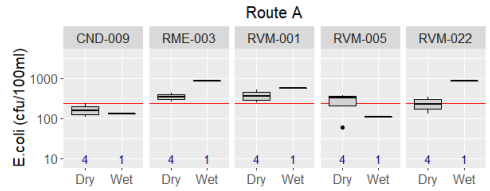
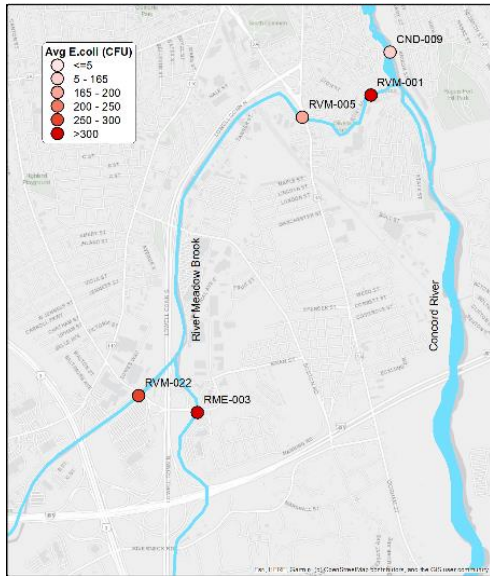
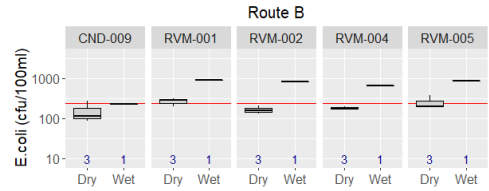
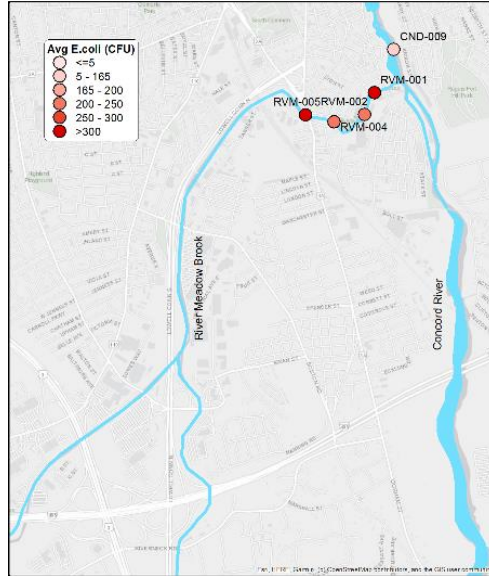


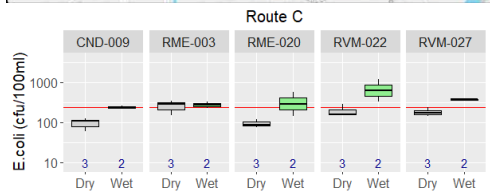
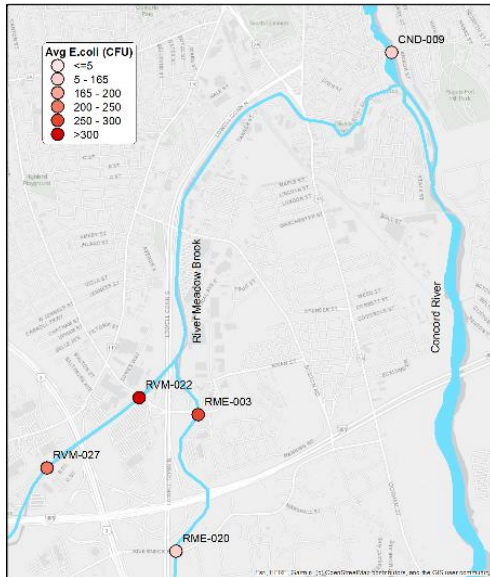
Route A



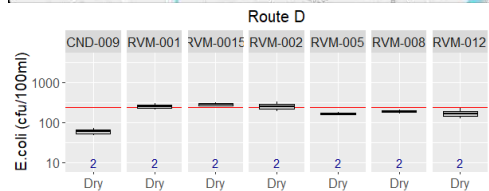
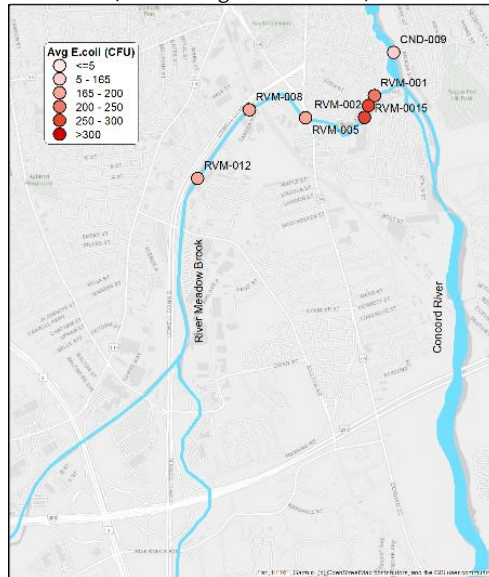
Route B (excluding 7/19/21)



