CRWA

Saving the Charles River since 1965

January 29, 2019

Henry F. Vitale
Executive Director
Boston Water & Sewer Commission
980 Harrison Avenue
Boston, MA 02119

Dear Mr. Vitale:

Charles River Watershed Association (CRWA) is pleased to provide you with this report of the 2018 season of the Charles River Water Quality Notification (Flagging) Program. We appreciate Boston Water and Sewer Commission's continued support of this program, which now informs the public about water quality conditions in the river on an hourly basis every day of the week throughout the peak boating season. BWSC's support is critical to our ability to provide this valuable public service. We thank you for your commitment to monitoring the Charles River in an effort to promote safe recreation.

2018 Water Quality Monitoring Results

Sampling Methods

CRWA conducts approximately two water quality monitoring events per week during the peak recreational season in the Lower Basin from late June to late October. During monitoring events, CRWA measures water temperature and depth and collects water quality samples at four sampling locations in the Lower Charles River Basin (Figure 1). G & L Laboratory in Quincy analyzes the samples for *E. coli* bacteria. We measure water temperature and depth *in situ* with a digital field thermometer and a digital depth finder, respectively. Sampling locations are center channel sites, upstream of the following bridges: North Beacon Street (1NBS), Larz Anderson Bridge (2LARZ), Boston University Bridge (3BU), and Longfellow Bridge (4LONG). All samples are manual grab samples collected from a boat.

Sampling is conducted in accordance with CRWA's Water Quality and Flow Monitoring Quality Assurance Project Plan (QAPP). CRWA regularly collects field duplicate samples to verify the repeatability of the sample collection process. During the 2018 season, quality assurance field duplicate samples were collected for 13% of samples. None of the field duplicates failed CRWA's data quality objectives (DQOs). On average, the relative percent difference between samples and field duplicates was 25.1%, which is well below the DQO for this parameter which is 100%.

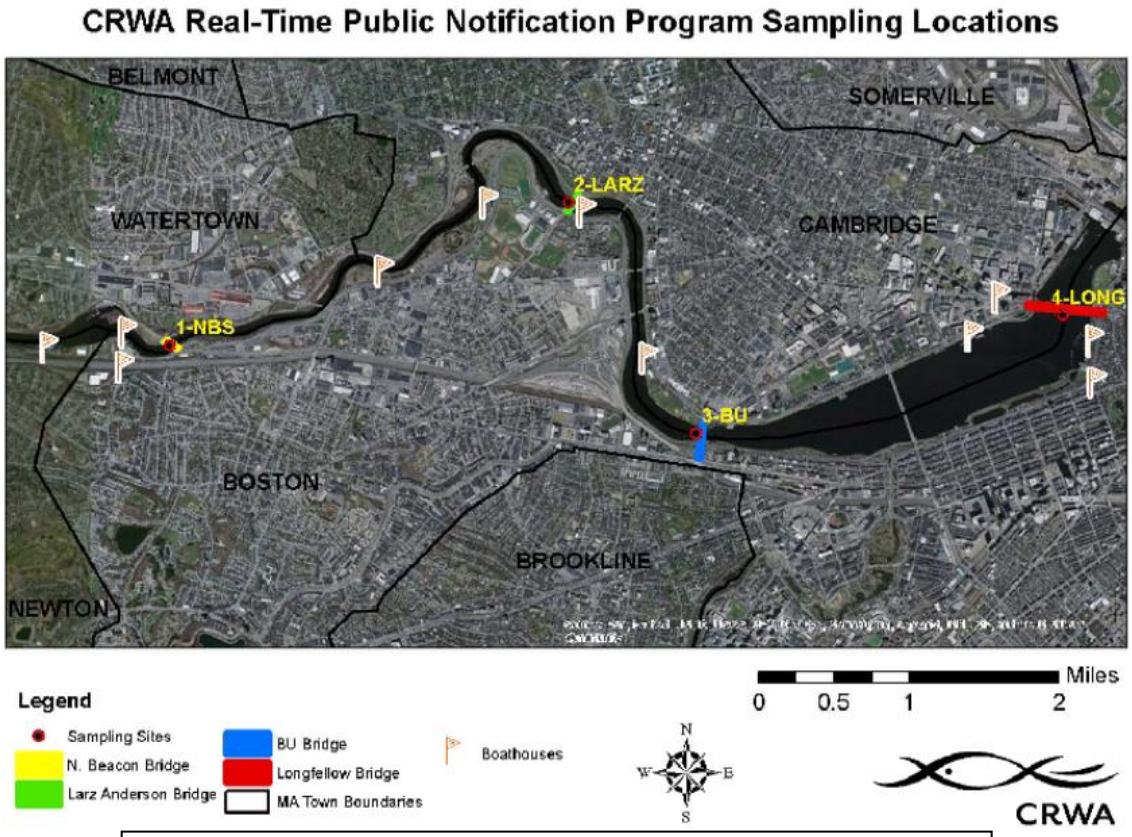

Figure 1. Map of sampling locations in the Charles River Lower

2018 Bacteria Levels

CRWA conducted 32 monitoring events along the Charles River from June 26th to October 18th. In total, 127 samples were collected from the four sites over the course of the season, excepting field duplicates. Of these, 91% met the Single Sample Standard for Secondary Contact (1,260 cfu/100 mL), herein referred to as the boating standard; and 61% met the Single Sample Standard for Primary Contact (235 cfu/100 mL), herein referred to as the swimming standard.

