EMBRACE-A-STREAM Grant Report

Deep Brook Assessment

Newtown, CT

Prepared for:
Pootatuck Watershed Association
Candlewood Valley Trout Unlimited
Newtown Land Use

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Introduction

In 2007 the Candlewood Valley Chapter of Trout Unlimited (CVTU) received funds from the EMBRACE-A-STREAM grant program to address water quality and wild salmonid conservation in Deep Brook and the Pootatuck Wild Trout Management area in Newtown, CT. This is the third phase of the project. The first two phases focused on habitat restoration and took place in 2005 and 2006. Restoration included installation of logs, boulders, and conifer tree revetments, and creating an extensive buffer around the stream. Invasive plants were removed and the area was replanted with native species. Electro-shocking data shows that trout population are sustaining in Deep brook, but have not flourished even with the extensive habitat restoration (see Appendix A). This phase of the project is focused on improving the water quality of the brook. The goal of this grant is to collect and analyze data as to confirm what the problem sources are so that an action plan can be developed to improve the water quality of Deep brook.

Site Description

The Pootatuck and Deep Brook watershed is contained mostly within the Town of Newtown, CT. The town of Newtown covers 60.38 sq miles in the southwest part of Connecticut, and is a traditionally rural community. It is located about 60 miles from New York City, and has undergone a significant increase in development and population in the last decade. The geography of the town is typical of southwest Connecticut with glacial till, rock outcroppings, and secondary forest where undeveloped.

The Pootatuck River is a typical old New England Mill River. It has a large stratified drift aquifer and good tree cover and therefore temperatures stay relatively cool all year. The Pootatuck is home to 4 species of trout: brook, brown, tiger, and rainbow. Portions of the river are classified as wild trout management areas.

Deep Brook is the Pootatuck River's largest tributary, and a nursery for the wild trout populations that live in the Pootatuck. It is designated as a "natural" wild trout fishery because it exhibits the ability to fill its carrying capacity through natural reproduction. Deep Brook is a class 1 Wild Trout Management Area and only catch and release fishing is permitted on the majority of it. The goal of CVTU is to focus primarily on native Brook trout (*Salvelinus fontinalis*), but there are other salmonid species present including Brown trout (*Salmo trutta*), Rainbow trout (*Oncorhynchus mykiss*), and Tiger trout (*Salmo trutta* x *Salvelinus fontinalis*). Deep Brook is less protected than the Pootatuck. It runs through residential areas, open fields, farms, a golf course, the former Fairfield Hills Hospital, and is crossed by several state highways. In the past there have been several issues that have influenced the water quality in Deep brook. There has been two significant oil spills. One in 2003 that leaked 5600 gallons of oil, and a smaller leak in 2004. Both of these occurred in a downstream reach of the current sampling area. With the increasing rate of land development and impervious cover, Deep Brook has developed a flashy nature and an unstable bank in places. The town of Newtown owns much of the land around lower Deep Brook, and the town Conservation Commission and Land Use office are active participants in the habitat restoration.

The sampling area used for this study is located at the intersection of Wasserman way and Queen Street about 500 feet NE of the intersection with Main St (RT 25). This area has many drainage streams and culverts that empty into the brook from surrounding areas within close proximity. One inlet is fed from Reed School and passes through sports fields, and there is impervious cover from the roads that drain in there as well. The area has good tree cover, but is plagued by invasive species such as Norway Maple (*Acer platinoides*), Multiflora rose (*Rosa mulitflora*), and Japanese knotweed (*Polygonaum cuspidatum*).

Methods and Meterials

Water Temperature

To see whether thermal pollution was the result of impervious runoff, thermographs were placed at three locations, upstream of the road for a control (Upstream Wasserman Way), at the Queen Street drain, and downstream of all impervious runoff inlets (Downstream Wasserman Way). These thermographs took hourly water temperature readings from May 25, 2007 through October 3, 2007 and also May 1, 2008 through October 4, 2008.

Significant rainfall events occurring between June and October were located for both 2007 and 2008 and the corresponding water temperatures for those days for both Upstream Wasserman Way (UWW) and Downstream Wasserman Way (DWW) were compared to see if a significant increase in water temperature was occurring from impervious runoff.

Water temperatures over 70°F and 75°F were collected for a single location for both 2007 and 2008. These water temperatures were compared with ambient air temperatures and rainfall amounts to see if thermal pollution was a result of impervious runoff or upstream land use.

