LimnoTech
Water | Environment | Scientists | Engineers

MEMORANDUM

DATE: November 22, 2013

FROM: Doug Bradley
Derek Schlea
Chris Cieciek

PROJECT: GRR13

TO: Mr. Thomas R. Ecklund, P.E.
Facilities Management Director
Gerald R. Ford International Airport

CC:

SUBJECT: Gerald R. Ford International Airport (GFIA) November 2013 Biofilm Monitoring Results

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Summary

The purpose of this memo is to summarize the observations collected during the November 2013 biofilm monitoring survey in the unnamed tributary to the Thornapple River. This is the fifteenth biofilm monitoring event conducted as required by Part I.A.7.d. of GFIA's NPDES Permit (MI0055735). The monitoring results and metric calculations are described below.

General Observations

Heterotrophic biofilm was observed at one transect at the 36th Street monitoring location. Heterotrophic biofilm was not observed at the Thornapple River Drive and Tricklewood Drive monitoring locations.

Monitoring Approach

On November 20, 2013, biofilm monitoring was conducted at three locations (sample stations) in the unnamed tributary of the Thornapple River. Stream assessment reaches were established at each of the locations during the first survey (July 2011) using a hand-held global position system (GPS) device. The monitoring locations are at 36th Street, Thornapple River Drive, and Tricklewood Drive and are shown in Figure 1. Consistent with previous surveys, monitoring was conducted using the Stevenson and Rollins 2007 procedure described in the Proposed Biofilm Monitoring Procedure memo submitted to and approved by MDEQ in June 2011 (LimnoTech, June 3, 2011).

At each of the three sample stations, five transects were designated and marked. The transects were selected based on substrate type. Riffles and/or run segments with coarse substrate materials were specifically targeted because they are most appropriate for periphyton and biofilm attachment and provide repeatable and reliable long-term monitoring locations (Stevenson and Rollins, 2007 in *Methods in Stream Ecology*, 2007). Sampling was conducted at 10 equally spaced points on each transect using the rapid periphyton survey method, Basic Method 1 (Stevenson and Rollins, 2007). Measurements were recorded on the field data sheet (Table 1). Physical habitat characterization forms from the EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish* were used to record field observations and measurements at each monitoring reach (EPA, 1999).

Figure 1. Unnamed Tributary Biofilm/Macroinvertebrate Monitoring Locations.

Community metric calculations include density and distribution estimates for functional categories of moss, macro, and micro (biofilm) algal species. As noted previously, slight modifications necessary to differentiate between microalgae and heterotrophic biofilm were added to the data collection procedure as described below.

1) The Sz column in the Field Data Sheet (Table 1) is intended for inventory of substrate particles >2 cm in size. Since a primary purpose of this monitoring effort is to characterize the presence of biofilm (which is associated with larger size substrates), the Sz column has been modified to instead identify substratum of < 2 cm (where it is not possible to collect community information). The sum of the Sz column observations is transferred to the NA row in Table 3 for extent and magnitude calculations. This modification was discussed with Stevenson and Rollins (personal communication with Doug Bradley, LimnoTech) and the authors stated that this modification is appropriate for the purpose of this monitoring effort.

2) The Algal Cover and Thickness Class Description (Table 2) include estimated cover classes for moss and macroalgae but not microalgae. The purpose of the monitoring was discussed with the procedure authors and it was suggested by Stevenson that including cover class for microalgae would provide estimated cover and thickness values that will improve the applicability of the procedure for tracking the status of the heterotrophic biofilm community. This component of the protocol was expanded for this monitoring event by adding a column (Table 2) to quantify the number of grid points counted over microalgae at 10 equally spaced points on each transect using a viewing bucket (EPA, 1999) with a 50-dot grid. The grid is used as a quantifiable and repeatable means for measuring distribution and density of biofilm across transects.

3) The calculations for the extent and magnitude of moss, and benthic algal cover (Table 3) include a row named NA. Following clarification from the authors, NA includes the points not sampled because no substrate particle >2 cm was present.

4) The microalgae functional class includes heterotrophic biofilm. The dominance of non-nuisance biofilm microalgae observed during the July and September field visits highlights the need to identify and calculate heterotrophic-specific biofilm observations as well as the other forms of microalgae. The calculation table (Table 3) used for the biofilm monitoring events beginning with the September 2011 event was expanded to quantify the extent and magnitude of biofilm-specific observations, and to estimate the cover of all microalgae as measured with the viewing bucket.

5) The microalgae thickness Class 2 of 0.5 to 1 mm is a transition category between non-visible (thin slimy layer) and visible microalgae (Stevenson and Bahls 1999). The category may misrepresent the presence of heterotrophic biofilm because the study approach prior to July 2012 grouped naturally occurring microalgae (diatoms and bluegreens) with heterotrophic biofilm in Class 2. Beginning with the September 2012 sampling event, we modified the Class 2 calculations to differentiate autotrophic/photosynthetic microalgae from heterotrophic biofilm in the extent and magnitude microalgae metrics (Table 3). Other calculations remain unchanged.

