Appendix D
WQ Monitoring and B-IBI Data

FORBES CREEK
2002-2003
WATER QUALITY MONITORING
DATA

PREPARED BY:
CITY OF KIRKLAND PUBLIC WORKS DEPARTMENT
SURFACE WATER DIVISION

Project Overview

This report presents water quality data collected throughout the Forbes Creek Watershed in Kirkland, Washington. Data was collected by City of Kirkland staff and trained citizen volunteers from March 2002 though December 2003.

In the fall of 2001 the City of Kirkland Department of Public Works became interested in the development of volunteer based stream monitoring program. The goals of this program would be to foster the community based stewardship of the City of Kirkland's water resources while educating the public about environmental issues and gaining valuable data for the future management of the City's water resources. While the volunteer program was being developed City of Kirkland staff began to collect monthly water quality samples at 5 sites within the Forbes Creek Watershed to serve as a baseline for the expanded volunteer monitoring efforts.

The Forbes Creek Water Quality Monitoring data was collected for the following purposes:

- Asses baseline conditions of Forbes Creek
- Measure changes and trends in the health of Forbes Creek
- Provide information for compliance with state and federal stormwater programs that require monitoring (such as National Pollution Discharge Elimination System (NPDES) Phase II stormwater permitting)
- Involve citizens in monitoring and data collection
- Educate citizens about resource and water quality issues

Data Usage

Information gathered during this study would be used by the City of Kirkland to determine areas to focus pollution source control efforts, provide data to meet NPDES Phase II requirements, provide a baseline snapshot of lake conditions to allow for comparison of water quality over time, and data for use in applying for water quality grant funds.

Monitoring Program Overview

Water sampling was conducted monthly at seven (7) locations within Forbes Creek Watershed from March 2002 through December 2003. These individual sampling locations were established in a manner as to afford reasonable baseline conditions.

Samples that were sent out-of-house for analysis were collected with bottles as provided by the contracted testing laboratory in a manner as required by the laboratory and transported following standard Chain-of-Custody procedures for the following parameters: Fecal Coliform, Total Nitrogen (TKN), Ammonia Nitrogen, Nitrate + Nitrite, Total Phosphorus, and Zinc.

Basic water quality tests (temperature, turbidity, pH, dissolved oxygen, and alkalinity) were conducted and data recorded onsite.

The volunteer methods (meters and purchased kits) were chosen to balance the ease of use and accuracy for volunteers with minimal training and cost. Many of the methods chosen were reported to be appropriate for use by other volunteer monitoring programs. The test kits were verified for precision by having concurrent samples collected and analyzed by laboratory analysis using EPA approved test methods.

Standards of Comparison

Water Quality: Washington Administrative Code (WAC) 173-201A mandates water quality standards fro Class A streams. See attached table.

Site #1

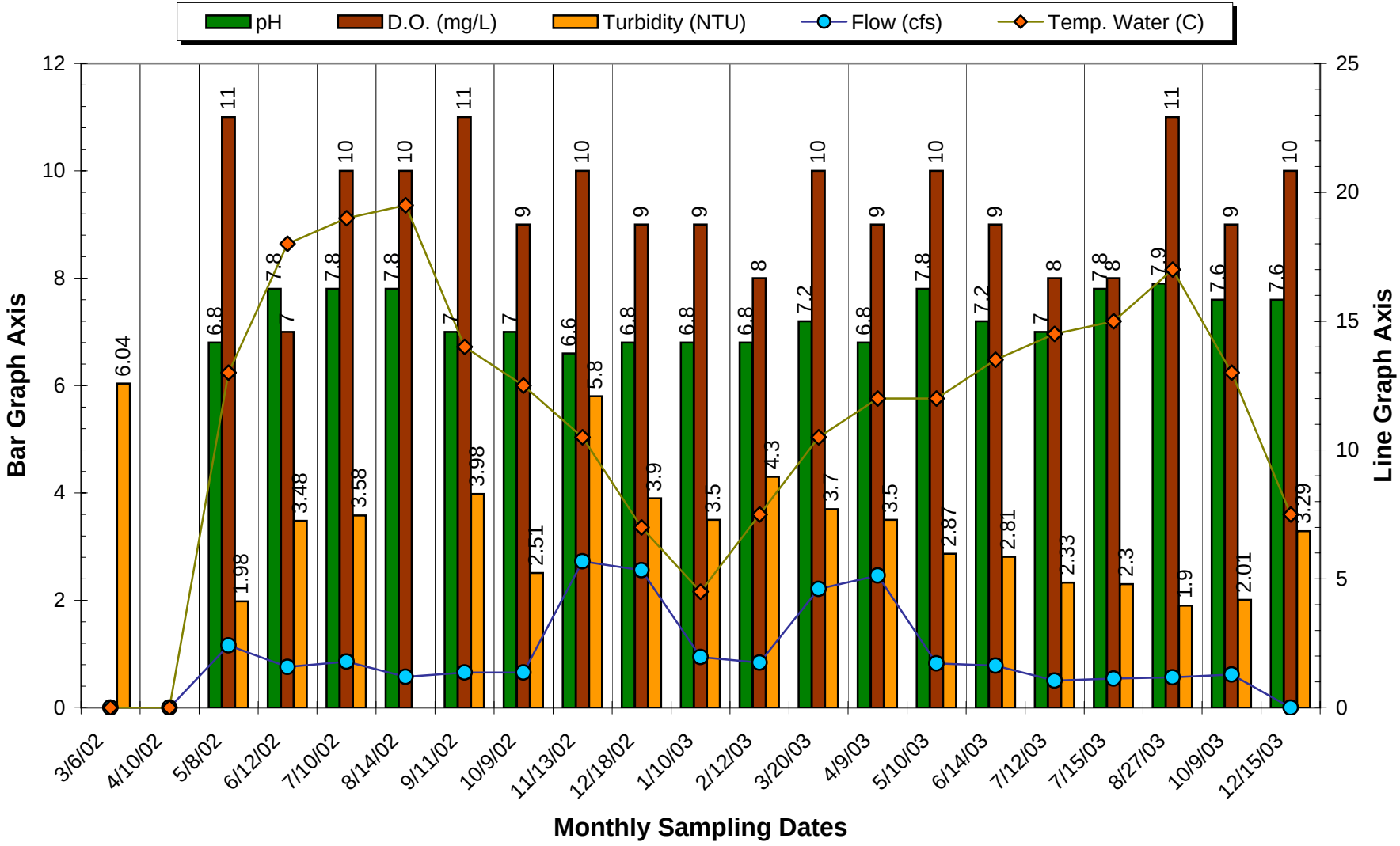
		3/6/02	4/10/02	5/8/02	6/12/02	7/10/02	8/14/02	9/11/02	10/9/02	11/13/02	12/18/02	1/10/03	2/12/03	3/20/03	4/9/03	5/10/03	6/14/03	7/12/03	7/15/03	8/27/03	10/9/03	12/15/03
In-House	Time	13:00	12:15	15:15	13:45	15:30	14:00	10:00	15:05	14:15	14:30	9:20	15:30	15:15	14:15	11:10	9:00	8:34	9:10	14:30	16:36	16:00
	Temp. Air (C)	4	*	20	39	32	28.5	17.5	12	14.5	6	3	7.5	11	17	15	14.5	19	19	25.5	13	6.5
	Temp. Water (C)	*	*	13	18	19	19.5	14	12.5	10.5	7	4.5	7.5	10.5	12	12	13.5	14.5	15	17	13	7.5
	pH	*	*	6.8	7.8	7.8	7.8	7	7	6.6	6.8	6.8	6.8	7.2	6.8	7.8	7.2	7	7.8	7.9	7.6	7.6
	D.O. (mg/L)	*	*	11	7	10	10	11	9	10	9	9	8	10	9	10	9	8	8	11	9	10
	Alkalinity (ppm)	*	*	140	120	80	120	100	100	120	40	80	80	40	80	120	110	100	100	160	100	100
	Total Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Free Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Total Hardenss (ppm)	*	*	120	120	120	120	120	120	120	120	200	120	*	*	*	*	*	*	*	*	*
	Turbidity (NTU)	6.04	*	1.98	3.48	3.58	*	3.98	2.51	5.8	3.9	3.5	4.3	3.7	3.5	2.87	2.81	2.33	2.3	1.9	2.01	3.29
	Flow (cfs)	*	*	2.42	1.58	1.79	1.2	1.37	1.37	5.68	5.34	1.97	1.75	4.61	5.13	1.72	1.63	1.05	1.13	1.18	1.29	*
Laboratory	Fecal Coliform (CFU/100ml)	70	500	270	760	290	180	500	400	100	8	870	9	20	83	120	260	*	560	196	1	35
	Ammonia Nitrogen (mg/L)	0.048	0.005	0.005	0.005	0.01	0.005	0.089	0.1	0.005	0.068	0.02	0.004	0.005	0.005	0.005	0.034	*	0.049	0.2	0.005	0.068
	TKN (mg/L)	2.7	0.79	0.46	0.28	0.25	0.25	0.25	0.56	0.25	0.25	0.29	*	0.35	*	0.31	1.2	*	0.25	0.44	2.2	0.25
	Nitrate + Nitrite (mg/L)	0.99	0.52	0.5	1.1	0.48	0.4	0.49	0.46	0.35	0.66	1	0.26	0.74	0.49	0.53	0.55	*	0.44	0.31	0.5	0.4
	Total Phosporus (mg/L)	0.097	0.07	0.11	0.64	0.096	0.15	0.078	0.078	0.11	0.056	0.088	0.072	0.051	0.036	0.05	0.25	*	0.065	0.053	0.08	0.036
	Surfactants (mg/L)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	*	*	*	*	*	*	*	*	*
	Surfactants as CTAS (mg/L)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*	*	*	*	*	*	*	*	*
	Zinc (mg/L)	0.002	0.014	0.014	0.012	0.007	0.002	0.006	0.001	0.001	0.01	0.007	0.01	0.009	0.019	0.007	0.011	*	0.002	0.001	0.004	0.006

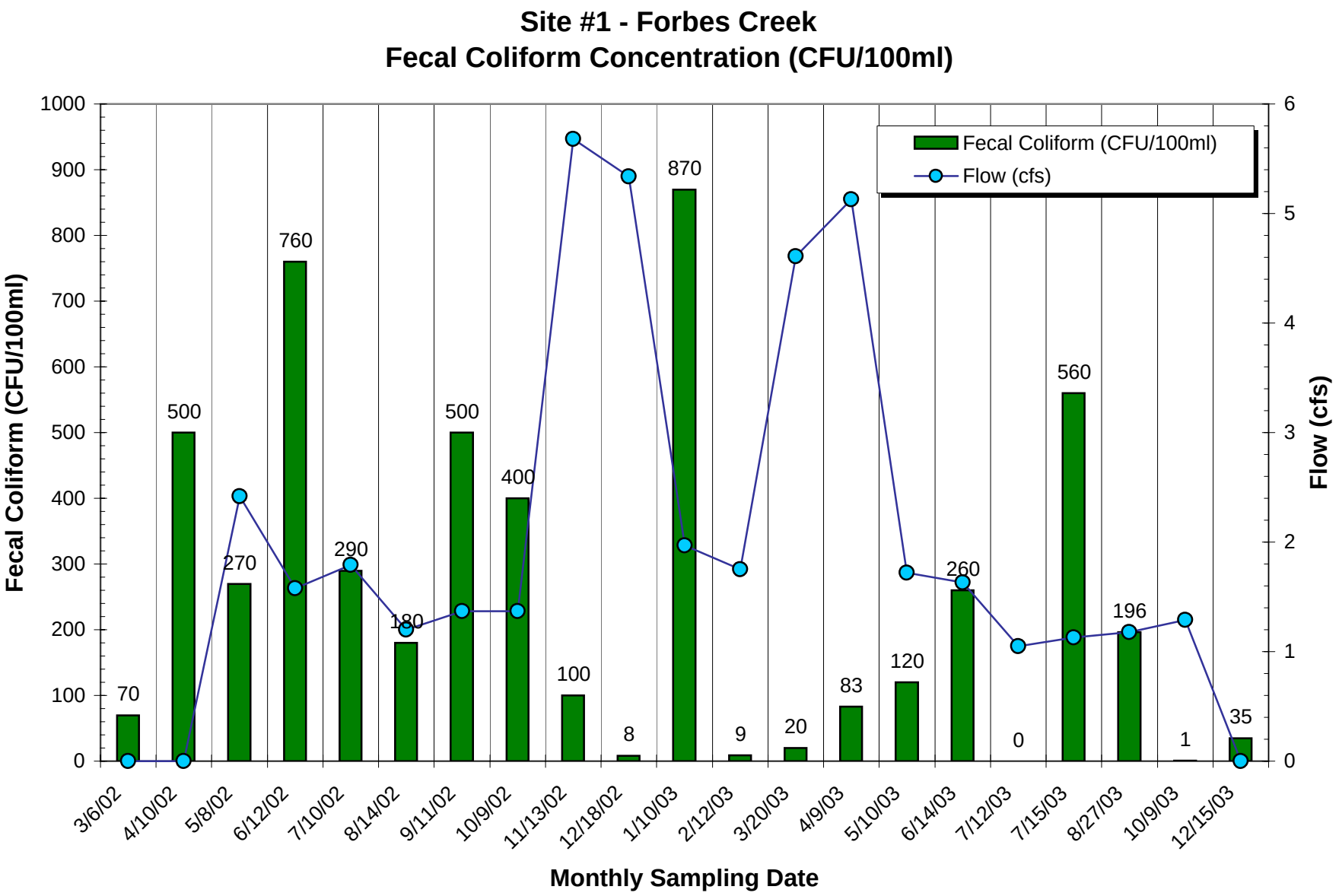
* No data taken or deemed invalid

Forbes Creek Site #1 is loacted approximately 2000 ft. downstream of 108th Ave NE within the Forbes Creek wetlands. See Site Map for

Average Values	
Temp. Water (C)	**12.7**
pH	**7.3**
D.O. (mg/L)	**9.4**
Turbidity (NTU)	**3.36**
Flow (cfs)	**2.35**
Fecal Coliform (CFU/100r	**262**
Ammonia Nitrogen (mg/L)	**0.037**
TKN (mg/L)	**0.63**
Alkalinity (ppm)	**99**
Total Hardness (ppm)	**128**
Nitrate + Nitrite (mg/L)	**0.56**
Total Phosporus (mg/L)	**0.113**
Surfactants (mg/L)	**0.05**
Surfactants as CTAS (mg	**0.10**
Zinc (mg/L)	**0.007**

Site #1 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration




Site #1 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Monthly Sampling Date
Fecal Coliform (CFU/100ml)
Flow (cfs)
1000
900
800
700
600
500
400
300
200
100
0
6
5
4
3
2
1
0
70
500
270
760
290
180
500
400
100
8
870
9
20
83
120
260
0
560
196
1
35
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
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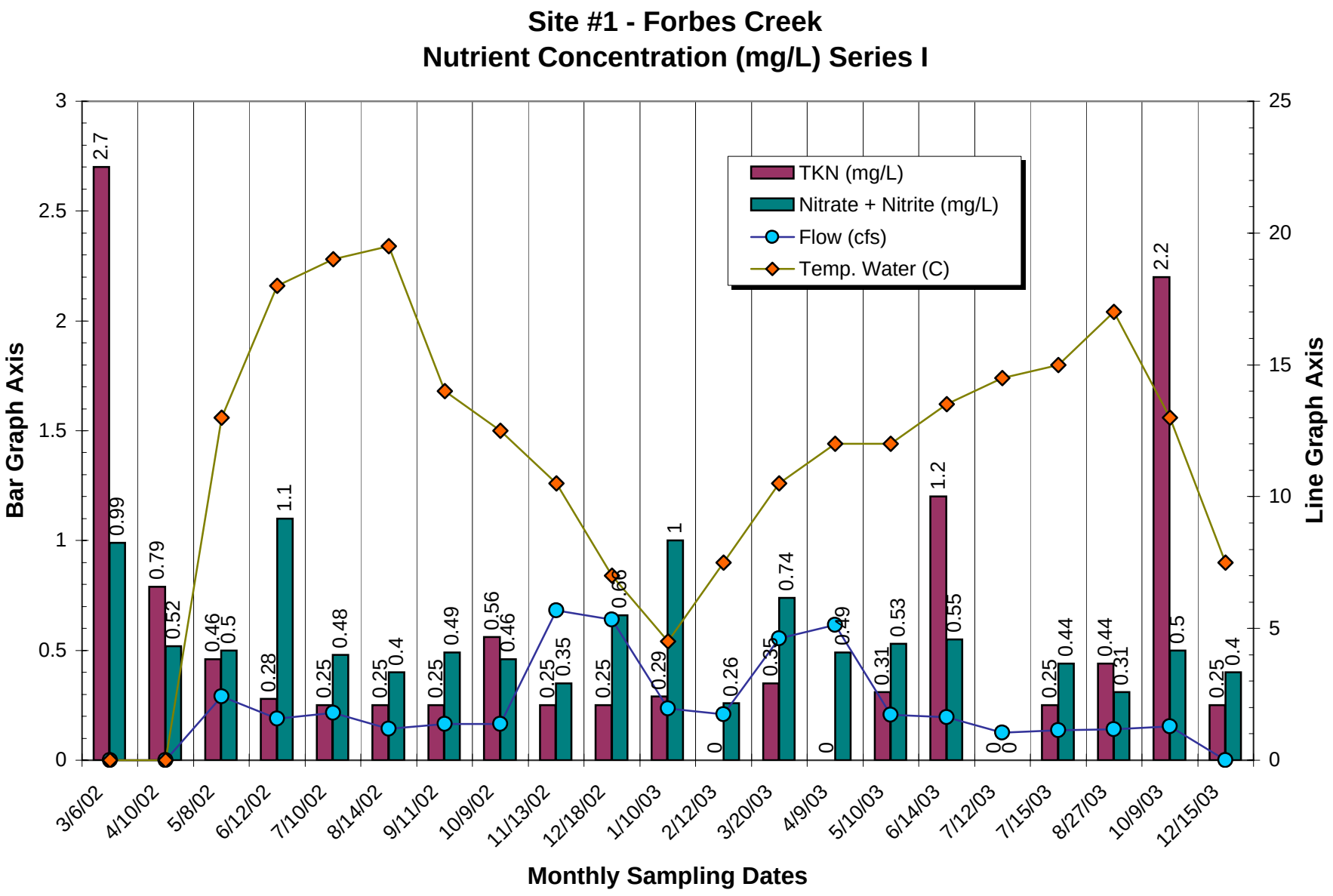
8/27/03
10/9/03
12/15/03


Site #1 - Forbes Creek
Nutrient Concentration (mg/L) Series I
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
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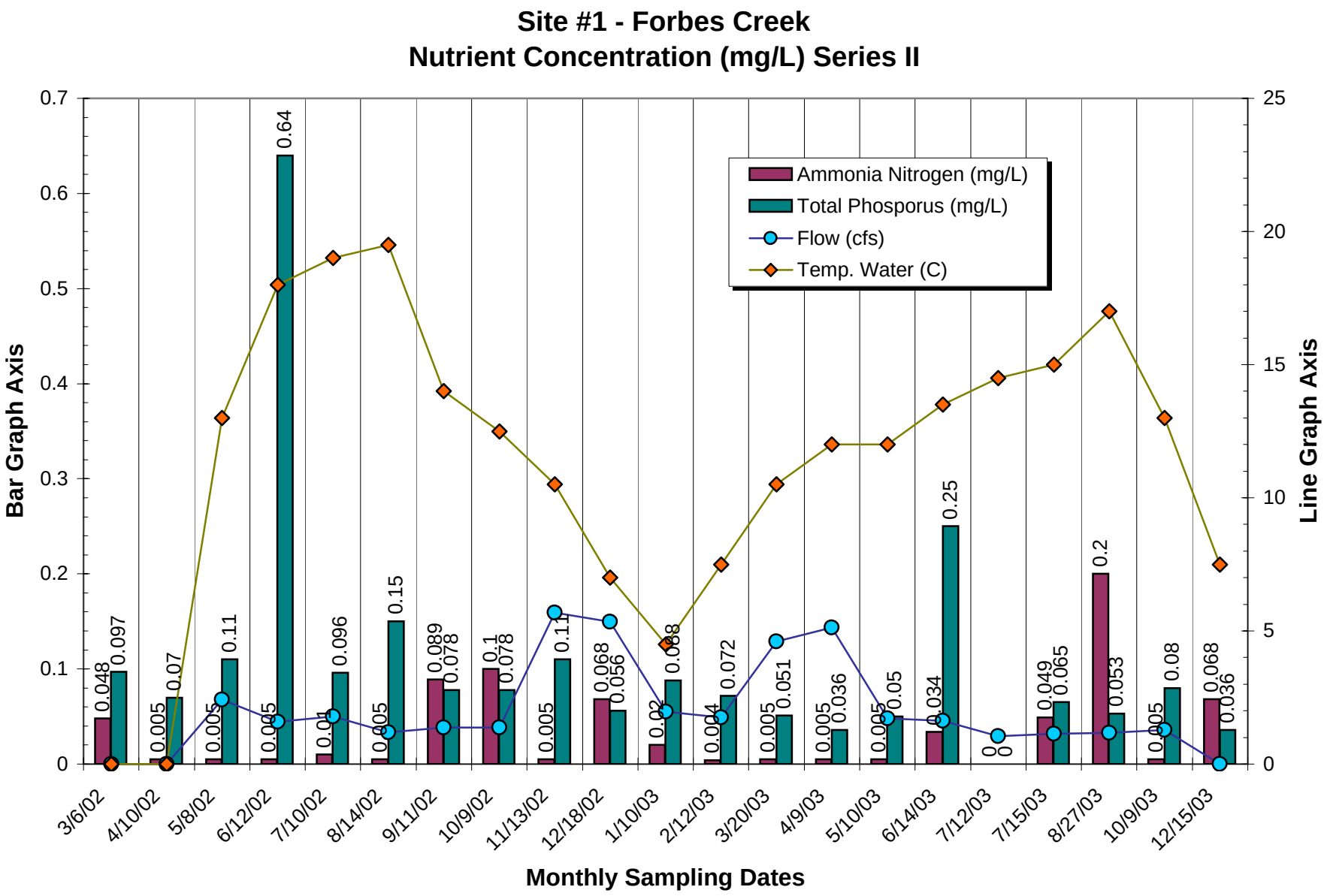
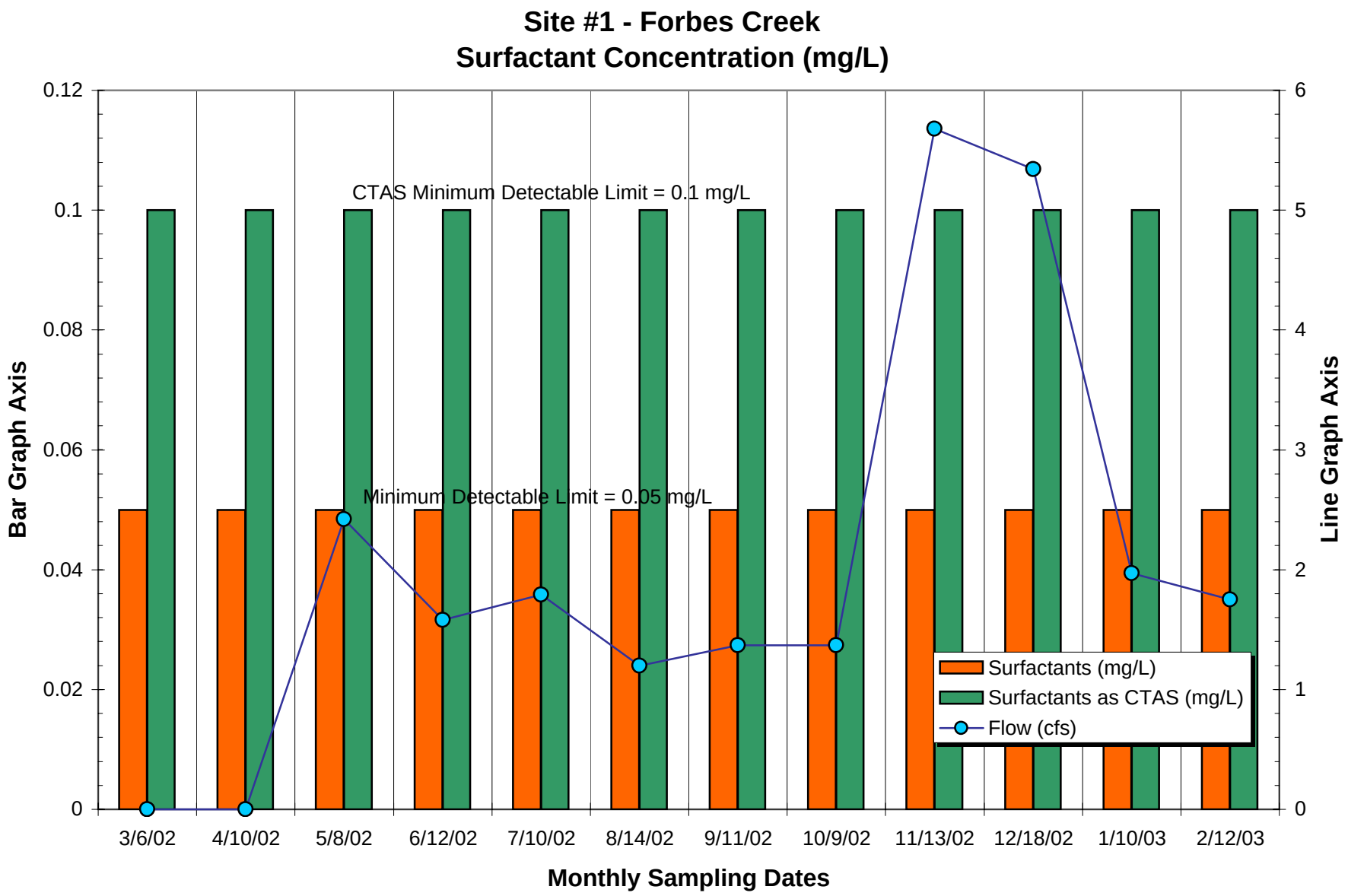
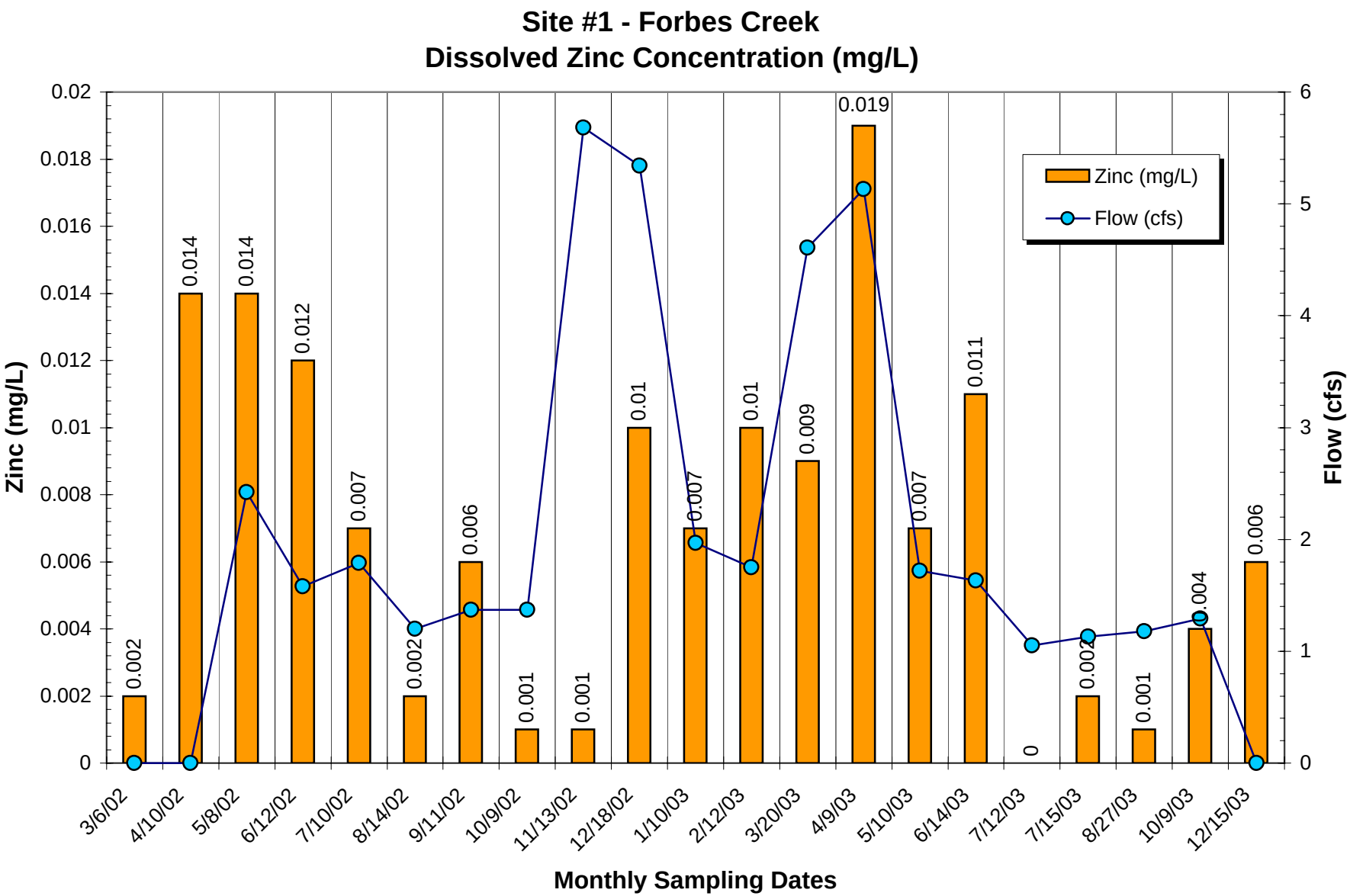
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03


