Surface Water Monitoring in the

Newport Water Supply Reservoirs 2015

Data Report

Rhode Island Department of Environmental Management

Office of Water Resources

2017

Amended May 10, 2017

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PROJECT PLANNING

In late 2014, RIDEM convened three meetings of a 'Technical Advisory Group' consisting of individuals from and/or representing RIDEM, University of Rhode Island, the Environmental Protection Agency (EPA) Atlantic Ecology Division, City of Newport, and the MA Department of Environmental Protection (MADEP) to provide advice and feedback to RIDEM on technical issues associated with development of the Newport Water Supply Reservoirs Total Maximum Daily Load (TMDL).

The advisory group discussed various the technical aspects of developing the TMDL such as 1) identification of water quality targets (total phosphorus, total nitrogen, chlorophyll-a, total organic carbon, that would be protective of the reservoirs' use as drinking water supplies, 2) evaluation of the linkages between nutrient-related enrichment and potential human health-related impacts to potable water supplies, 3) development of approaches to calculating existing and allowable phosphorus loads to each reservoir, and 4) identification of approaches to estimate internal phosphorus loading from reservoirs sediments. One of the issues raised by the group was the need for additional water quality data in the reservoirs to further evaluate the trophic status as well as to explore linkages between nutrient enrichment and potential human-health related impacts. It was agreed that if resources could be secured, additional monitoring should be undertaken.

At RIDEM's request, the Environmental Protection Agency (EPA) Atlantic Ecology Division (AED) and Mid Continent Ecology Division (MED) provided analytical assistance to RIDEM. This assistance consisted of both laboratory analytical analysis and sample preparation (including appropriate filtering) and shipment of samples. The AED Laboratory in Narragansett, Rhode Island analyzed samples for chlorophyll-a and ultraviolet absorbance and prepared and shipped samples to EPA's MED Laboratory in Duluth, Minnesota. EPA MED analyzed samples for the following parameters: nitrate-nitrite nitrogen, ammonia nitrogen, total nitrogen, dissolved organic carbon, total phosphorus, and orthophosphate. The Rhode Island Department of Health (HEALTH) Laboratories, located in Providence, Rhode Island analyzed samples for total trihalomethane yield (using uniform formation conditions) and Northeast Laboratories in Berlin, Connecticut analyzed samples for algal-cyanobacteria enumeration and identification and the algal toxin microcystin-LR.

GOALS AND OBJECTIVES OF MONITORING

Prior to the 2015 data collection efforts, the data available for evaluation of water quality in the reservoirs consisted of 2 years (2011-2012) worth of water chemistry and physical data from the nine reservoirs and two major tributaries. A data report documenting the quality assurance quality control of this data was never generated and RIDEM had concerns regarding some of this data. The proposed sampling was meant to fill significant data gaps and provide critical information needed for TMDL development. The specific objectives of the monitoring were as follows:

1. Obtain an additional year of water chemistry and field data that will be used to evaluate the trophic status of the reservoirs and develop the TMDLs.

2. Investigate the relationship(s) between nutrient related indices and selected human health related indices to better understand the relationships between phosphorus (and nitrogen),

chlorophyll *a*, Dissolved Organic Carbon (DOC)), and disinfection byproduct formation potential (measured as total trihalomethanes) in the drinking water reservoirs. The findings from this investigation may be used in the development of chlorophyll and phosphorus targets for the Newport Reservoirs.

3. Obtain an additional year of cyanobacteria cell abundance and microcystin concentrations to evaluate cyanobacteria bloom frequency and severity, and toxin formation.

4. Obtain sufficient water column data to estimate internal cycling of phosphorus from reservoir sediments.

SAMPLING OVERVIEW

The study design is described in detail in the EPA-approved Quality Assurance Project Plan (QAPP) (www.dem.ri.gov/pubs/qapp/newpresv.pdf). Staff from RIDEM collected water chemistry and phytoplankton samples, and other physical data in all nine reservoirs on a bi-weekly basis from early May through early October 2015. Surveys were conducted on the dates shown in Table 1. In total, 12 surveys were completed.

Table 1. 2015 Newport Reservoir Survey Dates.

May 6	May 19	June 1	June 17	June 30	July 16
July 29	Aug 12	Aug 24	Sept 8	Sept 21	Oct 5

The Newport Reservoir sampling sites, parameters and sampling frequency are described in Appendix A of the QAPP (RIDEM 2015). Sampling locations are shown in Figures 2-10 in Appendix B of the QAPP (RIDEM 2015). As specified in the QAPP (RIDEM 2015) each reservoir was sampled at a single location above its deepest point. Sampling efforts included various *in situ* measurements as well as water column sampling. Instantaneous in situ field measurements include Secchi disc depth and use of YSI ProPlus to measure temperature, dissolved oxygen (mg/L and percent saturation), specific conductance, and pH at half meter intervals for reservoirs less than 5m maximum depth and at 1m intervals in reservoirs greater than 5m maximum depth. No deviations from the sampling site, sample parameters, or sampling frequency were made. The only exception to this was that samples for total organic carbon was mistakenly not run by the EPA Laboratory in Duluth (EPA MED).

Sampling was conducted under both dry weather and wet weather conditions and no safety or weather related hazards occurred that caused pre-scheduled sampling dates to be modified or aborted. Sampling of all nine reservoirs was generally completed by two separate crews in a single day. In some cases, surveys were conducted in two consecutive days, this typically consisted of sampling the Aquidneck Island reservoirs on day one and Watson and Nonquit the following day.

Water samples collected during the study were analyzed for conventional parameters (e.g. trophic state variables, etc.) and associated human health parameters. Nutrient-related parameters proposed in this study include total phosphorus, ortho-phosphorus, dissolved organic carbon, nitrogen fractions, chlorophyll *a*, phytoplankton enumeration and identification, ultraviolet absorbance (UV254), and water

clarity, as measured by Secchi disk. The human health indices of focus in this study included trihalomethane formation potential as measured by the UFC test (RIDEM) and the algal toxin microcystin-LR.

The total number of water samples collected in each reservoir was dependent upon reservoir conditions at the time of sampling (i.e. stratified or un-stratified). Under stratified conditions: 1) samples to be analyzed for total and ortho-phosphorus were collected from three depths at the sample station- one from the epilimnion (upper waters), one from the thermocline surface, and one from the hypolimnion (lower waters). For un-stratified conditions- samples to be analyzed for total and ortho-phosphorus were collected from approximately 1-2 ft below the surface and approximately 1-2 ft above the bottom. The phosphorus samples collected from various depths will be used to support estimation of internal phosphorus loading.

Quality Assurance- Field Data Collection

Field sampling and measurement protocols followed those specified in the QAPP (RIDEM 2015) for *in-situ* temperature, dissolved oxygen, specific conductance, and pH measurements, using the YSI ProPlus meter, as well as for measurements of clarity (secchi depth). All ProPlus meters were calibrated and post-calibrated per manufacturer's instructions and the Standard Operating Procedure (SOP) (RIDEM 2015). Calibration records are kept at the RIDEM Office in Providence. No problems were encountered with calibration, post-calibration, or use of the YSI ProPlus meters and as such, all data were considered usable.

The only field measurement-related issue encountered was with use of the secchi discs. Both discs had previously broken from the measuring line and had to be refastened for use with this project. Due to these modifications, each secchi depth reading from Secchi disc #1 was reduced by one foot and each secchi depth reading from Secchi disc #2 was reduced by three feet. The secchi disc used (#1 or #2) was noted on each field sheet and each reading was reduced accordingly. During survey 1, staff neglected to record the # of the secchi disc used and as a result this data was not acceptable.

Analytical QA/QC

As specified in the QAPP (RIDEM 2015), analytical services were provided by 1) US EPA Mid-Continent Ecology Laboratory Division in Duluth, MN, 2) US EPA Atlantic Ecology Division in Narragansett, RI, 3) The Rhode Island Department of Health (HEALTH) Laboratory in Providence, RI, and 4) Northeast Laboratories Inc. in Berlin, CT. An analytical services summary is provided below in Table 2.

Table 2. Analytical Services Table.

Analytical Parameter	Lab	Analytical Method/Other Method	Number of Sampling Locations	Number of Sampling Events	Number of Samples	# of Field Duplicates (10% of total)	Total # of Samples
Chlorophyll-a	EPA-AED	EPA 445.0/446.0	9	12	108	10	118
Nitrate-Nitrogen (NO3)	EPA-MED	EPA 353.3/353.2	9	12	108	10	118
Ammonia Nitrogen (NH3-N)	EPA-MED	EPA 350.1	9	12	108	10	118
Nitrate-Nitrogen (NO2)	EPA-MED	EPA 353.3/353.2	9	12	108	10	118
Total Nitrogen	EPA-MED	EPA 351.3/351.1	9	12	108	10	118
Dissolved Organic Carbon	EPA-MED	EPA 415.3 (AED)	9	12	132	13	145
Total Organic Carbon	EPA-MED	EPA 415.3 (AED)	9	12	132	13	145
Uniform Formation Conditions (TTHM)	RI State Health Laboratories	SM4500 C1-I EPA 524.2	9	12	132	13	145
Ultraviolet Absorbance (254 nm)	EPA-AED	EPA 415.3 (AED)	9	12	132	13	145
Microcystin-LR	Northeast Laboratories Inc.	Abraxis 522015 ELISA	9	6 (1/month)	54	5	59
Total algal ID and enumeration	Northeast Laboratories Inc.	SM10200	9	6 (1/month)	54	5	59
Total Phosphorus	EPA-MED	EPA 365.1	9	12	216/324	22/32	238/356
Orthophosphate	EPA-MED	EPA 365.1	9	12	216/324	22/32	238/356

All applicable laboratory analytical methods and achievable laboratory limits are summarized below in Table 3 and the full laboratory SOP's (LSOP) are provided in Appendix D of the QAPP (RIDEM 2015).

Table 3. Newport Reservoir Analytical Parameters.

Parameter	Analytical Method/	Detection Limit, accuracy, precision	Instrument	Analytical Laboratory	Laboratory SOP (LSOP) Reference QAPP (RIDEM 2015)
Chlorophyll-a	EPA 445.0/446.0	RPO >90%	Turner Designs TD-700 digital Fluorometer	EPA AED Laboratory Narragansett, RI	LSOP1
Nitrate and Nitrite-Nitrogen (NO3)	EPA 353.3/353.2	MDL 1.0 ugl ±10%	Lachat 8000 Quik Chem System	EPA MED Laboratory Duluth, MN	LSOP2
Ammonia Nitrogen (NH3-N)	EPA 350.1	MDL 2.0 ug/l ±10%	Lachat 8000 Quik Chem System	EPA MED Laboratory Duluth, MN	LSOP3
Total Nitrogen	EPA 351.3/351.1	MDL 5.0 ug/l ±10%	Autoclave; Latchet Automated Ion Analyzer (FIA)	EPA MED Laboratory Duluth, MN	LSOP4
Dissolved Organic Carbon	EPA 415.3 (AED)	Precision 5-10% for total DL = 0.53 mg/L	Takmar-Dohrmann Phoenix 8000 TOC Analyzer	EPA MED Laboratory Duluth, MN	LSOP5
Total Organic Carbon	EPA 415.3 (AED)	Precision 5-10% for total DL = 0.53 mg/L	Takmar-Dohrmann Phoenix 8000 TOC Analyzer	EPA MED Laboratory Duluth, MN	LSOP5
Uniform Formation Conditions (TTHM)	SM4500 Cl-I EPA 524.2	± 30% Accuracy ± 30% Precision DL=1.0 ug/L	Tekmar Stratum Purge and Trap, Agilent GC/MSD 6890N/5973N	RI State Health Laboratories	LSOP6 ID 1083 Revision 4
Ultraviolet Absorbance (254 nm)	EPA 415.3 (AED)	Daily check ±10% Precision <10% RPD	Perkin-Elmer Lambda 35 UV Spectrophotometer	EPA AED Narragansett, RI	LSOP7
Microcystin-LR	Abraxis 522015 ELISA			Northeast Laboratories Inc. Berlin, CT	LSOP8
Total algal ID and enumeration	Standard Method SM 10200	NA	NA	Northeast Laboratories Inc. Berlin, CT	LSOP9
Total Phosphorus	EPA 365.1	MDL = 4.0 ug/l ±10%	Lachat 8000 Quik Chem System	EPA MED Laboratory Duluth, MN	LSOP10
Orthophosphate	EPA 365.1	MDL = 2.5 ug/l ±10%	Lachat 8000 Quik Chem System	EPA MED Laboratory Duluth, MN	LSOP10

All analytical QA/QC for nutrients, dissolved organic carbon, chlorophyll-a, and UV254 was provided by the EPA AED Laboratory in Narragansett. These QA/QC reports was submitted to RIDEM in four separate documents (EPA AED Inserted Documents 1 and 2 and EPA AED Memorandum 1 and 2). There is some overlap in the data reports and memorandums submitted by EPA with respect to data summaries, however it was felt that these reports should stay in their original format and are presented that way in this data report. In general, and at both AED and MED Laboratories, if samples didn't meet QA/QC criteria they were re-analyzed. Only data meeting the QA/QC criteria set forth in the QAPP (RIDEM 2015) were submitted to RIDEM.

Field duplicates from the final datasets were then evaluated by RIDEM and those samples not meeting the criteria set in the QAPP were removed from the final datasets. Field duplicate QA/QC was evaluated by RIDEM below. Unless otherwise noted, the relative percent difference (RPD) of not more than 20% was set as the criteria for acceptance of the field duplicate and original sample for all parameters. Field duplicate data, by waterbody, for nutrients and dissolved organic carbon are shown in Tables 4-11. The nutrients and dissolved organic carbon field duplicate for Sisson Pond were lost in transit.

Table 4. Field Duplicate Results for Nonquit Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (ug/l)
Nonquit S	6/17/2015	8.7	30.6	27.8	2.3	451.7	32.3	8.31
Nonquit S FD	6/17/2015	7.2	30.7	21.7	4.2	472.9	38.5	11.65
	RPD FD (%)	**19.38**	**0.27**	**24.77**	**58.45**	**4.59**	**17.66**	**33.47**
Nonquit D	6/17/2015	10.6	41.1	38.8	4.1	445.2	35.2	9.31
Nonquit D FD	6/17/2015	11.5	39.2	40.8	3.7	435.6	38.8	11.78
	RPD FD (%)	**8.08**	**4.77**	**5.02**	**9.45**	**2.17**	**9.66**	**23.47**
Nonquit S	9/21/2015	18.20	51.34	54.41	3.59	603.68	49.73	12.63
Nonquit S FD	9/21/2015	17.95	67.07	56.19	2.96	636.17	73.05	12.3
	RPD FD (%)	**1.39**	**26.57**	**3.22**	**19.00**	**5.24**	**37.98**	2.69
Nonquit D	9/21/2015	17.63	39.03	34.02	2.28	578.47	55.31	12.81
Nonquit D FD	9/21/2015	16.34	38.38	42.07	3.32	606.53	70.99	12.73
	RPD FD (%)	**7.58**	**1.67**	**21.14**	**36.89**	**4.74**	**24.82**	0.64

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 5. Field Duplicate Results for Watson Reservoir- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)
Watson S	7/29/2015	1.75	1.37	10.75	0.33	431.86	10.73	6.41
Watson S FD	7/29/2015	0.89	4.52	17.16	-0.72	454.40	10.85	6.42
	RPD FD (%)	**64.90**	**106.79**	**45.96**	**na**	5.09	1.05	4.59
Watson D	7/29/2015	2.40	2.59	149.26	-0.38	536.00	17.38	6.17
Watson D FD	7/29/2015	0.95	8.03	191.64	0.79	710.55	20.80	6.75
	RPD FD (%)	**86.59**	**102.35**	**24.86**	**na**	**28.01**	17.92	8.89

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 6. Field Duplicate Results for Lawton Valley Reservoir- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)
Lawton Valley S	8/25/2015	5.63	83.40	224.42	5.89	915.39	34.29	4.77
Lawton Valley S FD	8/25/2015	4.55	93.23	213.83	6.54	856.47	32.95	3.66
	RPD FD (%)	**21.14**	**11.12**	**4.84**	**10.47**	**6.65**	**3.97**	**26.31**
Lawton Valley D	8/25/2015	4.93	83.40	234.84	6.04	897.54	39.64	4.03
Lawton Valley D FD	8/25/2015	4.51	122.55	218.38	11.15	922.64	39.13	4.36
	RPD FD (%)	**8.98**	**38.02**	**7.26**	**59.50**	**2.76**	**1.30**	**7.96**
Lawton Valley S	10/6/2015	5.10	127.18	211.37	11.00	941.12	50.43	4.1
Lawton Valley S FD	10/6/2015	4.92	107.60	193.54	9.39	927.40	50.68	4.35
	RPD FD (%)	**3.63**	**16.68**	**8.81**	**15.80**	**1.47**	**0.50**	**5.9**
Lawton Valley D	10/6/2015	6.90	127.04	217.16	11.16	954.23	52.07	4.31
Lawton Valley D FD	10/6/2015	6.09	121.89	217.36	11.51	873.47	46.65	5.17
	RPD FD (%)	**12.41**	**4.13**	**0.09**	**3.04**	**8.84**	**10.98**	**18.2**

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 7. Field Duplicate Results for St. Marys Pond Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC-mg/l
St. Marys S	8/12/2015	5.07	28.42	180.76	3.33	1326.00	47.88	5.40
St. Marys S FD	8/12/2015	3.25	37.49	172.45	3.29	1292.00	57.30	5.44
	RPD FD (%)	**43.8**	**27.5**	**4.7**	**1.3**	**2.6**	**17.9**	**0.74**

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 8. Field Duplicate Results for North Easton Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N
North Easton S	6/29/2015	3.10	26.01	45.50	4.69	689.35
North Easton S FD	6/29/2015	3.34	32.01	42.62	3.40	651.35
	RPD FD (%)	**7.58**	**20.69**	**6.55**	**31.99**	**5.67**
North Easton D	6/29/2015	6.04	44.44	51.49	4.21	718.81
North Easton D FD	6/29/2015	7.97	41.92	57.52	4.30	672.11
	RPD FD (%)	**27.58**	**5.84**	**11.06**	**2.08**	**6.72**

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 9. Field Duplicate Results for South Easton Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)
South Easton S	7/15/2015	6.11	7.06	326.66	1.51	1186.00	62.12	5.43
South Easton S FD	7/15/2015	4.56	8.63	321.57	1.50	1194.00	61.62	5.56
	RPD FD (%)	**29.05**	**19.99**	**1.57**	**0.86**	**0.67**	**0.81**	**2.31**
South Easton D	7/15/2015	5.56	11.75	323.56	1.39	1160.00	63.13	5.34
South Easton D FD	7/15/2015	4.17	9.19	323.17	1.75	961.25	44.00	5.51
	RPD FD (%)	**28.57**	**24.43**	**0.12**	**22.65**	**18.74**	**35.72**	**3.03**

Red Font indicates exceedance of RPD criteria of 20%. S- Surface Sample, D- Depth Sample, FD-Field Duplicate

Table 10. Field Duplicate Results for Gardiner Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)
Gardiner Pond S	6/1/2015	4.19	0.66	15.94	0.72	683.54	43.88	5.83
Gardiner Pond S FD	6/1/2015	2.41	0.00	12.79	0.49	474.95	18.23	30.49
	RPD FD (%)	**53.97**	**200.00**	**21.87**	**38.04**	**36.01**	**82.57**	**135.84**
Gardiner Pond D	6/1/2015	2.59	1.04	11.93	0.68	498.25	22.77	5.27
Gardiner Pond D FD	6/1/2015	3.36	2.00	13.39	0.68	480.60	24.33	5.51
	RPD FD (%)	**26.08**	**63.38**	**11.50**	**0.00**	**3.61**	**6.64**	**4.46**

Red Font indicates exceedance of RPD criteria of 20%. Blue Font indicates flagged and accepted data. S- Surface Sample, D-Depth Sample, FD-Field Duplicate

Table 11. Field Duplicate Results for Paradise Pond- Nutrients.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)
Paradise S	9/9/2015	8.42	3.99	71.83	-0.21	1746.00	116.94	8.75
Paradise S FD	9/9/2015	13.43	4.88	36.39	-1.43	1996.00	138.75	8.71
	RPD FD (%)	**45.84**	**19.97**	**65.50**	**na**	**13.36**	**17.06**	**0.42**
Paradise D	9/9/2015	12.12	3.07	28.77	0.49	1454.00	123.58	8.19
Paradise D FD	9/9/2015	10.28	3.64	23.09	0.55	1372.00	112.66	7.79
	RPD FD (%)	**16.38**	**16.76**	**21.91**	**12.72**	**5.80**	**9.24**	**4.97**

Red Font indicates exceedance of RPD criteria of 20%. Blue Font indicates flagged and accepted data. S- Surface Sample, D-Depth Sample, FD-Field Duplicate

Tables 12-20 display the Field QA/QC results for chlorophyll-a, UV254, and TTHM. Unless otherwise noted, QA/QC acceptance criteria expressed as relative percent difference (RPD) is less than 20% between the original sample and the field duplicate.

Table 12. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-Nonquit Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
6/17/2015	Nonquit Pond	1	0.3579	0.3707	0.11
	Nonquit Pond	2	0.3835		
	Field Duplicate	1	0.3596	0.3703	
	Field Duplicate	2	0.3810		
9/21/2015	Nonquit Pond	1	0.5520	0.5528	1.49
	Nonquit Pond	2	0.5536		
	Field Duplicate	1	0.5342	0.5447	
	Field Duplicate	2	0.5551		
Date	**Station**	**Rep**	**Chl a in tample (ug/L)**	**Avg. Chl-a in Sample**	**RPD FD (%)**
6/17/2015	Nonquit Pond	1	16.08	16.18	4.50
	Nonquit Pond	2	16.27		
	Field Duplicate	1	16.77	16.92	
	Field Duplicate	2	17.08		
9/21/2015	Nonquit Pond	1	4.39	4.23	1.86
	Nonquit Pond	2	4.22		
	Nonquit Pond	3	4.09		
	Field Duplicate	1	4.12	4.31	
	Field Duplicate	2	4.12		
	Field Duplicate	3	4.72		
	Field Duplicate	4	4.29		
Date	**Station**	**Rep**	**Total Trihalomethanes (ug/L)**	**RPD FD (%)**	**Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)**
6/17/2015	Nonquit Pond	1	466	2.96	0.6
	Field Duplicate	2	480		0.58
9/21/2015	Nonquit Pond	1	414	16.47	0.93
	Field Duplicate	2	351		0.95

Table 13. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-Watson Reservoir.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
7/29/2015	Watson Reservoir	1	0.0882	0.0887	3.93
	Watson Reservoir	2	0.0891		
	Field Duplicate	1	0.0924	0.0922	
	Field Duplicate	2	0.0920		
Date	**Station**	**Rep**	**Chl a in sample (ug/L)**	**Avg. Chl-a in Sample**	**RPD FD (%)**
7/29/2015	Watson Reservoir	1	7.97	7.90	0.78
	Watson Reservoir	2	7.84		
	Field Duplicate	1	7.66	7.97	
	Field Duplicate	2	8.28		
Date	**Station**	**Rep**	**Total Trihalomethanes (ug/L)**	**RPD FD (%)**	**Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)**
7/29/2015	lab processing error field duplicate not run				

Table 14. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-Lawton Valley Reservoir.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
8/25/2015	Lawton Valley Reservoir	1	0.0800	0.0816	1.73
	Lawton Valley Reservoir	2	0.0831		
	Field Duplicate	1	0.0779	0.0802	
	Field Duplicate	2	0.0824		
10/6/2015	Lawton Valley Reservoir	1	0.0947	0.0960	1.65
	Lawton Valley Reservoir	2	0.0972		
	Field Duplicate	1	0.0972	0.0976	
	Field Duplicate	2	0.0979		
Date	**Station**	**Rep**	**Chl a in sample (ug/L)**	**Avg. Chl-a in Sample**	**RPD FD (%)**
8/25/2015	Lawton Valley Reservoir	1	36.71	37.02	7.20
	Lawton Valley Reservoir	2	37.33		
	Field Duplicate	1	34.60	34.44	
	Field Duplicate	2	34.29		
10/6/2015	Lawton Valley Reservoir	1	14.09	12.90	2.62
	Lawton Valley Reservoir	2	12.73		
	Lawton Valley Reservoir	3	12.01		
	Field Duplicate	1	13.10	13.30	
	Field Duplicate	2	13.47		
Date	**Station**	**Rep**	**Total Trihalomethanes (ug/L)**	**RPD FD (%)**	**Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)**
8/25/2015	Lawton Valley Reservoir	1	108	13.76	0.95
	Field Duplicate	2	94.1		0.93
10/6/2015	Lawton Valley Reservoir	1	160	45.21	0.88
	Field Duplicate	2	101		0.79

Table 15. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-Sisson Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
5/18/2015	Sisson Pond	1	0.1130	0.1145	4.51
	Sisson Pond	2	0.1160		
5/18/2015	Field Duplicate	1	0.1065	0.1095	
	Field Duplicate	2	0.1124		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
5/18/2015	Sisson Pond	1	12.21	12.15	0.00
	Sisson Pond	2	12.08		
5/18/2015	Field Duplicate	1	11.96	12.15	
	Field Duplicate	2	12.33		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
5/18/2015	Sisson Pond	1	116	6.22	1
	Field Duplicate	2	109		0.97

Table 16. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-St Mary's Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
8/12/2015	St. Marys Pond	1	0.1302	0.1335	11.53
	St. Marys Pond	2	0.1368		
	Field Duplicate	1	0.1175	0.1190	
	Field Duplicate	2	0.1204		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
8/12/2015	St. Marys Pond	1	60.47	64.63	7.00
	St. Marys Pond	2	68.78		
	Field Duplicate	1	60.29	60.26	
	Field Duplicate	2	60.23		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
8/12/2015	St. Marys Pond	1	93.8	2.37	0.61
	Field Duplicate	2	91.6		0.61

Table 17. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-North Easton Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
6/30/2015	North Easton Pond	1	0.1051	0.1068	0.28
	North Easton Pond	2	0.1085		
	Field Duplicate	1	0.1051	0.1065	
	Field Duplicate	2	0.1079		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
6/30/2015	North Easton Pond	1	51.67	51.73	5.00
	North Easton Pond	2	51.79		
	Field Duplicate	1	48.63	49.19	
	Field Duplicate	2	49.74		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
6/30/2015	North Easton Pond	1	130	0.00	0.76
	Field Duplicate	2	130		0.81

Table 18. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-South Easton Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
7/14/2015	South Easton Pond	1	0.1120	0.1130	0.44
	South Easton Pond	2	0.1139		
	Field Duplicate	1	0.1117	0.1125	
	Field Duplicate	2	0.1132		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
7/14/2015	South Easton Pond	1	20.67	20.05	0.00
	South Easton Pond	2	19.43		
	Field Duplicate	1	19.93	20.58	
	Field Duplicate	2	21.23		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
7/14/2015	South Easton Pond	1	113	12.51	0.57
	Field Duplicate	2	99.7		0.64

Table 19. Field QA/QC results for chlorophyll-a, UV 254, and TTHM-Gardiner Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
7/14/2015	Gardiner Pond	1	0.0730	0.0745	0.94
	Gardiner Pond	2	0.0760		
	Field Duplicate	1	0.0743	0.0752	
	Field Duplicate	2	0.0761		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
7/14/2015	Gardiner Pond	1	9.70	9.14	7.50
	Gardiner Pond	2	8.59		
	Field Duplicate	1	9.33	9.86	
	Field Duplicate	2	10.38		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
7/14/2015	Gardiner Pond	1	87.6	3.59	1.4
	Field Duplicate	2	90.8		1.4

Table 20. Field QA/QC results for chlorophyll-a, UV 254, and TTHM- Paradise Pond.

Date	Station	Rep	Absorbance at 254 nm (cm^{-1})	Avg Absorbance at 254 nm(cm^{-1})	RPD FD (%)
9/8/2015	Paradise Pond	1	0.2045	0.2108	1.36
	Paradise Pond	2	0.2170		
	Field Duplicate	1	0.2036	0.2079	
	Field Duplicate	2	0.2122		
Date	Station	Rep	Chl a in sample (ug/L)	Avg. Chl-a in Sample	RPD FD (%)
9/8/2015	Paradise Pond	1	38.22	36.18	17.65
	Paradise Pond	2	34.13		
	Field Duplicate	1	40.45	43.18	
	Field Duplicate	2	45.91		
Date	Station	Rep	Total Trihalomethanes (ug/L)	RPD FD (%)	Residual Chlorine (mg/L) (target: 0.6-1.4 mg/L)
9/8/2015	Paradise Pond	1	174	0.58	0.89
	Field Duplicate	2	173		0.84

EPA-AED Inserted Document 1: Surface Water Monitoring Results for Newport RI Drinking Water Reservoirs.

Surface Water Monitoring Results for Newport RI Drinking Water Reservoirs- EPA AED

Introduction

This report summarizes the analytical chemistry results of water quality monitoring data collected bi-weekly from early May through mid-October 2015 from the nine Newport Water Division drinking water supply reservoirs which includes: North and South Easton Ponds, Gardiner Pond, Paradise Pond, St Mary's Pond, Sis son Pond, Lawton Valley Reservoir, Nonquit Pond and Watson Reservoir (Figure 1). The reservoirs and their associated watersheds are located in Newport, Middletown, Portsmouth, Tiverton (Nonquit Pond), and Little Compton (Watson Reservoir), all towns located in southeastern Rhode Island. All of the original raw data that is summarized and presented in this report has been provided to RIDEM electronically.

Project Background

In the 2014 Clean Water Act (CWA) reporting cycle, Rhode Island Department of Environmental Management (RIDEM) identified all nine of the surface waters that supply source waters for Newport RI drinking water as impaired waters, and listed all of them on the CWA 303d list. RIDEM has begun work to develop TMDLs to address nutrient related water quality impairments in the nine water supply reservoirs operated by the City of Newport. The objective of the TMDLs is to restore the reservoirs such that both aquatic life and drinking water uses are supported, and more specifically relative to drinking water use that the raw water quality is conducive to the production of drinking water that with conventional treatment meets Safe Drinking Water Act (SDWA) requirements.

In late 2014, RIDEM and a Newport Water Supply TMDL 'Technical Advisory Group' consisting of individuals from and/or representing RIDEM, University of Rhode Island, the Environmental Protection Agency (EPA) Atlantic Ecology Division, City of Newport, and the MA Department of Environmental Protection (MADEP) concluded that there was the need for additional water quality data in the nine drinking water supply reservoirs to further evaluate the trophic status as well as to explore linkages between nutrient enrichment and potential human-health related impacts. It was decided that RIDEM would conduct water quality monitoring during 2015, specifically, every 2 weeks from May through late Oct on each of the nine reservoirs (one station at each) for a total of 12 sampling sessions (Table 1).

At RIDEM's request, the U.S. Environmental Protection Agency's (EPA) Atlantic Ecology Division (AED) and Mid Continent Ecology Division (MED) provided water chemistry analytical assistance to RIDEM. This assistance consisted of both laboratory analytical analysis and sample preparation (including appropriate filtering) and shipment of samples. The EPA AED Laboratory in Narragansett, Rhode Island analyzed samples for chlorophyll-*a* and ultraviolet absorbance (UVA) and also prepared (filtered, preserved) and shipped samples to EPA's MED Laboratory in Duluth, Minnesota. EPA MED analyzed the water samples for the following parameters: nitrate-nitrite nitrogen, ammonia nitrogen, total nitrogen, dissolved organic carbon, total phosphorus, and orthophosphate. The field samples collected by RIDEM and associated chain of custody forms were received and signed by Anne Kuhn (EPA AED). A copy of the signed chain of custody (COC) forms were given to the Project Manager when the samples were dropped off at the AED laboratory. COC forms were then developed and rechecked for the processed samples and these signed COC forms accompanied the overnight express shipped samples in coolers packed with ice. COC forms were also electronically emailed to the EPA MED laboratory in Duluth, MN so that samples could be verified with the COC forms and signed in upon arrival.

