Lake Quinsigamond
Watershed Association
PO Box 4243, Boston Turnpike
Shrewsbury, MA 01545

MassDEP – Watershed Planning Program
8 New Bond St
Worcester MA 01606
Attention: Robert Smith
RE: Water Quality Monitoring Lake Quinsigamond -EColi

Dear Mr. Smith,

Enclosed are the data deliverables for the 2023 sampling project performed in accordance with the approved 2022-2024 Water Quality Monitoring Program QAPP for "Bacterial Monitoring of Tributaries to Lake Quinsigamond".

Data deliverables include, and not limited to, sampling methodology, sampling locations with summary and site assessments, laboratory results, field observation results, quality control and quality assurance methods/results, summary reports, and supporting supplemental records. If you have any questions or need additional information, please feel free to contact me, Gia Coleman or Barbara Kickham.

Sincerely,

Michael Liberty

Michael Liberty
LQWA, Board Member

Ecc: MassDEP-QA Manager
Gia Coleman, LQWA
Barbara Kickham, LQWA
Peter Collins, LQC
Katie Liming, City of Worcester Lakes & Pond

Lake Quinsigamond EColi Bacteria Monitoring Program

2023

Bacteria Monitoring in Select Streams and Outfalls to Lake Quinsigamond

Lake Quinsigamond Watershed Association

In Partnership With

Lake Quinsigamond Commission

City of Worcester, Department of Public Works, Lakes and Ponds Program

Contents

Introduction

Located in Worcester County, Massachusetts, Lake Quinsigamond is a recreational body of water bordered by Worcester, Shrewsbury, and Grafton. In summer months when aquatic recreation is in high demand, contributions from streams and outfalls present challenges with water quality due to stormwater runoff in the largely urbanized bordering towns, as well as other point and nonpoint source pollution, resulting in beach closures and a lack of access to aquatic recreation for many people, some of whom have few other options available.

The Lake Quinsigamond Watershed Association (LQWA) is a volunteer-run organization founded in 1984 that aims to bring attention to the issue and enhance the quality of life in and around Lake Quinsigamond, Flint Pond, and Shirley Pond. Since its commencement in 2020, this monitoring project has utilized bi-weekly sampling from late spring to early fall at several strategic locations in and around the lake in order to monitor E. Coli levels in the watershed, with minor annual changes to site locations based on new information concerning upstream conditions.

Data collected from this project is provided to the Massachusetts Department of Environmental Protection (MassDEP) to aid in long-term assessment of water quality in and around Lake Quinsigamond. Data is also provided to the town of Shrewsbury and the city of Worcester to encourage action on their part to improve water quality.

This year, the LQWA conducted the Ecoli bacteria monitoring program from May 30th to October 4th, 2023. Samples were collected at ten locations (Figure 1, Table 1); five in the North Basin, five in the South Basin. Two samples were collected mid-lake, two outfalls, and six streams. Sampling occurred on ten days (Table 2), with two weeks between each sampling day. Activities were conducted in accordance with the 2022-2024 Water Quality Monitoring Program (Quality Assurance Project Plan (QAPP) for Bacterial Monitoring of Tributaries to Lake Quinsigamond (LQWA, 2022, 2023a).

The 2024 bacteria monitoring project was jointly funded by the Lake Quinsigamond Commission (LQC), the LQWA, and the City of Worcester Department of Public Works Lakes and Ponds Program.

Methods Used

Sample collection was performed in accordance with LQWA's project-specific Standard Operating Procedure #2020-02: Sample Collection Techniques for Bacterial Samples in Surface Waters, which references the following best practice methods: Field Safety SOP# CN 000.2 (MassDEP, 2009), Lake Sampling SOP# CN 151.0 (MassDEP, 2010), Sample Collection Techniques for Surface Water Quality Monitoring SOP# CN 1.21 (MassDEP, 2009), Field Equipment Decontamination to Prevent the Spread of Invasive Aquatic Organisms SOP# CN 59.5 (2015).

Sample collection was performed by using a combination of a sampling pole and gloved collection by hand. For both site and QA/QC samples, twelve collections were taken on each of the ten sampling days. Sampling events were performed every two weeks, beginning May 30th, 2023, and concluding on October 4th, 2023. Laboratory samples were analyzed for E. Coli by Alpha Analytical using Standards Method 121,9223B-Colilert-QT with 33 analyses (121-Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF).