Site #1 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
25
20
15
10
5
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03


Site #1 - Forbes Creek
Surfactant Concentration (mg/L)
CTAS Minimum Detectable Limit = 0.1 mg/L
Minimum Detectable Limit = 0.05 mg/L
Bar Graph Axis
Line Graph Axis
0.12
0.1
0.08
0.06
0.04
0.02
0
6
5
4
3
2
1
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
Monthly Sampling Dates
Surfactants (mg/L)
Surfactants as CTAS (mg/L)
Flow (cfs)


Site #1 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
Monthly Sampling Dates
0.002
0.014
0.014
0.012
0.007
0.002
0.006
0.001
0.001
0.01
0.007
0.01
0.009
0.019
0.007
0.011
0
0.002
0.001
0.004
0.006
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03

Site #2

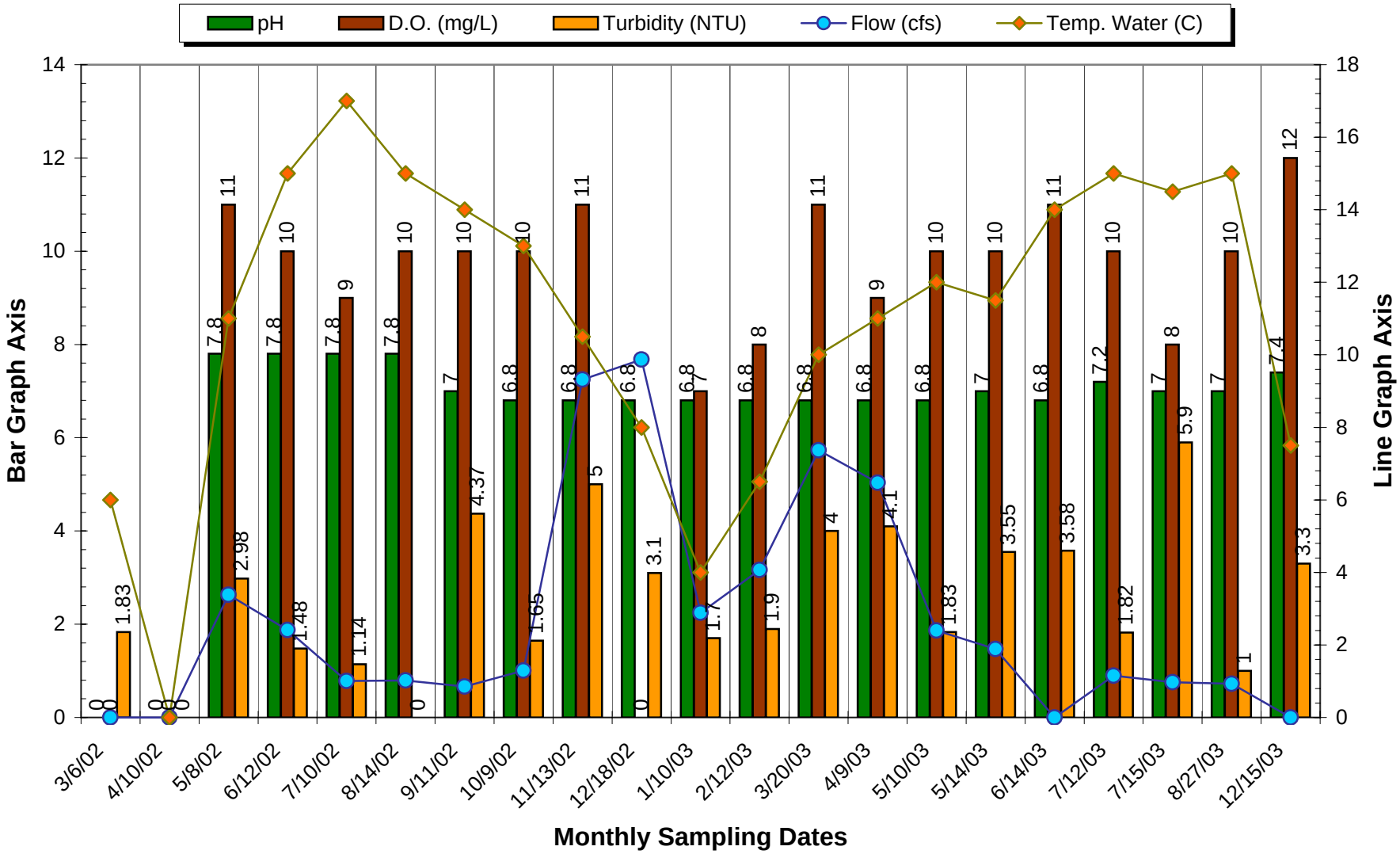
		3/6/02	4/10/02	5/8/02	6/12/02	7/10/02	8/14/02	9/11/02	10/9/02	11/13/02	12/18/02	1/10/03	2/12/03	3/20/03	4/9/03	5/10/03	5/14/03	6/14/03	7/12/03	7/15/03	8/27/03	12/15/03
In-House	Time	12:45	12:00	14:15	14:30	15:00	11:25	10:40	14:45	13:30	13:30	10:20	14:50	14:35	14:00	8:50	18:20	10:45	10:30	10:10	14:00	15:50
	Temp. Air (C)	5	*	14	28	25	18	17	11.5	13	7	5	10.5	13	13.5	13	11	16	20	18	21.5	6
	Temp. Water (C)	6	*	11	15	17	15	14	13	10.5	8	4	6.5	10	11	12	11.5	14	15	14.5	15	7.5
	pH	*	*	7.8	7.8	7.8	7.8	7	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	7	6.8	7.2	7	7	7.4
	D.O. (mg/L)	*	*	11	10	9	10	10	10	11	*	7	8	11	9	10	10	11	10	8	10	12
	Alkalinity (ppm)	*	*	120	120	80	120	80	120	60	40	80	40	40	80	120	80	120	120	10	120	100
	Total Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Free Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Total Hardenss (ppm)	*	*	120	250	120	120	120	120	120	120	120	120	*	*	*	*	*	*	*	*	*
	Turbidity (NTU)	1.83	*	2.98	1.48	1.14	*	4.37	1.65	5	3.1	1.7	1.9	4	4.1	1.83	3.55	3.58	1.82	5.9	1	3.3
	Flow (cfs)	*	*	3.38	2.41	1.01	1.02	0.85	1.29	9.32	9.87	2.89	4.07	7.37	6.47	2.4	1.89	*	1.15	0.97	0.93	*
Laboratory	Fecal Coliform (CFU/100ml)	100	1000	100	76	210	600	600	400	300	20	1000	72	30	92	60	*	350	*	100	402	45
	Ammonia Nitrogen (mg/L)	0.005	0.042	0.005	0.086	0.005	0.005	0.057	0.008	0.005	0.098	0.025	0.004	0.005	0.006	0.005	*	0.005	*	0.005	0.04	0.005
	TKN (mg/L)	2.9	1.5	0.54	0.25	0.3	0.25	0.25	0.55	0.25	0.31	0.29	*	0.3	*	0.27	*	1.2	*	0.25	0.43	0.25
	Nitrate + Nitrite (mg/L)	1.2	0.6	0.7	0.73	0.59	0.66	0.65	0.62	0.41	0.77	1	0.41	0.88	0.66	0.66	*	0.64	*	0.41	0.39	1.3
	Total Phosporus (mg/L)	0.067	0.054	0.091	0.069	0.041	0.1	0.12	0.075	0.072	0.06	0.088	0.085	0.056	0.028	0.055	*	0.079	*	0.079	0.07	0.005
	Surfactants (mg/L)	0.05	0.05	0.05	0.05	0.05	0.12	0.05	0.05	0.05	0.05	0.05	0.06	*	*	*	*	*	*	*	*	*
	Surfactants as CTAS (mg/L)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*	*	*	*	*	*	*	*	*
	Zinc (mg/L)	0.006	0.02	0.007	0.004	0.007	0.003	0.008	0.001	0.001	0.009	0.007	0.013	0.022	0.011	0.012	*	0.011	*	0.007	0.001	0.007

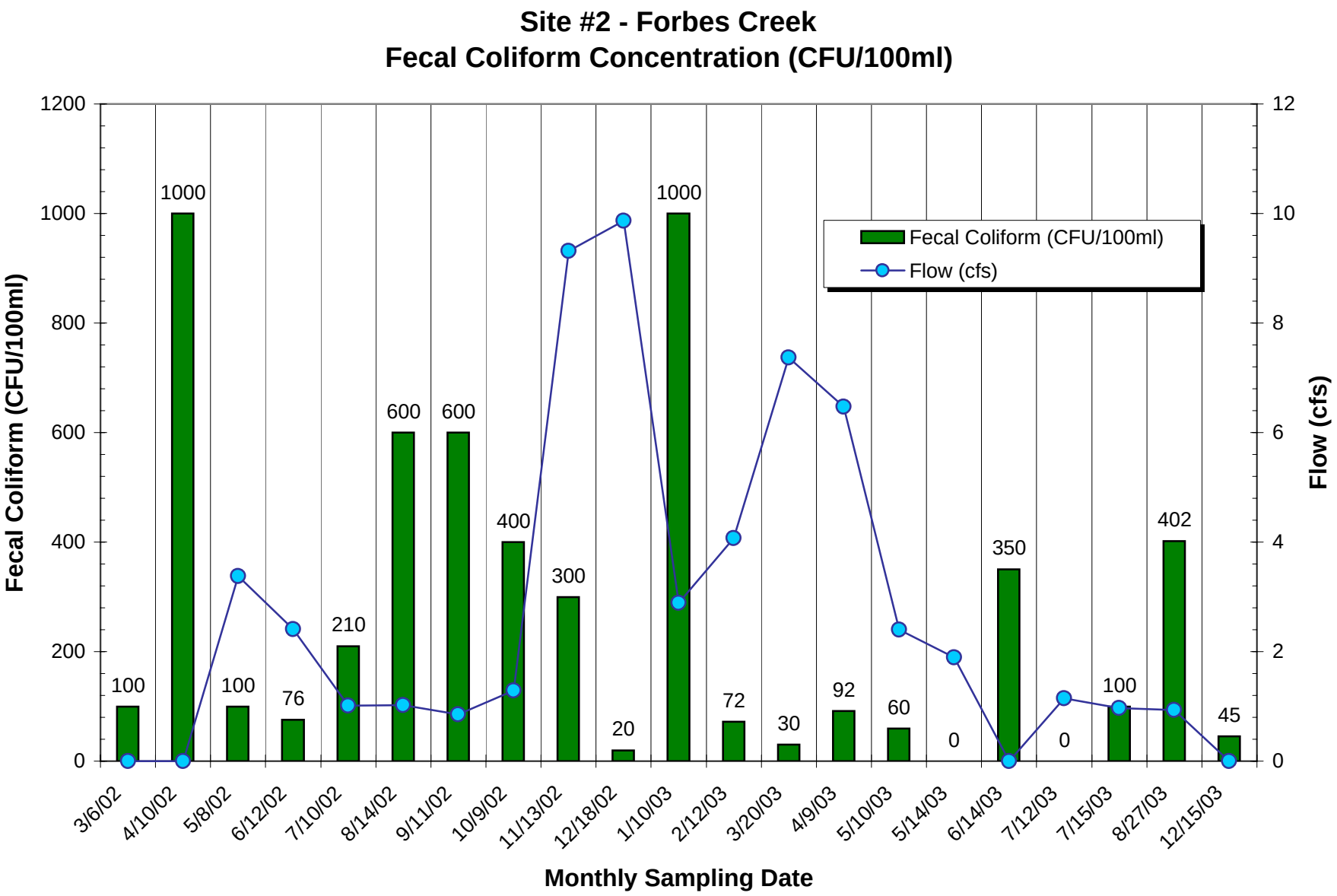
* No data taken or deemed invalid

Forbes Creek Site #2 is loacted just east of the 108th Ave NE stream crossing. See Site Map for exact location.

Average Values	
Temp. Water (C)	**11.5**
pH	**7.1**
D.O. (mg/L)	**9.8**
Turbidity (NTU)	**2.85**
Flow (cfs)	**3.37**
Fecal Coliform (CFU/100m	**292**
Ammonia Nitrogen (mg/L)	**0.022**
TKN (mg/L)	**0.59**
Alkalinity (ppm)	**87**
Total Hardness (ppm)	**133**
Nitrate + Nitrite (mg/L)	**0.70**
Total Phosporus (mg/L)	**0.07**
Surfactants (mg/L)	**0.06**
Surfactants as CTAS (mg/	**0.10**
Zinc (mg/L)	**0.008**

Site #2 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration




Site #2 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Monthly Sampling Date
Fecal Coliform (CFU/100ml)
Flow (cfs)
1200
1000
800
600
400
200
0
12
10
8
6
4
2
0
100
1000
100
76
210
600
600
400
300
20
1000
72
30
92
60
0
350
0
100
402
45
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
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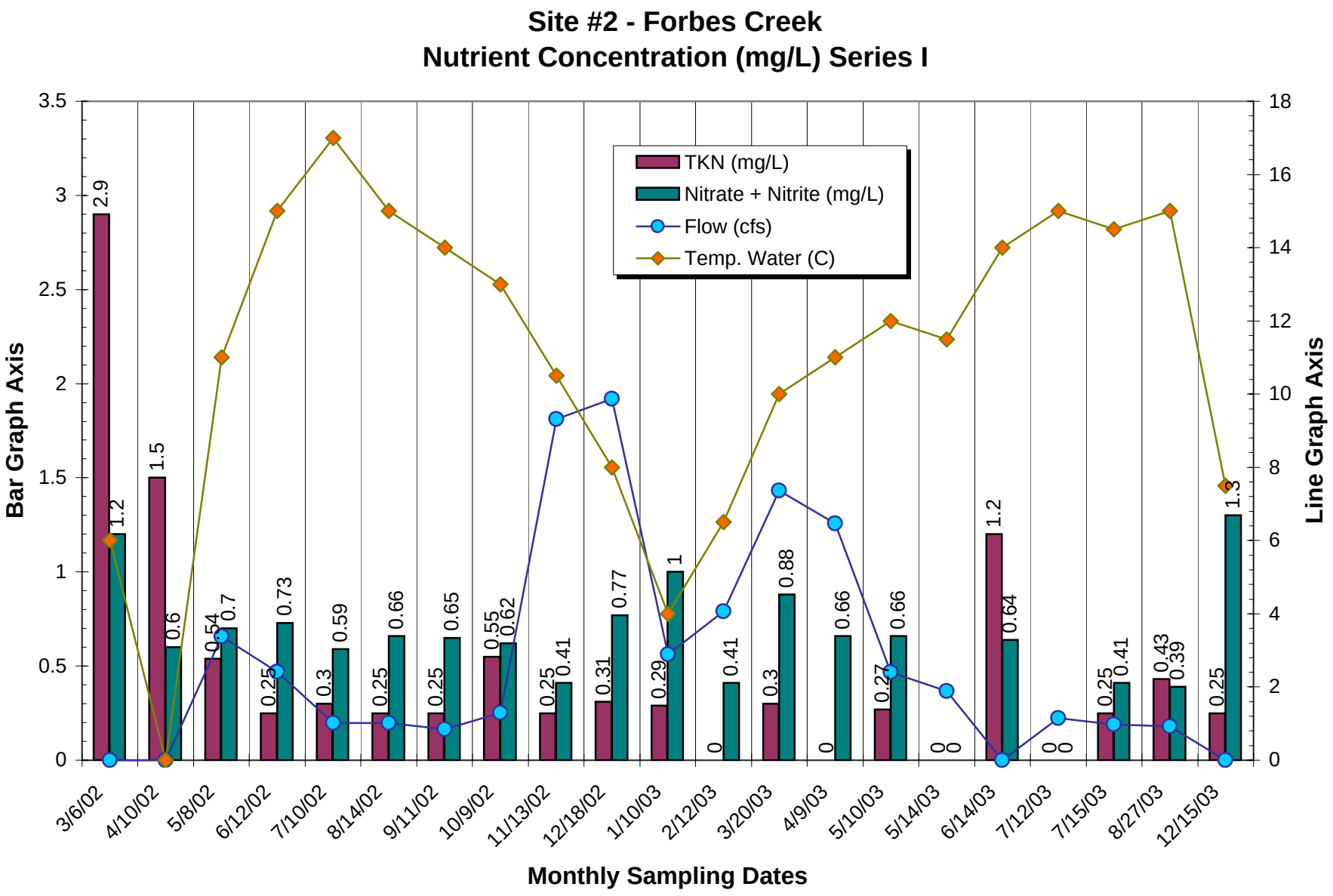
7/15/03
8/27/03
12/15/03


Site #2 - Forbes Creek
Nutrient Concentration (mg/L) Series I
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
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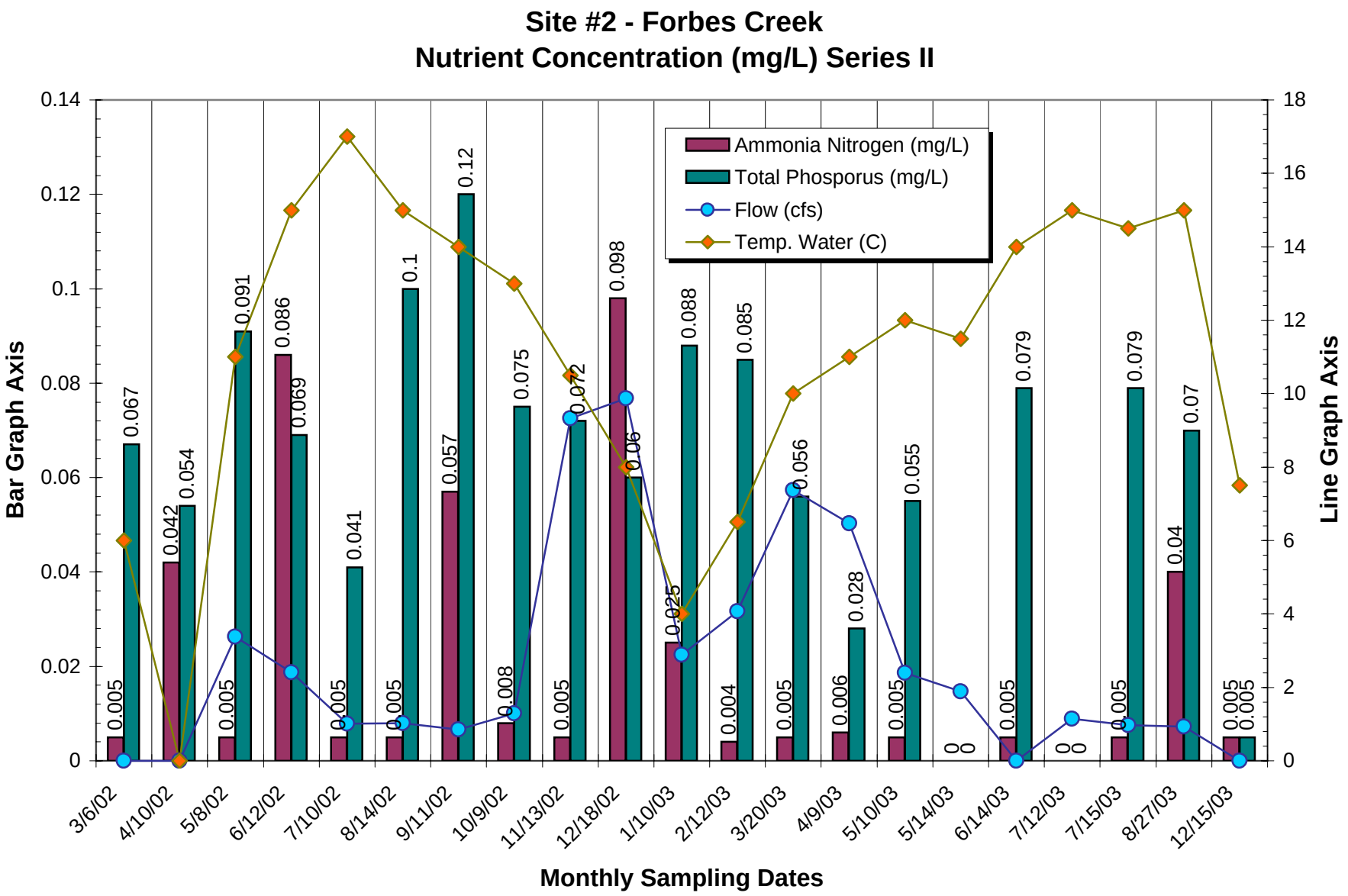
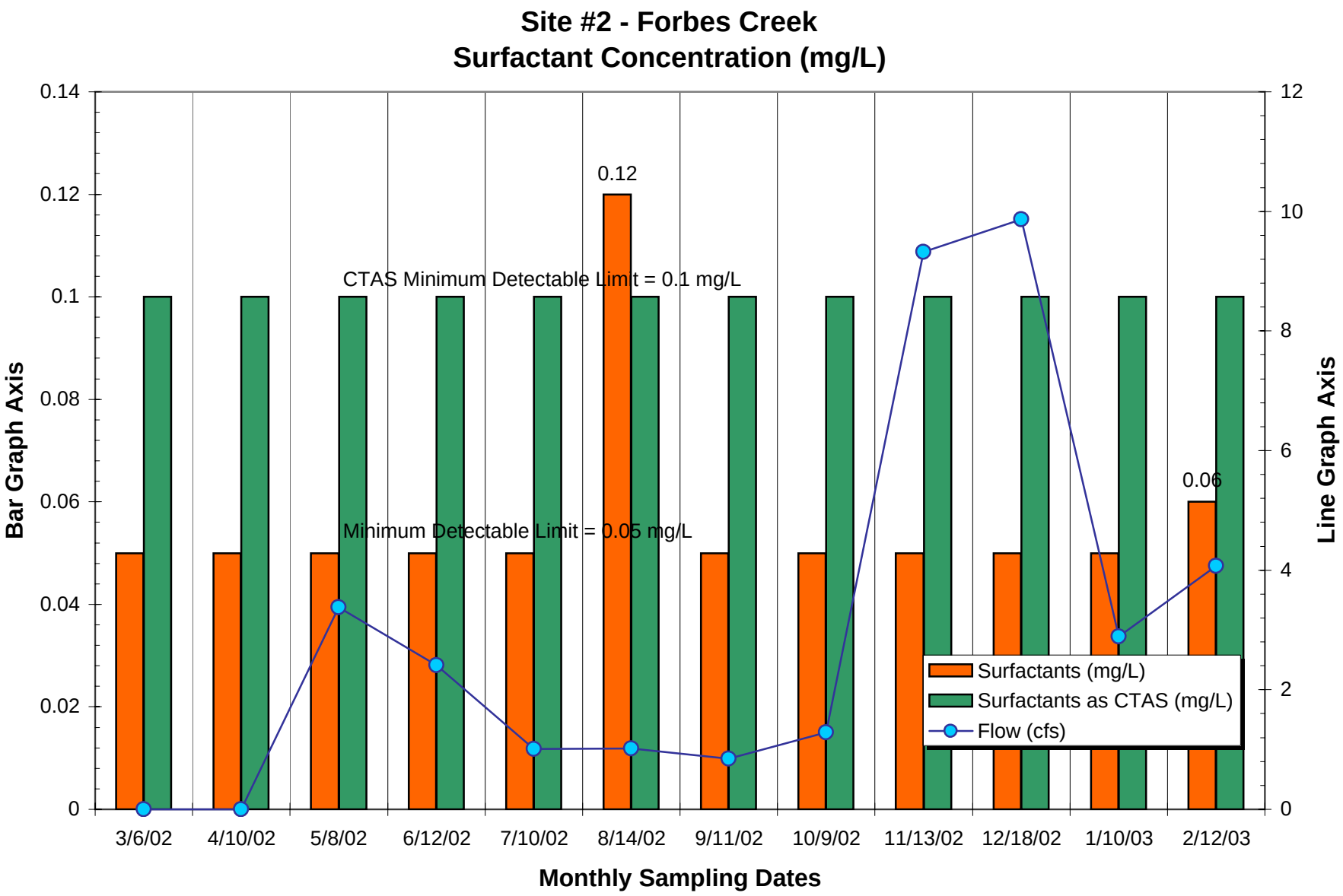
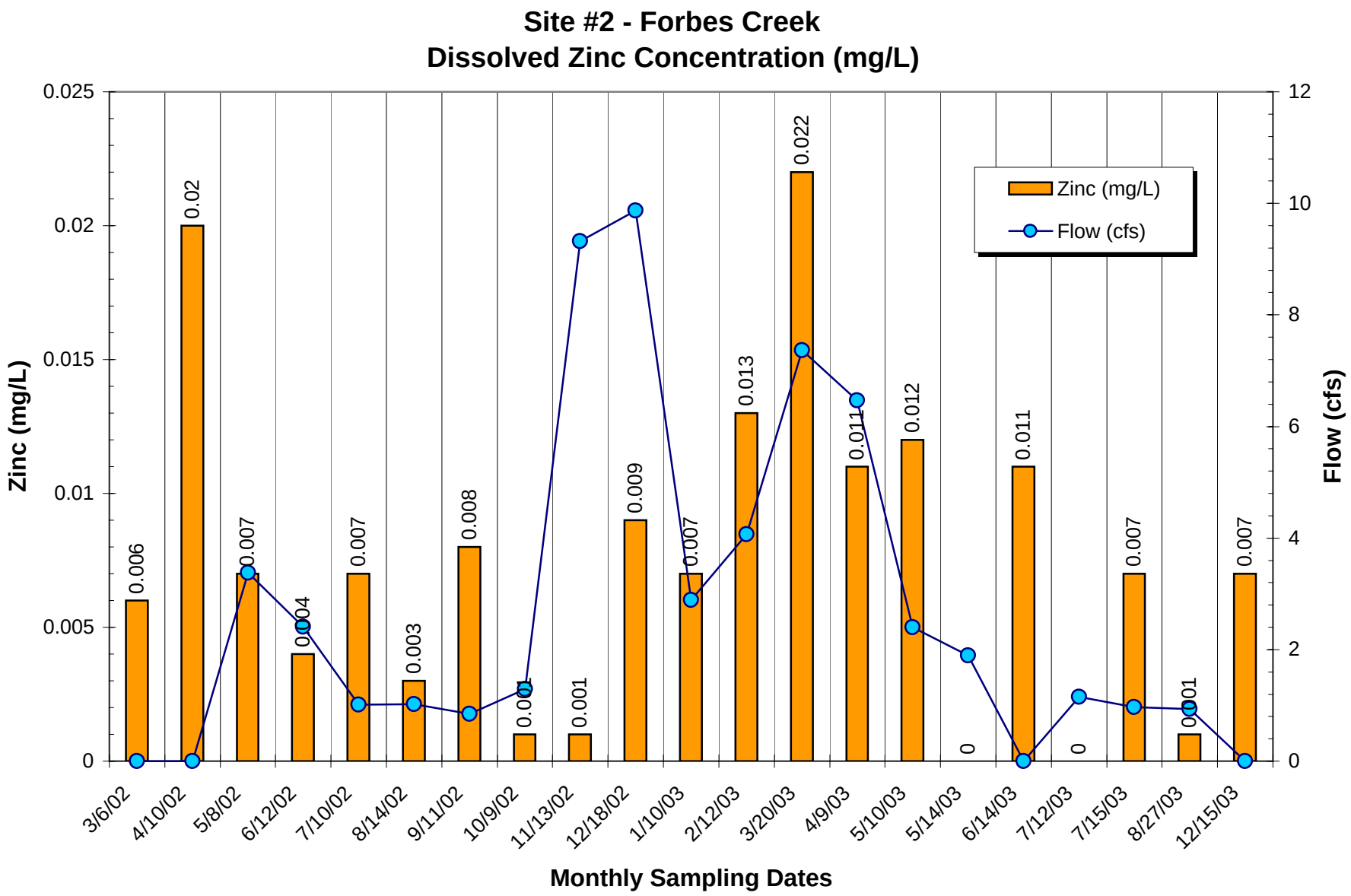
6/14/03
7/12/03
7/15/03
8/27/03
12/15/03


