

Appendix D
Addison County River Watch Collaborative
Summary Report: 2017 Sampling Results

Quality Assurance / Quality Control Summary Report

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I. Introduction

This appendix provides a summary of the Quality Assurance review of sampling results for the 2017 season in six watersheds monitored by the Addison County River Watch Collaborative:

- Lemon Fair River
- Lewis Creek
- Little Otter Creek (including Mud Creek)
- Middlebury River
- New Haven River
- Otter Creek

The Addison County River Watch Collaborative sampled 36 sites in these six watersheds during two Spring events (April and May) four Summer events (June, July, August and September). In addition, a special bracket monitoring study was carried out at 6 of these sites in the vicinity of Tyler Bridge Road in Lewis Creek watershed. Sentinel station LCR14 and five temporary sites upstream of this location were monitored as part of a special project to more closely bracket potential or suspected source(s) of pathogens that have been detected consistently at high levels at LCR14 over several years.

Table 1. Sampling Dates in 2017

Stations	Sampling Dates	
36 sentinel, rotational, and special-project stations	April 5	July 5
	May 3	Aug 2
	June 7	Sept 6
6 special-project bracket monitoring stations	September 27	
	October 3	
	October 25	

Sampling sites and parameters monitored during Spring and Summer months are presented in Table 2. Parameters included Total Phosphorus (TP), Dissolved Phosphorus (DP), Total Nitrogen (TN), nitrate-nitrite forms of nitrogen (NOX), Total Suspended Sediments (TSS), Turbidity, and *E. coli*.

II. Data Validation

The following sections discuss data quality objectives and 2017 season results with respect to completeness, accuracy (Field Blank results) and precision (Field Duplicate results). Recommended corrective actions for identified issues are addressed in Section IV.

II.A Completeness

Overall completeness (**99.7%**) exceeded the goal outlined in the ACRWC Quality Assurance Project Plan (80%) as detailed in Table 3. Due to differences in scheduled sites and parameters, completeness has been calculated separately for the Spring, Summer and Fall events.

Table 2. 2017 Schedule of Sites / Parameters – Spring, Summer & Fall Site Types: R = Rotational; S = Sentinel; O = Other (special project).

Project Name: Addison County River Watch Collaborative				Spring Schedule (Apr, May)						Summer Schedule (Jun, Jul, Aug, Sep)						Fall Schedule (pending flow events)							
Project Number: 137-01																							
Sample Year: 2017										PARAMETERS						PARAMETERS							
Type	River Name	Site ID	Site Location	TP	DP	TN	NOX	Turbidity	TSS	E.coli	TP	DP	TN	NOX	Turbidity	TSS	E.coli	TP	DP	TN	NOX	Turbidity	TSS
S	Lewis Creek	LCR3.7	Old Route 7 Bridge	X				X		X	X				X								
S	Lewis Creek	LCR14	Tyler Bridge	X	X	X		X		X	X	X	X		X		X	X					X
O	Hollow Bk (Lewis Ck)	LCHLW1.0	Tyler Bridge Rd Xg of Hollow Bk	X	X	X		X		X	X	X	X		X		X	X					X
O	Hollow Bk (Lewis Ck)	LCHLW0.1	Hollow Brook at Confl w/ Lewis	X	X	X		X		X	X	X	X		X		X	X					X
O	Lewis Creek	LCR14.3	Just above confluence of Hollow Bk	X	X	X		X		X	X	X	X		X		X	X					X
O	Lewis Creek	LCR15	Just above Clifford stabilized crossing	X	X	X		X		X	X	X	X		X		X	X					X
O	Lewis Creek	LCR16	LaRue bridge crossing	X	X	X		X		X	X	X	X		X		X	X					X
S	Lemon Fair River	LFR6.7	Route 125 bridge.	X	X			X	X	X	X	X			X	X							
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge	X	X			X	X	X	X	X			X	X							
S	Little Otter Creek	LOC4.3	Route 7 Bridge	X	X	X		X	X	X	X	X	X		X	X							
R	Little Otter Creek	LOC7.8	Middlebrook Rd (North)	X	X	X		X	X	X	X	X	X		X	X							
R	Little Otter Creek	LOC10	Monkton Road	X	X	X		X	X	X	X	X	X		X	X							
R	Little Otter Creek	LOC14.4	Plank Rd.	X	X	X		X	X	X	X	X	X		X	X							
R	Norton Brook	LOCNB0.2	Norton Brook	X	X	X		X	X	X	X	X	X		X	X							
R	Little Otter Creek	LOC20.3	Sawyer Road Bridge	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	Little Otter Creek	LOC21.5	Kilbourn property	X	X	X	X	X	X	X	X	X	X	X	X	X							
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)	X	X	X		X	X	X	X	X	X		X	X							
S	Middlebury River	MIR1.5	Shard Villa Road Bridge	X				X		X	X				X								
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	X				X		X	X				X								
S	Middlebury River (Midd Br)	MIR10.6	Natural Turnpike Road	X				X		X	X				X								
R	New Haven River	NHR0.5	Dog Team Tavern	X				X		X	X				X								
S	New Haven River	NHR2	Muddy Branch confluence (just below)	X				X		X	X				X								
R	Muddy Branch	NHM0.4	Just above confluence at Nash Fm	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	Muddy Branch	NHM1.4	Halpin Covered Bridge Rd	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	Muddy Branch	NHM3.6	Painter Road crossing	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	Muddy Branch	NHM5.2	Munger Road crossing	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	New Haven River	NHR5	New Haven Mills / Munger St Bridge	X				X		X	X				X								
R	West Brook	NHWB0.2	Cove Road crossing	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	West Brook	NHWB2.7	Rt 116 below Elephant Mtn Campground	X	X	X	X	X	X	X	X	X	X	X	X	X							
R	New Haven River	NHR6	Route 116 Bridge, Sycamore Park	X				X		X	X				X								
S	New Haven River	NHR9	South St. Bridge	X				X		X	X				X								
R	New Haven River	NHR11.5	Bartlett's Falls Pool	X				X		X	X				X								
R	New Haven River	NHR13	York Hill Rd Bridge	X				X		X	X				X								
R	New Haven River	NHR15	Garland's Bridge - Gap Road	X				X		X	X				X								
S	Otter Creek	OTR7.3	Vergennes Falls / below outfall	X				X		X	X				X								
S	Otter Creek	OTR18	Twin Bridges Picnic Area	X				X		X	X				X								