Route C



Route D (excluding 9/13/2021)



Recommendations

This study has confirmed that there is persistent bacterial pollution in several sections of River Meadow Brook, and possibly also at low-levels all along the developed sections of the brook. We have not been able to pinpoint exact sources yet, but we believe that this data has highlighted the important sections for follow-up and that it can help Lowell and Chelmsford conduct focused testing of outfall pipes in those sections to identify the sources. The next level of study may require some bacterial source tracking to differentiate between human and animal sources or detergent or ammonia testing to detect illicit discharges. Following are our recommendations for further focused testing:

1. Look for a dry-weather contamination source between RVM-0015 and RVM-002. Samples on 8/30/21, 8/16/21, 8/2/21, and 6/21/21 all showed higher bacteria levels downstream of RVM-002. There is an old industrial building that spans the brook in this section, which may have some leaking pipes. On one sampling event (9/7/21), results at RVM-002 indicated contamination also coming from upstream, where there are a few street storm catchments and a park. Microbial source tracking at RVM-002 would be useful to identify human or dog sources.

Site #	Description	6/21/2021	8/2/2021	8/16/2021	8/30/2021	9/7/2021
RVM-001	Lawrence St., Lowell	290	200	320	304	204
RVM-0015	UMACO, Lowell				320	248
RVM-002	Industrial Tool, Lowell	210	132	156	192	328
RVM-004	Newhall St, Lowell	200	168	172		
RVM-005	Gorham St., Lowell	380	200	200	152	184

2. Look for a dry-weather contamination source upstream of RVM-008. Samples on 8/30/21 showed higher bacteria levels at RVM-008 than at the next upstream site RVM-012. Samples on 8/16/21, 8/2/21, and 6/21/21 all showed relatively high bacteria levels at RVM-005, though no samples were collected farther upstream. Samples on 8/10/20 and 7/27/20 both showed higher bacterial levels at RVM-005 than upstream at RVM-012. There is a large homeless encampment between RVM-008 and RVM-012, which could be resulting in unsanitary conditions. Providing a public toilet facility in this area may be a way to protect the brook.

Site #	Description	7/27/2020	8/10/2020	6/21/2021	8/30/2021
RVM-004	Newhall St, Lowell			200	
RVM-005	Gorham St., Lowell	310	310	380	152
RVM-008	Howard St., Lowell				212
RVM-012	Lincoln St., Lowell	280	200		124
RVM-018	Behind Marshalls, Lowell	220	230		

3. Look for a dry-weather contamination source in the east branch upstream of RME-003. This site almost always exceeded the threshold of 235 CFU. Samples on 8/9/21, 7/26/21, and 6/14/21 all showed higher bacteria levels at RME-003 than at the next upstream site RME-020. This is a wooded section, so microbial source tracking would be useful here to clarify whether these bacteria are from humans or wildlife.

Site #	Description	6/7/2021	6/14/2021	6/28/2021	7/26/2021	8/9/2021	9/8/2020	9/14/2020
RVM-001	Lawrence St., Lowell	530		420			250	300
RME-003	Industrial Ave., Chelmsford	260	150	440	280	340	370	310
RME-020	Riverneck Rd, Chelmsford		120		88	76		

4. Look for a wet-weather contamination source in the west branch upstream of RVM-022. On 8/24/21, levels were very high at RVM-022 and much lower at the next upstream site RVM-027. On 8/31/20, levels were very high at RVM-022, though no upstream sampling was done. On 7/12/21, levels were relatively high at both RVM-022 and RVM-027. This is a wooded area, and there is a large presence of geese at the Crosspoint Tower parking lot. Microbial source tracking would be useful to clarify whether these bacteria are from humans or wildlife.

Site #	Description	7/12/2021	8/24/2021	8/31/2020
RVM-001	Lawrence St., Lowell			570
RVM-022	Crosspoint Tower, Lowell	330	1200	880
RVM-027	Glen Ave, Chelmsford	360	384	

5. Look for a wet-weather contamination source upstream of the Centennial Island site CND-012 on the Concord River. Wet-weather sampling on 6/22/20 returned very high bacteria counts at CND-012 and much lower counts just upstream at CND-017. Subsequent wet-weather samples on 6/29/20 and 7/6/20 were much lower, but also returned higher counts at the downstream site. This area was not tested in 2021. There is an active walking trail and large cemetery along the east bank of the river in this section. Microbial source tracking would be useful to clarify whether these bacteria are from humans or dogs.

Site #	Description	6/22/2020	6/29/2020	7/6/2020
CND-009	Rogers St. Bridge, Lowell	1650	440	220
RVM-001	Lawrence St., Lowell	1950	3040	1300
CND-012	Centennial Island E, Lowell	2650	220	160
CND-017	Muldoon Park, Lowell	580	70	130

Appendix A: Bacteria data by sampling route

Blue headers denote wet-weather prior to sampling. Pink shading denotes EPA swimming exceedance.

