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Nitrogen, Phosphorus, and Suspended Solids Concentrations in Tributaries to the Great Bay Estuary in 2019

Kalle Matso
University of New Hampshire

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Final Report

Submitted by

Kalle Matso
Piscataqua Region Estuaries Partnership
Durham, NH

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Introduction

Nitrogen, phosphorus, and sediment loads to the Great Bay Estuary are a constant concern. The Piscataqua Region Estuaries Partnership (PREP) calculates the nitrogen load from tributaries to the Great Bay Estuary for its State of Our Estuaries reports. Therefore, the purpose of this study was to collect representative data on nitrogen, phosphorus, and suspended solids concentrations in tributaries to the Great Bay Estuary in 2019. The study design followed the tributary sampling design, which was implemented by the New Hampshire Department of Environmental Services (NHDES) between 2001 and 2007 and sustained by the University of New Hampshire (UNH) from 2008 to the present, so as to provide comparable data to the previous loading estimates. The purpose of this memorandum is to document the results of quality assurance checks on the 2019 water quality data collected by UNH for the Great Bay Estuary Tidal Tributary Monitoring Program, so that PREP can calculate the nitrogen load from tributaries to the Great Bay Estuary. This program was previously established in the NHDES Environmental Monitoring Database with a project identifier of "GBETTMP." PREP reviewed these data to ensure that they met data quality objectives for PREP and for Section 305b water quality assessments.

Methods

Sampling and Analytical Methods

The field sampling and laboratory analysis methods have been documented in the approved Quality Assurance Project Plan or QAPP (Matso et al., 2019): https://scholars.unh.edu/prep/418/

UNH researchers collected grab samples from the head-of-tide stations in the freshwater portion of eight tributaries to the Great Bay Estuary (Figure 1 & Table 11) on a monthly frequency from March to December. The samples were analyzed for total dissolved nitrogen (TDN), total phosphorus (TP), orthophosphate (PO_4), total suspended solids (TSS), ammonium (NH_4), nitrate/nitrite (NO_3/NO_2), total suspended nitrogen (PN), dissolved organic nitrogen (DON), and non-purgeable organic carbon, which is equivalent to dissolved organic carbon (DOC). A total of 9 field duplicate samples were collected for each parameter (one station per sampling date) for quality assurance.

The Water Quality Analysis Laboratory at UNH used USGS Method I-4650-03 (alkaline persulfate digestion) to determine TP and high temperature catalytic oxidation (Merriam et al., 1996) to determine the TDN concentrations in samples. TSS concentrations were calculated using EPA method 160.2. NO_3/NO_2 concentration was determined using EPA method 353.2 and NH_4 using EPA method 350.1. PN was determined using EPA method 440.0. DOC was determined using EPA method 415.1. PO_4 was measured using EPA method 365.2. DON was calculated by subtracting NO_3/NO_2 and NH_4 from TDN.

DOC is not a required parameter in the approved QAPP (Matso et al., 2019). Measurements of DOC were collected as ancillary data. The DOC results were quality assured using the methods and objectives in the QAPP.

Physicochemical parameters (water temperature, specific conductance, dissolved oxygen, and pH) were measured in the field using a YSI Pro DSS multi-parameter instrument. A total of 9

field duplicate readings were collected for each parameter (one station per sampling date) for quality assurance; in 2019, the month of August did not have a duplicate sample because the pre-assigned location could not be accessed due to construction.

Quality Assurance Audit

UNH provided the field and laboratory data to PREP to be quality assured; the data were then sent to NHDES to be added to the Environmental Monitoring Database: https://www.des.nh.gov/resource-center/data-and-mapping/EMD

Field sampling proceeded as planned.

- 85 of the 90 planned samples were collected for laboratory analysis (94%). Four missed samples were due to work being done on the platform at Great Works River and one sample was missed at the Oyster River due to ice. This meets the data quality objective for completeness (equal to or greater than 90% of planned samples).

The results of quality control samples for TDN, TP, TSS, PN, NO_3/NO_2, NH_4, DOC, PO_4, and DON have been summarized in Tables 1 through 9. All of the data quality objectives for laboratory results for the study were substantially met. There were no major deviations from the planned laboratory methods.

Field Duplicate Samples

Below, relative percent difference (RPD) is calculated as:

$$RPD = \frac{|x_1 - x_2|}{\left(\frac{x_1 + x_2}{2}\right)} \times 100\%$$

- Total Dissolved Nitrogen: All data quality objectives met.
- Phosphorus: All data quality objectives met.
- Suspended Solids: All data quality objectives met.
- Total Suspended Nitrogen: All data quality objectives met.
- Ammonium: One of the 10 field duplicates had RPD values greater than the data quality objectives (<30%). The duplicate pair collected in the Salmon Falls River (station 05-SFR) on 9/25/2019 had an RPD value of 96% (2.251 and 0.789 ug N/L). These data were invalidated.
- Dissolved Organic Carbon: All data quality objectives met.
- Orthophosphate: All data quality objectives met.
- Dissolved Organic Nitrogen: All data quality objectives met.
- Nitrate/Nitrite: All data quality objectives met.

Laboratory Quality Control Samples

The results of laboratory QC tests are shown on Tables 1 through 9, measured by RPD and % recovery, calculated as:

$$R = \frac{|x_1 - x_2|}{(x_2)} \times 100\%$$

All of the instances where QC results did not meet data quality objectives were for low concentrations (<10x minimum detection limit (MDL)) or below the MDL, which is acceptable.

Logical Tests

Laboratory results for nitrogen and phosphorus species were checked to verify that dissolved species were not greater than total species.

- TN vs. TDN: TN should be greater than or equal to TDN. Out of the 85 results for TN and TDN, there were no results that had higher TDN values than TN.
- TDN vs. NO_3/NO_2 + NH_4: TDN should be greater than or equal to the sum of NO_3/NO_2 and NH_4. Out of 85 samples for NO_3/NO_2 + NH_4 and TDN, there were no results that had higher NO_3/NO_2 + NH_4 than TDN.
- TP vs. PO_4: TP should be greater than or equal to PO_4. Out of 85 samples for TP and PO_4, there were no results that had higher PO_4 than TP.

Results Below Reporting Limits

Reporting Limits (RLs) have been established by the UNH lab. Values lower than the RL are shown as "<[RL]" in Table 10. For example, if the RDL is 0.1 and the returned value was 0.05, the value in Table 10 will show "<0.1." The RLs for the parameters are as follows: TDN = 0.05 mg N/L; TP = 0.007 mg P/L; TSS = 1.00 mg/L; PN (Total Suspended Nitrogen) = 0.01 mg N/L; NO_3/NO_2 = 0.005 mg N/L; NH_4 = 0.005 mg N/L; DOC = 0.1 mg C/L; PO_4 = 0.001 mg P/L; DON = 0.05 mg N/L.

Five results (all for NH_4) were flagged (i.e., censored) as being below the RL. These results are noted in Table 10. While results below the RL are not necessarily invalid, they are regarded as less accurate than results at or above the RL.

Consistency/Comparability

The ranges of concentrations measured in 2019 were consistent with previous sampling efforts at these sites. Time series plots of the data at different stations were used to identify any unusual results.

Results and Discussion

The quality assured results for TP, TDN, TSS, NO_3/NO_2, NH_4, PN, PO_4, DON, and DOC concentrations, as well as the field parameters for each station visit are shown in Tables 1 through 9. Figures 2 through 10 show the monthly concentrations for each analyte at each station.

The purpose of this memorandum is to document the results of quality assurance checks on the 2019 water quality data collected by UNH, so that PREP can calculate the nitrogen load from

tributaries to the Great Bay Estuary. The following are some general observations, which can be made based on the quality assured data:

- The concentrations of TDN across stations and dates ranged from 0.28 to 0.83 mg N/L. The maximum concentrations most often occurred in the Cocheco River (station 07-CCH) and the Bellamy River (station 05-BLM).

