

Evaluating Ecological Risk of a Controlled Release Larvicide Applied to Catch Basin Systems that Drain Directly Into Natural Waterbodies

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Study Objective

To use small experimental systems to examine if the normal use of two different novaluron controlled release products could potentially have adverse effects on non-target aquatic macroinvertebrate communities in waterbodies that receive treated runoff.



Study Framework

Quantify actual environmental concentrations of novaluron in storm discharge, and the water column and substrate of natural water bodies that receive direct runoff from treated stormwater systems.

Sample aquatic macroinvertebrate communities inhabiting natural waterbodies that receive direct runoff from treated stormwater systems to determine any potential impact on non-target organisms.

Collect sufficient residue data, precipitation data, runoff data, and stormwater system parameter data for use in modeling novaluron fate at different scales under varying geographic and climate conditions.

Overview

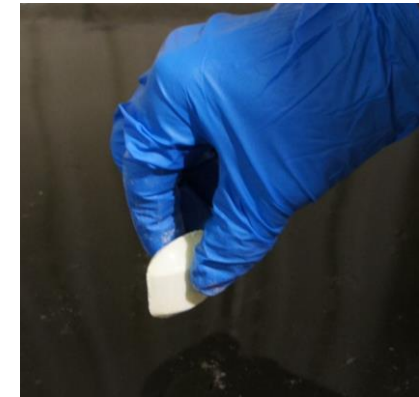
Two controlled release formulations

Two stormwater systems for each formulation

-Two types of receiving waterbody - Streams and Ponds

Stream Sites – Treatment waterbody downstream of the outfall and control upstream of outfall.

Pond Sites – Control was entirely separate stormwater system and pond.



Overview



Novaluron residue sampling was conducted at treated stormwater system outfalls and receiving waterbodies.

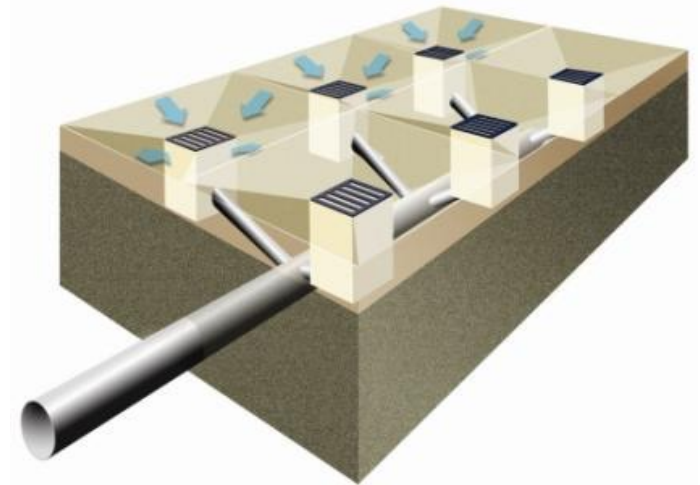
Autosamplers collected samples from treatment outfalls and streams during a runoff event. Treatment ponds were sampled manually immediately after runoff event.

Aquatic macroinvertebrate samples, sediment samples, control pond samples and catch basin samples were collected at regular intervals during the field season.

Test System

Stormwater infrastructure was selected as a worst-case scenario label use site – typically no buffer, consistent runoff into natural waterbodies, cement sumps/low organic matter (relatively high K_{oc}).

Stormwater infrastructure represented easily quantifiable water capacities, single exit points, and direct entry into natural waterbodies.



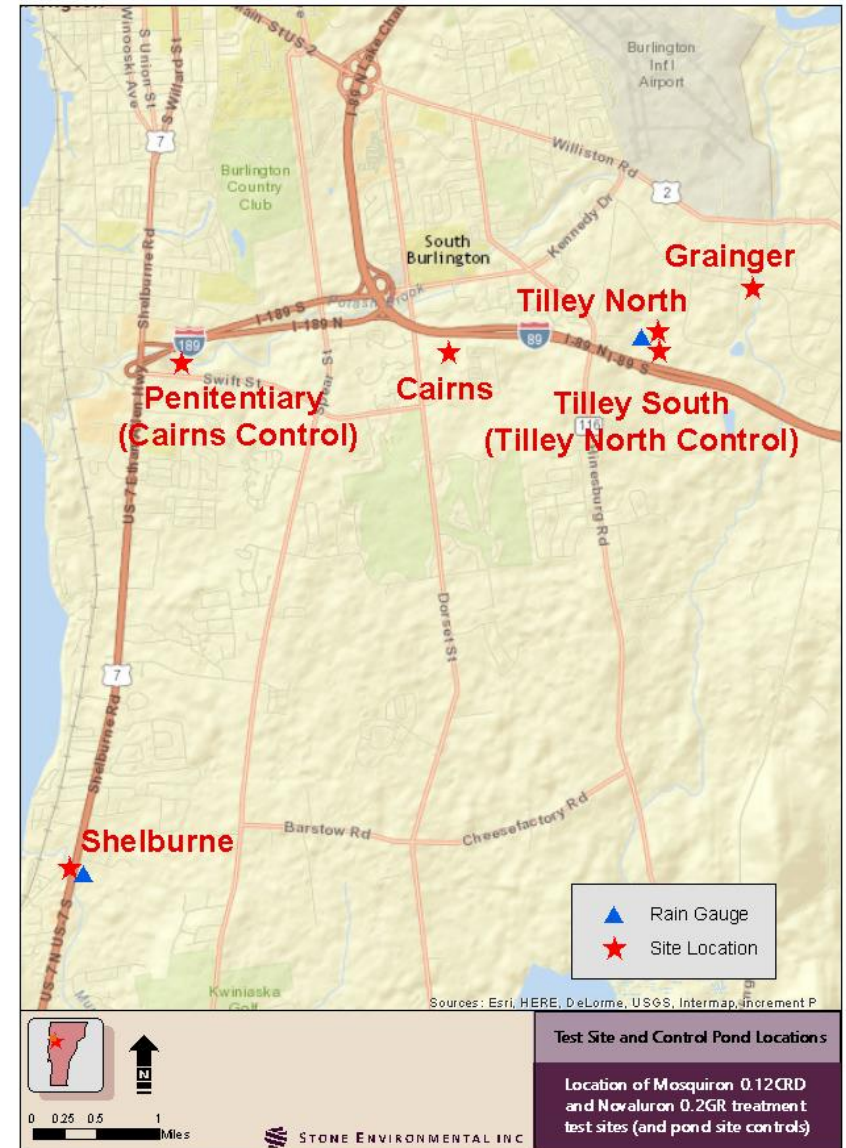
Two receiving waterbody types were used in the study to capture any variability in habitat and potential residue dilution that may have existed.