Study Area

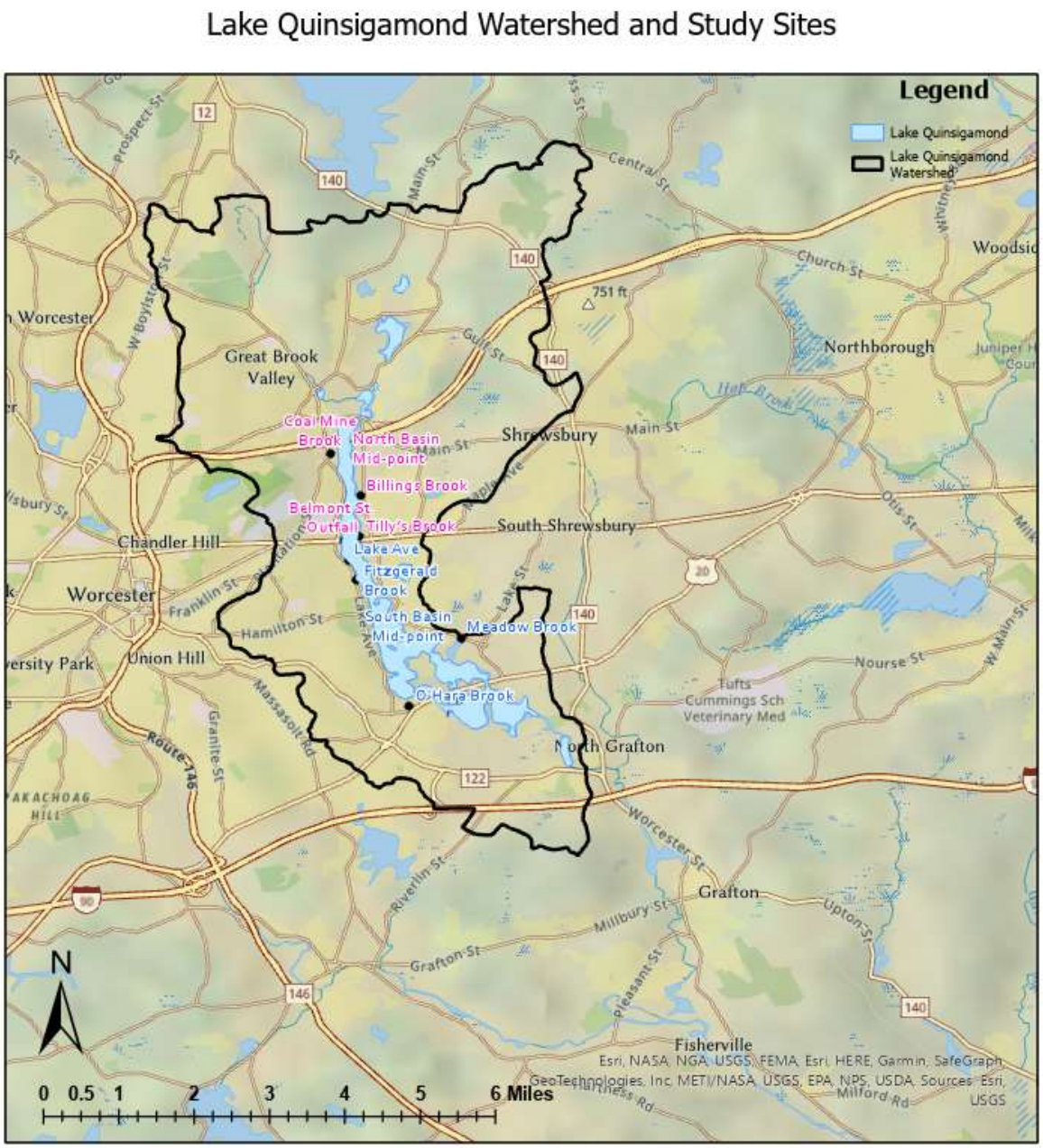

Figure 1. Study area map. North Basin sites are pink, and South Basin sites are blue. The Lake Quinsigamond watershed is shown in black.

Table 1. Study sites with site ID, name, town, and coordinates.

Site ID	Site Name/Desc.	Town	Lat	Long
01_NB	Belmont St. Outfall	Worcester	42.27422	-71.757372
04_NB	Coal Mine Brook	Worcester	42.29079	-71.760113
05_NB	Billings Brook	Shrewsbury	42.28268	-71.754262
06_NB	Tilly's Brook	Shrewsbury	42.27493	-71.754471
07_NB	North Basin Mid-point	Midpoint	42.28783	-71.756864
08_SB	O'Hara Book	Worcester	42.24242	-71.744942
10_SB	Fitzgerald Brook	Worcester	42.26659	-71.755255
11_SB	Lake Ave	Worcester	42.27048	-71.756633
12_SB	South Basin Mid-point	Midpoint	42.25326	-71.745226
13_SB	Meadow Brook	Shrewsbury	42.25552	-71.734974

I. Results

Table 2. Sampling results, organized by site and day. Values exceeding the 410 CFU threshold are in red bold italics.

Sampling Day/Date		*#1*	*#2*	*#3*	*#4*	*#5*	*#6*	*#7*	*#8*	*#9*	*#10*
SITE ID	**SITE NAME**	**5/30**	**6/13**	**6/27**	**7/11**	**7/25**	**8/8**	**8/22**	**9/6**	**9/20**	**10/4**
01_NB	BELMONT STREET OUTFALL	11	86.47	***2351***	***613.14***	47.3	***22818***	***517.21***	159.67	325.54	***980.39***
04_NB	COAL MINE BROOK	139.58	290.93	***1553.12***	***1732.89***	365.4	***23822***	***517.21***	***11,190***	***2462***	***648.82***
05_NB	BILLINGS BROOK	16.13	172.47	307.59	***1732.89***	69.7	***1203.33***	86.89	12.11	110.04	11.87
06_NB	TILLY'S BROOK	20.86	209.82	290.93	***1413.61***	24.6	***2433***	101.44	102.2	88.23	30.89
07_NB	NORTHBASIN MID_POINT	2.02	8.6	81.26	214.26	15.8	6.32	23.78	***1046.24***	43.09	22.81
08_SB	OHARA BROOK	***435.17***	47.25	***6367***	***1413.61***	***>2419.6***	***15046***	***4284***	65.68	***980.39***	25.3
10_SB	FITZGERALD BROOK	123.56	137.35	***4798***	***4257***	***613.1***	***81641***	325.54	27.85	***1986.29***	***579.43***
11_SB	LAKE AVE	11.9	193.49	***579.43***	***816.41***	96	***3129***	69.68	66.95	65.04	57.31
12_SB	SOUTH BASIN MID-POINT	4.13	8.6	13.1	51.22	12.2	13.5	2.01	6.32	4.05	8.52
13_SB	MEADOW BROOK	67.01	87.82	***1203.33***	***866.44***	105	387.32	156.48	83.29	204.59	24.62

The following are some notable results from the sampling:

- EColi concentration exceeded the Statistical Threshold Value (STV) of 410 MPN/100 ml in at least one sampling location in nine out of ten sampling events.
- The EColi STV was exceeded at least once at each sample site over the season with the exception of the mid-lake sample in the South Basin. No exceedances were observed there.
- On July 11, eight of the ten sample sites exceeded the STV; the only two that did not were the mid-lake samples. Five of the eight samples exceeded 1,000 MPN/100 ml.
- On August 8, Billings Brook, Tilly Brook and Meadow Brook were sampled prior to the start of a severe rain event, with the remaining samples collected during or just after the rain ceased. Seven out of ten samples exceeded the STV. The highest concentration of EColi observed during the sample season was collected on this day in Fitzgerald Brook with a concentration of 81,641 MPN/100 ml. Extremely turbid, grey water was videoed and reported to the City of Worcester, entering the lake from the Belmont St Outfall.
- On September 6, Coal Mine Brook exhibited a concentration of 11,190 MPN/100 ml. The North Basin mid-lake sample, which was collected ~200 feet from the mouth of Coal Mine Brook indicated a concentration of 1,046.24 MPN/100ml. This is the only mid-lake sample collected in the LQWA's four year program that

exceeded the STV. With the exception of July 11, samples collected mid-lake reflect "background" bacteria, generally less than 10 MPN/100 ML, occasionally higher.