- The concentrations of TP across stations and dates ranged from 0.011 to 0.121 mg P/L. The maximum concentrations most often occurred in the Cocheco River (station 07-CCH).

- The TSS concentrations ranged from 1.00 to 21.88 mg/L. The highest concentrations were in the Bellamy River (station 05-BLM) and the Oyster River (station 05-OYS).

- The concentrations of PN across stations and dates ranged from 0.02 to 0.20 mg N/L. The maximum concentrations occurred in the Bellamy River (station 05-BLM) and the Oyster River (station 05-OYS).

- The concentrations of NO_3/NO_2 across stations and dates ranged from 0.035 to 0.600 mg N/L. Concentrations in the Cocheco River (station 07-CCH) were highest, followed by concentrations in the Salmon Falls River (station 05-SFR).

- The concentrations of NH_4 across stations and dates ranged from <0.005 to 0.079 mg N/L. Concentrations in the Oyster River (station 05-OYS) were higher than any other stations during the summer. Otherwise, the stations were similar.

- The concentrations of DOC across stations and dates ranged from 3.90 to 9.77 mg C/L. Concentrations in the Winnicut River (station 02-WNC) were slightly higher than other stations.

- The average concentrations of PO_4 across stations and dates ranged from <0.001 to 0.104 mg P/L. The maximum concentrations occurred in the Cocheco River (station 07-CCH).

- The concentrations of DON across stations and dates ranged from 0.15 to 0.39 mg N/L. Concentrations in the Winnicut River (station 02-WNC) were slightly higher than other stations.

Summary

The 2019 water quality data for the GBETTMP project was checked by PREP for potential errors. All quality control steps and changes to the dataset have been documented in this memo.

References

Matso, Kalle; Shattuck, Michelle; and Potter, Jody, "Great Bay Estuary Tidal Tributary Monitoring Program (GBETTMP): Quality Assurance Project Plan 2019 - 2023" (2019). *PREP Reports & Publications*. 418. https://scholars.unh.edu/prep/418

Merriam, J.L, W.H. McDowell, and W.S. Currie. 1996. A high-temperature catalytic oxidation technique for determining total dissolved nitrogen. *Soil Science Society of America Journal* 60: 1050-1055.

Table 1: Summary of Quality Control Samples for Total Dissolved Nitrogen.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	11 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	11 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TDN concentrations in 2019 (0.28 – 0.83 mg N/L) was within the range from 2008-2015 (0.17 – 2.92 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 2: Summary of Quality Control Samples for Total Phosphorus.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	13 Lab Duplicates / 2 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	13 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TP concentrations in 2019 (0.011 – 0.121 mg P/L) was similar to the range from 2001-2015 (0.003 – 0.162 mg P/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 3: Summary of Quality Control Samples for Total Suspended Solids.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of TSS concentrations in 2019 (1.00 – 21.88 mg/L) was within the range from 2001-2015 (1 – 57 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 4: Summary of Quality Control Samples for Total Suspended Nitrogen.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	12 CRM tests / 0 Failed DQO **NO DATA** for LFM tests
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of PN in 2019 (0.02 – 0.20 mg N/L) was similar to the range from 2001-2015 (0.03 – 0.33 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 5: Summary of Quality Control Samples for Nitrate/Nitrite.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	16 Lab Duplicates / 1 Failed DQO The failures were for samples with low concentrations (<10x MDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	33 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of NO_3/NO_2 concentrations in 2019 (0.035 – 0.600 mg N/L) was within the range from 2009-2015 (0.005 – 2.52 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 6: Summary of Quality Control Samples for Ammonium.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 1 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	13 Lab Duplicates / 4 Failed DQO The failures were for samples with low concentrations (<10x MDL)
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	18 CRM tests / 0 Failed DQO 5 LFM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of NH_4 concentrations in 2019 (<0.005 – 0.079 mg N/L) was similar to the range from 2009-2015 (0.005 – 0.158 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 7: Summary of Quality Control Samples for Dissolved Organic Carbon.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	14 Lab Duplicates / 0 Failed DQO
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	18 CRM tests / 0 Failed DQO
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of DOC in 2019 (3.90 – 9.77 mg C/L) was similar to the range from 2011-2015 (2.27 – 15.3 mg C/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 8: Summary of Quality Control Samples for Orthophosphate.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Duplicates / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of PO_4 in 2019 (<0.001 – 0.104 mg P/L) was within the range from 2011-2015 (<0.005 – 0.340 mg/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 9: Summary of Quality Control Samples for Dissolved Organic Nitrogen.

Data Quality Indicators	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Results
Precision-Overall	RPD < 30%	Field Duplicates	9 Field Dupes / 0 Failed DQO
Precision-Lab	RPD < 15%	Lab Duplicates	**NO DATA**
Accuracy/Bias	RPD < 15% >85% and <115% recovery	Certified Reference Material Samples Laboratory Fortified Matrix Samples	**NO DATA**
Comparability	Measurements should follow standard methods that are repeatable	NA	The range of DON in 2019 (0.15 – 0.39 mg N/L) was similar to the range from 2010-2015 (<0.09 – 0.52 mg N/L).
Sensitivity	Not expected to be an issue for this project	NA	NA
Data Completeness	Valid data for 90% of planned samples (9 samples at each tributary)	Data Completeness Check	85 routine samples including 9 field duplicates were collected (94% of planned samples)

Table 10: Validated Laboratory Results and Field Data at Tributary Stations. Table caption explains highlighting, etc.