In 2018, the best water quality was observed at the downstream end of the Lower Basin. , No samples collected at 4LONG exceeded the boating standard, only 3 samples exceeded the swimming standard, and the geometric mean of all *E. coli* concentrations at the site was 54 cfu/100mL. The poorest water quality was observed at 1NBS where 4 samples exceeded the boating standard and 25 samples exceeded the swimming standard, with an overall geometric mean concentration of 304 cfu/100mL. Figure 2 shows the percentage of samples at each site that met or surpassed the standards, and the associated geometric mean concentrations.

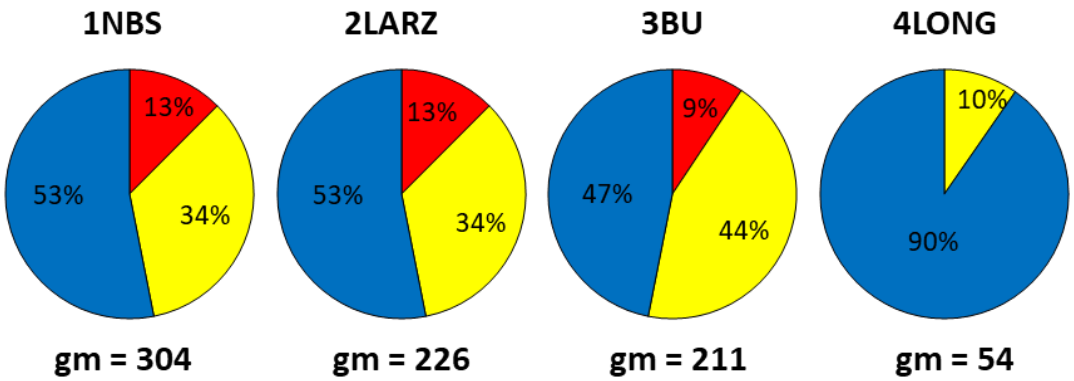

Figure 2. Percentage of samples collected at each site with concentrations passing or failing standards. The geometric means of *E. coli* concentrations (in cfu/100mL) of all samples collected at each site is shown below each graph. Blue represents samples passing both the boating and swimming standards (<235 cfu/100mL), yellow represents samples passing the boating standard but failing the swimming standard, and red represents samples failing both standards (>1,260 cfu/100mL).

As in previous years, the river water quality was negatively impacted by stormwater runoff and the highest *E. coli* concentrations were observed after rainfall. Wet weather events were defined as those when samples were collected following 0.2 inches or greater of rainfall in the 72 hours prior to sampling. For this purpose, rainfall is measured hourly at CRWA's meteorological station located near the Community Boating facility in Boston. Out of the 32 sampling events this season, 14 were wet weather events during which a total of 56 samples were taken. The other 18 sampling events were defined as dry weather events and a total of 71 samples were taken.

Overall, 80% of the samples collected in wet weather met the boating standard, while 100% of samples collected in dry weather met the standard. Only 36% of wet weather samples met the swimming standard, while 80% of dry weather samples met it. The geometric mean concentration of all samples taken in wet weather was 306 cfu/100mL, while the mean during dry weather was 105 cfu/100mL.

Some dry weather samples did have elevated *E. coli* concentrations. These elevated levels include 4 samples from 1NBS, 4 samples from 2LARZ, 5 samples from 3BU, and 1 sample from 4LONG that exceeded the swimming standard. Site 1NBS had the highest geometric mean for dry weather samples at 187 cfu/100mL, and 4LONG had the lowest mean for dry weather samples at 50 cfu/100mL. Figure 3 shows the percent of samples at each site that indicated boatable or swimmable conditions in wet and dry weather.