The information being collected and calculations being performed are consistent with the procedures described in the monitoring plan. The additional calculations provide added information on the biofilm community. The metrics will continue to be calculated consistently to support the evaluation of relative changes in the biofilm community.

Monitoring Summary

Site 1 36th Street – The site is approximately 75 meters long and average channel width was approximately 2.3 meters. Maximum stream velocity was measured at 0.19 m/sec. The site includes a mix of natural and re-establishing riparian vegetation, and channel re-alignment from the 36th Street road work conducted in 2006. The channel substrate is generally coarse with patches of fine sediment deposits. Evidence of active channel conditions was observed. Although heterotrophic biofilm was not observed during the thickness measurement collection, a small amount of white biofilm attached to a rock was observed at transect 2 during distribution (cover) measurement using the viewing bucket.

Site 2 Thornapple River Drive – The site is approximately 350 meters long and average channel width was approximately 3.2 meters. Maximum stream velocity was measured at 0.23 m/sec. This reach is longer than Sites 1 and 3 because of the limited amount of suitable coarse substrate upon which to locate survey transects. The site is densely vegetated along the banks and in the immediate riparian area. Evidence of channel shape modification, bed material movement, bank erosion and deposition is present throughout the reach. Heterotrophic biofilm was not present at any of the transects sampled.

Site 3 Tricklewood Drive – The site is approximately 135 meters long and average channel width was approximately 4.0 meters. Maximum stream velocity was measured at 0.18 m/sec. The northern banks of the site are more closely bound by residences than the other sites yet retain thick overhead cover but thin understory. The reach is characterized by a slightly higher gradient than Site 2 and contains a greater dominance of coarser substrates along with an outcrop of exposed hardpan clay. Evidence of active channel conditions was observed. Heterotrophic biofilm was not present at any of the transects sampled.

The field sheets and metric calculations are included as Attachment 1.

References

D. Bradley, LimnoTech. July 2011. Personal communication with J. Stevenson and S. Rollins.

MDEQ (Michigan Department of Environmental Quality). 2008. Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers. Water Bureau Policy and Procedures, WB-SWAS-051 (SWAS Procedure 51), revised December 2008.

Stevenson, R. J., and L. L. Bahls. 1999. Periphyton protocols. Pages 6-1 through 6-22 in M. T. Barbour,J. Gerritsen, and B. D. Snyder (Eds.) Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed. U. S. Environmental Protection Agency, Washington, D.C.

Stevenson, R.J. and S.L. Rollins. 2007. Ecological assessments with benthic algae. Pages 785-803 in F.R. Hauer and G.A. Lamberti (Eds.) Methods in Stream Ecology. Second edition, Academic Press, Burlington, MA.

Attachment 1
GFIA Biofilm Monitoring Field Sheets
November 20, 2013

(1)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 1/3; EPA 1999 (Form 1))

STREAM NAME *Unnamed Trib at 36th St.*	LOCATION *Upstream 36th Street*
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN *Thornapple River*
~~STORET#~~ *AUID 04050070408-02*	AGENCY *LimnoTech*
INVESTIGATORS *Doug Bradley, Derek Schlea / LimnoTech*	
FORM COMPLETED BY *D. Schlea*	DATE *11-20-13* TIME *9:10* AM PM *-10:00*
REASON FOR SURVEY *GFIA Biofilm Elimination/ NPDES Requirement*	

WEATHER CONDITIONS

Now		Past 24 Hours
☐	Storm (heavy rain)	☐
☐	Rain (steady rain)	☐
☐	Showers (intermittent)	☐
80% ☒	% cloud cover	☒ ____ %
☐	Clear/sunny	☒

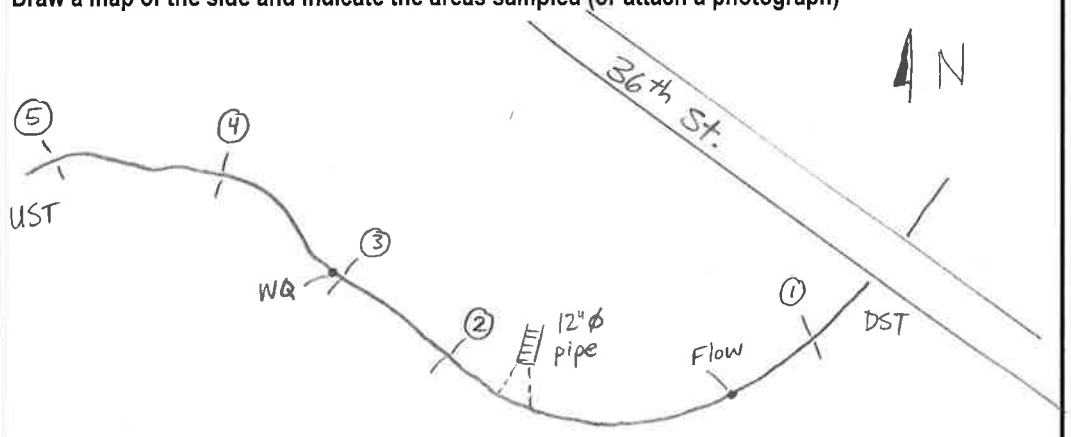
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No *0.46" on 11-16-13, 1.21" on 11-17-13*