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	NH_4 (mg N/L)	TDN (mg N/L)	NO_2 + NO_3 (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (ug N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
02-GWR	27-Mar	5.59	12.8	94.9	0.049	0.34	0.087	0.21	0.136	51.47	6.7	0.038	0.026	1.96	114.7	2.8
02-GWR	24-Apr	8.44	9.7	89.0	0.020	0.39	0.085	0.28	0.105	59.90	6.6	0.014	0.009	3.33	108.4	11.5
02-GWR	22-May	6.40	8.3	87.2	0.012	0.31	0.080	0.22	0.091	60.63	6.7	0.036	0.006	3.92	134.4	17.5
02-GWR	26-Jun	7.15	6.8	75.1	0.044	0.37	0.122	0.20	0.167	60.90	6.6	0.043	0.006	3.00	146.6	20.4
02-GWR	24-Jul	8.45	6.8	76.9	0.026	0.39	0.107	0.26	0.132	130.76	6.6	0.044	0.020	7.06	141.3	21.2
02-GWR	27-Nov	8.90	12.6	94.5	0.009	0.29	0.076	0.21	0.084	40.77	6.4	0.036	0.003	3.00	121.6	3.3
02-GWR	18-Dec	6.80	14.0	101.7	0.008	0.32	0.116	0.20	0.124	21.34	8.0	0.024	0.006	1.40	105	2.8
02-WNC	27-Mar	5.35	12.6	93.7	0.012	0.42	0.209	0.19	0.221	35.47	6.8	0.030	0.011	2.03	304.3	2.9
02-WNC	24-Apr	8.63	9.8	89.8	0.018	0.49	0.159	0.32	0.178	98.41	6.9	0.016	0.010	6.36	316.9	11.4
02-WNC	22-May	8.50	7.9	80.8	0.039	0.54	0.185	0.32	0.223	61.86	7.1	0.043	0.020	2.72	369.8	16.3
02-WNC	22-May	8.62	7.8	79.8	0.042	0.54	0.185	0.31	0.226	65.04	7.1	0.040	0.024	2.82	370.5	16.4
02-WNC	26-Jun	9.77	7.2	77.9	0.056	0.67	0.226	0.39	0.282	51.83	7.1	0.066	0.023	2.86	418.5	19.2
02-WNC	24-Jul	9.46	7.3	80.8	0.039	0.56	0.143	0.38	0.183	79.67	7.0	0.066	0.033	5.24	360.4	20.4
02-WNC	28-Aug	7.22	7.0	75.0	0.034	0.61	0.217	0.36	0.252	55.28	7.2	0.046	0.001	2.09	491.5	18.9
02-WNC	25-Sep	6.18	7.6	79.3	0.028	0.38	0.124	0.23	0.151	56.37	7.3	0.032	0.009	3.41	503	17.4
02-WNC	23-Oct	9.49	9.1	83.6	*<0.005*	0.42	0.112	0.31	0.113	85.76	6.7	0.053	0.028	7.65	433.3	11.7
02-WNC	27-Nov	9.17	12.7	93.3	0.014	0.59	0.183	0.39	0.197	67.59	7.0	0.050	0.009	5.29	195.7	3.0
02-WNC	18-Dec	7.67	13.4	97.3	0.011	0.50	0.231	0.26	0.242	23.37	7.2	0.030	0.007	1.41	249.5	2.1
05-BLM	27-Mar	4.77	13.3	102.5	0.013	0.33	0.122	0.19	0.136	63.98	6.7	0.042	0.005	1.50	176.2	4.4
05-BLM	24-Apr	6.46	10.2	99.9	0.013	0.33	0.069	0.25	0.082	67.55	6.9	0.011	0.005	4.48	146	14.4
05-BLM	22-May	6.31	9.4	100.6	0.027	0.36	0.079	0.25	0.106	77.91	7.0	0.035	0.009	3.11	179.2	18.9
05-BLM	26-Jun	5.84	9.2	104.7	0.055	0.53	0.217	0.25	0.272	62.48	7.3	0.042	0.006	10.00	244.5	21.7
05-BLM	24-Jul	7.01	8.3	99.9	0.012	0.38	0.083	0.29	0.095	92.68	6.8	0.035	0.007	6.32	178.5	24.9
05-BLM	24-Jul	7.61	8.6	103.9	0.012	0.40	0.078	0.31	0.089	106.58	6.9	0.035	0.008	6.32	178.6	25.0
05-BLM	28-Aug	6.02	9.4	104.8	0.025	0.40	0.180	0.19	0.204	48.08	7.5	0.032	0.004	3.67	256.4	21.0
05-BLM	25-Sep	6.51	9.4	100.4	0.011	0.39	0.128	0.25	0.139	57.70	7.3	0.066	0.007	3.24	239.6	18.4
05-BLM	23-Oct	6.62	9.3	87.6	0.010	0.43	0.151	0.27	0.160	204.38	6.6	0.053	0.028	21.88	235.5	12.7
05-BLM	27-Nov	8.27	12.8	99.1	0.022	0.35	0.091	0.24	0.113	84.47	6.1	0.041	0.002	8.67	179.2	4.7
05-BLM	18-Dec	6.97	13.8	100.2	0.021	0.33	0.131	0.18	0.151	176.52	7.0	0.039	0.004	3.64	151.7	2.3
05-LMP	27-Mar	4.18	13.6	100.2	0.012	0.31	0.101	0.20	0.114	42.72	6.7	0.024	0.012	1.01	123.4	2.9

Table 10 (cont'd): Validated Laboratory Results and Field Data at Tributary Stations

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (ug N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
05-LMP	27-Mar	4.29	13.2	99.0	0.014	0.30	0.102	0.19	0.116	44.55	6.7	0.027	0.011	1.25	127.1	3.2
05-LMP	24-Apr	5.56	10.1	96.2	0.012	0.30	0.074	0.22	0.087	59.13	6.8	0.025	0.014	2.37	133.2	13.4
05-LMP	22-May	4.57	9.0	94.0	0.021	0.31	0.075	0.21	0.096	45.88	7.0	0.030	0.008	1.00	144.2	17.4
05-LMP	26-Jun	5.55	8.2	92.2	0.043	0.45	0.186	0.22	0.229	44.52	6.9	0.035	0.005	1.59	166.3	21.3
05-LMP	24-Jul	6.03	6.2	73.5	0.036	0.36	0.120	0.20	0.156	75.46	6.7	0.050	0.011	3.21	188.4	24.3
05-LMP	28-Aug	5.90	6.0	67.5	0.013	0.38	0.123	0.24	0.136	72.97	6.6	0.025	0.007	1.32	211	21.6
05-LMP	25-Sep	6.23	8.1	88.1	*<0.005*	0.29	0.035	0.25	0.038	97.54	7.0	0.024	0.005	1.89	227.4	19.3
05-LMP	23-Oct	5.98	9.3	85.3	*<0.005*	0.28	0.065	0.22	0.068	69.79	6.5	0.112	0.031	3.16	185.2	11.6
05-LMP	27-Nov	6.70	12.5	94.9	0.017	0.35	0.131	0.20	0.148	16.06	6.4	0.029	0.008	1.67	160	4.0
05-LMP	27-Nov	6.74	12.4	94.8	0.013	0.36	0.133	0.21	0.145	19.03	6.4	0.032	0.007	1.67	159.1	4.1
05-LMP	18-Dec	6.78	12.6	96.3	0.011	0.32	0.126	0.18	0.136	38.91	7.4	0.029	0.006	1.25	98	4.3
05-OYS	27-Mar	4.67	13.0	97.8	0.016	0.35	0.135	0.20	0.151	151.68	6.1	0.031	0.014	10.00	200.3	3.2
05-OYS	24-Apr	7.09	10.0	92.6	0.023	0.42	0.137	0.26	0.160	72.89	6.8	0.021	0.011	5.71	213	12.1
05-OYS	22-May	5.14	8.5	87.8	0.022	0.33	0.119	0.19	0.141	57.74	7.1	0.044	0.011	4.00	239.4	16.8
05-OYS	26-Jun	6.59	6.7	73.8	0.073	0.54	0.258	0.21	0.331	72.41	6.9	0.045	0.012	2.50	279.9	19.8
05-OYS	26-Jun	6.69	6.8	74.3	0.072	0.55	0.266	0.21	0.339	61.28	6.9	0.048	0.014	2.50	280.6	19.9
05-OYS	24-Jul	7.87	7.0	78.3	0.079	0.63	0.227	0.33	0.306	172.39	6.8	0.060	0.041	14.44	213	20.8
05-OYS	28-Aug	6.29	5.5	60.5	0.019	0.35	0.064	0.27	0.082	154.82	6.7	0.039	0.002	3.93	337.1	19.8
05-OYS	25-Sep	5.94	8.5	88.1	0.007	0.35	0.048	0.29	0.055	188.13	7.2	0.035	0.006	5.16	325.7	17.2
05-OYS	23-Oct	7.67	8.0	73.8	0.017	0.37	0.116	0.24	0.133	103.82	6.7	0.075	0.044	5.00	279.3	11.8
05-OYS	27-Nov	7.84	12.3	91.8	0.014	0.40	0.178	0.21	0.192	35.81	7.0	0.050	0.007	3.10	196.9	3.1
05-SFR	27-Mar	5.10	14.5	105.5	0.031	0.31	0.102	0.18	0.133	49.13	6.7	0.028	0.009	1.11	113.8	2.3
05-SFR	24-Apr	5.75	10.9	101.2	0.020	0.29	0.095	0.17	0.115	59.56	6.8	0.019	0.012	1.85	94.2	12.0
05-SFR	22-May	4.67	9.8	100.6	0.031	0.31	0.135	0.15	0.167	63.84	7.0	0.028	0.021	1.61	123.2	16.6
05-SFR	26-Jun	6.32	8.3	97.0	0.029	0.42	0.194	0.19	0.222	67.73	6.9	0.030	0.002	1.92	132.4	23.3
05-SFR	24-Jul	6.77	7.1	86.6	0.044	0.54	0.253	0.24	0.297	80.75	6.7	0.038	0.009	5.50	166.7	25.4
05-SFR	28-Aug	7.83	8.2	93.8	0.013	0.54	0.319	0.20	0.331	149.65	6.9	0.033	0.001	5.00	158.5	22.1
05-SFR	25-Sep	7.83	8.4	93.4	**<0.005**	0.70	0.413	0.29	0.415	146.71	7.1	0.045	0.006	3.42	203.4	20.5
05-SFR	25-Sep	7.51	8.4	92.8	*<0.005*	0.68	0.397	0.28	0.398	148.76	7.1	0.039	0.005	2.80	203.3	20.5
05-SFR	23-Oct	7.59	10.0	92.4	0.011	0.32	0.109	0.20	0.120	71.79	6.6	0.032	0.006	3.75	126.8	11.8