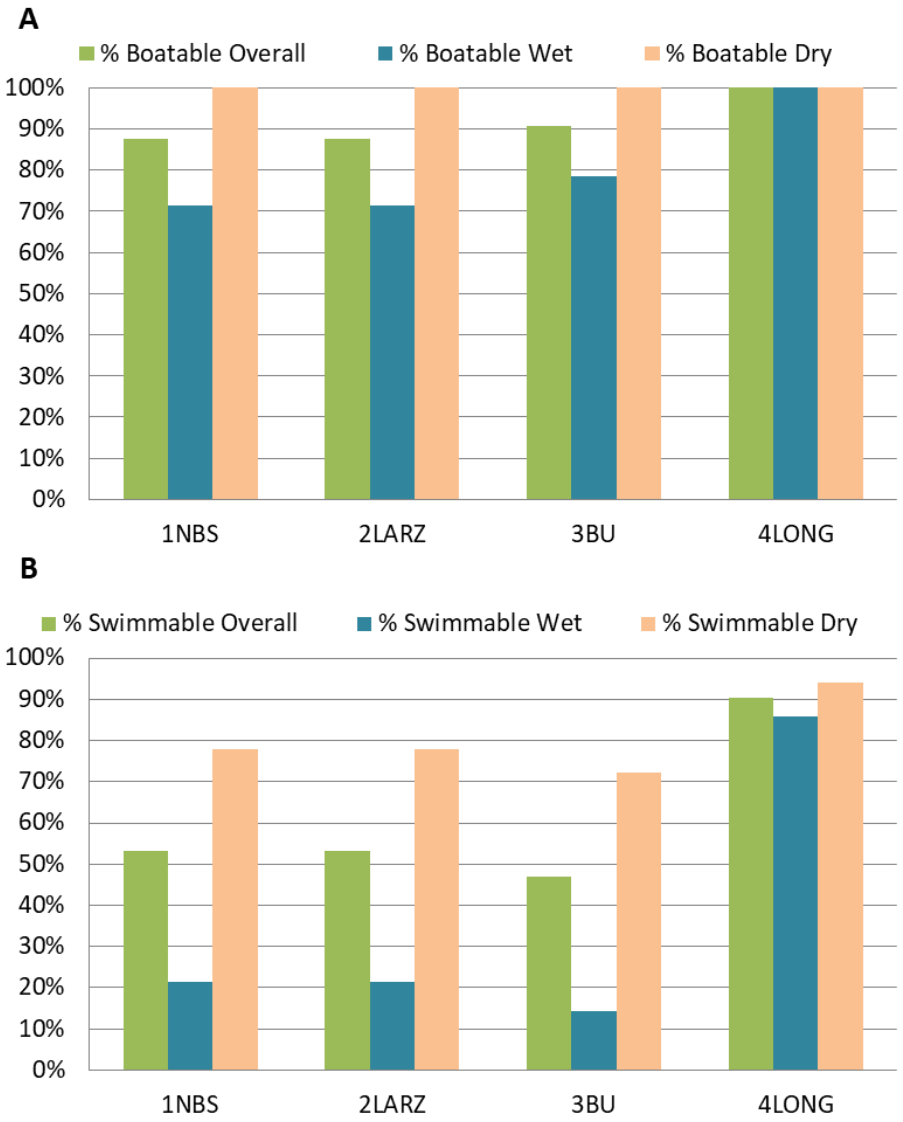

Figure 3. Percent of samples at each site that indicate boatable (A) or swimmable (B) conditions in the Lower Basin. Blue bars represent conditions during wet weather sampling, beige bars represent conditions during dry weather sampling, and green bars represent conditions overall.

Comparison with Previous Years

Sample data collected in 2018 were compared to previous years at each site for percent of samples meeting the boating (1,260 cfu/100mL) and swimming (235 cfu/100mL) standards, and for the geometric mean of *E. coli* concentrations. These data were also compared for wet and dry conditions (Figure 4).

Overall, samples collected during the 2018 season indicated slightly poorer water quality than samples collected in previous years, although this varied slightly by site and condition. Consistent with previous years, 4LONG had the best water quality with the three upstream sites having poorer water quality. The observed pattern of higher *E. coli* concentrations and lower boatability and swimmability during wet weather is also consistent with previous years.

At 1NBS, 3BU, and 4LONG the percentage of time water quality met the boating standard in 2018 was similar to past years , at 2LARZ, however, water quality met the boating standard less than any season in the past 3 years (Figure 4a). The percentage of time the water is safe for boating has been relatively consistent in recent years, however the percentage of time the water was swimmable decreased at all sites in 2018 compared with the past 3 years. The most dramatic decrease in percent swimmable was seen at 3BU, which was 90% swimmable in 2015 and only 47% swimmable in 2018 (Figure 4d). This can be attributed to an overall increase in the mean *E. coli* concentrations observed at all sites (Figure 4g).

With the exception of 3BU, mean dry weather *E. coli* concentrations have steadily increased for the past 4 years (Figure 4i), with a corresponding decrease in percent swimmable (Figure 4f). During wet weather, *E. coli* concentrations observed at 2LARZ and 3BU in 2018 were higher than the past 3 years, with mean values of 521 and 510 cfu/100mL, respectively (Figure 4h). This also corresponded with the lowest percent boatable and swimmable at these two sites in the past 4 years during wet weather (Figures 4b and 4e).