Phase 1 (in 2020)

Site #	Description	6/8/2020	6/15/2020	6/22/2020	6/29/2020	7/6/2020	7/13/2020	Phase 1 (geo-mean)
CND-017	Muldoon Park, Lowell	68	60	580	70	130	60	104
CND-012	Centennial Island E, Lowell	76	92	2650	220	160	40	172
CND-009	Rogers St. Bridge, Lowell	240	124	1650	440	220	110	284
RVM-001	Lawrence St., Lowell	164	240	1950	3040	1300	370	695
RVM-005	Gorham St., Lowell	148	182	3200	3360	1600	370	745

Phase 2 (in 2020)

Site #	Description	7/20/2020	7/27/2020	8/3/2020	8/10/2020	8/17/2020	8/24/2020	Phase 2 (geo-mean)
CND-009	Rogers St. Bridge, Lowell	220	180	220	200	260	130	197
RVM-001	Lawrence St., Lowell	280	320	270	290	320	270	291
RVM-005	Gorham St., Lowell	170	310	270	310	70	140	187
RVM-012	Lincoln St., Lowell	380	280	190	200	110	340	231
RVM-018	Behind Marshalls, Lowell	380	220	270	230	150	100	207

Route A (2020 and 2021)

Site #	Description	8/31/2020	9/8/2020	9/14/2020	6/7/2021	6/28/2021	Route A (geo-mean)
CND-009	Rogers St. Bridge, Lowell	130	110	240	190	130	153
RVM-001	Lawrence St., Lowell	570	250	300	530	420	394
RVM-005	Gorham St., Lowell	110	60	350	310	380	194
RVM-022	Crosspoint Tower, Lowell	880	130	340	185	280	289
RME-003	Industrial Ave., Chelmsford	860	370	310	260	440	408

Route B (in 2021)

Site #	Description	6/21/2021	7/6/2021	7/19/2021	8/2/2021	8/16/2021	Route B (geo-mean)	excl. 7/19 (geo-mean)
CND-009	Rogers St. Bridge, Lowell	270	230	10	88	116	91	159
RVM-001	Lawrence St., Lowell	290	890	10	200	320	175	359
RVM-002	Industrial Tool, Lowell	210	810	10	132	156	128	243
RVM-004	Newhall St, Lowell	200	660	90	168	172	203	249
RVM-005	Gorham St., Lowell	380	860	50	200	200	231	338

Route C (in 2021)

Site #	Description	6/14/2021	7/12/2021	7/26/2021	8/9/2021	8/24/2021	Route C (geo-mean)
CND-009	Rogers St. Bridge, Lowell	60	220	124	108	264	136
RVM-022	Crosspoint Tower, Lowell	280	330	160	156	1200	308
RVM-027	Glen Ave, Chelmsford	170	360	144	240	384	241
RME-003	Industrial Ave., Chelmsford	150	330	280	340	228	255
RME-020	Riverneck Rd, Chelmsford	120	580	88	76	144	146

Route D (in 2021)

Site #	Description	8/30/2021	9/7/2021	9/13/2021	Route D (geo-mean)	excl. 9/13 (geo-mean)
CND-009	Rogers St. Bridge, Lowell	48	72	1500	173	59
RVM-001	Lawrence St., Lowell	304	204	1500	453	249
RVM-0015	UMACO, Lowell	320	248	1500	492	282
RVM-002	Industrial Tool, Lowell	192	328	1500	455	251
RVM-005	Gorham St., Lowell	152	184	1500	347	167
RVM-008	Howard St., Lowell	212	168	1500	377	189
RVM-012	Lincoln St., Lowell	124	224	1500	347	167

Appendix B: Site list with coordinates

Site #	DESCRIPTION	TOWN	WATERBODY	LATITUDE	LONGITUDE
CND-009	Rogers Street bridge	Lowell	Concord River	42.635950	-71.301487
CND-012	Centennial Island East	Lowell	Concord River	42.632793	-71.299590
CND-017	Muldoon Park	Lowell	Concord River	42.625878	-71.295905
RVM-001	649 Lawrence St.	Lowell	River Meadow	42.633278	-71.303113
RVM-0015	UMACO	Lowell	River Meadow	42.632741	-71.303577
RVM-002	Industrial Tool	Lowell	River Meadow	42.631878	-71.303969
RVM-004	Newhall St.	Lowell	River Meadow	42.631250	-71.306048
RVM-005	Gorham/Chambers St.	Lowell	River Meadow	42.631908	-71.308884
RVM-008	Howard St.	Lowell	River Meadow	42.632453	-71.313522
RVM-012	Lincoln St.	Lowell	River Meadow	42.628175	-71.317949
RVM-014	Plain St.	Lowell	River Meadow	42.625100	-71.319213
RVM-018	Industrial Ave. behind Marshalls	Lowell	River Meadow	42.619696	-71.318965
RVM-022	Industrial Ave. at Crosspoint Tower	Lowell	River Meadow	42.614641	-71.322688
RVM-027	Glen Ave.	Chelmsford	River Meadow	42.610395	-71.330474
RME-003	Industrial Ave. East	Chelmsford	River Meadow East	42.613599	-71.317732
RME-020	Riverneck Rd.	Chelmsford	River Meadow East	42.605154	-71.319594