Air Temperature *2* °C

Other _____

SITE LOCATION MAP

Draw a map of the side and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial | ☐ Intermittent | ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

Catchment Area *~9.1* km²

(1)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 2/3 EPA 1999 (Form 1))

WATERSHED FEATURES

Predominant Surrounding Landuse

- [x] Forest
- [ ] Field/Pasture
- [ ] Agricultural
- [ ] Residential
- [ ] Commercial
- [ ] Industrial
- [x] Other Road

Local Watershed NPS Pollution

- [ ] No evidence
- [ ] Some potential sources
- [x] Obvious sources

Local Watershed Erosion

- [ ] None
- [x] Moderate
- [ ] Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present

- [ ] Trees
- [x] Shrubs
- [x] Grasses
- [ ] Herbaceous

Dominant species present _____

INSTREAM FEATURES

Estimated Reach Length 75 m

Estimated Stream Width 2.3 m

Sampling Reach Area 173 m²

Area in km² (m²x1000) _____ m²

Estimated Stream Depth 0.16 m

Surface Velocity (at thalwag) 0.19 m/sec

Canopy Cover

- [x] Partly open
- [ ] Partly shaded
- [ ] Shaded

High Water Mark

Proportion of Reach Represented by Stream Morphology Types

- [ ] Riffle 40 %
- [ ] Run 50 %
- [ ] Pool 10 %

Channelized [x] Yes [ ] No

Dam Present [ ] Yes [x] No

LARGE WOODY DEBRIS

LWD 12 ~~m²~~ pieces

Density of LWD 0.070 ~~m²/km²~~ (LWD/reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present

- [ ] Rooted emergent
- [ ] Rooted submergent
- [ ] Rooted floating
- [ ] Free floating
- [ ] Floating algae
- [x] Attached algae

Dominant species present

Portion of the reach with aquatic vegetation 15 %

WATER QUALITY

Temperature 7.28 °C

Specific Conductance 0.498 mS/cm

Dissolved Oxygen 10.81 mg/L

pH 8.02

Turbidity 4.6 NTU

WQ Instrument Used YSI 6920

Water Odors

- [x] Normal/None
- [ ] Petroleum
- [ ] Fishy
- [ ] Sewage
- [ ] Chemical
- [ ] Other _____

Water Surface Oils

- [ ] Slick
- [ ] Sheen
- [ ] Gloss
- [ ] Flecks
- [x] None
- [ ] Other _____

Turbidity (if not measured)

- [ ] Clear
- [ ] Slightly turbid
- [ ] Turbid
- [ ] Opaque
- [ ] Stained
- [ ] Other _____

SEDIMENT SUBSTRATE

Odors

- [ ] Normal
- [ ] Sewage
- [ ] Petroleum
- [ ] Chemical
- [ ] Anaerobic
- [x] None
- [ ] Other _____

Oils

- [x] Absent
- [ ] Slight
- [ ] Moderate
- [ ] Profuse

Deposits

- [ ] Sludge
- [ ] Sawdust
- [ ] Paper fiber
- [x] Sand
- [ ] Relict Shells
- [x] Other silt

Looking at stones which are not deeply embedded, are the undersides black in color?

- [x] Yes
- [ ] No

Notes:

- Thin layer of silt observed at transect 2
- Two thin strands of heterotrophic biofilm observed at transect 2 when sampling with viewing bucket
- Sand deposition observed at transect 4
- Channel conditions at transect 5 have changed relative to past surveys (newly deposited sand and silt, channel shape was slightly different)

(1)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 3/3; EPA 1999 (Form 1))

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock		–	Detritus	Sticks, wood, coarse plant materials (CPOM)	5
Boulder	>256mm (10")	10			
Cobble	64-256mm (2.5" – 10")	30	Muck-Mud	Black, very fine organic (FPOM)	5
Gravel	2-64mm (0.1" – 2.5")	35			
Sand	0.06 – 2mm (gritty)	20	Marl	Grey, shell fragments	–
Silt	0.004 – 0.06 mm	5			
Clay	<0.004mm (slick)	–			

①

Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection.
Modified from Stevenson and Rollins (2007; Table 34.1)

Trns = transect number; Macro = macroalgae; Micro = microalgae;
Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib at 36th St. Date: 11-20-13 Sampler: D. Bradley Recorder: D. Schlea

Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]	Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]	
1	1			1		14	26	3			2		9	
2	1		3	2		13	27	1			2		7	
3			4	2		12	28				2		10	
4				1		17	29					✓	4	
5				2		16	30	↓		3	2		7	
6				1		33	31	4				✓	0	
7			2	2		26	32	1	–	–	–		8	
8			3	2		10	33		–	–	–		5	
9				1		4	34			2	2		3	
10	↓			1		4	35					✓	4	
11	2			1		11	36			4	2		2	
12	1			2		16	37				1		4	
13				1		9	38			3	2		6	
14				2		10	39			2	1		6	
15			3	2		8	40	↓				✓	4	
16				1		4	41	5				✓	0	
17			2	2		5	42	1				✓	0	
18				2		8	43					✓	2	
19				1		9	44					✓	1	
20	↓	–	–	–		19	45					✓	0	
21	3			1		8	46				2		3	
22	1				✓	2	47				2		0	
23		–	–	–		0	48				2		4	
24		–	–	–		12	49				1		6	
25	↓			1		14	50	↓				✓	6	

width 6.0 ft
depth 0.4 ft
width 4.5 ft
depth 0.35 ft
width 5.7 ft
depth 0.9 ft
width 6.0 ft
depth 0.35 ft
width 16.2 ft
depth 0.7 ft

