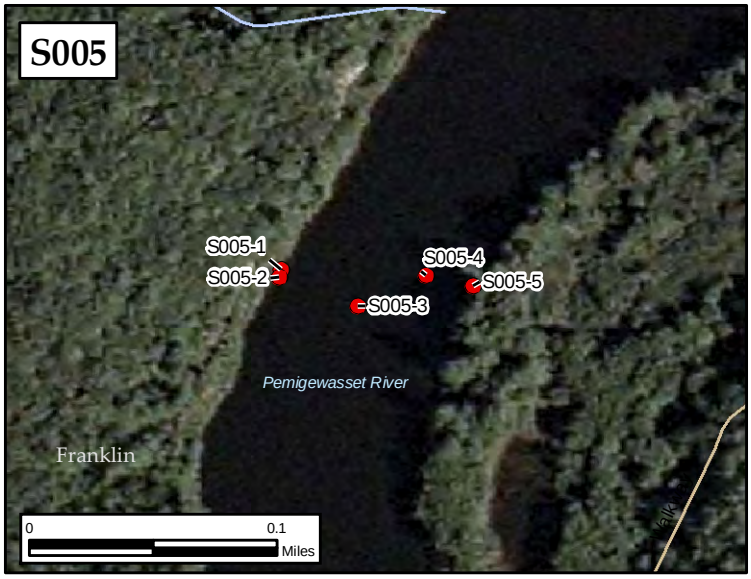
Map Created by EPA Region 1 GIS Center
Map Tracker ID 6494 December 30, 2009
Data Sources: Base map - TeleAtlas, 2007;

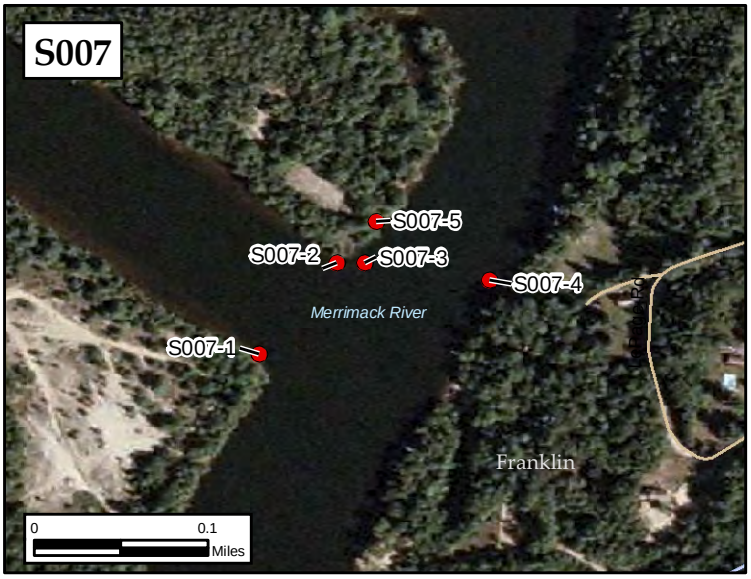












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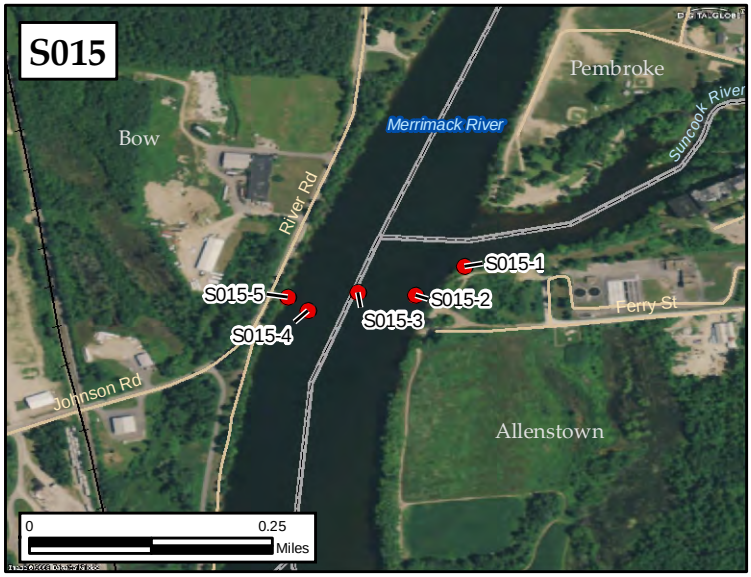
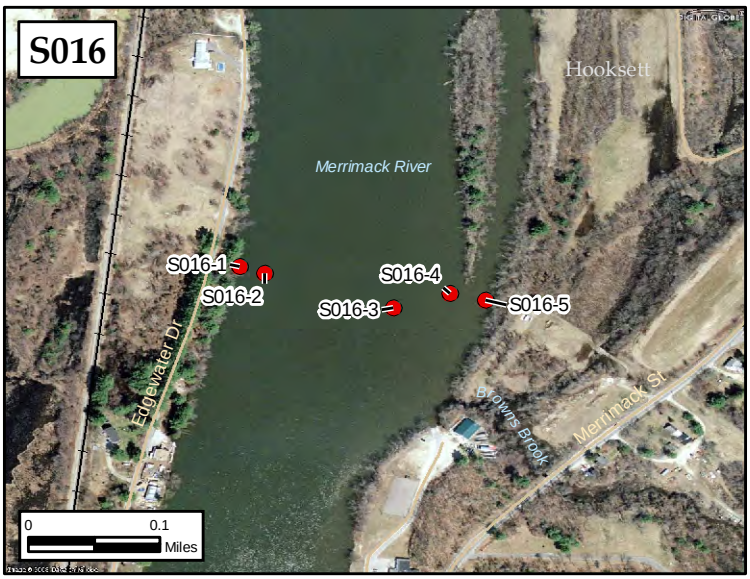
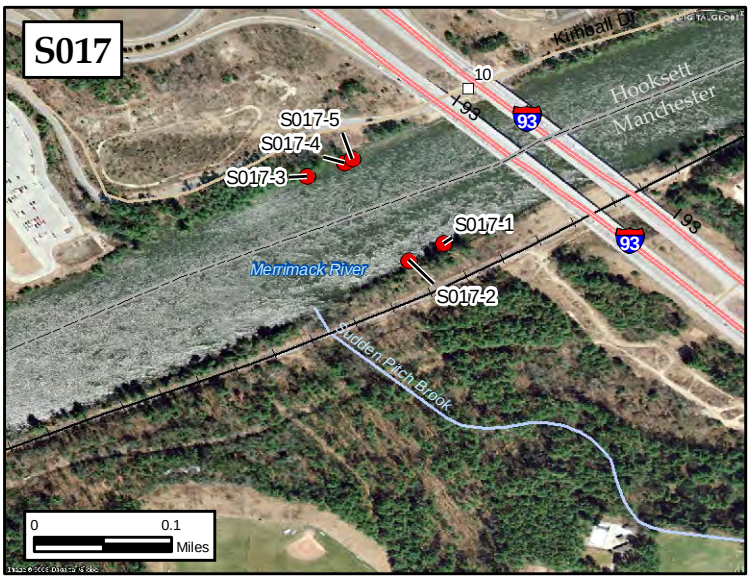
Merrimack River
SOD Sample Locations Insets
S001, S002, S003, S004, S005, S007