Table 10 (cont'd): Validated Laboratory Results and Field Data at Tributary Stations

Station ID	Collection Date	DOC (mg C/L)	DO (mg/l)	DO (%)	NH_4 (mg N/L)	TDN (mg N/L)	$NO_2 + NO_3$ (mg N/L)	DON (mg N/L)	DIN (mg N/L)	PN (ug N/L)	pH	TP (mg P/L)	PO_4 (mg P/L)	TSS (mg/L)	Spec. Cond (uS/cm)	Temp. (°C)
05-SFR	27-Nov	7.15	12.8	97.7	0.030	0.38	0.128	0.22	0.158	32.74	6.5	0.031	0.007	2.11	114.9	4.2
05-SFR	18-Dec	6.02	14.9	103.7	0.021	0.31	0.116	0.17	0.137	34.11	7.0	0.036	0.004	1.94	102.5	2.1
07-CCH	27-Mar	4.16	13.5	101.8	0.020	0.39	0.204	0.16	0.224	51.09	6.7	0.039	0.024	1.56	153.4	3.4
07-CCH	24-Apr	5.23	10.5	99.2	0.017	0.37	0.152	0.20	0.170	71.78	6.8	0.024	0.013	4.81	142.3	13.0
07-CCH	22-May	3.90	9.5	97.3	0.020	0.42	0.220	0.18	0.240	59.72	7.1	0.042	0.028	1.03	180.2	16.9
07-CCH	26-Jun	5.04	8.4	94.9	0.031	0.63	0.381	0.22	0.412	90.62	7.0	0.056	0.020	2.06	189.8	21.2
07-CCH	24-Jul	5.30	8.0	92.2	0.069	0.82	0.565	0.19	0.634	73.70	7.0	0.108	0.104	6.96	264.1	22.7
07-CCH	28-Aug	6.67	8.1	91.9	0.020	0.54	0.262	0.26	0.282	53.80	6.9	0.121	0.071	2.22	186.4	21.5
07-CCH	25-Sep	4.60	8.9	98.1	*<0.005*	0.78	0.600	0.18	0.601	79.22	7.3	0.121	0.076	2.00	354.3	20.1
07-CCH	23-Oct	5.61	10.2	92.3	0.007	0.50	0.296	0.20	0.303	91.41	6.6	0.078	0.055	6.71	173.7	10.9
07-CCH	23-Oct	5.82	10.2	92.1	0.008	0.53	0.319	0.20	0.327	107.53	6.6	0.082	0.061	7.33	173.7	11.3
07-CCH	27-Nov	5.86	12.9	100.2	0.013	0.39	0.197	0.18	0.209	49.30	6.5	0.055	0.017	3.48	137.3	4.6
07-CCH	18-Dec	5.79	13.8	99.7	0.014	0.38	0.197	0.17	0.211	29.64	6.7	0.035	0.009	1.78	119.4	1.8
09-EXT	27-Mar	4.79	12.8	96.0	0.010	0.28	0.090	0.18	0.100	35.23	6.7	0.026	0.008	1.30	163.1	3.3
09-EXT	24-Apr	7.39	9.3	88.5	0.014	0.37	0.072	0.29	0.086	54.55	6.6	0.026	0.010	4.07	176.4	13.1
09-EXT	24-Apr	7.42	9.4	89.2	0.013	0.38	0.076	0.29	0.090	69.96	6.7	0.029	0.013	4.29	177	13.1
09-EXT	22-May	6.31	7.6	78.2	0.049	0.45	0.095	0.30	0.144	76.30	6.9	0.044	0.013	2.00	199.7	17.1
09-EXT	26-Jun	9.11	7.2	80.2	0.032	0.51	0.170	0.31	0.202	44.88	6.9	0.049	0.018	3.24	213.7	20.8
09-EXT	24-Jul	8.14	6.8	77.6	0.033	0.48	0.126	0.32	0.159	83.64	6.8	0.067	0.031	6.80	225.1	22.3
09-EXT	28-Aug	7.55	7.3	80.6	0.013	0.38	0.088	0.28	0.101	49.85	6.9	0.041	0.005	2.35	249.3	20.5
09-EXT	25-Sep	7.46	8.2	87.7	0.008	0.40	0.122	0.27	0.130	58.35	7.1	0.050	0.045	7.44	255.9	18.4
09-EXT	23-Oct	8.37	8.9	81.1	*<0.005*	0.39	0.091	0.29	0.094	71.60	6.4	0.043	0.019	7.60	228.7	11.3
09-EXT	27-Nov	8.53	11.7	89.2	0.012	0.35	0.119	0.22	0.131	31.68	6.4	0.041	0.007	2.50	188.4	3.9
09-EXT	18-Dec	7.66	13.7	96.7	0.013	0.35	0.144	0.19	0.157	38.81	7.7	0.035	0.009	2.70	145.9	1.2
09-EXT	18-Dec	7.78	13.2	94.4	0.015	0.34	0.146	0.18	0.161	34.58	7.7	0.029	0.007	3.33	143.7	1.4

Bold and underlined values were invalidated through the QA/QC process.
Cells highlighted in yellow indicate duplicate samples.
Red italicized values were below the Reporting Limit (RL). The value is shown as being less than the given RL.

Figure 1: Sampling Locations in the Great Bay Estuary Coastal Basin

Table 11: Sampling Locations in the Great Bay Estuary, Coastal Basin.

Project ID	Station ID	Town	Station Description	Latitude	Longitude
GBETTMP	05-BLM	Dover	Route 108 bridge	43.179894	-70.878219
GBETTMP	05-LMP	Newmarket	Route 108 bridge	43.082056	-70.934961
GBETTMP	05-OYS	Durham	Route 108 bridge	43.130853	-70.918606
GBETTMP	05-SFR	Rollinsford	Route 4 bridge	43.227206	-70.811456
GBETTMP	07-CCH	Dover	Route 9 bridge	43.196489	-70.874139
GBETTMP	09-EXT	Exeter	High Street bridge	42.980923	-70.944114
GBETTMP	02-WNC	Greenland	Route 33 bridge	43.036067	-70.847983
GBETTMP	02-GWR	South Berwick	Brattle Street bridge	43.218870	-70.796660

Figure 2: Total Phosphorus Concentrations (in mg P/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