Table 3. Project Completeness

Parameter	Number of Samples Anticipated			Number of Valid Samples Collected & Analyzed			Percent Complete		
	Primary	QC	Total	Primary	QC	Total			
Chlorophyll- <i>a</i>	-	-	-						
Phosphorus	Total	Spring	72	16	88	70	15	85	96.6%
		Summer	144	32	176	144	32	176	100.0%
		Fall	18	6	24	18	6	24	100.0%
	Dissolved	Spring	44	12	56	45	11	56	100.0%
		Summer	64	16	80	64	16	80	100.0%
<i>E. coli</i>	Summer	144	32	176	143	32	175	99.4%	
	Fall	18	6	24	18	6	24	100.0%	
Total Suspended Solids	Spring	32	8	40	32	8	40	100.0%	
	Summer	64	16	80	64	16	80	100.0%	
Transparency			-						
Alkalinity	Summer	-	-	-					
pH			-						
Turbidity	Spring	72	16	88	71	16	87	98.9%	
	Summer	144	32	176	144	32	176	100.0%	
	Fall	18	6	24	18	6	24	100.0%	
Total Nitrogen	Spring	40	8	48	40	8	48	100.0%	
	Summer	80	16	96	80	16	96	100.0%	
Total Nox	Spring	16	4	20	16	4	20	100.0%	
	Summer	32	8	40	32	8	40	100.0%	
Si, dissolved		-	-	-					
Dissolved Oxygen		-	-	-					
Conductivity		-	-	-					
Temperature	Spring/Summer	216		216	215		215		

Overall Percent Completeness: 99.7%

Completeness - Primary Samples

Select constituent analyses for three primary samples were missed during the 2017 season:

- On **April 5**, samples scheduled for analysis of TP and Turbidity from New Haven River station NHR6 were not successfully collected. Due to a mix up during bottling / labeling and sample-kit preparation, these samples were mistakenly collected from a different site. This error was identified during sample check-in at ACRPC offices, and therefore these samples were not submitted to VAEL for analysis, as it was too late to return to the site and collect a proper sample.
- Also during the **April 5** event, a scheduled TP sample from New Haven River station NHR5 was instead analyzed for DP. The prelog and label request from ACRWC asked for TP analysis of this sample (#170088-23), but the prelog and labels generated for this sample incorrectly specified DP analysis. The ACRWC QA officer did not notice this error upon cross-checking the prelog/labels to the original prelog request and missed an opportunity to clarify that our requested analysis was for TP; therefore, this sample was analyzed for DP rather than TP.
- For the **Sept 6** event, no *E.coli* result was reported for the sample collected at New Haven River station NHR15. Field data sheets and sample delivery check sheets indicate that this sample was indeed collected and delivered to the lab. An inquiry was made to VAEL for any information that might explain why no *E.coli* result was reported for this sample (#171268-34-Ecoli). Lab notes indicated that this sample was broken in the lab and was therefore not analyzed (email communication from Dan Needham, 1/12/2018).