EPA

Map Created by EPA Region 1 GIS Center
Map Tracker ID 6494 January 5, 2010
Data Sources: Base map - TeleAtlas, 2007;



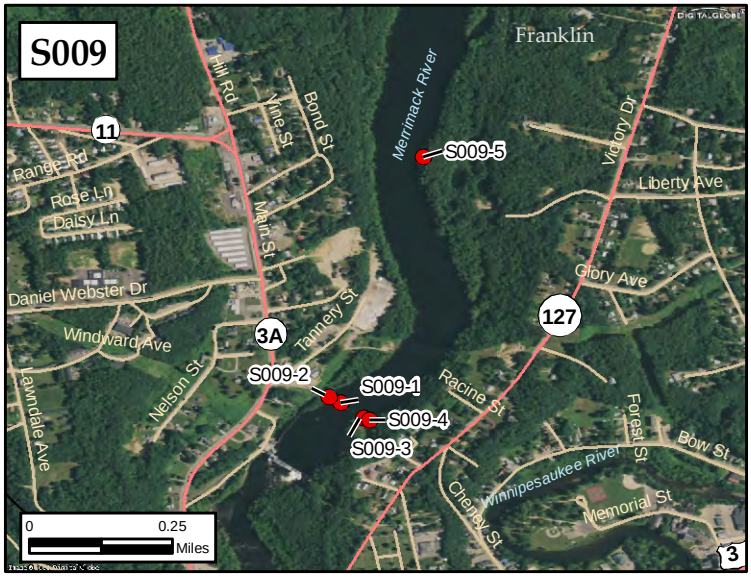


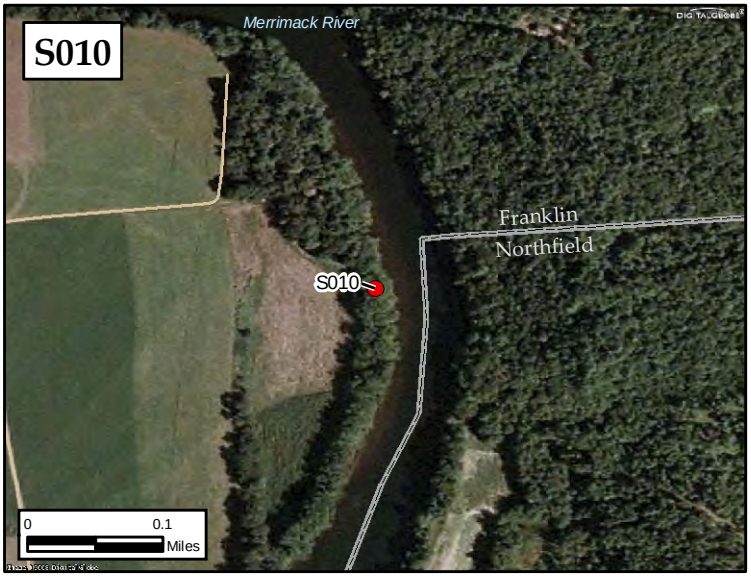


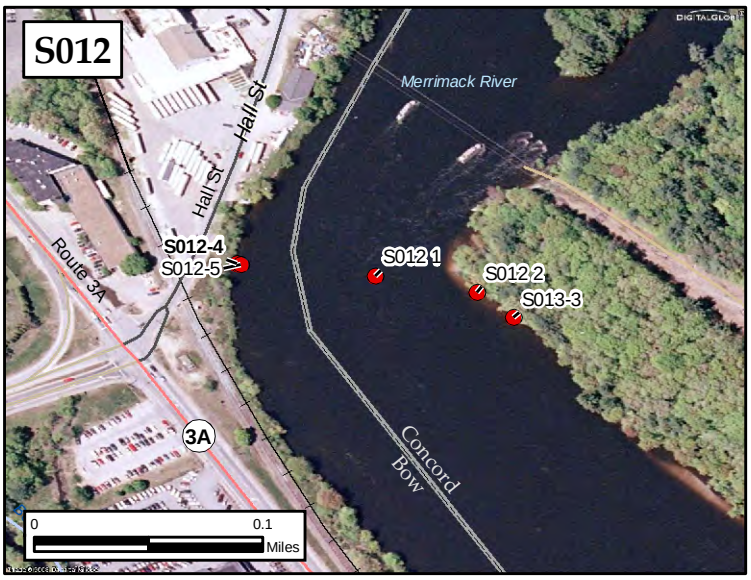
Merrimack River
SOD Sample Locations Insets
S015, S016, S017, S019, S020