- Out of the 100 samples collected in 2023; 35 samples exceeded the STV of 410 MPN/100 ml, 22 samples exceeded 1,000 MPN/100 ml, and five samples exceeded 10,000 MPN/100 ml.
- The most problematic locations, those locations with the highest concentration entering the lake are Coal Mine Brook, O'Hara Brook, Fitzgerald Brook, and Belmont Street outfall. Of the sample locations tested by the LQWA, the Belmont Street outfall contributes the largest volume of stormwater to the lake and on 50% of the sample days demonstrated elevated EColi.

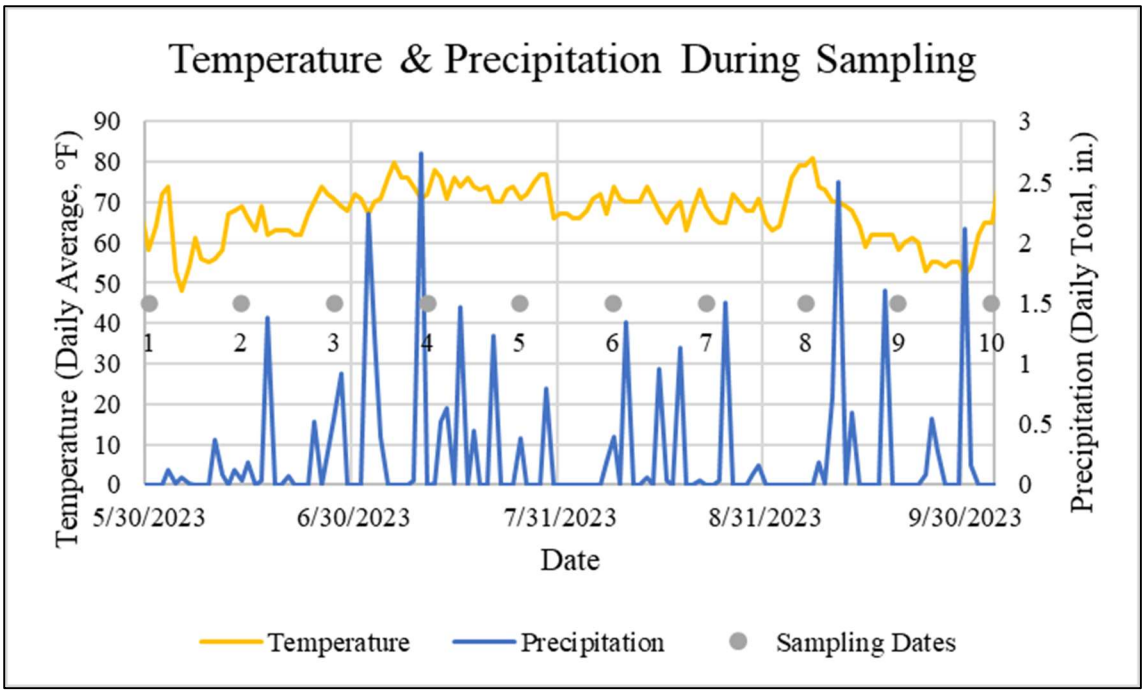

Figure 2. Temperature and precipitation over the sampling season, with sampling dates indicated in grey. Data from https://www.ncei.noaa.gov/cdo-web/ daily summaries, station ID USW00094746.

Data Quality Objectives

Following data quality reconciliation, performed by Gia Colman and Barbara Kickham, the final deliverables consistently met accuracy objectives outlined in the QAPP (LQWA, 2022). Seven out of ten sampling days met precision objectives outlined in the same document.

Table 3. Field accuracy & precision

Data Quality Objectives										
Sampling Day	***#1***	***#2***	***#3***	***#4***	***#5***	***#6***	***#7***	***#8***	***#9***	***#10***
Date										
Precision; Field (duplicate)										
Site ID	**04_NB**	**11_SB**	**13_SB**	**05_NB**	**04_NB**	**10_SB**	**07_NB**	**10_SB**	**04_NB**	**12_SB**
Sample	139.58	193.49	1203.33	1732.89	365.40	81641.00	23.78	27.85	2462.00	8.52
Duplicate	178.21	68.88	770.10	3786.00	248.10	68667.00	18.29	32.25	770.10	7.45
%RPD	**5**	**22**	**6**	**10**	**7**	**2**	**9**	**4**	**16**	**6**
Site ID	**04_NB**	**04_NB**	**06_NB**	**03_SB**	**10_SB**	**07_NB**	**06_NB**	**06_NB**	**10_SB**	**05_NB**
Result	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**
For Data Quality Objective QA/QC the duplicate and blank samples dated after were selected randomly to remove bias.										
Sampling Day	***#1***	***#2***	***#3***	***#4***	***#5***	***#6***	***#7***	***#8***	***#9***	***#10***
Precision; Field (duplicate)										
result (%RPD)	**5%**	**22%**	**6%**	**10%**	**7%**	**2%**	**9%**	**4%**	**16%**	**6%**
DQO Status	**Y**	**N**	**Y**	**N**	**Y**	**Y**	**Y**	**Y**	**N**	**Y**
Accuracy; Field (blank)										
result	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**	**<1**
DQO Status	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
All										

Table 4. Lab accuracy and precision from Alpha Analytical. Please note that week 5 samples were subcontracted to a different lab, who did not include their accuracy and precision QC results.