Chemical, Biological, and Physical Water Quality

To see if impervious runoff contains significant amounts of non-point source pollutants six sites were sampled for water quality. Site 1 is located south of Wasserman Way upstream from the large culvert that diverts the brook under the road; it represents the water quality before impervious runoff enters the brook. Site 2 is the drainage that flows from the Reed School. The area upstream includes many sports field. This inlet is exhibiting excessive incising and bank erosion. Site 3 is a Drainage pipe that transports runoff from Wasserman Way. Site 4 is a culvert that imports drainage water from a small wetland that receives storm drain runoff from Wasserman Way and also drains from parking lots of a few office buildings. Site 5 is drainage from Queen Street. Site 6 is downstream after the confluence of all aforementioned runoff.

The sites were sampled three times. The first sample was taken during baseline conditions on May 23, 2007. The following samples were timed to coincide with the approximate concentration of flow during a storm event. These samples were taken on June 27th, 2007 and the second on October 28, 2008. Where flow was sufficient all 6 sites were samples for biological, physical, and chemical parameters. The samples were taken to Aqua Environmental lab for analysis. The biological test was for E-Coli. The physical test included pH, alkalinity, and suspended solids. The chemical test includes ammonia, nitrate, nitrite, and phosphorus. Conductivity and water temperature readings were taken as well.

The baseline sampling occurred on May 23, 2007 at 10 am. The air temperature was 61 °F the weather was calm and clear. The previous 24 hours experienced a maximum temperature of 73 °F and a minimum temperature of 40 °F. There was less than .01" of rain received in the four days preceding the sampling. The second sampling occurred on June 27, 2007 at 10:30pm. The air temperature was 72°F, and the weather humid and rainy. The previous 24 hours experiences a maximum temperature of 91 °F and a minimum temperature of 69 °F. The storm event precipitated .39" of rain. There was no precipitation in the previous 4 days to sampling. The final sampling took place on October 28, 2008 at 4:30pm. The air temperature was 38 °F with rain and wind. The rain event dropped .86" of rain, but this was in addition to .48" on 10/27/08 and 1.4" received on 10/25/08. The maximum and minimum temperatures preceding the sampling were 61°F and 37 °F respectively.

Macroinvertebrates

Macroinvertebrate sampling was done 5/12/07, 10/19/07, 4/28/08. and 10/18/08 at both the upstream and downstream Wasserman Way locations. The Rapid Bioassessment in Wadeable Streams and Rivers by Volunteer Monitors (RBV) protocol set up by the DEP was used. The samples were sent to CT DEP for species identification. The RBV program characterizes riffle dwelling, benthic, macroinvertebrate organisms into three categories, These are the three categories and their definitions:

- **Most Wanted**: In general these organisms require a narrow range of environmental conditions. When found in abundance one can infer non-impaired stream condition.
- **Moderately Wanted**: These organisms can be found in a variety of water quality conditions. When found in abundance further information about the upstream watershed may be necessary to infer water quality.
- **Least Wanted**: These organisms tend to be very tolerant of a wide range of environmental conditions. As a result when these organisms comprise the majority of a sample, one can infer some level of water quality impairment

According to the Connecticut DEP, the presence of an organism is the most important factor rather than the number of a particular organism present. Mike Beauchene conducted the final analysis of all samples.

Results

Water Temperature

All rain events over .5" for each year were found by using the weather history for the Danbury, CT airport station from weather underground (www.wunderground.com). The corresponding water temperatures from the UWW and DWW thermographs were recorded for those dates. In 2007 there were 9 days between June and September that met the criteria, they are 6/4/07, 7/4/07, 7/18/07, 7/19/07, 7/23/07, 7/28/07, 8/8/07, 8/10/07, and 8/27/07. In 2008 there were eight days that matched the criteria 6/14/08, 7/1/08, 7/24/08, 8/7/08, 8/11/08, 9/6/08, 9/12/08, and 9/26/08. There was evidence of short temperature surges at the onset of rain events, but they were not significantly higher than the upstream temperatures, and often returned to similar or cooler temperatures than the upstream location very quickly. The following is rain event information for the two storms that occurred at the warmest temperatures, for each year. The temperature of the water for the runoff from the Queen St. drain corresponding to rain events in 2007 was also gathered to note the temperature of the impervious runoff entering the Brook at that location during those storm events. The average temperature for the UWW and DWW for the months of July and August (the two warmest months) was calculated to see which area was overall the warmest during the summer months. The numbers were very close, but in both years the upstream location had warmer water temperatures overall.