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 38.4 ft²
Substrata Sampled: (rock)/wood/plant
(circle) sand/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

① Unnamed Trib at 36th Street

Table 2. Algae and Moss Cover and Thickness Class Descriptions.
Modified from Stevenson and Rollins (2007; Table 34.2)

	Moss and Macroalgae Cover Classes						
Class	0	1	2	3	4		
Cover	0%	<5%	5% to 25%	25% to 50%	>50%		
	Microalgae Thickness Class[1]						
Class	0	1	2	2*	3	4	5
Thickness	0 mm	<0.5 mm	0.5 to 1 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	>20 mm
Characteristics	rough	slimy; visible evidence of biofilm absent	naturally occurring microalgae	heterotrophic biofilm			
	Microalgae Cover Class[2]						
Class	0	1	2	3	4	5	
Cover	0%	<5%	5% to 25%	25% to 50%	50% to 75%	75% to 100%	

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover.
Modified from Stevenson and Rollins (2007; Table 34.3)
Shaded cells do not have appropriate records or calculations.

Rank	Moss		Macroalagae		Microalgae Thickness		Microalgae Cover[2]	
	No	Rank x No	No	Rank x No	No	Rank x No	No	Rank x No
1	0	0	0	0	14	1×14 = 14	4	1×4 = 4
2	0	0	4	2×4 = 8	20	2×20 = 40	31	2×31 = 62
2* (heterotrophic biofilm)[1]					0	0		
3	0	0	5	3×5 = 15	0	0	7	3×7 = 21
4	0	0	2	4×2 = 8	0	0	2	4×2 = 8
5					0	0	0	0
NA	11		11		11			
(No > 0) ÷ (50 – NA)	0		0.28		0.87			
Sum ÷ (50 – NA)		0		$\frac{31}{39}$ = 0.79		$\frac{54}{39}$ = 1.38		$\frac{95}{50}$ = 1.90
(Count 2*, 3, 4, or 5) ÷ (50 – NA)	Extent of heterotrophic biofilm→				0			
(Sum If 2*, 3, 4, or 5) ÷ (50 – NA)	Magnitude of heterotrophic biofilm→					0		
(Sum #Dots) ÷ 2500	Density of all microalgae→							$\frac{385}{2500}$ = 0.15

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(2)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 1/3; EPA 1999 (Form 1))

STREAM NAME Unnamed Trib below TRD	LOCATION Downstream Thornapple River Dr.
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN Thornapple River
~~STORET#~~ AUID 04050070408-02	AGENCY Limno Tech
INVESTIGATORS Doug Bradley, Derek Schlea / Limno Tech	
FORM COMPLETED BY D. Schlea	DATE 11-20-13 TIME 10:20 AM PM -11:20
REASON FOR SURVEY GFIA Biofilm Elimination/ NPDES Requirement	

WEATHER CONDITIONS

Now		Past 24 Hours
☐	Storm (heavy rain)	☐
☐	Rain (steady rain)	☐
☐	Showers (intermittent)	☐
70% ☒	% cloud cover	☒ ___%
☐	Clear/sunny	☒

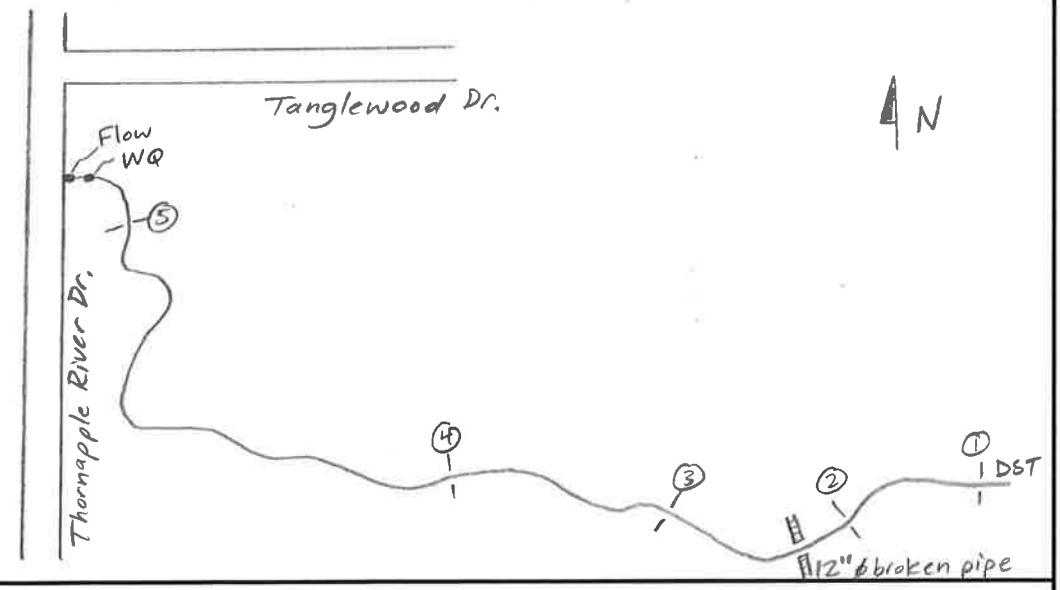
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No (0.46" on 11-16-13; 1.21" on 11-17-13)