Lab Analysis Date	Alpha Sample ID	Batch Samples	Lab Analysis Time	Result	Week
5/30/2023	WG1785025-1	sample(s) 01-10	16:35	<1	1
5/30/2023	WG1785027-1	sample(s) 11-12	16:35	<1	1
6/13/2023	WG1790801-1	sample(s) 01-06	15:59	<1	2
6/13/2023	WG1790842-1	sample(s) 07-12	17:20	<1	2
6/27/2023	WG1796770-1	sample(s) 01-10	14:45	<1	3
6/27/2023	WG1796771-1	sample(s) 11-12	14:35	<1	3
7/11/2023	WG1801971-1	sample(s) 01-10	15:22	<1	4
7/11/2023	WG1801976 -1	sample(s) 11-12	15:47	<1	4
8/8/2023	WG1813383-1	sample(s) 01-10	14:50	<1	6
8/8/2023	WG1813386-1	sample(s) 11-12	14:50	<1	6
8/22/2023	WG1818798-1	sample(s) 01-10	16:29	<1	7
8/22/2023	WG1818800-1	sample(s) 11-12	16:19	<1	7
9/6/2023	WG1824266-1	sample(s) 01-07	15:06	<1	8
9/6/2023	WG1824318-1	sample(s) 08-12	16:46	<1	8
9/20/2023	WG1829912-1	sample(s) 01-10	16:20	<1	9
9/20/2023	WG1829914-1	sample(s) 11-12	16:20	<1	9
10/4/2023	WG1835585-1	sample(s) 01-10	15:33	<1	10
10/4/2023	WG1835619-1	sample(s) 11-12	16:07	<1	10

Sample locations were selected based on geography, proximity to storm water outflow, tributary-transport status, and historical bacterial impairments and events. Investigation of sampling locations before and after sampling identified vulnerabilities and potential mitigation solutions. These include source tracking and watershed-based planning.

In addition to the sample design in the approved QAPP and SAP, in-depth site assessments were completed at each location. The assessments are based on tributary characteristics, field observations, tertiary evidence of land-use (i.e., storm water systems proximity, recreational use, etc.). Site assessments include imagery and video. Site assessments available upon request.

Table 5. Analyte field QC.

2. Analyte Field QC (use template or provide in other format)			Field Duplicate				Field Blanks		Performance Evaluation	
Date	**Parameter**	**StationID**	**Sample ID**	**Field Result**	**Dup Sample ID**	**Dup Result**	**Sample ID**	**Field Blank Result**	**True Value**	**Result**
5/30/2023	E.coli (MPN)	04_NB	L2329924-06	139.58	L2329924-12	178.21	04_NB	L2329924-11	<1	<1
6/13/2023	E.coli (MPN)	11_SB	L2333277-04	193.49	L2333277-11	68.88	04_NB	L2333277-11	<1	<1
6/27/2023	E.coli (MPN)	13_SB	L2336647-08	1203.33	L2336647-12	770.1	06_NB	L2336647-11	<1	<1
7/11/2023	E.coli (MPN)	05_NB	L2339280-10	1732.89	L2339280-12	3786	03_SB	L2339280-11	<1	<1
7/25/2023	E.coli (MPN)	04_NB	L2342615-11	365.4	12	248.1	10_SB	11	<1	<1
8/8/2023	E.coli (MPN)	10_SB	L2345620-07	81641	L2345620-12	68667	07_NB	L2345620-11	<1	<1
8/22/2023	E.coli (MPN)	07_NB	L2348551-02	23.78	L2348551-12	18.29	06_NB	L2348551-11	<1	<1
9/6/2023	E.coli (MPN)	10_SB	L2351518-06	27.85	L2351518-12	32.25	06_NB	L2351518-11	<1	<1
9/20/2023	E.coli (MPN)	04_NB	L2355088-06	2462	L2355088-12	770.1	10_SB	L2355088-11	<1	<1
10/4/2023	E.coli (MPN)	12_SB	L2358438-08	8.52	L2358438-12	7.45	05_NB	L2358438-11	<1	<1

Field quality control audits, monthly check-ins, and data reporting were conducted continuously (May 31st – October 4th) between Barbara Kickham (Quality Control Officer), Jacquelyn Burmeister (Field Coordinator) and Gia Coleman (Project Coordinator, Quality Control Officer). Every sample collected in this program was collected by Abby Beilman, (Sampling Intern), except for Week 8 samples, which were collected by Barbara Kickham. Data entry of field notes and laboratory results were entered by Abby Beilman, then reconciled with Gia Coleman or Barbara Kickham. Revisions were completed by Abby Beilman and checked again by Barbara Kickham. For quality data deliverable specifications, see laboratory results.

In the following figures, Figures 3 through 13, sample results above the “Exceedance” line on the graphs refers to sample results that exceed the Statistical Threshold Value (STV) of 410 MPN/100 ml. The STV may not exceed more than 10% of the samples. This study included ten rounds of samples, therefore only one sample per site may exceed 410 MPN/100 ml in compliance with Massachusetts Surface Water Quality Standards.