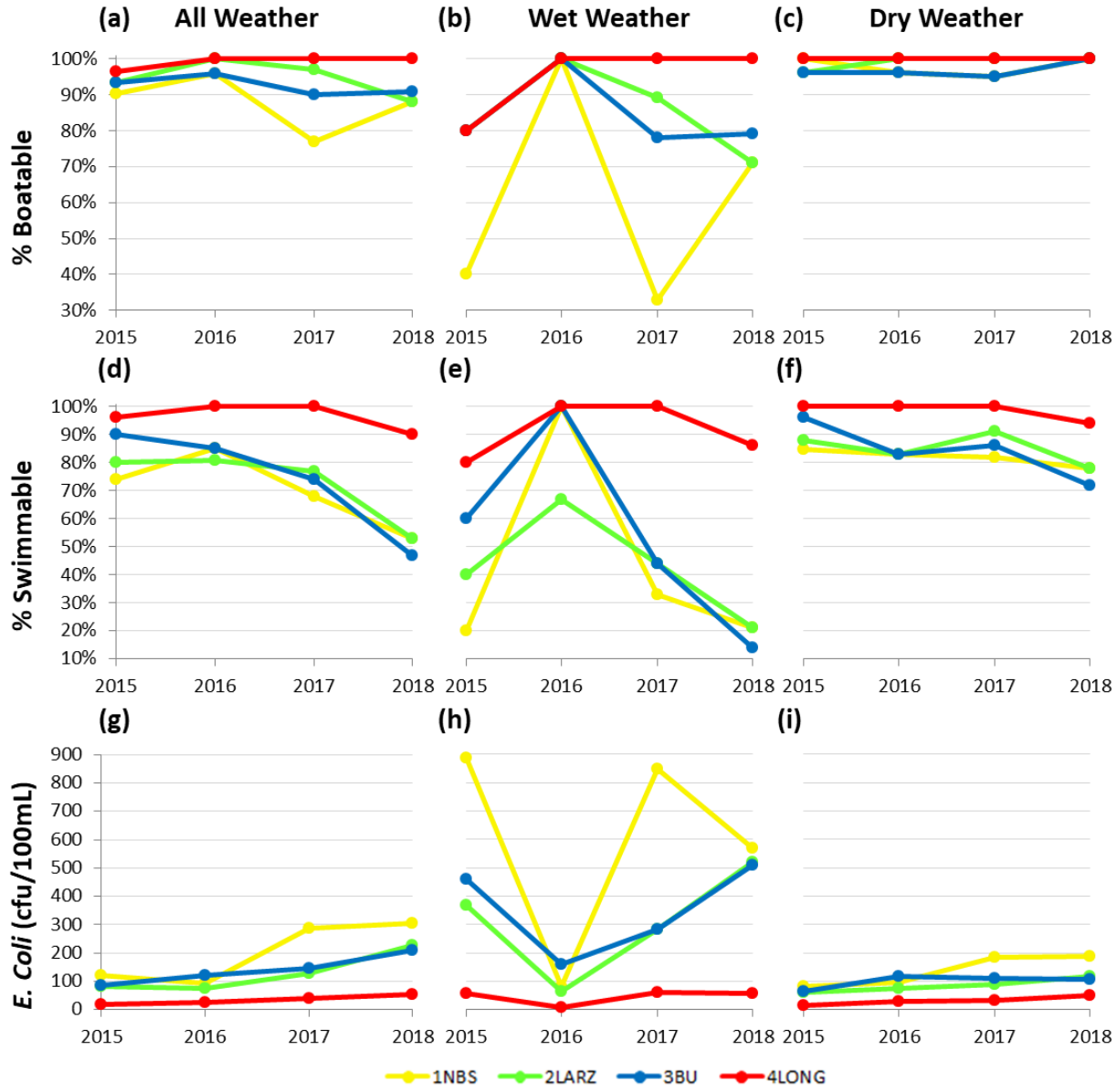

Figure 4. Lower Basin conditions from 2015 to 2018. Labels on top and left apply to all three graphs in the column or row. Vertical axes for each parameter are consistent for each graph in the row.

2018 Forecasting Model Results

Forecasting Model Methods

As you are aware, as part of our public notification program, CRWA uses statistical models to predict the likelihood that water quality will be in violation of the state geometric mean boating standard at each of our four sampling locations. The models use antecedent rainfall, river flow, wind speed and air temperature to make predictions every hour throughout the recreational season. Model predictions are now updated on an hourly basis after a program update completed during the 2015 season. Models are necessary to produce real-time water quality forecasts because *E. coli* analysis requires at least 24 hours between sample collection and result reporting. These hourly forecasts allow boaters to make informed decisions about their desired contact with the river based on current water quality conditions.

From August 23rd to September 21st, 2018, a connection error between the model and the Community Boating weather station suspended hourly forecasts. While this issue persisted CRWA staff manually updated the flag colors based on recent *E. coli* sample results and observed rainfall, and communicated these via our website, emails, and social media. Despite this hiatus in real-time results, model output for this time was available once the connection error had been resolved.

2018 Model Performance

A post-season analysis of model predictions was conducted for the period between June 26th and October 20th 2018. To determine the reliability of the model predictions, model results were compared to sampled *E. coli* concentrations. The model was determined to have an incorrect prediction when *E. coli* results were below the geometric mean boating standard (630 cfu/100mL), but the model indicated that a red flag should be flown (false positive), or when *E. coli* results were in violation of the state boating standard but the model indicated a blue flag should be flown (false negative).