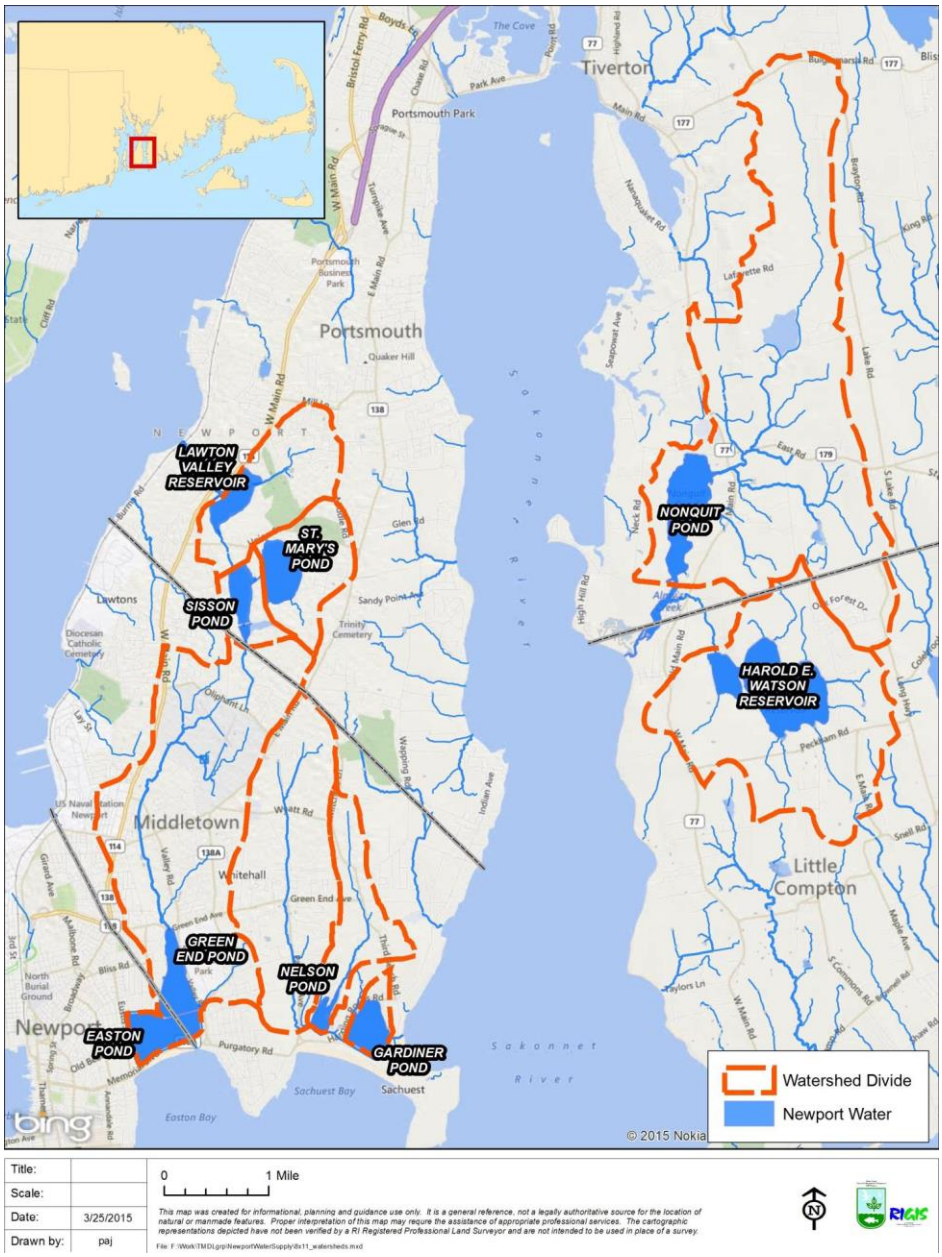


Figure 1. City of Newport drinking water supply reservoirs.

Water Quality Monitoring Results

Chlorophyll-*a*

Below are the data from the chlorophyll *a* analyses conducted at the Atlantic Ecology Division on twelve different sampling events from May through October 2015. The sample preparation and subsequent chlorophyll *a* fluorescence measurements were by Joseph Bishop (EPA student service contractor) and Glen Thursby (EPA AED). The analyses followed AED Laboratory Operating Procedure "Non-Acid

Determination of Chlorophyll *a* Using a Turner Designs AU-10 Fluorometer" (LOP-AED/WDB/GBT/2015-01-00-listed as LSOP1 in the RIDEM project QAPP). The measurements are based on overnight (minimum of 18 hours) extraction in a freezer in 90% acetone of chlorophyll *a* from particles retained on a glass fiber filter. Provided below is information on the creation of the chlorophyll *a* standard curves comparing values based on absorption measurements using a Perkin-Elmer Lambda 35 spectrometer with fluorescence values obtained using the Turner Designs instrument. The equation used for the spectrometric analysis is from Ritchie (2006).

Chlorophyll *a* standard curves

The source of chlorophyll a standard was Sigma-Aldrich product number C-6144—chlorophyll *a* from *Anacystis nidulans* (Cyanobacterium). Figure 2 shows the Atlantic Ecology Division's 2014 standard curve. This is not the standard curve used for the Newport samples. The purpose of showing this curve is to indicate the performance of chlorophyll *a* standards purchase from Turner Designs (187 and 20.0 ug/L). These two standards provided a check on the performance of AED's Lambda 35 spectrometer.

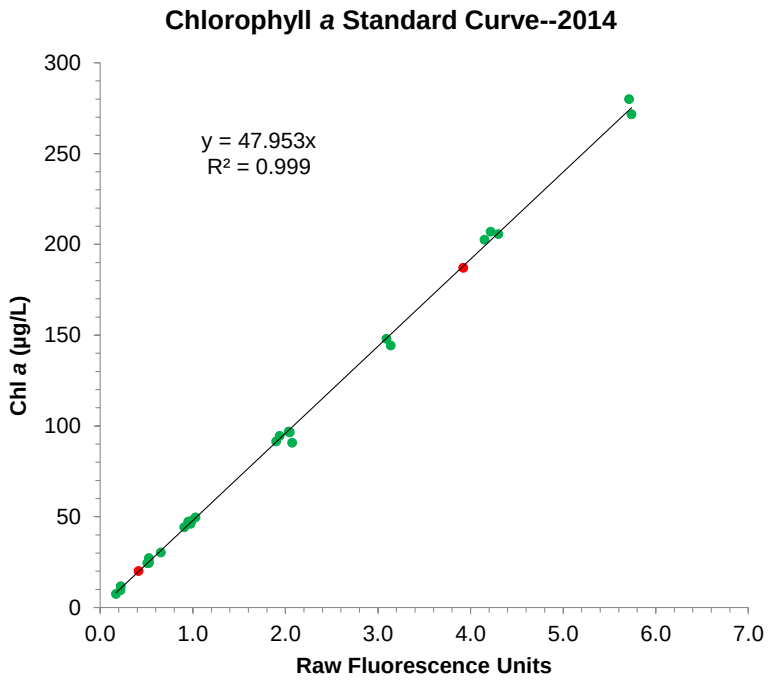


Figure 2. Chlorophyll *a* standard curve from 2014. X-axis is the raw fluorescence reading from the Turner Designs Model 10-AU fluorometer (corrected for procedural blank). Y-axis is the calculated chlorophyll *a* concentration in the 90% extraction solution using absorbance measured with the Perkin-Elmer Lambda 35 spectrometer. Red markers are the two Turner Design standards. The remaining markers are AED standards created from chlorophyll *a* powder purchased from Sigma-aldrich.

The solid standard fluorescence readings associated with the 2014 standard curve were 0.142 and 0.697 for the low and high standards, respectively. The solid standards are read with each chlorophyll *a* batch

and serve as a check on the performance of the Turner Design 10-AU. If the solid standards begin to change, then a new primary standard curve is warranted. In 2015, prior to the beginning of the Newport sampling effort, the solid standard readings had declined slightly to 0.127 and 0.626. A new primary standard curve was initiated for 2015. This is shown in Figure 3. Although initially the range of chlorophyll *a* values in the 2015 standard curve were similar to those in 2014, we later (November 9 & 10, 2015) extended the range because many of Newport water samples exceeded this initial range. Extraction concentrations of chlorophyll *a* up to around 1500 ug/L are well within the range of the procedure.

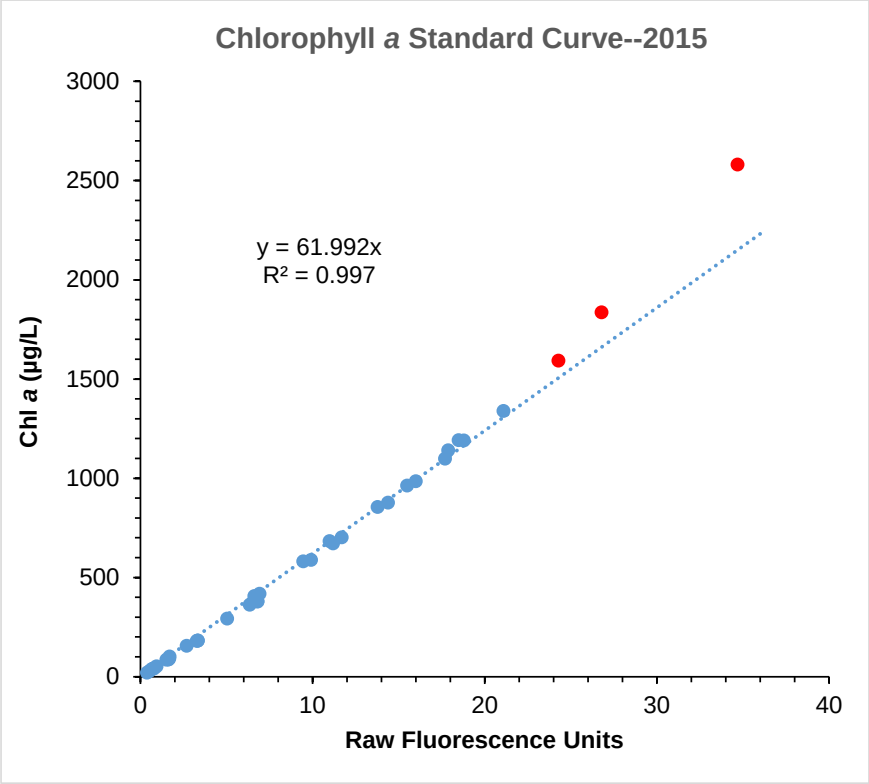


Figure 3. Chlorophyll *a* standard curve from 2015. X-axis is the raw fluorescence reading from the Turner Designs Model 10-AU fluorometer (corrected for procedural blank). Y-axis is the calculated chlorophyll *a* concentration in the 90% extraction solution using absorbance measured with the Perkin-Elmer Lambda 35 spectrometer. Red markers are values not used in the regression. The blue markers are values from three different standard curve runs (May, August and November 2015).

Chlorophyll-*a* Solid Fluorescence Standards

Measurements were made at the beginning and end of each set of chlorophyll *a* fluorescence measurements. These data are presented below in Figure 4. The slight drift in the readings is likely due to the aging of the lamp in Turner Designs Model 10-AU. However, the drift is not significant enough to warrant corrections to the raw Newport sample readings—within 5%.

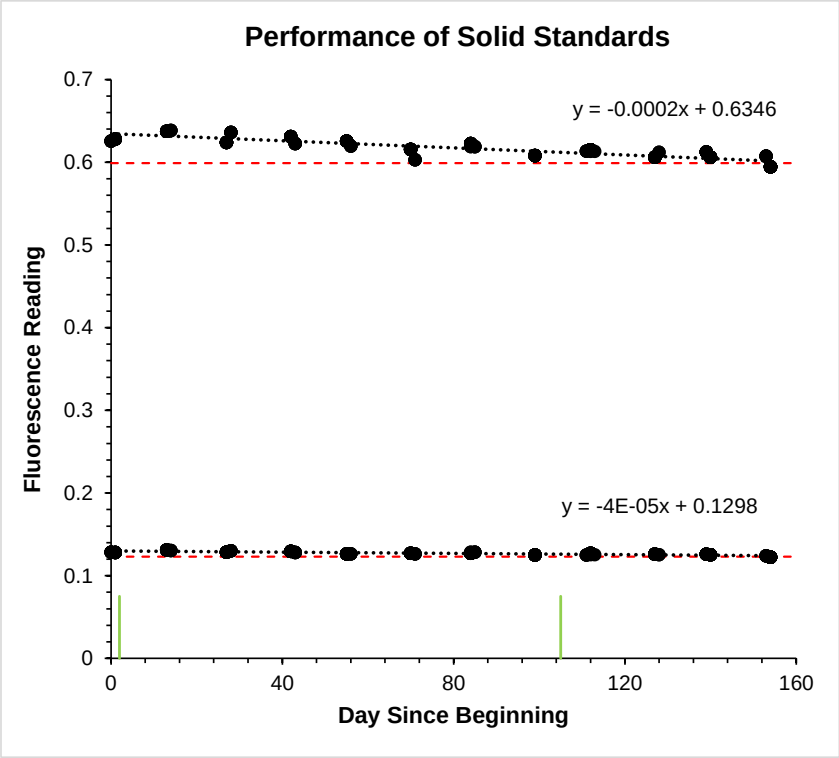


Figure 4. Data for the performance of the Turner Design solid standards. The upper set of data are for the high (H) standard and the lower set are for the low (L) standard. The short vertical green lines at day 2 and day 105 are when full standard curves were created using data generated from multiple secondary standards using a Perkin-Elmer Lambda 35 spectrometer. The horizontal red dashed lines represent the average of solid standard measurements made during the November 9 & 10 standard curves creation.

Chlorophyll-*a* Laboratory Analytical QC

Table 21 of the RIDEM project QAPP states that the desired acceptance limits for chlorophyll *a* laboratory replicates is 10% relative percent difference (RPD). However, we were not able to find any information within the existing literature where an RPD has been recommended for this procedure. Figure 5 shows the cumulative distributions for RPD values from work conducted at the Atlantic Ecology Division on Narragansett Bay, as well as RPD values from the current Newport project. They are separated because the range of chlorophyll *a* values for the two are very different. However, the distributions are very similar. These data sets suggest that 20% is a more reasonable threshold of concern. Only six of the values from Newport exceed 20%--and only one (40%) exceeded 30%.

Relative percent differences are typically calculated for measurements taken in duplicate. The Newport stations for the last two sampling events were measured in triplicate. However, we still calculated an RPD, but using the maximum minus the minimum divided by the average of all three.

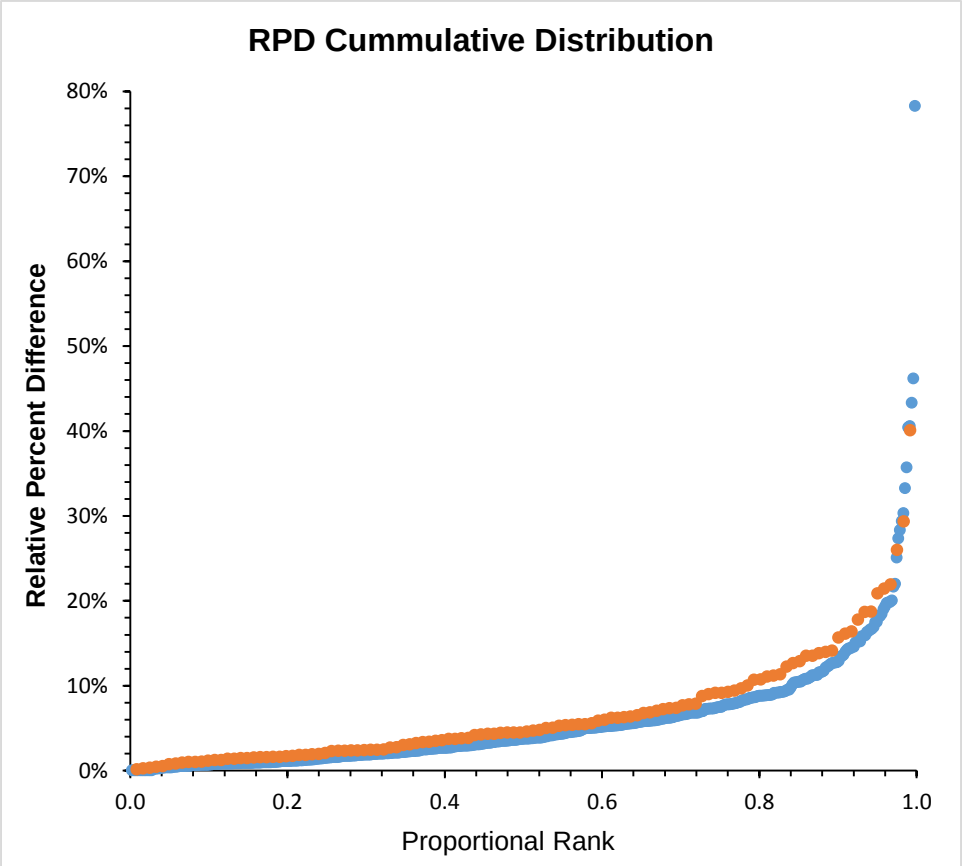


Figure 5. Cumulative distribution of chlorophyll *a* relative percent differences from the Turner fluorescence non-acidic technique. Blue markers are data from three different projects at the Atlantic Ecology Division for samples from Narragansett Bay (N = 474). Orange markers are data from the Newport project (N = 120).

In the few cases where the RPD exceeded the threshold, we did not accept any of the reanalyzed data. The sampling plan (QAPP) allowed water samples to be held up to 48 hours before analysis. However, this is likely too long—especially for samples high in chlorophyll. All samples except for two (Watson and Nonquit from September 8th) were filtered and the chlorophyll extraction begun within one to two hours of delivery to AED. The two that were not, were held overnight and processed the next morning. Even though the sampling plan allowed samples to be held up to 2 days under refrigeration, the generally accepted storage procedure is to first filter the samples, and then store the filters frozen until analysis. Early in the sampling (May) we re-analyzed several samples after 24 hours of refrigeration. The difference was insignificant; however, later in the summer (August, September) we again reanalyzed some samples—some with RPD that were higher than desired. Unfortunately, while many of these samples showed inconsequential changes in average concentration, a few of these samples showed a significant increase in the chlorophyll *a* concentration with the additional day of refrigeration. In at least one case the concentration more than doubled. Many phytoplankton species divide in the dark—

refrigeration in the dark can be an insufficient deterrent to growth. Because of this, we chose to only use data from the first analyses in the final data set.

Chlorophyll-*a* Data Summary

Figure 6 are graphs of the average chlorophyll *a* data for each location. The data for each replicate are in the attached file.

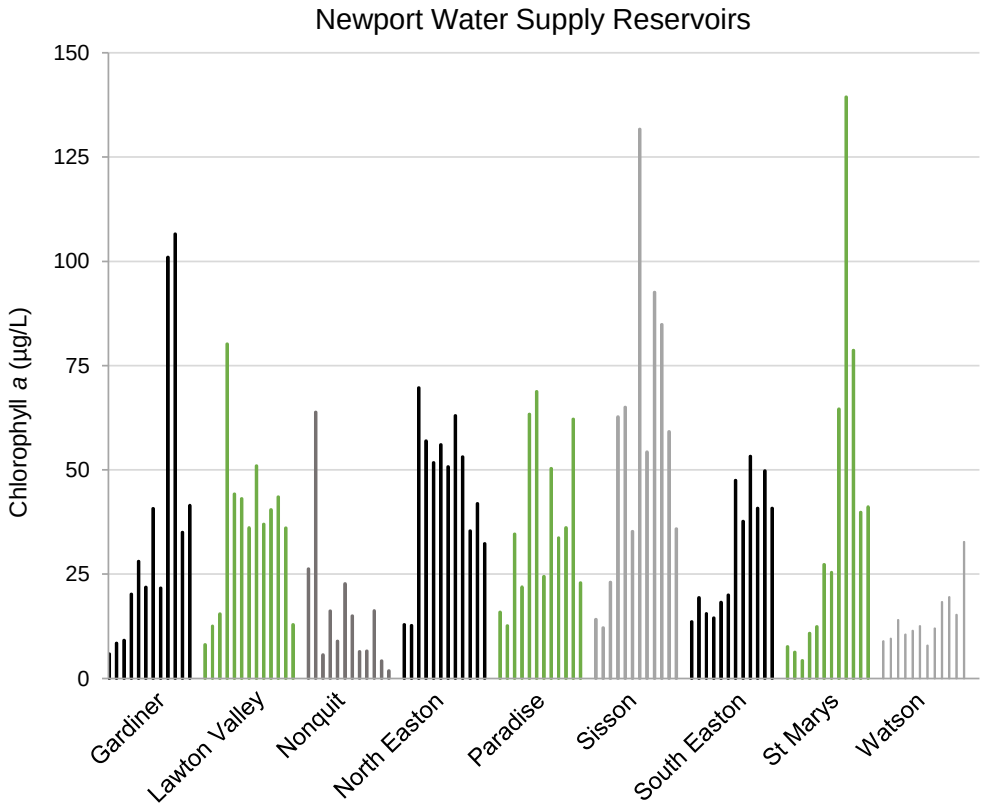


Figure 6. An overall summary plot of chlorophyll *a* data from 2015 samples of the Newport water supply reservoirs. For each location the earlies sampling event is to the left.

Ultraviolet absorbance (UVA)

Below are the data from the UVA analyses conducted at the Atlantic Ecology Division on twelve different sampling events from May through October 2015. The sample preparation and UVA measurements were performed by Joseph Bishop (EPA student service contractor), Darryl Keith, Joseph LiVolsi and Glen Thursby (EPA AED). The analyses generally followed AED Laboratory Operating Procedure "Determination of specific UV absorbance at 254 nm in source water and drinking water in support of TMDL development" (LOP-AED/MAB/DK/2015-01-00-listed as LSOP7 in the RIDEM project QAPP). Samples were measured using a Perkin-Elmer Lambda 35 spectrometer—scanning from 200 to 300 nm

in 1 nm widths as an additional check on the performance of spectrometer (making sure the general shape of the curve remained consistent).

There were some slight modifications to the LOP for the purpose of the Newport drinking water data analyses. First, we used laboratory reagent water (LWR) as the spectrometer reference instead of the In-Spec background solution. The IN-SPEC background solution and the IN-SPEC optical standard were measured separately against this reference. Second, we did not just test each lot of filters for the amount of preparation volumes to remove UV absorbing material from the filters and the inhibition of adsorption of UV absorbing material by the filters. Instead, we essentially tested each filter by using the same filter for each laboratory replicate. If the relative percent difference between these measurements was acceptable, then the pre-rinsing was sufficient. For each field sample, filters were pre-rinsed with 25 mL of LWR and then 40 mL of sample. Measurements were done on two consecutive 15 mL samples[1].

UVA In-Spec Standard

The optical standard was an IN-SPEC certified standard (#8303), Lot #C475890. The IN-SPEC background solution (#8300) was Lot #C475782. The certified absorbance at 254 nm was 0.1694 cm^{-1}. The data for the performance of the IN-SPEC optical standard are presented in Figure 7. Although the method only needs the absorbance at 254 nm, we include data for other certified values as well. All measurements of the standard were within the required 10% of the certified values.

[1] For the first sampling event we used 10-cm quartz cells in the spectrometer, so pre-rinse and sample volumes were all 50 mL. After determining that 1 cm cells would be sufficient, the rinse and sample volumes were reassessed.

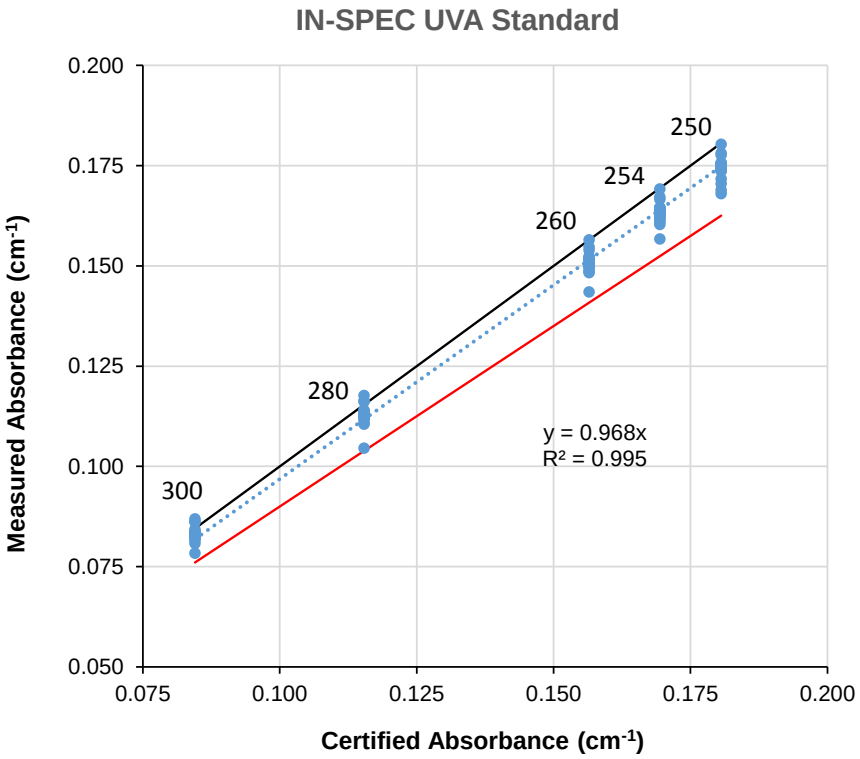


Figure 7. UVA standard performance for all sampling events. Numbers next to the data points are the wavelengths (nm) where certified values were available. The black line represents where the measured values would be equal to the certified values. The dashed blue line is the linear regression of the data. The red line is 90% of the certified values.

UVA Laboratory Analytical QC

Table 29 of the RIDEM QAPP states that the desired acceptance limits for UVA laboratory replicates is 20% relative percent difference (RPD). And that laboratory duplicates were only required once per batch. The original EPA method documentation[2] gives no information on the RPD for laboratory duplicates. It does, however, state that field duplicates should have an RPD of 10% or less. We chose to use the 10%. In addition, we performed laboratory duplicates on every sample[3]. Figure 8 shows the cumulative distributions for RPD values from the Newport drinking water supply project.

[2] Potter and Wimsatt. 2009. Determination of total organic carbon and specific UV absorbance at 254 nm in source water and drinking water. EPA/600/R-09/122.

[3] For some samples we actually used 3 to 5 replicates as an occasional check on the performance of the filters. In these cases, we used the last two replicates for the final dataset.

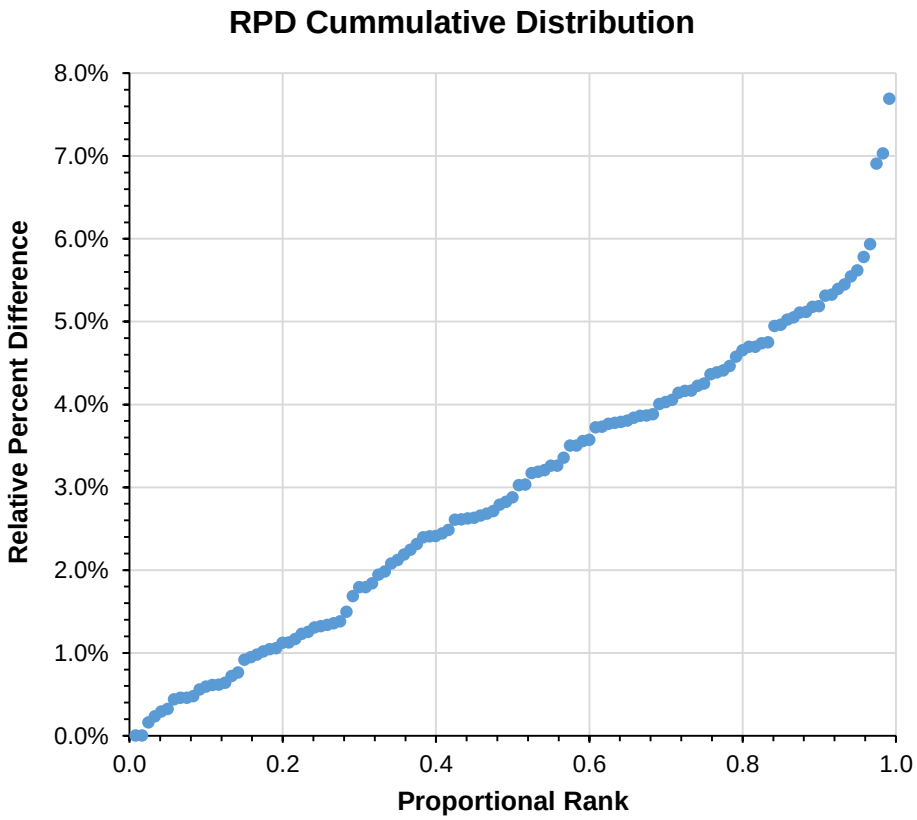


Figure 8. Cumulative distribition of UVA relative percent differences.

UVA Data Summary

Figure 9 are graphs of the average chlorophyll *a* data for each location. All samples were measured within 24 hr of delivery to AED—most the afternoon of arrival. The data for each replicate are in the attached file. The comment "Repeat" indicates original RPDs were near to or exceeded 10% and samples were reanalyzed the next morning (still within our desired 24 hr or less holding periods—which was less that the allowed 48 hr).

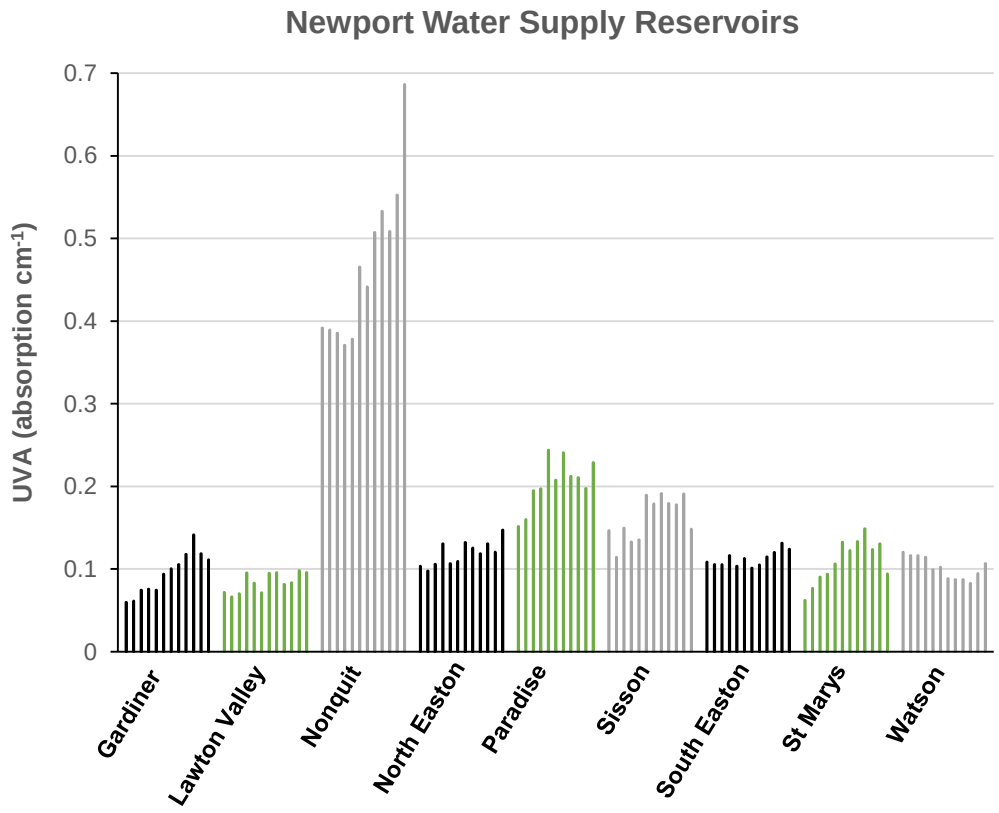


Figure 9. An overall summary plot of UVA data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

Nutrient Water Chemistry Analysis Summary

The total number of nutrient water samples collected in each reservoir was dependent upon reservoir conditions at the time of sampling (i.e. stratified or un-stratified). Under stratified conditions: samples analyzed for nutrient-related parameters were collected from three depths at the sample station- one from the epilimnion (upper waters or 'surface'), one from the thermocline surface, and one from the hypolimnion (lower waters or 'depth'). For un-stratified conditions: samples analyzed for nutrient-related parameters were collected from approximately one meter below the surface and approximately one meter above the bottom. Table 15 in the RIDEM QAPP summarizes the sampling protocol as based on vertical profiling data. Two ponds experienced stratification: Paradise Pond on 4 sampling dates (5/18/15, 7/15/15, 7/28/15 and 8/25/15) and Watson Reservoir on 7 sampling dates (5/19/15, 6/01/15, 6/17/15, 7/16/15, 7/29/15, 8/24/15 and 9/08/15). For the 12 biweekly sampling sessions from May thru October, there was a total of 227 water samples (including field blanks and thermocline samples) analyzed for total nitrogen, total phosphorus, nitrate-nitrite nitrogen, ammonia nitrogen, orthophosphate, and dissolved organic carbon.

Field samples collected by RIDEM were received at the AED laboratory in Narragansett, RI, and custody of the samples was transferred from RIDEM to Anne Kuhn (EPA AED) who logged-in and cross

referenced the chain of custody sheets that accompanied the samples. Samples were then processed (filtered, preserved) at the AED laboratory in Narragansett, RI by Dodi Borsay-Horowitz, Laura Coiro and Anne Kuhn (EPA AED), following the laboratory standard operating procedures for total nitrogen, total phosphorus, nitrate-nitrite nitrogen, ammonia nitrogen, orthophosphate, and dissolved organic carbon described in detail in the RIDEM QAPP: LSOP2: Nitrite-Nitrate Nitrogen; LSOP3: Ammonia Nitrogen; LSOP4: Total Nitrogen; LSOP5: Dissolved Organic Carbon/Total Organic Carbon; LSOP10: Total and Ortho-Phosphorus.