Sequential Data

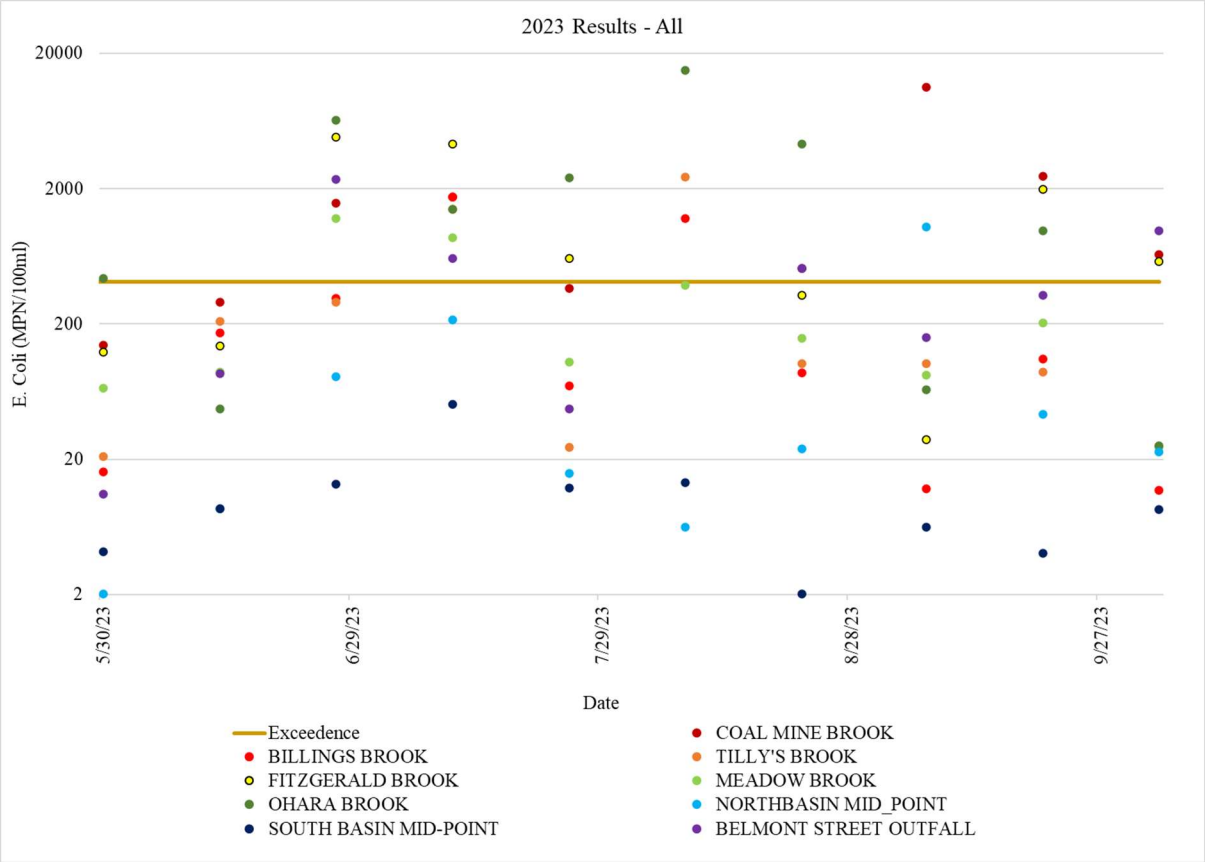

Figure 3. All data for 2023 sampling season. Exceedance indicates results above STV of 410 MPN/100ml.

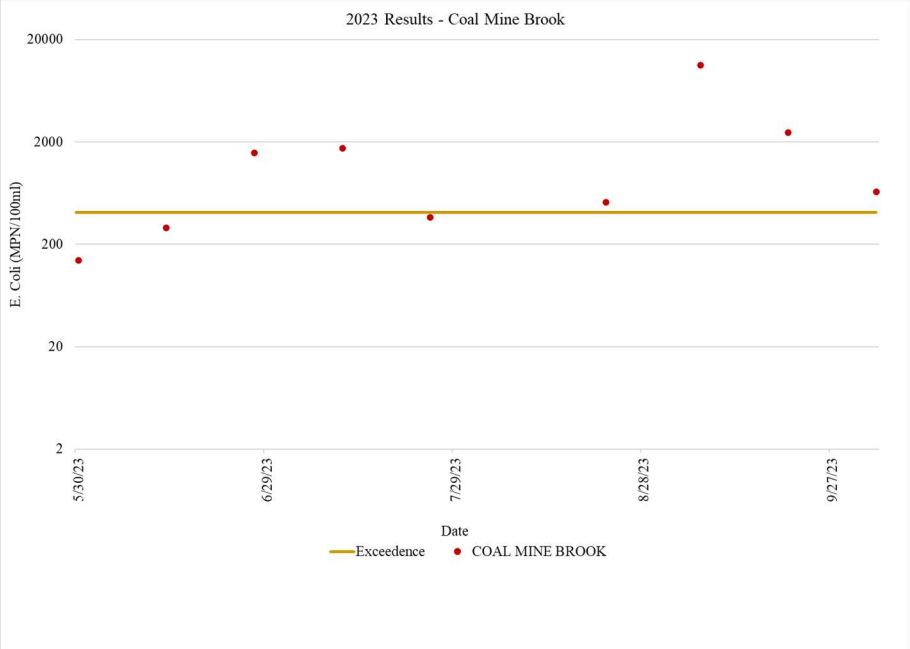

Figure 4. 2023 results for Coal Mine Brook. Exceedance indicates results above STV of 410 MPN/100ml.

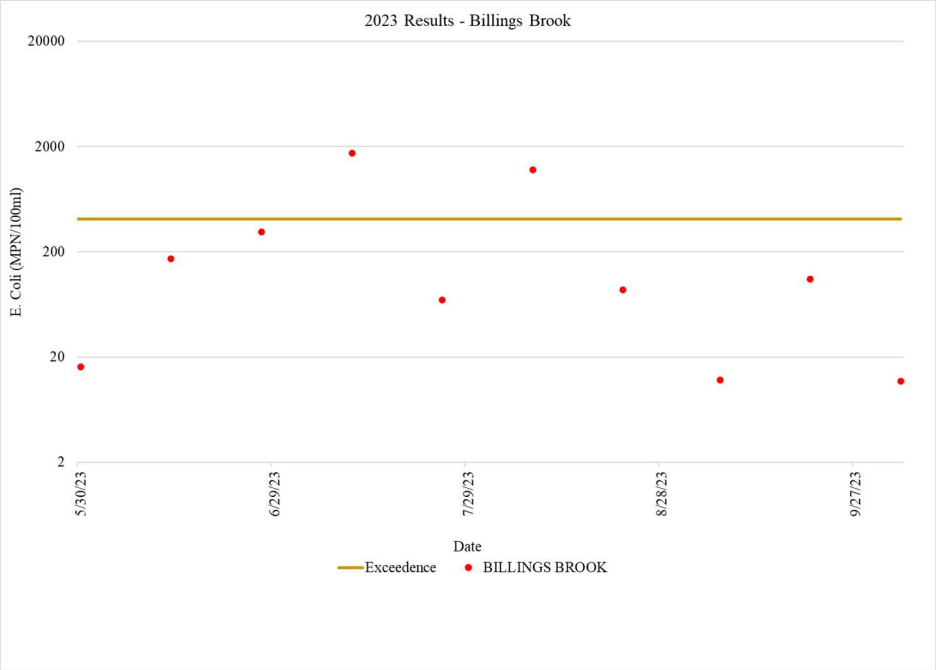

Figure 5. 2023 results for Billings Brook. Exceedance indicates results above STV of 410 MPN/100ml.