Sites

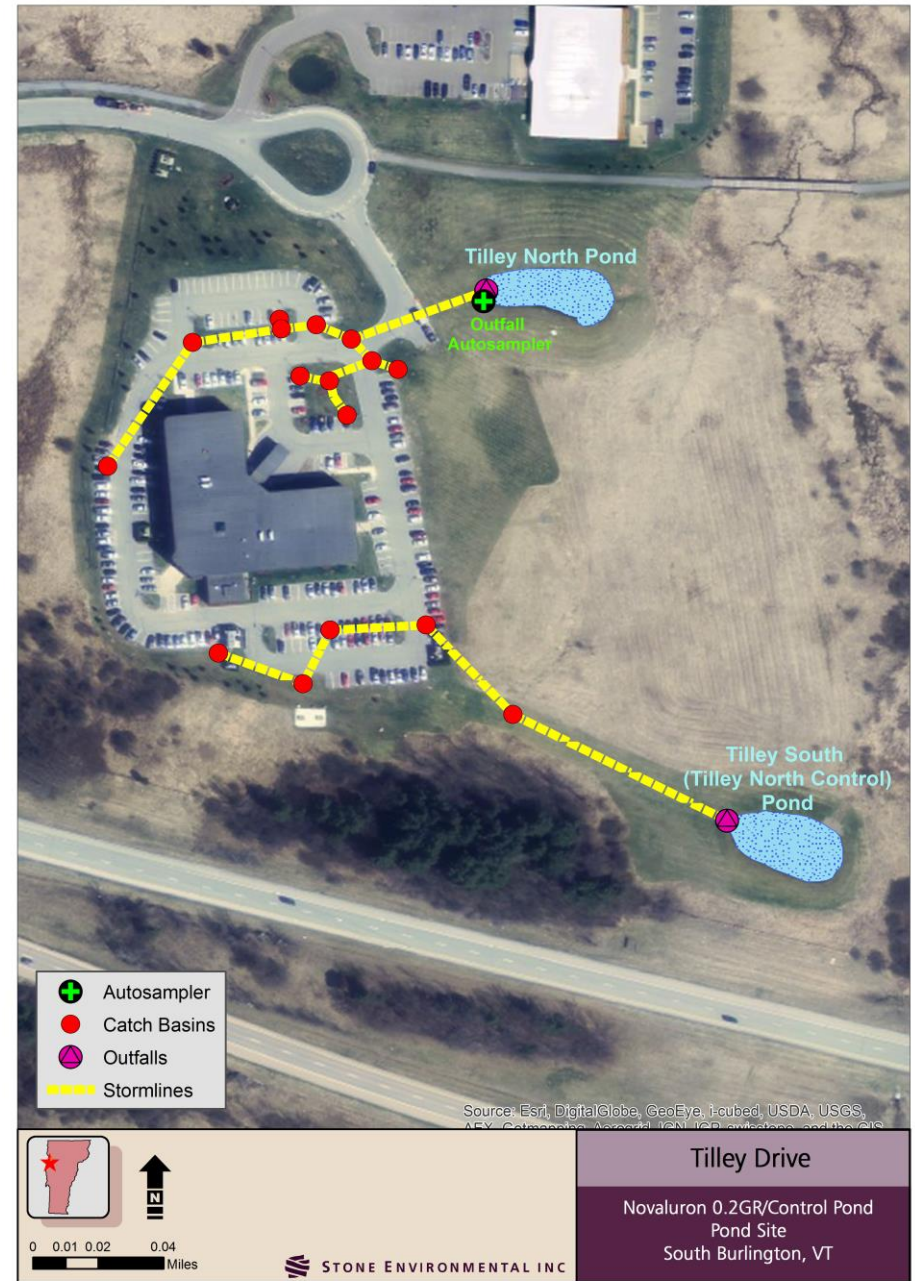
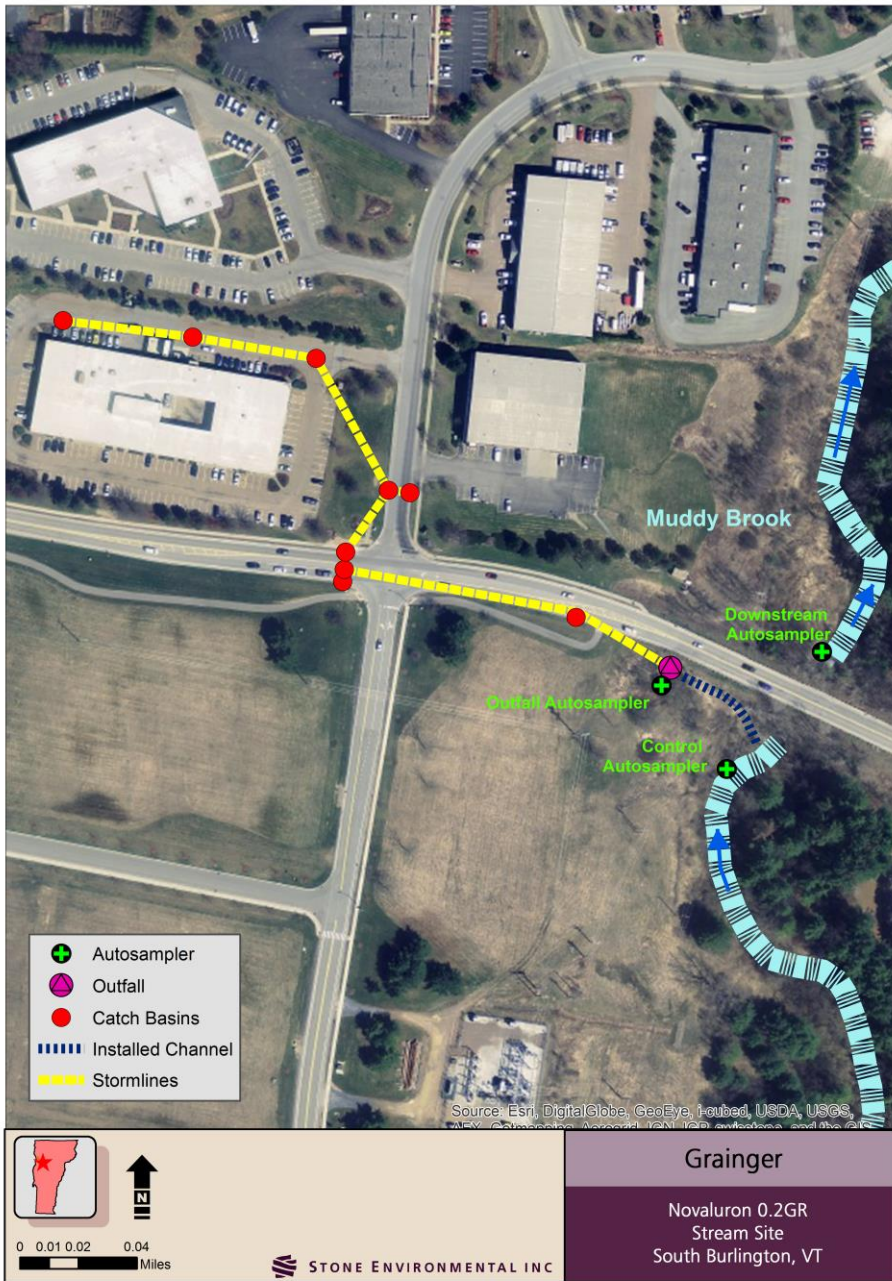
In Chittenden County, Vermont 1,053 catch basin systems qualified as potential sites.