Site #2 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
18
16
14
12
10
8
6
4
2
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/14/03
6/14/03
7/12/03
7/15/03
8/27/03
12/15/03
0.005
0.067
0.042
0.054
0.005
0.091
0.086
0.069
0.005
0.041
0.005
0.1
0.057
0.12
0.008
0.075
0.005
0.072
0.098
0.06
0.025
0.088
0.004
0.085
0.005
0.056
0.006
0.028
0.005
0.055
0
0
0.005
0.079
0
0
0.005
0.079
0.04
0.07
0.005
0.005


Site #2 - Forbes Creek
Surfactant Concentration (mg/L)
Bar Graph Axis
Line Graph Axis
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
12
10
8
6
4
2
0
0.12
0.06
CTAS Minimum Detectable Limit = 0.1 mg/L
Minimum Detectable Limit = 0.05 mg/L
Surfactants (mg/L)
Surfactants as CTAS (mg/L)
Flow (cfs)
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
Monthly Sampling Dates


Site #2 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
Monthly Sampling Dates
0.025
0.02
0.015
0.01
0.005
0
12
10
8
6
4
2
0
0.006
0.02
0.007
0.004
0.007
0.003
0.008
0.001
0.001
0.009
0.007
0.013
0.022
0.011
0.012
0
0.011
0
0.007
0.001
0.007
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/14/03
6/14/03
7/12/03
7/15/03
8/27/03
12/15/03

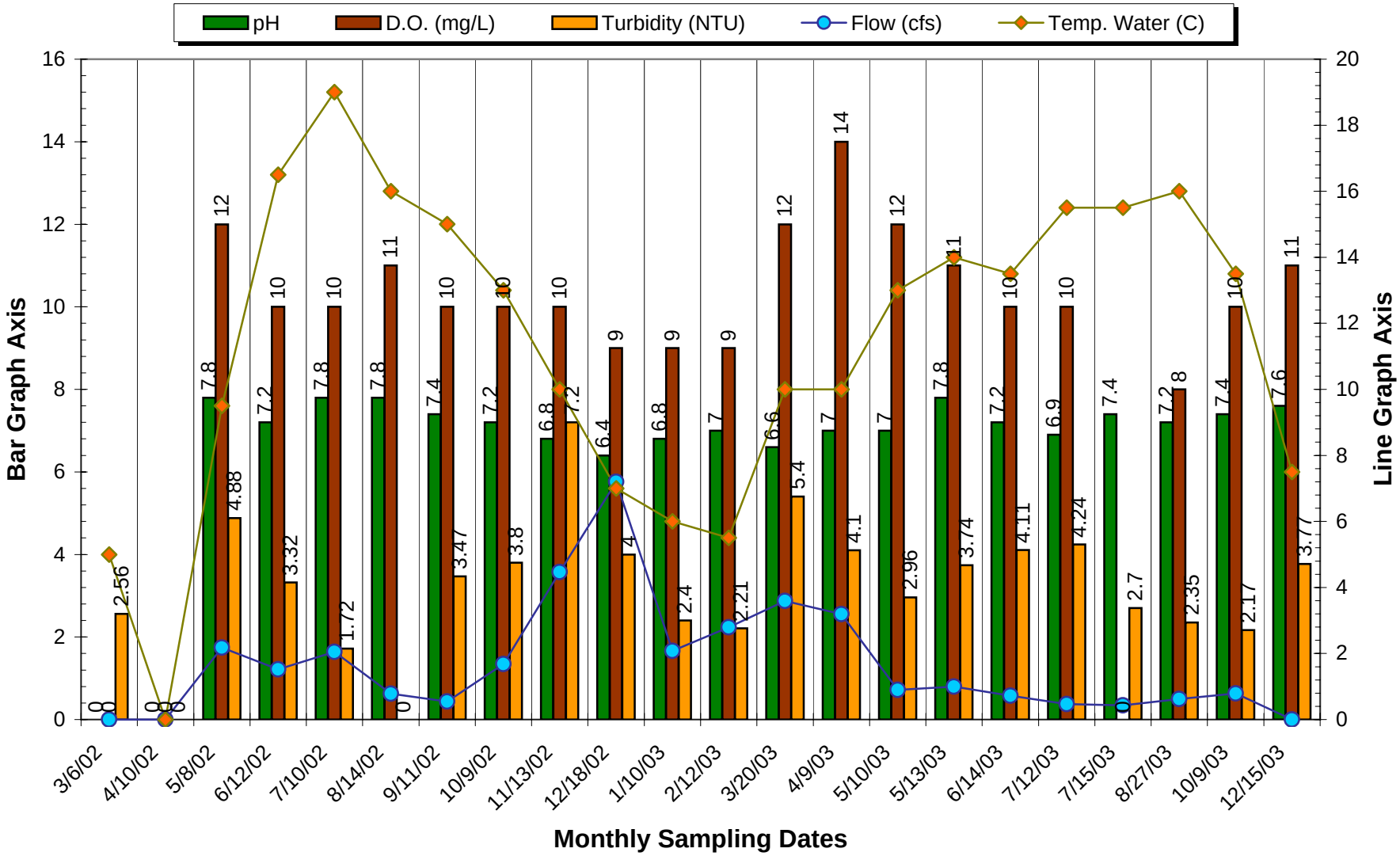
	Site #3	3/6/02	4/10/02	5/8/02	6/12/02	7/10/02	8/14/02	9/11/02	10/9/02	11/13/02	12/18/02	1/10/03	2/12/03	3/20/03	4/9/03	5/10/03	5/13/03	6/14/03	7/12/03	7/15/03	8/27/03	10/9/03	12/15/03
In-House	Time	10:45	11:45	11:30	15:15	14:15	10:40	13:45	14:00	11:00	10:45	14:50	11:00	13:35	10:25	12:25	6:30	9:40	9:36	11:00	11:05	17:30	15:00
	Temp. Air (C)	2	*	12	22	24.5	21	19	12.5	12	5.5	6	3.5	11.5	10	14.2	16.5	15	18.5	18.5	17	11.5	6.5
	Temp. Water (C)	5	*	9.5	16.5	19	16	15	13	10	7	6	5.5	10	10	13	14	13.5	15.5	15.5	16	13.5	7.5
	pH	*	*	7.8	7.2	7.8	7.8	7.4	7.2	6.8	6.4	6.8	7	6.6	7	7	7.8	7.2	6.9	7.4	7.2	7.4	7.6
	D.O. (mg/L)	*	*	12	10	10	11	10	10	10	9	9	9	12	14	12	11	10	10	*	8	10	11
	Alkalinity (ppm)	*	*	100	80	80	120	120	100	40	40	80	40	40	80	100	120	120	100	100	100	120	120
	Total Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*	*
	Free Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*	*
	Total Hardenss (ppm)	*	*	120	120	180	185	180	120	120	120	120	120	*	*	*	*	*	*	*	*	*	*
	Turbidity (NTU)	2.56	*	4.88	3.32	1.72	*	3.47	3.8	7.2	4	2.4	2.21	5.4	4.1	2.96	3.74	4.11	4.24	2.7	2.35	2.17	3.77
	Flow (cfs)	*	*	2.18	1.52	2.05	0.78	0.545	1.68	4.47	7.2	2.08	2.79	3.59	3.19	0.9	1	0.72	0.47	0.43	0.62	0.79	*
Laboratory	Fecal Coliform (CFU/100ml)	140	800	230	200	220	400	300	150	400	7	1	3	30	92	20	*	510	*	530	130	1	90
	Ammonia Nitrogen (mg/L)	0.049	0.021	0.041	0.28	0.074	0.005	0.075	0.013	0.005	0.14	0.085	0.008	0.005	0.006	0.005	*	0.02	*	0.036	0.005	0.005	0.005
	TKN (mg/L)	4.2	0.9	0.44	0.25	1	0.25	0.25	0.77	0.25	0.25	0.38	*	0.3	*	0.4	*	1.2	*	0.25	0.4	3.4	0.25
	Nitrate + Nitrite (mg/L)	1.4	0.59	0.87	0.97	0.7	1.2	1.4	0.045	0.41	0.82	1.1	1.3	0.88	0.66	1	*	0.78	*	0.78	0.77	2.6	1.4
	Total Phosporus (mg/L)	0.02	0.11	0.055	0.047	0.42	0.38	0.078	0.04	0.057	0.041	0.029	0.04	0.056	0.028	0.03	*	0.047	*	0.037	0.03	0.047	0.022
	Surfactants (mg/L)	0.05	0.05	0.37	0.05	0.05	0.05	0.05	0.05	0.13	0.06	0.05	0.05	*	*	*	*	*	*	*	*	*	*
	Surfactants as CTAS (mg/L)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*	*	*	*	*	*	*	*	*	*
	Zinc (mg/L)	0.01	0.02	0.007	0.004	0.005	0.01	0.006	0.001	0.001	0.018	0.008	0.008	0.022	0.011	0.01	*	0.013	*	0.003	0.001	0.006	0.006

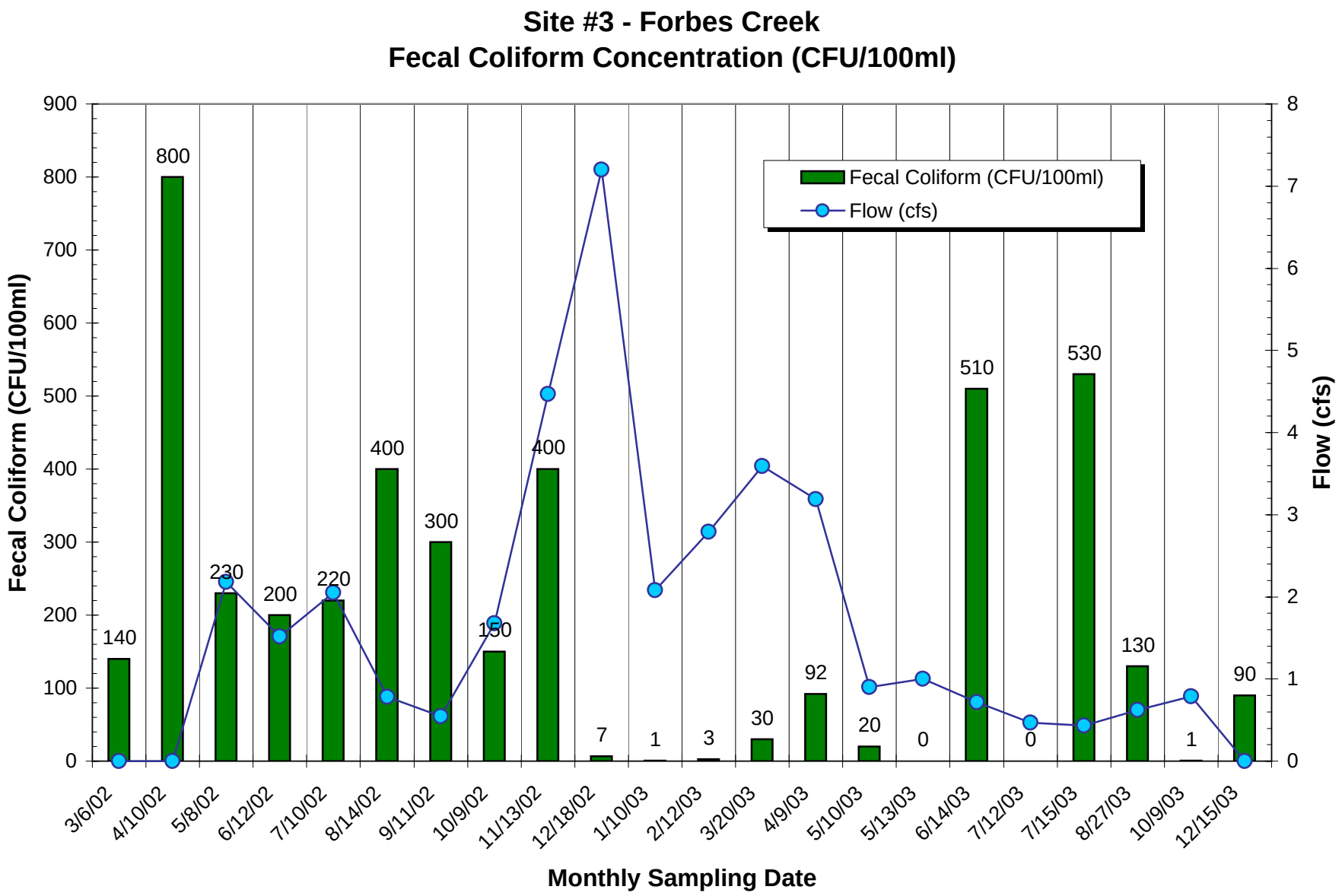
* No data taken or deemed invalid

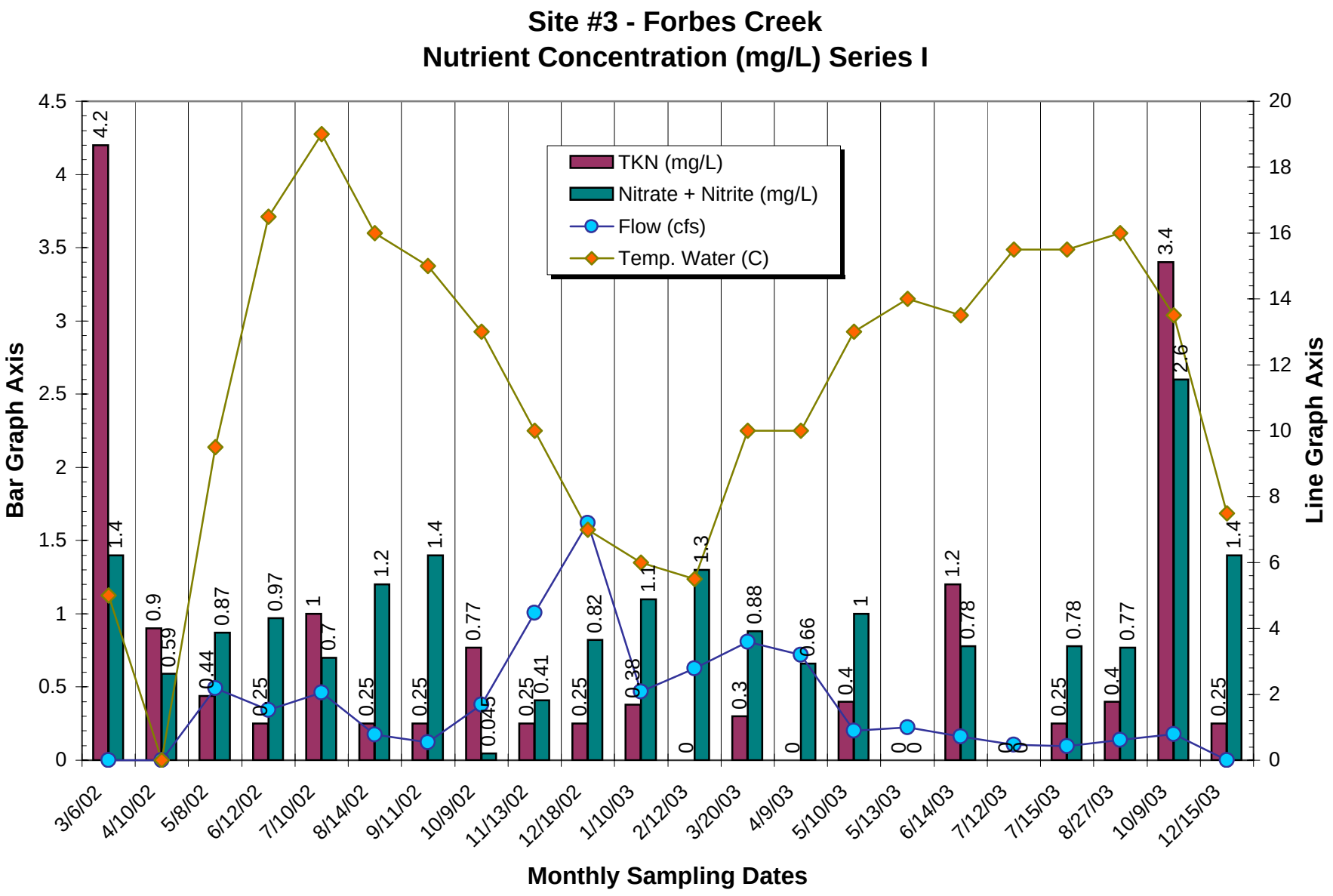
Forbes Creek Site #3 is loacted next to the emergency outfall of Coor's Pond. See Site Map for exac location.

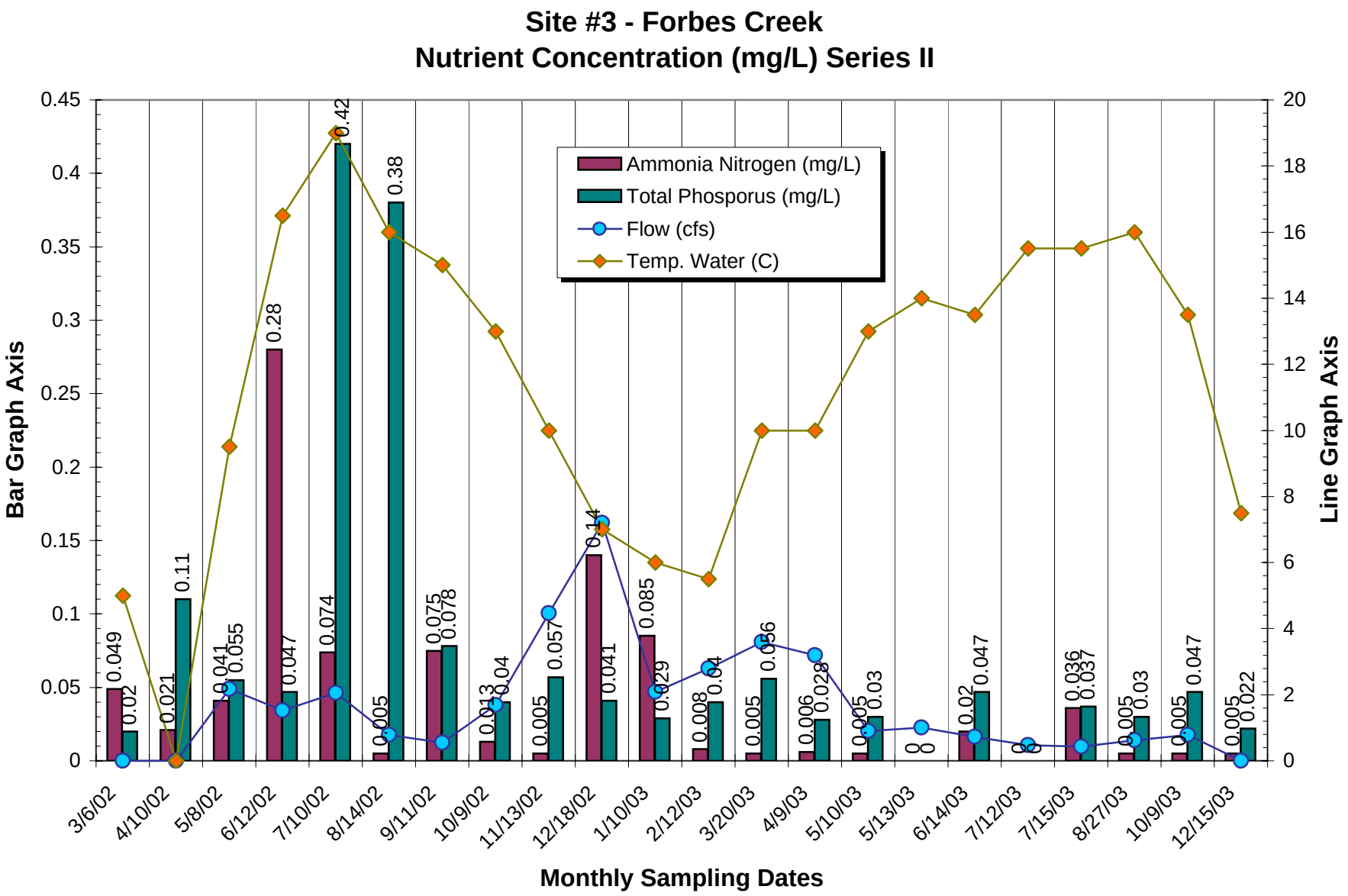
Average Values	
Temp. Water (C)	**12.0**
pH	**7.2**
D.O. (mg/L)	**10.4**
Turbidity (NTU)	**3.56**
Flow (cfs)	**1.95**
Fecal Coliform (CFU/100m	**213**
Ammonia Nitrogen (mg/L)	**0.04**
TKN (mg/L)	**0.84**
Alkalinity (ppm)	**90**
Total Hardness (ppm)	**139**
Nitrate + Nitrite (mg/L)	**0.98**
Total Phosporus (mg/L)	**0.081**
Surfactants (mg/L)	**0.08**
Surfactants as CTAS (mg/l	**0.10**
Zinc (mg/L)	**0.009**

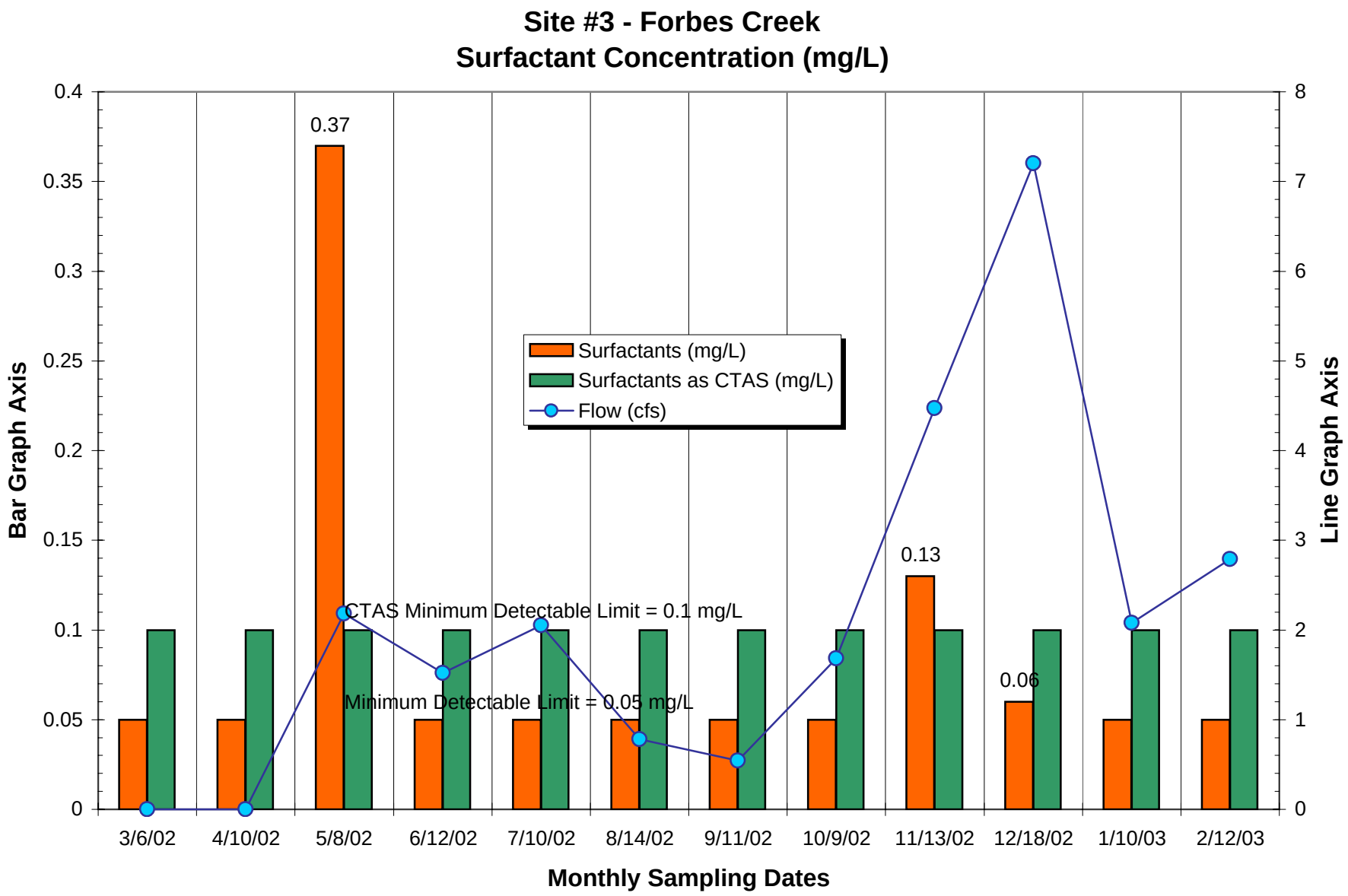
Site #3 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration

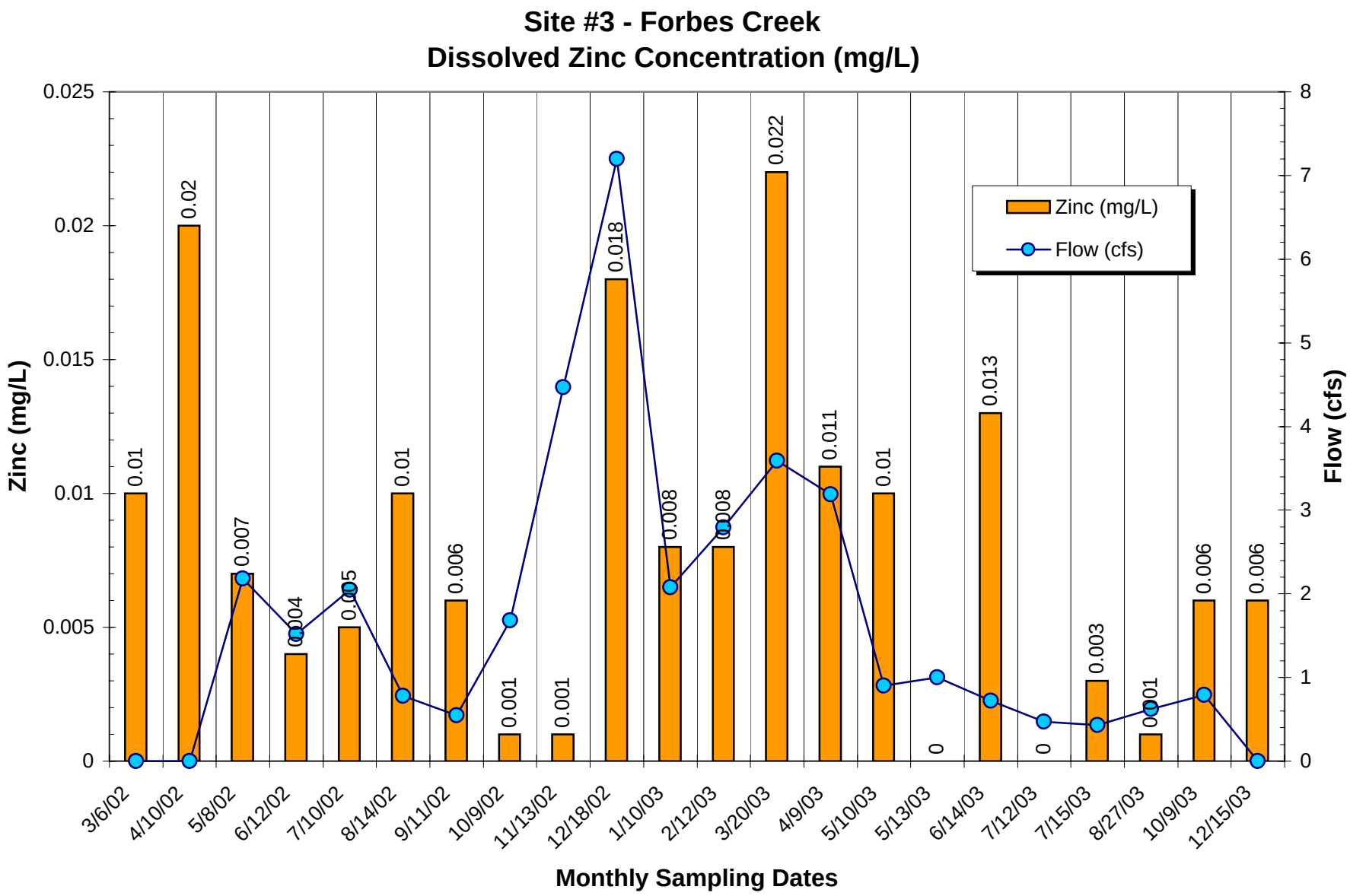



Site #3 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Monthly Sampling Date
Fecal Coliform (CFU/100ml)
Flow (cfs)
900
800
700
600
500
400
300
200
100
0
8
7
6
5
4
3
2
1
0
140
800
230
200
220
400
300
150
400
7
1
3
30
92
20
0
510
0
530
130
1
90
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/13/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03


Site #3 - Forbes Creek
Nutrient Concentration (mg/L) Series I
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/13/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03


Site #3 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/13/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03


Site #3 - Forbes Creek
Surfactant Concentration (mg/L)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
Surfactants (mg/L)
Surfactants as CTAS (mg/L)
Flow (cfs)
CTAS Minimum Detectable Limit = 0.1 mg/L
Minimum Detectable Limit = 0.05 mg/L
0.37
0.13
0.06
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
8
7
6
5
4
3
2
1
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03


Site #3 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
Monthly Sampling Dates
Zinc (mg/L)
Flow (cfs)
0.025
0.02
0.015
0.01
0.005
0
8
7
6
5
4
3
2
1
0
0.01
0.02
0.007
0.004
0.005
0.01
0.006
0.001
0.001
0.018
0.008
0.008
0.022
0.011
0.01
0
0.013
0
0.003
0.001
0.006
0.006
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
5/10/03
5/13/03
6/14/03
7/12/03
7/15/03
8/27/03
10/9/03
12/15/03

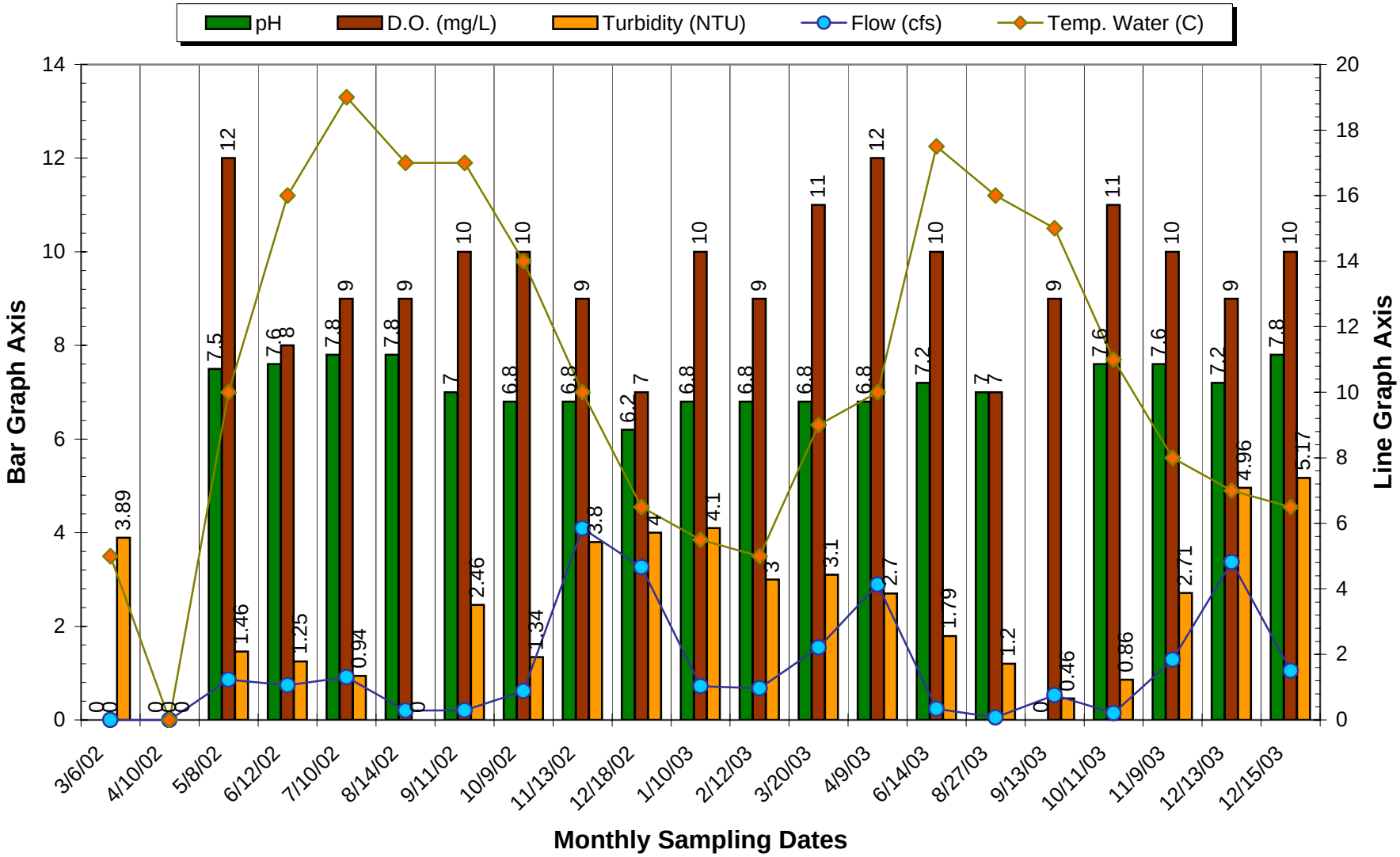
	Site #4	3/6/02	4/10/02	5/8/02	6/12/02	7/10/02	8/14/02	9/11/02	10/9/02	11/13/02	12/18/02	1/10/03	2/12/03	3/20/03	4/9/03	6/14/03	8/27/03	9/13/03	10/11/03	11/9/03	12/13/03	12/15/03
In-House	Time	10:15	9:30	10:30	10:30	10:15	9:35	14:50	10:20	10:00	9:15	15:25	10:15	11:00	9:50	13:15	10:25	9:15	9:45	9:45	9:35	14:30
	Temp. Air (C)	2.5	*	9	19	22	20	20	12.5	10	5	5.5	2	10.5	11	20	16.5	14	11	8	11.5	7.5
	Temp. Water (C)	5	*	10	16	19	17	17	14	10	6.5	5.5	5	9	10	17.5	16	15	11	8	7	6.5
	pH	*	*	7.5	7.6	7.8	7.8	7	6.8	6.8	6.2	6.8	6.8	6.8	6.8	7.2	7	*	7.6	7.6	7.2	7.8
	D.O. (mg/L)	*	*	12	8	9	9	10	10	9	7	10	9	11	12	10	7	9	11	10	9	10
	Alkalinity (ppm)	*	*	80	100	80	80	100	80	40	40	80	40	40	40	80	100	*	200	80	40	80
	Total Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Free Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*	*	*	*
	Total Hardenss (ppm)	*	*	120	120	120	250	180	120	120	120	120	120	*	*	*	*	*	*	*	*	*
	Turbidity (NTU)	3.89	*	1.46	1.25	0.94	*	2.46	1.34	3.8	4	4.1	3	3.1	2.7	1.79	1.2	0.46	0.86	2.71	4.96	5.17
	Flow (cfs)	*	*	1.23	1.06	1.31	0.29	0.29	0.88	5.85	4.66	1.03	0.97	2.21	4.13	0.34	0.08	0.76	0.21	1.84	4.82	1.5
Laboratory	Fecal Coliform (CFU/100ml)	510	700	1000	580	310	540	5400	700	300	9	44	17	140	109	860	2000	*	350	200	*	50
	Ammonia Nitrogen (mg/L)	0.084	0.031	0.049	0.065	0.005	0.005	0.005	0.013	0.005	0.22	0.16	0.006	0.054	0.007	0.005	0.005	*	0.005	0.005	*	0.005
	TKN (mg/L)	1.1	0.88	0.64	0.25	0.76	0.25	0.25	0.72	0.26	0.37	0.7	*	0.51	*	1.4	0.38	*	3.9	0.25	*	0.25
	Nitrate + Nitrite (mg/L)	1.2	0.53	0.98	0.51	0.55	1.7	2.1	0.84	0.32	0.66	1.1	0.39	0.84	0.58	0.77	0.92	*	0.76	2.3	*	1.3
	Total Phosporus (mg/L)	0.05	0.12	0.067	0.07	0.026	0.24	0.1	0.037	0.059	0.057	0.05	0.055	0.039	0.048	0.12	0.061	*	0.002	*	*	0.026
	Surfactants (mg/L)	0.05	0.14	0.05	0.05	0.05	0.05	0.05	0.05	0.21	0.07	0.05	0.05	*	*	*	*	*	*	*	*	*
	Surfactants as CTAS (mg/L)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*	*	*	*	*	*	*	*	*
	Zinc (mg/L)	0.01	0.02	0.016	0.006	0.004	0.022	0.009	0.001	0.001	0.014	0.01	0.023	0.017	0.027	0.011	0.028	*	0.005	0.006	*	0.008

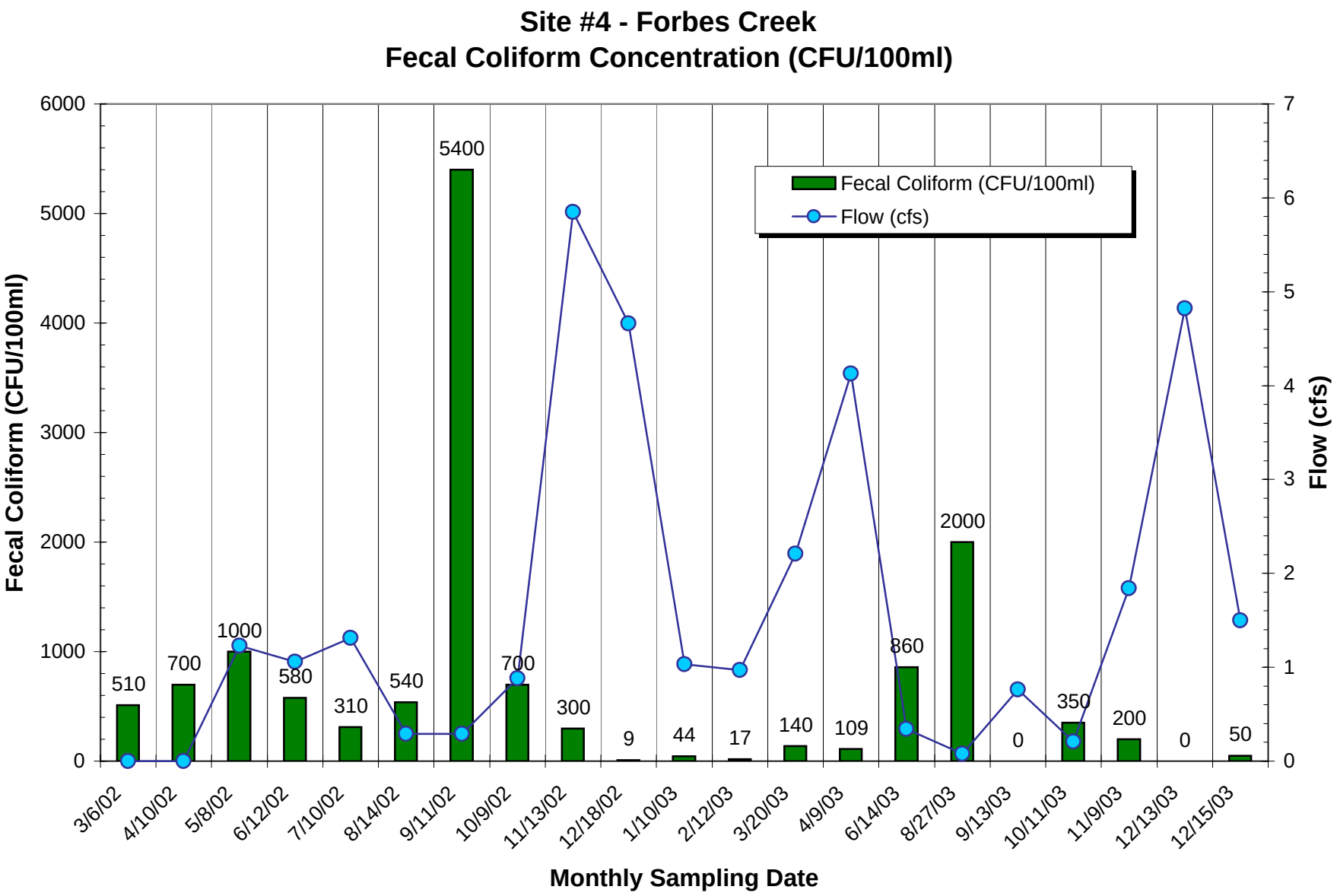
* No data taken or deemed invalid

Forbes Creek Site #4 is loacted approximately 50 ft. downstream of the Slater Avenue NE stream crossing just north of NE 100th Place. See Site Map for exact location.

Average Values	
Temp. Water (C)	**11.3**
pH	**7.6**
D.O. (mg/L)	**9.6**
Turbidity (NTU)	**2.59**
Flow (cfs)	**1.76**
Fecal Coliform (CFU/100ml)	**727**
Ammonia Nitrogen (mg/L)	**0.04**
TKN (mg/L)	**0.76**
Alkalinity (ppm)	**77**
Total Hardness (ppm)	**139**
Nitrate + Nitrite (mg	**0.97**
Total Phosporus (n	**0.065**
Surfactants (mg/L)	**0.07**
Surfactants as CTAS (mg/L)	**0.10**
Zinc (mg/L)	**0.013**

Site #4 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration




Site #4 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Monthly Sampling Date
Fecal Coliform (CFU/100ml)
Flow (cfs)
6000
5000
4000
3000
2000
1000
0
7
6
5
4
3
2
1
0
510
700
1000
580
310
540
5400
700
300
9
44
17
140
109
860
2000
0
350
200
0
50
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
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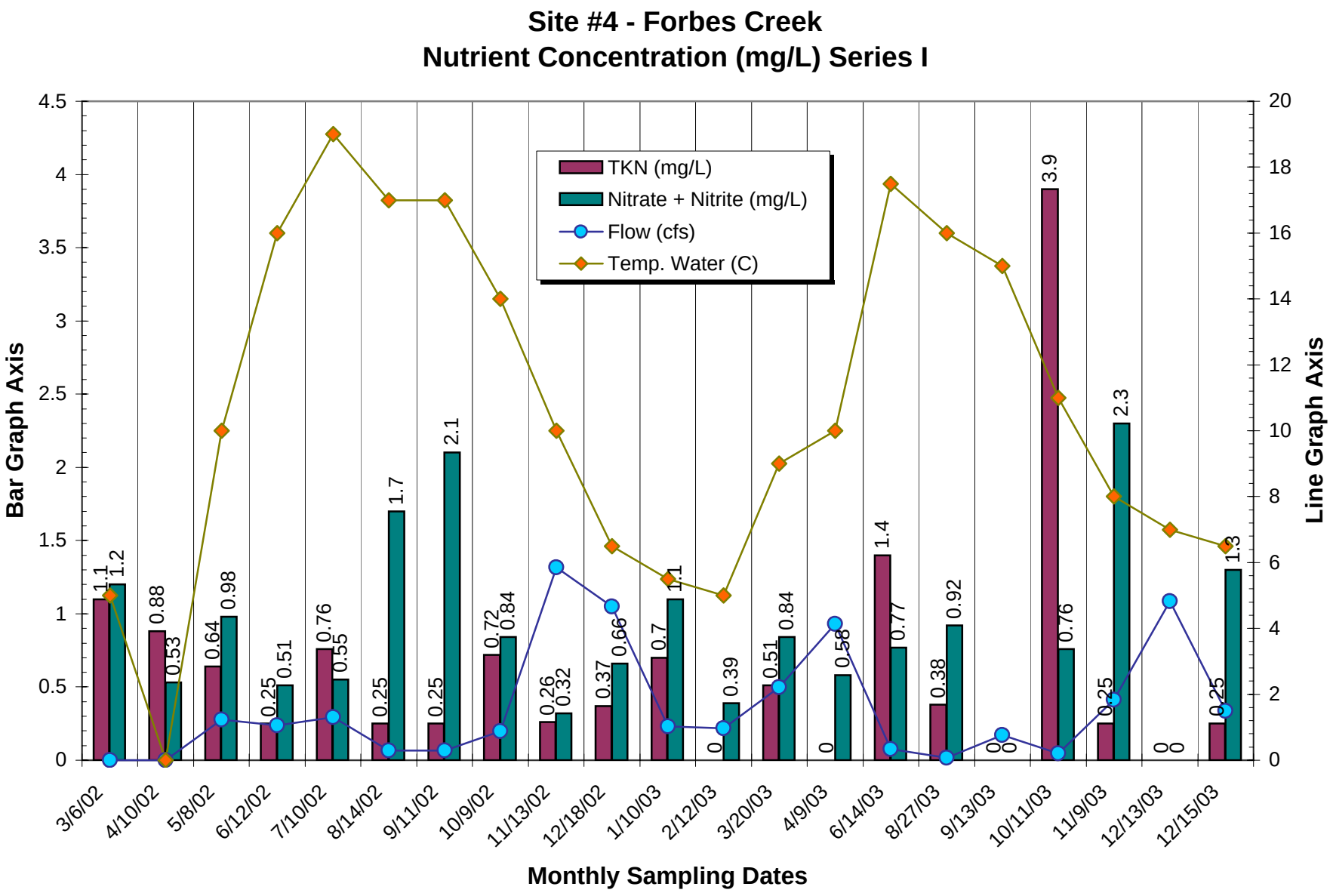
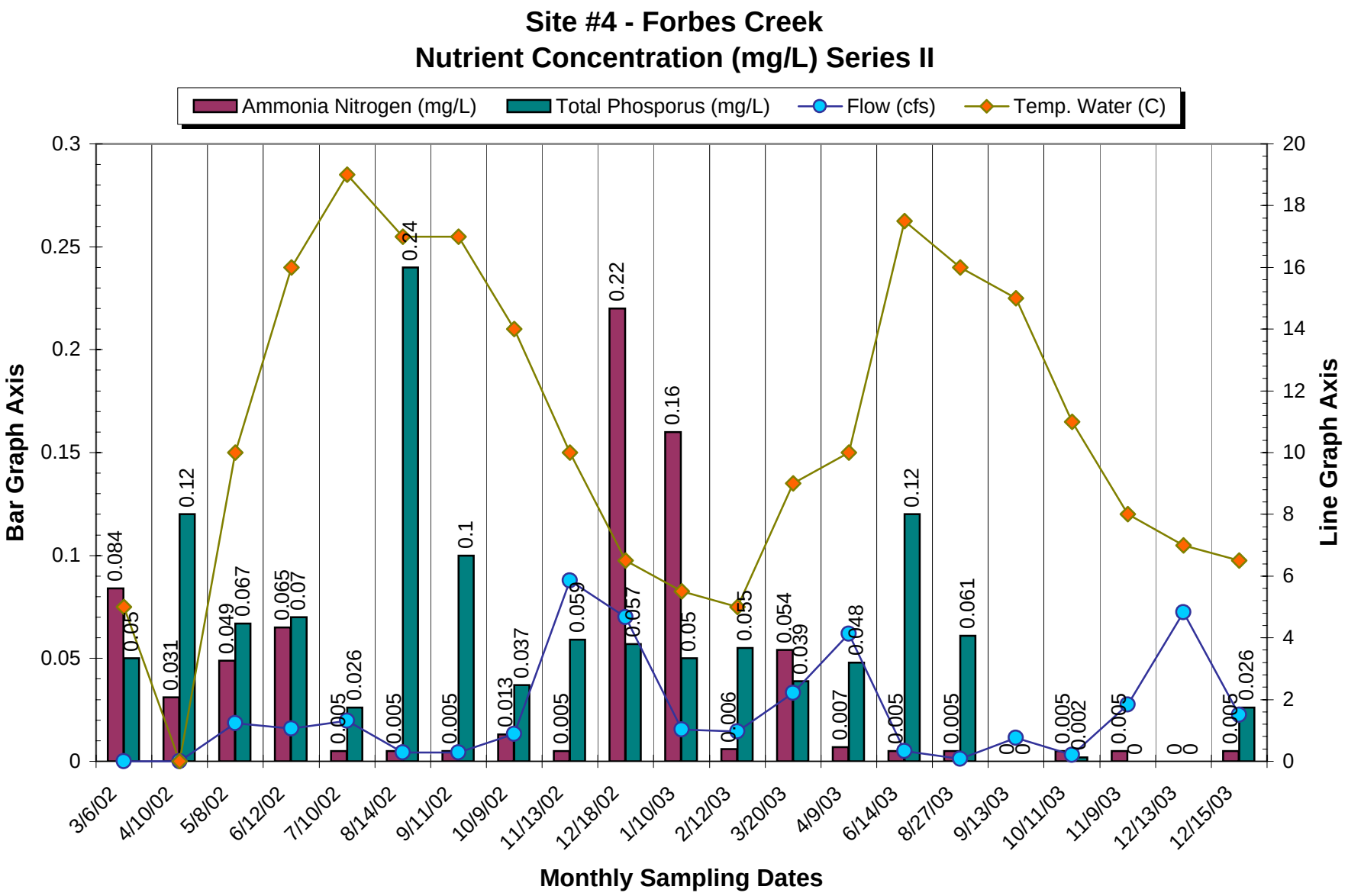
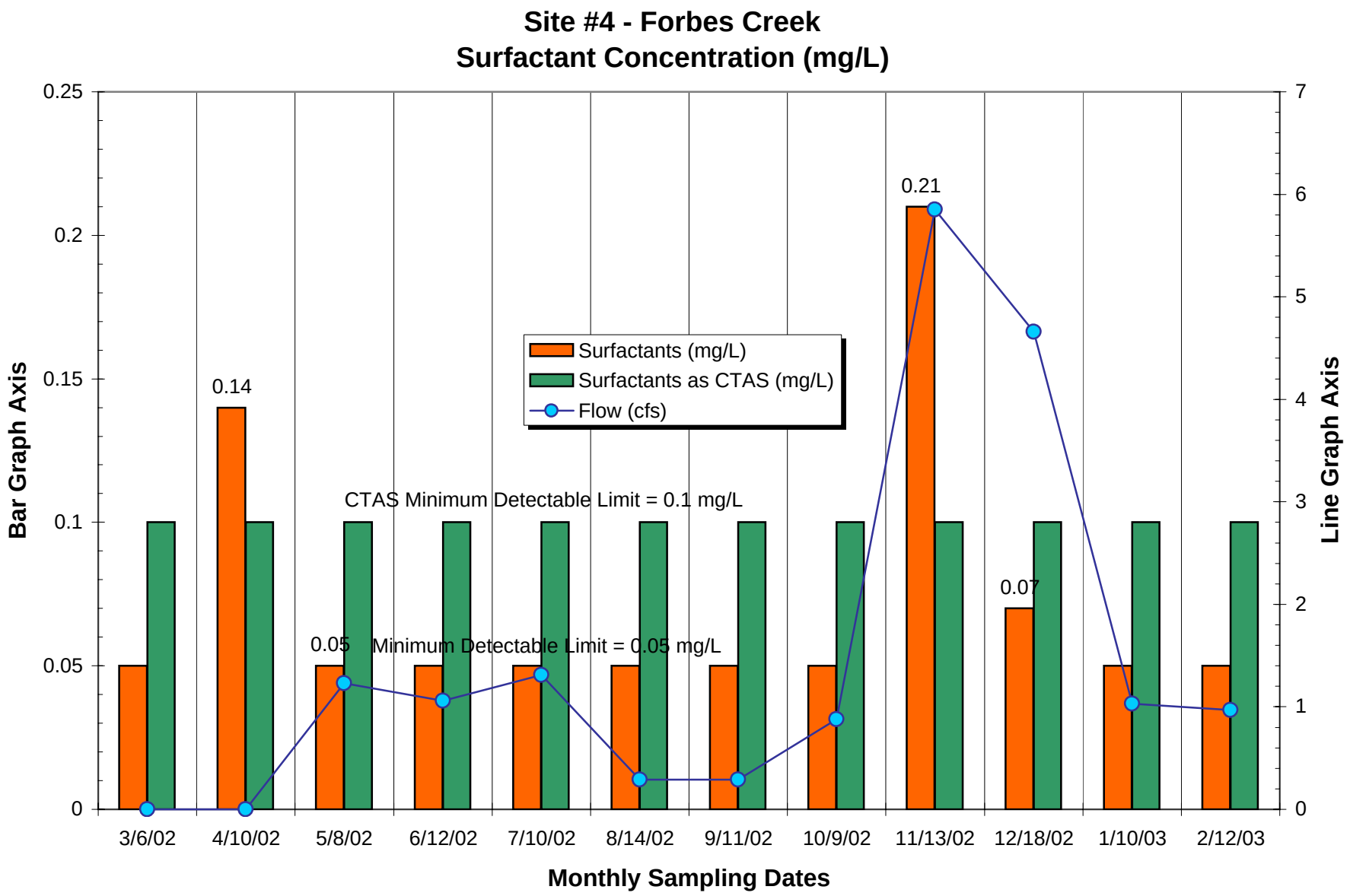
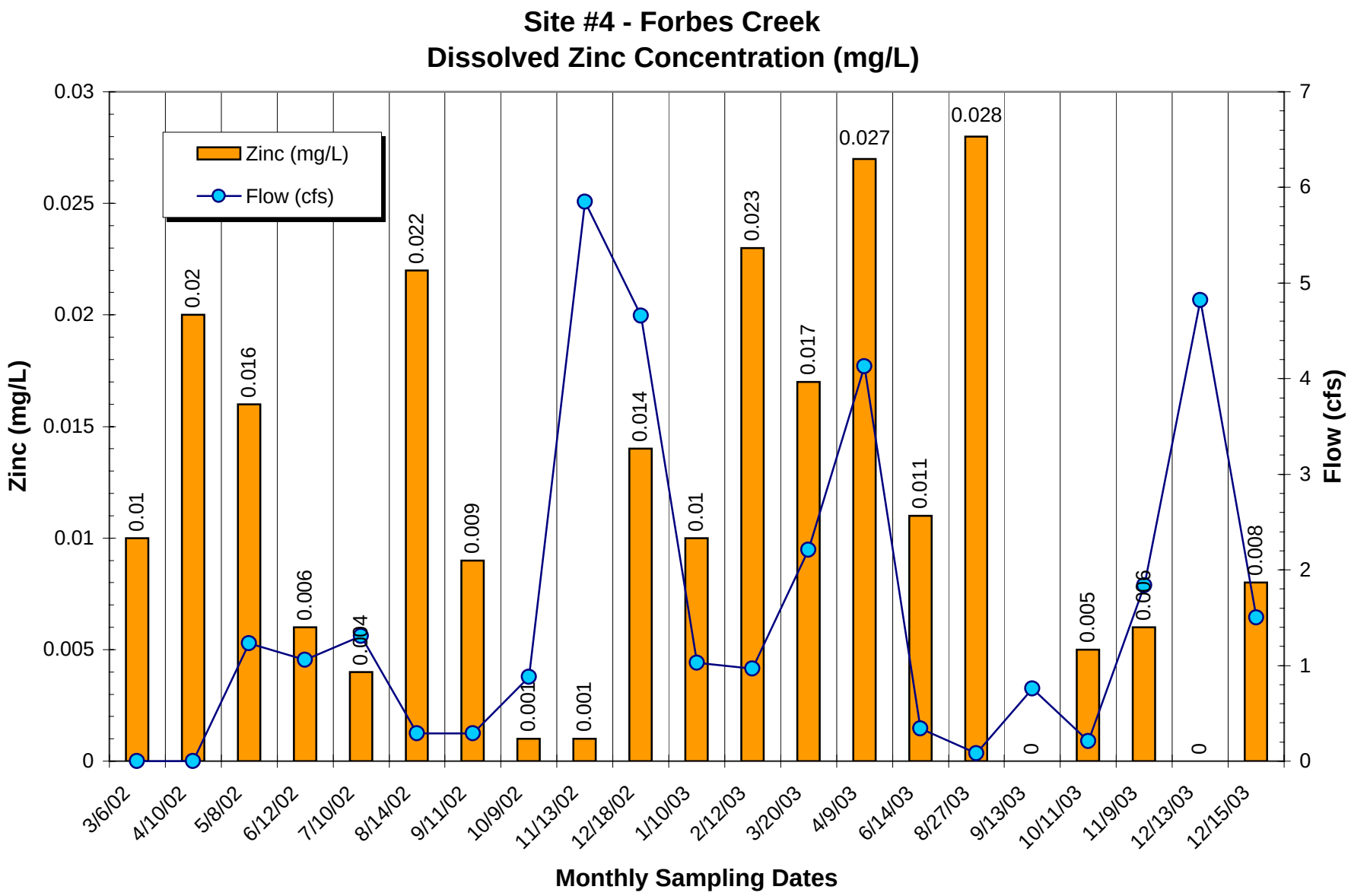
11/9/03
12/13/03
12/15/03