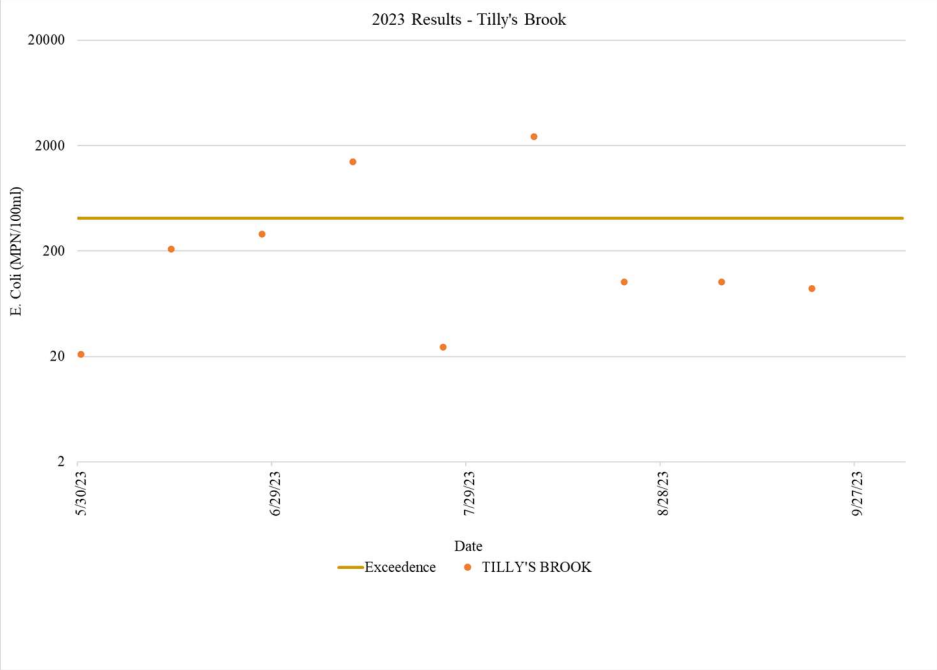

Figure 6. 2023 results for Tilly's Brook. Exceedance indicates results above STV of 410 MPN/100ml.

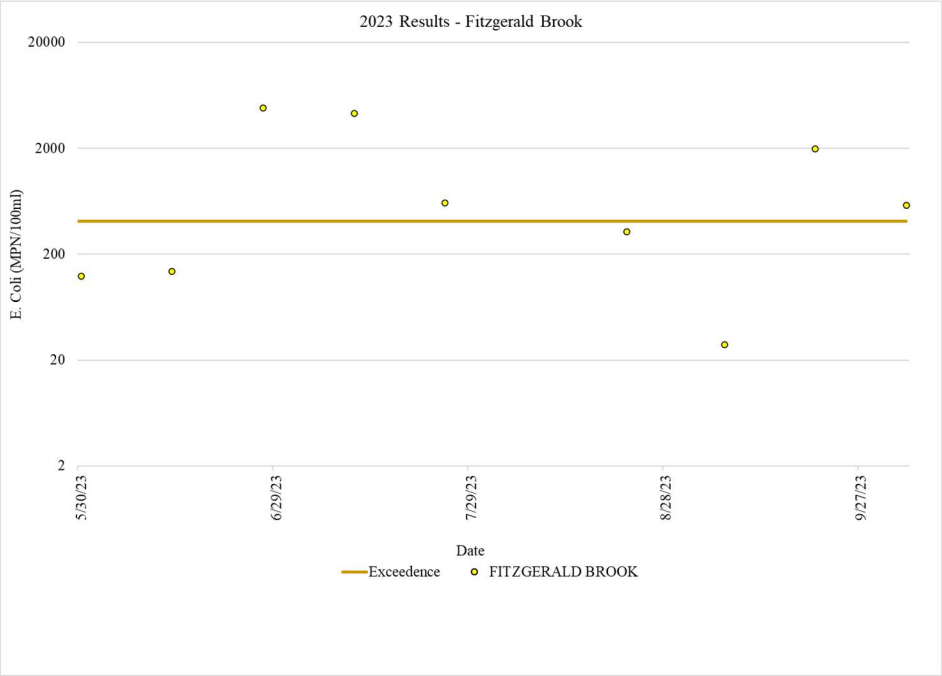

Figure 7. 2023 results for Fitzgerald Brook. Exceedance indicates results above STV of 410 MPN/100ml.

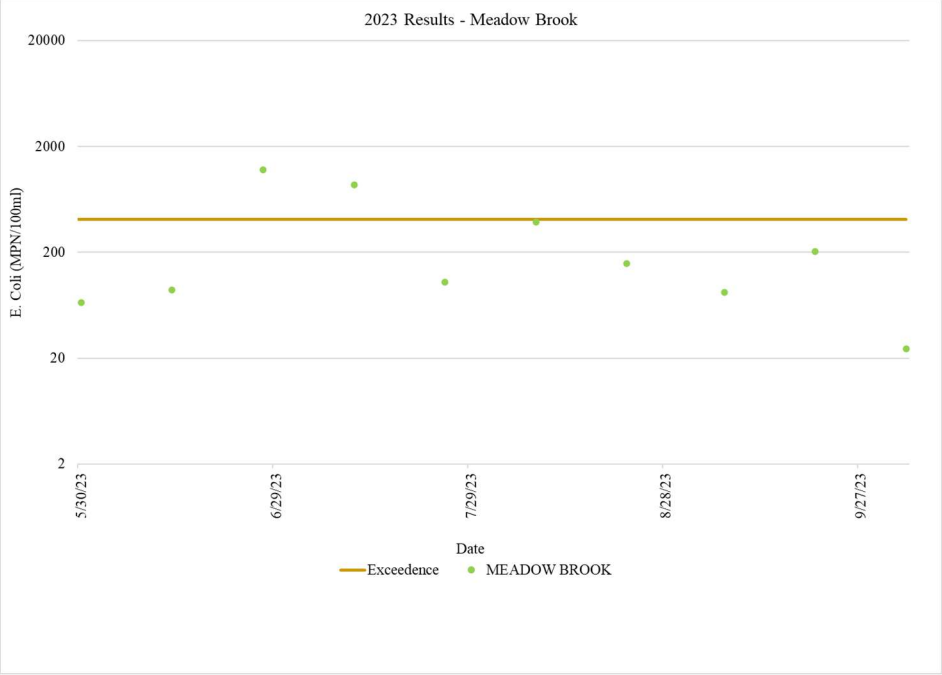

Figure 8. 2023 results for Meadow Brook. Exceedance indicates results above STV of 410 MPN/100ml.