Nutrient samples were processed (unfiltered and filtered through membrane filters ≤ 0.45 µ pore; 47 mm diameter) and dissolved organic carbon (DOC) samples were filtered (≤ 0.45 µ pore; 47 mm diameter) and acidified and preserved with 100 µL 50% Phosphoric acid (H_3PO_4), either the same day they were collected in the field or the next morning, always within 24 hours of field collection. All samples were processed into labeled pre-cleaned bottles provided by the MED laboratory following sample handling procedures listed in Table 18 of the RIDEM QAPP. After processing, preservation and storage in either freezer (filtered and unfiltered nutrients) or refrigerator (DOC), samples were then UPS overnight express shipped in coolers packed with ice packs to the MED laboratory for morning delivery. Chain of custody sheets were shipped with the samples and electronically emailed to the MED laboratory and samples were cross-verified with COC sheets upon arrival and appropriately stored until sample analysis.

The EPA MED laboratory (Colleen Elonen and Terri Jicha) in Duluth, MN analyzed the water samples collected in the field by RIDEM for the following parameters: nitrate-nitrite nitrogen, ammonia nitrogen, total nitrogen, dissolved organic carbon, total phosphorus, and orthophosphate. Method detection limits (MDL) for each of the analytes can be seen in the table below. The MDL is the lowest concentration of a substance that can reliably be measured and reported with some degree of confidence that the substance is present in the sample.

Analyte	MDL (ppb)
PO4	2.53
NOx	1.26
NH4	4.03
TN	77.49
TP	7

All laboratory analytical methods and achievable laboratory limits are summarized in Table 20 of the RIDEM QAPP with the full laboratory SOP's (LSOP) provided in Appendix D of the RIDEM QAPP.

For this report we will present only the summary **surface water** or **epilimnion** results for total nitrogen (TN), total phosphorus (TP), nitrate and nitrite (NO3 + NO2) nitrogen, orthophosphate (PO4-), ammonium (NH4+), and dissolved organic carbon for each drinking water supply pond for the 12 sampling sessions (biweekly May thru October). The entire nutrient-related parameter data set includes surface, depth and thermocline measurements (if the drinking water supply pond was stratified) for each pond, for each of the 12 sampling sessions, and has been provided to RIDEM in electronic data files.

An overall summary plot for each of the nutrient-related parameters from the nine Newport water supply reservoirs is displayed in Figures 10 thru 15 (TN, TP, NO3 + NO2, PO4-, NH4+, and DOC, respectively). Appendix A contains the surface water quality monitoring nutrient-related data for each of the nine Newport, RI drinking water supply ponds throughout the biweekly sampling period from May thru October. The parameters varied widely among the ponds and within ponds throughout the sampling period. Figures in Appendix B display the surface water quality for the nutrient-related parameters for each pond throughout the sampling period.

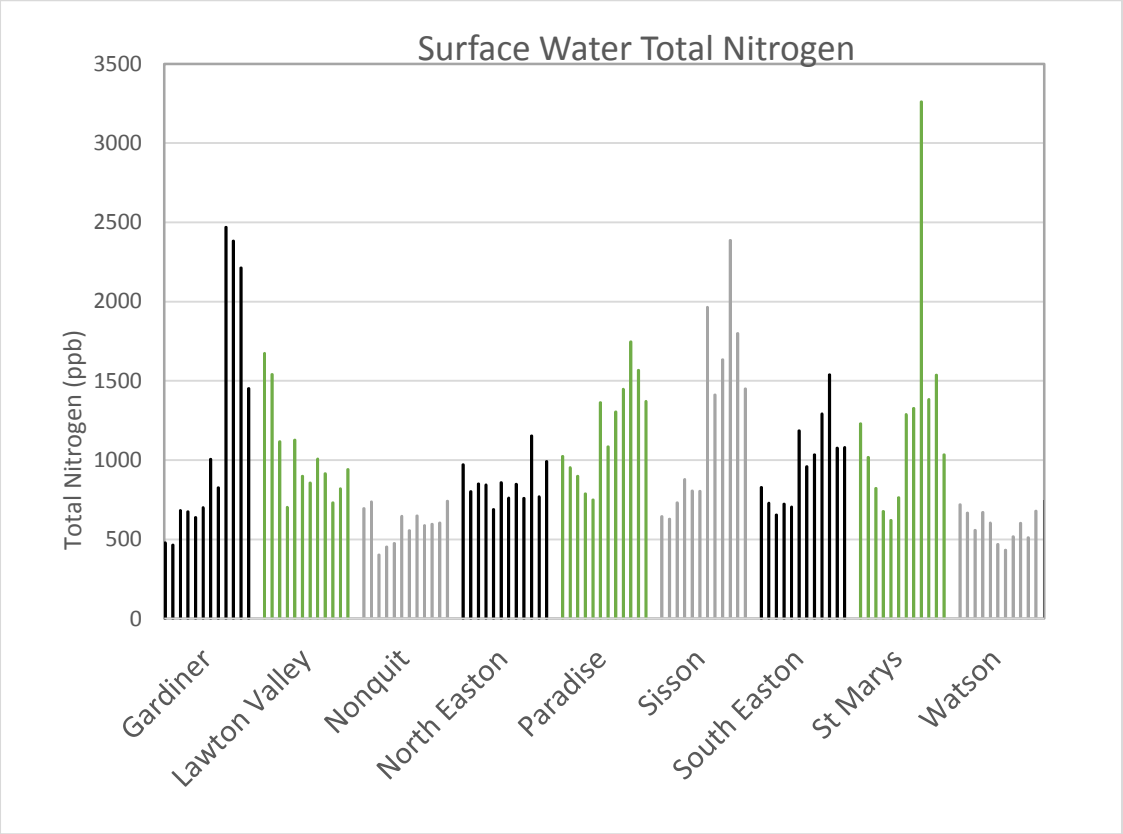


Figure 10. An overall summary plot of Total Nitrogen (TN) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

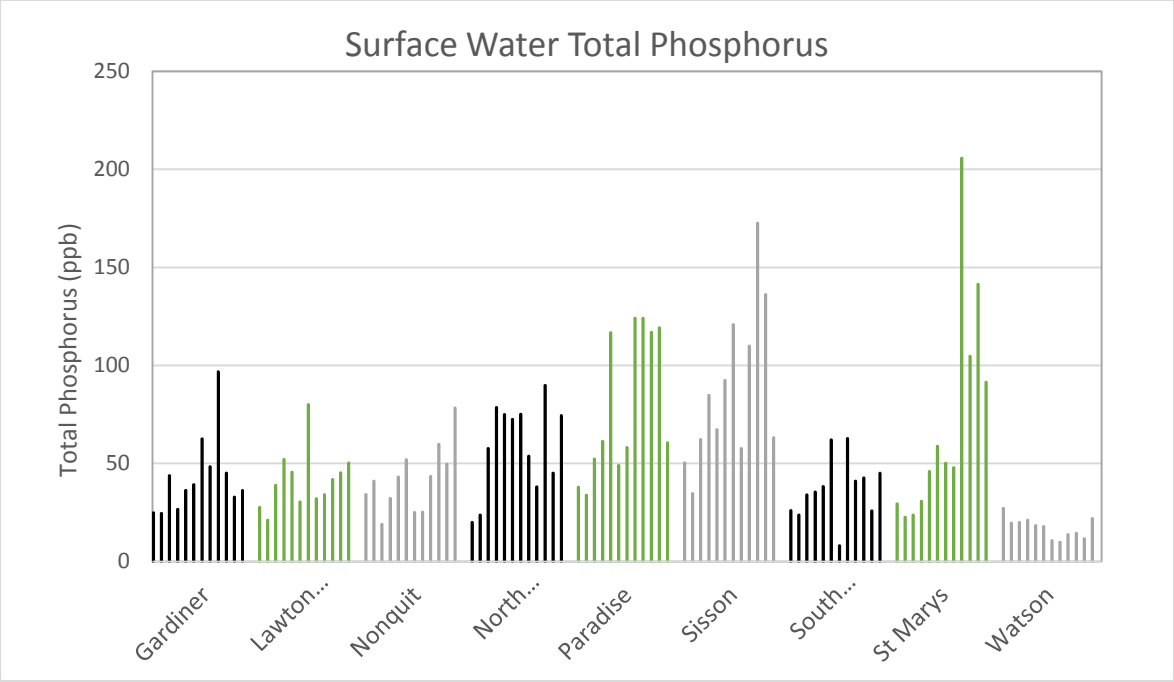


Figure 11. An overall summary plot of Total Phosphorus (TP) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

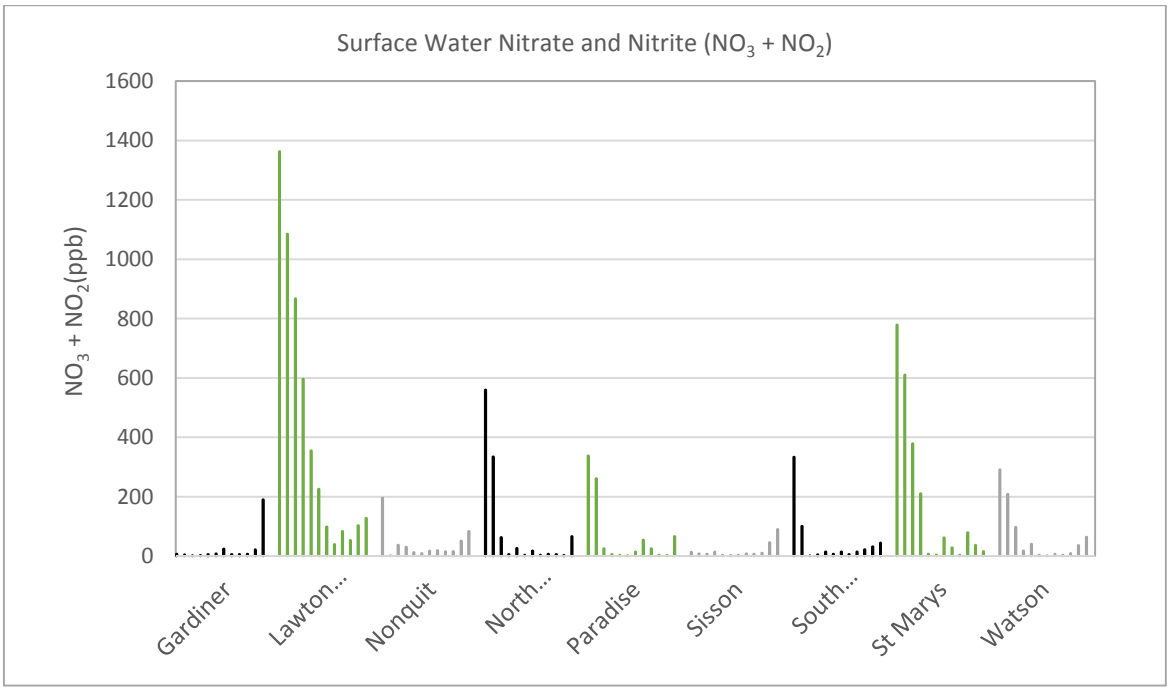


Figure 12. An overall summary plot of Nitrate and Nitrite (NO_3 + NO_2) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

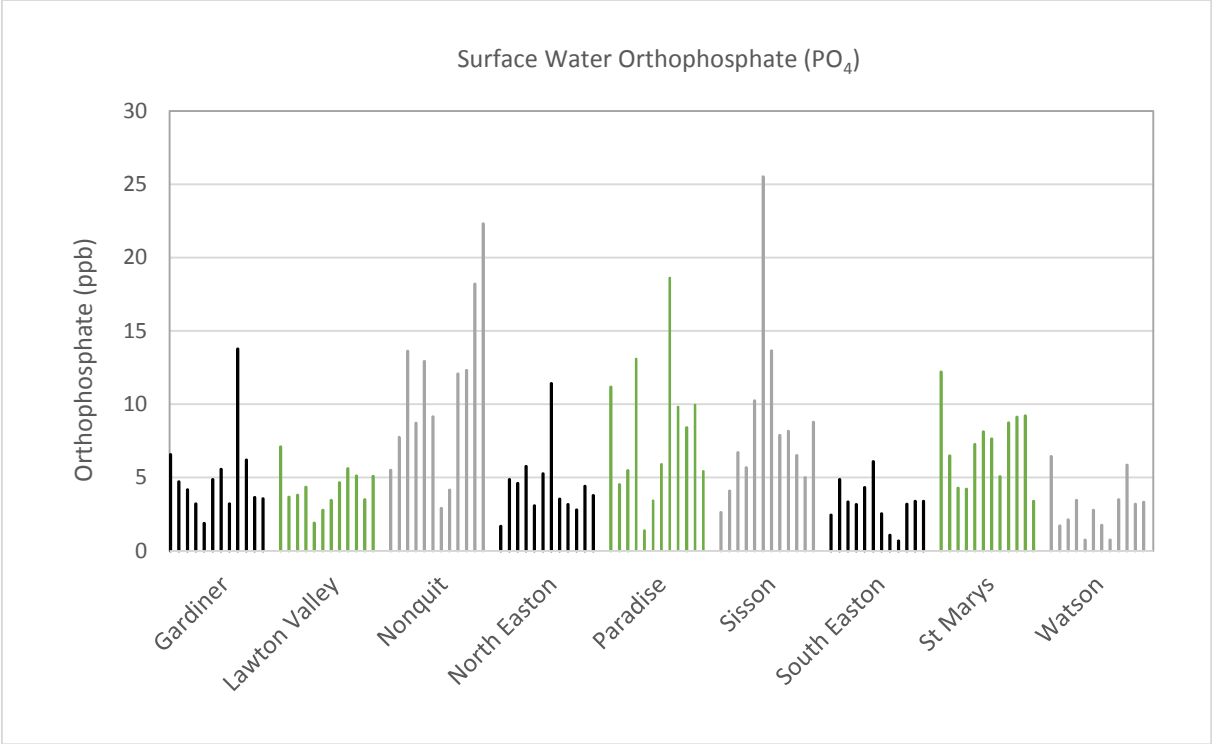


Figure 13. An overall summary plot of Orthophosphate (PO_4) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

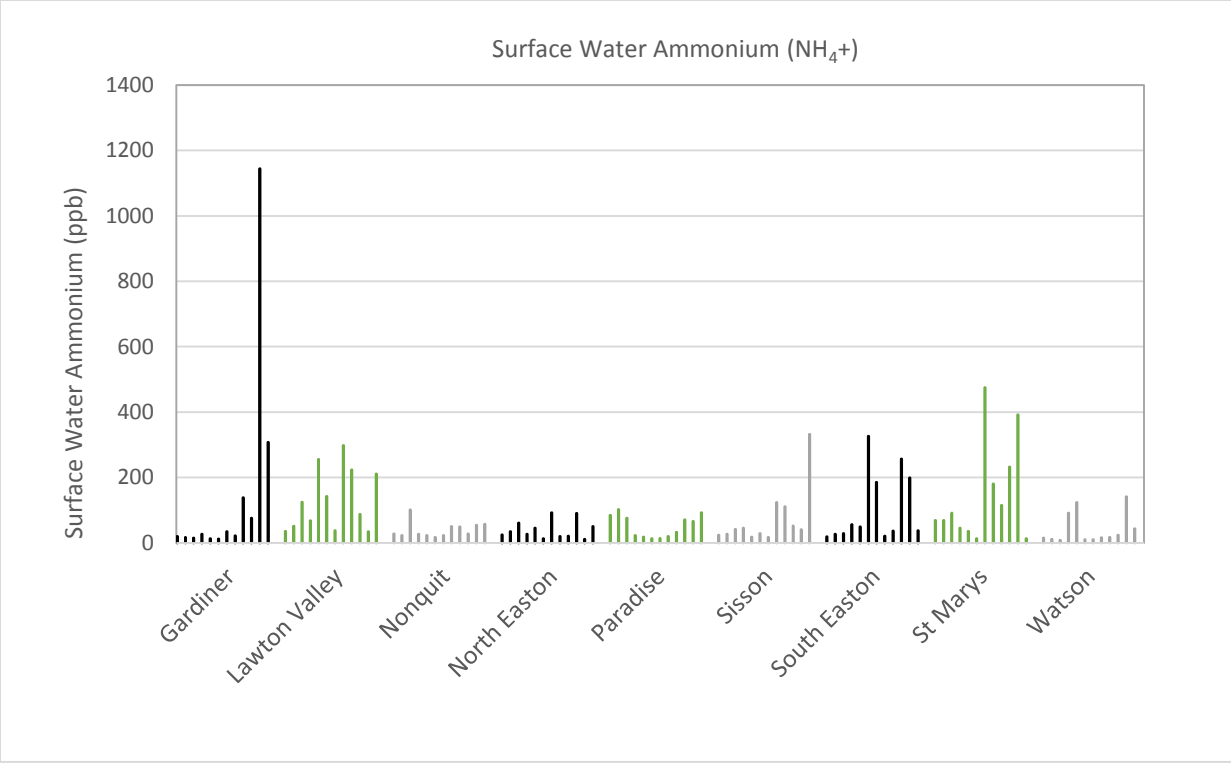


Figure 14. An overall summary plot of Ammonium (NH_4+) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

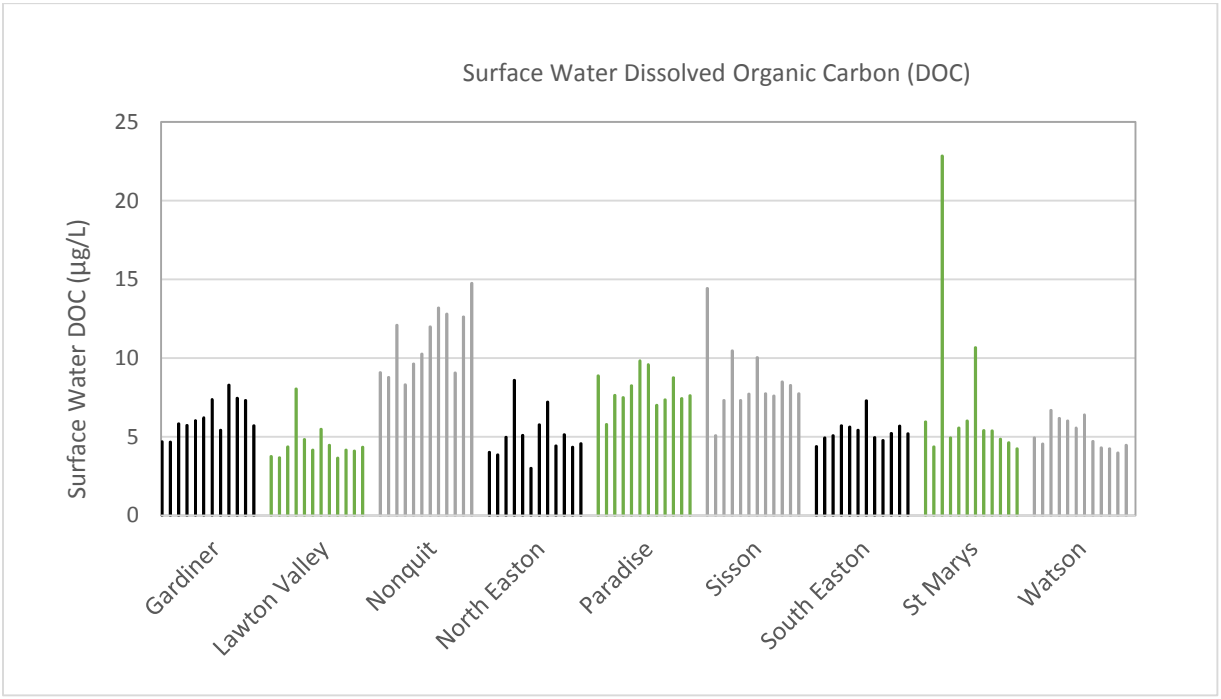


Figure 15. An overall summary plot of dissolved organic carbon (DOC) data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

Appendix A. Summary data for surface water quality monitoring nutrient-related parameters for nine Newport, RI drinking water supply ponds collected from May thru October 2015.

Pond Name	Sample Date	TN	TP	NO3 + NO2	PO4-	NH4+	DOC (µg/L)
Gardiner	5/6/2015	480	24.941	7	6.59	20.22	4.70
Gardiner	5/18/2015	465	24.5	5	4.73	17.60	4.67
Gardiner	6/1/2015	684	43.875	1	4.19	15.94	5.83
Gardiner	6/16/2015	675	26.775	3	3.22	26.92	5.73
Gardiner	6/29/2015	638	36.328	6	1.89	13.32	6.03
Gardiner	7/15/2015	700	39.26	8	4.89	13.05	6.23
Gardiner	7/28/2015	1006	62.546	24	5.57	34.89	7.39
Gardiner	8/12/2015	826	48.397	6	3.23	22.00	5.42
Gardiner	8/25/2015	2469	96.86	6	13.79	139.26	8.30
Gardiner	9/9/2015	2383	45.121	6	6.21	76.73	7.45
Gardiner	9/22/2015	2213	32.819	22	3.67	1144.00	7.32
Gardiner	10/6/2015	1452	36.335	190	3.58	308.35	5.71
Lawton Valley	5/6/2015	1674	27.699	1363	7.10	36.36	3.76
Lawton Valley	5/18/2015	1541	21.07	1085	3.67	51.69	3.67
Lawton Valley	6/1/2015	1116	38.879	867	3.81	125.31	4.37
Lawton Valley	6/16/2015	704	52.171	597	4.36	68.93	8.06
Lawton Valley	6/29/2015	1127	45.621	355	1.92	255.87	4.84
Lawton Valley	7/15/2015	898	30.448	225	2.78	142.36	4.17
Lawton Valley	7/28/2015	857	80.157	98	3.47	38.57	5.49
Lawton Valley	8/12/2015	1008	32.007	39	4.65	298.76	4.46
Lawton Valley	8/25/2015	915	34.286	83	5.63	224.42	3.66
Lawton Valley	9/9/2015	732	41.903	53	5.11	87.75	4.16
Lawton Valley	9/22/2015	820	45.313	103	3.50	35.12	4.11
Lawton Valley	10/6/2015	941	50.425	127	5.10	211.37	4.35
Nonquit	5/6/2015	695	34.145	196	5.516	28.65	9.09
Nonquit	5/18/2015	737	41.04	1	7.766	23.33	8.78
Nonquit	6/1/2015	403	19.078	37	13.636	101.38	12.10
Nonquit	6/17/2015	452	32.292	31	8.72	27.80	8.31
Nonquit	6/30/2015	474	43.255	12	12.932	23.15	9.63
Nonquit	7/16/2015	646	52.038	8	9.15	17.16	10.27
Nonquit	7/29/2015	555	25.033	18	2.913	23.82	12.00
Nonquit	8/12/2015	648	25.216	19	4.154	51.30	13.20
Nonquit	8/24/2015	589	43.498	16	12.074	49.57	12.82
Nonquit	9/8/2015	595	59.769	16	12.317	28.06	9.06
Nonquit	9/21/2015	604	49.73	51	18.202	54.41	12.63
Nonquit	10/5/2015	742	78.394	83	22.309	57.49	14.76

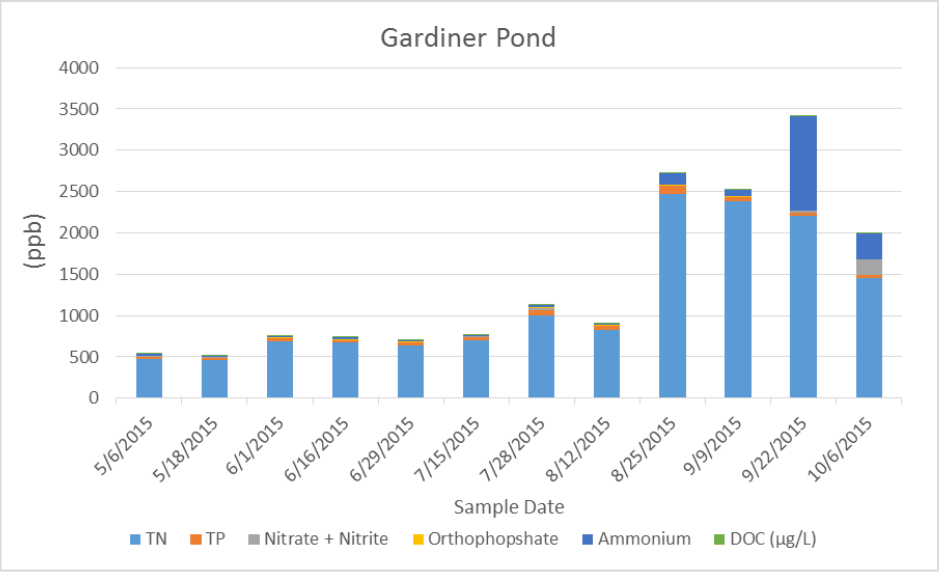
Continued – Appendix A. Summary data for water quality monitoring nutrient-related parameters for nine Newport, RI drinking water supply ponds collected from May thru October 2015.

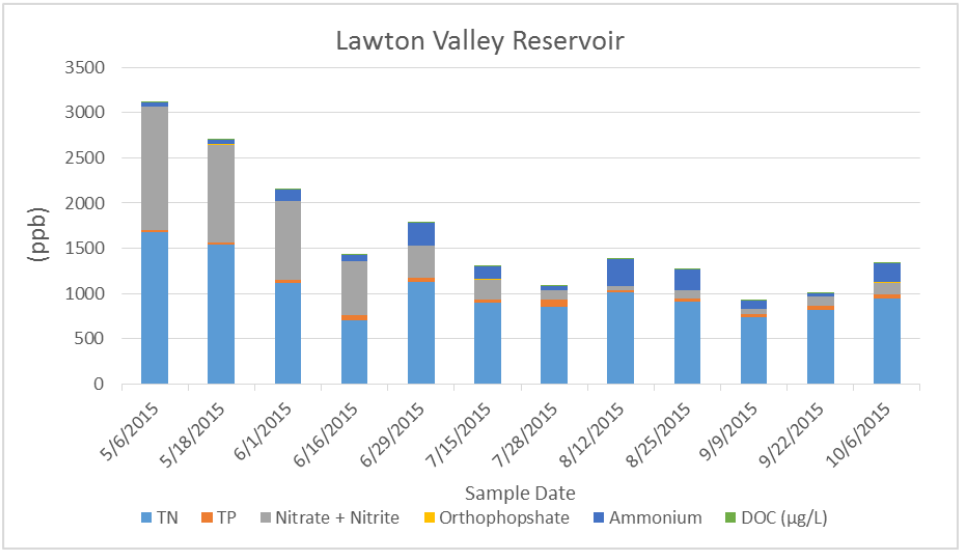
Pond Name	Sample Date	TN	TP	NO3+NO2	PO4-	NH4+	DOC (µg/L)
NorthEaston	5/6/2015	971	20.038	559	1.688	25.23	4.02
North Easton	5/18/2015	801	23.798	334	4.885	34.99	3.85
North Easton	6/1/2015	851	57.713	63	4.614	61.95	4.98
North Easton	6/16/2015	845	78.532	5	5.771	27.75	8.59
North Easton	6/29/2015	689	74.95	26	3.095	45.50	5.10
North Easton	7/15/2015	858	72.5	4	5.273	13.63	3.01
North Easton	7/28/2015	762	75.102	18	11.416	93.07	5.77
North Easton	8/12/2015	849	53.731	4	3.544	20.64	7.22
North Easton	8/25/2015	759	38.129	7	3.167	21.42	4.42
North Easton	9/9/2015	1154	89.905	6	2.806	91.36	5.15
North Easton	9/22/2015	769	45.184	3	4.419	11.37	4.35
North Easton	10/6/2015	992	74.549	66	3.794	50.97	4.56
Paradise	5/6/2015	1024	37.974	338	11.18	85.33	8.89
Paradise	5/18/2015	954	33.9	261	4.534	102.37	5.79
Paradise	6/1/2015	898	52.271	25	5.488	75.82	7.64
Paradise	6/16/2015	787	61.373	5	13.106	23.15	7.51
Paradise	6/29/2015	749	116.749	3	1.418	18.17	8.25
Paradise	7/15/2015	1364	49.041	1	3.434	13.57	9.83
Paradise	7/28/2015	1084	58.207	14	5.915	14.21	9.60
Paradise	8/12/2015	1304	124.187	54	18.636	20.08	7.01
Paradise	8/25/2015	1448	124.133	25	9.838	33.59	7.35
Paradise	9/9/2015	1746	116.936	4	8.419	71.83	8.75
Paradise	9/22/2015	1568	119.249	2	9.965	66.06	7.45
Paradise	10/6/2015	1371	60.581	66	5.449	93.22	7.62
Sisson	5/6/2015	645	50.383	13	2.63	24.46	14.43
Sisson	5/18/2015	628	34.75	8	4.086	27.69	5.08
Sisson	6/1/2015	731	62.267	6	6.7	42.17	7.32
Sisson	6/16/2015	879	84.831	14	5.693	46.00	10.46
Sisson	6/29/2015	805	67.35	3	10.255	18.29	7.32
Sisson	7/15/2015	803	92.505	2	25.522	29.08	7.73
Sisson	7/28/2015	1964	120.958	3	13.643	17.28	10.04
Sisson	8/12/2015	1411	57.75	8	7.89	124.65	7.74
Sisson	8/25/2015	1634	109.997	6	8.179	111.28	7.60
Sisson	9/9/2015	2386	172.661	10	6.523	52.67	8.50
Sisson	9/22/2015	1800	136.21	46	5.015	41.10	8.27
Sisson	10/6/2015	1451	63.266	90	8.79	332.37	7.74

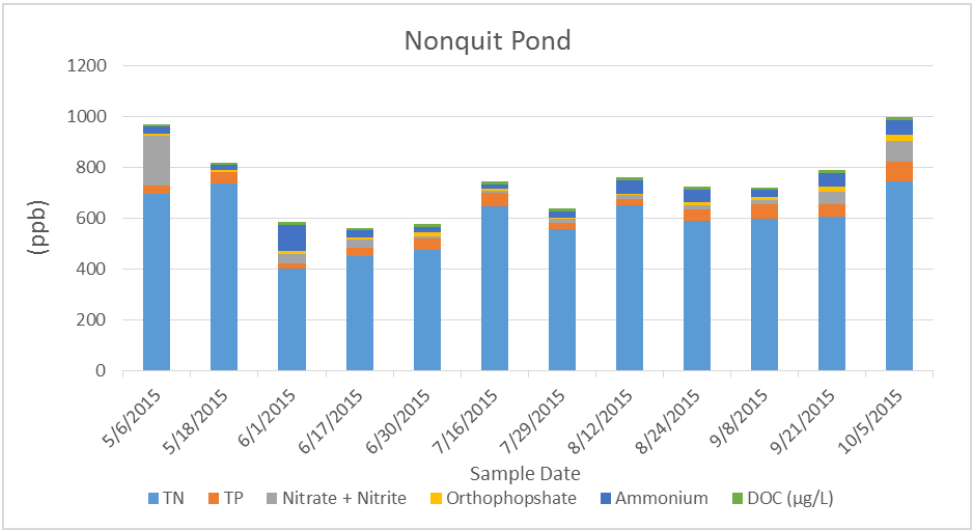
Continued – Appendix A. Summary data for water quality monitoring nutrient-related parameters for nine Newport, RI drinking water supply ponds collected from May thru October 2015.