Average Water Temperature July/August

	UWW	DWW
2007	68.58°F	68.05°F
2008	68.42°F	68.61°F

July 28, 2007

Precipitation (in)	Air temp (°F)	Time UWW	UWW Temp (°F)	Time DWW	DWW Temp (°F)
0.04	76	13:00:00	72.007	13:25:49	72.523
0	76	14:00:00	72.264	14:25:50	72.221
0.07	80	15:00:00	72.653	15:25:51	72.394
0.35	76	16:00:00	72.567	16:25:52	72.48
0.57	71	17:00:00	72.739	17:25:53	73.688
0.01	73	18:00:00	72.61	18:25:54	72.653
0	74	19:00:00	72.523	19:25:55	72.48
0	73	20:00:00	73.342	20:25:56	72.997
0	71	21:00:00	73.342	21:25:57	73.213
0	71	22:00:00	73.126	22:25:58	72.997
0	70	23:00:00	72.912	23:25:59	72.826

August 8, 2007

Precipitation (in)	Air temp (°F)	Time UWW	UWW Temp (°F)	Time DWW	DWW Temp (°F)
0.02	74	4:00:00	71.577	4:30:04	71.146
0.15	75	5:00:00	71.577	5:30:05	72.264
0.4	73	6:00:00	71.704	6:30:06	73.645
0.09	73	7:00:00	71.577	7:30:07	71.877
0.01	72	8:00:00	71.62	8:30:08	71.49
0	73	9:00:00	71.533	9:30:09	71.577
0	76	10:00:00	71.791	10:30:10	71.834
0	79	11:00:00	72.007	11:30:11	72.05
0	82	12:00:00	72.783	12:30:12	72.653
0	85	13:00:00	73.99	13:30:13	73.861
0	87	14:00:00	75.333	14:30:14	74.943
0	88	15:00:00	76.375	15:30:15	75.898
0	89	16:00:00	76.899	16:30:16	76.464

July 28, 2007

Time	Queen Street Drain Temperature (°F)
11:00:00	63.133
12:00:00	80.272
13:00:00	75.853
14:00:00	68.913
15:00:00	66.814
16:00:00	65.701
17:00:00	81.199
18:00:00	70.63
19:00:00	67.242

August 8, 2007

Time	Queen Street Drain Temperature (°F)
4:00:00	64.247
5:00:00	70.887
6:00:00	76.203
7:00:00	74.899
8:00:00	72.221
9:00:00	69.129
10:00:00	68.185

June 14, 2008

Precipitation	Air temp (°F)	Time UWW	UWW Temp (°F)	Time DWW	DWW Temp (°F)
0.02	81	12:00:00	69.47	12:24:24	69.21
0.02	77	13:00:00	69.77	13:24:25	69.47
0.07	73	14:00:00	69.99	14:24:26	69.64
0	74	15:00:00	70.33	15:24:27	69.94
0	81	16:00:00	70.93	16:24:28	70.33
0	76	17:00:00	70.89	17:24:29	70.33
0	74	18:00:00	70.76	18:24:30	70.29
0.05	70	19:00:00	70.33	19:24:31	70.67
0.3	68	20:00:00	70.12	20:24:32	70.12
0.07	62	21:00:00	70.16	21:24:33	69.99
0	62	22:00:00	70.16	22:24:34	70.03
0	62	23:00:00	71.02	23:24:35	70.72

July 1, 2008

Precipitation (in)	Air temp (°F)	Time UWW	UWW Temp (°F)	Time DWW	DWW Temp (°F)
0.04	75	18:00:00	69.39	18:17:42	68.79
0.41	69	19:00:00	69.00	19:17:43	71.83
0.25	68	20:00:00	68.66	20:17:44	69.60
0.1	68	21:00:00	73.30	21:17:45	73.82
0	68	22:00:00	71.53	22:17:46	71.27
0	68	23:00:00	70.33	23:17:47	70.24