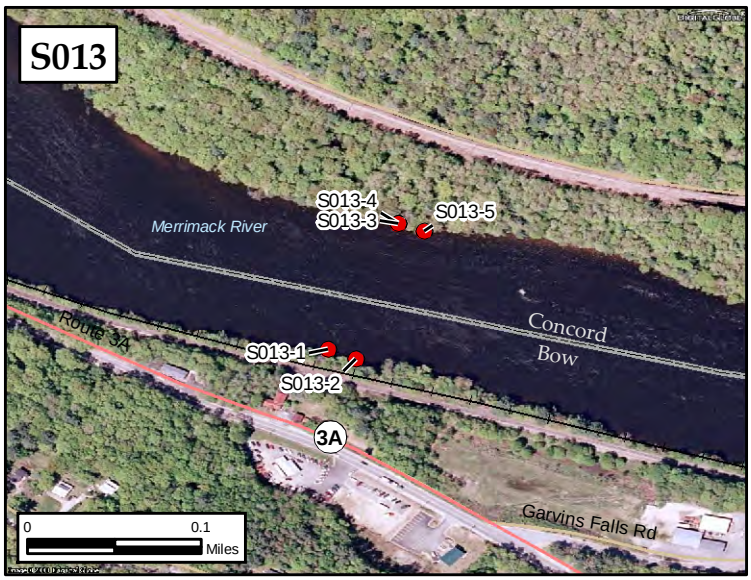
EPA

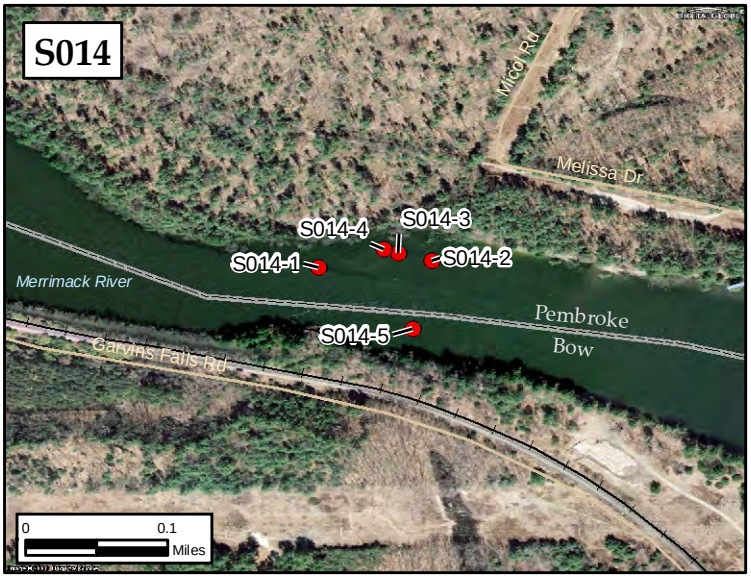
Map Created by EPA Region 1 GIS Center
Map Tracker ID 6494 January 7, 2010
Data Sources: Base map - TeleAtlas, 2007;











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Merrimack River
SOD Sample Locations Insets

S009, S010, S011, S012, S013, S014

EPA

Map Created by EPA Region 1 GIS Center
Map Tracker ID 6494 December 30, 2009
Data Sources: Base map - TeleAtlas, 2007;