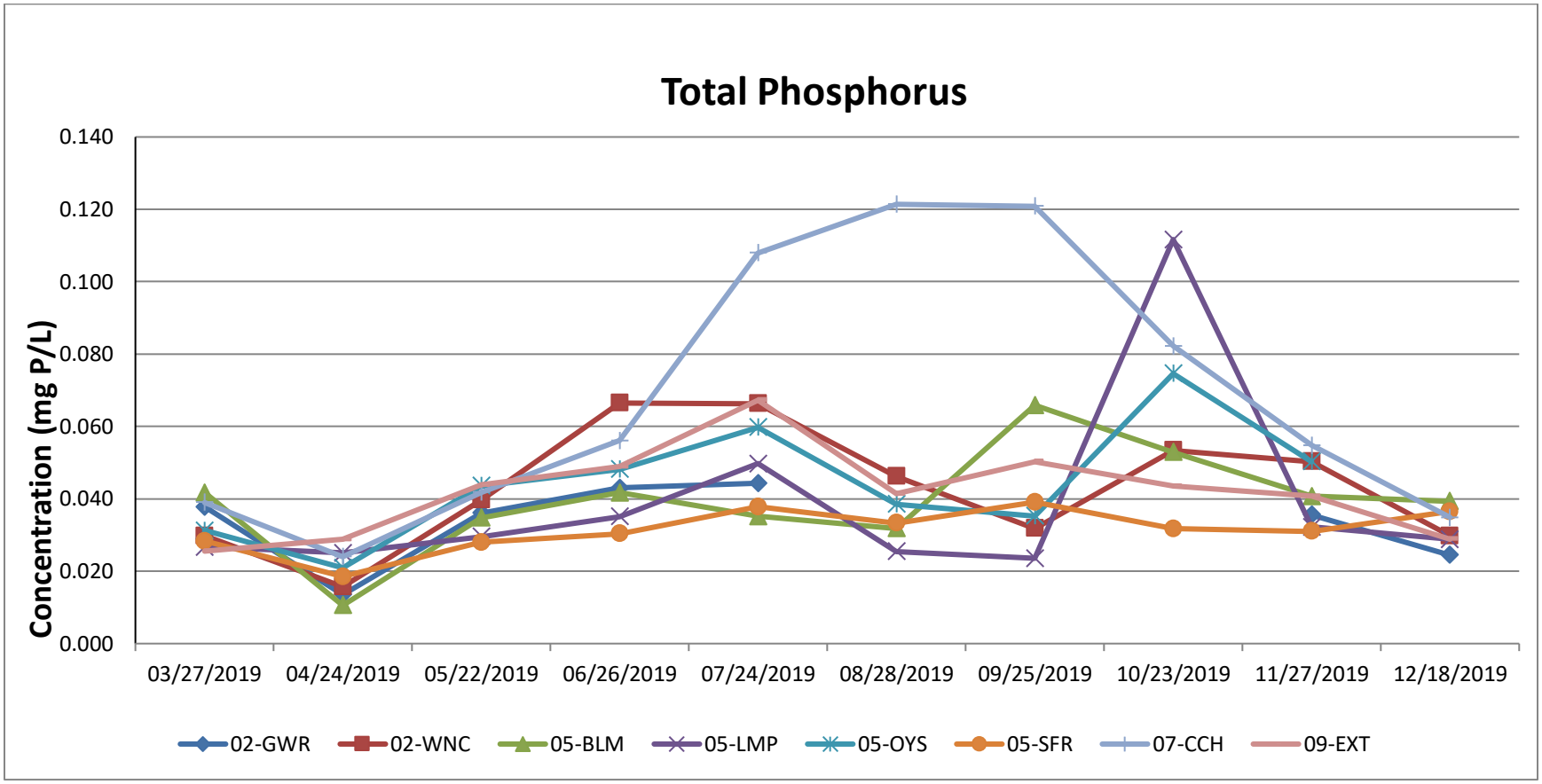

Figure 3: Total Dissolved Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

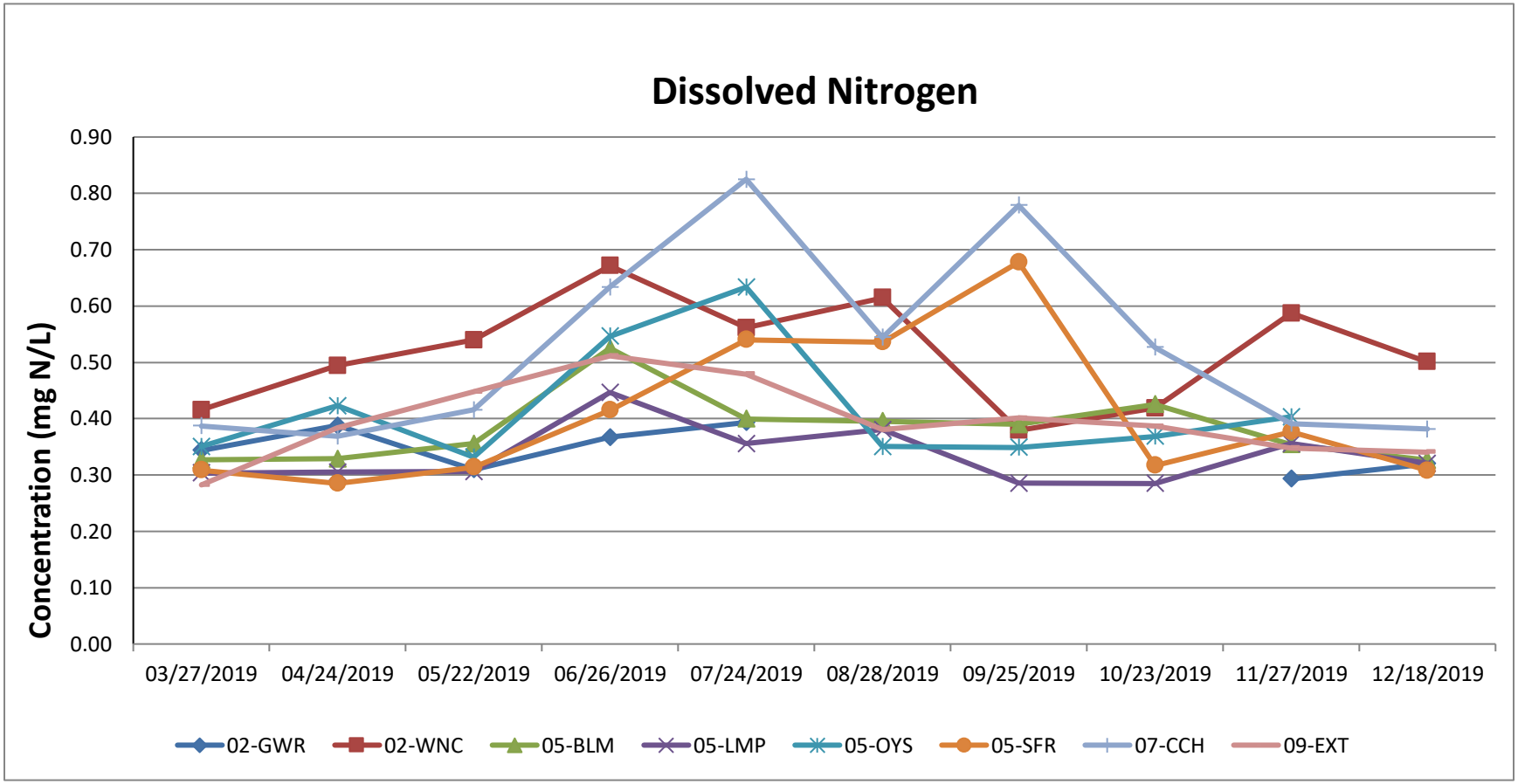

Figure 4: Total Suspended Solids Concentrations (in mg/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