There were times in both 2007 and 2008 that the water temperature in Deep Brook reached critical temperatures above 70ºF. Fewer, but even more significant were water temperatures exceeding 75°F which occurred in both years as well. The number of instances and the duration that temperatures surpassed these critical levels was recorded. Although some of these instances coincided with a rain event, most did not. In 2007 there were 36 instances of water temperatures exceeding 70ºF with the longest event having a duration of 84 hours. There were seven instances of water temperatures exceeding 75°F with a maximum duration of 11 hours. In 2008, there were 35 instances of water temperatures exceeding 70°F with a maximum duration of 155 hours, and 5 instances where water temperatures exceeded 75°F with a maximum duration of 6 hours. In both years these critical temperatures occurred both in the UWW and DWW thermograph locations indicating that runoff from the intersection of Wasserman Way and Queen Street was not the main factor in the thermal pollution of the brook. The UWW location temperatures were used to create the following tables as they indicate overall stream temperature.

Instances of water temperature exceeding 70ºF (2007) UWW location

Date	Time	Duration	Air temp High/Low (°F)	Precipitation (in)
6/1/07	5pm-9pm	4 hours	86/57	0
6/2-6/3	3pm-12am	9 hrs	84/62	0
6/26-6/27	2pm-3am	13 hrs	91/63	0
6/27-6/29	11am-6am	43 hrs	91/68	.11
29-Jun	2pm-6pm	4 hrs	75/59	0
7/6/07	3pm-4pm	1 hr	82/59	0.23
7-Jul	7pm-8pm	1 hr	82/55	0.01
7/8-7/9	2pm-6am	16 hrs	90/60	0
7/9-7/12	10am-5am	67 hrs	91/66	0.01

7/12/07	1pm-10pm	9 hrs	78/59	0
7/13/07	3pm-6pm	3 hrs	80/55	0
7/14/07	4pm-7pm	3 hrs	82/55	0
7/15-7/16	1pm-12am	11 hrs	87/66	0.1
7/16/08	2pm-9pm	7 hrs	79/61	0.01
7/17/07	2pm-11pm	9 hrs	87/59	0
7/18-7/19	8pm-2am	6 hrs	73/68	.39
7/19-7/20	12pm-1am	13 hrs	81/66	1.58
7/20-7/21	1pm-12am	11 hrs	75/64	.41
7/25/07	5pm-10pm	5 hrs	82/59	0
7/26-7/30	3pm-3am	84 hrs	84/62	.1
7/30-8/1	12pm-5am	41 hrs	87/62	0
8/1-8/2	10am-5am	19 hrs	91/63	0
8/2-8/5	11am-11pm	84 hrs	91/63	Possible rain event
8/6-8/7	3pm-1am	10 hrs	87/66	0
8/7-8/9	11am-3am	64 hrs	90/66	.73
8/13/07	3pm-10pm	7hrs	84/66	0
8/16/07	4pm-10pm	6 hrs	82/64	.01
8/25-8/26	1pm-10pm	33 hrs	87/69	0
8/27/07	2pm-7pm	5 hrs	81/60	0
8/28/07	3pm-6pm	3 hrs	80/57	0
8/29/07	3pm-8pm	5 hrs	82/60	0
8/30/07	4pm-7pm	3 hrs	84/60	0
8/31/07	3pm-6pm	3 hrs	77/63	0
9/7/07	4pm-8pm	4 hrs	87/66	0
9/8-9/9	1pm-2am	13 hrs	89/69	.04
9/9/07	1pm-11pm	10 hrs	84/66	0

Instances of water temperature exceeding 75°F (2007) UWW location

Date	Time	Duration	Air temp High/Low (°F)	Precipitaiton (in)
7/9/07	4pm-7pm	3 hrs	90/69	0
7/10/07	2pm-9pm	7 hrs	91/66	0
7/11/07	4pm	<1 hr	82/71	0
8/2/07	4pm-6pm	2 hrs	91/63	0
8/3/07	3pm-8pm	5 hrs	91/66	Possible rain event
8/4/07	3pm-7pm	4 hrs	87/64	0
8/8-8/9	2pm-1am	11 hrs	90/71	.73