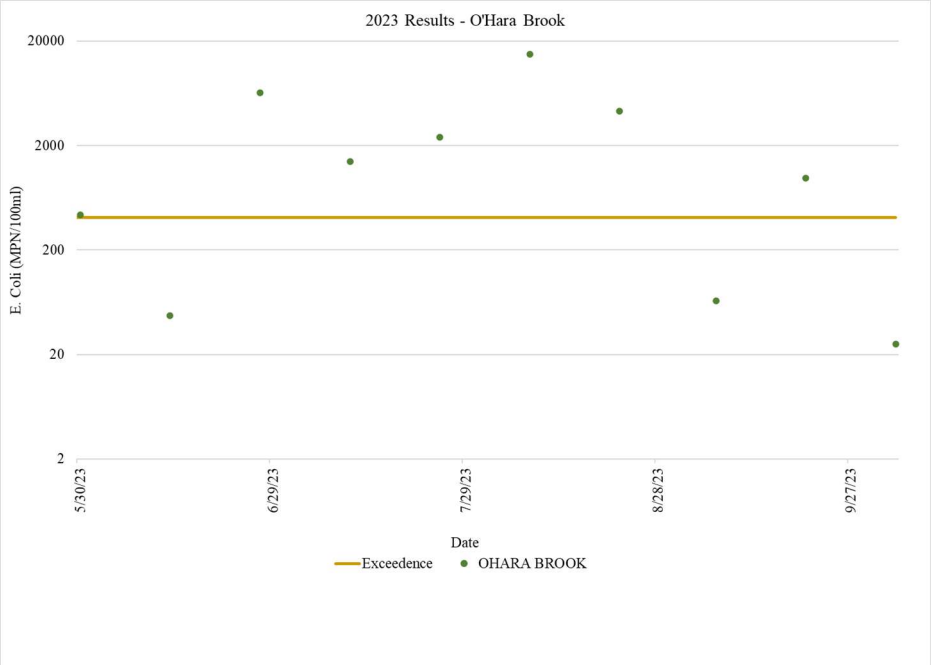

Figure 9. 2023 results for O'Hara Brook. Exceedance indicates results above STV of 410 MPN/100ml.

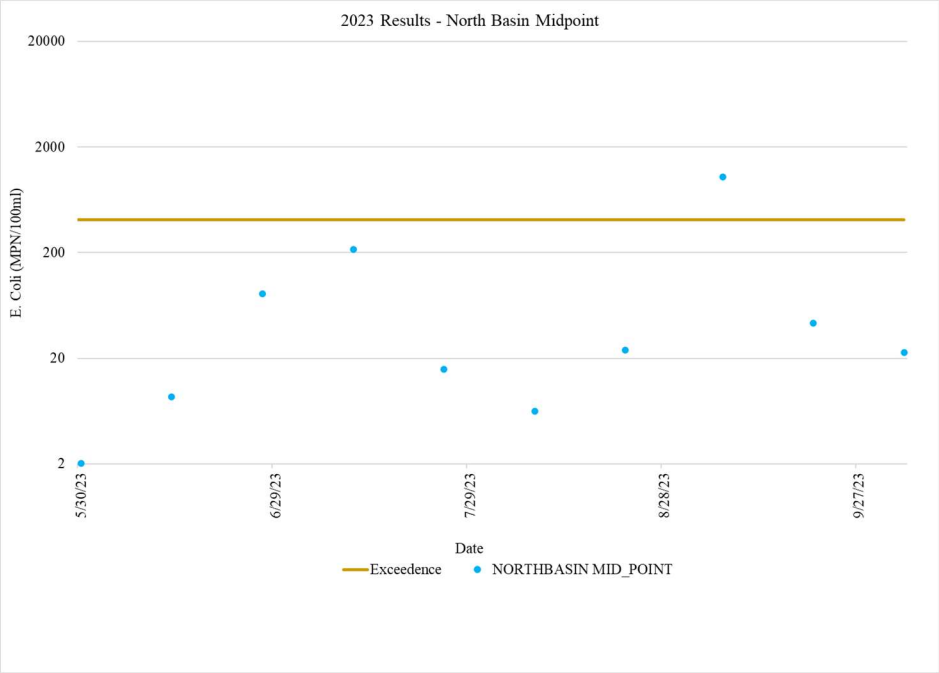

Figure 10. 2023 results for North Basin Midpoint. Exceedance indicates results above STV of 410 MPN/100ml.

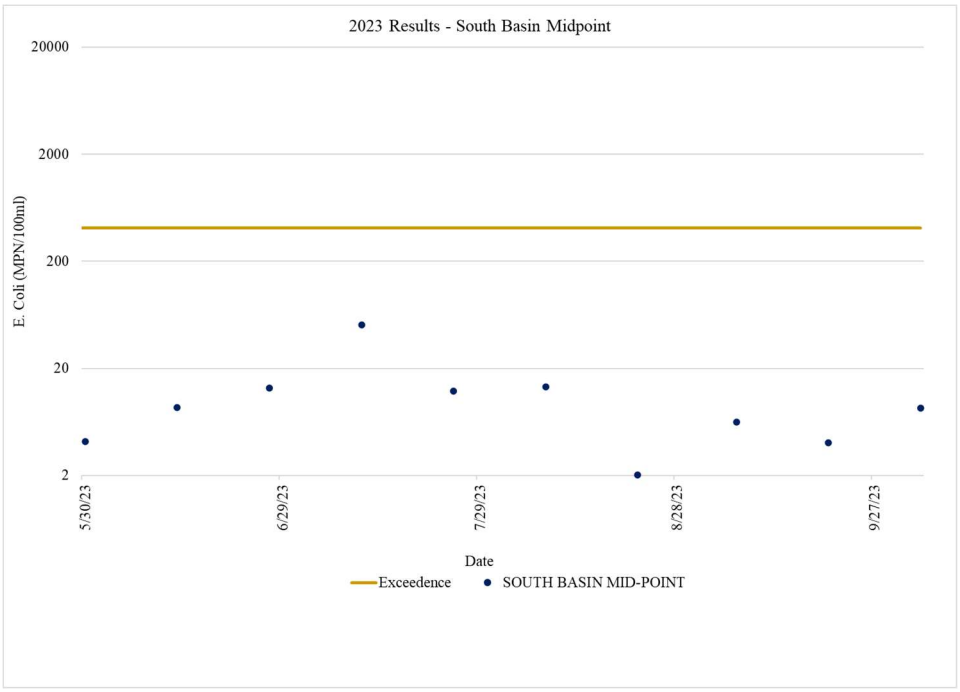

Figure 11. 2023 results for South Basin Midpoint. Exceedance - results above STV of 410 MPN/100ml.