Over 50 sites were visited

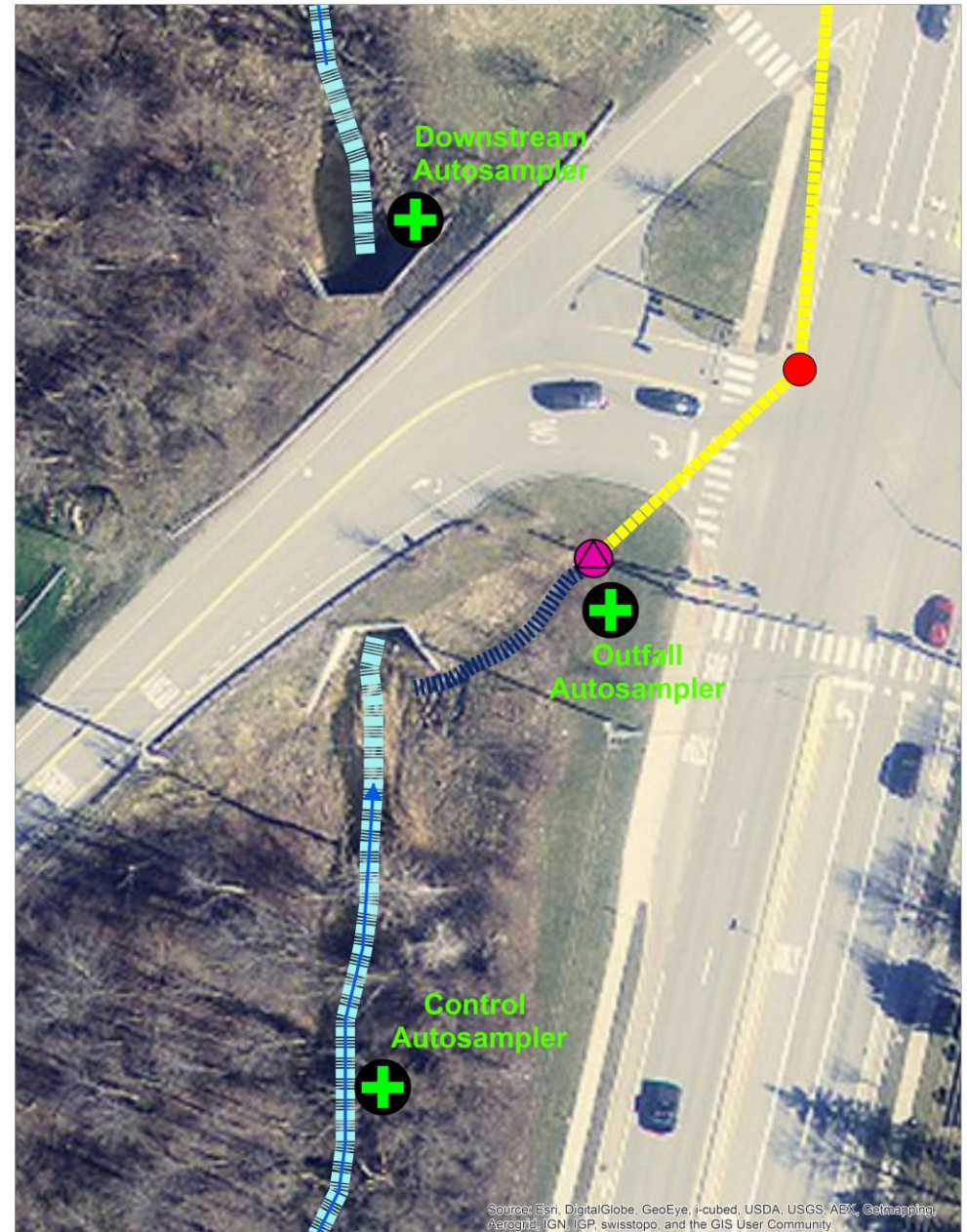
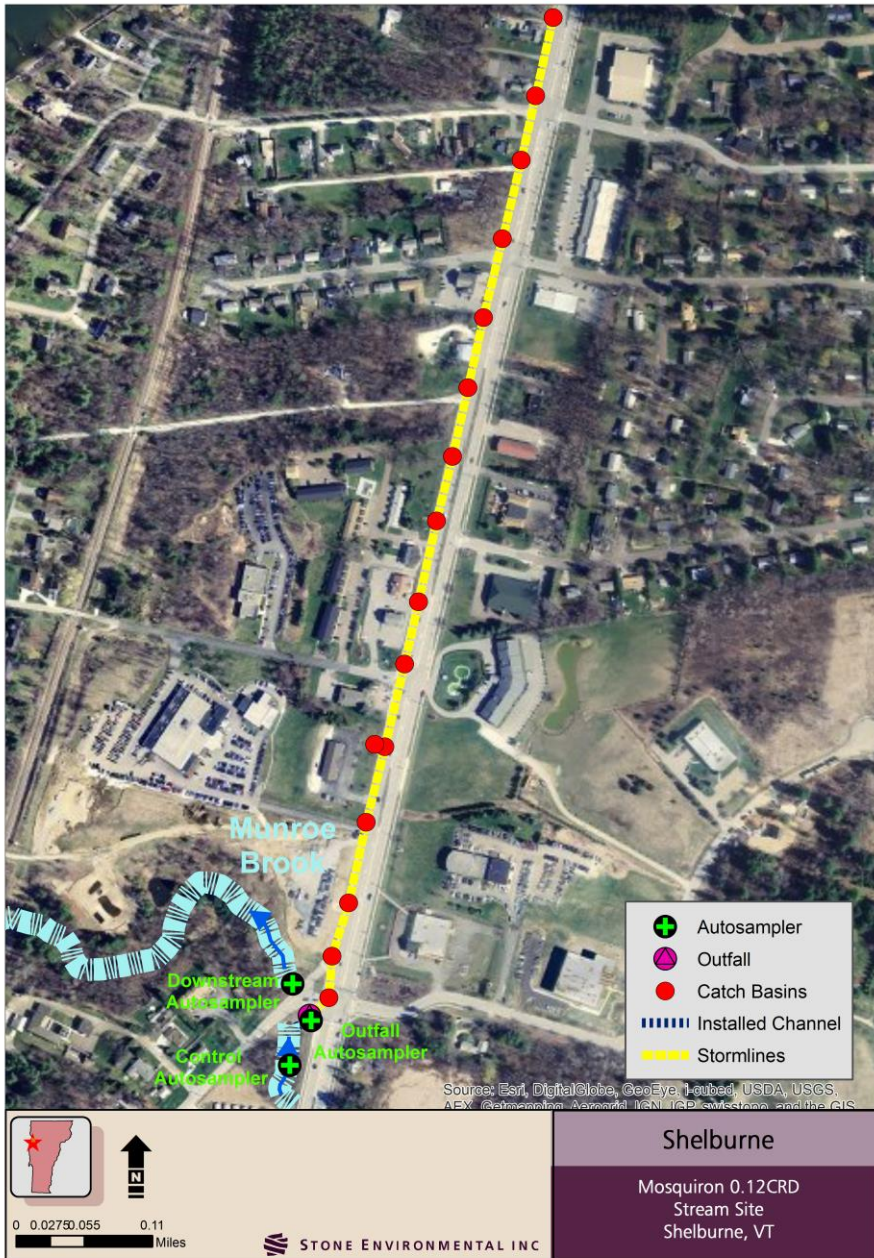
Four treatment sites and two control pond sites were selected