Instances of water temperature exceeding 70°F (2008) UWW location

Date	Time	Duration	Air temp High/Low (°F)	Precipitaiton (in)
27-May	5pm-6pm	1 hr	82/55	.25
6/7-6/8	7pm-2am	7 hrs	91/57	0
6/8-6/9	2pm-5am	15 hrs	93/66	0
6/9-6/12	12pm-3am	63 hrs	93/66	.23"
12-Jun	4pm-8pm	4 hrs	79/55	0
6/14/08	7pm	<1 hr	87/57	1.31
6/14/08	9pm-11pm	2 hrs	87/57	1.31
6/15/08	4pm-8pm	4 hrs	81/60	Possible rain event
6/28-6/29	4pm-3am	11 hrs	86/62	.1"
6/29/6/30	1pm-5am	16 hrs	84/64	0
6/30-7/1	1pm-2am	13 hrs	81/62	0
7/1-7/2	4pm-3am	11 hrs	81/60	.04
7/2/08	3pm-10pm	7 hrs	81/60	0
7/3/08	3pm-10pm	7 hrs	86/62	.02
7/4/08	3pm-7pm	4 hrs	75/66	.31
7/7-7/8	2pm-6am	16 hrs	82/69	0
7/8-7/11	11am-1am	62 hrs	86/60	0
7/11/08	3pm-9pm	6 hrs	82/54	0
7/12-7/13	2pm-12am	10 hrs	82/63	0
7/13-7/15	1pm-12am	35 hrs	80/62	0
7/15/08	3pm-10pm	7 hrs	82/55	0
7/16/08	3pm-10pm	7 hrs	84/55	0
7/17-7/18	2pm-3am	13 hrs	87/62	0
7/18-7/24	12pm-11pm	155 hrs	89/66	.32
7/25-7/26	3pm-12am	9 hrs	82/55	.01
26-Jul	4pm-11pm	7 hrs	82/57	0
7/27-7/28	10pm-1am	3 hrs	78/64	1.03
7/28-7/29	2pm-3am	13 hrs	82/64	0
7/29-7/30	1pm-1am	12 hrs	84/62	0
7/30-8/2	2pm-3am	61 hrs	86/64	.45
8/2/08	1pm	<1 hr	78/63	.39
8/5/08	4pm-5pm	1 hr	81/61	Possible rain event
8/6-8/7	12pm-6pm	30 hrs	84/63	.23
9/6-9/7	2am-1am	23 hrs	80/69	5.22
9/7/08	12pm-8pm	8 hrs	77/59	0

Instances of water temperature exceeding 75°F (2008) UWW location

Date	Time	Duration	Air temp High/Low (°F)	Precipitaiton (in)
9-Jun	5pm-10pm	5 hrs	93/70	0
6/10/08	4pm-10pm	6 hrs	93/66	.06
Jul-08	5pm-8pm	3 hrs	86/66	0
7/21/08	4pm-9pm	5 hrs	87/69	.07
30-Jul	6pm	<1 hr	84/62	0

Chemical, Biological, and Physical Water Quality

The parameters set for water quality by the State of Connecticut EPA for class A designated use is what will be used for reference for water quality in this analysis. The definition of a class A by the state of Connecticut EPA is as follows:

> "Surface waters are designated for: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture." (CT DEP)

Deep Brook is a tributary of the Pootatuck River, and lies in the Pootatuck watershed. The Pootatuck aquifer is used as a drinking water supply for the town of Newtown, therefore the class A designation is used. It would be possible to use the class B designation because this water is not directly used for drinking water supply. The defination of a class B is as follows:

> "Surface waters are designated for: habitat for fish and other aquatic life and wildlife; recreation; navigation; and industrial and agricultural water supply. " (CT DEP)

For the purpose of this study we chose class A designation, although many of the requirements are not significantly different.

Bacteria

Total coliform permitted in a single sample should not exceed 500/100ml for drinking water sources or 576/100ml for recreational sources. Baseline conditions at all sites with sufficient flow were under this threshold. On June 28, 2007 all samples taken were significantly higher than that threshold with concentrations exceeding the maximum recordable 2419/100ml for 3 sites sampled. Levels found in samples from October 28, 2008 had similar results with 3 samples exceeding the maximum, but the other three fell in or around acceptable levels for recreation.

Chemical

Water samples were tested for concentrations of Nitrogen (N) in three forms: Ammonia, Nitrate, and Nitrite as well as total Phosphorus (P). The concentrations of these nutrients indicate whether the body of water is oligotrophic, mesotrophic, or eutrophic. We will use the guidelines established by the EPA for lakes to compare our data to.