Site #4 - Forbes Creek
Nutrient Concentration (mg/L) Series I
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03


Site #4 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03


Site #4 - Forbes Creek
Surfactant Concentration (mg/L)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
Surfactants (mg/L)
Surfactants as CTAS (mg/L)
Flow (cfs)
CTAS Minimum Detectable Limit = 0.1 mg/L
Minimum Detectable Limit = 0.05 mg/L
0.14
0.05
0.21
0.07
0.25
0.2
0.15
0.1
0.05
0
7
6
5
4
3
2
1
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03

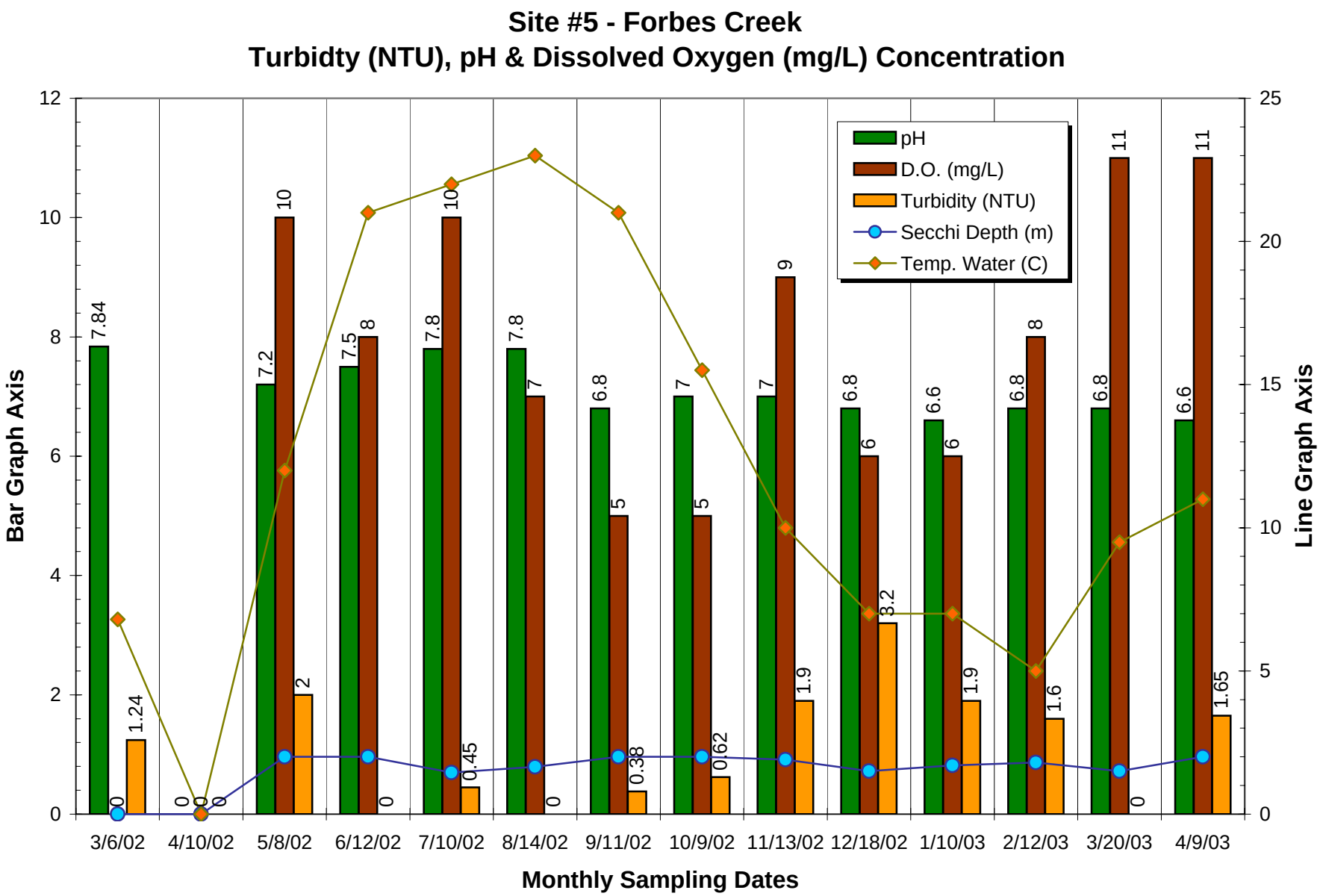

Site #4 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
0.03
0.025
0.02
0.015
0.01
0.005
0
7
6
5
4
3
2
1
0
0.01
0.02
0.016
0.006
0.004
0.022
0.009
0.001
0.001
0.014
0.01
0.023
0.017
0.027
0.011
0.028
0
0.005
0.006
0
0.008
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03
Monthly Sampling Dates

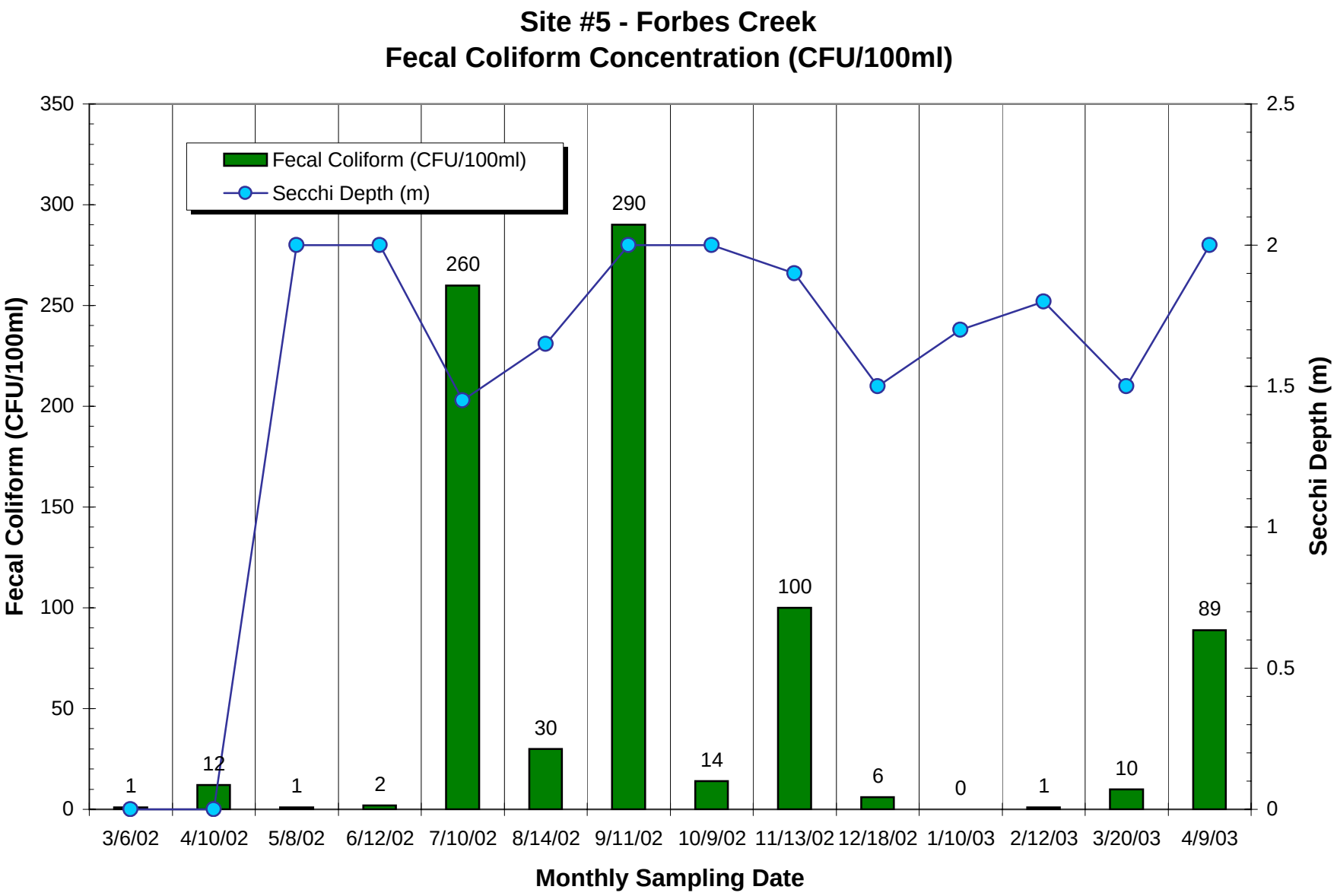
	Site #5	3/6/02	4/10/02	5/8/02	6/12/02	7/10/02	8/14/02	9/11/02	10/9/02	11/13/02	12/18/02	1/10/03	2/12/03	3/20/03	4/9/03
In-House	Time	9:30	9:10	9:45	9:45	9:30	8:55	15:25	9:45	9:20	9:45	15:40	9:30	10:05	9:30
	Temp. Air (C)	2	*	12	27	41	25	25	12.5	14	6	7	6	9.5	10
	Temp. Water (C)	6.8	*	12	21	22	23	21	15.5	10	7	7	5	9.5	11
	pH	7.84	*	7.2	7.5	7.8	7.8	6.8	7	7	6.8	6.6	6.8	6.8	6.6
	D.O. (mg/L)	*	*	10	8	10	7	5	5	9	6	6	8	11	11
	Alkalinity (ppm)	*	*	80	80	80	80	90	80	40	40	40	40	60	40
	Total Chlorine (ppm)	*	*	0	0	0	0.5	0	0	0	0	0	0	*	*
	Free Chlorine (ppm)	*	*	0	0	0	0	0	0	0	0	0	0	*	*
	Total Hardenss (ppm)	*	*	120	120	180	120	120	120	120	120	100	120	*	*
	Turbidity (NTU)	1.24	*	2	*	0.45	*	0.38	0.62	1.9	3.2	1.9	1.6	*	1.65
	Secchi Depth (m)	*	*	2	2	1.45	1.65	2	2	1.9	1.5	1.7	1.8	1.5	2
Laboratory	Fecal Coliform (CFU/100ml)	1	12	1	2	260	30	290	14	100	6	*	1	10	89
	Ammonia Nitrogen (mg/L)	0.14	0.07	0.09	0.06	0.01	0.005	0.005	0.008	0.005	0.43	0.36	0.004	0.062	0.006
	TKN (mg/L)	2.30	1.90	0.77	0.25	0.60	0.25	0.4	0.66	0.62	0.35	0.78	*	0.75	*
	Nitrate + Nitrite (mg/L)	0.43	0.43	0.13	0.26	0.12	0.01	0.1	0.042	0.11	0.2	0.22	0.096	0.34	0.36
	Total Phosporus (mg/L)	0.02	0.05	0.06	0.02	0.02	0.031	0.036	0.02	0.035	0.067	0.2	0.084	0.032	0.048
	Surfactants (mg/L)	0.05	0.82	0.05	0.05	0.11	0.05	0.05	0.05	0.26	0.05	0.05	0.05	*	*
	Surfactants as CTAS (mg/L)	0.20	0.10	0.10	0.10	0.10	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*	*
	Zinc (mg/L)	0.10	0.02	0.01	0.01	0.002	0.005	0.013	0.001	0.001	0.008	0.007	0.007	0.015	0.037

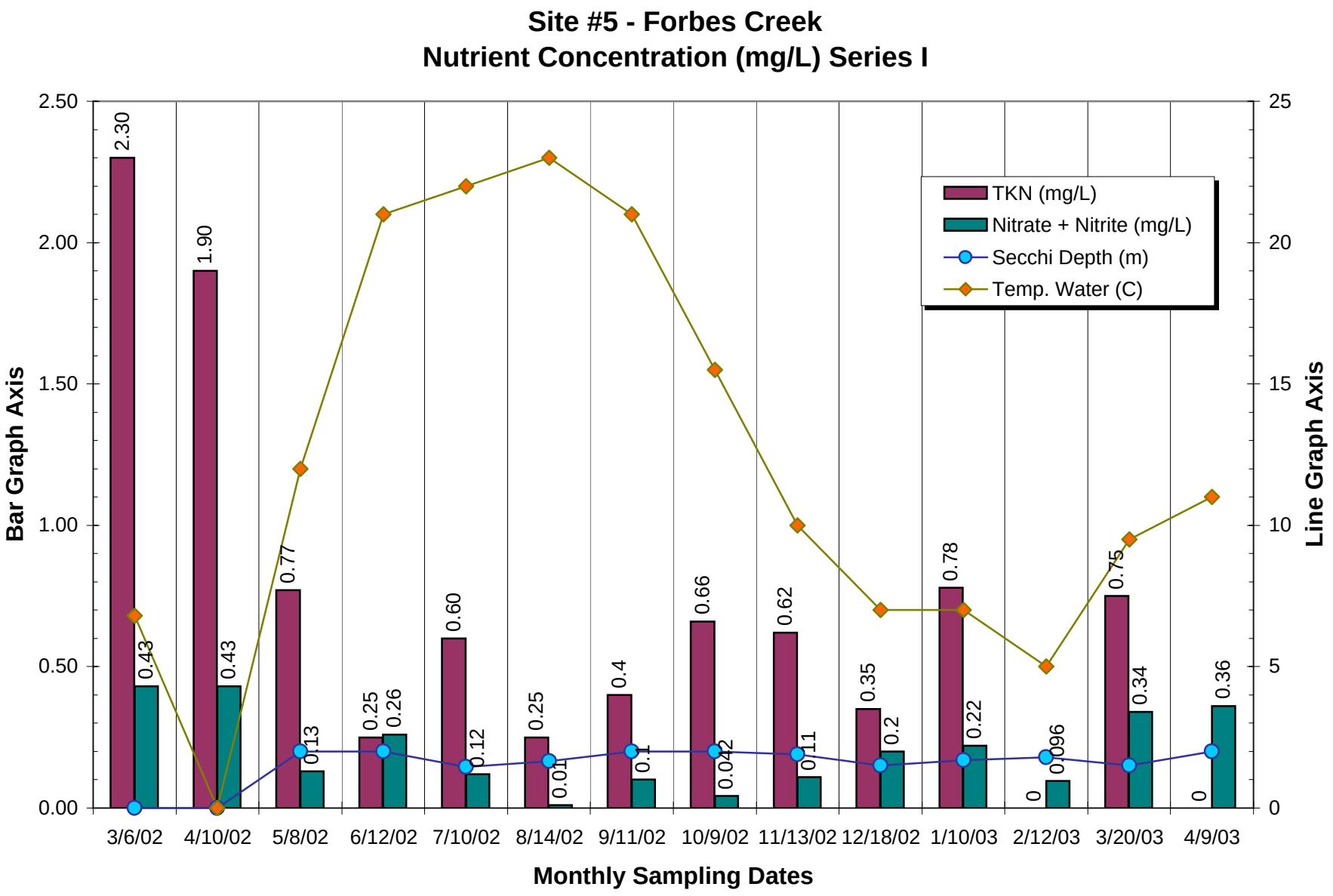
* No data taken or deemed invalid

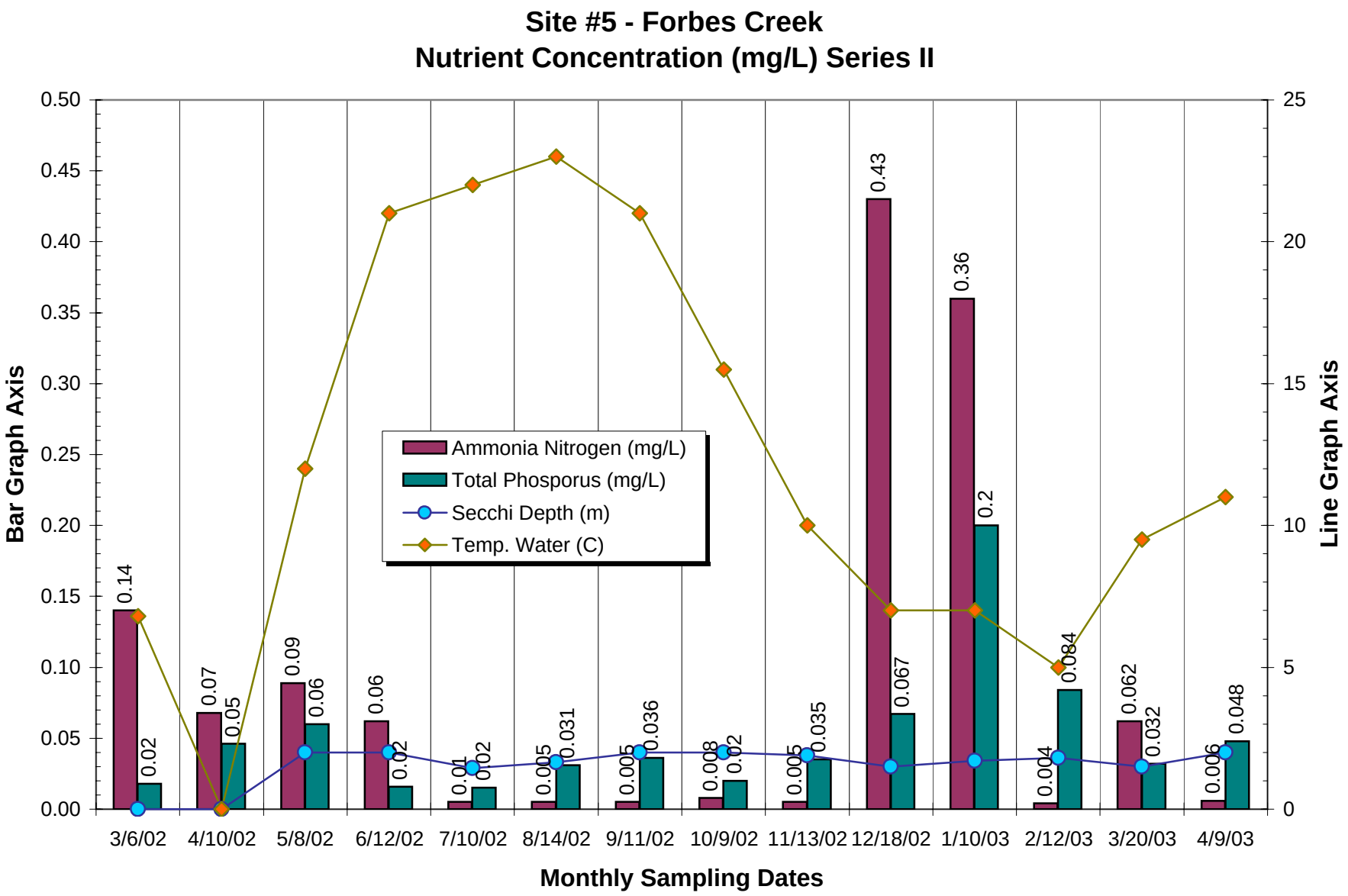
Forbes Creek Site #5 is loacted at Forbes Lake off of the dock at 12031 NE 97th Street (Private Property). See Site Map for exact location.

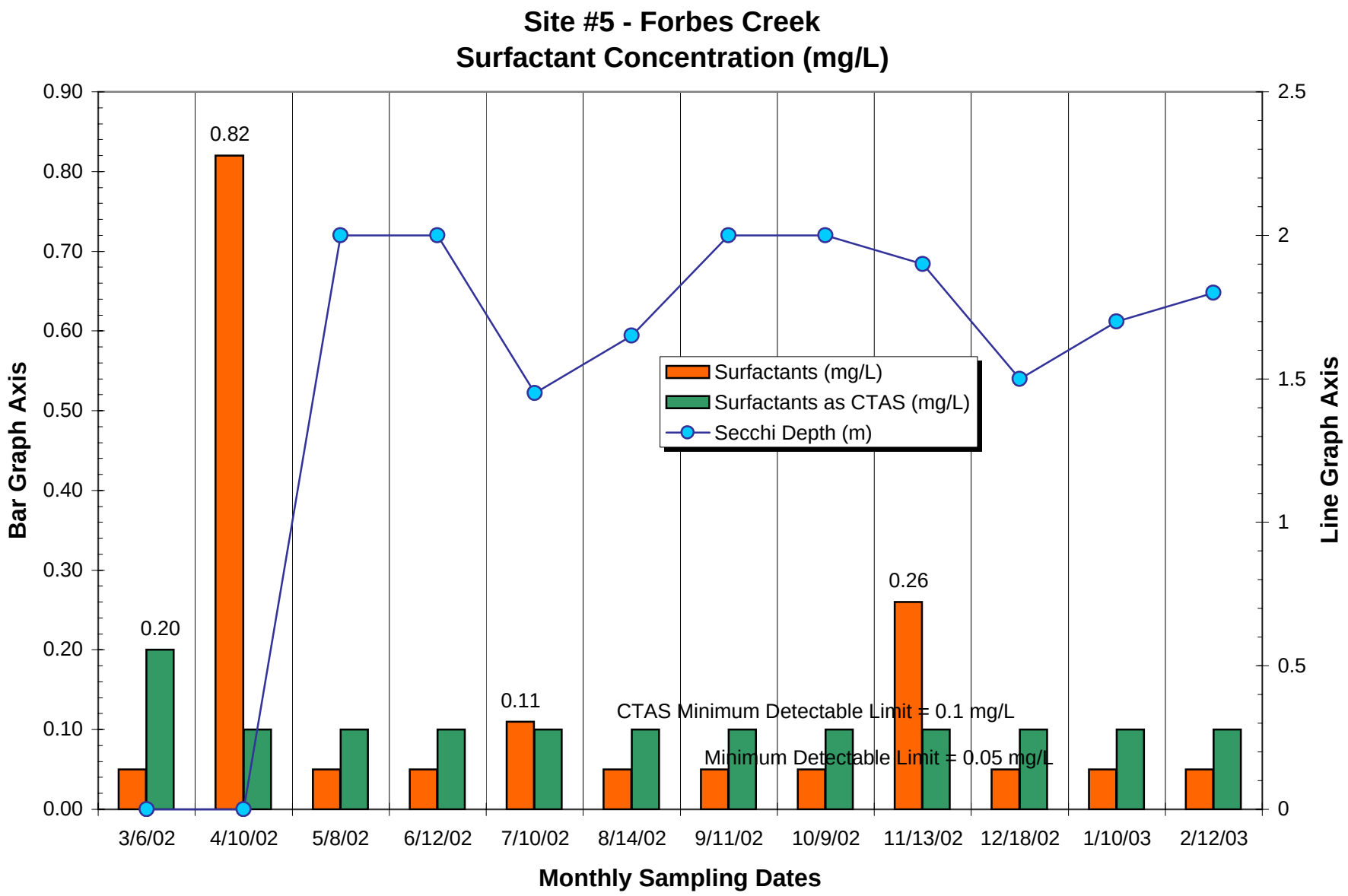
Average Values	
Temp. Water (C)	**13.1**
pH	**7.1**
D.O. (mg/L)	**8.0**
Turbidity (NTU)	**1.49**
Secchi (m)	**1.80**
Fecal Coliform (CFU/100ml)	**63**
Ammonia Nitrogen (mg/L)	**0.089**
TKN (mg/L)	**0.80**
Alkalinity (ppm)	**63**
Total Hardness (ppm)	**124**
Nitrate + Nitrite (mg/L	**0.20**
Total Phosporus (mg/	**0.051**
Surfactants (mg/L)	**0.14**
Surfactants as CTAS (mg/L)	**0.11**
Zinc (mg/L)	**0.017**