Completeness - Field QC Samples

The ACRWC QAPP specifies collection of Field Blanks and Field Duplicates at a frequency of 1 / 10 primary samples for each scheduled analyte, per event. Field Blank samples were collected and processed at a frequency of 10% or greater during each of the Spring, Summer and Fall sampling events – meeting the completeness goal for QC samples. Field duplicates were also collected and processed at a 10% frequency in each event, except in one instance:

- On **April 5**, due to a problem in the field or in bottle preparation and labelling, Field Duplicates at LCR14 were not collected for TP or DP (though they were collected at this site for TN and Turb, as scheduled). Therefore, a Duplicate/Primary sample pair was not available for calculation of Relative Percent Difference for TP and DP. Thus, for this event, for constituent TP, only 3 duplicate pairs were collected for a total of 36 sampling stations, equating to (8.3%), just barely under the 10% completeness goal. And the 10% goal for DP was missed since only 2 Field Duplicates were collected for a total of 22 samples (or 9.1%).

II.B Field Blank results

Field Blank results are summarized in Table 4. Field Blanks collected for each constituent in the Spring, Summer and Fall events were within field accuracy goals (no constituents detected above the respective method detection limits in the blanks) – except for the following cases.

- In some Field Blank results for various events and various constituents, a value of the indicated constituent was detected slightly above the respective method detection limit (see light orange-shaded values in Table 4). It is unknown whether contamination of the Field Blank occurred in the field or in the lab. ACRWC utilized deionized water that had been provided by the VAEL. Since the reported value was only slightly above the detection limit, none of the corresponding results for these stations have been rejected or flagged as estimated values on account of these Field Blank results.
- On **June 7**, the Turbidity results for the Field Blanks from stations NHM3.6 on Muddy Branch tributary of the New Haven River and OTR18 on the Otter Creek were between 2 and 4 times the detection limit, while results for analysis of other constituents were below their respective detection limits (except TP in NHM3.6). It is unknown whether contamination of the Turbidity Field Blank occurred in the field or in the lab. It is possible that the Turbidity bottle was mistakenly filled with river water; however, there is no suggestion of this in the field notes or lab runner log. The fact that *E.coli*, Turbidity, TSS, and TN results were non-detect would suggest that samplers followed protocol and filled all Field Blank vials with deionized water that had been provided by the VAEL. The detected value of Turbidity in the primary sample collected at NHM3.6 and OTR18 was 8 and 27.7 NTUs, respectively, so 40 and 139 times the detection limit. Turbidity detected in other primary samples from these two watersheds ranged from 1.0 to 52 NTUs, or 5 to 260 times that detection limit. It is not uncommon for Turbidity and TP to be detected in Field Blanks at very low levels, but somewhat above the method detection limit (Jim Kellogg, email communication, 1/15/2018). Field **duplicate** results for Turbidity and TP for the June 7 event were well within target Relative Percent Difference for each analyte (see next section). Following the above reasoning, none of the corresponding results for these stations have been rejected or flagged as estimated values on account of these Field Blank results.