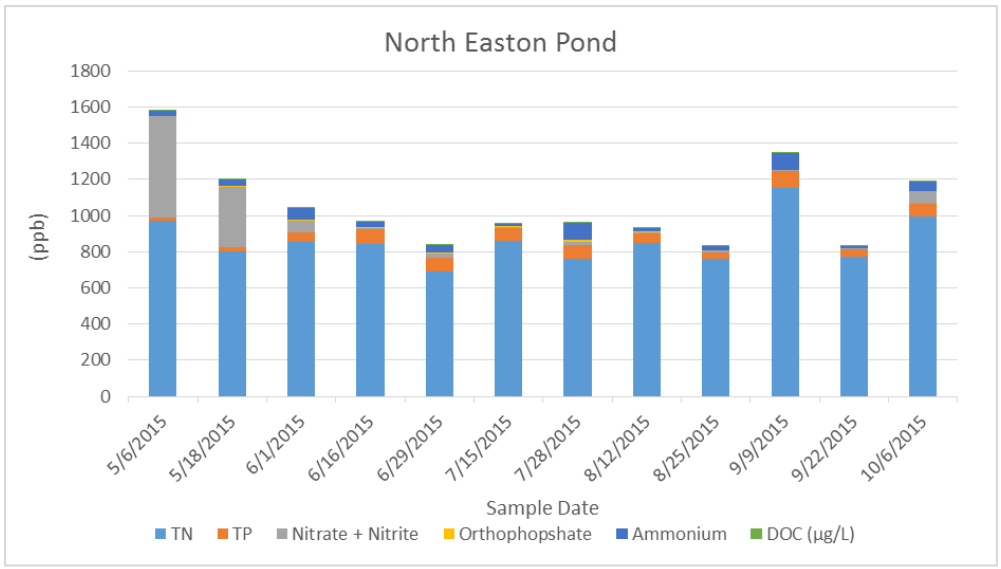
Pond Name	Sample Date	TN	TP	NO3 + NO2	PO4-	NH4+	DOC (µg/L)
South Easton	5/5/2015	829	26.066	334	2.462	19.08	4.40
South Easton	5/18/2015	730	23.76	100	4.875	26.98	4.95
South Easton	6/1/2015	655	33.987	1	3.36	28.88	5.08
South Easton	6/16/2015	724	35.504	5	3.185	56.83	5.71
South Easton	6/29/2015	705	38.315	14	4.328	50.21	5.63
South Easton	7/15/2015	1186	62.116	7	6.11	326.66	5.43
South Easton	7/28/2015	960	8.05	15	2.544	185.85	7.29
South Easton	8/12/2015	1034	62.784	5	1.076	21.50	4.95
South Easton	8/25/2015	1292	41.142	15	0.678	37.43	4.77
South Easton	9/9/2015	1539	42.759	21	3.19	257.23	5.22
South Easton	9/22/2015	1077	25.851	31	3.392	199.65	5.69
South Easton	10/6/2015	1080	45.169	44	3.398	38.09	5.19
St Marys	5/6/2015	1230	29.399	779	12.212	69.16	5.96
St Marys	5/18/2015	1018	22.658	610	6.49	69.68	4.38
St Marys	6/1/2015	823	23.788	379	4.279	92.26	22.84
St Marys	6/16/2015	677	30.834	210	4.233	46.26	4.95
St Marys	6/29/2015	621	45.979	7	7.276	35.82	5.56
St Marys	7/15/2015	764	58.841	3	8.126	13.48	6.02
St Marys	7/28/2015	1288	50.262	62	7.646	475.15	10.66
St Marys	8/12/2015	1326	47.88	28	5.067	180.76	5.40
St Marys	8/25/2015	3261	205.763	4	8.733	114.90	5.38
St Marys	9/9/2015	1383	104.748	79	9.138	233.17	4.85
St Marys	9/22/2015	1537	141.518	37	9.213	391.96	4.64
St Marys	10/6/2015	1035	91.514	15	3.399	13.77	4.24
Watson	5/6/2015	718	27.128	291	6.459	15.71	4.94
Watson	5/19/2015	667	19.618	209	1.721	11.63	4.56
Watson	6/1/2015	559	19.961	98	2.124	8.82	6.68
Watson	6/17/2015	671	21.08	18	3.469	92.18	6.19
Watson	6/30/2015	604	18.428	40	0.753	123.89	6.01
Watson	7/16/2015	470	17.833	4	2.785	10.51	5.56
Watson	7/29/2015	432	10.733	1	1.753	10.75	6.41
Watson	8/12/2015	517	9.867	7	0.746	16.44	4.71
Watson	8/24/2015	602	13.853	3	3.506	17.82	4.30
Watson	9/8/2015	510	14.503	9	5.856	23.96	4.25
Watson	9/21/2015	680	11.599	36	3.193	141.62	3.99
Watson	10/5/2015	745	21.882	64	3.334	44.25	4.47

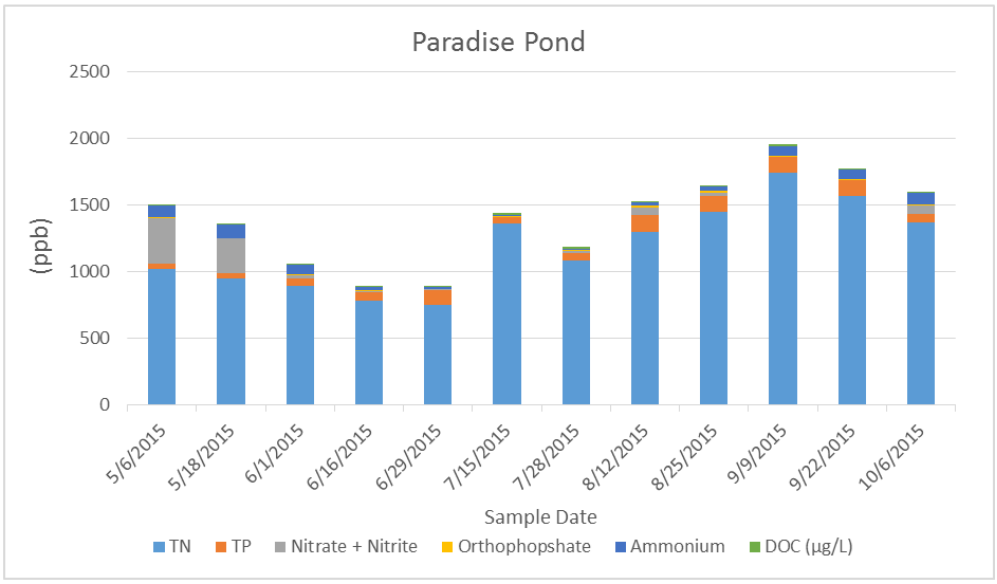
Appendix B


Gardiner Pond
4000
3500
3000
2500
2000
1500
1000
500
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


Lawton Valley Reservoir
3500
3000
2500
2000
1500
1000
500
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


Nonquit Pond
1200
1000
800
600
400
200
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/17/2015
6/30/2015
7/16/2015
7/29/2015
8/12/2015
8/24/2015
9/8/2015
9/21/2015
10/5/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


North Easton Pond
1800
1600
1400
1200
1000
800
600
400
200
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


Paradise Pond
2500
2000
1500
1000
500
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
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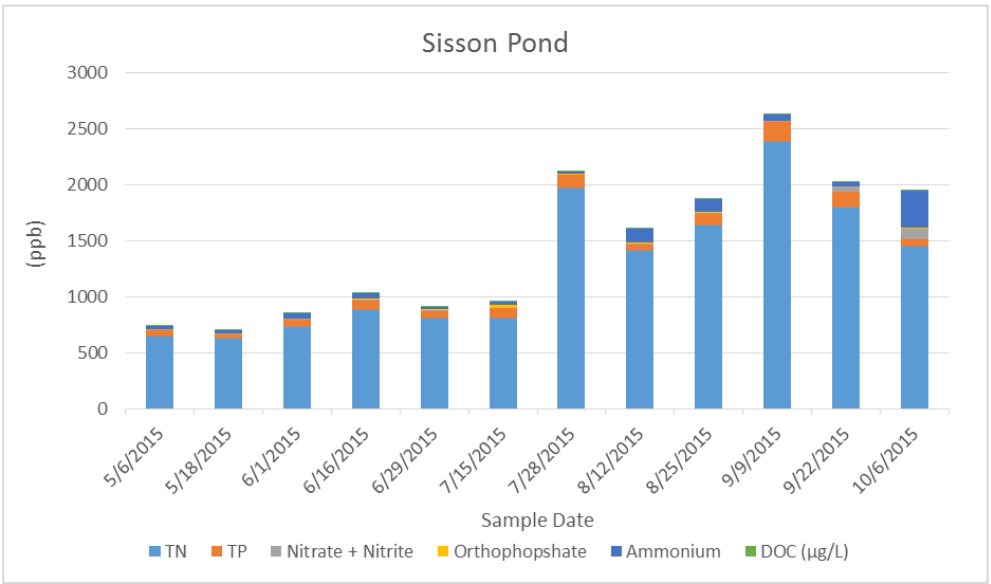
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


Sisson Pond
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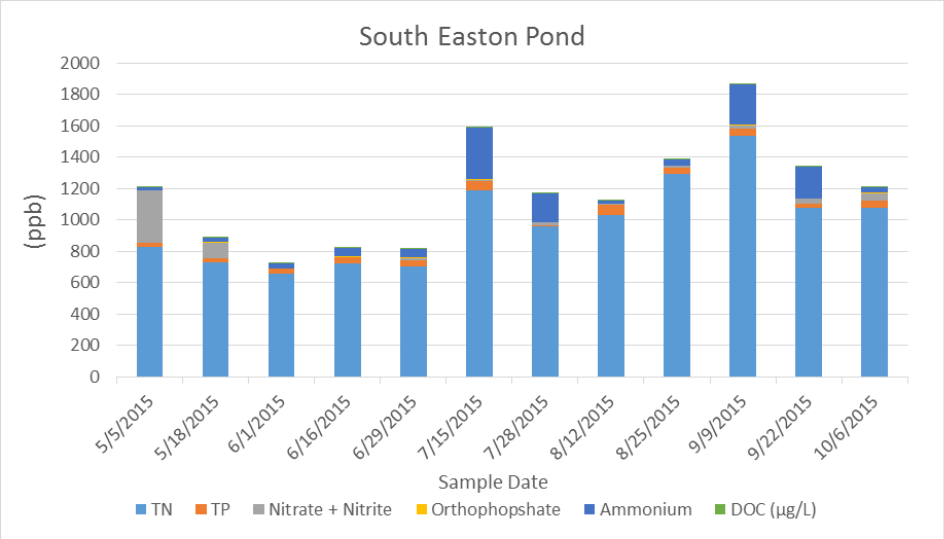
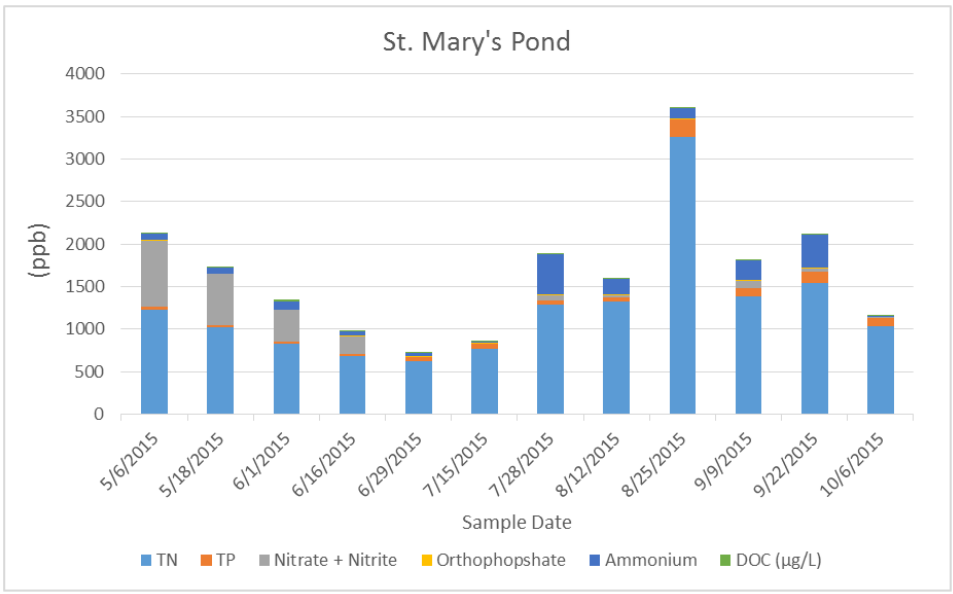
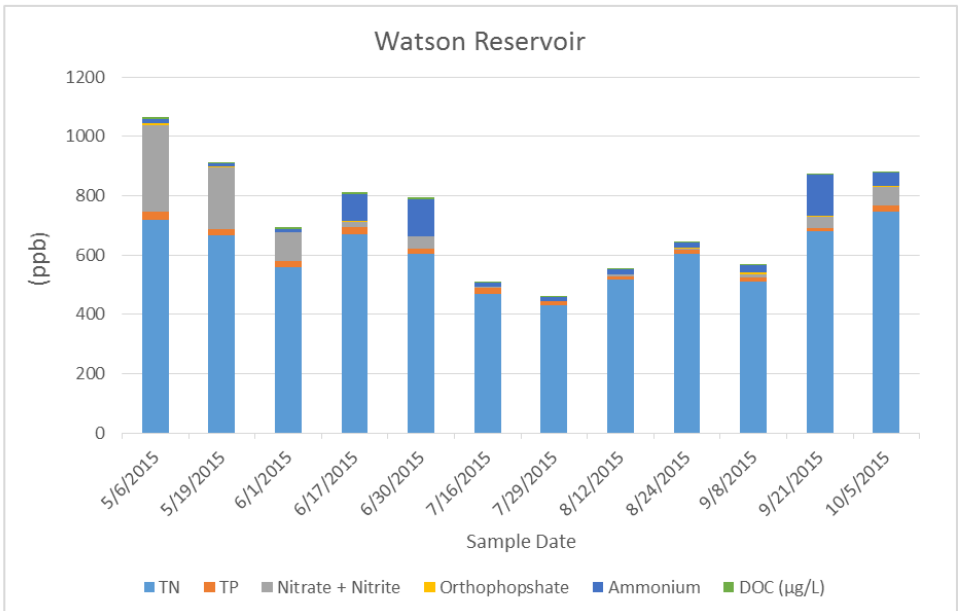
2000
1500
1000
500
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


South Easton Pond
2000
1800
1600
1400
1200
1000
800
600
400
200
0
(ppb)
5/5/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


St. Mary's Pond
4000
3500
3000
2500
2000
1500
1000
500
0
(ppb)
5/6/2015
5/18/2015
6/1/2015
6/16/2015
6/29/2015
7/15/2015
7/28/2015
8/12/2015
8/25/2015
9/9/2015
9/22/2015
10/6/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)


Watson Reservoir
1200
1000
800
600
400
200
0
(ppb)
5/6/2015
5/19/2015
6/1/2015
6/17/2015
6/30/2015
7/16/2015
7/29/2015
8/12/2015
8/24/2015
9/8/2015
9/21/2015
10/5/2015
Sample Date
TN
TP
Nitrate + Nitrite
Orthophopshate
Ammonium
DOC (µg/L)

EPA-AED Inserted Document 2: Quality Control Summary-Review of Submitted Datasets

Surface Water Monitoring Results for Newport RI Drinking Water Reservoirs

Quality Control Summary: Review of submitted data sets

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June 24, 2016

Surface Water Monitoring Quality Control Summary for Newport RI Drinking Water Reservoirs

INTRODUCTION

This report summarizes the quality control for the analytical chemistry analyses conducted by USEPA – Mid-Atlantic Ecology Division (MED) for the water quality monitoring data collected from early May through mid-October, 2015 from the nine Newport Water Division drinking water supply reservoirs. All of the original raw data which this quality control data supports has previously been provided to RIDEM electronically.

As indicated in the QA plan, MED performed analyses on prepared samples for nitrate-nitrite nitrogen, ammonia nitrogen, total nitrogen, dissolved organic carbon, total phosphorus, and orthophosphate (as it turned out, total organic carbon was not included in sample preparation and analysis).

Field crews for the Rhode Island Department of Environmental Management, (DEM) collected and delivered all samples to the USEPA-AED laboratory (AED) between the dates May 15 and October 31, 2015, comprising a total of twelve sampling events. Each cooler included a temperature blank that was measured upon delivery.

Copies of the chain-of-custody forms containing this information, along with the container inventory, are being kept as part of the record. AED prepared samples for shipment following the sample handling procedures listed in Table 18 of the QA plan. Samples were shipped to MED within one week of arrival at AED, including chain-of-custody forms providing the sample inventory. Analyses were conducted over the summer of 2015 and into January of 2016.

ANALYTES MEASURED

Analytical services were provided by the US EPA Mid-Continent Ecology Laboratory Division in Duluth, MN (MED) and the US EPA Atlantic Ecology Division in Narragansett, RI (AED) as follows in the following table. Total organic carbon, as an oversight, was not analyzed.

Analytical Parameters. Parameter	**Analytical Method/**	**Detection Limit, accuracy, precision**	**Analytical Laboratory**	**Laboratory SOP (LSOP) Reference**
Nitrate and Nitrite-Nitrogen (NO3)	EPA 353.3/353.2	MDL 1.0 ug/L ±10%	EPA MED	LSOP2
Ammonia Nitrogen (NH3-N)	EPA 350.1	MDL 2.0 ug/L ±10%	EPA MED	LSOP3
Total Nitrogen	EPA 351.3/351.1	MDL 5.0 ug/L ±10%	EPA MED	LSOP4
Dissolved Organic Carbon	EPA 415.3	Precision 5-10% for total DL = 0.53 mg/L	EPA MED	LSOP5
Total Organic Carbon	EPA 415.3	Precision 5-10% for total DL = 0.53 mg/L	EPA MED	LSOP5
Total Phosphorus	EPA 365.1	MDL = 4.0 ug/L ±10%	EPA MED	LSOP10
Orthophosphate	EPA 365.1	MDL = 2.5 ug/L ±10%	EPA MED	LSOP10
Chlorophyll-a	EPA 445.0/446.0	RPO >90%	EPA AED	LSOP1
Ultraviolet Absorbance (254 nm)	EPA 415.3 (AED)	Daily check ±10% Precision <10% RPD	EPA AED	LSOP7

Chlorophyll-*a* and UVA254 measurements conducted at AED, including quality control aspects, were previously reported separately. This summary focuses on QC data provided with samples analyzed by MED.

SAMPLE CHAIN of CUSTODY and TRACEABILITY

Generally speaking, Chain-of-Custody (COC) documentation is complete and collected samples are traceable from collection, through shipping, to data reporting. Sample labeling followed Section 3.4, *Sample Identification* of the QAPP and included the reservoir name (Station ID# following Table A1 in QAPP), depth (denoted s-surface, t-thermocline, d-depth), and date. For example, NEP-S-071515 refers to the sample collect at the North Easton Pond station, at the surface, on July 15, 2015.

The few discrepancies that exist are between the COC form and the shipping form. In twenty instances the shipping inventory indicates samples were collected one data later than the COC form indicates. Additionally, in eight instances the shipping inventory indicates samples were

collected one day prior to the date indicated on the COC form. This one day discrepancy is not seen to be an issue for the final data.

Three samples were mislabeled on the shipping inventory and had to be corrected (incorrect dates). This solution was explained and documented in an email from Anne Kuhn, USEPA-AED to Brian Zalewsky, RI DEM, on January 28, 2016. These samples are:
NP-S-072915 changed to NP-S-081215
WR-S-072915 changed to WR-S-081215
WR-D-072915 changed to WR-D-081215

HOLDING TIMES

Analyte	**Sample Holding Time Source**		
	QAPP (Table 18)	**SOP**	**SOP**
PO4- – P	28 days	6 months LSOP2	6 months LSOP12
(NO_3^- + NO_2^-) – N	6 months	6 months LSOP2	
NH4+ – N	6 months	6 months LSOP3	
NO2- – N	6 months	6 months LSOP12	
TN	6 months	6 months LSOP4	
TP	28 days	6 months LSOP4	
DOC	28 days	28 days LSOP5	6 months LSOP12

For this QC review, due to the conflict in documentation, sample holding times are considered to be 6 months for all analytes. However, concern should be given to the fact that 28 day holding times were exceeded. The discrepancies between holding times in Table 18 of the QAPP and those in various EPA MED LSOP's, which were submitted to RIDEM during QAPP preparation, was investigated further. Several issues were resolved and the data analyzed outside of holding times were deemed to be accurate.

First, it was determined that Table 18 of the RIDEM prepared QAPP should have had the same holding times as those specified in the SOP's. This appears to be an error on the part of RIDEM. Second, RIDEM consulted with EPA MED Laboratory staff regarding holding times for DOC, TN, and TP and specifically regarding the integrity of the data that were analyzed outside of reported holding times. It was determined that the 28 day holding time for TP was an error in the QAPP. Holding times for TP and PO4-P are 6 months. Holding times for TN, Nitrate, Nitrite, and NH4 are also 6 months. EPA MED staff notified RIDEM that the 6 month holding time for TN and TP is highly conservative and they have high confidence that the TN and TP data analyzed outside of the 6 month holding time is accurate. EPA MED have provided literature to support this (Avanzino 1993).

Third, EPA MED staff believe that the true holding time for DOC is 6 months, not 28 days. MED staff informed RIDEM that they are confident that DOC samples held greater than 28 days but less than 56 days are accurate and valid. Samples are stored according to analytical

protocols-amber glass bottles preserved with H3PO4 to a pH of 2 in a controlled temperature room at 4°C.

TOTAL NITROGEN (TN) results: It appears that there were technical issues (QC spiking errors) for the following TN samples, run initially in mid-July 2015 that required rerunning them. The following sample reruns were conducted outside a six-month TN holding time window.

TN Samples Rerun out of 6 Month Holding Time

NEP-S-061615	FB-2-061715	SEP-S-062915	LVR-S-062915
NEP-D-061615	SM-S-061615	PP-D-062915	LVR-D-062915
SEP-S-061615	SM-D-061615	GP-S-062915	NP-S-063015
SEP-D-061615	LV-D-061615	GP-D-062915	NP-D-063015
PP-S-061615	NP-S-061715	SP-S-062915	WR-S-063015
PP-D-061615	NP-D-061715	SP-D-062915	WR-D-063015
GP-S-061615	WR-S-061715	FD-S-062915	
SP-S-061615	WR-D-061715	FD-D-062915	
SP-D-061615	NEP-S-062915	SMP-S-062915	
FB-1-061715	NEP-D-062915	SMP-D-062915	

TOTAL PHOSPHORUS (TP) results: Similar technical issues occurred with the TP sample analyses that were initially run early on, but later found to require reruns. The following sample reruns for reported TP data were conducted outside a six-month TP holding time window.

TP Samples Rerun out of 6 Month Holding Time

WR-T-060115	SP-D-061615	WR-D-061715	GP-D-062915	NP-S-063015
NEP-S-061615	FB-1-061715	WR-T-061715	SP-S-062915	NP-D-063015
NEP-D-061615	FB-2-061715	NEP-S-062915	SP-D-062915	WR-S-063015
SEP-S-061615	SM-S-061615	NEP-D-062915	FD-S-062915	
SEP-D-061615	SM-D-061615	SEP-S-062915	FD-D-062915	
PP-S-061615	LV-D-061615	SEP-D-062915	SMP-S-062915	
PP-D-061615	NP-S-061715	PP-S-062915	SMP-D-062915	
GP-S-061615	NP-D-061715	PP-D-062915	LVR-S-062915	

SP-S-061615	WR-S-061715	GP-S-062915	LVR-D-062915

It was also noted that TP results for samples GP-D-061615 and LV-S-061615 appearing in the final dataset were not found in the corresponding TP worksheets. The analysis dates of these presented data are not available.

ORTHO-PHOSPHATE (PO4-) results: Three samples were rerun outside the PO4- 6 month holding time window.

NE-S-050515
NE-D-050515
SE-D-050515

(NO3- + NO2-) – N, NO2- – N, and NH4+ – N results were obtained via initial or rerun analyses within holding times.

DISSOLVED ORGANIC CARBON (DOC) analysis times (from sample collection to analysis) averaged 26 days, with a range from within three days of collection to 48 days of collection. As a matter of information, and because the operating procedures and QA plan conflict, those sample that exceed a holding time of 28-days are listed in Table 1 at end of this document.

SAMPLE HANDLING

Upon arrival at AED a sample inventory was taken, temperature blanks evaluated and recorded, and COC forms signed and copied. Samples requiring shipping to MED were prepared (filtering and preservation) upon arrival or were refrigerated at 4°C and prepared the following morning. Preparation was conducted following procedures and shipping kits provided by MED.

Temperature blanks were used to monitor the handling of samples from the time of collection to delivery at AED. Tables 33 to 44 in the QAPP indicate that the temperature blank acceptance criterion is 4°C or less. Upon arrival, coolers used in all sampling events had temperature blanks that gave readings well below the 4°C criterion except the last two sampling events on October 5th and 6th, 2015, which had temperature blank readings of 6.5°C and 5.8, respectively. These sampling events include the follow samples and measured temperatures:

Sample ID	**Temp Blank °C**
NP-S-100515	6.5
WR-S-100515	6.5
WR-D-100515	6.5
NEP-S-100615	5.8
NEP-D-100615	5.8
SEP-S-100615	5.8
SEP-D-100615	5.8

PP-S-100615	5.8
GP-S-100615	5.8
FD-S-100615	5.8
FD-D-100615	5.8
SMP-S-100615	5.8
LVR-S-100615	5.8
LVR-D-100615	5.8
SP-S-100615	5.8

QUALITY CONTROL SAMPLES

Quality control criteria in use.

	TN	NO_x	NH_4^+	TP	PO_4	DOC
Blank (MED)	<MDL	<20 PPB	<10 PPB	<10 PPB	<10 PPB	<10 X lowest conc
Lab Dup	≤20% RPD	≤10% RPD	≤20% RPD	≤10% RPD	≤10% RPD	≤20% RPD
Lab Dup Spk	75-125% recovery	80-120% recovery	75-125% recovery	80-120% recovery	80-120% recovery	75-125% recovery
QC chk std	80-120%		80-120%			80-120%
MDL	5 µg/L	1 µg/L	2 µg/L	4 µg/L	2.5 µg/L	0.53 mg/L
MDL MED	77.49 µg/L	1.26 µg/L	4.03 µg/L	7 µg/L	2.53 µg/L	2 µg/L

Quality control results that support the reported data are discussed below by analyte.

TOTAL NITROGEN

Blanks: All twenty-eight (28) blank analyses are acceptable, turning in results below the detection limit (77 µg/L)

Blank Spikes (Lab Control Samples): All nine (9) blank spike analyses returned % recoveries between 83 and 108%, except one, which due to instrument malfunction, was not analyzed.

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: $RPD = ((m2\text{-}m1)/(m2+m1)/2\ )\ X\ 100$

Of the thirty (30) laboratory duplicates that were run to support the reported data, twenty-seven had RPDs ranging from 0.29 – 14.2, below the 20% criterion. Two laboratory duplicate samples failed with RPDs of 26% and 29%. The remaining laboratory duplicate failed due to instrument malfunction.

Laboratory Spikes (Matrix Spikes):
Spikes for the following samples initially failed and were rerun outside of holding time

Sample	MED#	Collection Date	Initial Spike Analysis Date (p/f)	Re-Analysis Date (p/f)	Re-Analysis Date (p/f)
GP-S-061615	66	6/16/2015	1/8/2016 (p)		
LV-S-061615	74	6/16/2015	7/15/2015(f)	12/29/2015(p)	
NEP-S-062915	81	6/29/2015	1/8/2016(p)		
SEP-D-062915	84	6/29/2015	1/8/2016(p)		
NP-D-063015	98	6/30/2015	7/15/2015(f)	12/29/2015(p)	
WR-D-063015	100	6/30/2015	12/29/2015(p)		
LVR-D-071515	115	7/15/2015	12/23/2015(f)	1/5/2016(f)	1/8/2016(p)
RISS-1079-071615	126	7/16/2015	12/23/2015(f)	1/5/2016(f)	1/8/2016(f)
Patchett 071315	134-1	7/13/2015	12/23/2015(p)	1/5/2016	
WR-S-072915	152	7/29/2015	12/23/2015(f)	1/5/2016(p)	

For samples in the table below, the analyst indicated there was not enough sample left to rerun the spikes (that had failed at least once), so dilution was used to verify the presence (or lack) of matrix interference. Dilution factors (provided by the analyst) and results for these four diluted samples are below. Because the calculated and measured concentrations agree, within about 10% (correcting for dilution), interferences are not seen to be present and the original results of July 15, 2015 are acceptable and reported (though, holding time issues for the diluted reruns should be considered).

Sample	MED#	Dilution. Factor	Diluted Conc.*	Calculated Conc.**	Measured Conc.***	%D
PP-D-060115	44	2	385.726	771.452	800.929	3.68
GP-D-061615	67	1.18	433.633	511.687	512.78	0.21
WR-T-061715	80	5	137.938	689.69	616.489	11.87
PP-S-062915	85	1.18	631.238	744.861	749.41	0.61

* Run on 1/5/16
** Dilution Factor x Diluted Concentration
*** Measured Concentration from the initial analyses on 7/15/2015.

Quality Control Check Stds:
Three concentrations of laboratory control samples (QA) were used for TN analyses. These are listed as "HI QA," "LO QA," and "LO LO QA" samples with concentrations of 248µg/L, 124µg/L, and 62 µg/L, respectively. LO LO QA samples, being below MED's detection limit of 77µg/L for TN, failed each time they were run. This seems to be without consequence for the lowest reported sample concentration is 403µg/L for sample NP-S-060115.

Of the thirty-seven HI QA runs that were interspersed throughout the sample batches, two failed, however, they were paired with HI QA runs that passed. Of the thirty-one LO QA runs that were

interspersed throughout the sample batches, two failed, the first being paired with successful runs of the HI QA standard prior to, and a blank and blank spike run, after the run, and the second having a recovery of 65%.

TOTAL PHOSPHORUS (TP)

Blanks: Twenty-three (23) blank analyses are acceptable, turning in results below the TP detection limit (10 µg/L). One blank failed due to no injection. One blank failed with a TP result of 11.6 µg/L, just over the detection limit. However, just previous to this blank (7/15/2015 9:33:51AM), both HI & LO QA samples, a sample duplicate, and a sample spike met their acceptability requirements.

Blank Spikes (Lab Control Samples): All eight (8) blank spike analyses returned % recoveries between 87 and 102%, except one, which due to instrument malfunction, was not analyzed.

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: $RPD = ((m2\text{-}m1)/(m2+m1)/2\ )\ X\ 100$

Of the twenty-six (26) laboratory duplicates that were run to support the reported data, twenty-three had RPDs ranging from 0.01 – 16.45, below the 20% criterion. Three laboratory duplicate samples failed with RPDs of 24% (AED15- 100 DUP), 39% (AED15- 081 DUP), and 45% (AED15- 168 DUP). One remaining laboratory duplicate failed due to instrument malfunction.

Laboratory Duplicate Spikes (Matrix Spikes):
Twenty-eight matrix spikes were run throughout the Newport Water sample analyses with all meeting the recovery criterion of 80 – 120% for the project. It is important to note that the following duplicate/spike pairs support samples noted above as having been run outside of the holding time limit of six months.

AED15-066 DUP/SPK, corresponding to GP-S-061615
AED15-080 DUP/SPK, corresponding to WR-T-061715
AED15-081 DUP/SPK, corresponding to NEP-S-062915
AED15-084 DUP/SPK, corresponding to SEP-062915
AED15-085 DUP/SPK, corresponding to PP-S-062915
AED15-098 DUP/SPK, corresponding to NP-D-063015
AED15-100 DUP/SPK, corresponding to WR-D-063015

Quality Control Check Stds:
Three concentrations of laboratory control samples (QA) were used for TN analyses. These are listed as "HI QA," "LO QA," and "LO LO QA" samples with concentrations of approximately 250µg/L, 125µg/L, and 62 µg/L, respectively.

All the thirty-three HI QA runs that were interspersed throughout the sample batches passed the QC criterion. All thirty LO QA runs that were interspersed throughout the sample batches passed the QC criterion. All seven LO LO QA runs passed the QC criterion.

(NO3- + NO2-) – N:

Blanks: Blanks: Sixteen (16) blank analyses were run interspersed across all samples runs and all meet the QC criterion (<20 µg/L), with twelve being at or below the detection limit of 1.26 µg/L.

Blank Spikes (Lab Control Samples): Five blank spikes samples were run, interspersed across all sample runs, and all met the QC criterion of 80-120% recovery, all falling within a range of 100 - 108% recovery.

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: RPD = ((m2-m1)/(m2+m1)/2) X 100

Twenty-one laboratory duplicates were run, interspersed across all sample runs, with relative percent differences falling from 0.09 to 10.37, meeting the QC criterion of RPD <20.

Laboratory Duplicate Spikes (Matrix Spikes): Twenty-one laboratory duplicate spikes were run, interspersed across all sample runs, with all spike recoveries falling between 89.52 and 106.17%, meeting the QC criterion window of 80-120%.

Quality Control Check Standards:
Two concentrations of laboratory control samples (QA) were used for (NO3 + NO2) – N analyses. These are listed as "HI QA" and "LO QA" samples with concentrations of approximately 485µg/L and 48.5µg/L, respectively.

All the thirty-one HI QA runs that were interspersed throughout the sample batches passed the QC criterion, with a recovery range of 90 – 108%. All eighteen LO QA runs that were interspersed throughout the sample batches passed the QC criterion, with a range of 99.5 – 107.75% recovery

Column Check Standards: A nitrite standard (NO2, 250 µg/L) is run periodically when analyzing for (NO3+NO2) – N to monitor instrument column efficiency. The acceptance criterion is 212.5-287.5 or 85-115% of the true value. Three such standards were run during the analyses of Newport water samples, having sample results of 107, 107, and 102%, meeting the criterion.