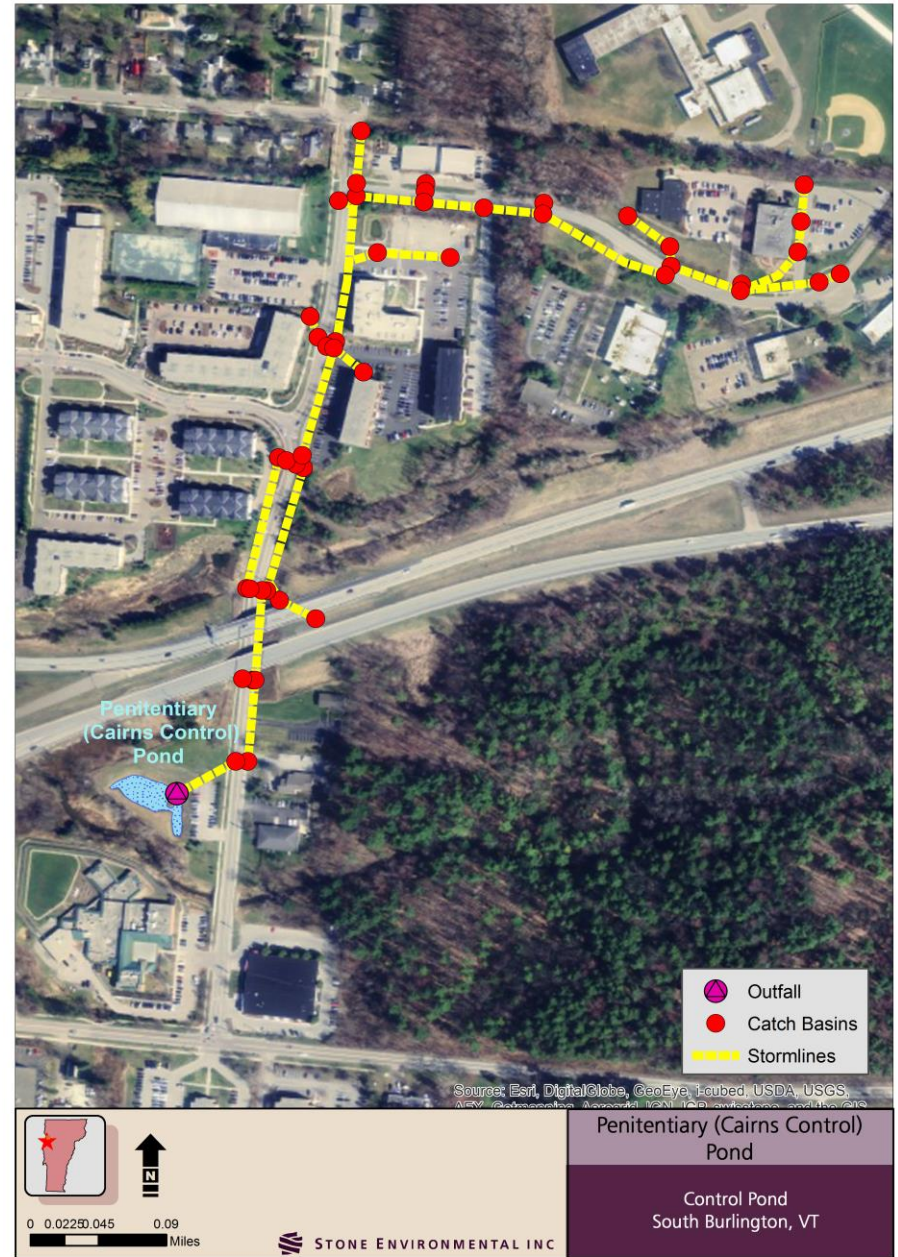
Sites (Granule Formulation)



Sites (Wax Briquette Formulation)



Sites (Wax Briquette Formulation)



Application

Applications of the granule formulation were made to Grainger and Tilly North on July 17, 2014.