Latitude	*Longitude*	*Station*	*PDOP*	*Correction Status*	*Unit Type*	*Date*	*Time*	*Feature Type*	*Filename*	*# of Pos*	*Horiz Acc*	*Depth*	*Water Temp*
decdeg	*decdeg*				*Trimble*		*EST*				*meteres*	*feet*	*Surface (F)*
43.611147	-71.665893	S001-1	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	13:25:10	Point	B100813A.cor	24	1.0	11.2	55.4
43.611576	-71.666396	S001-2	2.7	Postprocessed Code	GeoExplorer 3	10/8/2009	13:55:45	Point	B100813A.cor	12	1.0	1.5	55.4
43.611585	-71.665970	S001-3	4.2	Postprocessed Code	GeoExplorer 3	10/8/2009	13:56:53	Point	B100813A.cor	58	1.2	2.6	52.7
43.611146	-71.664721	S001-4	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	14:10:48	Point	B100813A.cor	64	1.0	9.7	52.7
43.602281	-71.675310	S001-5	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	14:18:54	Point	B100813A.cor	211	1.3	6.1	52.7
43.595368	-71.688881	S002-1	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	14:39:37	Point	B100813A.cor	28	1.7	8.1	51.8
43.595249	-71.688696	S002-2	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	14:46:25	Point	B100813A.cor	34	1.6	10.5	51.8
		S002-3		No Satellites under canopy Eastern Shore		10/8/2009						3.6	51.8
43.595263	-71.689084	S002-4	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	15:16:29	Point	B100813A.cor	36	1.7	9.5	51.8
43.595343	-71.688961	S002-5	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	15:19:39	Point	B100813A.cor	29	1.7	6.8	51.8
43.599685	-71.710624	S003-1	4.8	Real-time SBAS Corrected	GeoXM 2008	10/15/2009	15:18:42	Point	R101512A.cor	4	4.2	2.8	43.7
43.599478	-71.711414	S003-2	2.3	Postprocessed Code	GeoXM 2008	10/15/2009	15:22:40	Point	R101512A.cor	27	1.5	1.5	43.7
43.599237	-71.711776	S003-3	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	15:26:33	Point	R101512A.cor	10	4	2.7	42.7
43.601196	-71.716507	S003-4	5.3	Postprocessed Code	GeoXM 2008	10/15/2009	15:37:49	Point	R101512A.cor	9		2.7	42.7
43.493066	-71.657981	S004-1	4.1	Postprocessed Code	GeoExplorer 3	10/12/2009	12:34:43	Point	B101215A.cor	22	1.1	4.0	53.6
43.493347	-71.657772	S004-2	4.7	Postprocessed Code	GeoExplorer 3	10/12/2009	12:43:58	Point	B101215A.cor	51	1.0	10.6	52.7
43.493652	-71.657578	S004-3	4.7	Postprocessed Code	GeoExplorer 3	10/12/2009	12:49:03	Point	B101215A.cor	65	1.1	14.6	52.7
43.494055	-71.657569	S004-4	4.4	Postprocessed Code	GeoExplorer 3	10/12/2009	12:54:59	Point	B101215A.cor	69	1.0	17.4	58.1
43.494303	-71.657420	S004-5	4.2	Postprocessed Code	GeoExplorer 3	10/12/2009	13:02:26	Point	B101215A.cor	12	1.0	3.2	53.6
43.484320	-71.661223	S005-1	4.0	Postprocessed Code	GeoExplorer 3	10/12/2009	11:40:57	Point	B101215A.cor	11	1.5	2.0	59.0
43.484276	-71.661230	S005-2	4.0	Postprocessed Code	GeoExplorer 3	10/12/2009	11:52:28	Point	B101215A.cor	17	1.6	19.5	53.6
43.484111	-71.660770	S005-3	3.4	Postprocessed Code	GeoExplorer 3	10/12/2009	12:00:46	Point	B101215A.cor	49	1.0	52.7	24.2
43.484288	-71.660372	S005-4	4.3	Postprocessed Code	GeoExplorer 3	10/12/2009	12:13:31	Point	B101215A.cor	34	0.9	22.2	55.4
43.484229	-71.660093	S005-5	4.6	Postprocessed Code	GeoExplorer 3	10/12/2009	12:19:28	Point	B101215A.cor	19	1.2	2.9	52.7
43.461799	-71.653455	S007-1	4.3	Postprocessed Code	GeoXM 2008	10/9/2009	11:04:11	Point	R100910A.cor	21	1.4	7.1	51.8
43.462559	-71.652804	S007-2	2.9	Postprocessed Code	GeoXM 2008	10/9/2009	11:09:12	Point	R100910A.cor	22	1.3	5.7	51.8
43.462558	-71.652567	S007-3	2.4	Postprocessed Code	GeoXM 2008	10/9/2009	11:16:08	Area	R100910A.cor	22		11.1	51.8
43.462417	-71.651530	S007-4	4.7	Postprocessed Code	GeoXM 2008	10/9/2009	11:23:55	Area	R100910A.cor	21		9.3	51.8
43.462905	-71.652470	S007-5	4.3	Postprocessed Code	GeoXM 2008	10/9/2009	11:28:25	Area	R100910A.cor	44		1.5	51.8
43.448763	-71.656629	S009-1	3.4	Postprocessed Code	GeoXM 2008	10/9/2009	10:20:31	Point	R100910A.cor	25	1.0	11.8	55.4
43.448929	-71.656922	S009-2	3.7	Postprocessed Code	GeoXM 2008	10/9/2009	10:35:50	Point	R100910A.cor	21	1.4	1.5	53.6
43.448394	-71.656034	S009-3	2.7	Postprocessed Code	GeoXM 2008	10/9/2009	10:46:45	Point	R100910A.cor	20	1.0	12.8	53.6
43.448328	-71.655893	S009-4	5.1	Postprocessed Code	GeoXM 2008	10/9/2009	10:49:31	Point	R100910A.cor	55	1.4	1.5	53.6
43.455014	-71.654512	S009-5	5.3	Postprocessed Code	GeoXM 2008	10/9/2009	10:53:02	Point	R100910A.cor	612	1.0	5.4	52.7
43.404883	-71.641898	S010	4.8	Real-time SBAS Corrected	GeoXM 2008	10/14/2009	14:18:48	Point	S010 WALK IN.cor	20	3.0		
43.191910	-71.522110	S011-1	4.5	Postprocessed Code	GeoXM 2008	10/15/2009	12:59:51	Point	R101512A.cor	42	1.1	3.5	44.6
43.191739	-71.522245	S011-2	4.5	Postprocessed Code	GeoXM 2008	10/15/2009	13:03:29	Point	R101512A.cor	43	1	2.6	44.6
43.191400	-71.521750	S011-3	2.6	Postprocessed Code	GeoXM 2008	10/15/2009	13:13:36	Point	R101512A.cor	25	1.4	3.2	42.8
43.191340	-71.523067	S011-4	4.7	Postprocessed Code	GeoXM 2008	10/15/2009	13:20:37	Point	R101512A.cor	38	2.2	4.3	44.6
43.191449	-71.523306	S011-5	4.7	Postprocessed Code	GeoXM 2008	10/15/2009	13:26:14	Point	R101512A.cor	12	2.2	5.2	44.6