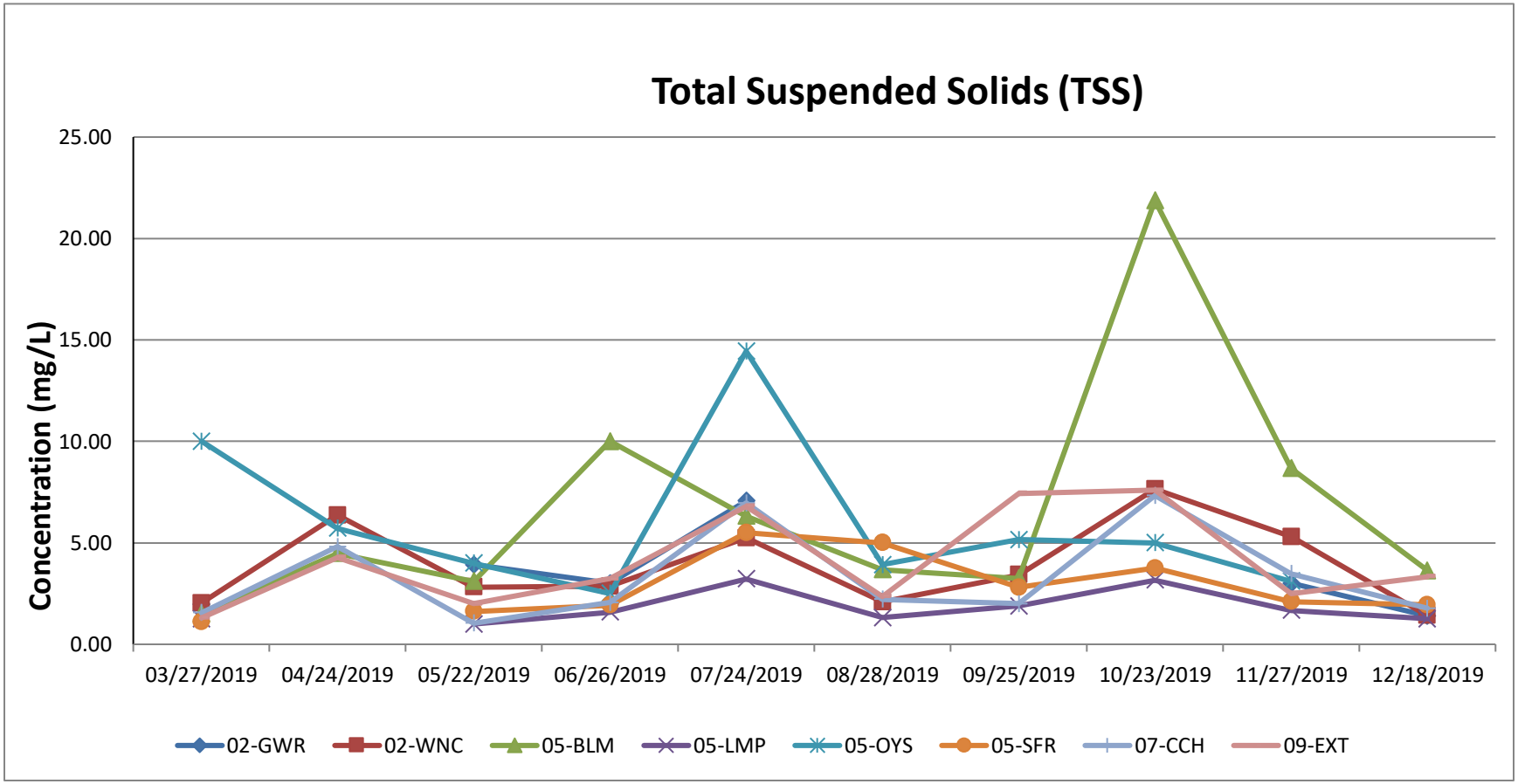

Figure 5: Nitrate/Nitrite Concentrations (in mg N/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

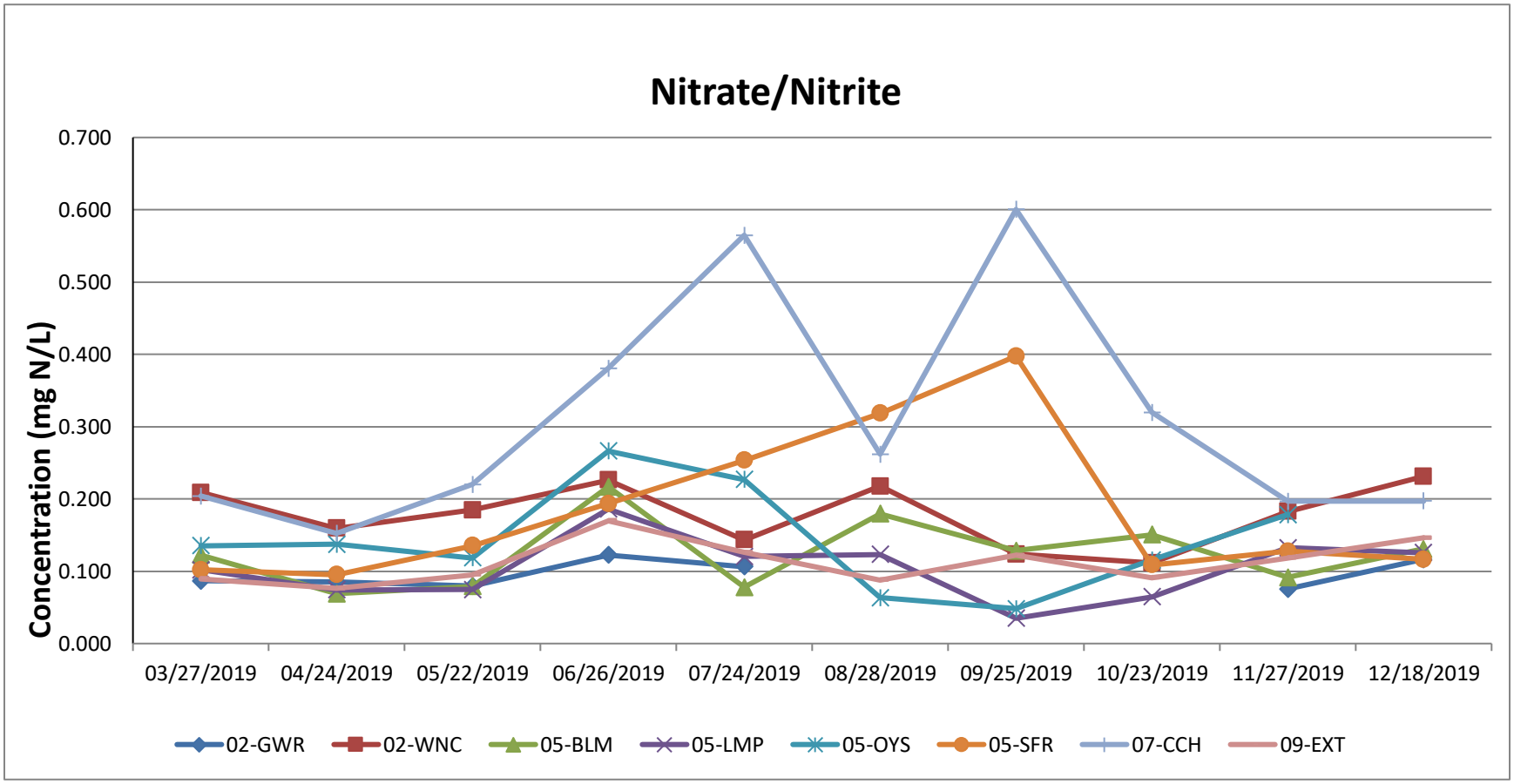

Figure 6: Ammonium Concentrations (in mg N/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice. Station-SFR September data point removed due to failing QA/QC.