	Oligotrophic	Mesotrophic	Eutrophic	Highly Eutrophic
Total P	0-.01 mg/L	.01-.03 mg/L	.03-.05 mg/L	>.05 mg/L
Total N	0-2 mg/L	2-6 mg/L	6-10 mg/L	>10 mg/L

All the sites fell into either the oligotrophic or mesotrophic categories for total N at all samples. Total P concentrations were not as good. The only sample that was not eutrophic was the baseline for site 5–all other samples were either eutrophic or highly eutrophic for P concentrations. The highest concentrations of P were found at sites 3 and 4, and concentrations were higher in rainfall events than in baseline conditions. Overall levels of N and P were lower during the October 28, 2008 rain event, than the June 2007 event. One possible explanation for the lower levels in some of the runoff is that the

October storm event was much larger and followed many days of rain. There was less time for these pollutants to build up on the road before the storm. Another is that the timing of the June event coincides with fertilization regimens on farms, lawns, and the golf course.

Physical

Water samples were tested for pH, alkalinity, conductivity, and suspended solids. The pH levels fell consistently between 6.5 and 7.5 during all tests. Suspended solid data was higher during rain events than baseline conditions, but never exceeded 50 mg/L in storm-water runoff. During the October 28, 2008 storm event site 1 (UWW) exhibited levels of suspended solids >100 mg/L a concentration considered toxic to fish. By the time the water reached the downstream location the levels were much lower. This is an indication that the suspended solids are dropping out of the stream before this location. It may be happening at the base of the culvert that brings the stream under Wasserman Way where the stream takes a hard turn and then is diverted under the road.

Summary of storm water samples

site 1: UWW

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			51°F	70°F
conductivity			75-90	no limit
eColi bacteria	345 Col/100 ml	>2419 Col/100 ml	>2419 Col/100 ml	500 Col/100 ml
Alkalinity	56 mg/L	66 mg/L	38 mg/L	no limit
Ammonia as N	.28 mg/L	.28 mg/L	<.1 mg/L	
Nitrate as N	.46 mg/L	.76 mg/L	<.5 mg/L	
Nitrite as N	<.1 mg/L	<.1 mg/L	<.1 mg/L	
Total N	.74 mg/L	1.04 mg/L	<.7 mg/L	6 mg/L
Phosphorus	.04 mg/L	.13 mg/L	.1 mg/L	.03 mg/L
pH	7.3	7.5	7.2	5 to 8
Suspended Solids	2.5 mg/L	32 mg/L	116.6 mg/L	80 mg/L

site 2: Reed School Creek

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			50°F	70°F
conductivity			50	no limit
eColi bacteria	N/A*	N/A*	>2419 Col/100 ml	500 Col/100 ml
Alkalinity	N/A*	N/A*	22 mg/L	no limit
Ammonia as N	N/A*	N/A*	<.1 mg/L	
Nitrate as N	N/A*	N/A*	<.5 mg/L	
Nitrite as N	N/A*	N/A*	<.1 mg/L	
Total N	N/A*	N/A*	<.7 mg/L	6 mg/L
Phosphorus	N/A*	N/A*	.18 mg/L	.03 mg/L
pH	N/A*	N/A*	7.2	5 to 8
Suspended Solids	N/A*	N/A*	3.3 mg/L	80 mg/L

*insufficient flow

site 3: Draige Pipe WW

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			48°F	70°F
conductivity			10	no limit
eColi bacteria	N/A*	>2419 Col/ 100 ml	488 Col/100 ml	500 Col/100 ml
Alkalinity	N/A*	16 mg/L	<20	no limit
Ammonia as N	N/A*	.84 mg/L	<.1 mg/L	
Nitrate as N	N/A*	.63 mg/L	<.5 mg/L	
Nitrite as N	N/A*	<.1 mg/L	<.1 mg/L	
Total N	N/A*	1.47 mg/L	<.7 mg/L	6 mg/L
Phosphorus	N/A*	.25 mg/L	.09 mg/L	.03 mg/L
pH	N/A*	6.9	6.8	5 to 8
Suspended Solids	N/A*	50 mg/L	22 mg/L	80 mg/L