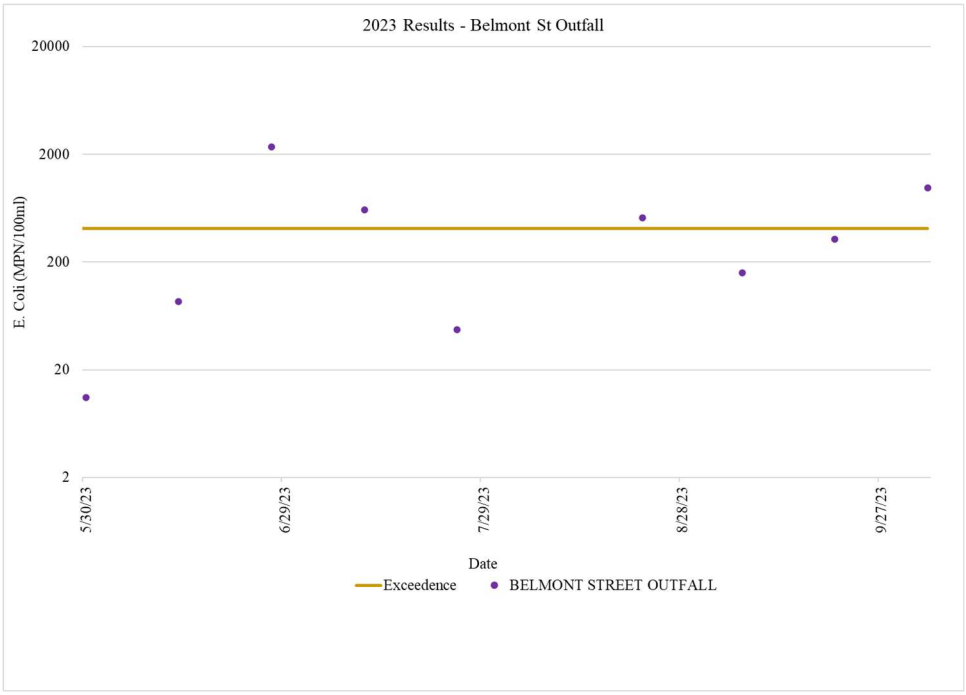

Figure 12. 2023 results for Belmont St Outfall. Exceedance indicates results above STV of 410 MPN/100ml.

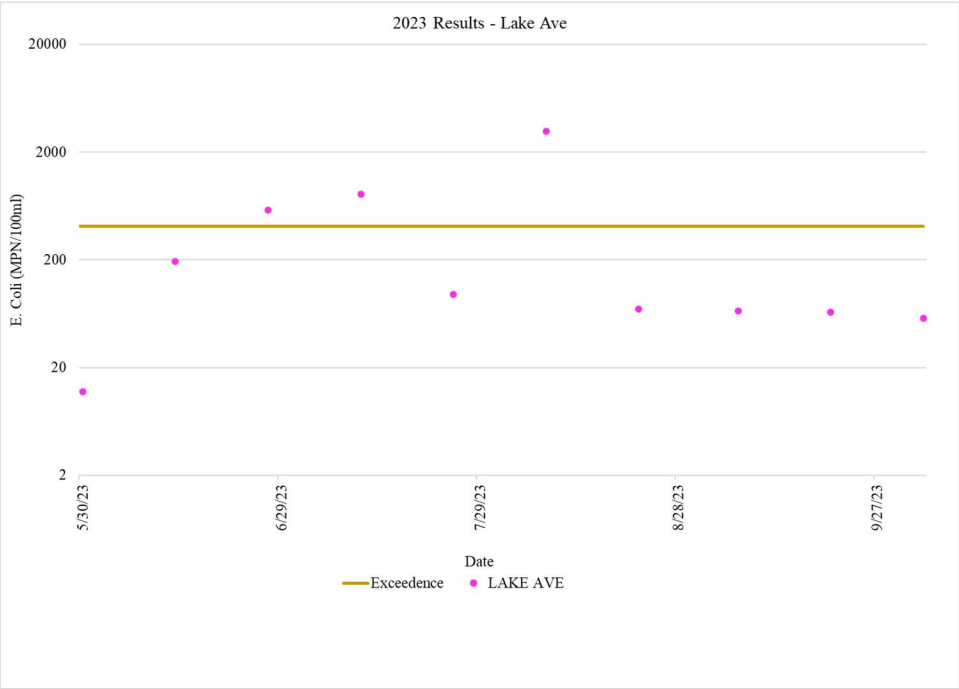

Figure 13. 2023 results for Lake Ave. Exceedance indicates results above STV of 410 MPN/100ml.

All supplementary data provided in separate zipped file.

References

LQWA (2020). Standard Operating Procedure Sample Collection Techniques for Bacterial Samples in Surface Waters #2020-02.

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LQWA (2023b). Sampling & Analysis Plan, in Accordance with the Lake Quinsigamond Water Quality Monitoring Program, Quality Assurance Project Plan.

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MassDEP, (2020). Quality Assurance Project Plan (QAPP), Surface Water Monitoring and Assessment, Division of Watershed Management, CN 520.1. Retrieved from https://Www.Mass.Gov/Doc/Quality-Assurance-Program-Plan-ForSurface-Water-Monitoring-Assessment-2020-2024/Download

MassDEP (2021). Massachusetts Surface Water Quality Standards (314 CMR 4.00). Massachusetts Department of Environmental Protection, 1 Winter Street, Boston, MA