ORTHO PHOSPHATE (PO4)

Blanks: Blanks: Twenty-three (23) blank analyses were run interspersed across all samples runs and all meet the QC criterion (<10 µg/L), with most being at or below the detection limit of 2.53 µg/L.

Blank Spikes (Lab Control Samples): Seven blank spikes samples were run, interspersed across all sample runs, and of these four met the QC criterion of 80-120% recovery, while three did not.

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: RPD = ((m2-m1)/(m2+m1)/2) X 100

Nineteen laboratory duplicates were run, interspersed across all sample runs. Of these, six failed to meet the criterion due to sample concentrations being at or near the detection limit (019, 030, 057, 080, 224, 241). Additionally, one had negative peak (AED15-042 DUP/SPK) and needed to be discarded.

Laboratory Duplicate Spikes (Matrix Spikes): Twenty-one laboratory duplicate spikes were run, interspersed across all sample runs, with all spike recoveries falling between 79.68% and 99.04%, with 20 meeting the QC criterion window of 80-120%.

Quality Control Check Stds:

Four concentrations of QC check standards (QA) were used for PO_4- analyses. These are listed as "QA HI," "QA HI 42.4," "QA LO," and "QA LO 21.2" having concentrations of approximately 424 µg/L-P, 42.4 µg/L-P, 42.4 µg/L-P, and 21.2 µg/L-P, respectively. It is important to note that the "QA HI 42.4" and "QA LO 21.2" were run in pairs when lower sample concentrations were expected.

All the fourteen QA HI runs that were interspersed throughout the sample batches passed the QC criterion, with a recovery range of 87 – 110%. All eighteen QA LO runs that were interspersed throughout the sample batches passed the QC criterion, with a range of 82 – 114% recovery. The two pairs of "QA HI 42.4" and "QA LO 21.2" which were run when lower concentrations were necessary, had recoveries ranging from 91-104%.

AMMONIUM - N

Blanks: Blanks: Twenty-three (23) blank analyses were run interspersed across all samples runs and all meet the QC criterion (<10 µg/L-N), with most being at or below the detection limit of 4.03 µg/L-N.

Blank Spikes (Lab Control Samples): Five blank spikes samples were run, interspersed across all sample runs, and all five met the QC criterion of 75-125% recovery (range 104-119%).

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: $RPD = ((m2\text{-}m1)/(m2+m1)/2\ )\ X\ 100$
Twenty-three laboratory duplicates were run, interspersed across all sample runs. All met the QC criterion with a RPD range of 0.00 to 8.4.

Laboratory Duplicate Spikes (Matrix Spikes): Twenty-two laboratory duplicate spikes were run, interspersed across all sample runs, with all spike recoveries falling between the QC criterion of 75 – 125%, with a range of 82-113%.

Quality Control Check Stds:
Two concentrations of QC check standards (QA) were used for NH_4+ analyses. These are listed as "QA HI," or "QA," and "QA LO," having concentrations of approximately 424 µg/L-P, and 42.4 µg/L-P, respectively.

Eight QA HI standards were run with samples on July 8, 2015. Of these, seven had results of 123-125% of true value, outside the acceptance criteria of 80-120%. The remaining performance standards, regardless of concentration had recoveries between 90-113%, well within the criterion.

NITRITE – N

Blanks: Blanks: Twelve (12) blank analyses were run interspersed across all samples runs and all meet the QC criterion (<10 µg/L-N), with most being at or below the detection limit of 1.26 µg/L-N.

Blank Spikes (Lab Control Samples): Five blank spikes were run, one for each sample run. Of these, by the results two appear not to have actually been spiked, one had results well out of range and failed, and two passed the criterion (75-125%)

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: RPD = ((m2-m1)/(m2+m1)/2) X 100

Thirty laboratory duplicates were run across all sample sets. Most duplicates met the criterion, with a few not passing due to levels being measured around or below the method detection limit.

Laboratory Duplicate Spikes (Matrix Spikes): According to notes in the spreadsheet, no spikes were run with samples run in the July 8, 2015 set. Four spiked duplicates run with samples on July 21, 2015 met the criterion. Duplicate Spikes (and duplicates) associated with samples 88 - 173, run on the afternoon of October 22, 2015 all met the criterion, except for one which had an identified "air spike." Other duplicate spikes (and duplicates) run that morning had numerous problems identified with the spike levels (air spikes). These or other sample/duplicates/spike duplicates were rerun on November 17, 2015 and results met the criterion.

Quality Control Check Stds:

Twenty-five check standards accompanied the sample runs for nitrite-N. All standards met their QC criterion, except one, which was an "air sample" (no injection).

DISSOLVED ORGANIC CARBON

Blanks: The four blanks that were reported with the dissolved organic carbon analyses dataset resulted in apparent concentrations of 0.11, 0.27, 0.28, and 0.36 mg/L. These are a factor of ten below reported sample concentrations.

Laboratory Duplicates: Relative Percent Difference (RPD) between duplicates was calculated using the formula: RPD = ((m2-m1)/(m2+m1)/2) X 100

Laboratory duplicates had relative percent differences within a range of 3.5%, well within the quality control criterion.

Laboratory Duplicate Spikes (Matrix Spikes): Spiked duplicates recoveries range from 95 – 130%. With the exception of one spike duplicate (%Rec 129) all recoveries fall within the quality control range of 75-125% recovery (LSOP5).
Quality Control Check Stds: All quality control check standards fell within the acceptable range of 75-125%, except one that measured 13%.

Calibration Check Standards: All calibration check standard results associated with the reported dataset fell in the range of 83 – 109%.

Table 1. DOC Samples Analyzed after 28-Day Holding Time but within 6-Month Holding Time

Sample ID	Days Held	Sample ID	Days Held	Sample ID	Days Held	Sample ID	Days Held	Sample ID	Days Held	Sample ID	Days Held	Sample ID	Days Held
NE-S-050515	48	SEP-S-051815	35	SEP-S-061615	44	NEP-D-062915	31	NEP-D-072815	31	NP-Borden-072915	30	SP-S-090915	42
NE-D-050515	48	SEP-D-051815	35	SEP-D-061615	44	SEP-S-062915	31	SEP-S-072815	31	NP-S-081215	30	NP-S-092115	30
SE-S-050515	48	PP-S-051815	35	PP-S-061615	44	SEP-D-062915	31	SEP-D-072815	31	WR-S-081215	30	NP-D-092115	30
SE-D-050515	48	PP-D-051815	35	PP-D-061615	44	PP-S-062915	31	PP-S-072815	31	WR-D-081215	30	WR-S-092115	30
LV-S-050515	48	PP-T-051815	35	GP-S-061615	44	PP-D-062915	31	PP-D-072815	31	NP-S-090815	43	WR-D-092115	30
LV-D-050515	48	GP-S-051815	35	GP-D-061615	44	GP-S-062915	31	PP-T-072815	31	WR-S-090815	43	NEP-S-092215	29
PP-S-050615	47	GP-D-051815	35	SP-S-061615	44	GP-D-062915	31	GP-S-072815	31	WR-D-090815	43	NEP-D-092215	29
PP-D-050615	47	SP-S-051815	35	SP-D-061615	44	SP-S-062915	31	SP-S-072815	31	WR-T-090815	43	SEP-S-092215	29
GP-S-050615	47	SP-D-051815	35	FB-1-061715	43	SP-D-062915	31	SP-D-072815	31	NEP-S-090915	42	SEP-D-092215	29
GP-D-050615	47	SM-S-051815	35	FB-2-061715	43	FD-S-062915	31	FD-1-072915	30	NEP-D-090915	42	PP-S-092215	29
SP-S-050615	47	SM-D-051815	35	SM-S-061615	44	FD-D-062915	31	FD-2-072915	30	SEP-S-090915	42	GP-S-092215	29
SP-D-050615	47	LV-S-051815	35	SM-D-061615	44	SMP-S-062915	31	SMP-S-072815	31	SEP-D-090915	42	FD-S-092115	30
SM-S-050615	47	LV-D-051815	35	LV-S-061615	44	SMP-D-062915	31	SMP-D-072815	31	PP-S-090915	42	FD-D-092115	30
SM-D-050615	47	NOP-S-051815	34	LV-D-061615	44	LVR-S-062915	31	LVR-S-072815	31	PP-D-090915	42	SMP-S-092215	29
NOP-S-050615	47	NOP-D-051815	34	NP-S-061715	43	LVR-D-062915	31	LVR-D-072815	31	GP-S-090915	42	LVR-S-092215	29
NOP-D-050615	47	WR-S-051915	34	NP-D-061715	43	NP-S-063015	30	NP-S-072915	30	FD-S-090915	42	LVR-D-092215	29
WR-S-050615	47	WR-D-051915	34	WR-S-061715	43	NP-D-063015	30	NP-D-072915	30	FD-D-090915	42	SP-S-092215	29
WR-D-050615	47	WR-T-051915	34	WR-D-061715	43	WR-S-063015	30	WR-S-072915	30	SMP-S-090915	42	PW-S-092115	30

NEP-S-051815	35	NEP-S-061615	44	WR-T-061715	43	WR-D-063015	30	WR-D-072915	30	LVR-S-090915	42
NEP-D-051815	35	NEP-D-061615	44	NEP-S-062915	31	NEP-S-072815	31	WR-T-072915	30	LVR-D-090915	42

Avanzino, Ronald and Kennedy, Vance. 1993. Long-Term Frozen Storage of Stream Water Samples for Dissolved Orthophosphate, Nitrate Plus Nitrite, and Ammonia Analysis. Water Resources Research. Vol 29. No. 10. Pages 3357-3362.

EPA-AED Inserted Memorandum 1: Chlorophyll-a Data Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS
RESEARCH LABORATORY
ATLANTIC ECOLOGY DIVISION
27 TARZWELL DRIVE • NARRAGANSETT, RI 02882

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Chlorophyll *a* Data Report for Surface Water Monitoring in the City of Newport's Nine Water Supply Reservoirs--2015

FROM: Glen B Thursby
Atlantic Ecology Division

TO: Anne Kuhn, Local Project Lead
Atlantic Ecology Division

DATE: November 30, 2015

Below are the data from the chlorophyll *a* analyses conducted at the Atlantic Ecology Division on twelve different sampling events from May through October 2015. The sample preparation and subsequent chlorophyll *a* fluorescence measurements were by Joseph Bishop (student service contractor) and myself. The analyses followed AED Laboratory Operating Procedure "Non-Acid Determination of Chlorophyll *a* Using a Turner Designs AU-10 Fluorometer[1]" (LOP-AED/WDB/GBT/2015-01-00). The measurements are based on overnight (minimum of 18 hr) extraction in a freezer in 90% acetone of chlorophyll *a* from particles retained on a glass fiber filter.

The report begins with information on the creation of the chlorophyll *a* standard curves comparing values based on absorption measurements using a Perkin-Elmer Lambda 35 spectrometer with fluorescence values obtained using the Turner Designs instrument. The equation used for the spectrometric analysis is from Ritchie (2006)[2].

[1] The actual name of the instrument is a Turner Design Model **10-AU**.

[2] Ritchie, R. 2006. Consistent sets of spectrophotometric chlorophyll equations for acetone, methanol and ethanol solvents. Photosynth. Res. 89:27-41.

Chlorophyll *a* standard curves

The source of chlorophyll a standard was Sigma-Aldrich product number C-6144—chlorophyll *a* from *Anacystis nidulans* (Cyanobacterium).

Figure 1 shows the Atlantic Ecology Division's 2014 standard curve. This is not the standard curve used for the Newport samples. The purpose of showing this curve is to indicate the performance of chlorophyll *a* standards purchase from Turner Designs (187 and 20.0 ug/L). These two standards provided a check on the performance of AED's Lambda 35 spectrometer.

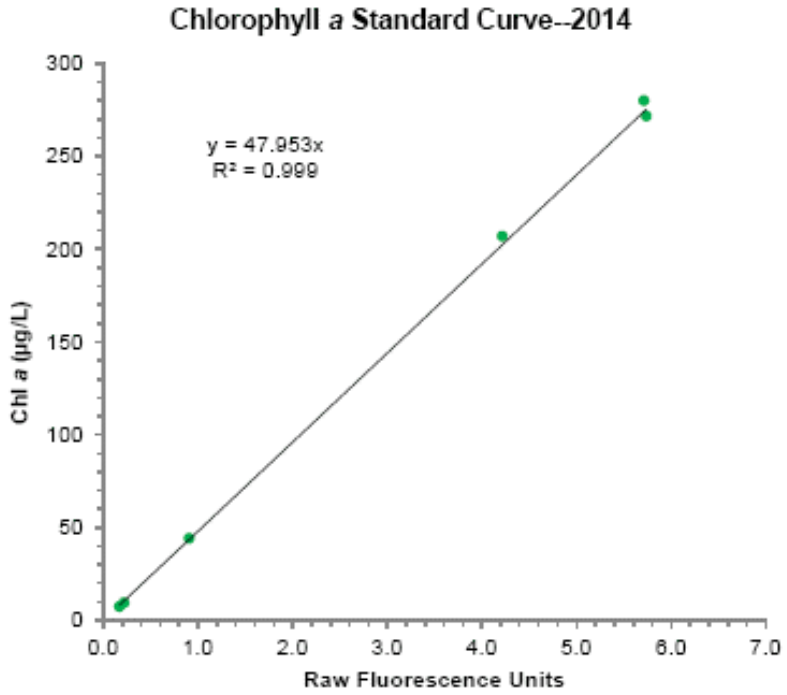

Figure 1. Chlorophyll *a* standard curve from 2014. X-axis is the raw fluorescence reading from the Turner Designs Model 10-AU fluorometer (corrected for procedural blank). Y-axis is the calculated chlorophyll *a* concentration in the 90% extraction solution using absorbance measured with the Perkin-Elmer Lambda 35 spectrometer. Red markers are the two Turner Design standards. The remaining markers are AED standards created from chlorophyll *a* powder purchased from Sigma-aldrich.

The solid standard fluorescence readings associated with the 2014 standard curve were 0.142 and 0.697 for the low and high standards, respectively. The solid standards are read with each chlorophyll *a* batch and serve as a check on the performance of the Turner Design 10-AU. If the solid standards begin to change, then a new primary standard curve is warranted. In 2015, prior to the beginning of the Newport sampling effort, the solid standard readings had declined slightly to 0.127 and 0.626. A new primary standard curve was initiated for 2015. This is shown in Figure 2. Although initially the range of chlorophyll *a* values in the 2015 standard curve were

similar to those in 2014, we later (November 9 & 10, 2015) extended the range because many of Newport water samples exceeded this initial range. Extraction concentrations of chlorophyll *a* up to around 1500 ug/L are well within the range of the procedure.

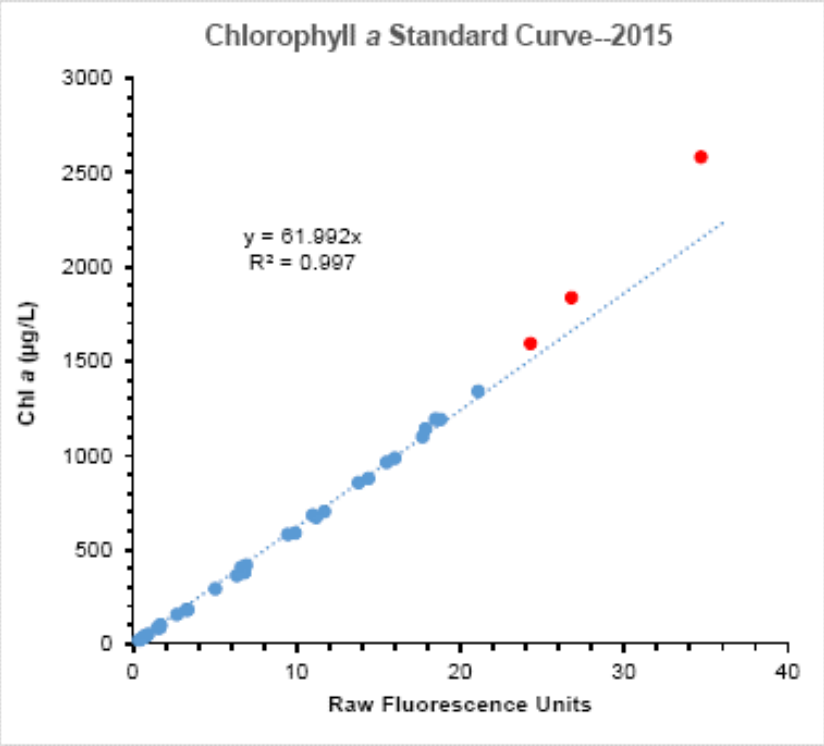

Figure 2. Chlorophyll *a* standard curve from 2015. X-axis is the raw fluorescence reading from the Turner Designs Model 10-AU fluorometer (corrected for procedural blank). Y-axis is the calculated chlorophyll *a* concentration in the 90% extraction solution using absorbance measured with the Perkin-Elmer Lambda 35 spectrometer. Red markers are values not used in the regression. The blue markers are values from three different standard curve runs (May, August and November 2015).

Solid Fluorescence Standards

Measurements were made at the beginning and end of each set of chlorophyll *a* fluorescence measurements. These data are presented below in Figure 3. The slight drift in the readings is likely due to the aging of the lamp in Turner Designs Model 10-AU. However, the drift is not significant enough to warrant corrections to the raw Newport sample readings—within 5%.

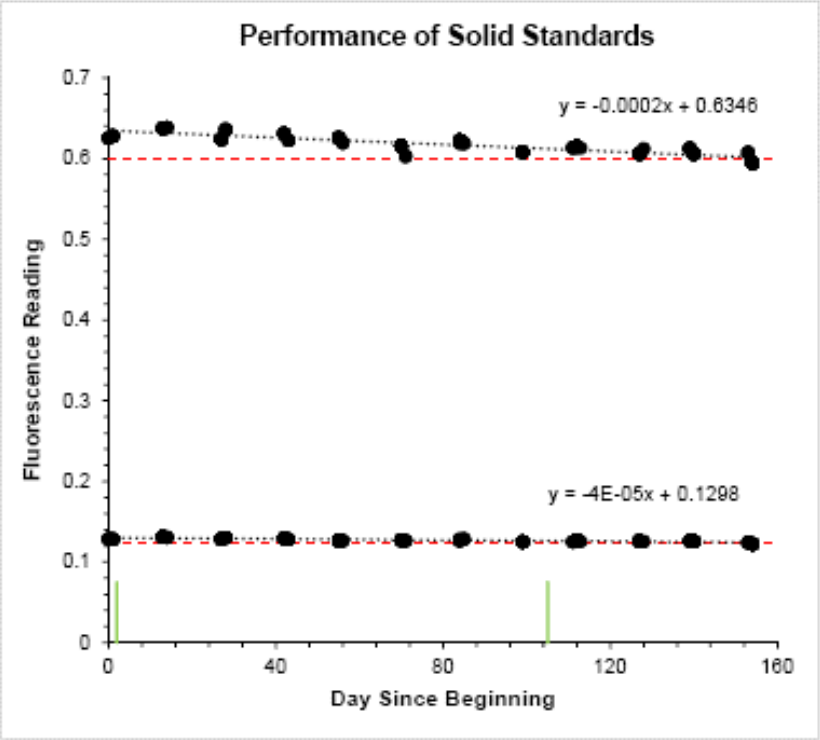

Figure 3. Data for the performance of the Turner Design solid standards. The upper set of data are for the high (H) standard and the lower set are for the low (L) standard. The short vertical green lines at day 2 and day 105 are when full standard curves were created using data generated from multiple secondary standards using a Perkin-Elmer Lambda 35 spectrometer. The horizontal red dashed lines represent the average of solid standard measurements made during the November 9 & 10 standard curves creation.

Laboratory Analytical QC

Table 21 of the "Sampling Plan" states that the desired acceptance limits for chlorophyll *a* laboratory replicates is 10% relative percent difference (RPD). I could not find, however, any information within the existing literature where an RPD has been recommended for this procedure. Figure 4 shows the cumulative distributions for RPD values from work conducted at the Atlantic Ecology Division on Narragansett Bay, as well as RPD values from the current Newport project. They are separated because the range of chlorophyll *a* values for the two are very different. However, the distributions are very similar. These data sets suggest that 20% is a more reasonable threshold of concern. Only six of the values from Newport exceed 20%--and only one (40%) exceeded 30%.

Relative percent differences are typically calculated for measurements taken in duplicate. The Newport stations for the last two sampling events were measured in triplicate. However, we still calculated an RPD, but using the maximum minus the minimum divided by the average of all three.

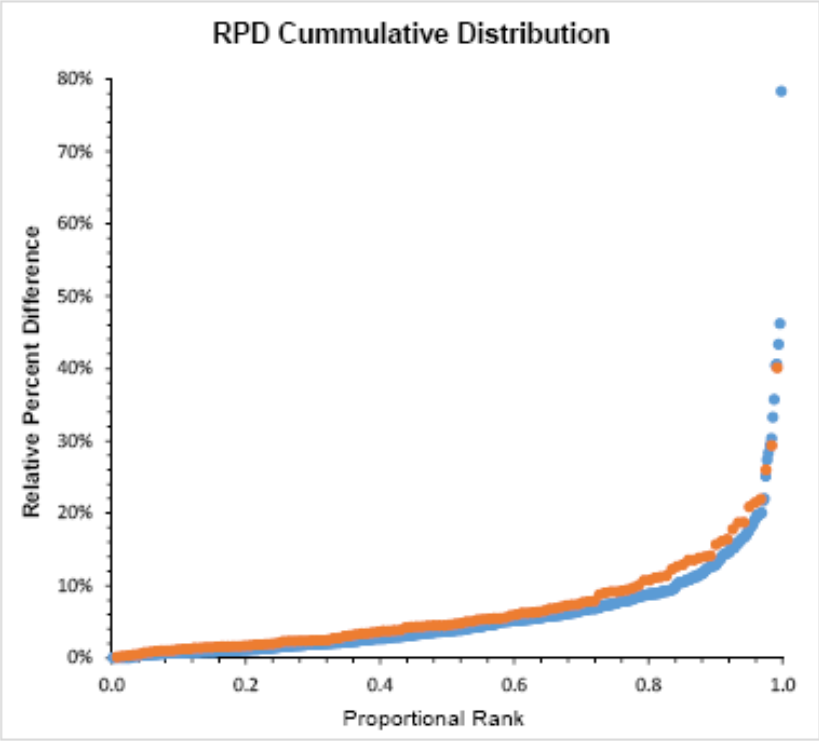

Figure 4. Cumulative distribution of chlorophyll *a* relative percent differences from the Turner fluorescence non-acidic technique. Blue markers are data from three different projects at the Atlantic Ecology Division for samples from Narragansett Bay (N = 474). Orange markers are data from the Newport project (N = 120).

In the few cases where the RPD exceeded the threshold, we did not accept any of the reanalyzed data. The Sampling Plan allowed water samples to be held up to 48 hours before analysis. However, this is likely too long—especially for samples high in chlorophyll. All samples except for two (Watson and Nonquit from September 8th) were filtered and the chlorophyll extraction begun within one to two hours of delivery to AED. The two that were not, were held overnight and processed the next morning. Even though the Plan allowed samples to be held up to 2 days under refrigeration, the generally accepted storage procedure is to first filter the samples, and then store the filters frozen until analysis. Early in the sampling (May) we re-analyzed several samples after 24 hours of refrigeration. The difference was insignificant; however, later in the summer (August, September) we again reanalyzed some samples—some with RPD that were higher than desired. Unfortunately, while many of these samples showed inconsequential changes in average concentration, a few of these samples showed a significant increase in the chlorophyll *a* concentration with the additional day of refrigeration. In at least one case the concentration more than doubled. Many phytoplankton species divide in the dark—refrigeration in the dark can be an insufficient deterrent to growth. Because of this, we chose to only use data from the first analyses in the final data set.

Data Summary

Figure 5 are graphs of the average chlorophyll *a* data for each location. The data for each replicate are in the attached file.

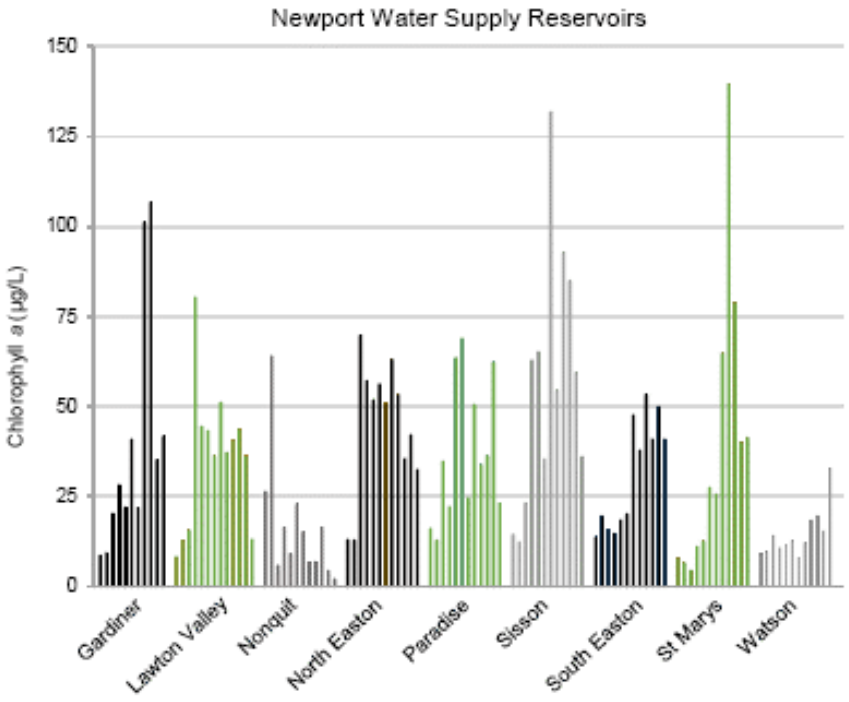

Figure 5. An overall summary plot of chlorophyll *a* data from 2015 samples of the Newport water supply reservoirs. For each location the earlies sampling event is to the left.

EPA-AED Inserted Memorandum 2: UVA Data Report

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HEALTH AND ENVIRONMENTAL EFFECTS
RESEARCH LABORATORY
ATLANTIC ECOLOGY DIVISION
27 TARZWELL DRIVE • NARRAGANSETT, RI 02882

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: UVA Data Report for Surface Water Monitoring in the City of Newport's Nine Water Supply Reservoirs--2015

FROM: Glen B Thursby
Atlantic Ecology Division

TO: Anne Kuhn, Local Project Lead
Atlantic Ecology Division

DATE: December 2, 2015

Below are the data from the UVA analyses conducted at the Atlantic Ecology Division on twelve different sampling events from May through October 2015. The sample preparation and UVA measurements were by Joseph Bishop (student service contractor), Darryl Keith, Joseph LiVolsi and myself. The analyses generally followed AED Laboratory Operating Procedure "Determination of specific UV absorbance at 254 nm in source water and drinking water in support of TMDL development" (LOP-AED/MAB/DK/2015-01-00). Samples were measured using a Perkin-Elmer Lambda 35 spectrometer—scanning from 200 to 300 nm in 1 nm widths as an additional check on the performance of spectrometer (making sure the general shape of the curve remained consistent).

There were some slight modifications to the LOP for the purpose of the Newport data analyses. First, we used laboratory reagent water (LWR) as the spectrometer reference instead of the In-Spec background solution. The IN-SPEC background solution and the IN-SPEC optical standard were measured separately against this reference. Second, we did not just test each lot of filters for the amount of preparation volumes to remove UV absorbing material from the filters and the inhibition of adsorption of UV absorbing material by the filters. Instead, we essentially tested each filter by using the same filter for each laboratory replicate. If the relative percent difference between these measurements was acceptable, then the pre-rinsing was sufficient. For each field sample, filters were pre-rinsed with 25 mL of LWR and then 40 mL of sample. Measurements were done on two consecutive 15 mL samples[1].

[1] For the first sampling event we used 10-cm quartz cells in the spectrometer, so pre-rinse and sample volumes were all 50 mL. After determining that 1 cm cells would be sufficient, the rinse and sample volumes were reassessed.

UVA In-Spec Standard

The optical standard was an IN-SPEC certified standard (#8303), Lot #C475890. The IN-SPEC background solution (#8300) was Lot #C475782. The certified absorbance at 254 nm was 0.1694 cm^{-1}. The data for the performance of the IN-SPEC optical standard are presented in Figure 1. Although the method only needs the absorbance at 254 nm, we include data for other certified values as well. All measurements of the standard were within the required 10% of the certified values.

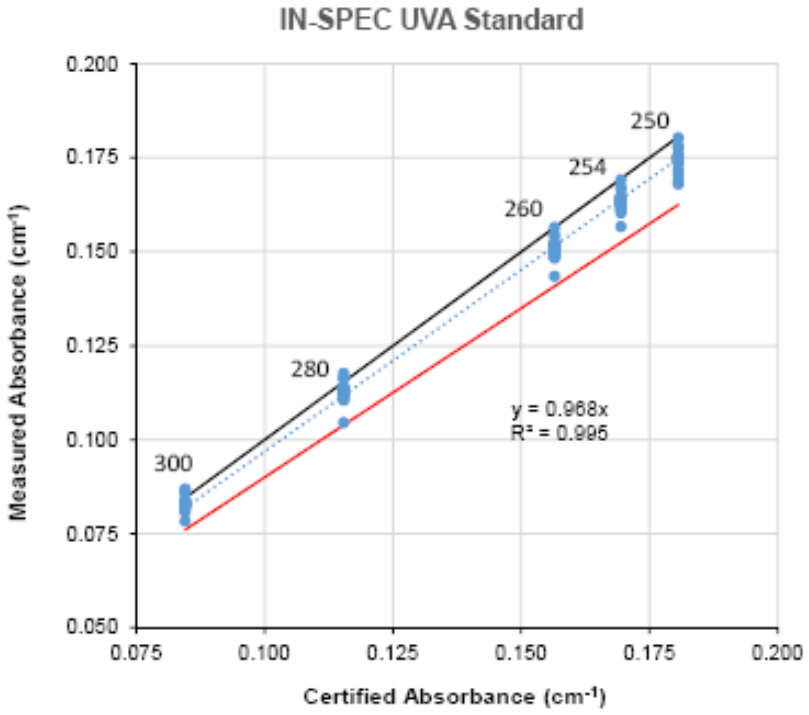

Figure 1. UVA standard performance for all sampling events. Numbers next to the data points are the wavelengths (nm) where certified values were available. The black line represents where the measured values would be equal to the certified values. The dashed blue line is the linear regression of the data. The red line is 90% of the certified values.

Laboratory Analytical QC

Table 29 of the "Sampling Plan" states that the desired acceptance limits for UVA laboratory replicates is 20% relative percent difference (RPD). And that laboratory duplicates were only required once per batch. The original EPA method documentation[2] gives no information on the RPD for laboratory duplicates. It does, however, state that field duplicates should have an RPD of 10% or less. We chose to use the 10%. In addition, we performed laboratory duplicates on every sample[3]. Figure 2 shows the cumulative distributions for RPD values from the current Newport project.

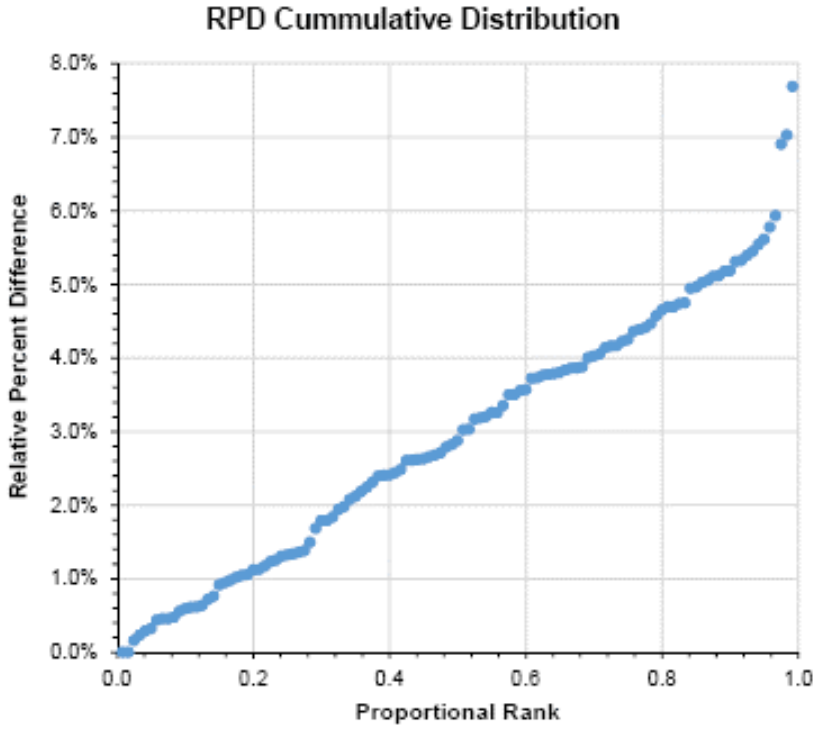

Figure 2. Cumulative distribition of UVA relative percent differences.