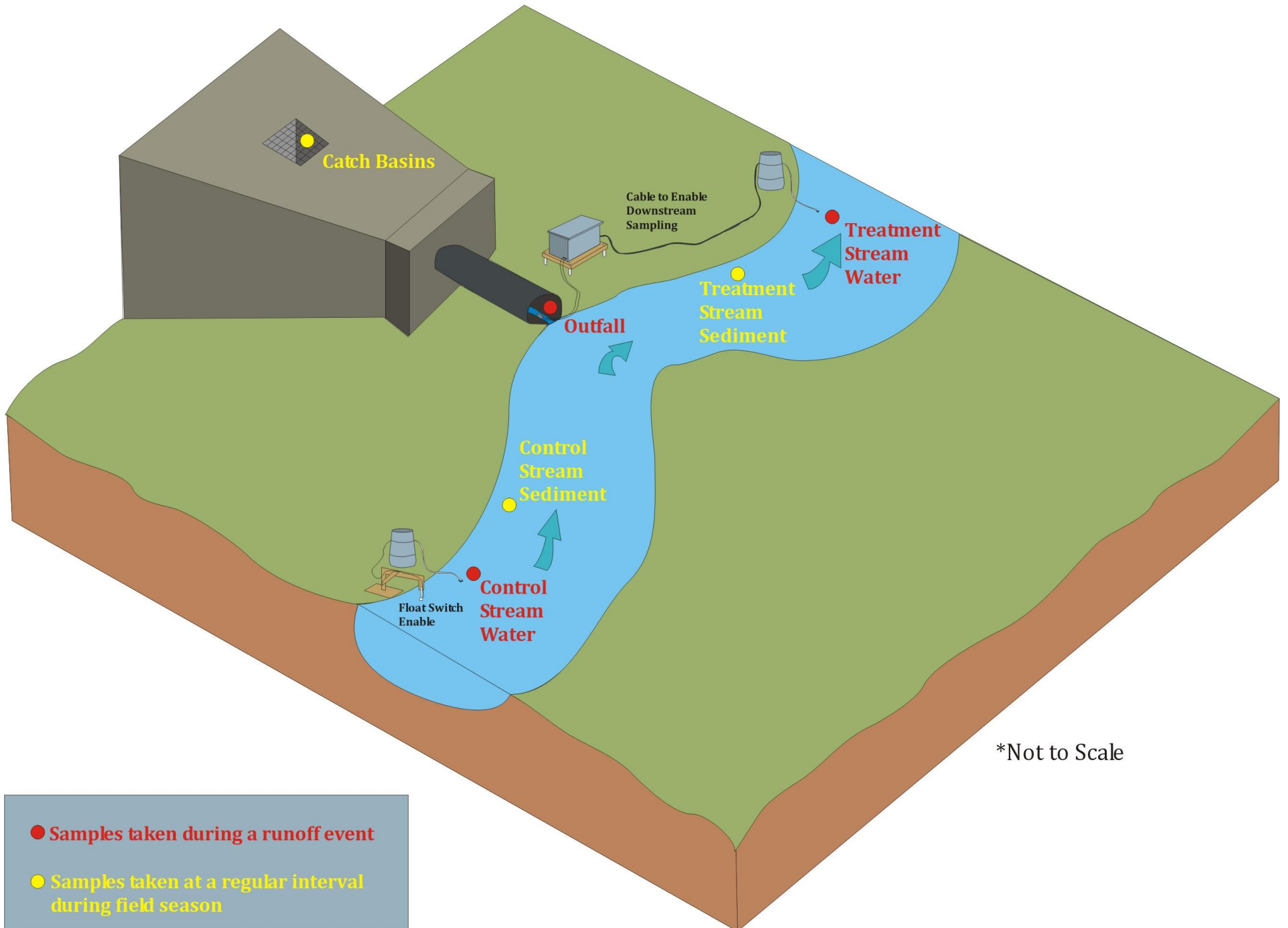
Applications of the wax briquette formulation were made to Shelburne and Cairns on July 18, 2014.

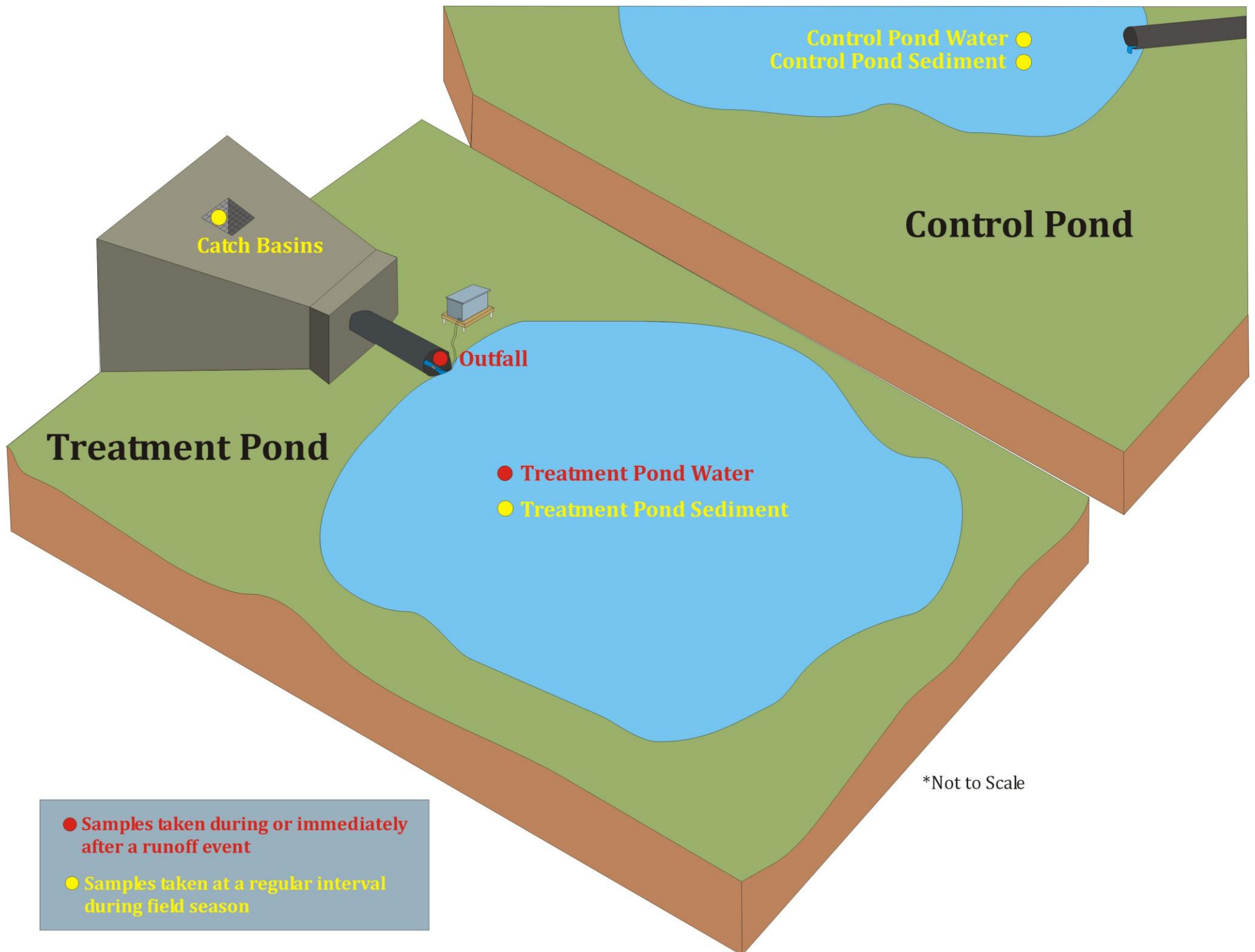
Applications to catch basins in system were made following label instructions for the maximum rate.