Latitude	*Longitude*	*Station*	*PDOP*	*Correction Status*	*Unit Type*	*Date*	*Time*	*Feature Type*	*Filename*	*# of Pos*	*Horiz Acc*	*Depth*	*Water Temp*
decdeg	*decdeg*				*Trimble*		*EST*				*meteres*	*feet*	*Surface (F)*
43.172345	-71.525547	S012 1	3.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:30:02	Point	S012.cor	21	1.9	2.1	45.5
43.172239	-71.524903	S012 2	4.1	Postprocessed Code	GeoXM 2008	10/15/2009	11:41:57	Point	S012.cor	42	2.2	2.1	45.5
43.172078	-71.524670	S013-3	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	11:45:54	Point	S012.cor	21	2.3	4.4	44.6
43.172425	-71.526425	S012-4	4.1	Postprocessed Code	GeoXM 2008	10/15/2009	11:51:58	Point	S012.cor	20	1.8	4.4	44.6
43.172419	-71.526404	S012-5	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	11:54:37	Point	S012.cor	78	2.0	4.4	44.6
43.166069	-71.517729	S013-1	3.3	Postprocessed Code	GeoXM 2008	10/15/2009	10:31:57	Point	S013.cor	21	1.2	3.0	41.0
43.165992	-71.517499	S013-2	2.8	Postprocessed Code	GeoXM 2008	10/15/2009	10:57:03	Point	S013.cor	21	1.5	6.3	41.8
43.167115	-71.517149	S013-3	4.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:15:36	Point	S013.cor	22	2.2	3.0	44.6
43.167115	-71.517149	S013-4	4.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:15:36	Point	S013.cor	22	2.2	3.0	44.6
43.167049	-71.516929	S013-5	4.6	Postprocessed Code	GeoXM 2008	10/15/2009	11:19:24	Point	S013.cor	21	2.5	3.0	44.6
43.155338	-71.488354	S014-1	3.5	Postprocessed Code	GeoExplorer 3	10/8/2009	10:42:43	Point	B100813A.cor	4	1.1	3.6	54.5
43.155408	-71.487202	S014-2	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	10:55:28	Point	B100813A.cor	41	1.1	19.2	54.5
43.155480	-71.487547	S014-3	4.9	Postprocessed Code	GeoExplorer 3	10/8/2009	11:04:31	Point	B100813A.cor	43	1.1	7.5	54.5
43.155522	-71.487690	S014-4	4.0	Postprocessed Code	GeoExplorer 3	10/8/2009	11:10:22	Point	B100813A.cor	18	1.2	7.5	54.5
43.154713	-71.487396	S014-5	4.1	Postprocessed Code	GeoExplorer 3	10/8/2009	11:12:27	Point	B100813A.cor	42	1.4	7.6	54.5
43.127264	-71.463961	S015-1	4.9	Postprocessed Code	GeoExplorer 3	10/8/2009	9:34:31	Point	B100813A.cor	22	1.3	6.5	57.2
43.126842	-71.464692	S015-2	3.1	Postprocessed Code	GeoExplorer 3	10/8/2009	9:51:16	Point	B100813A.cor	29	1.1	5.0	56.3
43.126878	-71.465552	S015-3	3.1	Postprocessed Code	GeoExplorer 3	10/8/2009	9:53:57	Point	B100813A.cor	39	1.1	9.0	55.4
43.126607	-71.466297	S015-4	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	10:02:30	Point	B100813A.cor	23	1.0	9.5	54.5
43.126804	-71.466596	S015-5	4.3	Postprocessed Code	GeoExplorer 3	10/8/2009	10:10:24	Point	B100813A.cor	22	1.0	8.1	54.0
43.108161	-71.466115	S016-1	4.0	Postprocessed Code	GeoExplorer 3	10/6/2009	10:53:09	Point	B100614A.cor	15	1.2	7.0	68.0
43.108090	-71.465837	S016-2	4.2	Postprocessed Code	GeoExplorer 3	10/6/2009	11:14:27	Point	B100614A.cor	13	1.0	7.6	66.0
43.107702	-71.464409	S016-3	4.1	Postprocessed Code	GeoExplorer 3	10/6/2009	11:27:23	Point	B100614A.cor	14	1.3	9.6	62.0
43.107864	-71.463783	S016-4	4.3	Postprocessed Code	GeoExplorer 3	10/6/2009	11:33:03	Point	B100614A.cor	87	1.3	7.6	59.0
43.107789	-71.463393	S016-5	4.8	Postprocessed Code	GeoExplorer 3	10/6/2009	11:51:59	Point	B100614A.cor	18	1.3	5.1	59.0
43.039817	-71.461782	S017-1		Google Map Location	N/A	10/14/2009		Point				1.0	49.1
43.037928	-71.461782	S017-2		Google Map Location	N/A	10/14/2009		Point				8.3	44.5
43.040533	-71.463225	S017-3		Google Map Location	N/A	10/14/2009		Point				7.4	46.4
43.040669	-71.462825	S017-4		Google Map Location	N/A	10/14/2009		Point				10.9	48.2
43.040715	-71.462742	S017-5		Google Map Location	N/A	10/14/2009		Point				1.0	49.1
43.009827	-71.475544	S019-1		Google Map Location	N/A	10/14/2009		Point				2.0	57.2
43.009687	-71.475640	S019-2		Google Map Location	N/A	10/14/2009		Point				7.6	53.6
43.009645	-71.475802	S019-3		Google Map Location	N/A	10/14/2009		Point				8.3	50.9
43.010247	-71.472817	S019-4		Google Map Location	N/A	10/14/2009		Point				11.2	48.3
43.010261	-71.472597	S019-5		Google Map Location	N/A	10/14/2009		Point				1.5	46.4
42.71781032	-71.43634464	S020	5.9	Postprocessed Code	GeoXM 2008	10/14/2009	16:56:13	Point_generic	S020 1-5_1.cor	21	4.5		