[2] Potter and Wimsatt. 2009. Determination of total organic carbon and specific UV absorbance at 254 nm in source water and drinking water. EPA/600/R-09/122.

[3] For some samples we actually used 3 to 5 replicates as an occasional check on the performance of the filters. In these cases, we used the last two replicates for the final dataset.

Data Summary

Figure 3 are graphs of the average chlorophyll *a* data for each location. All samples were measured within 24 hr of delivery to AED—most the afternoon of arrival. The data for each replicate are in the attached file. The comment "Repeat" indicates original RPDs were near to or exceeded 10% and samples were reanalyzed the next morning (still within our desired 24 hr or less holding periods—which was less that the allowed 48 hr).

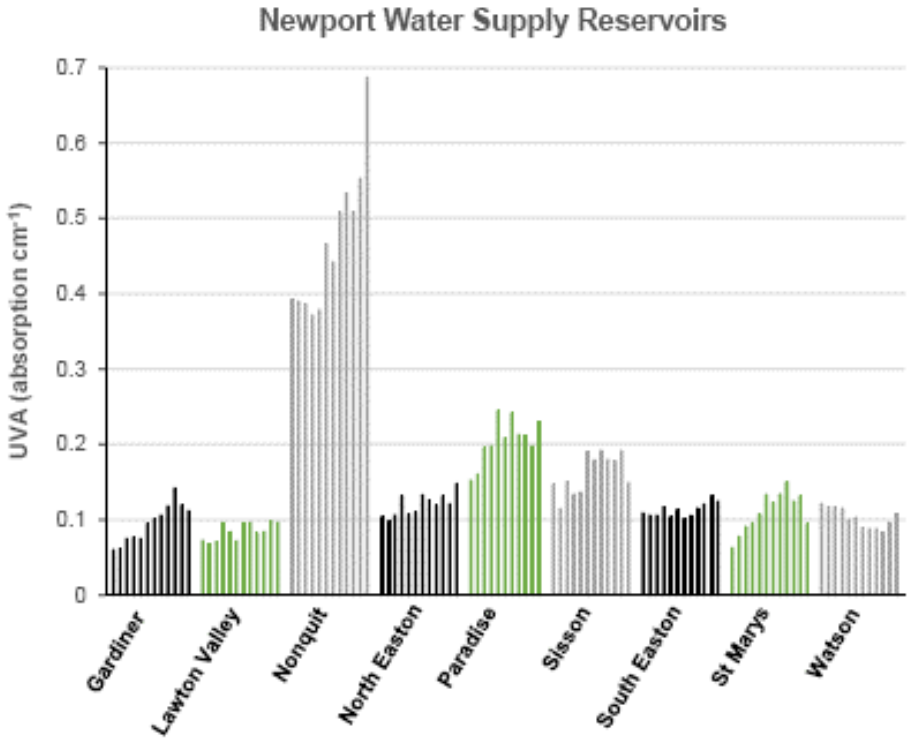

Figure 5. An overall summary plot of UVA data from 2015 samples of the Newport water supply reservoirs. For each location the earliest sampling event is to the left.

Final Results

Final results for all analytical parameters for each reservoir are displayed in Tables 21-29.

Table 21. Final analytical results-Nonquit Pond-2015 sampling.

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (ug/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Nonquit S	5/6/2015	5.5	195.9	28.7	4.8	694.8	34.1	9.1	26.3	0.3919	214
Nonquit D	5/6/2015	19.8	188.0	38.4	4.5	672.1	33.0	9.0			
Nonquit S	5/18/2015	7.8	0.6	23.3	3.0	737.2	41.0	8.8	63.8	0.3896	277
Nonquit D	5/18/2015	5.1	16.6	36.9	2.9	453.4	30.2	9.9			
Nonquit S	6/1/2015	13.6	36.5	101.4	3.8	402.8	19.1	12.1	5.7	0.3855	364
Nonquit D	6/1/2015	9.8	31.9	107.2	3.4	449.3	22.0	7.8			
Nonquit S	6/17/2015	8.7	30.6	na	na	na	32.3	na	16.2	0.3707	466
Nonquit D	6/17/2015	10.6	41.1	38.8	4.1	445.2	35.2	na			
Nonquit S FD	6/17/2015	7.2	30.7	na	na	na	38.5	na	16.9	0.3703	480
Nonquit D FD	6/17/2015	11.5	39.2	40.8	3.7	435.6	38.8	na			
Nonquit S	6/30/2015	12.9	12.1	23.2	2.4	473.9	43.3	9.6	8.9	0.3781	447
Nonquit D	6/30/2015	8.6	18.4	28.2	2.4	554.6	55.6	9.7			
Nonquit S	7/16/2015	9.2	8.5	17.2	2.4	646.4	52.0	10.3	22.7	0.4655	468
Nonquit D	7/16/2015	8.3	6.9	19.7	3.3	499.6	36.9	10.1			
Nonquit S	7/29/2015	2.9	17.7	23.8	3.8	554.8	25.0	12.0	15	0.4415	502
Nonquit D	7/29/2015	5.1	30.7	48.2	3.8	598.3	39.4	12.0			
Nonquit S	8/12/2015	4.2	18.8	51.3	3.3	648.1	25.2	13.2	6.5	0.5072	423
Nonquit S	8/24/2015	12.1	15.8	49.6	1.1	588.6	43.5	12.8	6.6	0.5331	595
Nonquit D	8/24/2015	12.1	15.2	56.2	3.1	638.8	45.6	12.1			
Nonquit S	9/8/2015	12.3	15.9	28.1	1.9	595.1	59.8	9.1	16.3	0.5086	600
Nonquit S	9/21/2015	18.2	na	54.4	3.6	603.7	na	12.6	4.2	0.5528	414
Nonquit D	9/21/2015	17.6	39.0	34.0	na	578.5	na	12.3			
Nonquit S FD	9/21/2015	18.0	na	56.2	3.0	636.2	na	12.8	4.3	0.5445	351
Nonquit D FD	9/21/2015	16.3	38.4	42.1	na	606.5	na	12.7			
Nonquit S	10/5/2015	22.3	82.9	57.5	4.4	742.2	78.4	14.8	1.9	0.686	440

Table 22. Final analytical results-Watson Reservoir-2015 sampling.

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (ug/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Watson S	5/6/2015	6.5	291.0	15.7	2.6	718.2	27.1	4.9	8.98	0.1205	na
Watson D	5/6/2015	1.9	293.6	51.1	2.5	585.1	20.6	4.2			
Watson S	5/19/2015	1.7	208.8	11.6	2.5	667.3	19.6	4.6	9.55	0.1165	128
Watson T	5/19/2015	1.9	212.0	72.9	2.7	562.6	19.7	4.4			
Watson D	5/19/2015	4.8	173.6	192.8	3.1	748.8	26.3	4.4			
Watson S	6/1/2015	2.1	97.6	8.8	2.8	558.5	20.0	6.7	14.01	0.1164	140
Watson T	6/1/2015	28.7	125.6	25.2	2.7	440.6	15.3	4.8			
Watson D	6/1/2015	3.1	92.4	222.0	3.8	631.8	45.3	5.0			
Watson S	6/17/2015	3.5	17.8	92.2	1.3	671.2	21.1	6.2	10.54	0.1145	141
Watson T	6/17/2015	2.0	35.7	104.2	2.6	616.5	26.4	5.4			
Watson D	6/17/2015	3.0	45.0	215.1	3.7	577.1	16.2	5.2			
Watson S	6/30/2015	0.8	40.2	123.9	1.2	603.7	18.4	6.0	11.48	0.0993	127
Watson D	6/30/2015	0.3	20.3	372.5	1.3	707.3	12.6	6.2			
Watson S	7/16/2015	2.8	4.0	10.5	0.3	469.7	17.8	5.6	12.55	0.1025	113
Watson T	7/16/2015	1.5	21.0	1.7	1.6	500.9	10.5	5.2			
Watson D	7/16/2015	1.6	19.1	149.5	1.4	597.5	13.8	5.2			
Watson S	7/29/2015	na	na	na	0.3	431.9	10.7	6.4	7.9	0.0887	124
Watson T	7/29/2015	-0.6	4.6	23.1	0.6	416.5	13.0	6.1			
Watson D	7/29/2015	na	na	na	-0.4	na	17.4	5.7			
Watson S FD	7/29/2015	na	na	na	-0.7	454.4	10.8	6.2	7.97	0.0922	na
Watson D FD	7/29/2015	na	na	na	0.8	na	20.8	6.7			
Watson S	8/12/2015	0.7	7.3	16.4	0.5	516.8	9.9	4.7	12	0.0874	107
Watson D	8/12/2015	0.8	14.0	172.5	1.2	655.9	33.7	5.1			
Watson S	8/24/2015	3.5	3.5	17.8	-0.5	602.3	13.9	4.3	18.33	0.0872	116
Watson T	8/24/2015	5.4	7.9	36.2	0.1	496.4	12.0	4.6			
Watson D	8/24/2015	5.8	4.2	546.2	0.0	906.5	26.4	4.3			
Watson S	9/8/2015	5.9	9.3	24.0	-1.5	510.5	14.5	4.2	19.53	0.0829	106
Watson T	9/8/2015	4.4	6.1	189.1	-0.2	642.8	8.5	4.3			
Watson D	9/8/2015	3.0	13.7	1980.0	0.3	2197.0	72.6	5.2			
Watson S	9/21/2015	3.2	35.9	141.6	0.7	679.6	11.6	4.0	15.27	0.0948	91
Watson D	9/21/2015	4.1	31.3	176.6	1.9	760.1	13.5	4.2			
Watson S	10/5/2015	3.3	64.0	44.2	1.4	744.6	21.9	4.5	32.75	0.1069	123
Watson D	10/5/2015	3.5	65.6	26.7	2.2	792.9	21.2	4.2			

Table 23. Final analytical results-Lawton Valley Reservoir-2015 sampling.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Lawton Valley S	5/5/2015	7.1	1363.0	36.4	8.6	1674.0	27.7	3.8	8.15	0.07191	95.2
Lawton Valley D	5/5/2015	6.6	1033.0	204.3	10.1	1604.0	25.9	5.3			
Lawton Valley S	5/18/2015	3.7	1085.0	51.7	10.2	1541.0	21.1	3.7	12.61	0.06635	79.4
Lawton Valley D	5/18/2015	3.4	1073.0	93.6	10.6	1526.0	27.6	3.7			
Lawton Valley S	6/1/2015	3.8	867.1	125.3	14.5	1116.0	38.9	4.4	15.51	0.07035	96.3
Lawton Valley D	6/1/2015	4.7	856.1	121.2	14.1	1314.0	24.5	5.3			
Lawton Valley S	6/16/2015	4.4	597.0	68.9	15.1	704.0	52.2	8.1	80.23	0.09535	96.8
Lawton Valley D	6/16/2015	3.9	670.0	81.5	16.9	1241.0	39.9	4.4			
Lawton Valley S	6/29/2015	1.9	355.0	255.9	11.8	1127.0	45.6	4.8	44.23	0.08315	112
Lawton Valley D	6/29/2015	5.0	336.5	296.1	11.8	1079.0	42.3	4.6			
Lawton Valley S	7/15/2015	2.8	225.2	142.4	12.0	898.1	30.4	4.2	43.14	0.0716	90.3
Lawton Valley D	7/15/2015	3.1	180.5	454.2	13.1	1213.0	75.9	4.2			
Lawton Valley S	7/28/2015	3.5	98.3	38.6	5.9	856.9	80.2	5.5	36.2	0.0952	124
Lawton Valley D	7/28/2015	14.1	126.1	388.2	8.5	1191.0	92.6	5.9			
Lawton Valley S	8/12/2015	4.7	39.2	298.8	2.1	1008.0	32.0	4.5	50.99	0.09585	92.3
Lawton Valley D	8/12/2015	3.9	48.1	298.4	2.1	908.4	33.2	4.4			
Lawton Valley S	8/25/2015	na	83.4	224.4	5.9	915.4	34.3	na	37.02	0.08155	108
Lawton Valley D	8/25/2015	4.9	na	234.8	na	897.5	39.6	na			
Lawton Valley S FD	8/25/2015	na	93.2	213.8	6.5	856.5	33.0	4.0	34.44	0.08015	94.1
Lawton Valley D FD	8/25/2015	4.5	na	218.4	na	922.6	39.1	4.4			
Lawton Valley S	9/9/2015	5.1	52.7	87.8	3.4	732.1	41.9	4.2	43.52	0.08335	80.8
Lawton Valley D	9/9/2015	6.6	50.9	224.7	3.9	846.7	63.4	4.0			
Lawton Valley S	9/22/2015	3.5	102.5	35.1	8.0	820.2	45.3	4.1	36.13	0.0981	90.3
Lawton Valley D	9/22/2015	3.2	45.1	26.4	2.5	919.6	65.6	3.8			
Lawton Valley S	10/6/2015	5.1	127.2	211.4	11.0	941.1	50.4	4.1	12.94	0.09595	na
Lawton Valley D	10/6/2015	6.9	127.0	217.2	11.2	954.2	52.1	4.3			
Lawton Valley S FD	10/6/2015	4.9	107.6	193.5	9.4	927.4	50.7	4.3	13.28	0.09755	na
Lawton Valley D FD	10/6/2015	6.1	121.9	217.4	11.5	873.5	46.6	5.2			

Table 24. Final analytical results-Sisson Pond-2015 sampling.

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Sisson S	5/6/2015	2.63	13.31	24.46	1.42	644.86	50.38	14.43	14.19	0.1466	128
Sisson D	5/6/2015	6.15	10.28	33.64	1.23	782.78	64.13	6.02			
Sisson S	5/18/2015	4.09	7.50	27.69	1.18	628.17	34.75	5.08	12.15	0.1145	116
Sisson D	5/18/2015	5.59	0.89	26.08	0.95	710.87	49.70	5.11			
Sisson S FD	5/18/2015	na	na	na	na	na	na	na	12.15	0.10945	109
Sisson D FD	5/18/2015	na	na	na	na	na	na	na			
Sisson S	6/1/2015	6.70	6.49	42.17	1.79	730.78	62.27	7.32	23.06	0.1495	138
Sisson D	6/1/2015	6.55	9.53	53.83	1.60	696.80	54.37	5.86			
Sisson S	6/16/2015	5.69	13.93	46.00	2.06	878.73	84.83	10.46	62.75	0.13305	136
Sisson D	6/16/2015	5.11	10.22	63.19	2.76	779.33	70.37	7.79			
Sisson S	6/29/2015	10.26	3.35	18.29	0.71	804.96	67.35	7.32	65.06	0.13515	159
Sisson D	6/29/2015	7.61	11.92	40.78	1.26	754.90	74.79	7.35			
Sisson S	7/15/2015	25.52	2.40	29.08	0.22	803.36	92.51	7.73	35.27	0.18945	144
Sisson D	7/15/2015	26.83	2.14	33.38	0.73	864.21	99.26	8.24			
Sisson S	7/28/2015	13.64	3.30	17.28	0.78	1964.00	120.96	10.04	131.69	0.1792	126
Sisson D	7/28/2015	9.03	1.94	16.43	-0.41	1464.00	104.39	9.47			
Sisson S	8/12/2015	7.89	7.95	124.65	2.19	1411.00	57.75	7.74	54.31	0.19125	160
Sisson D	8/12/2015	14.90	8.75	150.24	2.24	2038.00	119.05	8.20			
Sisson S	8/25/2015	8.18	6.41	111.28	1.21	1634.00	110.00	7.60	92.62	0.1794	156
Sisson S	9/9/2015	6.52	9.55	52.67	0.97	2386.00	172.66	8.50	84.9	0.178	145
Sisson S	9/22/2015	5.02	45.52	41.10	2.43	1800.00	136.21	8.27	59.2	0.19095	129
Sisson S	10/6/2015	8.79	89.59	332.37	33.21	1451.00	63.27	7.74	35.87	0.1484	108

Table 25. Final analytical results-St Marys Pond-2015 sampling[1].

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
St. Marys S	5/6/2015	12.21	779.00	69.16	4.14	1230.00	29.40	5.96	7.63	0.1088	88.8
St. Marys D	5/6/2015	5.54	769.03	62.65	4.42	1215.00	30.07	10.13			
St. Marys S	5/18/2015	6.49	610.07	69.68	6.31	1018.00	22.66	4.38	6.32	0.1057	73.2
St. Marys D	5/18/2015	5.72	609.29	72.50	6.50	1159.00	30.47	5.95			
St. Marys S	6/1/2015	4.28	378.76	92.26	5.48	823.07	23.79	22.84	4.29	0.1055	97.4
St. Marys D	6/1/2015	5.48	369.46	95.77	5.30	974.77	32.67	8.00			
St. Marys S	6/16/2015	4.23	210.32	46.26	4.97	677.42	30.83	4.95	10.84	0.1163	107
St. Marys D	6/16/2015	4.66	206.23	45.25	4.74	730.73	36.44	4.85			
St. Marys S	6/29/2015	7.28	7.08	35.82	1.00	620.74	45.98	5.56	12.43	0.1037	123
St. Marys D	6/29/2015	12.40	6.85	37.83	1.43	528.56	41.70	5.67			
St. Marys S	7/15/2015	8.13	3.26	13.48	0.55	764.09	58.84	6.02	27.3	0.113	128
St. Marys S	7/28/2015	7.65	62.02	475.15	4.05	1288.00	50.26	10.66	25.47	0.1014	157
St. Marys D	7/28/2015	6.79	73.42	475.49	3.93	1436.00	79.48	7.37			
St. Marys S	8/12/2015	na	na	180.76	3.33	1326.00	47.88	5.40	64.63	0.1054	93.8
St. Marys S FD	8/12/2015	na	na	172.45	3.29	1292.00	57.30	5.44	60.26	0.119	91.6
St. Marys S	8/25/2015	8.73	3.93	114.90	0.15	3261.00	205.76	5.38	139.42	0.1149	63.7
St. Marys D	8/25/2015	5.91	4.90	463.62	1.07	2353.00	180.53	6.32			
St. Marys S	9/9/2015	9.14	78.54	233.17	7.52	1383.00	104.75	4.85	78.7	0.1202	122
St. Marys S	9/22/2015	9.21	36.52	391.96	2.84	1537.00	141.52	4.64	39.85	0.1316	86.2
St. Marys S	10/6/2015	3.40	15.48	13.77	0.57	1035.00	91.51	4.24	41.16	0.1242	107

Table 26. Final analytical results-North Easton Pond-2015 sampling.

RIDEM ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
North Easton S	5/15/2015	1.69	559.49	25.23	8.72	971.06	20.04	4.02	12.9	0.1038	139
North Easton D	5/15/2015	4.58	576.56	41.82	8.72	1054.00	25.40	4.09			
North Easton S	5/18/2015	4.89	334.22	34.99	10.75	801.20	23.80	3.85	12.7	0.0978	106
North Easton D	5/18/2015	3.26	338.75	34.30	10.89	775.21	29.20	5.58			
North Easton S	6/1/2015	4.61	62.91	61.95	9.18	851.06	57.71	4.98	69.7	0.1058	144
North Easton D	6/1/2015	4.52	68.47	71.36	10.29	843.42	62.40	5.30			
North Easton S	6/16/2015	5.77	5.49	27.75	1.74	844.99	78.53	8.59	57.0	0.1308	133
North Easton D	6/16/2015	4.94	11.74	38.36	2.11	848.82	81.50	5.24			
North Easton S	6/29/2015	3.10	26.01	45.50	na	689.35	74.95	5.10	51.7	0.1068	130
North Easton D	6/29/2015	na	44.44	51.49	4.21	718.81	75.00	5.84			
North Easton S FD	6/29/2015	3.34	32.01	42.62	na	651.35	60.07	5.21	49.2	0.1065	130
North Easton D FD	6/29/2015	na	41.92	57.52	4.30	672.11	69.24	5.57			
North Easton S	7/15/2015	5.27	3.87	13.63	-1.38	857.52	72.50	3.01	56.1	0.1095	120
North Easton D	7/15/2015	4.88	3.99	10.79	0.73	801.11	67.58	4.76			
North Easton S	7/28/2015	11.42	18.02	93.07	1.97	761.83	75.10	5.77	50.8	0.1323	130
North Easton D	7/28/2015	6.22	23.54	202.26	1.80	1061.00	84.16	5.96			
North Easton S	8/12/2015	3.54	3.58	20.64	-0.19	848.76	53.73	7.22	63.0	0.1256	153
North Easton D	8/12/2015	12.52	21.81	84.48	2.67	1138.00	106.82	5.07			
North Easton S	8/25/2015	3.17	6.63	21.42	0.63	759.46	38.13	4.42	53.2	0.1189	150
North Easton D	8/25/2015	2.70	7.24	48.74	0.76	849.95	40.84	4.77			
North Easton S	9/9/2015	2.81	5.76	91.36	0.88	1154.00	89.91	5.15	35.4	0.1307	160
North Easton D	9/9/2015	4.77	7.24	100.85	0.92	1088.00	83.97	5.25			
North Easton S	9/22/2015	4.42	2.54	11.37	0.06	769.02	45.18	4.35	41.9	0.1206	131
North Easton D	9/22/2015	0.67	1.92	3.73	-0.22	903.98	72.63	4.37			
North Easton S	10/6/2015	3.79	65.98	50.97	3.09	991.51	74.55	4.56	32.3	0.1475	108
North Easton D	10/6/2015	2.85	78.11	48.32	3.37	1282.00	157.26	4.85			

[1] Flagged data point (DOC red font St. Marys Pond 6.1.2015) was not used to calculate epilimnetic mean. Field notes by DEM staff indicate sample was inadvertently collected in brownish plume. Likely not representative.

Table 27. Final analytical results- South Easton Pond- 2015 sampling.

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
South Easton S	5/5/2015	2.46	333.93	19.08	5.25	828.56	26.07	4.40	13.7	0.10875	144
South Easton D	5/5/2015	3.32	333.03	24.06	5.07	899.34	28.67	4.88			
South Easton S	5/18/2015	4.88	100.12	26.98	5.62	730.03	23.76	4.95	19.4	0.1057	110
South Easton D	5/18/2015	4.91	109.82	43.73	6.36	733.61	31.81	4.69			
South Easton S	6/1/2015	3.36	1.34	28.88	0.49	654.72	33.99	5.08	15.6	0.1055	140
South Easton D	6/1/2015	1.52	2.42	22.53	0.68	620.27	29.70	5.25			
South Easton S	6/16/2015	3.19	4.95	56.83	1.65	723.64	35.50	5.71	14.5	0.11625	131
South Easton D	6/16/2015	6.31	4.16	45.62	1.14	641.45	34.33	9.07			
South Easton S	6/29/2015	4.33	14.48	50.21	4.67	705.10	38.32	5.63	18.3	0.10365	125
South Easton D	6/29/2015	5.30	9.99	70.89	0.26	684.49	38.88	5.73			
South Easton S	7/15/2015	na	7.06	326.66	1.51	1186.00	62.12	5.43	20.1	0.11295	113
South Easton D	7/15/2015	na	na	323.56	na	1160.00	na	5.56			
South Easton S FD	7/15/2015	na	8.63	321.57	1.50	1194.00	61.62	5.34	20.6	0.11245	100
South Easton D FD	7/15/2015	na	na	323.17	na	961.25	na	5.51			
South Easton S	7/28/2015	2.54	14.68	185.85	2.03	959.81	8.05	7.29	47.5	0.1014	125
South Easton D	7/28/2015	2.95	12.02	199.69	2.45	1004.00	54.47	9.12			
South Easton S	8/12/2015	1.08	5.23	21.50	0.83	1034.00	62.78	4.95	37.7	0.10535	150
South Easton D	8/12/2015	2.60	6.05	35.92	0.58	753.33	37.12	5.03			
South Easton S	8/25/2015	0.68	14.71	37.43	0.40	1292.00	41.14	4.77	53.3	0.11485	149
South Easton D	8/25/2015	3.50	4.99	28.86	0.36	1247.00	46.47	4.72			
South Easton S	9/9/2015	3.19	21.45	257.23	2.45	1539.00	42.76	5.22	40.9	0.1202	150
South Easton D	9/9/2015	6.58	19.86	263.48	3.46	1462.00	39.39	5.57			
South Easton S	9/22/2015	3.39	31.33	199.65	5.09	1077.00	25.85	5.69	49.8	0.1316	146
South Easton D	9/22/2015	3.10	29.90	196.23	5.16	1177.00	34.26	5.72			
South Easton S	10/6/2015	3.40	44.22	38.09	4.64	1080.00	45.17	5.19	40.8	0.1242	160
South Easton D	10/6/2015	3.04	32.58	45.82	3.85	1150.00	50.99	5.26			

Table 28. Final analytical results- Gardiner Pond- 2015 sampling.

Sample ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Gardiner Pond S	5/6/2015	6.59	6.61	20.22	0.68	479.64	24.94	4.70	5.88	0.06	86
Gardiner Pond D	5/6/2015	9.64	7.17	34.74	0.91	472.05	22.20	12.30			
Gardiner Pond S	5/18/2015	4.73	5.04	17.60	0.82	464.89	24.50	4.67	8.49	0.0615	65.1
Gardiner Pond D	5/18/2015	4.60	2.24	15.71	0.77	494.94	20.78	5.15			
Gardiner Pond S	6/1/2015	na	na	na	na	na	na	na	9.14	0.0745	87.6
Gardiner Pond D	6/1/2015	na	na	11.93	0.68	498.25	22.77	na			
Gardiner Pond S FD	6/1/2015	na	na	na	na	na	na	5.27	9.86	0.0752	90.8
Gardiner Pond D FD	6/1/2015	na	na	13.39	0.68	480.60	24.33	5.51			
Gardiner Pond S	6/16/2015	3.22	2.63	26.92	0.82	675.39	26.78	5.73	20.23	0.0757	99
Gardiner Pond D	6/16/2015	5.24	6.39	38.44	0.58	512.78	30.72	9.04			
Gardiner Pond S	6/29/2015	1.89	6.21	13.32	1.05	637.65	36.33	6.03	28.08	0.0745	93.1
Gardiner Pond D	6/29/2015	1.27	4.88	17.28	0.38	695.09	43.56	6.50			
Gardiner Pond S	7/15/2015	4.89	8.01	13.05	13.06	700.12	39.26	6.23	21.88	0.0941	84.1
Gardiner Pond S	7/28/2015	5.57	23.93	34.89	0.81	1006.00	62.55	7.39	40.75	0.1005	124
Gardiner Pond S	8/12/2015	3.23	5.85	22.00	-0.45	825.83	48.40	5.42	21.67	0.1057	112
Gardiner Pond D	8/12/2015	5.27	6.82	24.39	0.71	1064.00	62.07	5.35			
Gardiner Pond S	8/17/2015	14.38	7.45	23.87	0.66	1196.00	54.26	6.97			
Gardiner Pond S	8/25/2015	13.79	5.80	139.26	0.60	2469.00	96.86	8.30	100.99	0.118	102
Gardiner Pond D	8/25/2015	12.53	21.52	53.48	0.19	1627.00	62.39	7.69	na		
Gardiner Pond S	9/9/2015	6.21	6.47	76.73	0.53	2383.00	45.12	7.45	106.6	0.1414	113
Gardiner Pond S	9/22/2015	3.67	21.58	1144.00	3.21	2213.00	32.82	7.32	35.04	0.1189	35.8
Gardiner Pond S	10/6/2015	3.58	189.97	308.35	12.55	1452.00	36.34	5.71	41.49	0.1113	101

Table 29. Final analytical results- Paradise Pond- 2015 sampling.

Station ID	Date	PO4 PPB-P	NO3+NO2 PPB-N	NH4 PPB-N	NO2 PPB-N	TN PPB-N	TP PPB-P	DOC (mg/l)	Chl-a (ug/l)	UV254 nm(cm-1)	TTHM (ug/l)
Paradise S	5/6/2015	11.18	337.81	85.33	14.63	1024.00	37.97	8.9	15.94	0.1515	165
Paradise D	5/6/2015	7.29	344.95	96.48	12.78	1075.00	54.94	18.1			
Paradise S	5/18/2015	4.53	261.07	102.37	9.59	954.18	33.90	5.8	12.64	0.1601	155
Paradise T	5/18/2015	3.88	255.40	156.75	9.32	947.29	43.96	7.0			
Paradise D	5/18/2015	8.62	231.22	251.16	8.72	988.24	49.40	5.6			
Paradise S	6/1/2015	5.49	25.16	75.82	5.30	898.45	52.27	7.6	34.65	0.195	201
Paradise D	6/1/2015	5.26	31.82	84.06	5.99	800.93	54.65	7.9			
Paradise S	6/16/2015	13.11	5.41	23.15	2.52	787.47	61.37	7.5	21.99	0.1973	199
Paradise D	6/16/2015	13.49	10.77	205.94	2.02	994.36	175.28	9.5			
Paradise S	6/29/2015	1.42	3.50	18.17	0.59	749.41	116.75	8.2	63.38	0.1905	211
Paradise D	6/29/2015	1.99	11.86	43.51	1.84	966.87	67.67	8.1			
Paradise S	7/15/2015	3.43	0.88	13.57	1.74	1364.00	49.04	9.8	68.77	0.2242	172
Paradise T	7/15/2015	12.72	2.75	310.51	1.17	1147.00	63.77	8.3			
Paradise D	7/15/2015	30.67	2.09	1101.00	7.94	1624.00	179.38	8.8			
Paradise S	7/28/2015	5.92	14.23	14.21	1.89	1084.00	58.21	9.6	24.45	0.2078	214
Paradise T	7/28/2015	21.17	30.86	325.56	3.14	1256.00	112.42	9.4			
Paradise D	7/28/2015	22.61	6.85	680.16	1.45	1568.00	263.93	9.5			
Paradise S	8/12/2015	18.64	53.79	20.08	2.23	1304.00	124.19	7.0	50.37	0.2409	194
Paradise D	8/12/2015	20.22	49.96	222.55	2.83	1263.00	105.13	6.6			
Paradise S	8/25/2015	9.84	25.08	33.59	0.92	1448.00	124.13	7.3	33.7	0.2122	209
Paradise T	8/25/2015	21.90	7.20	50.43	0.19	1292.00	142.16	7.9			
Paradise D	8/25/2015	198.41	10.96	1623.40	1.03	2409.00	602.05	5.9			
Paradise S	9/9/2015	na	3.99	na	-0.21	1746.00	116.94	8.8	36.18	0.2108	174
Paradise D	9/9/2015	12.12	3.07	28.77	0.49	1454.00	123.58	8.7			
Paradise S FD	9/9/2015	na	4.88	na	-1.43	1996.00	138.75	8.2	43.18	0.2079	173
Paradise D FD	9/9/2015	10.28	3.64	23.09	0.55	1372.00	112.66	7.8			
Paradise S	9/22/2015	9.97	2.08	66.06	0.19	1568.00	119.25	7.4	62.16	0.1977	184
Paradise S	10/6/2015	5.45	66.01	93.22	2.00	1371.00	60.58	7.6	22.93	0.2289	165

Phytoplankton/Cyanobacteria Summaries

As stated in the QAPP (RIDEM 2015) samples for phytoplankton analysis were collected monthly rather than bi-weekly. Phytoplankton summaries for each reservoir are presented in Table 30. The individual reports from Northeast Laboratories include identification of 5 families (*Diatomaceae, Chlorophyceae, Cyanophyceae, Protozoa, and Rotifera*) as well as between 10-28 genera of each family. Table 30 displays the total number of cells of all genera within each of the five families. Units are in cells per milliliter. The reports are available at RIDEM office in Providence.

Monthly samples submitted to Northeast Laboratories were also analyzed for microcystin-LR. All samples submitted came back as non-detect. If RIDEM staff observed a cyanobacteria bloom on any of the reservoirs, a sample was collected and submitted to the Rhode Island Department of Health (HEALTH) for analysis of the following algal toxins: Anatoxin-a, Cylindrospermopsin, Microcystins, Nodularians, and Saxitoxin.

Table 30. Phytoplankton Summaries for Newport Reservoirs-2015.