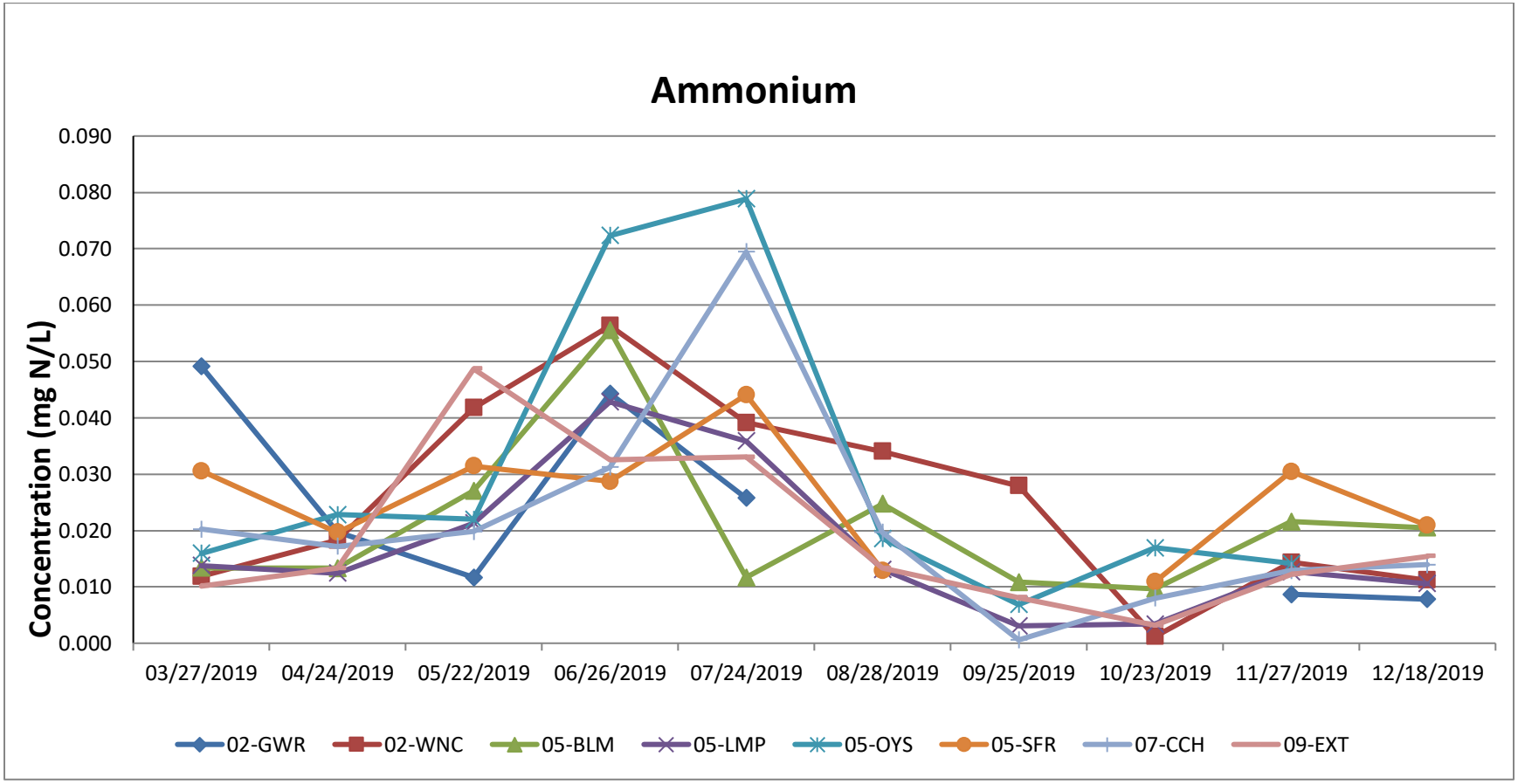

Figure 7: Dissolved Organic Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

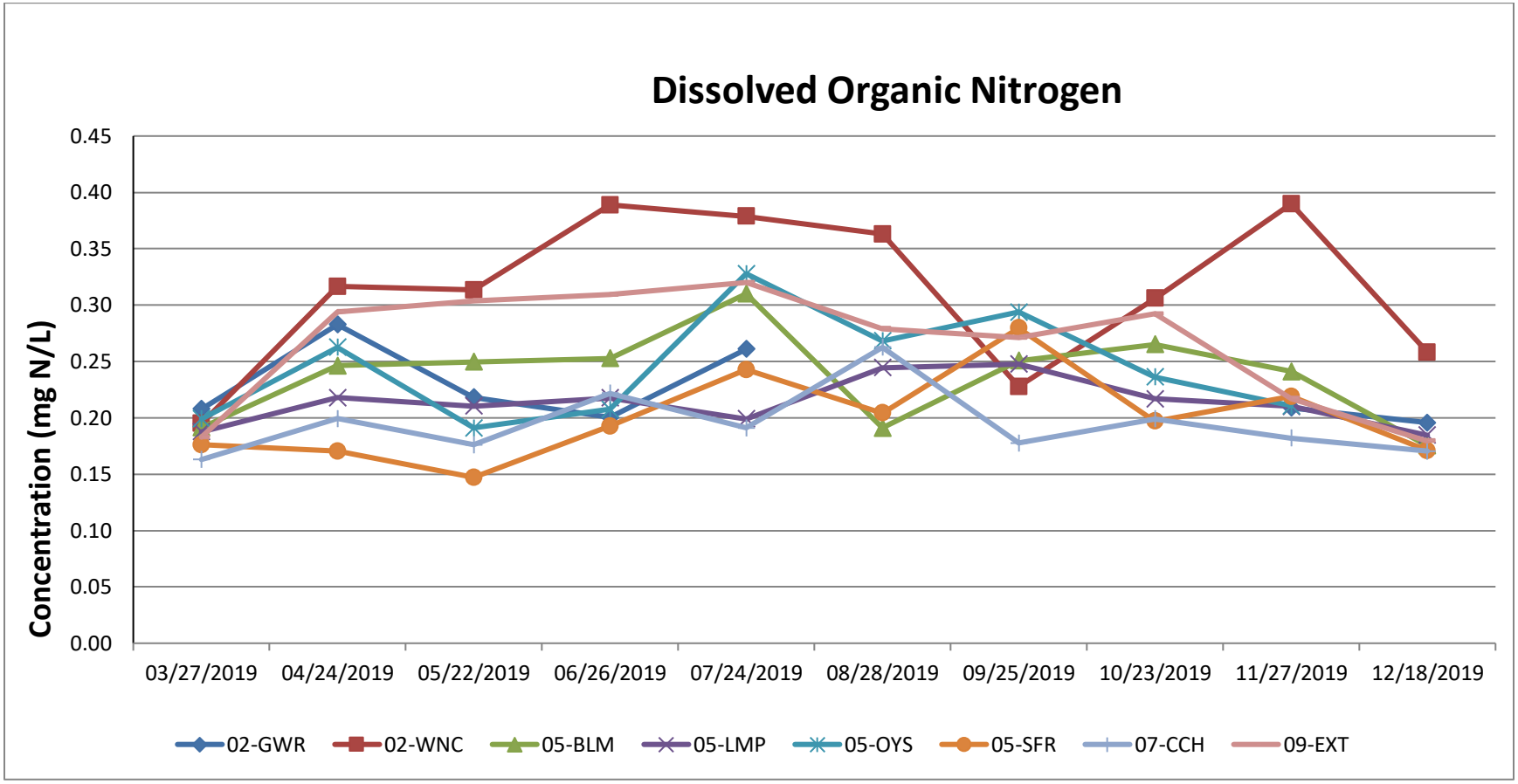

Figure 8: Dissolved Organic Carbon Concentrations (in mg C/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