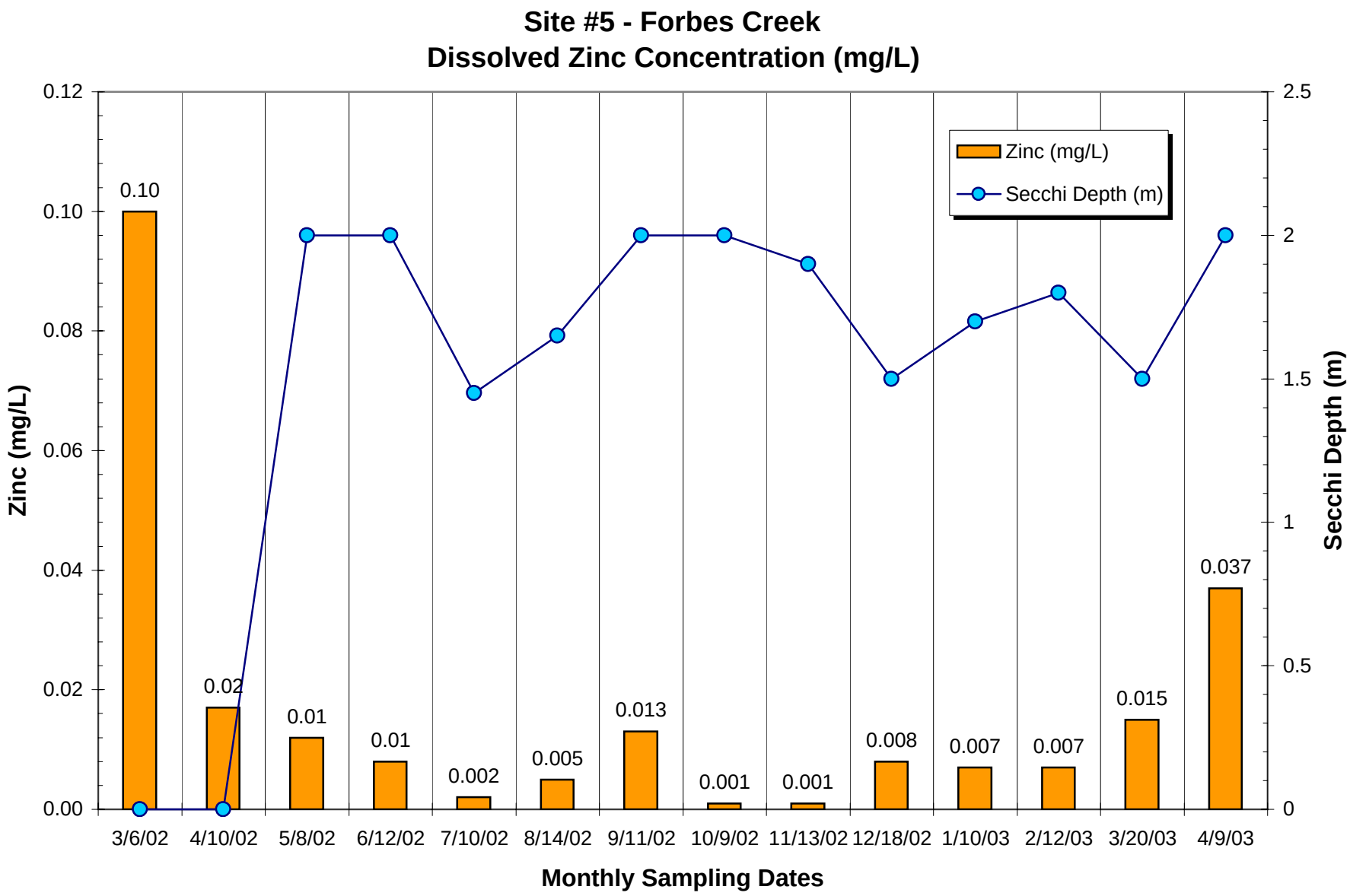

Site #5 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
pH
D.O. (mg/L)
Turbidity (NTU)
Secchi Depth (m)
Temp. Water (C)
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03


Site #5 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Secchi Depth (m)
Fecal Coliform (CFU/100ml)
Secchi Depth (m)
350
300
250
200
150
100
50
0
2.5
2
1.5
1
0.5
0
1
12
1
2
260
30
290
14
100
6
0
1
10
89
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
Monthly Sampling Date


Site #5 - Forbes Creek
Nutrient Concentration (mg/L) Series I
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Secchi Depth (m)
Temp. Water (C)
2.50
2.00
1.50
1.00
0.50
0.00
25
20
15
10
5
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
2.30
0.43
1.90
0.43
0.77
0.13
0.25
0.26
0.60
0.12
0.25
0.01
0.4
0.1
0.66
0.042
0.62
0.11
0.35
0.2
0.78
0.22
0
0.096
0.75
0.34
0
0.36


Site #5 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Secchi Depth (m)
Temp. Water (C)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
25
20
15
10
5
0
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
0.14
0.02
0.07
0.05
0.09
0.06
0.06
0.02
0.01
0.02
0.005
0.031
0.005
0.036
0.008
0.02
0.005
0.035
0.43
0.067
0.36
0.2
0.004
0.084
0.062
0.032
0.006
0.048


Site #5 - Forbes Creek
Surfactant Concentration (mg/L)
Bar Graph Axis
Line Graph Axis
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
2.5
2
1.5
1
0.5
0
0.20
0.82
0.11
0.26
Surfactants (mg/L)
Surfactants as CTAS (mg/L)
Secchi Depth (m)
CTAS Minimum Detectable Limit = 0.1 mg/L
Minimum Detectable Limit = 0.05 mg/L
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
Monthly Sampling Dates


Site #5 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Secchi Depth (m)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2.5
2
1.5
1
0.5
0
0.10
0.02
0.01
0.01
0.002
0.005
0.013
0.001
0.001
0.008
0.007
0.007
0.015
0.037
3/6/02
4/10/02
5/8/02
6/12/02
7/10/02
8/14/02
9/11/02
10/9/02
11/13/02
12/18/02
1/10/03
2/12/03
3/20/03
4/9/03
Monthly Sampling Dates

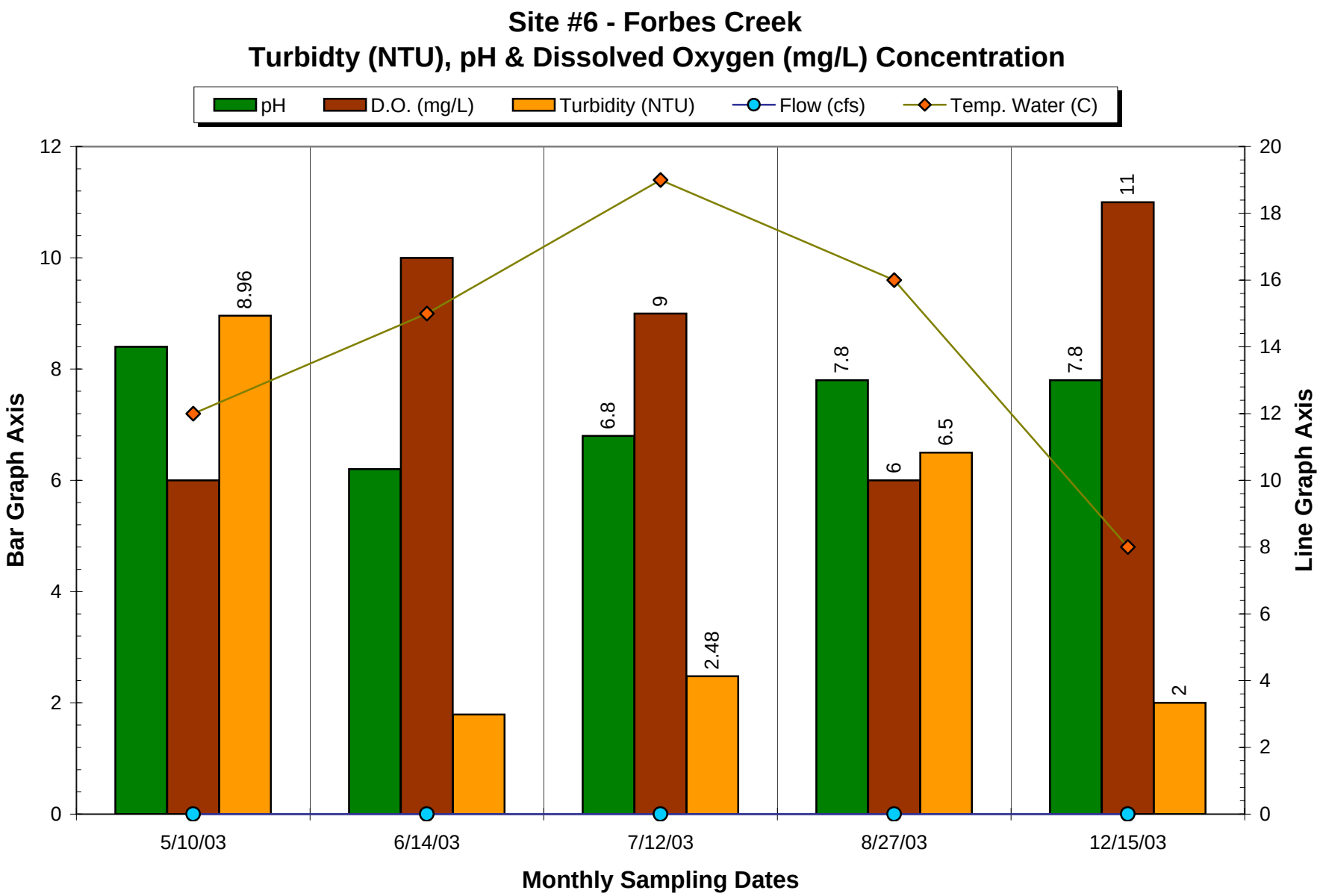
Site #6

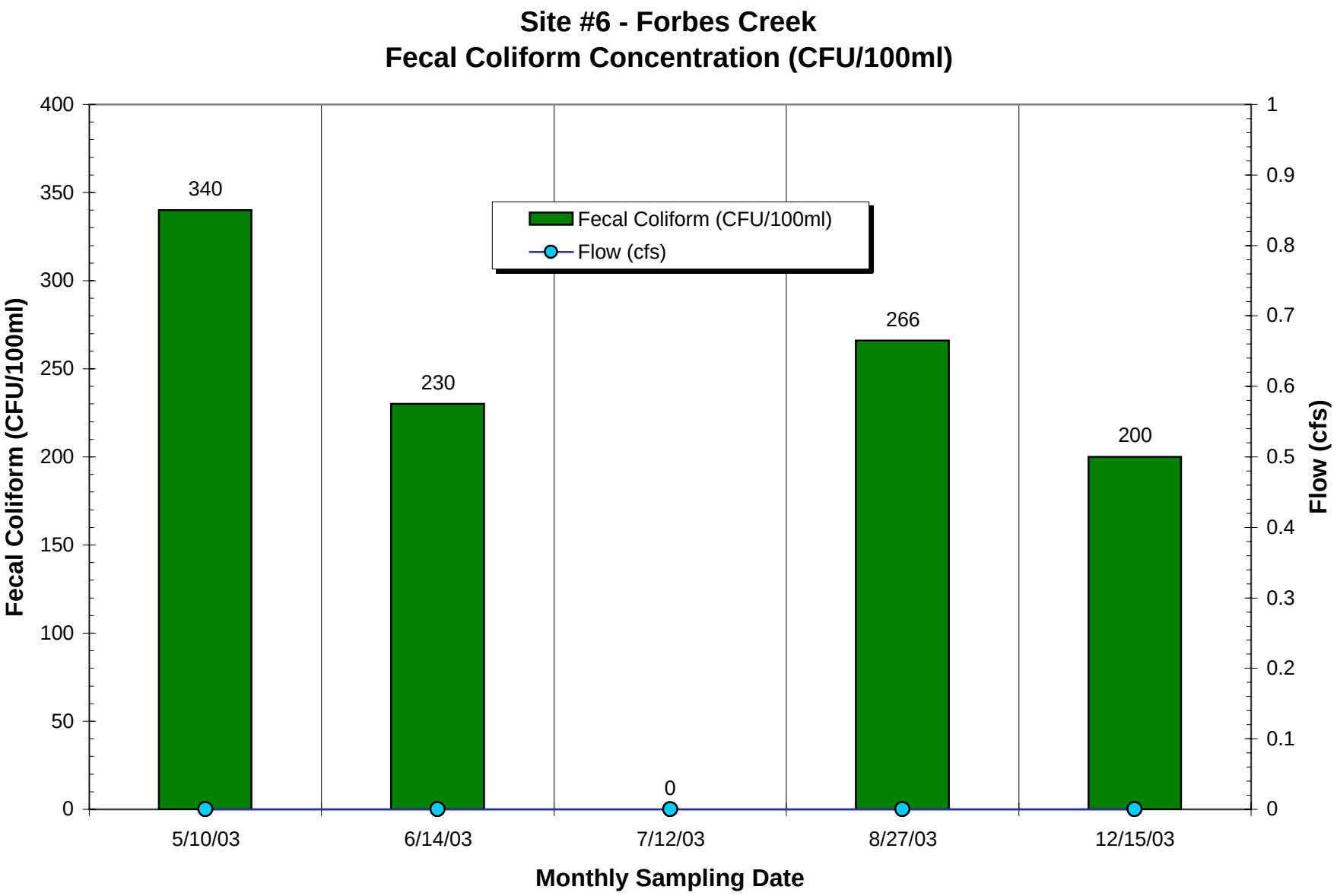
		5/10/03	6/14/03	7/12/03	8/27/03	12/15/03
In-House	Time	10:05	11:40	11:25	10:00	14:15
	Temp. Air (C)	13	18	28	19	9
	Temp. Water (C)	12	15	19	16	8
	pH	8.4	6.2	6.8	7.8	7.8
	D.O. (mg/L)	6	10	9	6	11
	Turbidity (NTU)	8.96	1.79	2.48	6.5	2
	Alkalinity (ppm)	80	120	80	120	180
	Flow (cfs)	*	*	*	*	*
Laboratory	Fecal Coliform (CFU/100ml)	340	230	*	266	200
	Ammonia Nitrogen (mg/L)	0.005	0.005	*	0.005	0.11
	TKN (mg/L)	0.25	0.97	*	0.5	0.25
	Nitrate + Nitrite (mg/L)	2.6	3.6	*	2.7	2.7
	Total Phosporus (mg/L)	0.06	0.04	*	0.019	0.005
	Zinc (mg/L)	0.018	0.014	*	0.008	0.009

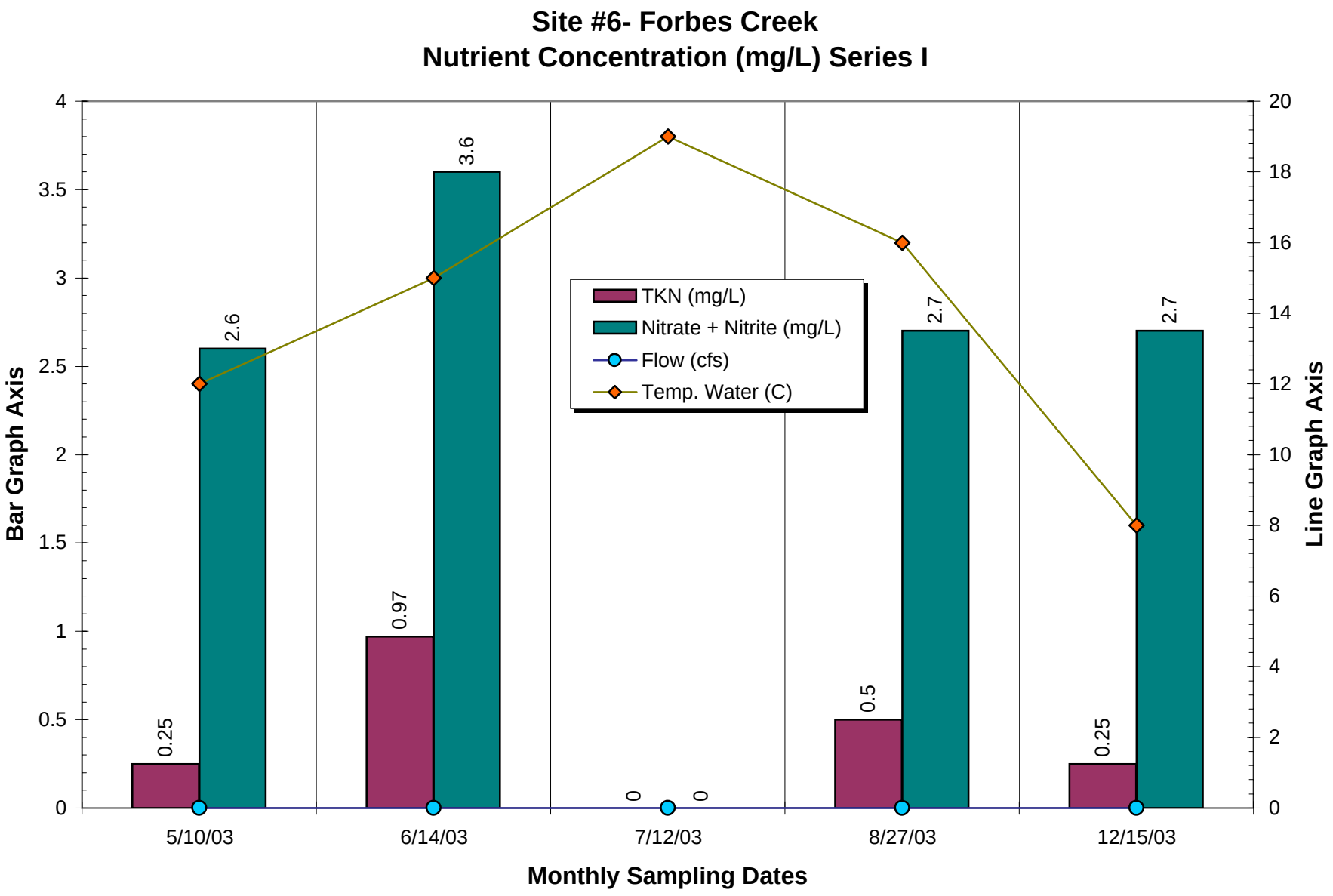
* No data taken or deemed invalid

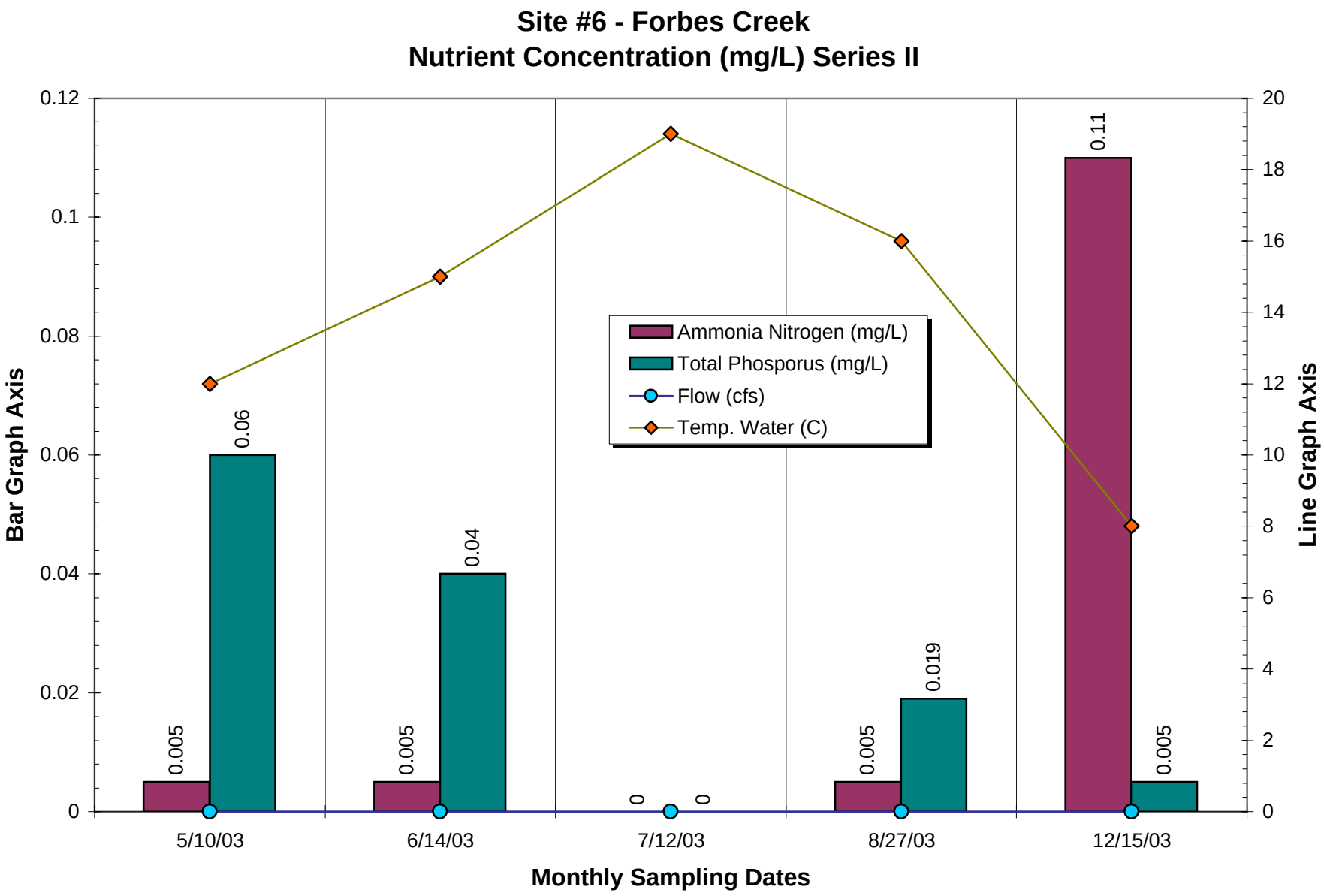
Forbes Creek Site #6 is loacted at the southeast corner of 126th Avenue NE and NE 95th Street. See Site Map for exact location.

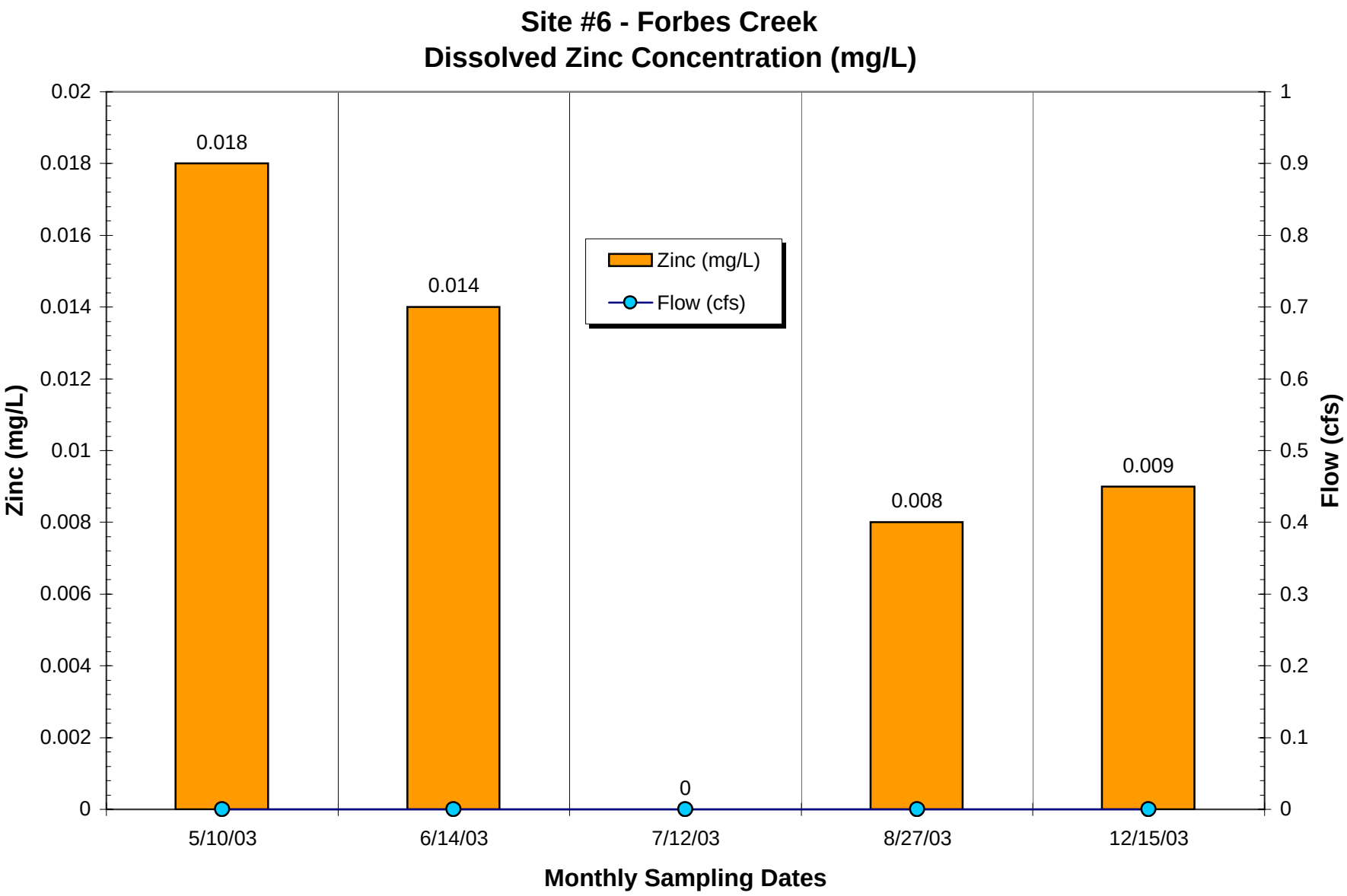
Average Values	
Temp. Water (C)	**14.0**
pH	**7.4**
D.O. (mg/L)	**8.4**
Turbidity (NTU)	**4.35**
Flow (cfs)	**0.00**
Fecal Coliform (CFU/100ml)	**207**
Ammonia Nitrogen (mg/L)	**0.03**
TKN (mg/L)	**0.49**
Alkalinity (ppm)	**116**
Nitrate + Nitrite (mg	**2.93**
Total Phosporus (m	**0.03**
Zinc (mg/L)	**0.012**


Site #6 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration
pH
D.O. (mg/L)
Turbidity (NTU)
Flow (cfs)
Temp. Water (C)
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
5/10/03
6/14/03
7/12/03
8/27/03
12/15/03
8.96
6.8
9
2.48
7.8
6
6.5
7.8
11
2
0
2
4
6
8
10
12
0
2
4
6
8
10
12
14
16
18
20


Site #6 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Fecal Coliform (CFU/100ml)
Flow (cfs)
340
230
0
266
200
400
350
300
250
200
150
100
50
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5/10/03
6/14/03
7/12/03
8/27/03
12/15/03
Monthly Sampling Date


Site #6- Forbes Creek
Nutrient Concentration (mg/L) Series I
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
5/10/03
6/14/03
7/12/03
8/27/03
12/15/03
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
0.25
2.6
0.97
3.6
0
0
0.5
2.7
0.25
2.7
0
0.5
1
1.5
2
2.5
3
3.5
4
0
2
4
6
8
10
12
14
16
18
20


Site #6 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
5/10/03
6/14/03
7/12/03
8/27/03
12/15/03
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
0.005
0.06
0.005
0.04
0
0
0.005
0.019
0.11
0.005
0
0.02
0.04
0.06
0.08
0.1
0.12
0
2
4
6
8
10
12
14
16
18
20


Site #6 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
0.018
0.014
0
0.008
0.009
Zinc (mg/L)
Flow (cfs)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5/10/03
6/14/03
7/12/03
8/27/03
12/15/03
Monthly Sampling Dates