*insufficient flow

site 4: Wetland culvert

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			48°F	70°F
conductivity			60	no limit
eColi bacteria	13 Col/100ml	1986 Col/100 ml	548 Col/100 ml	500 Col/100 ml
Alkalinity	68 mg/L	56 mg/L	<20 mg/L	no limit
Ammonia as N	.56 mg/L	1.12 mg/L	<.1 mg/L	
Nitrate as N	.12 mg/L	1.10 mg/L	<.5 mg/L	
Nitrite as N	<.1 mg/L	.44 mg/L	<.1 mg/L	
Total N	.68 mg/L	2.66 mg/L	<.7 mg/L	6 mg/L
Phosphorus	.12 mg/L	.25 mg/L	.06 mg/L	.03 mg/L
pH	6.9	7.1	6.8	5 to 8
Suspended Solids	6.4 mg/L	32.4 mg/L	9.3 mg/L	80 mg/L

site 5: Queen St. drainage

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			55.5°F	70°F
conductivity			250	no limit
eColi bacteria	0 Col/100 ml	1413 Col/100 ml	102 Col/100 ml	500 Col/100 ml
Alkalinity	96 mg/L	26 mg/L	26 mg/L	no limit
Ammonia as N	.28 mg/L	1.12 mg/L	<.1 mg/L	
Nitrate as N	2.5 mg/L	.82 mg/L	.98 mg/L	
Nitrite as N	<.1 mg/L	<.1 mg/L	<.1 mg/L	
Total N	2.78 mg/L	1.94 mg/L	<1 mg/L	6 mg/L
Phosphorus	.03 mg/L	.1 mg/L	.03 mg/L	.03 mg/L
pH	6.9	6.9	6.9	5 to 8
Suspended Solids	.4 mg/L	12.8 mg/L	3.3 mg/L	80 mg/L

site 6: DWW

	23-May-07	28-Jun-07	28-Oct-08	limits
water temperature			49°F	70°F
conductivity			100	no limit
eColi bacteria	172 Col/ml	>2419 Col/100 ml	>2419 Col/100 ml	500 Col/100 ml
Alkalinity	58 mg/L	56 mg/L	38 mg/L	no limit
Ammonia as N	<.28 mg/L	1.12 mg	<.1 mg/L	
Nitrate as N	.49 mg/L	.82 mg/L	<.5 mg/L	
Nitrite as N	<.1 mg/L	<.1 mg/L	<.1 mg/L	
Total N	.49 mg/L	1.94 mg/L	<.7 mg/L	6 mg/L
Phosphorus	.1 mg/L	.07 mg/L	.11 mg/L	.03 mg/L
pH	7.3	7.4	7.2	5 to 8
Suspended Solids	5.3 mg/L	6.6 mg/L	12 mg/L	80 mg/L

Macroinvertebrates

The data from the macroinvertebrate sampling for 2007 and 2008 does not indicate that there is a substantial difference in the populations of most and moderately wanted macroinvertebrates in the upstream and downstream locations. The fact that the numbers are very low for the most wanted group of species should elicit concern, but the numbers are similar in both locations.

Collection Date	Sample site	Most Desired Species	Moderately Desired Species	Least Desired Species
5/12/07	upstream Wasserman Way	1	5	1
5/12/07	downstream Wasserman Way	0	3	2
		0	0	0
10/19/07	upstream Wasserman Way	0	4	3
10/19/07	downstream Wasserman Way	1	4	1
		0	0	0
4/28/08	upstream Wasserman Way	2	4	2
4/28/08	downstream Wasserman Way	0	3	0
		0	0	0
10/18/08	upstream Wasserman Way	1	5	1
10/18/08	downstream Wasserman Way	1	5	3

Discussion

Brook Trout (*Salveinus fontinalis*) is not actually a trout at all, but a type of char. Brook trout are native to cool water streams and lakes in Canada and the Northeast U.S. down through the Southeast U.S. where water temperatures aren't prohibitive. Optimum temperatures are between 55°F and 65°F, with overall species survival occurring from 32°F to 72°F. Temperature over 75°F can result in instant mortality. Most of the water temperatures occurring in the critical ranges took place during the summer months. The trout can move downstream to the Pootatuck River during these hot summer months. The Trout are much more sensitive in the late fall through spring. They can also utilize springs and flows that introduce cool groundwater into the stream. These can act as refuges during short to intermediate periods of warm water temperatures. There was excessive thermal pollution recorded throughout the two-year sampling. The data does not support that it is primarily a result of storm water runoff, although it does contribute to the problem. The problem, most likely, has to do with land use upstream.