Latitude	*Longitude*	*Station*	*PDOP*	*Correction Status*	*Unit Type*	*Date*	*Time*	*Feature Type*	*Filename*	*# of Pos*	*Horiz Acc*	*Depth*	*Water Temp*
decdeg	*decdeg*				*Trimble*		*EST*				*meteres*	*feet*	*Surface (F)*
43.611147	-71.665893	S001-1	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	13:25:10	Point	B100813A.cor	24	1.0	11.2	55.4
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43.611146	-71.664721	S001-4	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	14:10:48	Point	B100813A.cor	64	1.0	9.7	52.7
43.602281	-71.675310	S001-5	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	14:18:54	Point	B100813A.cor	211	1.3	6.1	52.7
43.595368	-71.688881	S002-1	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	14:39:37	Point	B100813A.cor	28	1.7	8.1	51.8
43.595249	-71.688696	S002-2	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	14:46:25	Point	B100813A.cor	34	1.6	10.5	51.8
		S002-3		No Satellites under canopy Eastern Shore		10/8/2009						3.6	51.8
43.595263	-71.689084	S002-4	5.0	Postprocessed Code	GeoExplorer 3	10/8/2009	15:16:29	Point	B100813A.cor	36	1.7	9.5	51.8
43.595343	-71.688961	S002-5	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	15:19:39	Point	B100813A.cor	29	1.7	6.8	51.8
43.599685	-71.710624	S003-1	4.8	Real-time SBAS Corrected	GeoXM 2008	10/15/2009	15:18:42	Point	R101512A.cor	4	4.2	2.8	43.7
43.599478	-71.711414	S003-2	2.3	Postprocessed Code	GeoXM 2008	10/15/2009	15:22:40	Point	R101512A.cor	27	1.5	1.5	43.7
43.599237	-71.711776	S003-3	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	15:26:33	Point	R101512A.cor	10	4	2.7	42.7
43.601196	-71.716507	S003-4	5.3	Postprocessed Code	GeoXM 2008	10/15/2009	15:37:49	Point	R101512A.cor	9		2.7	42.7
43.493066	-71.657981	S004-1	4.1	Postprocessed Code	GeoExplorer 3	10/12/2009	12:34:43	Point	B101215A.cor	22	1.1	4.0	53.6
43.493347	-71.657772	S004-2	4.7	Postprocessed Code	GeoExplorer 3	10/12/2009	12:43:58	Point	B101215A.cor	51	1.0	10.6	52.7
43.493652	-71.657578	S004-3	4.7	Postprocessed Code	GeoExplorer 3	10/12/2009	12:49:03	Point	B101215A.cor	65	1.1	14.6	52.7
43.494055	-71.657569	S004-4	4.4	Postprocessed Code	GeoExplorer 3	10/12/2009	12:54:59	Point	B101215A.cor	69	1.0	17.4	58.1
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43.484320	-71.661223	S005-1	4.0	Postprocessed Code	GeoExplorer 3	10/12/2009	11:40:57	Point	B101215A.cor	11	1.5	2.0	59.0
43.484276	-71.661230	S005-2	4.0	Postprocessed Code	GeoExplorer 3	10/12/2009	11:52:28	Point	B101215A.cor	17	1.6	19.5	53.6
43.484111	-71.660770	S005-3	3.4	Postprocessed Code	GeoExplorer 3	10/12/2009	12:00:46	Point	B101215A.cor	49	1.0	52.7	24.2
43.484288	-71.660372	S005-4	4.3	Postprocessed Code	GeoExplorer 3	10/12/2009	12:13:31	Point	B101215A.cor	34	0.9	22.2	55.4
43.484229	-71.660093	S005-5	4.6	Postprocessed Code	GeoExplorer 3	10/12/2009	12:19:28	Point	B101215A.cor	19	1.2	2.9	52.7
43.461799	-71.653455	S007-1	4.3	Postprocessed Code	GeoXM 2008	10/9/2009	11:04:11	Point	R100910A.cor	21	1.4	7.1	51.8
43.462559	-71.652804	S007-2	2.9	Postprocessed Code	GeoXM 2008	10/9/2009	11:09:12	Point	R100910A.cor	22	1.3	5.7	51.8
43.462558	-71.652567	S007-3	2.4	Postprocessed Code	GeoXM 2008	10/9/2009	11:16:08	Area	R100910A.cor	22		11.1	51.8
43.462417	-71.651530	S007-4	4.7	Postprocessed Code	GeoXM 2008	10/9/2009	11:23:55	Area	R100910A.cor	21		9.3	51.8
43.462905	-71.652470	S007-5	4.3	Postprocessed Code	GeoXM 2008	10/9/2009	11:28:25	Area	R100910A.cor	44		1.5	51.8
43.448763	-71.656629	S009-1	3.4	Postprocessed Code	GeoXM 2008	10/9/2009	10:20:31	Point	R100910A.cor	25	1.0	11.8	55.4
43.448929	-71.656922	S009-2	3.7	Postprocessed Code	GeoXM 2008	10/9/2009	10:35:50	Point	R100910A.cor	21	1.4	1.5	53.6
43.448394	-71.656034	S009-3	2.7	Postprocessed Code	GeoXM 2008	10/9/2009	10:46:45	Point	R100910A.cor	20	1.0	12.8	53.6
43.448328	-71.655893	S009-4	5.1	Postprocessed Code	GeoXM 2008	10/9/2009	10:49:31	Point	R100910A.cor	55	1.4	1.5	53.6
43.455014	-71.654512	S009-5	5.3	Postprocessed Code	GeoXM 2008	10/9/2009	10:53:02	Point	R100910A.cor	612	1.0	5.4	52.7
43.404883	-71.641898	S010	4.8	Real-time SBAS Corrected	GeoXM 2008	10/14/2009	14:18:48	Point	S010 WALK IN.cor	20	3.0		
43.191910	-71.522110	S011-1	4.5	Postprocessed Code	GeoXM 2008	10/15/2009	12:59:51	Point	R101512A.cor	42	1.1	3.5	44.6
43.191739	-71.522245	S011-2	4.5	Postprocessed Code	GeoXM 2008	10/15/2009	13:03:29	Point	R101512A.cor	43	1	2.6	44.6
43.191400	-71.521750	S011-3	2.6	Postprocessed Code	GeoXM 2008	10/15/2009	13:13:36	Point	R101512A.cor	25	1.4	3.2	42.8
43.191340	-71.523067	S011-4	4.7	Postprocessed Code	GeoXM 2008	10/15/2009	13:20:37	Point	R101512A.cor	38	2.2	4.3	44.6
43.191449	-71.523306	S011-5	4.7	Postprocessed Code	GeoXM 2008	10/15/2009	13:26:14	Point	R101512A.cor	12	2.2	5.2	44.6