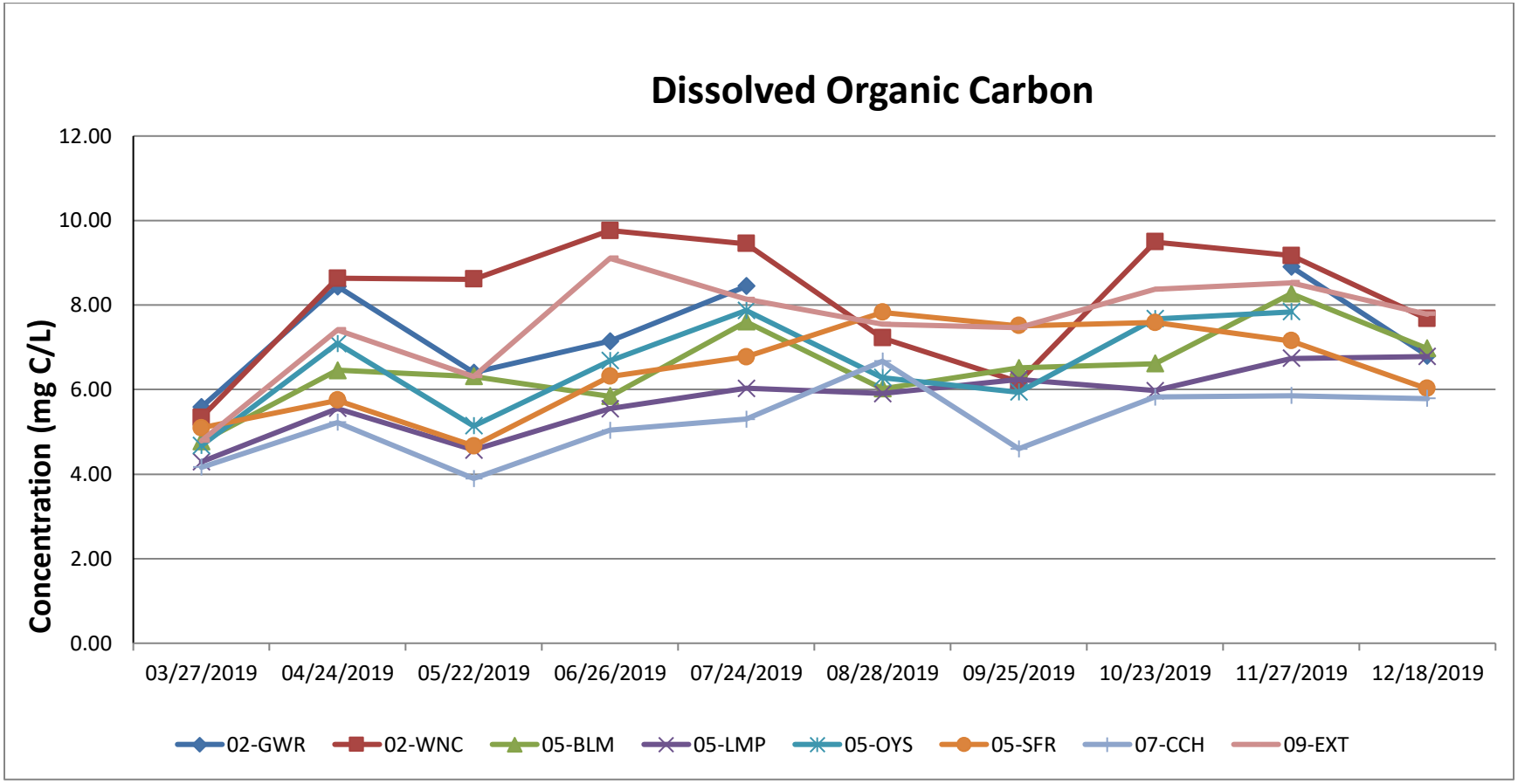

Figure 9: Total Suspended Nitrogen Concentrations (in mg N/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)

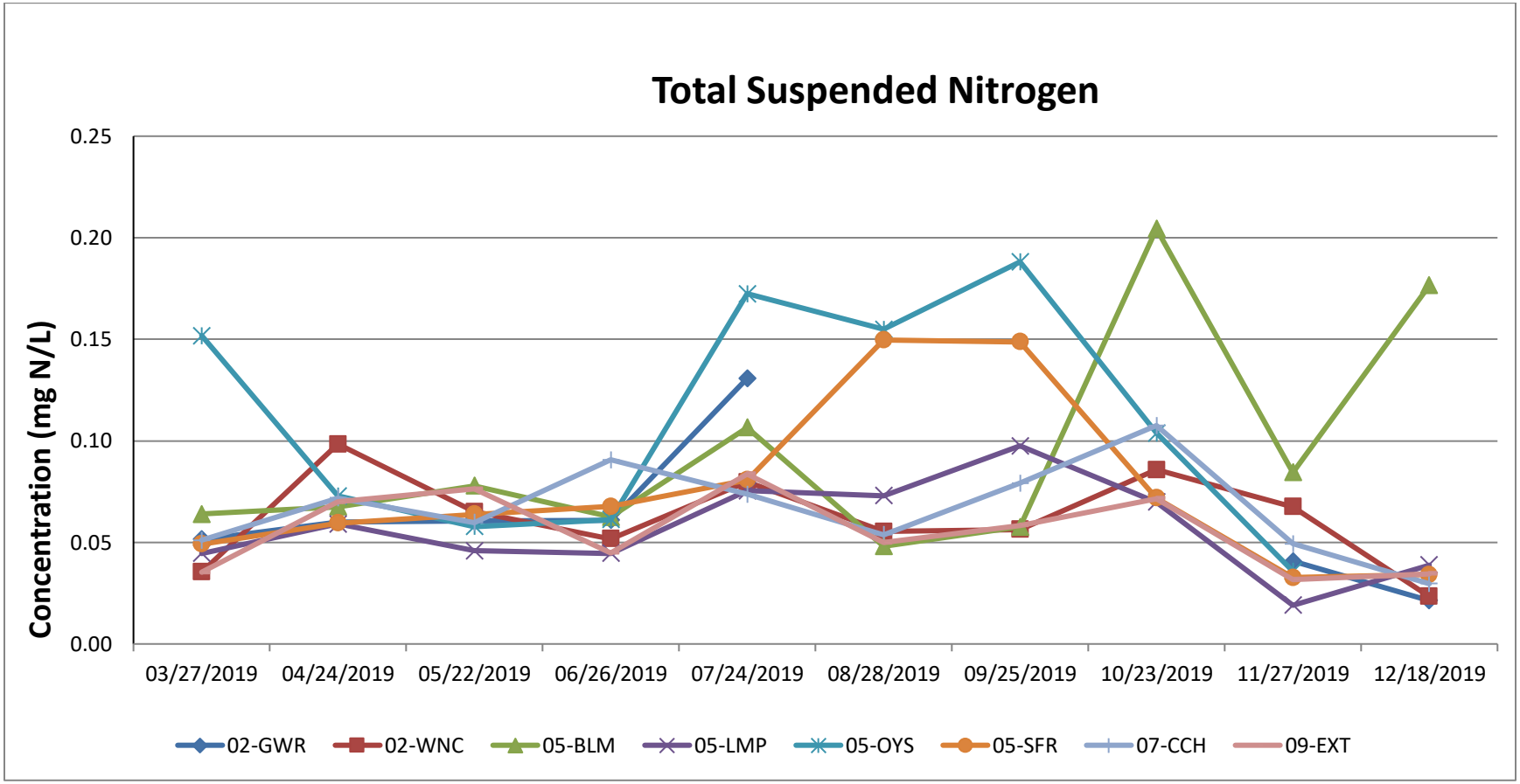

Figure 10: Orthophosphate Concentrations (in mg P/L) at Tributary Stations. (Station 02-GWR missing four data points due to construction impeding access to sampling area. Station 05-OYS missing December data due to ice.)