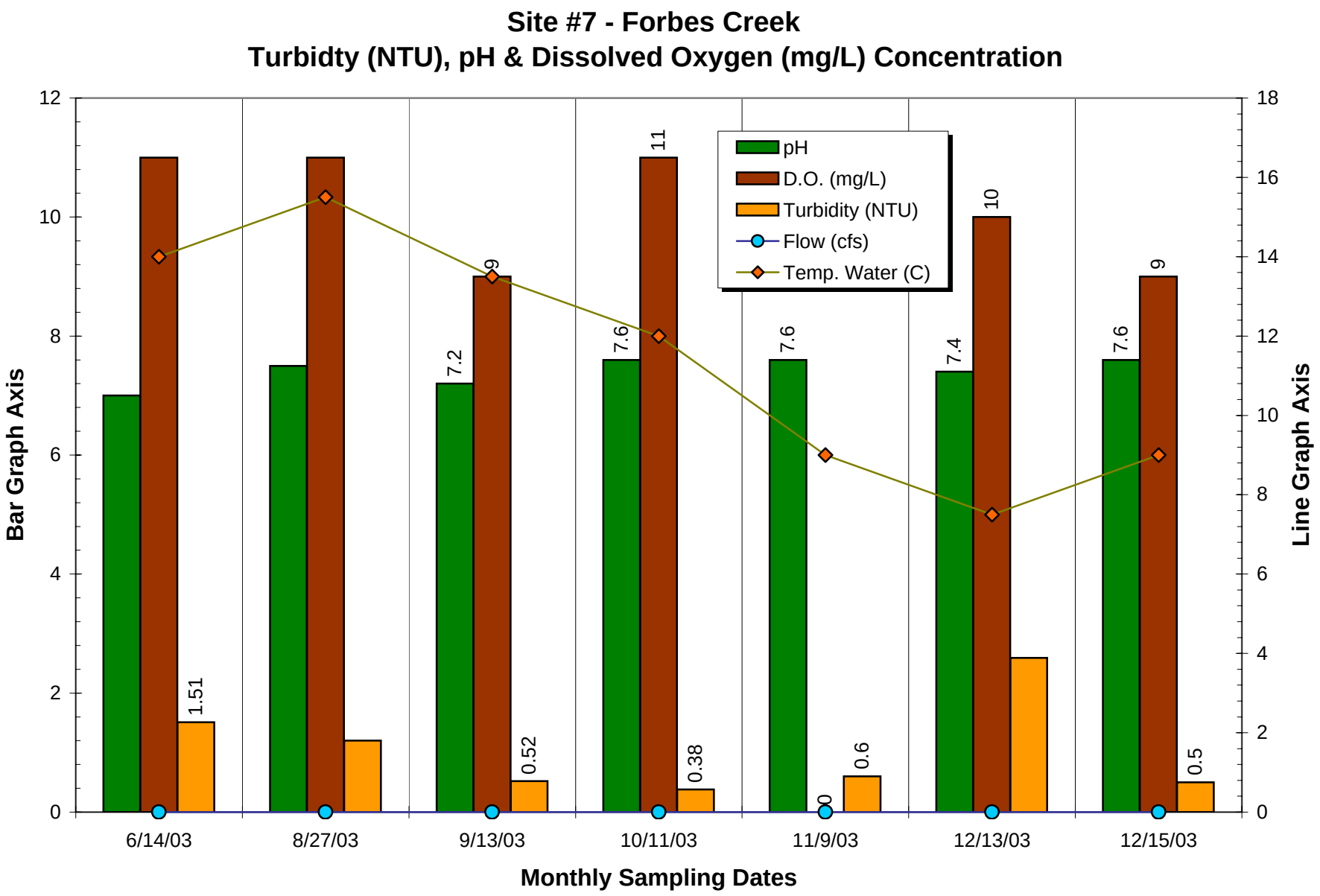
Site #7

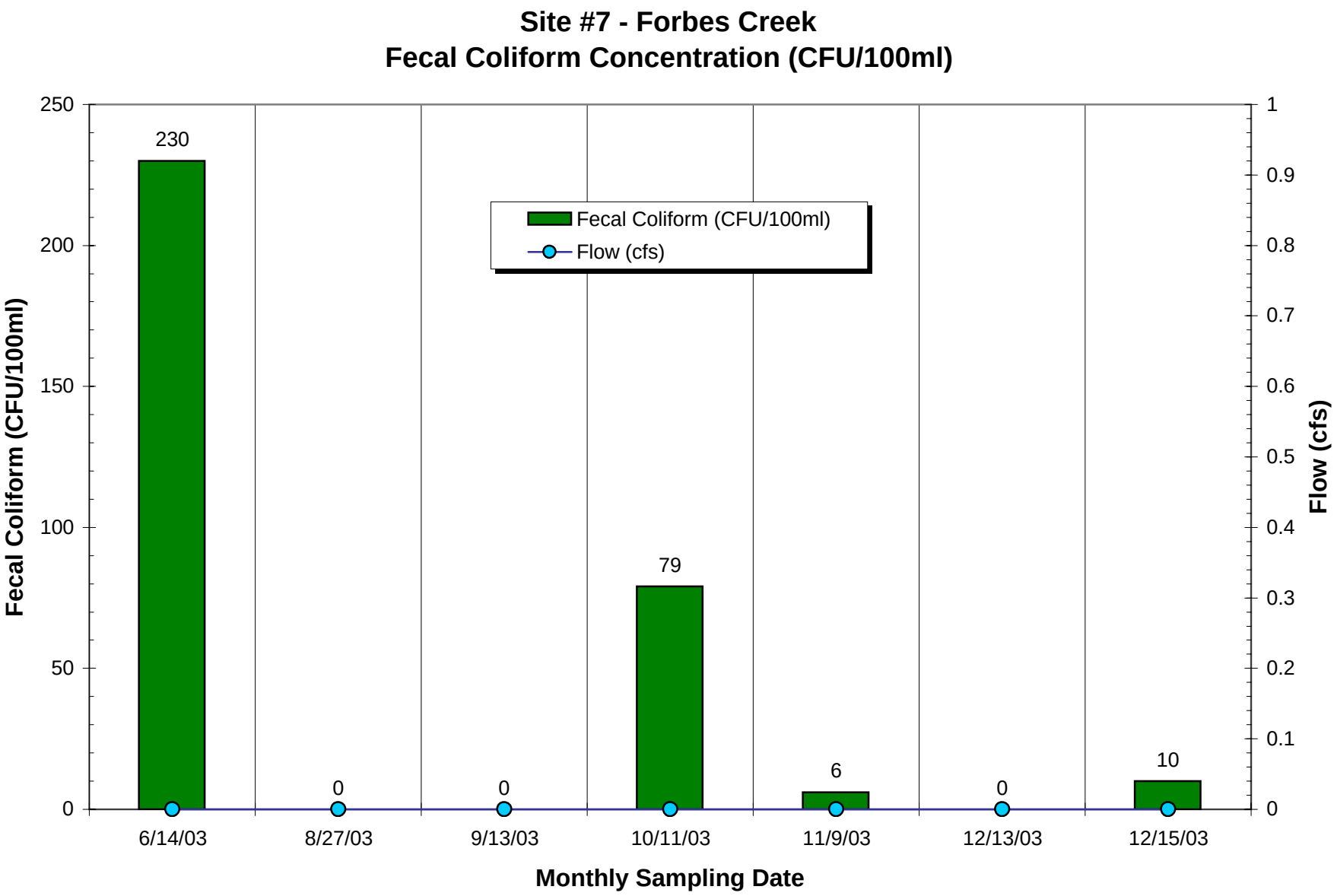
		6/14/03	8/27/03	9/13/03	10/11/03	11/9/03	12/13/03	12/15/03
In-House	Time	12:45	9:30	10:14	10:30	10:35	10:05	14:00
	Temp. Air (C)	20.5	17.5	15	11	7	9.5	10.5
	Temp. Water (C)	14	15.5	13.5	12	9	7.5	9
	pH	7	7.5	7.2	7.6	7.6	7.4	7.6
	D.O. (mg/L)	11	11	9	11	*	10	9
	Turbidity (NTU)	1.51	1.2	0.52	0.38	0.6	2.59	0.5
	Alkalinity (ppm)	80	100	120	80	100	60	180
	Flow (cfs)	*	*	*	*	*	*	*
Laboratory	Fecal Coliform (CFU/100ml)	230	*	*	79	6	*	10
	Ammonia Nitrogen (mg/L)	0.005	*	*	0.005	0.005	*	0.035
	TKN (mg/L)	0.97	*	*	2.8	0.56	*	0.25
	Nitrate + Nitrite (mg/L)	3.6	*	*	*	4	*	4.8
	Total Phosporus (mg/L)	0.04	*	*	0.073	*	*	0.005
	Zinc (mg/L)	0.014	*	*	0.016	0.015	*	0.012

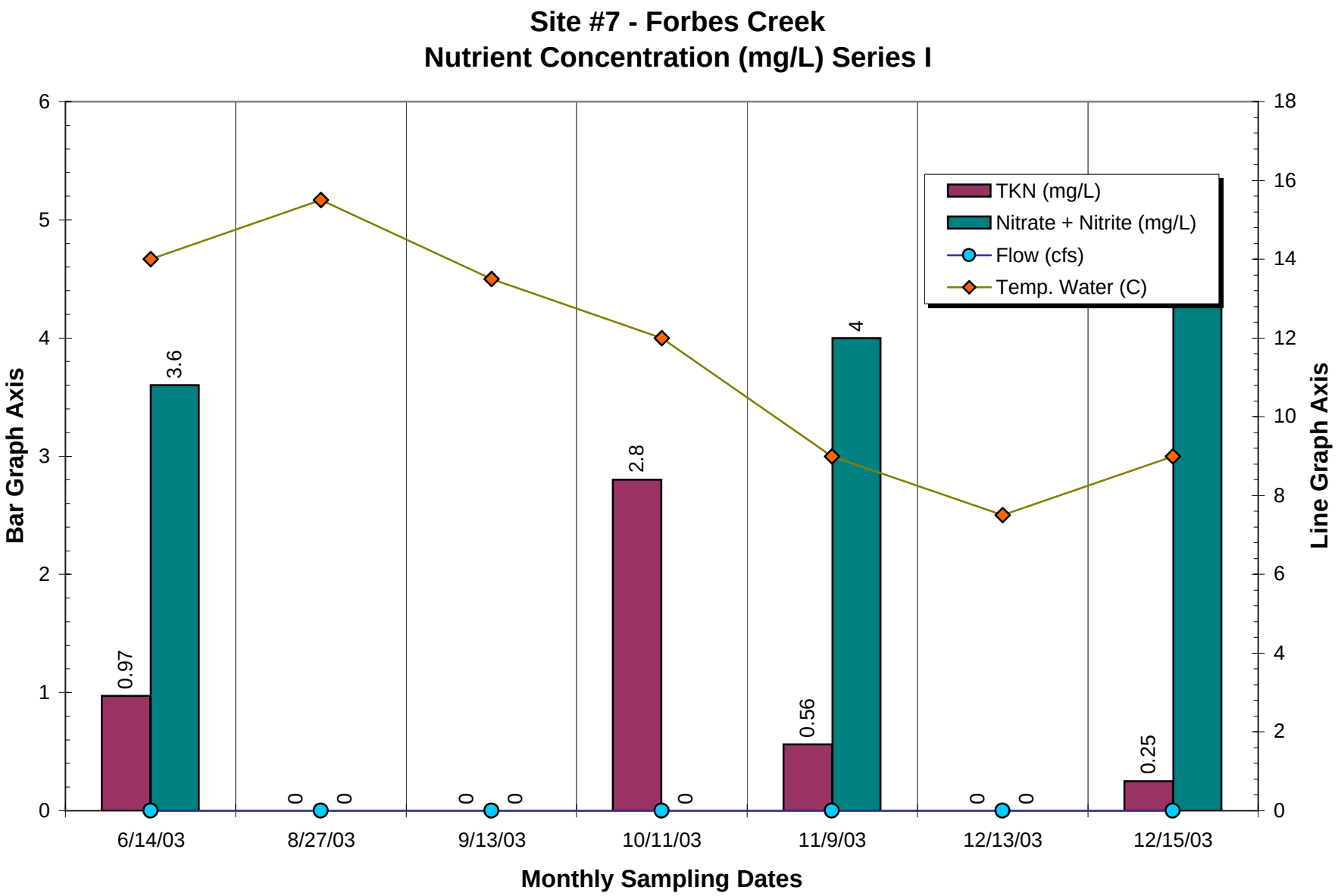
* No data taken or deemed invalid

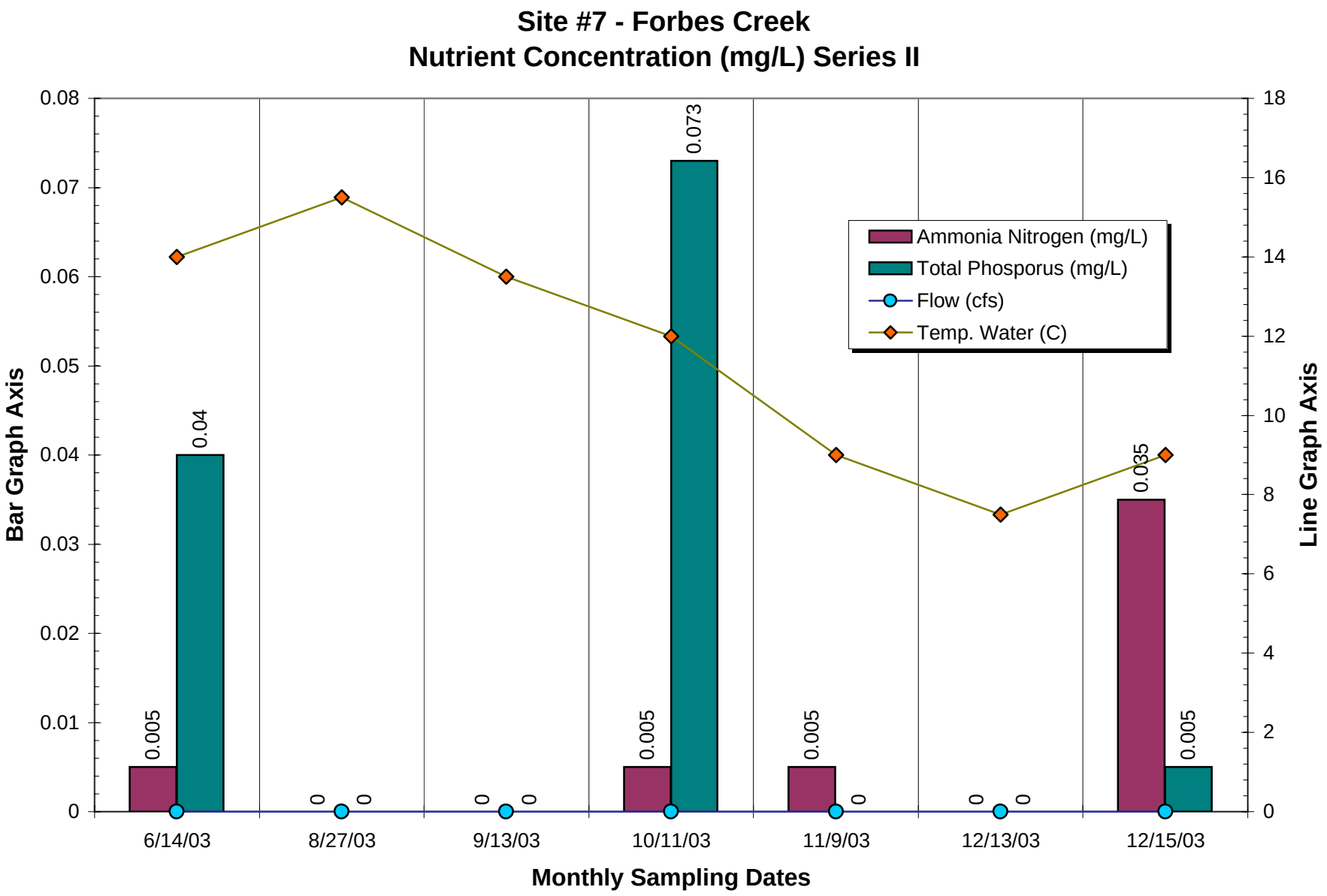
Forbes Creek Site #7 is loacted approximately 50 feet west of the 128th Avenue NE and NE 90th Street Intersection on the north side of NE

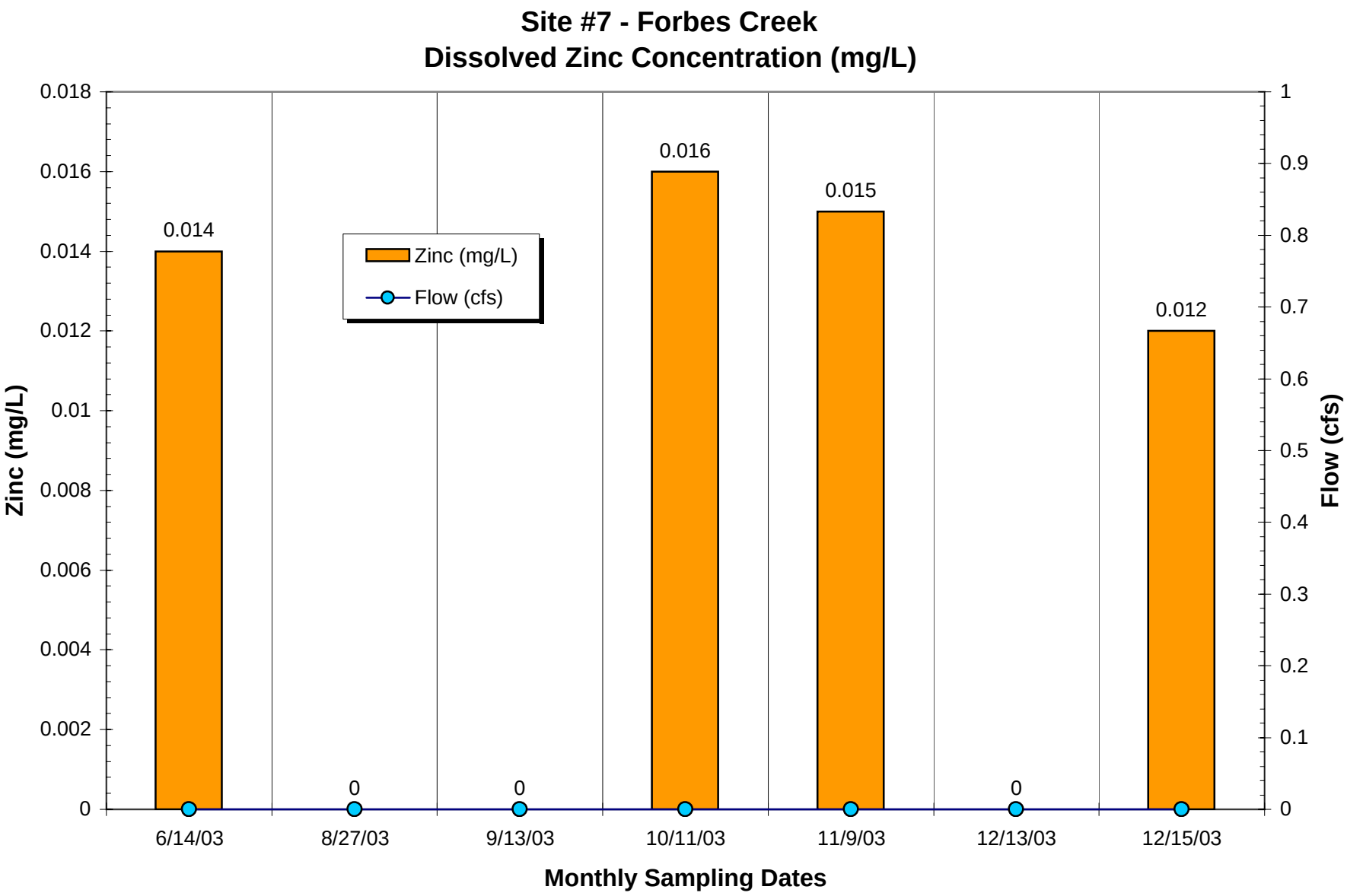
Average Values	
Temp. Water (C)	**11.5**
pH	**16.1**
D.O. (mg/L)	**10.2**
Turbidity (NTU)	**1.04**
Flow (cfs)	**0.00**
Fecal Coliform (CFU/100ml)	**81**
Ammonia Nitrogen (mg/L)	**0.013**
TKN (mg/L)	**1.15**
Alkalinity (ppm)	**103**
Nitrate + Nitrite (mg/L)	**3.10**
Total Phosporus (mg/L)	**0.04**
Zinc (mg/L)	**0.014**


Site #7 - Forbes Creek
Turbidty (NTU), pH & Dissolved Oxygen (mg/L) Concentration
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03
pH
D.O. (mg/L)
Turbidity (NTU)
Flow (cfs)
Temp. Water (C)
1.51
7.2
9
0.52
7.6
11
0.38
7.6
0
0.6
7.4
10
7.6
9
0.5


Site #7 - Forbes Creek
Fecal Coliform Concentration (CFU/100ml)
Fecal Coliform (CFU/100ml)
Flow (cfs)
Fecal Coliform (CFU/100ml)
Flow (cfs)
250
200
150
100
50
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
230
0
0
79
6
0
10
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03
Monthly Sampling Date

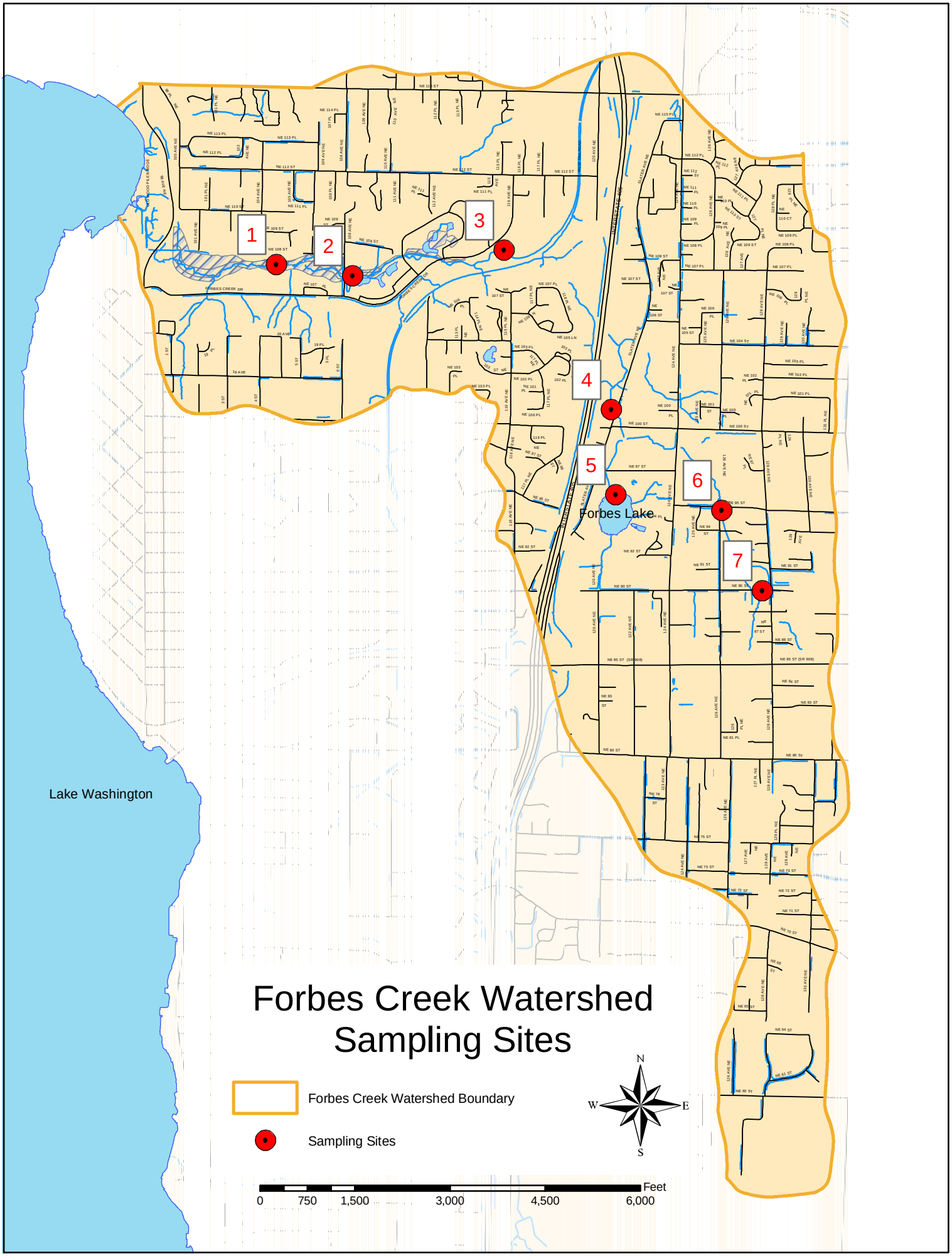

Site #7 - Forbes Creek
Nutrient Concentration (mg/L) Series I
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
TKN (mg/L)
Nitrate + Nitrite (mg/L)
Flow (cfs)
Temp. Water (C)
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03
0.97
3.6
0
0
0
0
2.8
0
0.56
4
0
0
0.25
0
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
16
18


Site #7 - Forbes Creek
Nutrient Concentration (mg/L) Series II
Bar Graph Axis
Line Graph Axis
Monthly Sampling Dates
Ammonia Nitrogen (mg/L)
Total Phosporus (mg/L)
Flow (cfs)
Temp. Water (C)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
18
16
14
12
10
8
6
4
2
0
0.005
0.04
0
0
0
0
0.005
0.073
0.005
0
0
0
0.035
0.005
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03


Site #7 - Forbes Creek
Dissolved Zinc Concentration (mg/L)
Zinc (mg/L)
Flow (cfs)
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.014
0
0
0.016
0.015
0
0.012
6/14/03
8/27/03
9/13/03
10/11/03
11/9/03
12/13/03
12/15/03
Monthly Sampling Dates

Water Integrity Parameters, Descriptions and State Standards

Parameter	Description	WA State Standard for Class A Streams
Temperature	Water temperature is affected by air temperature, groundwater inflow, streamside vegetation, and stormwater inputs.	<18°C
pH	pH is the concentration of hydrogen ions in water in moles per liter. It is a measure of the acidity and basicity of water. pH can have a direct and indirect effects on stream water chemistry and the biota of aquatic ecosystems.	6.5 to 8.5
Dissolved Oxygen (mg/L)	The amount of oxygen dissolved in water. The capacity of water to hold oxygen is inversely proportional to water temperature: increases in water temperature lower the dissolved oxygen (DO).	> 8.0 mg/L
Turbidity (NTU)	Turbidity is the amount of light scattered or absorbed bya fluid. Water becomes turbid usually as a result of suspended particles of silt and clay. Other materials such as finely divided organic matter, plankton, and microorganisms can contribute to turbidity.	Not to exceed 5 NTU over background turbidity
Phosphorus (mg/L)	Phosphorus is a nutrient necessary for plant growth in aquatic and terrestrial sysytems, but excess phosphorus in surface waters can results in eutrophication (nutrient enrichment) of ater bodies. This can lead to excess awuatic plant growth in shallow waters and algal blooms.	No WA State standard, but the US EPA threshold for waters draining to lakes is 0.050 mg/L
Fecal Coliform (CFU/100ml)	Fecal coliform bacteria are microscopic organisms that live in the intestines of warm-bloded animals. They also live in the waste materials or feces excreted from the intestinal tract. Although not necessariliy agents of desease, fecal coliform bacteria indicate the potential presence of pathogenic organisms. Genetic testing must be conducted to distinguish human sources from animal sources.	100 CFU/100ml
Zinc (mg/L)	Many trace metal are toxic to aquatic organisms at very low concentrations. Zinc is commonly associated with urban runoff and is easily detectable	0.058 mg/L (based on a Hardness of 50 mg/L of $CaCO_3$)
Stream Flow (CFS)	Stream flow data is necessary for the interpretation of water quality data. For example, high pollutant concentrations at high flow would indicate runoff pollution while high pollutant concentrations at low flow would indicate that the source of the pollutant is likely associated with illicit discharges or direct discharges to the stream.	N/A
Nitrogen (mg/L)	Nitrogen can be measured as total Kjeldahl nitrogen (TKN), nitrate-nitrite nitrogen (NO_3-NO_2), and ammonia-nitrogen (NH_4). TKN represents the fraction of total nitrogen that is unavailable for growth or bound up in organic form. The remaining fraction NO_3-NO_2 and NH_4 represent bioavilable forms of nitrogen. Decomposition of organic nitrogen consumes oxygen and can deplete dissolved oxygen levels in a waterbody. Nitrogen also serves as an essential nutrient for plant growth and can lead to eutrification.	N/A


Forbes Creek Watershed
Sampling Sites
Forbes Creek Watershed Boundary
Sampling Sites
Lake Washington
Forbes Lake
1
2
3
4
5
6
7
N
S
E
W
0
750
1,500
3,000
4,500
6,000
Feet

FORBES LAKE
2004
WATER QUALITY MONITORING DATA

PREPARED BY:
CITY OF KIRKLAND PUBLIC WORKS DEPARTMENT
SURFACE WATER DIVISION

Project Overview

The City of Kirkland Department of Public Works in cooperation with the North Rose Hill Neighborhood Association (NRHNA) organized and implemented this lake monitoring program within the Forbes Lake watershed. This project employed city staff and trained volunteers to gather baseline information on the water quality and depth of Forbes Lake.