Latitude	*Longitude*	*Station*	*PDOP*	*Correction Status*	*Unit Type*	*Date*	*Time*	*Feature Type*	*Filename*	*# of Pos*	*Horiz Acc*	*Depth*	*Water Temp*
decdeg	*decdeg*				*Trimble*		*EST*				*meteres*	*feet*	*Surface (F)*
43.172345	-71.525547	S012 1	3.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:30:02	Point	S012.cor	21	1.9	2.1	45.5
43.172239	-71.524903	S012 2	4.1	Postprocessed Code	GeoXM 2008	10/15/2009	11:41:57	Point	S012.cor	42	2.2	2.1	45.5
43.172078	-71.524670	S013-3	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	11:45:54	Point	S012.cor	21	2.3	4.4	44.6
43.172425	-71.526425	S012-4	4.1	Postprocessed Code	GeoXM 2008	10/15/2009	11:51:58	Point	S012.cor	20	1.8	4.4	44.6
43.172419	-71.526404	S012-5	5.7	Postprocessed Code	GeoXM 2008	10/15/2009	11:54:37	Point	S012.cor	78	2.0	4.4	44.6
43.166069	-71.517729	S013-1	3.3	Postprocessed Code	GeoXM 2008	10/15/2009	10:31:57	Point	S013.cor	21	1.2	3.0	41.0
43.165992	-71.517499	S013-2	2.8	Postprocessed Code	GeoXM 2008	10/15/2009	10:57:03	Point	S013.cor	21	1.5	6.3	41.8
43.167115	-71.517149	S013-3	4.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:15:36	Point	S013.cor	22	2.2	3.0	44.6
43.167115	-71.517149	S013-4	4.8	Postprocessed Code	GeoXM 2008	10/15/2009	11:15:36	Point	S013.cor	22	2.2	3.0	44.6
43.167049	-71.516929	S013-5	4.6	Postprocessed Code	GeoXM 2008	10/15/2009	11:19:24	Point	S013.cor	21	2.5	3.0	44.6
43.155338	-71.488354	S014-1	3.5	Postprocessed Code	GeoExplorer 3	10/8/2009	10:42:43	Point	B100813A.cor	4	1.1	3.6	54.5
43.155408	-71.487202	S014-2	4.8	Postprocessed Code	GeoExplorer 3	10/8/2009	10:55:28	Point	B100813A.cor	41	1.1	19.2	54.5
43.155480	-71.487547	S014-3	4.9	Postprocessed Code	GeoExplorer 3	10/8/2009	11:04:31	Point	B100813A.cor	43	1.1	7.5	54.5
43.155522	-71.487690	S014-4	4.0	Postprocessed Code	GeoExplorer 3	10/8/2009	11:10:22	Point	B100813A.cor	18	1.2	7.5	54.5
43.154713	-71.487396	S014-5	4.1	Postprocessed Code	GeoExplorer 3	10/8/2009	11:12:27	Point	B100813A.cor	42	1.4	7.6	54.5
43.127264	-71.463961	S015-1	4.9	Postprocessed Code	GeoExplorer 3	10/8/2009	9:34:31	Point	B100813A.cor	22	1.3	6.5	57.2
43.126842	-71.464692	S015-2	3.1	Postprocessed Code	GeoExplorer 3	10/8/2009	9:51:16	Point	B100813A.cor	29	1.1	5.0	56.3
43.126878	-71.465552	S015-3	3.1	Postprocessed Code	GeoExplorer 3	10/8/2009	9:53:57	Point	B100813A.cor	39	1.1	9.0	55.4
43.126607	-71.466297	S015-4	3.9	Postprocessed Code	GeoExplorer 3	10/8/2009	10:02:30	Point	B100813A.cor	23	1.0	9.5	54.5
43.126804	-71.466596	S015-5	4.3	Postprocessed Code	GeoExplorer 3	10/8/2009	10:10:24	Point	B100813A.cor	22	1.0	8.1	54.0
43.108161	-71.466115	S016-1	4.0	Postprocessed Code	GeoExplorer 3	10/6/2009	10:53:09	Point	B100614A.cor	15	1.2	7.0	68.0
43.108090	-71.465837	S016-2	4.2	Postprocessed Code	GeoExplorer 3	10/6/2009	11:14:27	Point	B100614A.cor	13	1.0	7.6	66.0
43.107702	-71.464409	S016-3	4.1	Postprocessed Code	GeoExplorer 3	10/6/2009	11:27:23	Point	B100614A.cor	14	1.3	9.6	62.0
43.107864	-71.463783	S016-4	4.3	Postprocessed Code	GeoExplorer 3	10/6/2009	11:33:03	Point	B100614A.cor	87	1.3	7.6	59.0
43.107789	-71.463393	S016-5	4.8	Postprocessed Code	GeoExplorer 3	10/6/2009	11:51:59	Point	B100614A.cor	18	1.3	5.1	59.0
43.039817	-71.461782	S017-1		Google Map Location	N/A	10/14/2009		Point				1.0	49.1
43.037928	-71.461782	S017-2		Google Map Location	N/A	10/14/2009		Point				8.3	44.5
43.040533	-71.463225	S017-3		Google Map Location	N/A	10/14/2009		Point				7.4	46.4
43.040669	-71.462825	S017-4		Google Map Location	N/A	10/14/2009		Point				10.9	48.2
43.040715	-71.462742	S017-5		Google Map Location	N/A	10/14/2009		Point				1.0	49.1
43.009827	-71.475544	S019-1		Google Map Location	N/A	10/14/2009		Point				2.0	57.2
43.009687	-71.475640	S019-2		Google Map Location	N/A	10/14/2009		Point				7.6	53.6
43.009645	-71.475802	S019-3		Google Map Location	N/A	10/14/2009		Point				8.3	50.9
43.010247	-71.472817	S019-4		Google Map Location	N/A	10/14/2009		Point				11.2	48.3
43.010261	-71.472597	S019-5		Google Map Location	N/A	10/14/2009		Point				1.5	46.4
42.71781032	-71.43634464	S020	5.9	Postprocessed Code	GeoXM 2008	10/14/2009	16:56:13	Point_generic	S020 1-5_1.cor	21	4.5		