Table 4. Field Blank Results

Sample Number	Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	NO2-NO3 Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
170088-37	LCR14 BLK	4/5/2017	B		< 0.1		< 5	< 5		< 0.2
170088-39	LFR12 BLK	4/5/2017	B				< 5	< 5	< 1	< 0.2
170088-41	LOC21.5 BLK	4/5/2017	B		< 0.1	< 0.05	8.17	7.65	2.3	0.33
170088-43	NHM5.2 BLK	4/5/2017	B		< 0.1	< 0.05	5.6	< 5	< 1	< 0.2
170090-37	LCR15 BLK	5/3/2017	B		< 0.1		< 5	< 5		< 0.2
170090-39	LOCNB0.2 BLK	5/3/2017	B		< 0.1		< 5	< 5	< 1	< 0.2
170090-43	MIR1.5 BLK	5/3/2017	B				< 5			< 0.2
170090-41	NHM0.4 BLK	5/3/2017	B		< 0.1	< 0.05	< 5	< 5	< 1	< 0.2
170758-37	LCHLW1.0 BLK	6/7/2017	B	< 1	< 0.1		6.8	< 5		< 0.2
170758-39	LOC14.4 BLK	6/7/2017	B	< 1	< 0.1		< 5	< 5	< 1	< 0.2
170758-41	NHM3.6 BLK	6/7/2017	B	< 1	< 0.1	< 0.05	7.21	< 5	< 1	0.77
170758-43	OTR18 BLK	6/7/2017	B	< 1			< 5			0.44
170871-37	LCR14 BLK	7/5/2017	B	< 1	< 0.1		< 5	< 5		< 0.2
170871-39	LOC10 BLK	7/5/2017	B	< 1	< 0.1		< 5	< 5	< 1	< 0.2
170871-43	MIR10.6 BLK	7/5/2017	B	< 1			< 5			< 0.2
170871-41	NHWB0.2 BLK	7/5/2017	B	< 1	< 0.1	< 0.05	< 5	< 5	< 1	< 0.2
171130-37	LCR15 BLK	8/2/2017	B	< 1	< 0.1		< 5	< 5		0.28
171130-39	LOCNB0.2 BLK	8/2/2017	B	< 1	< 0.1		< 5	< 5	< 1	< 0.2
171130-41	NHM5.2 BLK	8/2/2017	B	< 1	< 0.1	< 0.05	< 5	< 5	< 1	< 0.2
171130-43	NHR13 BLK	8/2/2017	B	< 1			< 5			< 0.2
171268-37	LCR15 BLK	9/6/2017	B	< 1	< 0.1		< 5	< 5		< 0.2
171268-39	LOC7.8 BLK	9/6/2017	B	< 1	< 0.1		< 5	< 5	< 1	< 0.2
171268-41	NHM0.4 BLK	9/6/2017	B	< 1	< 0.1	< 0.05	< 5	< 5	< 1	< 0.2
171268-43	NHR6 BLK	9/6/2017	B	< 1			< 5			< 0.2
170093-07	LCR14 BLK	9/22/2017	B	< 1			7.79			< 0.2
170094-07	LCR14 BLK	10/3/2017	B	< 1			9.24			< 0.2
170095-07	LCR14 BLK	10/25/2017	B	< 1			< 5			0.25

Shaded cells indicate values detected at or above the method detection limit.

II.C Field Duplicate results

Field Duplicate results are summarized in Table 5, which presents the Relative Percent Difference (RPD) values for each analyte for each Field Duplicate pair. As per the QAPP, Mean Relative Percent Difference was calculated as follows:

$$RPD_{\text{field duplicate pair } 1} = \frac{\text{absolute value (sample}_1 - \text{sample}_2)}{\text{average (sample}_1 \text{ and sample}_2)}$$

$$\text{and, mean RPD for "n" duplicate pairs} = \text{average (RPD}_{\text{pair } 1} + \text{RPD}_{\text{pair } 2} + \dots + \text{RPD}_{\text{pair } n})$$

Mean RPD values for the season were within the precision goals specified for the project for all analytes.

While, the mean values met precision goals, RPD values for select constituents during select events exceeded this goal (shaded in light orange in Table 5). Various aspects of sampling and analysis procedures, as well as natural variability, may have contributed to these elevated RPD values. In most of these cases, the detected concentration in the duplicate pair was quite low – a condition which can contribute to elevated RPD. Since the overall mean RPD for the 2017 sample year met the precision goal, none of the results were rejected or flagged as estimated values on account of RPD results for Field Duplicate pairs.

III. Other QA/QC Issues

1. Results for the first of three Fall bracket-sampling events in Lewis Creek (Batch # 170093) were provisionally reported by the lab as occurring on 9/22. However, the event actually took place on 9/27/2017. This inconsistency was reported to VAEL, and the state’s database was corrected to reflect the actual sample date of 9/27/2017.
2. In one Lewis Creek sample (LCHLW1.0), collected during very low flow conditions on August 2, subtraction of the reported DP concentration from the TP concentration resulted in a negative value. However, the difference was a very low number, less than the detection limit of the method (5 ug/L). It is also notable that suspended solids were very low or non-detectable in these samples, as measured by both Total Suspended Solids and Turbidity. These results were interpreted to indicate that the full amount of TP in this sample was present in the dissolved form.