Reservoir	Organism	5/6/2015	6/1/2015	6/30/2015	7/29/2015	8/24/2015	9/21/2015
Nonquit	Diatomaceae	1000	480	340	3440	5200	320
	Chlorophyceae	800	0	64	800	0	16120
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	1300	0	390	24200	4500	10100
	Protozoa	1092	160	100	800	12120	24080
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
Watson	Diatomaceae	5000	0	0	1560	0	600
	Chlorophyceae	24	1140	5120	33800	0	280
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	3500	25600	19000	10000	91000	9600
	Protozoa	60	0	160	200	0	3320
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
Lawton Valley	Diatomaceae	3376	1380	1920	5680	0	40220
	Chlorophyceae	1472	26920	21826	84587	1620	141100
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	1200	0	19000	87780	15700	298000
	Protozoa	300	100	62	237	0	740
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
Sisson	Diatomaceae	768	640	1200	840	0	2060
	Chlorophyceae	954	10720	480	17500	1340	10880
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	5800	120	210160	4400	63100	3100
	Protozoa	496	340	1280	160	600	29240
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
St. Marys	Diatomaceae	1368	0	0	3900	0	5640
	Chlorophyceae	1326	280	2350	1200	0	76460
	Rotifera	8	40	16	0	0	0
	Cyanophyceae	480	0	500	67000	348000	27600
	Protozoa	320	0	48	1600	180	22560
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
North Easton	Diatomaceae	584	2140	9920	5600	0	12380
	Chlorophyceae	4062	3500	18300	32200	200	53420
	Rotifera	8	0	0	0	0	0
	Cyanophyceae	3300	230000	6400	10380	124400	49600
	Protozoa	86	0	200	680	0	15280
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
South Easton	Diatomaceae	2596	12600	480	5520	0	6800
	Chlorophyceae	2932	15410	9260	24640	340	131820
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	400	74000	88600	5160	88400	98400
	Protozoa	5360	0	680	480	0	27220
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
Gardiner	Diatomaceae	3208	4800	2900	18690	0	2320
	Chlorophyceae	716	340	5900	13140	0	260
	Rotifera	0	0	0	0	0	0
	Cyanophyceae	320	0	208	31600	56000	51200
	Protozoa	16000	9600	220	840	160	0
	Organism	**5/6/2015**	**6/1/2015**	**6/30/2015**	**7/29/2015**	**8/24/2015**	**9/21/2015**
Paradise	Diatomaceae	8160	0	480	4300	0	1020
	Chlorophyceae	6064	12760	20000	120	0	19000
	Rotifera	16	0	0	0	0	0
	Cyanophyceae	520	120000	73600	44400	106000	47000
	Protozoa	760	200	240	320	180	7340

Vertical Profiling Data

Tables 31-42 display the vertical profiling data from the nine reservoirs for each of 12 surveys. As specified in the QAPP (RIDEM 2015) this data collected during the profiling included dissolved oxygen, percent saturation, pH, temperature, and specific conductance.

Table 31. Survey 1 Vertical Profiling Data.

Site	Sample Date	Sample Time	*no DO week 1														
WR	5/6/2015	12:20	T (°C)	15.50	15.50	15.40	15.40	15.30	15.30	15.20	14.30	14.00	13.20	13.00	12.50	12.40	12.20
			Depth (m)	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
			T (°F)	59.90	59.90	59.72	59.72	59.54	59.54	59.36	57.74	57.20	55.76	55.40	54.50	54.32	53.96
			Depth (ft)	1.64	3.28	4.92	6.56	8.20	9.84	11.48	13.12	14.76	16.40	18.04	19.69	21.33	22.97
NP	5/6/2015	12:20	T (°C)	16.11	16.11	16.11	16.11	16.11	16.06	16.11	16.11	16.11	16.00	15.89			
			Depth (m)	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74	3.05	3.35	3.66			
			T (°F)	61.00	61.00	61.00	61.00	61.00	60.90	61.00	61.00	61.00	60.80	60.60			
			Depth (ft)	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00			
LVR	5/5/2015	8:36	T (°C)	14.80	14.40	14.40	14.20	14.20	14.20	14.20	13.90	13.50	12.80	12.40	12.00	11.70	11.50
			Depth (m)	0.61	1.22	1.83	2.44	3.05	3.66	4.27	4.88	5.49	6.10	6.71	7.32	7.92	8.53
			T (°F)	58.64	57.92	57.92	57.56	57.56	57.56	57.56	57.02	56.30	55.04	54.32	53.60	53.06	52.70
			Depth (ft)	2.00	4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00	26.00	28.00
SMP	5/6/2015	9:15	T (°C)	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20
			Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50
			T (°F)	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16
			Depth (ft)	0.82	1.64	2.46	3.28	4.10	4.92	5.74	6.56	7.38	8.20	9.02	9.84	10.66	11.48
SP	5/6/2015	9:00	T (°C)	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.80	16.60	16.60	16.20	16.00	
			Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	
			T (°F)	62.24	62.24	62.24	62.24	62.24	62.24	62.24	62.24	62.24	61.88	61.88	61.16	60.80	
			Depth (ft)	0.82	1.64	2.46	3.28	4.10	4.92	5.74	6.56	7.38	8.20	9.02	9.84	10.66	
NEP	5/5/2015	11:05	T (°C)	15.50	15.50	15.50	15.40	15.10	14.90	14.90	14.90	14.90	14.80	14.80			
			Depth (m)	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74	3.05	3.35	3.66			
			T (°F)	59.90	59.90	59.90	59.72	59.18	58.82	58.82	58.82	58.82	58.64	58.64			
			Depth (ft)	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00			
SEP	5/5/2015	10:25	T (°C)	16.50	15.80	15.50	15.50	15.20	15.20	15.20	15.20	15.20					
			Depth (m)	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74	3.05					
			T (°F)	61.70	60.44	59.90	59.90	59.36	59.36	59.36	59.36	59.36					
			Depth (ft)	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00					
GP	5/6/2015	10:55	T (°C)	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.20	16.00	16.00			
			Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75			
			T (°F)	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	61.16	60.80	60.80			
			Depth (ft)	0.82	1.64	2.46	3.28	4.10	4.92	5.74	6.56	7.38	8.20	9.02			
PP	5/6/2015	10:05	T (°C)	16.30	16.30	16.30	16.30	16.30	16.30	16.30	16.20	15.90	15.50	15.10	14.50	14.30	13.80	13.30
			Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75
			T (°F)	61.34	61.34	61.34	61.34	61.34	61.34	61.34	61.16	60.62	59.90	59.18	58.10	57.74	56.84	55.94
			Depth (ft)	0.82	1.64	2.46	3.28	4.10	4.92	5.74	6.56	7.38	8.20	9.02	9.84	10.66	11.48	12.30

Table 32. Survey 2 Vertical Profiling Data.

Sample Time																	
8:45	T (C)	19.60	19.70	19.70	19.70	19.70	19.70	19.70	19.70	19.30	18.60	18.10	17.70	17.50	16.70	16.00	
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	
	DO (mg/L)	7.48	7.50	7.52	7.50	7.51	7.52	7.52	7.53	6.93	6.50	5.02	4.23	2.28	1.38	0.65	
8:00	T (C)	19.00	19.00	19.00	19.00	19.00	19.00	18.90	18.90	18.90	18.80						
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50						
	DO (mg/L)	7.70	7.34	7.76	7.86	7.82	7.89	7.97	7.94	7.93	7.30						
8:00	T (C)			19.31		19.31	19.31	19.31	19.27	19.29	19.29	19.28	19.24	19.18			
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25			
	DO (%)			104		103.70	103.60	103.50	103.10	103.30	103.20	103.10	103.00	88.40			
	DO (mg/L)			9.58		9.54	9.53	9.53	9.50	9.50	9.52	9.48	9.50	8.46			
10:25	T (C)		19.85	19.85	19.85	19.85	19.85	19.83	19.84	19.84	19.81	19.78	19.71	19.23	18.53		
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50		
	DO (%)		107.10	106.70	106.40	106.80	106.40	106.40	105.70	106.30	106.30	105.60	105.00	99.80	84.80		
	DO (mg/L)		9.76	9.71	9.69	9.73	9.69	9.69	9.68	9.68	9.69	9.63	9.61	9.08	7.98		
10:45	T (C)		19.97	19.97	19.95	19.93	19.90	19.90	19.76	19.62	19.45						
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50						
	DO (%)		105.00	104.90	104.80	104.90	104.60	104.30	103.10	97.70	92.60						
	DO (mg/L)		9.55	9.55	9.53	9.53	9.52	9.50	9.37	8.50	8.31						
10:45	T (C)	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9					
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75					
	DO (mg/L)	7.86	7.97	7.96	7.98	8.08	8.05	7.99	8.04	7.90	8.00	6.00					
9:35	T (C)		18.78	18.75	18.58	18.61	18.56	18.55	18.49	18.33	17.73	17.63	17.53	17.44	17.22	16.83	16.48
	Depth (m)	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50
	DO (%)		102.80	102.60	101.00	100.20	99.40	99.10	98.40	96.50	92.30	92.40	85.70	83.10	78.70	71.10	60.10
	DO (mg/L)		9.58	9.55	9.46	9.36	9.30	9.27	9.22	9.32	8.78	8.80	8.19	7.92	7.57	6.75	5.49
8:30	T (C)		20.5		20.5		20.6		20.3		20.0		19.6				
	Depth (m)	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00				
	DO (mg/L)		6.70		7.40		7.00		7.07		7.30		6.89				
9:30	T (C)		19.30	19.30	19.30	19.30	19.10	19.10	19.00	17.60	16.80	15.50	14.50	13.30	13.00		
	Depth (m)	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50		
	DO (mg/L)		7.83	7.88	7.95	7.95	7.96	7.92	7.92	6.6	6.34	5.32	4.62	3.39	3.07		

Table 33. Survey 3 Vertical Profiling Data.

Site	Sample Date	Sample Time																	
SP	6/1/2015	11:20	T (C)	20.00		20.00		20.00		20.00	19.80								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75								
			DO (%)	76.50		76.40		75.80		75.50	72.00								
			DO (mg/L)	6.91		6.94		6.91		6.86	6.53								
			SPC (uS/cm)	158.6		158.60		158.60		158.70	158.80								
			pH	7.32		7.27		7.25		7.23	7.19								
			*0 = surface measurement																
PP	6/1/2015	9:50	T (C)	19.70		19.70		19.70		19.70		19.70		19.70		18.70			
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			
			DO (%)	101.20		101.10		100.30		101.10		100.90		100.30		52.80			
			DO (mg/L)	9.26		9.25		9.17		9.23		9.17		9.20		4.77			
			SPC (uS/cm)	263.9		264.00		264.00		264.00		264.00		264.00		266.60			
			pH	9.03		9.05		9.06		9.09		9.07		9.04		7.58			
GP	6/1/2015	8:30	T (C)	19.00		19.10		19.10		19.10		19.10		19.10					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50					
			DO (%)	89.90		92.00		91.40		89.90		90.70		89.20					
			DO (mg/L)	8.33		8.50		8.44		8.34		8.40		8.33					
			SPC (uS/cm)	199.4		199.50		199.40		199.40		199.40		199.40					
			pH	7.62		7.6		7.56		7.63		7.57		7.55					
														*bottom					
SMP	6/1/2015	12:00	T (C)	20.30		20.40		20.40		20.40		20.40							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00							
			DO (%)	87.60		88.10		88.70		88.20		87.20							
			DO (mg/L)	7.89		7.93		7.99		7.94		7.87							
			SPC (uS/cm)	221.2		221.20		221.20		221.20		221.30							
			pH	7.44		7.42		7.42		7.39		7.35							
NP	6/1/2015	~9:30	T (C)		20.50	20.60	20.60	20.60	20.60	20.60		20.60		20.60		20.60			
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			
			DO (%)		86.50	86.40	85.50	87.40	88.70	88.20		87.30		87.40		86.90			
			DO (mg/L)		7.73	7.75	7.81	7.83	7.78	7.90		7.86		7.86		7.86			
			SPC (uS/cm)		154.30	154.20	154.20	154.30	154.40	154.40		154.40		154.50		154.50			
			pH		*no pH on YSI 85														
WR	6/1/2015	12:30	T (C)			19.50	19.60	19.60	19.60	19.60	19.50	19.50	19.4	19.3	18.6	18.2	17.5	17.1	16.7
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
			DO (%)			103.30	102.00	103.30	102.70	102.20	100.80	100.30	99.8	98.8	85.3	77.9	50	34.7	25.3
			DO (mg/L)			9.41	9.40	9.44	9.39	9.38	9.18	9.22	9.18	9.1	8.11	6.89	4.76	3.44	2.43
			SPC (uS/cm)			170.70	170.70	170.60	170.60	170.40	170.50	170.60	170.5	170.6	170.5	170.7	173.3	174.8	176
			pH		*no pH on YSI 85														
NEP	6/2/2015	8:40	T (C)		18.27	18.28	18.28	18.28	18.28	18.28	18.28	18.27	18.28	18.28	18.42				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75				
			DO (%)		84.10	85.40	87.00	87.10	86.90	86.70	86.60	86.30	86.30	86.40	28.90				
			DO (mg/L)		7.88	8.18	8.18	8.17	8.17	8.14	8.14	7.90	8.13	8.12	2.42				
			SPC (uS/cm)		475.00	475.00	475.00	475.00	475.00	475.00	475.00	475.00	475.00	475.00	460.00				
			pH		7.55	7.53	7.5	7.49	7.48	7.48	7.47	7.46	7.46	7.45	7.23				
SEP	6/2/2015	9:20	T (C)		18.01	18.01	18.01	18.00	18.00	17.96	17.95	17.95	17.89	17.87					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50					
			DO (%)		88.90	88.60	86.40	88.40	88.20	87.70	87.40	87.00	67.30	57.70					
			DO (mg/L)		8.40	8.38	8.18	8.35	8.34	8.30	8.26	8.24	6.62	4.88					
			SPC (uS/cm)		460.00	460.00	460.00	460.00	460.00	459.00	459.00	459.00	459.00	450.00					
			pH		7.53	7.55	7.45	7.55	7.54	7.53	7.52	7.51	7.31	7.33					
LVR	6/2/2015	10:30	T (C)		18.56	18.59	18.59	18.59	18.60	18.60	18.60	18.60	18.6	18.6	18.6	18.59	18.6	18.6	18.59
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
			DO (%)		97.30	93.10	91.60	91.20	91.00	90.60	90.40	90.30	90.1	90.1	90	90	89.9	89.8	52.3
			DO (mg/L)		9.06	8.69	8.57	8.53	8.50	8.46	8.45	8.44	8.43	8.42	8.43	8.41	8.4	8.4	4.52
			SPC (uS/cm)		233.00	233.00	233.00	233.00	233.00	233.00	233.00	233.00	233	233	233	233	233	233	237
			pH		7.44	7.39	7.33	7.33	7.32	7.31	7.3	7.29	7.29	7.29	7.29	7.29	7.29	7.28	7.09

Table 34. Survey 4 Vertical Profiling Data.

Sample Time																	
8:15	T (C)		20.90	20.90	20.90	20.90	20.80	20.80	20.80	20.80	20.80	20.80	20.70				
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75				
	DO (%)		72.40	71.90	71.20	71.40	70.10	69.50	68.20	66.50	66.20	67.00	60.00				
	DO (mg/L)		6.46	6.44	6.30	6.40	6.24	6.22	6.10	5.97	5.91	5.97	5.39				
	SPC (uS/cm)		156.10	156.00	156.00	156.00	156.10	156.00	156.10	156.10	156.20	156.50	156.80				
	pH																
	*0 = surface measurement																
11:10	T (C)		22.40	22.20	21.60	21.30	21.10	21.10	21.10	21.10	21.00	20.90	20.40	19.70	18.50	17.80	
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	
	DO (%)		98.10	96.80	96.60	93.20	89.00	86.40	86.20	84.30	83.10	80.00	59.00	16.50	4.00	0.20	
	DO (mg/L)		8.55	8.43	8.57	8.23	7.91	7.68	7.67	7.50	7.39	7.16	5.30	1.70	0.40	0.02	
	SPC (uS/cm)		262.00	262.30	261.60	261.40	261.30	261.30	261.40	261.50	261.50	261.10	260.20	265.70	275.00	288.10	
	pH													*DO bouncing			
10:30	T (C)		21.00	20.90	20.70	20.60	20.60	20.60	20.50	20.50							
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00							
	DO (%)		89.90	90.90	91.40	91.40	91.40	90.70	85.90	84.20							
	DO (mg/L)		8.00	8.12	8.17	8.22	8.19	8.14	7.74	7.57							
	SPC (uS/cm)		200.90	201.00	201.00	200.90	200.90	200.90	201.00	200.90							
	pH																
9:00	T (C)		21.20	21.20	21.20	21.10	21.10	21.00	21.00	21.00	20.90	20.80					
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50					
	DO (%)		96.80	95.90	95.80	95.80	95.80	95.90	95.30	94.80	93.60	93.90					
	DO (mg/L)		8.59	8.52	8.50	8.52	8.47	8.53	8.49	8.43	8.38	8.41					
	SPC (uS/cm)		219.30	219.30	219.30	219.40	219.30	219.20	219.10	219.20	218.90	218.70					
	pH																
9:10	T (C)		22.20	22.20	22.20	22.20	22.20	22.20	22.10	22.10	22.10	22.00	21.90	21.80			
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			
	DO (%)		97.20	96.00	96.40	95.60	95.20	94.20	94.00	92.50	92.30	89.00	85.30	83.40			
	DO (mg/L)		8.46	8.34	8.37	8.26	8.29	8.16	8.16	8.02	8.04	7.68	7.47	7.24			
	SPC (uS/cm)		149.40	149.40	149.30	149.40	149.60	149.40	149.50	149.50	149.60	150.20	150.30	150.50			
	pH		7.44	7.36	7.29	7.25	7.2	7.16	7.12	7.13	7.06	7.04	6.98	6.94			
10:00	T (C)	21.30		21.30	21.30	21.30	21.30	21.20	21.20	21.00	19.8	19.3	19	18.6	18.1	17.8	17.5
	Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00
	DO (%)	91.2		90.6	89.3	89.6	89.9	89.5	88.5	86.9	72.1	65.0	61.0	54.5	38.0	26.0	18.2
	DO (mg/L)	8.06		8.01	7.94	7.99	7.93	7.89	7.93	7.65	6.57	5.99	5.62	5.11	3.39	2.3	1.61
	SPC (uS/cm	161.8		161.70	161.70	161.80	161.80	161.80	161.80	161.90	163.1	163.8	164.3	165	167.5	171	175.6
	pH	7.37		7.27	7.16	7.12	7.09	7.05	7.03	6.98	6.84	6.74	6.58	6.53	6.45	6.36	6.26
10:00	T (C)		21.43	21.43	21.34	21.28	21.19	21.14	21.09	21.06	21.05						
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25						
	DO (%)		87.60	85.90	82.60	81.60	80.60	79.70	78.80	78.50	71.60						
	DO (mg/L)		7.70	7.48	7.30	7.21	7.14	7.07	6.98	6.98	6.35						
	SPC (uS/cm)		465.00	465.00	464.00	464.00	464.00	464.00	464.00	464.00	464.00						
	pH		7.47	7.4	7.34	7.31	7.28	7.25	7.23	7.19	7.14						
9:20	T (C)		20.86	20.87	20.84	20.76	20.72	20.67	20.61	20.49	20.38						
	Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25						
	DO (%)		92.80	91.80	91.20	90.40	90.40	90.70	90.20	87.80	86.20						
	DO (mg/L)		8.28	8.19	8.15	8.09	8.10	8.13	8.07	7.84	7.77						
	SPC (uS/cm)		463.00	463.00	463.00	463.00	463.00	463.00	463.00	463.00	462.00						
	pH		7.82	7.74	7.7	7.67	7.65	7.65	7.62	7.58	7.51						
8:15	T (C)		21.15	21.15	21.15	21.15	21.15	21.15	21.15	21.15	21.15	21.15	21.09	20.98			
	Depth (m)	0.00	0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25	5.75			
	DO (%)		106.70	106.50	106.30	106.30	106.30	106.20	106.00	106.00	105.9	105.5	104.7	101.6			
	DO (mg/L)		9.47	9.46	9.45	9.44	9.45	9.43	9.43	9.42	9.41	9.37	9.29	9.02			
	SPC (uS/cm)		233.00	233	233	233	233	233	233	233	233	233	233	234			
	pH		9.05	9.05	9.05	9.04	9.04	9.04	9.04	9.03	9.03	9.02	8.98	8.82			

Table 35. Survey 5 Vertical Profiling Data.

Site	Sample Date	Sample Time																
SP	6/29/2015	10:15	T (C)		21.10	21.10	21.00	20.80	20.80	20.70	20.60	20.60	20.60	20.50				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50				
			DO (%)		93.00	93.40	92.10	88.20	87.80	87.20	82.80	73.00	70.10	56.10				
			DO (mg/L)		8.25	8.28	8.18	7.70	7.84	7.81	7.35	6.52	6.29	4.93				
			SPC (uS/cm)		151.70	155.70	151.70	151.60	151.40	151.30	151.50	152.10	152.40	153.50				
			pH		8.68	8.66	8.61	8.44	8.3	8.17	8.06	7.9	7.81	7.7				
PP	6/29/2015	9:30	T (C)		22.10	22.00	21.60	21.60	21.50	21.50	21.50	21.50	21.50	21.50	21.40	21.40	21.10	20.40
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50
			DO (%)		112.70	109.40	95.30	91.60	91.00	91.20	89.50	88.70	87.50	86.10	86.40	84.30	66.90	57.80
			DO (mg/L)		9.80	9.45	8.40	8.00	8.03	8.00	7.88	7.84	7.71	7.60	7.64	7.52	5.92	5.21
			SPC (uS/cm)		258.90	258.60	258.00	257.50	257.50	257.60	257.60	257.40	257.50	257.90	258.40	257.90	251.50	233.70
			pH		9.34	9.17	9	8.92	8.89	8.81	8.78	8.78	8.72	8.66	8.63	8.60	8.7	7.64
GP	6/29/2015	8:30	T (C)		20.90	20.90	20.90	20.80	20.80	20.80	20.80	20.80						
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00						
			DO (%)		86.30	85.70	84.70	82.60	81.00	81.20	81.70	81.30						
			DO (mg/L)		7.71	7.66	7.59	7.37	7.25	7.27	7.30	7.29						
			SPC (uS/cm)		199.60	199.60	199.60	199.60	199.60	199.50	199.60	199.70						
			pH		7.7	7.58	7.57	7.49	7.48	7.46	7.48	7.47						
SMP	6/29/2015	11:00	T (C)		21.10	21.00	20.80	20.70	20.50	20.50	20.40							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75							
			DO (%)		88.30	88.60	88.40	88.20	88.40	88.60	86.80							
			DO (mg/L)		7.85	7.92	7.94	7.90	7.99	7.97	7.83							
			SPC (uS/cm)		214.50	214.10	214.50	214.40	214.20	214.20	214.00							
			pH		8.66	8.73	8.77	8.72	8.79	8.76	8.71							
NP	6/30/2015	8:45	T (C)		22.30	22.30	22.30	22.30	22.10	22.10	22.10	22.10	22.10	22.10	22.00	21.80		
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00		
			DO (%)		97.20	96.80	97.00	96.50	95.20	94.60	95.00	94.60	94.10	93.30	90.20	88.00		
			DO (mg/L)		8.45	8.42	8.45	8.40	8.30	8.25	8.31	8.24	8.20	8.14	7.91	7.71		
			SPC (uS/cm)		149.70	149.70	149.80	149.80	149.80	149.80	149.90	149.80	149.80	149.90	150.20	150.10		
			pH		7.31	7.27	7.25	7.2	7.19	7.18	7.19	7.18	7.15	7.13	7.08	7.08		
WR	6/30/2015	9:45	T (C)		22.40	22.40	22.30	22.10	22.00	21.90	21.90	21.90	21.9	21.8	21.4	20.8	20	19.1
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50
			DO (%)		98.6	98.8	98.1	97.8	96.1	95.4	94.4	93.0	92.8	89.9	72.0	43.0	14.4	0.8
			DO (mg/L)		8.58	8.57	8.54	8.54	8.42	8.36	8.26	8.15	8.17	7.87	6.41	3.61	1.3	0.07
			SPC (uS/cm)		163.8	163.80	163.70	163.80	163.80	163.80	163.80	163.80	163.7	163.6	163.9	167.5	171.8	180.1
			pH		7.36	7.26	7.22	7.18	7.17	7.15	7.14	7.12	7.09	7.07	6.95	6.79	6.65	6.59
NEP	6/29/2015	8:21	T (C)		21.32		21.29	21.23	21.20	21.08	20.95	20.21	20.00	20.00	20.03			
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75			
			DO (%)		86.00		85.70	84.50	84.20	84.60	84.60	85.50	64.00	61.50	39.40			
			DO (mg/L)		7.62		7.57	7.49	7.47	7.52	7.57	7.74	5.79	5.59	3.08			
			SPC (uS/cm)		438.00		437.00	434.00	433.00	427.00	417.00	343.00	325.00	325.00	327.00			
			pH		7.58		7.53	7.49	7.46	7.44	7.43	7.38	7.18	7.1	7.04			
SEP	6/29/2015	9:15	T (C)		21.21	20.96	20.94	20.91	20.88	20.82	20.69	20.68	20.70					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25					
			DO (%)		92.80	92.10	91.50	90.60	89.70	89.40	89.00	86.50	54.60					
			DO (mg/L)		8.23	8.21	8.15	8.06	8.00	7.99	7.94	7.75	4.82					
			SPC (uS/cm)		467.00	468.00	468.00	468.00	468.00	467.00	467.00	467.00	467.00					
			pH		7.53	7.42	7.5	7.49	7.47	7.46	7.45	7.41	7.16					
LVR	6/29/2015	11:00	T (C)		22.34	22.22	22.26	22.16	22.14	22.09	22.05	22.06	21.98	21.96	21.93	21.84	21.81	
			Depth (m)	0.00	0.25	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	
			DO (%)		99.60	97.90	97.20	96.40	95.40	93.70	91.50	90.50	89.5	89.3	87.9	84.8	81.9	
			DO (mg/L)		8.65	8.52	8.46	8.40	8.30	8.14	7.98	7.90	7.81	7.81	7.69	7.44	7.81	
			SPC (uS/cm)		236.00	236	236.00	236.00	236.00	236.00	236.00	236.00	236	236	236	236	236	
			pH		7.78	7.72	7.71	7.67	7.64	7.59	7.56	7.53	7.48	7.48	7.45	7.41	7.37	

Table 36. Survey 6 Vertical Profiling Data.

Site	Sample Date	Sample Time																	
SP	7/14/2015	8:00	T (C)		26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00							
			DO (%)		94.60	92.20	92.60	91.70	92.20	91.60	91.40	89.10							
			DO (mg/L)		7.66	7.52	7.52	7.70	7.48	7.43	7.42	7.24							
			SPC (uS/cm)		155.50	155.60	155.60	155.60	155.50	155.30	155.30	155.00							
			pH		9.15	9.12	9.13	9.13	9.13	9.1	9.12	9.04							
PP	7/14/2015	11:00	T (C)		26.60	26.60	26.60	26.50	26.40	26.20	25.30	24.90	24.60	24.10	23.10	21.70		21.00	20.70
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75
			DO (%)		120.80	120.30	120.40	119.60	114.90	110.60	78.30	30.10	21.80	18.90	1.40	0.40		0.10	0.01
			DO (mg/L)		9.69	9.67	9.73	9.61	9.30	8.98	6.10	2.57	1.81	1.42	0.18	0.03		0.01	0.01
			SPC (uS/cm)		258.60	258.70	258.50	258.10	257.40	255.90	255.30	253.20	253.30	254.00	259.50	260.90		283.60	286.9
			pH		9.72	9.74	9.72	9.71	9.68	9.62	9.24	7.85	7.68	7.45	7.22	7.08		7.06	7.07
GP	7/14/2015	9:45	T (C)		25.80	25.80	25.80	25.80	25.80	25.80	25.80	25.80	25.80						
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25						
			DO (%)		108.00	107.80	106.90	106.80	106.80	106.10	107.00	108.40	103.00						
			DO (mg/L)		8.77	8.75	8.72	8.74	8.70	8.70	8.76	8.82	8.57						
			SPC (uS/cm)		204.80	204.80	204.70	204.70	204.80	204.90	204.80	204.60	204.50						
			pH		9.48	9.5	9.5	9.5	9.53	9.55	9.56	9.51	9.49						
SMP	7/14/2015	8:45	T (C)		25.60	25.60	25.60	25.60	25.50	25.50									
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50									
			DO (%)		101.50	101.90	101.80	101.50	99.80	99.80									
			DO (mg/L)		8.29	8.30	8.32	8.32	8.17	8.16									
			SPC (uS/cm)		214.90	215.00	215.00	214.90	215.10	214.70									
			pH		9.16	9.15	9.16	9.14	9.14	9.12									
NP	5/15/2015	8:45	T (C)		27.00	27.00	27.00	26.90	26.90	26.90	26.80	26.70	26.70	26.60	26.60	26.10			
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			
			DO (%)		96.40	95.30	95.00	91.20	90.60	90.60	91.60	91.60	90.50	90.10	85.60	54.50			
			DO (mg/L)		7.68	7.58	7.56	7.28	7.24	7.25	7.37	7.35	7.25	7.23	6.86	4.51			
			SPC (uS/cm)		148.60	148.60	148.70	148.80	148.80	148.80	148.60	148.60	148.70	148.70	148.90	150.30			
			pH		7.71	7.49	7.37	7.29	7.25	7.22	7.19	7.15	7.12	7.09	7.08	6.91			
WR	7/15/2015	9:35	T (C)		26.50	26.40	26.30	26.20	26.20	26.10	26.10	25.80	24.6	23.9	21.9	20.7	19.6		
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00		
			DO (%)		109.9	109.9	108.1	104.7	102.9	102.3	96.6	90.2	57.2	41.1	2.8	0.3	0.3		
			DO (mg/L)		8.81	8.84	8.77	8.43	8.33	8.34	7.75	7.33	4.72	3.28	0.25	0.03	0.03		
			SPC (uS/cm)		163.8	163.70	163.70	163.40	163.50	163.40	163.70	163.60	164.3	165	169.6	179	196.7		
			pH		8.15	8.19	8.16	8.04	7.83	7.71	7.59	7.43	7.09	6.81	6.51	6.55	6.67		
NEP	7/14/2015	10:15	T (C)		25.97	25.96	25.95	25.91	25.93	25.92	25.92	25.89	25.85	25.79	25.42				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75				
			DO (%)		88.90	88.80	88.60	87.60	87.90	87.70	87.40	87.00	85.30	82.50	8.80				
			DO (mg/L)		7.21	7.21	7.19	7.11	7.14	7.12	7.10	7.06	6.92	6.72	0.68				
			SPC (uS/cm)		394.00	394.00	394.00	394.00	394.00	394.00	394.00	394.00	394.00	394.00	413.00				
			pH		7.55	7.6	7.61	7.59	7.59	7.59	7.59	7.58	7.54	7.47	7.4				
			Chl		17.5	16.3	16.3	16.9	sonde confirm										
SEP	7/14/2015	9:45	T (C)		25.73	25.73	25.71	25.71	25.72	25.72	25.72	25.63							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00							
			DO (%)		70.50	67.40	66.70	66.30	66.40	66.10	65.80	58.30							
			DO (mg/L)		5.70	5.48	5.44	5.40	5.41	5.37	5.36	4.27							
			SPC (uS/cm)		466.00	466.00	466.00	466.00	466.00	466.00	466.00	464.00							
			pH		7.34	7.26	7.21	7.2	7.18	7.17	7.15	6.96							
				Chl:	6.8														
LVR	7/14/2015	8:15	T (C)		25.83	25.85	25.84	25.85	25.85	25.85	25.85	25.83	25.84	25.78	25.2	25.01	24.5		
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00		
			DO (%)		98.30	97.50	97.70	97.70	97.60	97.30	97.30	96.30	96.5	89.4	64.4	46.3	18.5		
			DO (mg/L)		7.98	7.93	7.95	7.95	7.93	7.91	7.91	7.82	7.85	7.16	5.07	3.63	1.37		
			SPC (uS/cm)		232.00	232.00	232.00	232.00	232.00	232.00	232.00	232.00	232	232	234	234	240		
			pH		7.89	7.89	7.92	7.93	7.93	7.91	7.91	7.88	7.88	7.69	7.36	7.16	6.94		
				Chl:	14.90	14.10		13.40											

Table 37. Survey 7 Vertical Profiling Data.