All catch basins in treatment systems received applications of novaluron products except for the catch basin immediately before the outfall.

Site	Formulation	Date of Application	Number of Catch Basins	Total Mass Applied (g)	AI (g)
Grainger	Granule	7/17/14	9	286	0.57
Tilley North	Granule	7/17/14	11	577	1.15
Shelburne	Wax Briquette	7/18/14	16	767	0.92
Cairns	Wax Briquette	7/18/14	30	1,305	1.57

Methods







ISCO 6712 Autosamplers

ISCO 750 Area Velocity sensors recorded depth and velocity of discharge.

AV sensors enabled autosamplers when runoff began.





At stream sites – Outfall autosampler and downstream autosampler were able to communicate for simultaneous sampling.



Short Program		Long Program	
Bottle Number	Time (min)	Bottle Number	Time (min)
1	0	13	0
2	5	14	20
3	10	15	40
4	15	16	60
5	20	17	80
6	25	18	100
7	30	19	120
8	35	20	140
9	40	21	160
10	45	22	180
11	50	23	200
12	55	24	220

In-stream ISCO sampling was time paced.

Sigma autosampler enabled by a float switch was used to collect control stream samples.



Treatment pond samples collected manually.

Control pond water samples, treated catch basin water samples, and all sediment samples were collected at regular intervals during the field season.



Effects Metrics

The 21 day lowest observed effect concentration (LOEC) for pelagic macroinvertebrates is 0.06 ppb¹.

The 28 day LOEC for benthic macroinvertebrates is 25 ppb.

Analytical method limit of quantitation (LOQ) was 0.03 ppb.



¹ Effects metrics from *Intrinsik* review and analysis of ecotoxicological studies.