Merrimack River Grain Size Analysis

Sample ID	SAND COMPONENT on #200 sieve		
	Tare Weight of Dry 300 mL Beaker (g)	*Final Dry Weight of Sand + Beaker (g)*	*Total Dry Sand Component (g)*
S001	181.4	229.7	48.3
S002	179.3	218.4	39.1
S003	182.4	230.7	48.3
S004	143.6	170.5	26.9
S005	98.8	130.4	31.6
S007	99.8	144.6	44.8
S009	133.3	197.6	64.3
S010	143.6	208.6	65
S011	98.7	169.6	70.9
S012	144.0	207.3	63.3
S013	148.1	203.6	55.5
S014	137.4	195.3	57.9
S015	141.7	213.1	71.4
S016	133.3	216.1	82.8
S017	144.0	205.0	61
S019	143.6	206.6	63
S020	141.5	215.5	74
S099 Dup	132.2	204.9	72.7

Sample ID	SILT COMPONENT thru #200 sieve			
	Tare Weight of Dry 300 mL Beaker (g)	**Dry Weight of Sample + Beaker (g)**	**Weight of Silt Component (g)**	**Total Dry Weight of Silt (dispersant & dilution corrected) (g)**
S001	133.4	133.5	0.1	9.9
S002	137.8	138.1	0.3	29.9
S003	132.2	132.3	0.1	9.9
S004	142.6	142.9	0.3	29.9
S005	137.2	137.4	0.2	19.9
S007	144.0	144.2	0.2	19.9
S009	142.6	142.7	0.1	9.9
S010	137.9	137.9	<0.1	<1
S011	137.2	137.3	0.1	9.9
S012	132.2	132.3	0.1	9.9
S013	143.4	143.5	0.1	9.9
S014	139.4	139.6	0.2	19.9
S015	99.8	99.9	0.1	9.9
S016	137.9	137.9	<0.1	<1
S017	148.1	148.3	0.2	19.9
S019	137.2	137.4	0.2	19.9
S020	142.6	142.7	0.1	9.9
S099 Dup	143.4	143.4	<0.1	<1

Merrimack River Grain Size Analysis

Sample ID	PERCENT CALCULATION			
	Total Dry Weight of Silt Component (g)	***Total Dry Weight of Sample (g)***	***Percent Silt***	***Percent Sand***
S001	9.9	58.2	17.0	83.0
S002	29.9	69.0	43.3	56.7
S003	9.9	58.2	17.0	83.0
S004	29.9	56.8	52.7	47.3
S005	19.9	51.5	38.7	61.3
S007	19.9	64.7	30.8	69.2
S009	9.9	74.2	13.4	86.6
S010	<1	65	0.0	100.0
S011	9.9	80.8	12.3	87.7
S012	9.9	73.2	13.5	86.5
S013	9.9	65.4	15.2	84.8
S014	19.9	77.8	25.6	74.4
S015	9.9	81.3	12.2	87.8
S016	<1	82.8	0.0	100.0
S017	19.9	80.9	24.6	75.4
S019	19.9	82.9	24.0	76.0
S020	9.9	83.9	11.8	88.2
S099 Dup	<1	72.7	0.0	100.0