During this period, CRWA's models predicted red flag occurrences at two or more sites on a total of 25 days. Overall, red flags constituted 5% of predictions for 1NBS, 7% of predictions for 2LARZ, 15% of predictions for 3BU, and 11% of predictions for 4LONG this season. In total, 21 model errors were confirmed when compared to the 127 *E. coli* samples collected. Of these, 13 were false negatives and 8 were false positives. 1NBS had the most model errors with 7, all of which were false negatives, and 4LONG had the fewest model errors with 4, all of which were false positives. Based on this comparison, the model at 1NBS was correct 78% of the time, the models at 2LARZ and 3BU were correct 84% of the time, and the model at 4LONG was correct 87% of the time.

One weakness of our models is that they generally cannot predict instances of dry weather contamination and false negatives occur, which accounted for 3 of the 4 errors that occurred during dry weather (2 at 1NBS and 1 at 3BU). The 17 errors that occurred during wet weather errors were both false positives and false negatives, which may result from a discrepancy between how long after a rain event the model predicts high bacteria levels and how long the contamination stays elevated in the river. Since all of the wet weather errors at 1NBS were false negatives, it appears this model is under-predicting the contamination after rainfall events. Contrarily, the wet weather errors at 4LONG were all false positives, indicating that the model for this river reach is over-predicting the contamination after rainfall.

CRWA plans to review these issues before the 2019 season and make adjustments to the models as needed. We also plan on testing new models for each river reach using 2018 and past seasons' sampling data and data collected from the weather station. We hope this will improve the accuracy of our water quality forecasts for the future.

2018 Cyanobacteria

CRWA works with the Massachusetts Department of Public Health (DPH), Department of Conservation and Recreation (DCR), and the City of Cambridge Health Department to circulates advisories for cyanobacterial blooms. CRWA collects *in situ* measurements of phycocyanin and chlorophyll *a* at three locations in the Lower Basin on a weekly or bi-weekly basis.

In previous years, when CRWA has reported high readings or presence of a visible scum, DPH has collected water samples and analyzed them for cyanobacteria cell counts and mycrocystin toxin levels. If one of these factors exceeds DPH's advisory limits (>70,000 cells/mL), CRWA flew yellow flags to alert the public about the possible health risk of these blooms. This year, a cyanobacterial bloom advisory was in effect at Charles River Yacht Club, Union Boat Club, Charles River Canoe and Kayak Kendall Square, and Community Boating from July 11th through 30th due to the presence of a visible scum, and CRWA flew red flags; DPH did not collect cell count data until the week following the advisory.

Public Notification

This season, flags were flown at 10 boating centers along the river (Figure 1). In addition to flying the physical flags, flag colors were also communicated via email, CRWA's website, and Twitter™ @charlesriver. In 2018, when CRWA's models predicted a greater than 70% chance that water quality will exceed the state geometric mean standard (630 cfu/100mL), a red flag was flown. When the models predicted a less than 70% chance of a water quality violation, a blue flag was flown.

Red flags were also flown for 48 hours following the combined sewer overflows (CSOs) that occurred at MWRA's Cottage Farm Facility in Cambridge from 5:58 to 8:18 pm on July 17th and from 12:37 to 2:30 pm on September 18th. In accordance with Department of Public Health (MassDPH) recommendations, CRWA flies red flags for 48 hours following a CSO notification, regardless of the model prediction. Red flags were also flown when a cyanobacteria bloom was present, from July 11th - 30th, regardless of model predictions. This was a change from previous seasons, in which yellow flags were flown during cyanobacteria blooms.

I have enclosed a spreadsheet which contains sampling results from the 2018 sampling season along with daily flag colors flown. Please contact me if you have any questions or would like any additional information. CRWA appreciates BWSC's continued support of this program. We look forward to working with you again next season.

Sincerely,

Lisa Kumpf
Rita Barron Fellow

cc: John Sullivan (via e-mail)
Amy Schofield (via e-mail)