Air Temperature 3 °C

Other _____

SITE LOCATION MAP

Draw a map of the side and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial | ☐ Intermittent | ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

Catchment Area ~9.1 km² km²

(2)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 2/3 EPA 1999 (Form 1))

WATERSHED FEATURES

Predominant Surrounding Landuse

- [x] Forest
- [ ] Field/Pasture
- [ ] Agricultural
- [x] Residential
- [ ] Commercial
- [ ] Industrial
- [ ] Other _____

Local Watershed NPS Pollution

- [ ] No evidence
- [x] Some potential sources
- [ ] Obvious sources

Local Watershed Erosion

- [ ] None
- [ ] Moderate
- [x] Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present

- [x] Trees
- [x] Shrubs
- [ ] Grasses
- [ ] Herbaceous

Dominant species present _____

INSTREAM FEATURES

Estimated Reach Length 350 m

Estimated Stream Width 3.2 m

Sampling Reach Area 1120 m²

Area in km² (m²x1000) _____ m²

Estimated Stream Depth 0.19 m

Surface Velocity (at thalwag) 0.23 m/sec

Canopy Cover

- [ ] Partly open
- [x] Partly shaded
- [ ] Shaded

High Water Mark

Proportion of Reach Represented by Stream Morphology Types

- [ ] Riffle 10 %
- [ ] Run 65 %
- [ ] Pool 25 %

Channelized [x] Yes [ ] No

Dam Present [ ] Yes [x] No

LARGE WOODY DEBRIS

LWD 210 ~~m²~~ pieces

Density of LWD 0.188 ~~m²/km²~~ (LWD/reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present

- [ ] Rooted emergent
- [ ] Rooted submergent
- [ ] Rooted floating
- [ ] Free floating
- [ ] Floating algae
- [x] Attached algae

Dominant species present

Portion of the reach with aquatic vegetation 2 %

WATER QUALITY

Temperature 5.62 °C

Specific Conductance 0.632 mS/cm

Dissolved Oxygen 10.90 mg/L

pH 7.55

Turbidity 5.9 NTU

WQ Instrument Used YSI 6920

Water Odors

- [x] Normal/None
- [ ] Petroleum
- [ ] Fishy
- [ ] Sewage
- [ ] Chemical
- [ ] Other _____

Water Surface Oils

- [ ] Slick
- [ ] Sheen
- [ ] Gloss
- [ ] Flecks
- [x] None
- [ ] Other _____

Turbidity (if not measured)

- [ ] Clear
- [ ] Slightly turbid
- [ ] Turbid
- [ ] Opaque
- [ ] Stained
- [ ] Other _____

SEDIMENT SUBSTRATE

Odors

- [ ] Normal
- [ ] Sewage
- [ ] Petroleum
- [ ] Chemical
- [ ] Anaerobic
- [x] None
- [ ] Other _____

Oils

- [x] Absent
- [ ] Slight
- [ ] Moderate
- [ ] Profuse

Deposits

- [ ] Sludge
- [ ] Sawdust
- [ ] Paper fiber
- [x] Sand
- [ ] Relict Shells
- [ ] Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?

- [x] Yes
- [ ] No

Notes:

- Evidence of active channel conditions observed throughout reach (newly fallen trees, bed material movement, sand deposition, and channel shape modifications)
- Layer of sand covered >90% of transect 1 and nearly 100% of transect 3
- Fine sand deposition observed at transect 4
- Channel conditions at transect 5 have changed relative to past surveys (widening, scour, downcutting)

(2)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 3/3; EPA 1999 (Form 1))

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock		—	Detritus	Sticks, wood, coarse plant materials (CPOM)	20
Boulder	>256mm (10")	—			
Cobble	64-256mm (2.5" – 10")	2	Muck-Mud	Black, very fine organic (FPOM)	5
Gravel	2-64mm (0.1" – 2.5")	6			
Sand	0.06 – 2mm (gritty)	90	Marl	Grey, shell fragments	—
Silt	0.004 – 0.06 mm	2			
Clay	<0.004mm (slick)	—			

(2)

Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection.
Modified from Stevenson and Rollins (2007; Table 34.1)

Trns = transect number; Macro = macroalgae; Micro = microalgae;
Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below TRD Date: 11-20-13 Sampler: D.Bradley Recorder: D.Schlea

Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]	Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]
1	1				✓	0	26	3				✓	0
2	↓				✓	0	27	↓				✓	3
3					✓	0	28					✓	0
4					✓	0	29					✓	0
5					✓	0	30	↓				✓	2
6					✓	0	31	4	–	–	–		0
7					✓	0	32	↓				✓	0
8		–	–	–		0	33		–	–	–		0
9		–	–	–		2	34		–	–	–		1
10	↓	–	–	–		0	35		–	–	–		0
11	2		2	2		12	36				1		4
12	↓			2		17	37					✓	0
13				1		9	38		–	–	–		2
14			1	1		17	39					✓	0
15			4	2		14	40	↓				✓	0
16				2		22	41	5				✓	4
17			3	2		19	42	↓				✓	8
18				2		15	43					✓	2
19				1		5	44					✓	11
20	↓				✓	3	45					✓	2
21	3				✓	0	46				1		8
22	↓				✓	7	47				1		4
23					✓	0	48		–	–	–		4
24					✓	4	49		–	–	–		0
25	↓				✓	0	50	↓			1		9

width 14.2 ft
depth 0.4 ft
width 11.4 ft
depth 0.35 ft
width 10.4 ft
depth 1.1 ft
width 8.5 ft
depth 0.5 ft
width 7.4 ft
depth 0.7 ft

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 51.9 Ft^2
Substrata Sampled: (rock)/wood/plant
(circle) (sand)/silt/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

(2) Unnamed Trib below TRD

Table 2. Algae and Moss Cover and Thickness Class Descriptions. Modified from Stevenson and Rollins (2007; Table 34.2)

	Moss and Macroalgae Cover Classes						
Class	0	1	2	3	4		
Cover	0%	<5%	5% to 25%	25% to 50%	>50%		
	Microalgae Thickness Class[1]						
Class	0	1	2	2*	3	4	5
Thickness	0 mm	<0.5 mm	0.5 to 1 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	>20 mm
Characteristics	rough	slimy; visible evidence of biofilm absent	naturally occurring microalgae	heterotrophic biofilm			
	Microalgae Cover Class[2]						
Class	0	1	2	3	4	5	
Cover	0%	<5%	5% to 25%	25% to 50%	50% to 75%	75% to 100%	

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover. Modified from Stevenson and Rollins (2007; Table 34.3)
Shaded cells do not have appropriate records or calculations.

Rank	Moss		Macroalagae		Microalgae Thickness		Microalgae Cover[2]	
	No	Rank x No	No	Rank x No	No	Rank x No	No	Rank x No
1	0	0	1	1×1 = 1	7	1×7 = 7	6	1×6 = 6
2	0	0	1	2×1 = 2	6	2×6 = 12	15	2×15 = 30
2* (heterotrophic biofilm)[1]					0	0		
3	0	0	1	3×1 = 3	0	0	6	3×6 = 18
4	0	0	1	4×1 = 4	0	0	0	0
5					0	0	0	0
NA	27		27		27			
(No > 0) ÷ (50 – NA)	0		0.17		0.57			
Sum ÷ (50 – NA)		0		$\frac{10}{23}$ = 0.43		$\frac{19}{23}$ = 0.83		$\frac{54}{50}$ = 1.08
(Count 2*, 3, 4, or 5) ÷ (50 – NA)	*Extent of heterotrophic biofilm→*				0			
(Sum If 2*, 3, 4, or 5) ÷ (50 – NA)	*Magnitude of heterotrophic biofilm→*					0		
(Sum #Dots) ÷ 2500	*Density of all microalgae→*							$\frac{210}{2500}$ = 0.08

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid

(3)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 1/3; EPA 1999 (Form 1))

STREAM NAME Unnamed Trib below Tricklewood	LOCATION Downstream Tricklewood Dr.	
STATION # _____ RIVERMILE _____	STREAM CLASS	
LAT _____ LONG _____	RIVER BASIN Thornapple River	
~~STORET#~~ AUID 04050070408-02	AGENCY LimnoTech	
INVESTIGATORS Doug Bradley, Derek Schlea / LimnoTech		
FORM COMPLETED BY D. Schlea	DATE 11-20-13 TIME 11:45 AM PM -12:45	REASON FOR SURVEY GFIA Biofilm Elimination/ NPDES Requirement

WEATHER CONDITIONS

Now		Past 24 Hours
☐	Storm (heavy rain)	☐
☐	Rain (steady rain)	☐
☐	Showers (intermittent)	☐
50% ☒	% cloud cover	☒ ___ %
☒	Clear/sunny	☒