Aquatic Macroinvertebrate Sampling

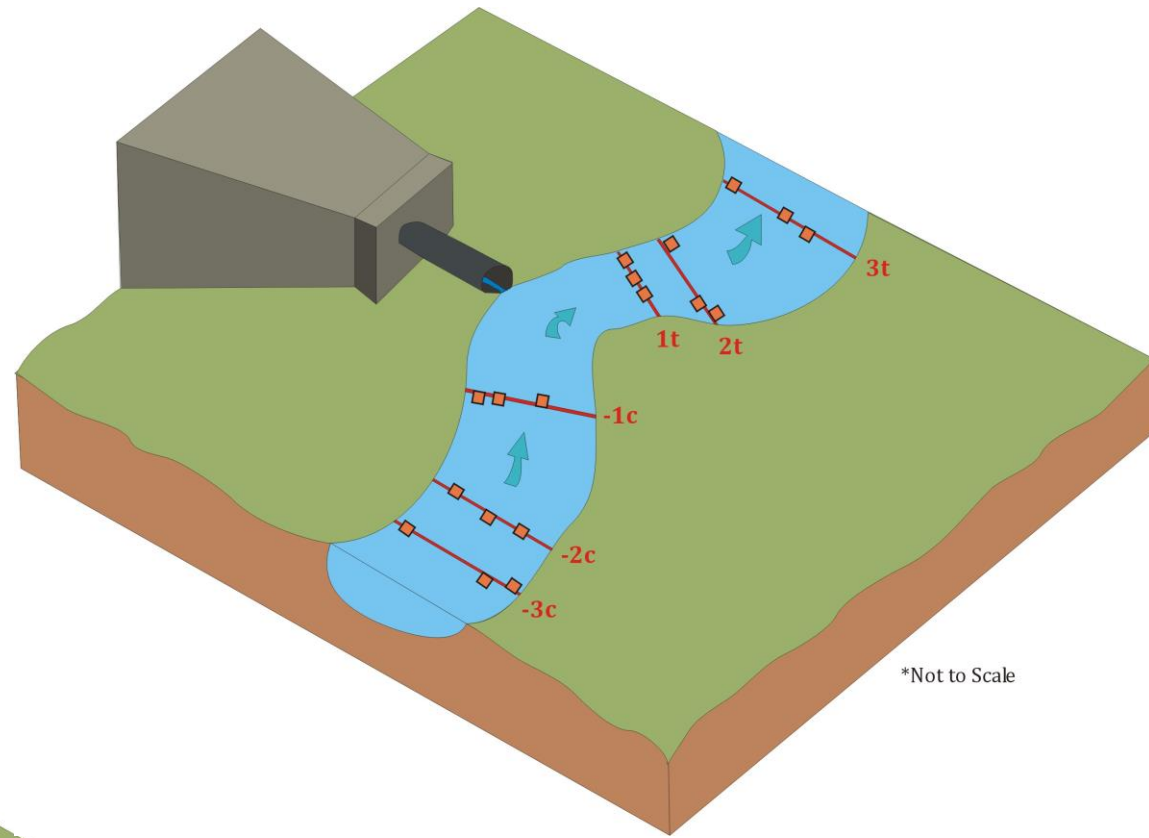
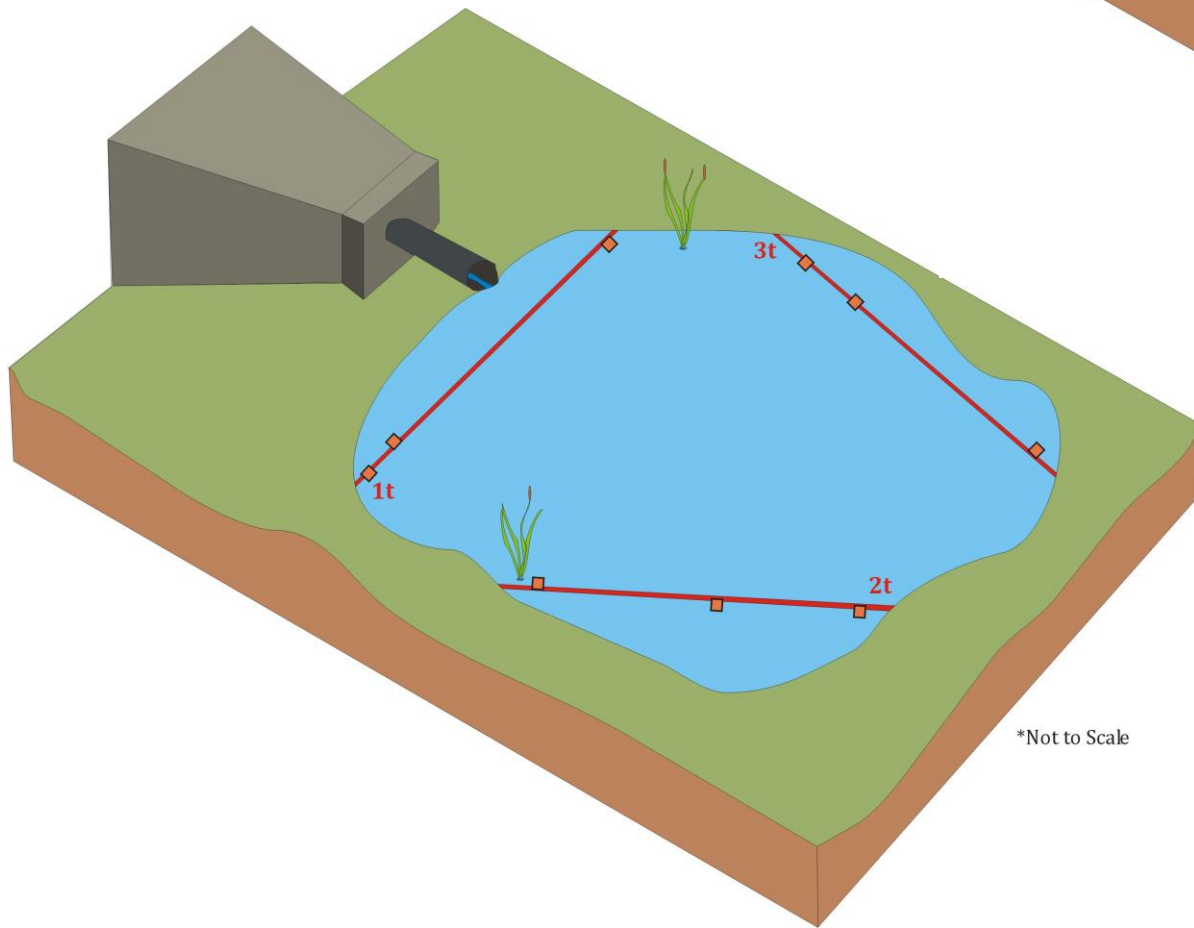
Macroinvertebrate samples established abundance and diversity data



Aquatic macroinvertebrates were sampled three times during the field season

Kick samples were collected from a 0.25 m² benthic area in receiving waterbodies with a 0.5 m wide dip net with 500 μm mesh.