Specific objectives of this project were to: 1) create a baseline snapshot of lake water quality; 2) develop a map detailing the current depth profile of the lake to be compared to future conditions.

Data Usage

Information gathered during this study will be used by the City of Kirkland, the NRHNA, and residents of the Forbes Lake watershed. The City of Kirkland will use this data to determine areas to focus pollution source control efforts, provide data to meet NPDES Phase II requirements, provide a baseline snapshot of lake conditions to allow for comparison of water quality over time, and data for use in applying for water quality grant funds. The NRHNA and Forbes Lake Watershed residents will use the data to secure grant funds, advise public of pollution concerns, suggest pollution source control measure, and generate a base of community interest and stewardship toward Forbes Lake and local natural resources.

Monitoring Program Overview

Water sampling was conducted bi-weekly at five (2) locations within Forbes Lake for the period of seven (4) months from June 2004 through September 2004. These individual sampling locations were be established in a manner as to afford reasonable baseline conditions.

Samples to be sent out-of-house for analysis were collected with bottles as provided by the contracted testing laboratory in a manner as required by the laboratory and transported following standard Chain-of-Custody procedures for the following parameters: Fecal Coliform, Total Nitrogen (TKN), and Chlorophyll *a*.

Basic water quality tests (temperature, turbidity, secchi depth, pH, dissolved oxygen, and alkalinity) will be conducted and data recorded onsite.

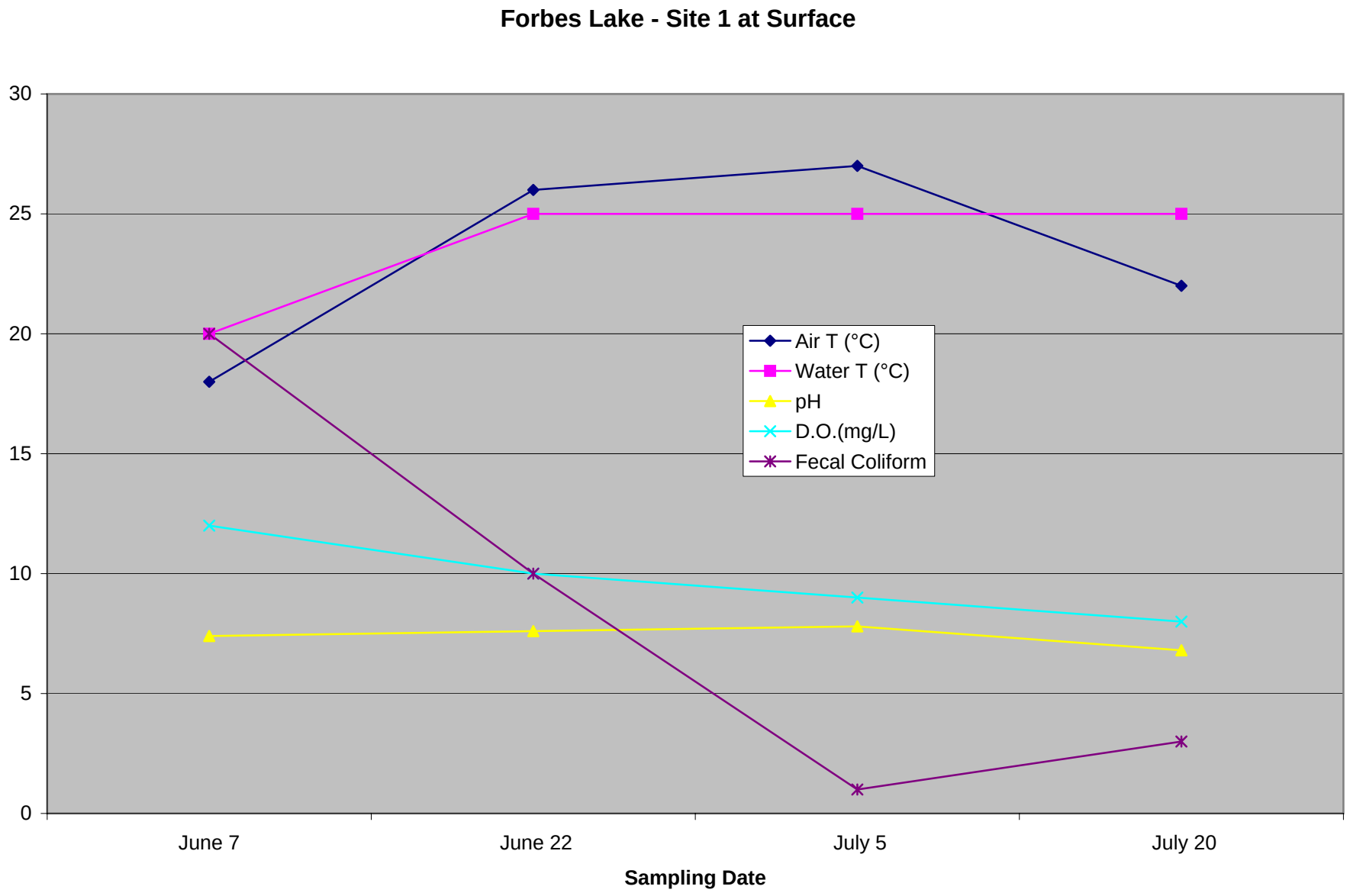
The volunteer methods (meters and purchased kits) were chosen to balance the ease of use and accuracy for volunteers with minimal training and cost. Many of the methods chosen were reported to be appropriate for use by other volunteer monitoring programs.

The volunteer methods (meters and purchased kits) were chosen to balance the ease of use and accuracy for volunteers with minimal training and cost. Many of the methods chosen were reported to be appropriate for use by other volunteer monitoring programs. The test kits were verified for precision by having concurrent

samples collected and analyzed by laboratory analysis using EPA approved test methods.

Standards of Comparison

Water Quality: Washington Administrative Code (WAC) 173-201A mandates water quality standards for Class A water bodies. See attached table.


Forbes Lake - Site 1 at Surface
30
25
20
15
10
5
0
June 7
June 22
July 5
July 20
Sampling Date
Air T (°C)
Water T (°C)
pH
D.O.(mg/L)
Fecal Coliform

Forbes Lake Monitoring Results from June-August 2004

Forbes Lake 1 Surface			June Average			July Average			August Average			September Average
Date	6/7/2004	6/22/2004		7/5/2004	7/20/2004		8/2/2004	8/17/2004		9/8/2004	9/23/2004	
Time	18:40	14:00		13:30	19:40		18:30	18:30		19:00	17:30	
Secchi Depth (m)	1.5	1.8	**1.65**	2.25	2.4	**2.33**	2.9	2.5	**2.70**	1.75	1	**1.38**
Depth	7.5	7.6	**7.55**	8.7	8.4	**8.55**	7.75	9	**8.38**	8.25	8	**8.13**
Air T (°C)	18	26	**22.00**	27	22	**24.50**	25	24	**24.50**	19	16	**17.50**
Water T (°C)	20	25	**22.50**	25	25	**25.00**	26	27	**26.50**	21	15	**18.00**
pH	7.4	7.6	**7.50**	7.8	6.8	**7.30**	7.3	6.9	**7.10**	7.2	7.2	**7.20**
D.O.(mg/L)	12	10	**11.00**	9	8	**8.50**	7	7	**7.00**	8	11	**9.50**
Turbidity (NTU)	2.28	1.34	**1.81**	1.2	1.75	**1.48**	0.86	0.52	**0.69**	2.65	9.56	**6.11**
Alkalinity (ppm)	80	90	**85.00**	150	120	**135.00**	120	50	**85.00**	40	80	**60.00**
Fecal Coliform	20	10	**15.00**	1	3	**2.00**	60	30	**45.00**	9	1	**5.00**
Chlorophyll a	1.1	3.2	**2.15**	2.1	4.3	**3.20**	1.6	< 0.3	**0.80**	13	59	**36.00**
Pheophytin	0.24	< 0.03	**0.12**	0.48	2.3	**1.39**	0.45	10	**5.23**	0.3	0.3	**0.30**
Total Nitrogen	0.22	0.35	**0.29**	0.25	0.39	**0.32**	0.28	0.37	**0.33**	0.65	0.02	**0.34**
Total Phosphorus	0.038		**0.04**	0.018	0.041	**0.03**	0.054	0.023	**0.04**	0.005	0.04	**0.02**
Total Dissolved Solids		90	**90.00**									

Forbes Lake 1 Mid-Depth			June Average			July Average			August Average			September Average
Date	6/7/2004	6/22/2004		7/5/2004	7/20/2004		8/2/2004	8/17/2004		9/8/2004	9/23/2004	
Time	18:40	14:30		13:50	19:50		18:50	18:50		19:15	17:55	
Depth	3.25	3.8	**3.53**	4.3	4.2	**4.25**	3.88	4.5	**4.19**	4.13	4	**4.07**
Air T (°C)	18	28	**23.00**	27	22	**24.50**	25	24	**24.50**	19	16	**17.50**
Water T (°C)	14	11	**12.50**	12	11	**11.50**	140	12	**76.00**	13	15	**14.00**
pH	7.3	7.2	**7.25**	7	6.8	**6.90**	7.2	6.9	**7.05**	6.8	7.1	**6.95**
D.O.(mg/L)	6	4	**5.00**	3	3	**3.00**	4	3	**3.50**	3	10	**6.50**
Turbidity (NTU)	4	2.72	**3.36**	2.23	1.8	**2.02**	1.71	1.44	**1.58**	1.19	6.69	**3.94**
Alkalinity (ppm)	100	90	**95.00**	90	120	**105.00**	80	50	**65.00**	40	60	**50.00**
Fecal Coliform	24	< 1	**12.00**	40	< 1	**20.00**	20	10	**15.00**	3	4	**3.50**
Chlorophyll a	2.7	4.4	**3.55**	2.1	4.3	**3.20**	5.9	3.2	**4.55**	3.2	37	**20.10**
Pheophytin	1.3	2.4	**1.85**	1.8	2.3	**2.05**	1.6	4.8	**3.20**	0.3	0.3	**0.30**
Total Nitrogen	0.2	0.37	**0.29**	0.35	0.39	**0.37**	0.46	0.45	**0.46**	0.52	0.1	**0.31**
Total Phosphorus	0.031		**0.03**	0.024	0.041	**0.03**	0.059	0.029	**0.04**	0.005	0.038	**0.02**
Total Dissolved Solids		110	**110.00**									

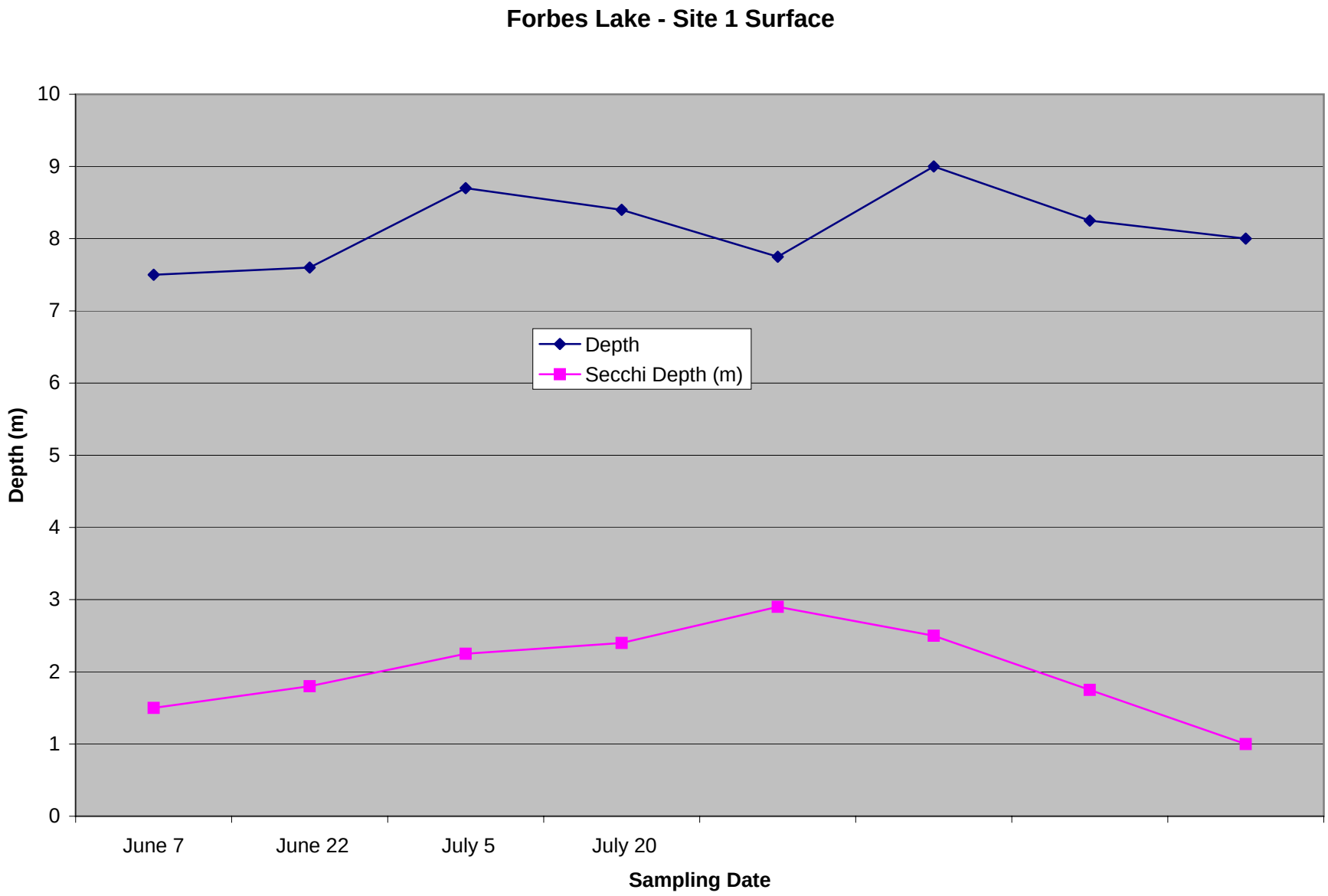
Forbes Lake Monitoring Results from June-August 2004

Forbes Lake 2 Surface			June Average			July Average			August Average			September Average
Date	6/7/2004	6/22/2004		7/5/2004	7/20/2004		8/2/2004	8/17/2004		9/8/2004	9/23/2004	
Time	19:20	14:50		14:10	18:54		19:15	19:10		19:30	18:05	
Secchi Depth (m)	1.4	2.1	**1.75**	2.5	2.6	**2.55**	3.1	2.5	**2.80**	1.5	1	**1.25**
Depth	3.5	4.4	**3.95**	4.3	4.4	**4.35**	4.2	5.5	**4.85**	4.25	4	**4.13**
Air T (°C)	17.5	30	**23.75**	27	22	**24.50**	23	23.5	**23.25**	17	14	**15.50**
Water T (°C)	20	26	**23.00**	25	25.5	**25.25**	26	26	**26.00**	21	18	**19.50**
pH	7.6	8	**7.80**	8	7	**7.50**	7.8	6.9	**7.35**	6.6	7.2	**6.90**
D.O.(mg/L)	6	7	**6.50**	9	9	**9.00**	8	5	**6.50**	9	12	**10.50**
Turbidity (NTU)	1.9	1.29	**1.60**	0.69	1.08	**0.89**	0.61	1.03	**0.82**	3.63	10.26	**6.95**
Alkalinity (ppm)	120	100	**110.00**	150	100	**125.00**	110	60	**85.00**	40	80	**60.00**
Fecal Coliform	10	12	**11.00**	< 1	7	**3.50**	10	20	**15.00**	3	1	**2.00**
Chlorophyll a	0.27	3.5	**1.89**	2.1	1.9	**2.00**	1.6	1.1	**1.35**	14	35	**24.50**
Pheophytin	1	< 0.3	**0.50**	0.67	< 0.3	**0.34**	< 0.3	2.4	**1.20**	0.3	0.3	**0.30**
Total Nitrogen	< 0.1	0.2	**0.10**	0.36	0.35	**0.36**	0.36	0.47	**0.42**	0.6	0.15	**0.38**
Total Phosphorus	0.038		**0.04**	0.019	0.034	**0.03**	0.055	0.019	**0.04**	0.005	0.027	**0.02**
Total Dissolved Solids		100	**100.00**									

Forbes Lake 2 Mid-Depth			June Average			July Average			August Average			September Average
Date	6/7/2004	6/22/2004		7/5/2004	7/20/2004		8/2/2004	8/17/2004		9/8/2004	9/23/2004	
Time	19:20	14:50		14:20	19:15		19:30	19:30		19:45	18:40	
Depth	1.75	2.2	**1.98**	2.15	2.2	**2.18**	2.1	2.75	**2.43**	2.13	2.2	**2.17**
Air T (°C)	17.5	28	**22.75**	27	22	**24.50**	23	23.5	**23.25**	17	14	**15.50**
Water T (°C)	17	20	**18.50**	22	22	**22.00**	22	22	**22.00**	20	15	**17.50**
pH	7.4	7.4	**7.40**	7.4	6.8	**7.10**	7.6	6.8	**7.20**	6.8	7.3	**7.05**
D.O.(mg/L)	10	9	**9.50**	8	7	**7.50**	9	2	**5.50**	2	11	**6.50**
Turbidity (NTU)	2.45	2.26	**2.36**	1.67	1.89	**1.78**	1.04	1.65	**1.35**	2.8	8.42	**5.61**
Alkalinity (ppm)	80	100	**90.00**	90	100	**95.00**	80	40	**60.00**	30	90	**60.00**
Fecal Coliform	1	< 1	**0.50**	10	1	**5.50**	40	23	**31.50**	10	8	**9.00**
Chlorophyll a	5.1	4.3	**4.70**	1.9	4.3	**3.10**	2.1	4	**3.05**	11	58	**34.50**
Pheophytin	3.7	0.77	**2.24**	0.75	1.5	**1.13**	0.67	2.9	**1.79**	0.3	0.3	**0.30**
Total Nitrogen	0.3	0.32	**0.31**	0.35	0.36	**0.36**	0.3	0.35	**0.33**	0.48	0.14	**0.31**
Total Phosphorus	0.042		**0.04**	0.02	0.035	**0.03**	0.054	0.024	**0.04**	0.005	0.039	**0.02**
Total Dissolved Solids		80	**80.00**									

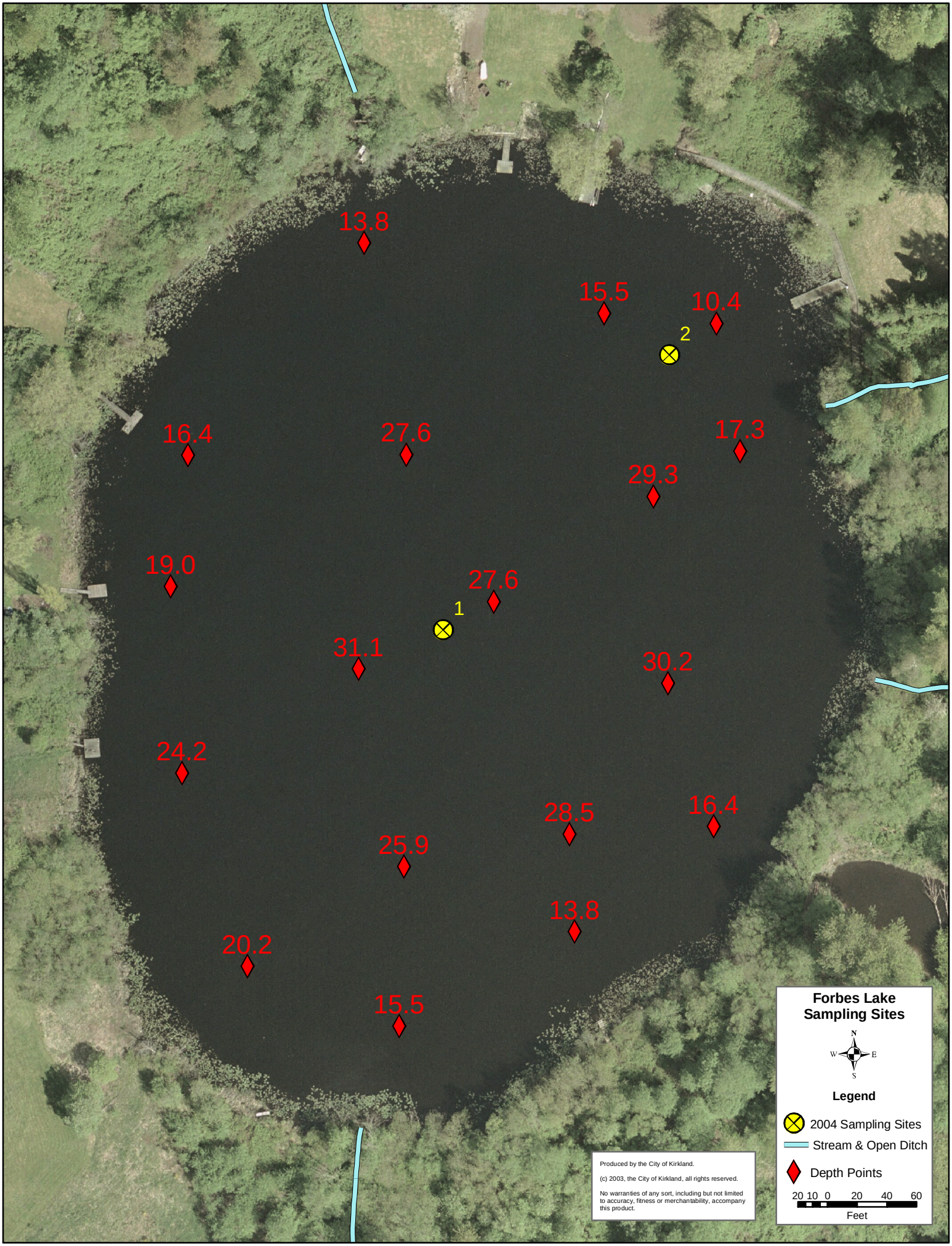
June 2004 Averages

	Site 1		Site 2	
	Surface	**Mid-Depth**	**Surface**	**Mid-depth**
Secchi Depth	1.7	n/a	1.8	n/a
Depth	7.6	3.5	4.0	2.0
Air T	22.0	23.0	23.8	23.8
Water T	22.5	12.5	23	18.5
pH	7.5	7.25	7.8	7.4
DO	11	5	6.5	9.5
Turbidity	1.81	3.36	1.60	2.36
Alkalinity	85	95	110	90
Fecal Coliform	15	12.5	11	1
Chlorophyll a	2.15	3.55	1.89	4.70
Pheophytin	0.135	1.85	0.65	2.24
Total Nitrogen	0.285	0.285	0.031	0.31
Total Phosphorus	0.038	0.031	0.038	0.042
Total Dissolved Solids	90	110	100	80


Forbes Lake - Site 1 Surface
10
9
8
7
6
5
4
3
2
1
0
Depth (m)
Depth
Secchi Depth (m)
June 7
June 22
July 5
July 20
Sampling Date

Water Integrity Parameters, Descriptions and State Standards

Parameter	Description	WA State Standard for Class A Streams
Temperature	Water temperature is affected by air temperature, groundwater inflow, streamside vegetation, and stormwater inputs.	<18°C
pH	pH is the concentration of hydrogen ions in water in moles per liter. It is a measure of the acidity and basicity of water. pH can have a direct and indirect effects on stream water chemistry and the biota of aquatic ecosystems.	6.5 to 8.5
Dissolved Oxygen (mg/L)	The amount of oxygen dissolved in water. The capacity of water to hold oxygen is inversely proportional to water temperature: increases in water temperature lower the dissolved oxygen (DO).	> 8.0 mg/L
Turbidity (NTU)	Turbidity is the amount of light scattered or absorbed bya fluid. Water becomes turbid usually as a result of suspended particles of silt and clay. Other materials such as finely divided organic matter, plankton, and microorganisms can contribute to turbidity.	Not to exceed 5 NTU over background turbidity
Phosphorus (mg/L)	Phosphorus is a nutrient necessary for plant growth in aquatic and terrestrial sysytems, but excess phosphorus in surface waters can results in eutrophication (nutrient enrichment) of ater bodies. This can lead to excess awuatic plant growth in shallow waters and algal blooms.	No WA State standard, but the US EPA threshold for waters draining to lakes is 0.050 mg/L
Fecal Coliform (CFU/100ml)	Fecal coliform bacteria are microscopic organisms that live in the intestines of warm-bloded animals. They also live in the waste materials or feces excreted from the intestinal tract. Although not necessariliy agents of desease, fecal coliform bacteria indicate the potential presence of pathogenic organisms. Genetic testing must be conducted to distinguish human sources from animal sources.	100 CFU/100ml
Zinc (mg/L)	Many trace metal are toxic to aquatic organisms at very low concentrations. Zinc is commonly associated with urban runoff and is easily detectable	0.058 mg/L (based on a Hardness of 50 mg/L of $CaCO_3$)
Stream Flow (CFS)	Stream flow data is necessary for the interpretation of water quality data. For example, high pollutant concentrations at high flow would indicate runoff pollution while high pollutant concentrations at low flow would indicate that the source of the pollutant is likely associated with illicit discharges or direct discharges to the stream.	N/A
Nitrogen (mg/L)	Nitrogen can be measured as total Kjeldahl nitrogen (TKN), nitrate-nitrite nitrogen (NO_3-NO_2), and ammonia-nitrogen (NH_4). TKN represents the fraction of total nitrogen that is unavailable for growth or bound up in organic form. The remaining fraction NO_3-NO_2 and NH_4 represent bioavilable forms of nitrogen. Decomposition of organic nitrogen consumes oxygen and can deplete dissolved oxygen levels in a waterbody. Nitrogen also serves as an essential nutrient for plant growth and can lead to eutrification.	N/A


13.8
15.5
10.4
2
16.4
27.6
17.3
29.3
19.0
27.6
1
31.1
30.2
24.2
28.5
16.4
25.9
13.8
20.2
15.5
Forbes Lake
Sampling Sites
N
W
E
S
Legend
2004 Sampling Sites
Stream & Open Ditch
Depth Points
20 10 0 20 40 60
Feet
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