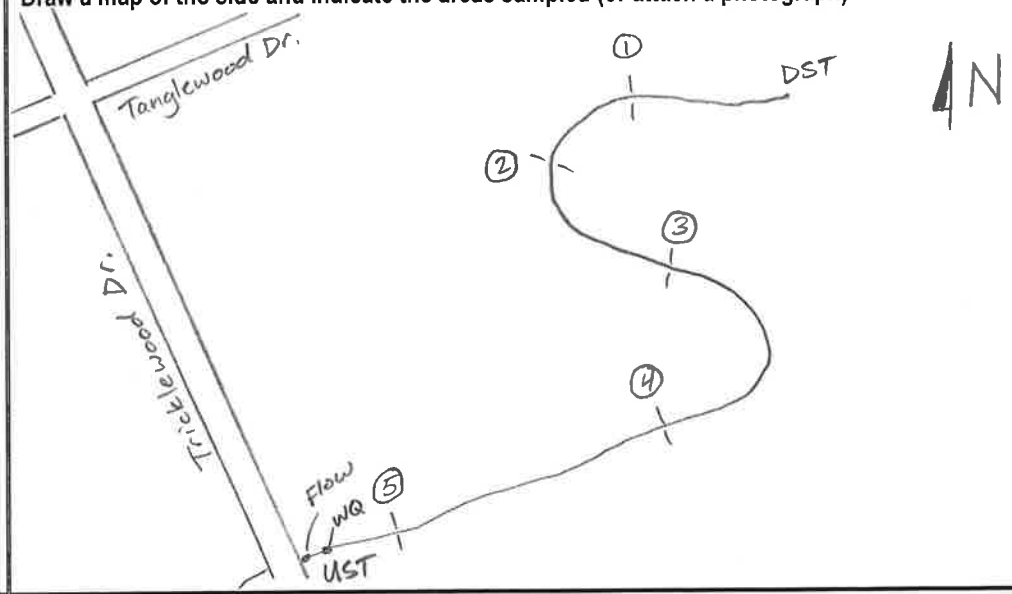
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No 0.46" on 11-16-13, 1.21" on 11-17-13

Air Temperature 5 °C

Other _____

SITE LOCATION MAP

Draw a map of the side and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial | ☐ Intermittent | ☐ Tidal

Stream Type
☐ Coldwater ☒ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bcg
☐ Spring-fed
☒ Mixture of origins
☐ Other _____

Catchment Area ~9.1 km²

(3)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 2/3 EPA 1999 (Form 1))

WATERSHED FEATURES

Predominant Surrounding Landuse

- [x] Forest
- [ ] Field/Pasture
- [ ] Agricultural
- [x] Residential
- [ ] Commercial
- [ ] Industrial
- [ ] Other _____

Local Watershed NPS Pollution

- [ ] No evidence
- [x] Some potential sources
- [ ] Obvious sources

Local Watershed Erosion

- [ ] None
- [x] Moderate
- [ ] Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present

- [x] Trees
- [x] Shrubs
- [ ] Grasses
- [ ] Herbaceous

Dominant species present _____

INSTREAM FEATURES

Estimated Reach Length 135 m

Estimated Stream Width 4.0 m

Sampling Reach Area 540 m²

Area in km² (m²x1000) _____ m²

Estimated Stream Depth 0.11 m

Surface Velocity (at thalwag) 0.18 m/sec

Canopy Cover

- [ ] Partly open
- [x] Partly shaded
- [ ] Shaded

High Water Mark

Proportion of Reach Represented by Stream Morphology Types

- [ ] Riffle 40 %
- [ ] Run 50 %
- [ ] Pool 10 %

Channelized [x] Yes [ ] No

Dam Present [ ] Yes [x] No

LARGE WOODY DEBRIS

LWD 25 ~~m²~~ pieces

Density of LWD 0.046 ~~m²/km²~~ (LWD/reach area)

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present

- [ ] Rooted emergent
- [ ] Rooted submergent
- [ ] Rooted floating
- [ ] Free floating
- [ ] Floating algae
- [x] Attached algae

Dominant species present

Portion of the reach with aquatic vegetation 5 %

WATER QUALITY

Temperature 6.29 °C

Specific Conductance 0.792 mS/cm

Dissolved Oxygen 11.19 mg/L

pH 7.62

Turbidity 4.0

WQ Instrument Used YSI 6920

Water Odors

- [x] Normal/None
- [ ] Petroleum
- [ ] Fishy
- [ ] Sewage
- [ ] Chemical
- [ ] Other _____

Water Surface Oils

- [ ] Slick
- [ ] Sheen
- [ ] Gloss
- [ ] Flecks
- [x] None
- [ ] Other _____

Turbidity (if not measured)

- [ ] Clear
- [ ] Slightly turbid
- [ ] Turbid
- [ ] Opaque
- [ ] Stained
- [ ] Other _____

SEDIMENT SUBSTRATE

Odors

- [ ] Normal
- [ ] Sewage
- [ ] Petroleum
- [ ] Chemical
- [ ] Anaerobic
- [x] None
- [ ] Other _____

Oils

- [x] Absent
- [ ] Slight
- [ ] Moderate
- [ ] Profuse

Deposits

- [ ] Sludge
- [ ] Sawdust
- [ ] Paper fiber
- [x] Sand
- [ ] Relict Shells
- [x] Other silt

Looking at stones which are not deeply embedded, are the undersides black in color?