Sample Date	Sample Time																	
7/28/2015	10:30	T (C)		24.10	24.10	24.10	24.00	24.00	24.00	23.80								
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75								
		DO (%)		117.30	115.60	114.50	110.50	109.80	110.00	102.30								
		DO (mg/L)		9.87	9.70	9.62	9.32	9.26	9.26	8.62								
		SPC (uS/cm)		147.10	146.80	146.30	149.90	145.60	145.30	143.70								
		pH		9.49	9.43	9.43	9.39	9.37	9.32	9.11								
7/28/2015	9:15	T (C)		24.80	24.80	24.80	24.80	24.70	24.70	24.70	24.70	24.60	24.20	22.50	22.20	21.40		
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	
		DO (%)		81.00	78.70	77.30	76.50	76.00	76.70	76.40	76.10	60.10	21.40	2.70	0.40	0.40	0.30	
		DO (mg/L)		6.71	6.54	6.42	6.34	6.31	6.37	6.35	6.33	4.87	1.77	0.23	0.04	0.03	0.03	
		SPC (uS/cm)		252.80	252.80	252.80	252.80	252.90	252.90	252.80	252.90	253.90	255.80	281.90	299.90	297.90	337.40	
		pH		7.87	7.81	7.78	7.74	7.73	7.68	7.67	7.62	7.42	7.25	6.98	7.04	6.97	6.89	
7/28/2015	8:20	T (C)		24.50	24.50	24.50	24.50	24.40	24.40	24.40	24.40	24.40						
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25						
		DO (%)		84.40	80.90	81.60	80.10	80.20	79.30	75.40	76.50	63.20						
		DO (mg/L)		7.03	6.75	6.81	6.72	6.71	6.64	6.30	6.35	5.12						
		SPC (uS/cm)		204.80	204.80	204.80	204.80	204.90	204.60	204.40	204.40	201.60						
		pH		9.16	9.15	9.16	9.16	9.17	9.14	9.05	9.01	8.4						
7/28/2015	11:00	T (C)		23.70	23.60	23.50	23.40	23.30	23.30	23.20								
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75								
		DO (%)		74.30	73.00	74.40	73.70	71.20	69.20	60.80								
		DO (mg/L)		6.27	6.21	6.30	6.19	6.02	5.83	5.05								
		SPC (uS/cm)		196.70	196.60	195.60	195.40	195.40	195.20	192.90								
		pH		7.46	7.35	7.32	7.25	7.22	7.19	7.13								
7/29/2015	9:00	T (C)		26.10	25.70	25.70	25.50	25.40	25.40	25.40	25.40	25.30	25.30	24.80	24.80			
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00			
		DO (%)		109.10	107.30	104.70	100.80	97.90	95.40	95.30	96.60	95.00	91.40	87.00	83.10			
		DO (mg/L)		8.81	8.78	8.49	8.20	7.85	7.82	7.83	7.81	7.95	7.54	7.16	6.85			
		SPC (uS/cm)		146.20	146.00	145.90	146.70	145.20	145.40	145.40	146.10	144.60	144.60	144.10	140.70			
		pH		7.2	7.18	7.13	7.06	6.97	6.91	6.88	6.87	6.84	6.81	6.76	6.69			
7/29/2015	10:00	T (C)		26.6	26.5	26.1	25.8	25.6	25.4	25.30	25.10	24.9	24.6	24	21.7	20.5		
		Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00		
		DO (%)		111.3	110.1	107.9	108.4	106.9	102.2	96.2	87.6	81.0	67.3	27.6	1.0	0.7		
		DO (mg/L)		8.94	8.84	8.77	8.83	8.73	8.36	7.82	7.12	6.54	5.47	2.22	0.07	0.06		
		SPC (uS/cm)		163.6	163.70	163.60	162.80	162.80	162.80	163.00	163.90	164	165.4	166.9	190.8	204		
		pH		7.55	7.5	7.6	7.47	7.37	7.27	7.21	7.1	7.02	6.87	6.64	6.69	6.76		
7/28/2015	8:20	T (C)		24.51	24.49	24.49	24.45	24.39	24.35	24.35	24.32	24.25	24.25	23.86				
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75				
		DO (%)		85.10	82.20	81.60	79.70	77.00	70.20	70.60	66.40	64.70	49.10	38.10				
		DO (mg/L)		7.09	6.86	6.80	6.67	6.37	5.87	5.87	5.41	5.42	4.11	3.21				
		SPC (uS/cm)		386.00	386.00	387.00	390.00	392.00	391.00	390.00	377.00	370.00	371.00	329.00				
		pH		7.39	7.37	7.36	7.34	7.31	7.23	7.21	7.17	7.1	7.02	6.9				
7/28/2015	9:00	T (C)		24.3	24.27	24.26	24.23	24.19	24.15	24.11	24.06	24.07						
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25						
		DO (%)		90.40	89.30	88.90	87.90	86.70	84.40	82.40	43.30	14.90						
		DO (mg/L)		7.56	7.47	7.43	7.34	7.23	7.07	6.86	3.00	1.25						
		SPC (uS/cm)		471.00	470.00	470.00	470.00	470.00	471.00	471.00	470.00							
		pH		7.26	7.25	7.24	7.23	7.21	7.2	7.17	6.97	6.9						
7/28/2015	10:15	T (C)		24.76	24.70	24.73	24.69	24.68	24.60	24.65	24.64	24.63	24.58	24.48	24.32	23.92	23.83	
		Depth (m)	0.00	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	5.80	
		DO (%)		97.10	96.50	96.10	95.60	95.00	93.90	92.00	90.40	90.40	87.9	82.8	71.4	32.1	16.9	
		DO (mg/L)		8.06	8.01	7.98	7.94	7.88	7.80	7.63	7.52	7.52	7.24	6.83	5.98	2.7	1.27	
		SPC (uS/cm)		218.00	218.00	218	218.00	218.00	218.00	218.00	216.00	216.00	216	216	219	202	202	
		pH		7.65	7.64	7.63	7.62	7.61	7.6	7.52	7.46	7.44	7.39	7.32	7.19	6.96	6.81	

Table 38. Survey 8 Vertical Profiling Data.

Site	Sample Date	Sample Time																						
SP	8/12/2015	11:00	T (C)		23.60	23.40	23.10	23.10	22.70	22.70	22.70													
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75													
			DO (%)		67.20	65.00	63.30	62.00	55.50	52.20	50.80													
			DO (mg/L)		5.68	5.51	5.41	5.30	4.83	4.51	4.36													
			SPC (uS/cm)		141.50	141.60	141.50	141.30	141.30	141.40	141.50													
			pH		7.27	7.22	7.19	7.19	7.16	7.1	7.05													
PP	8/12/2015	12:15	T (C)		24.25	23.35	22.97	22.92	22.88	22.86	22.85	22.82	22.77	22.75	22.76									
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75									
			DO (%)		108.80	101.10	87.90	80.90	72.10	67.40	65.30	62.50	57.40	53.00	15.70									
			DO (mg/L)		9.16	8.63	7.54	6.76	6.19	5.79	5.62	5.38	4.94	4.56	1.28									
			SPC (uS/cm)		239.00	239.00	239.00	238.00	238.00	239.00	239.00	240.00	241.00	240.00	241.00									
			pH		8.11	7.91	7.73	7.59	7.5	7.41	7.35	7.29	7.22	7.16	7.05									
GP	8/12/2015	11:30	T (C)		23.79	23.12	23.03	22.94	22.88	22.87	22.85	22.85												
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00												
			DO (%)		91.00	92.30	90.20	87.60	88.00	86.10	83.30	79.00												
			DO (mg/L)		7.69	7.89	7.68	7.52	7.56	7.40	7.16	6.97												
			SPC (uS/cm)		208.00	207.00	207.00	207.00	208.00	207.00	207.00	205.00												
			pH		9.12	9.18	9.1	9.01	8.98	8.95	8.8	8.78												
SMP	8/12/2015	12:00	T (C)		23.30	22.80	22.70	22.60	22.60	22.50	22.40													
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75													
			DO (%)		95.30	88.40	87.70	88.40	87.00	79.50	71.80													
			DO (mg/L)		8.08	7.60	7.56	7.63	7.49	6.89	6.23													
			SPC (uS/cm)		186.70	187.10	187.10	187.20	187.20	186.70	187.70													
			pH		6.52	7.5	7.44	7.47	7.44	7.21	7.22													
NP	8/12/2015	8:30	T (C)		23.70	23.70	23.70	23.70	23.70	23.70	23.70	23.70	23.70	23.70	23.60	23.40	22.50							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25							
			DO (%)		81.00	80.60	79.80	79.50	79.20	79.00	78.60	78.70	78.00	80.90	78.00	75.50	72.20							
			DO (mg/L)		6.86	6.82	6.75	6.73	6.69	6.68	6.66	6.66	6.59	6.81	6.55	6.40	6.29							
			SPC (uS/cm)		140.90	140.80	140.90	140.90	140.90	140.90	140.80	140.80	140.20	140.50	139.00	132.20	125.90							
			pH		7.74	7.54	7.44	7.36	7.33	7.3	7.25	7.18	7.11	7.09	7.03	6.95	6.77							
WR	8/12/2015	9:20	T (C)		24.3	24.3	24.3	24.2	24.2	24.2	24.2	24.1	24.1	24.1	24.10	24.10	24.10	24.10	24.10	24.1	24.1	24.1	23.3	22	20.8
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.50	5.00	5.50	6.00	6.40
			DO (%)		78.4	78.9	78.2	76.2	79.4	77.5	76.5	75.1	76.3	76.2	77.5	78.2	79.6	79.7	79.8	79.9	78.9	77.3	49.5	1.2	0.6
			DO (mg/L)		6.6	6.51	6.51	6.41	6.56	6.42	6.36	6.24	6.28	6.39	6.54	6.61	6.69	6.70	6.7	6.71	6.64	6.42	4.26	0.09	0.05
			SPC (uS/cm)		161.9	162.00	162	162.00	162	161.90	161.8	161.90	161.9	161.90	161.8	161.80	161.8	161.80	161.8	161.80	161.80	161.70	160.9	200	213
			pH		7.12	7.08	7.05	7.03	7.01	7	6.98	6.97	6.96	6.95	6.93	6.92	6.92	6.92	6.91	6.92	6.93	6.88	6.63	6.6	6.73
NEP	8/12/2015	10:00	T (C)		23.55	23.37	23.29	23.14	23.14	23.14	23.13	23.13	23.07	22.70	22.27	22.21								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	2.90								
			DO (%)		103.60	101.90	96.20	85.50	83.60	82.90	81.50	80.30	80.10	65.30	49.80	39.80								
			DO (mg/L)		8.80	8.59	8.20	7.34	7.14	7.08	6.95	6.84	6.85	5.45	4.22	3.46								
			SPC (uS/cm)		346.00	348.00	348.00	349.00	349.00	349.00	348.00	346.00	337.00	264.00	230.00	228.00								
			pH		7.8	7.74	7.66	7.5	7.42	7.37	7.32	7.29	7.24	7.15	7.01	6.82								
SEP	8/12/2015	9:20	T (C)		22.7	22.67	22.56	22.56	22.49	22.49	22.49													
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75													
			DO (%)		91.80	91.50	90.00	88.50	87.00	85.80	55.20													
			DO (mg/L)		7.91	7.88	7.75	7.63	7.52	7.38	4.77													
			SPC (uS/cm)		451.00	451.00	451.00	451.00	451.00	451.00	400.00													
			pH		7.51	7.47	7.44	7.4	7.38	7.34	7.23													
LVR	8/12/2015	8:10	T (C)		23.92	23.92	23.92	23.92	23.91	23.91	23.91	23.91	23.91	23.91	23.9	23.88								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00								
			DO (%)		67.70	63.50	62.80	62.10	61.70	61.20	60.80	60.50	60.30	60.2	60.1	58								
			DO (mg/L)		5.64	5.35	5.29	5.23	5.20	5.16	5.12	5.10	5.09	5.08	5.07	4.83								
			SPC (uS/cm)		222.00	222.00	222	222.00	222.00	221.00	221.00	221.00	221.00	221	221	222								
			pH		7.73	7.59	7.51	7.45	7.38	7.33	7.26	7.22	7.2	7.18	7.16	7.14								

Table 39. Survey 9 Vertical Profiling Data.

Site	Sample Date	Sample Time																
SP	8/25/2015	10:40	T (C)		26.70	26.60	26.60	26.50	26.40	26.40	26.30							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75							
			DO (%)		107.40	107.30	105.70	99.50	96.40	87.80	67.10							
			DO (mg/L)		8.62	8.63	8.48	8.20	7.73	7.00	5.42							
			SPC (uS/cm)		145.00	145.00	144.70	144.20	143.90	143.80	144.10							
			pH		9.08	9.1	9.04	9.02	8.72	8.03	7.65							
PP	8/25/2015	10:00	T (C)		26.50	26.50	26.50	26.50	26.50	26.50	26.50	26.30	24.90	24.90				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50				
			DO (%)		99.60	99.50	98.70	99.20	98.10	97.30	89.70	30.60	2.10	0.50				
			DO (mg/L)		7.99	7.99	7.94	7.97	7.88	7.83	7.20	2.48	0.12	0.04				
			SPC (uS/cm)		241.50	241.50	241.50	241.50	241.40	241.40	240.80	241.60	254.20	258.20				
			pH		9.28	9.28	9.29	9.3	9.28	9.29	9.06	7.72	7.04	7.03				
GP	8/25/2015	8:15	T (C)		26.80	26.80	26.80	26.80	26.80	26.60	26.60	26.40	26.30					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25					
			DO (%)		113.10	111.00	111.00	110.00	109.70	94.60	94.10	51.00	7.70					
			DO (mg/L)		9.04	8.86	8.88	8.79	8.87	7.55	8.60	3.90	0.63					
			SPC (uS/cm)		222.40	222.00	222.30	222.20	222.20	218.40	211.80	215.60	220.00					
			pH		9.91	9.9	9.91	9.92	9.92	9.75	9.66	9.07	7.7					
SMP	8/25/2015	11:00	T (C)		26.90	26.80	26.60	26.40	26.30	26.20	26.10							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75							
			DO (%)		103.50	96.00	76.80	72.20	67.20	61.00	49.80							
			DO (mg/L)		8.26	7.74	6.21	5.84	5.42	4.83	4.07							
			SPC (uS/cm)		185.00	184.80	185.00	185.40	185.80	186.30	187.90							
			pH		8.74	8.26	7.6	7.37	7.29	7.19	7.12							
NP	8/24/2015	9:15	T (C)		26.50	26.50	26.50	26.50	26.50	26.40	26.40	26.40	26.40	26.40	26.40	26.40		
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00		
			DO (%)		70.50	68.80	69.60	67.70	67.70	67.90	68.40	68.70	68.50	69.90	68.30	66.90		
			DO (mg/L)		5.70	5.57	5.60	5.45	5.45	5.46	5.50	5.57	5.54	5.54	5.46	5.30		
			SPC (uS/cm)		142.10	142.10	142.10	142.10	142.10	142.10	142.10	142.00	141.90	141.70	142.00	142.10		
			pH		6.88	6.76	6.72	6.7	6.7	6.69	6.66	6.65	6.64	6.64	6.63	6.62		
WR	8/24/2005	11:01	T (C)		26.6	26.6	26.6	26.6	26.5	26.4	26.30	26.30	25.4	24	22.9	21.7		
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50		
			DO (%)		114.2	107.4	108.1	102.4	97.6	93.7	93.0	92.6	32.3	3.5	0.9	0.9		
			DO (mg/L)		9.1	8.60	8.32	8.24	7.90	7.58	7.50	7.40	2.52	0.22	0.06	0.07		
			SPC (uS/cm)		164.1	164.20	164.30	164.30	163.80	163.40	163.60	163.60	164.00	163.20	183.90	200.6		
			pH		8.58	8.58	8.52	8.51	8.1	7.82	7.74	7.56	6.99	6.71	6.66	6.84		
NEP	8/25/2015	8:15	T (C)		26.52	26.51	26.52	26.50	26.48	26.40	26.32	26.21	26.07	26.04				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50				
			DO (%)		88.60	92.30	92.10	91.10	89.40	86.50	82.80	83.00	61.40	48.90				
			DO (mg/L)		7.19	7.41	7.40	7.32	7.15	6.88	6.68	6.72	4.88	3.94				
			SPC (uS/cm)		351.00	351.00	351.00	351.00	351.00	351.00	351.00	352.00	353.00	355.00				
			pH		7.73	7.77	7.78	7.77	7.74	7.69	7.63	7.55	7.42	7.22				
SEP	8/25/2015	9:00	T (C)		25.7	25.70	25.70	25.69	25.66	25.67	25.43							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75							
			DO (%)		100.50	100.50	95.90	96.10	93.30	82.90	64.10							
			DO (mg/L)		8.19	8.19	7.81	7.83	7.61	6.73	5.25							
			SPC (uS/cm)		463.00	463.00	463.00	463.00	463.00	463.00	464.00							
			pH		7.79	7.79	7.68	7.66	7.56	7.52	7.23							
LVR	8/25/2015	10:20	T (C)		26.62	26.59	26.56	26.55	26.54	26.53	26.53	26.51	26.51	26.46	26.43	26.34	26.3	26.27
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.25
			DO (%)		90.00	88.90	87.90	86.90	86.20	85.70	85.40	84.40	84.3	82.8	82.3	81	74.5	69.9
			DO (mg/L)		7.20	7.13	7.05	6.97	6.92	6.89	6.85	6.77	6.77	6.65	6.62	6.54	6	5.65
			SPC (uS/cm)		217.00	217.00	217.00	217.00	217.00	217.00	217.00	217.00	217	218	218	218	219	219
			pH		7.3	7.27	7.24	7.22	7.2	7.17	7.16	7.13	7.12	7.1	7.09	7.07	7.03	6.92

Table 40. Survey 10 Vertical Profiling Data.

Site	Sample Date	Sample Time																
SP	9/9/2015	8:30	T (C)		25.30	25.20	25.30	25.20	25.20	25.20								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50								
			DO (%)		80.80	79.50	79.00	77.50	76.30	75.10								
			DO (mg/L)		6.66	6.54	6.49	6.39	6.22	6.14								
			SPC (uS/cm)		145.80	145.80	145.90	145.90	146.00	146.00								
			pH		8.03	7.98	8	7.91	7.82	7.74								
PP	9/9/2015	11:30	T (C)		25.80	25.80	25.70	25.70	25.70	25.70	25.50	25.30	24.70	24.80				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50				
			DO (%)		114.50	114.60	110.30	111.90	108.30	108.30	55.40	44.80	41.40	0.80				
			DO (mg/L)		9.34	9.33	9.04	9.18	8.80	8.80	4.38	3.69	3.34	0.06				
			SPC (uS/cm)		246.80	246.70	246.80	246.80	246.60	246.50	247.30	246.30	246.40	246.50				
			pH		9.11	9.1	9.09	9.09	9.07	9.01	7.87	7.53	7.31	7.11				
GP	9/9/2015	10:15	T (C)		24.90	24.90	24.90	24.90	24.90	24.80	24.80	24.80	24.80	24.80				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50				
			DO (%)		101.50	100.90	99.00	97.80	98.30	96.90	95.50	93.60	91.60	91.20				
			DO (mg/L)		8.43	8.33	8.81	7.96	8.08	8.01	7.81	7.86	7.55	7.48				
			SPC (uS/cm)		226.10	226.10	225.40	225.40	225.60	225.00	225.10	224.30	223.70	222.60				
			pH		9.9	9.91	9.9	9.9	9.89	9.88	9.88	9.86	9.84	9.81				
SMP	9/9/2015	9:15	T (C)		25.50	25.50	25.30	25.30	25.20	25.10	25.10							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75							
			DO (%)		92.30	91.10	84.70	82.90	83.10	82.50	76.50							
			DO (mg/L)		7.57	7.40	7.01	6.83	6.82	6.61	6.21							
			SPC (uS/cm)		195.20	195.30	195.40	195.50	195.50	195.60	195.70							
			pH		7.74	7.62	7.51	7.43	7.39	7.31	7.26							
NP	9/8/2015	9:30	T (C)		25.50	25.50	25.40	25.40	25.30	26.30	25.30	25.30	25.30	25.30	25.20			
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75			
			DO (%)		90.50	87.60	86.00	85.20	84.20	82.30	82.80	82.80	82.70	81.80	77.80			
			DO (mg/L)		7.36	7.18	7.06	7.00	6.90	6.73	6.79	6.81	6.79	6.69	6.41			
			SPC (uS/cm)		144.40	144.40	144.50	144.40	144.40	144.50	144.40	144.40	144.50	144.50	144.60			
			pH		7.2	7.07	7.01	6.97	6.96	6.93	6.9	6.88	6.87	6.85	6.79			
WR	9/8/2015	10:15	T (C)		25.8	25.8	25.5	25.3	25.2	25.1	25.10	25.10	25.1	25	22.9	21.6	20.5	20.1
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.25
			DO (%)		93.2	91.2	89.4	88.8	87.4	85.8	84.0	82.6	82.3	69.7	2.1	0.9	0.7	0.6
			DO (mg/L)		7.55	7.42	7.30	7.30	7.18	7.09	6.94	6.81	6.79	5.65	0.16	0.07	0.06	0.05
			SPC (uS/cm)		166	166.00	166.20	166.10	166.10	166.10	166.20	166.40	166.50	167.10	202.50	223.9	249.4	258.9
			pH		7.32	7.27	7.26	7.25	7.22	7.19	7.14	7.11	7.05	6.91	6.76	6.89	6.93	7.02
NEP	9/9/2015	10:00	T (C)		25.42	25.40	25.39	25.36	25.37	25.36	25.32	25.26	25.19					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25					
			DO (%)		86.70	85.20	84.70	83.70	83.20	83.00	82.70	80.60	70.90					
			DO (mg/L)		7.10	6.99	6.94	6.86	6.81	6.80	6.77	6.63	5.87					
			SPC (uS/cm)		362.00	362.00	362.00	362.00	362.00	362.00	362.00	362.00	362.00					
			pH		7.36	7.31	7.28	7.26	7.24	7.23	7.21	7.19	7.05					
SEP	9/9/2015	9:30	T (C)		25.54	25.51	25.47	25.41	25.38	25.35								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50								
			DO (%)		97.00	95.70	94.50	93.00	89.70	86.60								
			DO (mg/L)		7.92	7.83	7.72	7.58	7.33	7.04								
			SPC (uS/cm)		472.00	472.00	472.00	472.00	472.00	472.00								
			pH		7.6	7.56	7.54	7.51	7.46	7.43								
LVR	9/9/2015	8:30	T (C)		25.55	25.56	25.55	25.55	25.54	25.55	25.54	25.52	25.52	25.49	25.49	25.4	25.24	25.21	25.03
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	6.75
			DO (%)		93.00	92.00	91.20	90.60	90.00	90.00	89.60	89.20	87.9	85.4	84.3	75.4	63.7	55.4	18.9
			DO (mg/L)		7.59	7.51	7.45	7.41	7.36	7.36	7.32	7.30	7.19	6.96	6.89	6.09	5.19	4.46	1.56
			SPC (uS/cm)		211.00	211.00	211.00	211.00	211.00	211.00	211.00	211.00	211	210	211	208	212	213	219
			pH		7.79	7.68	7.61	7.56	7.52	7.47	7.44	7.4	7.36	7.35	7.31	7.25	7.16	7.01	6.78

Table 41. Survey 11 Vertical Profiling Data.

Site	Sample Date	Sample Time																			
SP	9/22/2015	8:20	T (C)		20.30	20.30	20.20	20.30	20.30	20.30	20.30										
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75										
			DO (%)		70.00	70.10	70.40	70.00	69.00	69.40	69.50										
			DO (mg/L)		6.31	6.33	6.33	6.34	6.24	6.27	6.29										
			SPC (uS/cm)		145.30	145.30	145.30	145.30	145.30	145.40	145.30										
			pH		7.38	7.34	7.35	7.33	7.32	7.32	7.33										
PP	9/22/2015	11:20	T (C)		20.90	20.90	20.90	20.90	20.80	20.80	20.80	20.80	20.80								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25								
			DO (%)		79.60	79.40	71.30	78.10	75.20	72.80	69.80	68.10	67.00								
			DO (mg/L)		7.10	7.90	6.84	6.98	6.69	6.53	6.19	6.09	6.00								
			SPC (uS/cm)		248.40	248.40	248.40	248.40	248.40	248.40	248.70	248.40	248.40								
			pH		7.69	7.69	7.65	7.63	7.54	7.51	7.48	7.48	7.38								
GP	9/22/2015	10:20	T (C)		20.40	20.40	20.40	20.40	20.40	20.40	20.40	20.40	20.40								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25								
			DO (%)		62.50	62.40	63.20	63.00	63.00	62.10	62.60	62.10	61.30								
			DO (mg/L)		5.63	5.64	5.69	5.68	5.68	5.59	5.66	5.59	5.50								
			SPC (uS/cm)		226.90	227.00	227.00	226.90	226.90	227.00	227.00	227.00	227.00								
			pH		7.22	7.21	7.21	7.2	7.2	7.19	7.2	7.2	7.2								
SMP	9/22/2015	9:00	T (C)		19.80	19.80	19.80	19.80	19.80	19.80	19.80										
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75										
			DO (%)		73.30	73.00	73.10	72.70	73.00	72.60	72.60										
			DO (mg/L)		6.69	6.66	6.64	6.63	6.66	6.60	6.62										
			SPC (uS/cm)		195.30	195.30	195.50	195.30	195.30	195.30	195.30										
			pH		7.13	7.12	7.09	7.08	7.08	7.08	7.08										
NP	9/21/2015	9:20	T (C)		22.60	22.60		22.60		22.50		22.50		22.50		22.40					
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00					
			DO (%)		71.10	70.50		68.50		69.10		68.60		68.20		67.00					
			DO (mg/L)		6.16	6.07		5.92		5.97		5.94		5.90		5.79					
			SPC (uS/cm)		144.70	144.60		144.70		144.60		144.70		144.60		144.80					
			pH		6.74	6.55		6.5		6.48		6.46		6.45		6.44					
WR	9/21/2015	10:20	T (C)		22.8	22.8	22.8	22.8	22.8	22.8	22.80	22.50	22.4								
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00								
			DO (%)		88.7	86.8	86.3	85.9	85.7	85.8	83.6	60.0	60.3								
			DO (mg/L)		7.59	7.47	7.43	7.38	7.38	7.36	7.22	5.02	5.25								
			SPC (uS/cm)		168.9	168.90	169.00	168.90	168.90	168.90	169.10	170.80	171.00								
			pH		6.89	7	7.01	7	7.04	7.02	7.02	6.84	6.82								
NEP	9/22/2015	8:15	T (C)		20.83	20.85	20.85	20.86	20.86	20.86	20.86	20.86	20.85	20.85							
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50							
			DO (%)		85.70	88.00	87.60	87.50	87.30	87.30	87.30	87.30	87.30	87.00							
			DO (mg/L)		7.66	7.87	7.83	7.81	7.80	7.79	7.80	7.80	7.80	7.77							
			SPC (uS/cm)		362.00	362.00	361.00	361.00	361.00	361.00	361.00	361.00	361.00	361.00							
			pH		7.54	7.55	7.57	7.58	7.57	7.58	7.58	7.58	7.58	7.58							
SEP	9/22/2015	8:45	T (C)		19.43	19.43	19.44	19.43	19.43	19.45	20.43										
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.67										
			DO (%)		95.60	94.90	94.60	94.40	94.30	93.20	14.00										
			DO (mg/L)		8.78	8.72	8.68	8.66	8.66	8.53	1.50										
			SPC (uS/cm)		473.00	473.00	473.00	473.00	473.00	473.00	455.00										
			pH		7.58	7.54	7.54	7.54	7.54	7.55	7.09										
											in the muck?										
LVR	9/22/2015	9:45	T (C)		22.26	22.27	22.28	22.25	22.25	22.26	22.23	22.23	22.23	22.22	22.22	22.19	22.19	22.2	22.18	22.16	22.13
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
			DO (%)		92.50	90.80	89.80	89.30	89.10	88.90	88.80	88.70	88.5	88.4	88.4	88.2	87.9	88	87.6	86.7	71.2
			DO (mg/L)		8.03	7.89	7.81	7.77	7.75	7.73	7.72	7.72	7.7	7.7	7.69	7.68	7.65	7.66	7.63	7.55	6.34
			SPC (uS/cm)		207.00	206.00	207.00	206.00	206.00	206.00	206.00	206.00	206	206	206	207	207	206	207	207	207
			pH		7.65	7.58	7.53	7.57	7.43	7.4	7.39	7.35	7.31	7.29	7.28	7.26	7.26	7.23	7.22	7.21	7.17

Table 42. Survey 12 Vertical Profiling Data.

Site	Sample Date	Sample Time																		
SP	10/6/2015	9:45	T (C)	13.5		13.50		13.40		13.40		13.30								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00								
			DO (%)	89.70		89.60		88.20		87.60		87.00								
			DO (mg/L)	9.29		9.29		9.20		9.15		9.08								
			SPC (uS/cm)	141.1		141.10		141.00		141.10		141.00								
			pH	7.58		7.56		7.57		7.46		7.6								
PP	10/6/2015	8:45	T (C)	14.2		14.20		14.20		14.20		14.20		14.20						
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50						
			DO (%)	89.70		89.90		89.50		88.70		88.00		87.00						
			DO (mg/L)	9.25		9.25		9.17		9.11		9.02		8.93						
			SPC (uS/cm)	231.9		231.90		231.90		232.00		232.00		232.00						
			pH	7.62		7.64		7.64		7.52		7.49		7.32						
GP	10/6/2015	8:00	T (C)		13.70	13.70		13.70		13.70		13.70		13.70						
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50						
			DO (%)		91.40	87.90		87.50		86.40		85.10		85.20						
			DO (mg/L)		9.42	9.15		9.07		8.94		8.81		8.82						
			SPC (uS/cm)		208.50	208.50		208.50		208.50		208.60		208.60						
			pH		7.81	7.64		7.63		7.46		7.52		7.54						
SMP	10/6/2015	10:15	T (C)	13.60		13.60		13.40		13.40		13.40								
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00								
			DO (%)	96.90		96.90		95.80		95.90		94.70								
			DO (mg/L)	10.1		10.10		10.01		9.99		9.91								
			SPC (uS/cm)	170.1		170.30		178.00		178.00		177.90								
			pH	8.13		8.11		8.05		8		7.94								
NP	10/5/2015	9:15	T (C)		14.80	14.80	14.80	14.80	14.80	14.80	14.80	14.80	14.80	14.80	14.70	14.50				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00				
			DO (%)		100.00	95.40	93.00	92.20	91.30	90.70	90.40	90.20	89.80	89.80	89.70	87.80				
			DO (mg/L)		10.00	9.64	9.41	9.30	9.23	9.16	9.17	9.12	9.11	9.10	9.10	8.94				
			SPC (uS/cm)		131.90	131.90	132.00	132.10	132.10	132.20	132.20	132.20	132.10	132.10	131.10	123.10				
			pH		7.4	7.21	7.13	7.04	7.01	6.99	6.93	6.9	6.92	6.84	6.83	6.73				
WR	10/5/2015	10:15	T (C)	16.20		16.2	16.2	16.2	16.2	16.2	16.10	16.10	16.1	16.1	16.1					
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00					
			DO (%)	97.2		95.9	95.4	95.3	94.2	94.9	95.5	94.5	93.0	92.9	93.6					
			DO (mg/L)	9.48		9.43	9.37	9.34	9.28	9.33	9.39	9.29	9.17	9.15	9.22					
			SPC (uS/cm)	159.3		159.30	159.40	159.30	159.20	159.20	159.10	158.50	158.50	158.60	158.50					
			pH	7.21		7.22	7.25	7.22	7.27	7.28	7.2	7.27	7.23	7.24	7.25					
NEP	10/6/2015	8:15	T (C)		14.18	14.18	14.17	14.17	14.17	14.16	14.16	14.16	14.15	14.17	14.18	14.40				
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00				
			DO (%)		105.00	93.40	93.40	93.40	93.20	93.20	93.20	93.10	93.20	92.80	92.80	32.30				
			DO (mg/L)		10.77	9.59	9.54	9.58	9.57	9.56	9.56	9.55	9.55	9.52	9.51	3.00				
			SPC (uS/cm)		282.00	282.00	282.00	282.00	282.00	282.00	282.00	282.00	282.00	282.00	282.00	276.00				
			pH		7.49	7.45	7.44	7.42	7.39	7.37	7.36	7.35	7.34	7.32	7.27	7.1				
SEP	10/6/2015	9:00	T (C)		13.45	13.44	13.43	13.43	13.41	13.41										
			Depth (m)	0.00	0.25	0.50	0.75	1.00	1.25	1.50										
			DO (%)		99.90	99.40	99.20	99.00	98.60	98.50										
			DO (mg/L)		10.40	10.35	10.32	10.32	10.28	10.28										
			SPC (uS/cm)		406.00	406.00	406.00	406.00	406.00	406.00										
			pH		7.67	7.66	7.64	7.63	7.61	7.6										
LVR	10/6/2015	9:45	T (C)		15.94	15.94	15.94	15.93	15.94	15.93	15.93	15.93	15.92	15.91	15.91	15.91	15.91	15.85	15.84	15.85
			Depth (m)	0.00	0.25	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50
			DO (%)		85.90	84.00	83.20	82.90	82.60	82.60	82.40	82.20	82.1	81.9	81.7	81.5	81.3	80.9	80.4	64.1
			DO (mg/L)		8.45	8.29	8.22	8.19	8.16	8.16	8.14	8.12	8.11	8.1	8.07	8.06	8.04	8	7.96	5.64
			SPC (uS/cm)		202.00	202.00	202.00	202.00	202.00	202.00	202.00	202.00	202	202	202	202	202	202	202	202
			pH		7.61	7.54	7.54	7.45	7.42	7.4	7.38	7.36	7.35	7.33	7.32	7.31	7.29	7.28	7.11	7.25