Sample Number	Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	NO2-NO3 Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)	TP-DP
171130-04	LCHLW1.0	8/2/2017	A	13.5	0.73		5.5	5.75		0.27	(0.25)

Table 5. Field Duplicate Results (presented values are Relative Percent Difference of Field Duplicate pairs)

Sample Number	Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	NO2-NO3 Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
170088-38	LCR14	4/5/2017	D		0.0		NM	NM		2.6
170088-40	LCR12	4/5/2017	D				0.0	2.3	5.7	4.9
170088-42	LOC21.5	4/5/2017	D		2.1	3.1	3.6	6.8	1.9	7.2
170088-44	NHM5.2	4/5/2017	D		4.4	4.2	2.8	3.5	0.0	4.0
170090-38	LCR15	5/3/2017	D		2.6		7.7	11.6		2.2
170090-40	LOCNB0.2	5/3/2017	D		0.0		8.4	3.7	35.7	12.5
170090-44	MIR1.5	5/3/2017	D				9.2			5.4
170090-42	NHM0.4	5/3/2017	D		7.8	0.0	1.9	0.3	4.3	12.3
170758-38	LCHLW1.0	6/7/2017	D	23.3	0.0		5.1	0.0		8.3
170758-40	LOC14.4	6/7/2017	D	18.7	1.2		1.0	3.9	0.0	6.2
170758-42	NHM3.6	6/7/2017	D	0.0	4.3	17.5	0.0	4.6	12.4	2.5
170758-44	OTR18	6/7/2017	D	23.0			2.5			1.9
170871-38	LCR14	7/5/2017	D	9.5	5.4		15.3	5.1		5.3
170871-40	LOC10	7/5/2017	D	10.9	152.9		2.4	1.6	12.6	6.3
170871-44	MIR10.6	7/5/2017	D	14.3 ‡			8.9			2.5
170871-42	NHWB0.2	7/5/2017	D	35.0	1.7	0.0	0.0	6.2	16.8	25.8
171130-38	LCR15	8/2/2017	D	42.1	2.4		8.5	2.3		53.4
171130-40	LOCNB0.2	8/2/2017	D	38.3	3.8		6.3	6.2	2.5	21.3
171130-42	NHM5.2	8/2/2017	D	6.4	4.3	0.0	1.8	5.9	3.2	5.4
171130-44	NHR13	8/2/2017	D	14.7			0.0			90.6
171268-38	LCR15	9/6/2017	D	28.0	2.2		15.4	3.2		4.8
171268-40	LOC7.8	9/6/2017	D	0.0	7.8		2.0	2.0	6.1	4.4
171268-42	NHM0.4	9/6/2017	D	0.0	4.7	9.5	4.9	0.9	11.1	17.0
171268-44	NHR6	9/6/2017	D	12.9			1.6			9.9
170093-08	LCR14	9/22/2017	D	28.8			6.7			23.8
170094-08	LCR14	10/3/2017	D	1.4			2.4			27.6
170095-08	LCR14	10/25/2017	D	0.0			3.1			5.3
# duplicate pairs				19	18	7	26	18	13	27
Average RPD for Sample Year				16.3	11.5	4.9	4.7	3.9	8.6	13.8
				14.3 ‡						
QAPP acceptable RPD				≤50% (>25mpn) ≤125% (<25mpn) ‡	≤ 20%	≤ 10%	≤ 30%	≤ 30%	≤ 15%	≤ 15%

IV. Corrective Actions

The following corrective actions are recommended to address issues encountered in 2017.

- A. ACRWC will continue with the annual refresher training that is mandatory for all volunteer samplers. A new sampling instruction video has been prepared by ACRWC that will be used at training, and available to samplers throughout the season, to emphasize proper sampling techniques. <http://acrpc.org/programs-services/natural-resources/acrwc/whatsnew/>
- B. Incidents of missed primary or field duplicate samples in 2017 appeared to stem from sampling coordinators and/or volunteers not carefully reading bottle labels to confirm the proper set of vials was selected for the given sampling station. Training in March 2018 will particularly emphasize the need to carefully cross check that proper bottles have been selected for the given sampling site before proceeding with bottle collection.
- C. Spring training has been emphasizing field collection methods for duplicate and field blank samples, as this is an area of recurring sampling errors. Sampling coordinators have been making concerted efforts to ensure that field blank vials are filled with DI water prior to sampling so that there is no opportunity to fill a blank vial (erroneously) with river water. There was a reduced incidence of errors resulting from confusion about field blank and duplicate sample collection during the 2017 season as compared to previous years.
- D. The ACRWC Coordinator will continue to generate a Lab Runner Log. This form was used to document any QA issues relevant to sample transport and delivery and record them as they happened, which proved useful to the generation of this QA/QC summary report.
- E. ACRWC was able to avoid many QC issues this year, as a result of a series of checks and data reviews throughout the sampling season (detailed in the 2010 season QA Summary Report). Far fewer omissions and incidents have occurred in recent years as a result of instituting these checks and balances. ACRWC will continue with these procedures in future years.