- [x] Yes
- [ ] No

Notes:

- Thin layer of silt observed at transect 1
- Sand and gravel deposition observed at transect 2

(3)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(Pg 3/3; EPA 1999 (Form 1))

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	**Substrate Type**	**Characteristic**	**% Composition in Sampling Area**
Bedrock		–	Detritus	Sticks, wood, coarse plant materials (CPOM)	10
Boulder	>256mm (10")	5			
Cobble	64-256mm (2.5" – 10")	10	Muck-Mud	Black, very fine organic (FPOM)	5
Gravel	2-64mm (0.1" – 2.5")	20			
Sand	0.06 – 2mm (gritty)	30	Marl	Grey, shell fragments	–
Silt	0.004 – 0.06 mm	5			
Clay	<0.004mm (slick)	30			

(3)

Table 1. Field Data Sheet for Rapid Periphyton Survey and Algal Sample Collection.
Modified from Stevenson and Rollins (2007; Table 34.1)

Trns = transect number; Macro = macroalgae; Micro = microalgae;
Sz = check column to indicate substratum <2 cm; #Dots = grid points counted on viewing bucket[1].

Stream: Unnamed Trib below Tricklewood Date: 11-20-13 Sampler: D. Bradley Recorder: D. Schlea

Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]	Point	Trns	Moss	Macro	Micro	Sz	#Dots[1]	
1	1			2		26	26	3			1		12	
2	↓			2		16	27	↓			1		9	
3				2		14	28				1		4	
4				1		28	29			2	2		11	
5			1	1		24	30	↓			1		3	
6				2		19	31	4				✓	16	
7			2	2		17	32	↓			1		19	
8			2	1		22	33			2	2		17	
9			3	2		13	34				2		22	
10	↓			1		7	35			1	2		11	
11	2			2		11	36				1		4	
12	↓			1		5	37			2	2		7	
13					✓	12	38					✓	13	
14				1		7	39				2		9	
15				1		7	40	↓		1	1		17	
16			2	2		6	41	5		3	2		21	
17				2		13	42	↓			2		17	
18				1		17	43			3	2		18	
19			3	2		13	44				1		11	
20	↓		1	2		18	45			1	2		17	
21	3		2	2		15	46		–	–	–		9	
22	↓		2	2		17	47				2		9	
23				1		6	48			3	2		11	
24				1		10	49				1		11	
25	↓				✓	13	50	↓		1	2		9	

width 10.3 ft
depth 0.3 ft
width 12.3 ft
depth 0.3 ft
width 15.7 ft
depth 0.3 ft
width 16.4 ft
depth 0.4 ft
width 11.1 ft
depth 0.5 ft

Total Algae Sample Volume = NA
Identification Subsample Volume = NA
Chlorophyll Subsample Volume = NA
AFDM Subsample Volume = NA

Surface Area Sampled = 65.8 ft²
Substrata Sampled: (rock)/wood/plant
(circle) (sand)/(silt)/other

[1] Added number of points that occur over microalgae using viewing bucket with 50-dot grid

③ Unnamed Trib below Tricklewood Dr.

Table 2. Algae and Moss Cover and Thickness Class Descriptions. Modified from Stevenson and Rollins (2007; Table 34.2)

	Moss and Macroalgae Cover Classes						
Class	0	1	2	3	4		
Cover	0%	<5%	5% to 25%	25% to 50%	>50%		
	Microalgae Thickness Class[1]						
Class	0	1	2	2*	3	4	5
Thickness	0 mm	<0.5 mm	0.5 to 1 mm	0.5 to 1 mm	1 to 5 mm	5 to 20 mm	>20 mm
Characteristics	rough	slimy; visible evidence of biofilm absent	naturally occurring microalgae	heterotrophic biofilm			
	Microalgae Cover Class[2]						
Class	0	1	2	3	4	5	
Cover	0%	<5%	5% to 25%	25% to 50%	50% to 75%	75% to 100%	

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover class to estimate extent from points counted using viewing bucket with 50-dot grid

Table 3. Calculations for Extent and Magnitude of Moss and Benthic Algal Cover. Modified from Stevenson and Rollins (2007; Table 34.3)
Shaded cells do not have appropriate records or calculations.

Rank	Moss		Macroalagae		Microalgae Thickness		Microalgae Cover[2]	
	No	Rank x No	No	Rank x No	No	Rank x No	No	Rank x No
1	0	0	6	1 x 6 = 6	19	1 x 19 = 19	0	0
2	0	0	8	2 x 8 = 16	26	2 x 26 = 52	24	2 x 24 = 48
2* (heterotrophic biofilm)[1]					0	0		
3	0	0	5	3 x 5 = 15	0	0	24	3 x 24 = 72
4	0	0	0	0	0	0	2	4 x 2 = 8
5					0	0	0	0
NA	4		4		4			
(No > 0) ÷ (50 – NA)	0		0.41		0.98			
Sum ÷ (50 – NA)		0		$\frac{37}{46}$ = 0.80		$\frac{71}{46}$ = 1.54		$\frac{128}{50}$ = 2.56
(Count 2*, 3, 4, or 5) ÷ (50 – NA)	*Extent of heterotrophic biofilm→*				0			
(Sum If 2*, 3, 4, or 5) ÷ (50 – NA)	*Magnitude of heterotrophic biofilm→*					0		
(Sum #Dots) ÷ 2500	*Density of all microalgae→*							$\frac{663}{2500}$ = 0.27

[1] Added microalgae thickness class 2* to distinguish between naturally occurring microalgae and heterotrophic biofilm
[2] Added microalgae cover to estimate extent from points counted using viewing bucket with 50-dot grid