Enclosures: Flagging season sampling results

Flagging Sampling Data 2018

Date	Day of Weather and Flow				CRWA Site															Field Duplicate	
	Rainfall (inches)	Rainfall (inches)	Rainfall (inches)	Average Streamflow (ft^3/sec.)	North Beacon Street Bridge (1NBS)			Flag Color	Larz Anderson (JFK Street) Bridge (2LARZ)			Flag Color	Boston University Bridge (3BU)			Flag Color	Longfellow Bridge (4LONG)			Flag Color		
	Logan Airport*	Muddy River	Comm. Boating WS	Moody St. Waltham USGS gauge*	*E.Coli* Result	E.Coli Sample Collection Time	Temperature °C		*E.Coli* Result	*E.Coli* Sample Collection Time	Temperature °C		*E.Coli* Result	*E.Coli* Sample Collection Time	Temperature °C		*E.Coli* Result	*E.Coli* Sample Collection Time	Temperature °C		Site	Result
6/24/2018	0.26	0.22	0.22	81																		
6/25/2018	0.33	0.28	0.22	106																		
6/26/2018	0.00	0.00	0.00	83	3200	9:42am	29.0	Blue	1530	9:10am	22.0	Blue	320	8:50am	21.5	Blue	120	8:33am	21.5	Blue	1NBS	2700
6/27/2018	0.09	0.03	0.00	75				Blue				Blue				Blue				Blue		
6/28/2018	1.16	1.43	1.08	165	250	8:56am	21.5	Blue	389	8:35am	22.0	Blue	130	8:23am	22.0	Blue	40	8:07am	22.0	Blue		
6/29/2018	0.00	0.00	0.00	204				Blue				Blue				Blue				Blue		
6/30/2018	0.00	0.00	0.00	157				Blue				Blue				Blue				Blue		
7/1/2018	0.00	0.00	0.00	152				Blue				Blue				Blue				Blue		
7/2/2018	0.00	0.00	0.00	153				Blue				Blue				Blue				Blue		
7/3/2018	0.01	0.00	0.16	145	170	9:24am	28.5	Blue	60	8:51am	**29.0**	Blue	20	8:35am	27.5	Blue	20	8:12am	**28.5**	Blue	2LARZ	35
7/4/2018	0.00	0.00	0.00	128				Blue				Blue				Blue				Blue		
7/5/2018	0.00	0.00	0.00	112	220	11:11am	31.0	Blue	140	10:46am	**32.0**	Blue	60	10:30am	**31.5**	Blue	20	10:10am	**31.5**	Blue		
7/6/2018	0.35	0.34	0.31	105				Blue				Blue				Blue				Blue		
7/7/2018	0.00	0.00	0.00	116				Blue				Blue				Blue				Blue		
7/8/2018	0.00	0.00	0.00	115				Blue				Blue				Blue				Blue		
7/9/2018	0.00	0.00	0.00	106				Blue				Blue				Blue				Blue		
7/10/2018	0.00	0.00	0.04	94	180	9:37am	28.5	Blue	50	9:09am	26.5	Blue	60	8:45am	26.0	Blue		8:20am	25.0	Blue		
7/11/2018	0.19	0.12	0.04	96				Blue				Blue				Blue				Red		
7/12/2018	0.00	0.00	0.00	90	80	11:03am	30.0	Blue	50	10:25am	26.5	Blue	70	10:08am	26.5	Blue	40	9:52am	26.0	Red	3BU	100
7/13/2018	0.00	0.00	0.00	85				Blue				Blue				Blue				Red		
7/14/2018	0.31	0.01	0.02	80				Blue				Blue				Blue				Red		
7/15/2018	0.01	0.00	0.00	73				Blue				Blue				Blue				Red		
7/16/2018	0.00	0.00	0.00	67				Blue				Blue				Blue				Red		
7/17/2018	2.68	1.86	0.88	147	340	9:38am	28.0	Blue	20	9:05am	27.5	Blue	50	8:42am	27.0	Blue	20	8:22am	27.0	Red	4LONG	20
7/18/2018	0.06	0.05	0.99	220				Red				Red				Red				Red		
7/19/2018	0.00	0.00	0.00	163	410	9:30am	31.7	Red	820	8:59am	25.0	Red	480	8:44am	24.0	Red	80	8:25am	22.5	Red		
7/20/2018	0.00	0.00	0.00	134				Blue				Blue				Blue				Red		
7/21/2018	0.00	0.00	0.00	119				Blue				Blue				Blue				Red		
7/22/2018	0.17	0.26	0.10	124				Blue				Blue				Blue				Red		
7/23/2018	0.03	0.12	0.13	132				Blue				Blue				Blue				Red		
7/24/2018	0.00	0.00	0.00	119	300	9:23am	27.0	Blue	140	8:48am	26.5	Blue	360	8:29am	26.0	Blue	<10	8:12am	26.0	Red	1NBS	330
7/25/2018	0.14	0.18	0.00	106				Blue				Blue				Blue				Red		
7/26/2018	0.60	0.54	0.31	126	620	9:15am	26.5	Blue	240	8:50am	26.0	Blue	200	8:35am	25.9	Blue	40	8:18am	27.0	Red		
7/27/2018	0.00	0.00	0.17	136				Blue				Blue				Blue				Red		
7/28/2018	0.00	0.00	0.00	136				Blue				Blue				Blue				Red		