Ponds

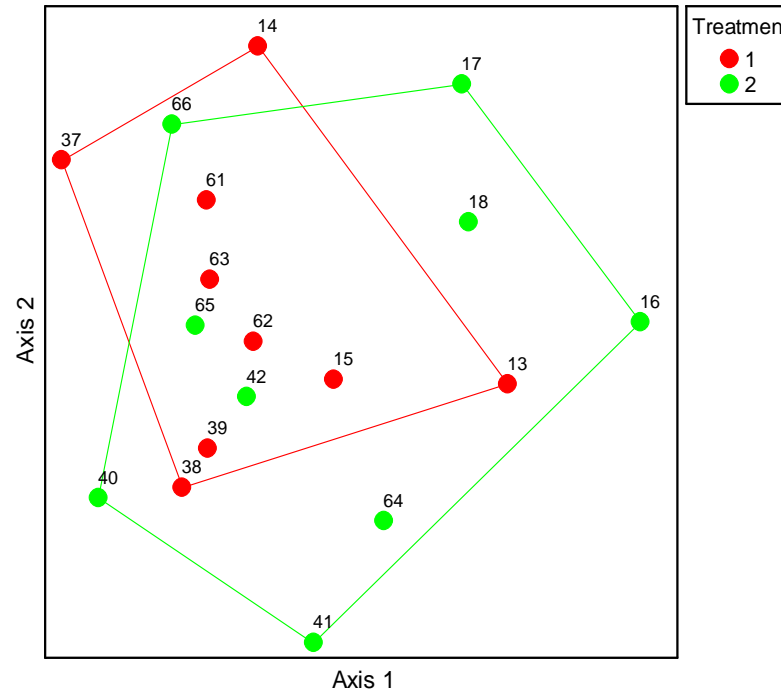


Streams

■ Aquatic Macroinvertebrate Sample Point

Results

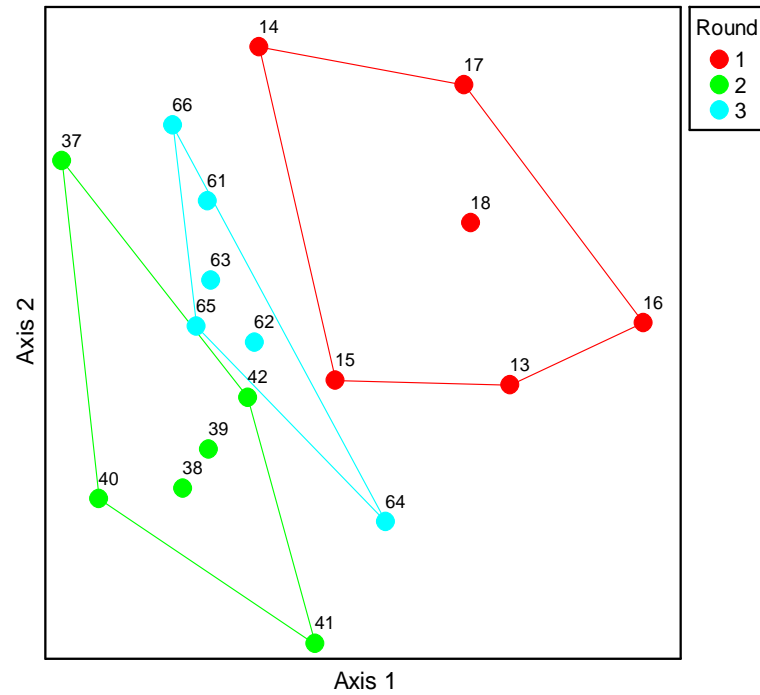
Macroinvertebrate Sampling



Macroinvertebrate data from the 2014 field season supports our selection of treatment and control pairs.

Results

Macroinvertebrate Sampling



Community composition varies widely over the course of one season.

Water Sample Results – Granule Formulation

Grainger (Stream)

Event	Outfall Flow Volume (m ³)	Outfall Concentration (ppb)	% of Total Applied Recovered at Outfall	Waterbody Concentration (ppb)
7/23/14	21.86	1.48	5.66	<i>No Data</i>
7/27/14	102.36	BQL	BQL	0.00941*
7/27/14	60.96	0.00902*	0.0962	BQL
7/28/14	375.72	n.d.	0	0.0672
7/31/14	44.90	n.d.	0	0.00874*
8/4/14	10.40	n.d.	0	BQL
8/5/14	10.05	n.d.	0	n.d.
8/7/14	8.22	n.d.	0	BQL
8/13/14	283.21	n.d.	0	n.d.
8/15-8/16/14	23.90	n.d.	0	n.d.
8/21-8/22/14	39.38	n.d.	0	n.d.
9/2/14	94.13	n.d.	0	n.d.

*Concentrated sample analyzed was above 0.03ppb; No Data = Samples Broken or Lost; BQL= Below Quantitation Limit; n.d.= Non-Detect.

Water Sample Results – Granule Formulation

Tilley North (Pond)

Event	Outfall Flow Volume (m ³)	Outfall Concentration (ppb)	% of Total Applied Recovered at Outfall	Waterbody Concentration (ppb)
7/23/14	- ^a	0.0272*	-	BQL
7/27/14	-	BQL	-	<i>No Data</i>
7/27/14	-	BQL	-	<i>No Data</i>
7/28/14	-	n.d.	-	n.d.
7/31/14	-	n.d.	-	n.d.
8/4-8/5/14	-	n.d.	-	n.d.
8/7/14	-	n.d.	-	n.d.
8/13/14	-	n.d.	-	n.d.
8/21-8/22/14	22.78	n.d.	0	n.d.
9/2/14	100.05	n.d.	0	n.d.

^aThe ISCO 6712 malfunctioned and flow data was lost and/or couldn't be collected until its replacement;
 *Concentrated sample analyzed above 0.03ppb; BQL = Below Quantitation Limit; *No Data* = Samples Broken or Lost; n.d. = Non-Detect.

Water Sample Results – Wax Briquette Formulation

Shelburne (Stream)

Event	Outfall Flow Volume (m ³)	Outfall Concentration (ppb)	% of Total Applied Recovered at Outfall	Waterbody Concentration (ppb)
7/23/14	6.03	BQL	BQL	BQL
7/27/14	6.70	n.d.	0	<i>No Data</i>
7/28/14	14.97	n.d.	0	0.0917
7/31/14	2.58	BQL	BQL	n.d.
8/4/14	2.48	n.d.	0	n.d.
8/5-8/7/14	6.14	n.d.	0	n.d.
8/13/14	23.45	n.d.	0	n.d.
8/15-8/16/14	7.75	n.d.	0	n.d.
8/21-8/22/14	15.93	n.d.	0	n.d.
9/2/14	6.53	n.d.	0	n.d.

*Concentrated sample analyzed above 0.03ppb; BQL = Below Quantitation Limit; n.d. = Non-Detect; No Data = Samples Broken or Lost.

Water Sample Results – Wax Briquette Formulation

Cairns (Pond)

Event	Outfall Flow Volume (m ³)	Outfall Concentration (ppb)	% of Total Applied Recovered at Outfall	Waterbody Concentration (ppb)
7/23/14	8.21	2.96	1.55	BQL
7/27/14	130.61	0.371	3.10	No Data
7/27/14	27.89	0.192	0.0342	No Data
7/28/14	889.15	n.d.	0	0.0789
7/31/14	113.72	0.0173*	0.126	0.0284*
8/4-8/5/14	59.90	BQL	BQL	0.0231*
8/7/14	38.63	0.0165*	0.0407	0.0147*
8/13/14	616.96	0.0149*	0.587	BQL
8/21-8/22/14	69.98	0.00896*	0.0401	n.d.
8/31/14	1.65	0.102	0.0108	0.0154*
9/2/14	97.67	0.0322	0.201	BQL
9/6/14	114.34	0.0105*	0.0767	BQL
9/11/14	3.39	0.00981*	0.00212	BQL

*Concentrated sample analyzed above 0.03ppb; BQL = Below Quantitation Limit; No Data = Samples Broken or Lost; n.d. = Non-Detect.

Sediment Residue

Test Site	7/23/14	8/1/14	8/19/14	9/25/14
Grainger	n.d.	n.d.	n.d.	n.d.
Tilley North	n.d.	n.d.	n.d.	n.d.
Shelburne	n.d.	n.d.	n.d.	n.d.
Cairns	5.47	23.3	n.d.	n.d.

Values reported in ppb; LOQ is 0.03ppb; n.d. = non-detect.

Two sediment samples contained detectable residue – both at Cairns during the first two sampling periods.

Conclusions



Highest outfall residues occur during first runoff events followed by precipitous decline in residue recovery.

Large precipitation events appear to dilute outfall residues, but may briefly produce detectable waterbody concentrations.

First year of macroinvertebrate data illustrates good treatment-control pairs. Community changes over course of season.

Based on the residue data collected in the first year it appears that non-target organisms would likely not be affected by treated runoff entering natural waterbodies.



Thank you.