7/29/2018	0.00	0.00	0.00	146				Blue				Blue				Blue				Red			
7/30/2018	0.00	0.00	0.00	153				Blue				Blue				Blue				Red			
7/31/2018	0.00	0.00	0.00	146	220	9:06am	24.5	Blue	90	8:40am	25.0	Blue	30	8:23am	25.0	Blue	50	8:07am	25.0	Blue	2LARZ	60
8/1/2018	0.00	0.00	0.00	131				Blue				Blue				Blue				Blue		
8/2/2018	0.00	0.02	0.00	113	100	10:12am	31.0	Blue	60	8:56am	27.0	Blue	30	8:43am	27.0	Blue	20	8:28am	27.5	Blue		
8/3/2018	0.06	0.17	0.05	103				Blue				Blue				Blue				Blue		
8/4/2018	0.64	0.52	0.56	120				Blue				Blue				Blue				Blue		
8/5/2018	0.00	0.00	0.05	132				Blue				Blue				Red				Blue		
8/6/2018	0.00	0.00	0.00	141				Blue				Blue				Blue				Blue		
8/7/2018	0.00	0.00	0.00	150	130	9:28am	28.5	Blue	150	8:55am	**28.5**	Blue	80	8:39am	**28.5**	Blue	5	8:17am	28.0	Blue	3BU	110
8/8/2018	0.98	0.49	0.31	156				Blue				Blue				Blue				Blue		
8/9/2018	0.06	0.06	0.05	229	2820	8:55am	26.0	Red	80	8:30am	26.0	Blue	1550	8:16am	26.0	Red	10	8:04am	26.0	Blue		
8/10/2018	0.00	0.00	0.00	208				Blue				Blue				Blue				Blue		
8/11/2018	0.39	0.44	0.42	245				Blue				Blue				Blue				Blue		
8/12/2018	1.38	1.77	1.69	238				Red				Red				Red				Blue		
8/13/2018	0.29	0.28	0.34	217				Blue				Blue				Red				Blue		
8/14/2018	0.01	0.17	0.04	240	800	9:30am	24.0	Blue	270	9:07am	23.5	Blue	470	8:48am	24.5	Red	60	8:31am	24.0	Blue	4LONG	60
8/15/2018	0.00	0.00	0.00	255				Blue				Blue				Blue				Blue		
8/16/2018	0.00	0.00	0.00	262	140	9:01am	30.5	Blue	600	8:34am	26.0	Blue	760	8:20am	26.0	Blue	90	8:07am	25.5	Blue		
8/17/2018	0.20	0.24	0.18	269				Blue				Blue				Blue				Blue		
8/18/2018	0.13	0.16	0.06	272				Blue				Blue				Blue				Blue		
8/19/2018	0.01	0.03	0.03	258				Blue				Blue				Red				Blue		
8/20/2018	0.00	0.01	0.00	240				Blue				Blue				Red				Blue		
8/21/2018	0.00	0.00	0.00	226	140	9:15am	21.5	Blue	300	8:51am	22.0	Blue	80	8:35am	22.0	Blue	30	8:20am	22.0	Blue	1NBS	60
8/22/2018	0.50	0.44	0.31	278				Blue				Blue				Blue				Blue		
8/23/2018	0.00	0.00	0.00	264	440	9:19am	21.0	Blue	3000	8:50am	20.5	Blue	250	8:38am	21.0	Blue	10	8:22am	22.0	Blue		
8/24/2018	0.00	0.00	0.00	241				Blue				Blue				Blue				Blue		
8/25/2018	0.00	0.00	0.00	220				Blue				Blue				Blue				Blue		
8/26/2018	0.00	0.00	0.00	198				Blue				Blue				Blue				Blue		
8/27/2018	0.00	0.00	0.00	176				Blue				Blue				Blue				Blue		
8/28/2018	0.00	0.00	0.00	156				Blue				Blue				Blue				Blue		
8/29/2018	0.00	0.00	0.00	135				Blue				Blue				Blue				Blue		
8/30/2018	0.00	0.00	0.00	119	90	9:22am	29.5	Blue	200	8:46am	27.0	Blue	380	8:27am	26.5	Blue	20	8:08am	27.0	Blue	2LARZ	180
8/31/2018	0.00	0.00	0.00	106				Blue				Blue				Blue				Blue		
9/1/2018	0.00	0.00	0.00	92				Blue				Blue				Blue				Blue		
9/2/2018	0.00	0.00	0.00	85				Blue				Blue				Blue				Blue		
9/3/2018	0.00	0.00	0.00	79				Blue				Blue				Blue				Blue		
9/4/2018	0.00	0.00	0.00	74				Blue				Blue				Blue				Blue		
9/5/2018	0.00	0.00	0.00	73				Blue				Blue				Blue				Blue		
9/6/2018	0.03	0.16	0.03	72	140	9:25am	27.2	Blue	50	8:55am	27.0	Blue	700	8:40am	26.0	Blue	20	8:25am	26.5	Blue		
9/7/2018	0.00	0.00	0.00	86				Blue				Blue				Blue				Blue		
9/8/2018	0.00	0.00	0.00	78				Blue				Blue				Blue				Blue		
9/9/2018	0.00	0.00	0.00	71				Blue				Blue				Blue				Blue		
9/10/2018	0.76	0.76	0.60	70				Blue				Blue				Blue				Blue		
9/11/2018	0.53	0.49	0.61	161	3600	9:48am	19.0	Red	1500	9:25am	20.0	Red	5000	9:09am	21.9	Red	60	8:54am	20.0	Blue	4LONG	40
9/12/2018	0.26	0.23	0.17	158				Blue				Blue				Blue				Blue		
9/13/2018	0.44	0.54	0.41	220	1600	11:08am	22.0	Red	600	10:40am	21.0	Blue	520	9:53am	21.9	Red	110	9:39am	21.0	Blue		
9/14/2018	0.00	0.00	0.00	198				Blue				Blue				Blue				Blue		
9/15/2018	0.00	0.00	0.00	222				Blue				Blue				Blue				Blue		
9/16/2018	0.00	0.00	0.00	246				Blue				Blue				Blue				Blue		
9/17/2018	0.00	0.00	0.00	263				Blue				Blue				Blue				Blue		
9/18/2018	1.15	1.19	1.23	443	1100	9:18am	25.2	Blue	370	8:51am	24.7	Blue	260	8:38am	24.3	Blue	70	8:23am	23.0	Blue	1NBS	1000
9/19/2018	0.00	0.01	0.00	460				Red				Red				Red				Red		

9/20/2018	0.00	0.00	0.00	398	420	9:16am	18.5	Red	670	8:54am	19.0	Red	1400	8:36 AM	18.5	Red	600	8:25 AM	18.5	Red		
9/21/2018	0.00	0.00	0.00	469				Blue				Blue				Blue				Blue		
9/22/2018	0.03	0.05	0.00	489				Blue				Blue				Blue				Blue		
9/23/2018	0.00	0.00	0.00	507				Blue				Blue				Blue				Blue		
9/24/2018	0.00	0.00	0.00	513				Blue				Blue				Blue				Blue		
9/25/2018	1.24	1.66	0.90	554	80	9:45am	15.0	Blue	120	9:21am	15.0	Blue	60	9:08am	15.0	Blue	60	8:57am	19.1	Blue	2LARZ	140
9/26/2018	0.28	0.16	0.64	686				Blue				Blue				Red				Red		
9/27/2018	0.05	0.16	0.30	672	650	8:45 AM		Blue	1460	8:19 AM		Red	770	8:05 AM		Red	780	7:51 AM		Red		
9/28/2018	0.35	0.43	0.30	681				Blue				Blue				Blue				Blue		
9/29/2018	0.00	0.00	0.00	693				Blue				Blue				Blue				Blue		
9/30/2018	0.00	0.00	0.00	687				Blue				Blue				Blue				Blue		
10/1/2018	0.06	0.04	0.03	679																		
10/2/2018	0.29	0.33	0.27	684	740	8:50 AM	14.0		180	8:27 AM	14.0		70	8:10 AM	15.0		150	7:58 AM	14.5		4LONG	150
10/3/2018	0.21	0.30	0.23	727																		
10/4/2018	0.00	0.00	0.01	685	130	10:06 AM	20.0	Blue	310	9:39 AM	17.0	Blue	360	9:19 AM	16.5	Blue	160	9:01 AM	16.0	Blue	3BU	350
10/5/2018	0.00	0.00	0.00	659				Blue				Blue				Blue				Blue		
10/6/2018	0.00	0.00	0.00	649				Blue				Blue				Blue				Blue		
10/7/2018	0.10	0.03	0.07	646				Blue				Blue				Blue				Blue		
10/8/2018	0.00	0.01	0.00	637				Blue				Blue				Blue				Blue		
10/9/2018	0.00	0.00	0.00	617	90	8:36 AM	16.0	Blue	120	8:13 AM	16.5	Blue	180	8:00AM	17.2	Blue	130	7:48 AM	17.1	Blue	3BU	140
10/10/2018	0.00	0.00	0.00	587				Blue				Blue				Blue				Blue		
10/11/2018	0.60	0.61	0.51	595	120	10:12 AM	17.0	Blue	170	9:43 AM	17.5	Blue	250	9:28 AM	17.0	Blue	100	9:12 AM	17.0	Blue		
10/12/2018	0.09	0.05	0.05	603				Red				Red				Red				Blue		
10/13/2018	0.13	0.14	0.08	562				Blue				Blue				Blue				Blue		
10/14/2018	0.00	0.00	0.00	531				Blue				Blue				Blue				Blue		
10/15/2018	0.07	0.00	0.00	515				Blue				Blue				Blue				Blue		
10/16/2018	0.03	0.12	0.06	504	230	8:56 AM	8.5	Blue	320	8:25 AM	9.0	Blue	370	8:15 AM	10.0	Blue	310	7:56 AM	11.5	Blue	4LONG	270
10/17/2018	0.00	0.00	0.00	497				Blue				Blue				Blue				Blue		
10/18/2018	0.00	0.00	0.00	475	110	9:13 AM	5.0	Blue	220	8:34 AM	5.0	Blue	170	8:31 AM	6.5	Blue	230	8:11 AM	7.5	Blue		
10/19/2018	0.00	0.00	0.00	454				Blue				Blue				Blue				Blue		
10/20/2018	0.00	0.00	0.00	427				Blue				Blue				Blue				Blue		