Brook trout are extremely tolerant to a wide pH range with lower limits around 4.8 and upper limits near 8. The pH of all samples was well within the range suitable for brook trout populations. Alkalinity is not a limiting factor for brook trout populations as long as habitat requirements are met. Although brook trout are considered the most sensitive of trout populations, they are actually better suited to cope with low alkalinity conditions and more drastic fluctuations in pH than brown trout.

Brook trout require clean, low nutrient water. Excess nutrients such as Nitrogen (N) and Phosphorus (P) can cause eutrophic conditions in water bodies. Eutrophic conditions can cause algae blooms and macrophyte conditions. Excess Phosphorus is an indicator of overall water quality. Excessive levels of coliform bacteria has no known effect on native brook trout, but is a concern for drinking water security (Modde et al. 1986, Davis 2006) especially when levels are as high as were found in our samples. Our samples exhibited high concentrations of both coliform bacteria and the nutrient Phosphorus. Both of these pollutants can occur from agricultural use or from human wastewater (i.e. failing septic systems). Canadian Geese (*Branta canadensis*) are another potential problem as large populations live and defecate in many parts of the upstream watershed. These pollutants can be entering the brook from groundwater or upstream land use.

Suspended solids are a reflection of excessive erosion, or other land use that puts excess particles into the water. High levels of suspended solids have a detrimental effect on brook trout populations. They can directly affect the survival, growth, and disease resistance of adult fish, and can smother the eggs and larvae when silt and clay settle out. They can also affect fish behaviors such as feeding and migration patterns. Habitat for fish spawning and macroinvertebrates are negatively affected when stream-bed aggradation occurs from excessive sediment loads. Streams with suspended sediment loads under 80 mg/L should be able to sustain trout populations.

Conclusions and Recommendations

The most pressing issue affecting trout populations in Deep Brook is thermal pollution. The high temperature of the brook for excessive periods is detrimental to fish populations. This is probably an affect of land use upstream. There are many areas where Deep Brook flows without overhead cover, including fields, farms, and a golf course. I suggest that more thermograph tests be done. One thermograph should be used to record ambient air temperature, while the others should be placed in upstream reaches corresponding to different land use types. This will make it possible to chart air and water temperature together on an hourly basis. This will give a better idea of what the critical air temperature is, and how far downstream is affected when these temperatures are reached. Well-placed thermographs for a complete season will hopefully reveal which land uses are causing the crucial temperature thresholds to be surpassed. Only then can these land use issues be addressed. The Pootatuck Watershed Association, Trout Unlimited, and Newtown Conservation can then work with land-owners to increase vegetative cover in these places. As weather patterns continue to change this is of increasing importance. We are experiencing longer durations of higher air temperatures, and storms are less frequent, but more severe. Connecticut is experiencing an increase in yearly precipitation, but this is more than cancelled out by the decrease in groundwater infiltration and impervious cover of development. A survey of potential groundwater discharges into the stream should be done as well. This will give an idea of the amount of refugia available for trout when water temperatures rise above optimal levels.

The issue of excess coliform and Phosphorus in runoff should also be addressed. Unfortunately, this is non-point source pollution without an exact source. There are definitely pollutants entering the stream during storm events as these levels are much higher in the storm samples than the baseline conditions. However baseline conditions even in the upstream Wasserman Way location are still suboptimal. Increased buffers are one way we can address this issue. This is particularly important for upstream farms, parks, the golf course, and any other areas with high populations of Canadian Geese. It is possible though that these pollutants may be a pervasive problem in the groundwater.

We did not test for the presence of pesticides in the water. Due to the proximity of the golf course, the Fairfield Hills campus, and other farms and residences that may use persistent chemicals this should be a consideration in future assessments. If the thermal issue and habitat requirements are met and populations still do not rebound this is an area that should be explored.

Due to the high concentration of suspended solids in the upstream storm-water sample from October 2008, substrate should be monitored and inventoried in the stream. This inventory should check for any areas exhibiting settling out of clay and silt particles that would impact trout spawning and habitat. At the same time monitoring of banks that are eroding and responsible for these suspended solids can be targeted for stabilization projects.

There are a number of issues affecting Deep Brook and keeping it from being optimal trout habitat. Upstream land use seems to be responsible for many of these issues. Further monitoring and action plans should focus on the upstream portions of the stream. Buffers and vegetative cover should be the immediate focus of any action.

Appendix 1.

Electro-shocking census data for Deep Brook

Deep Brook WTMA

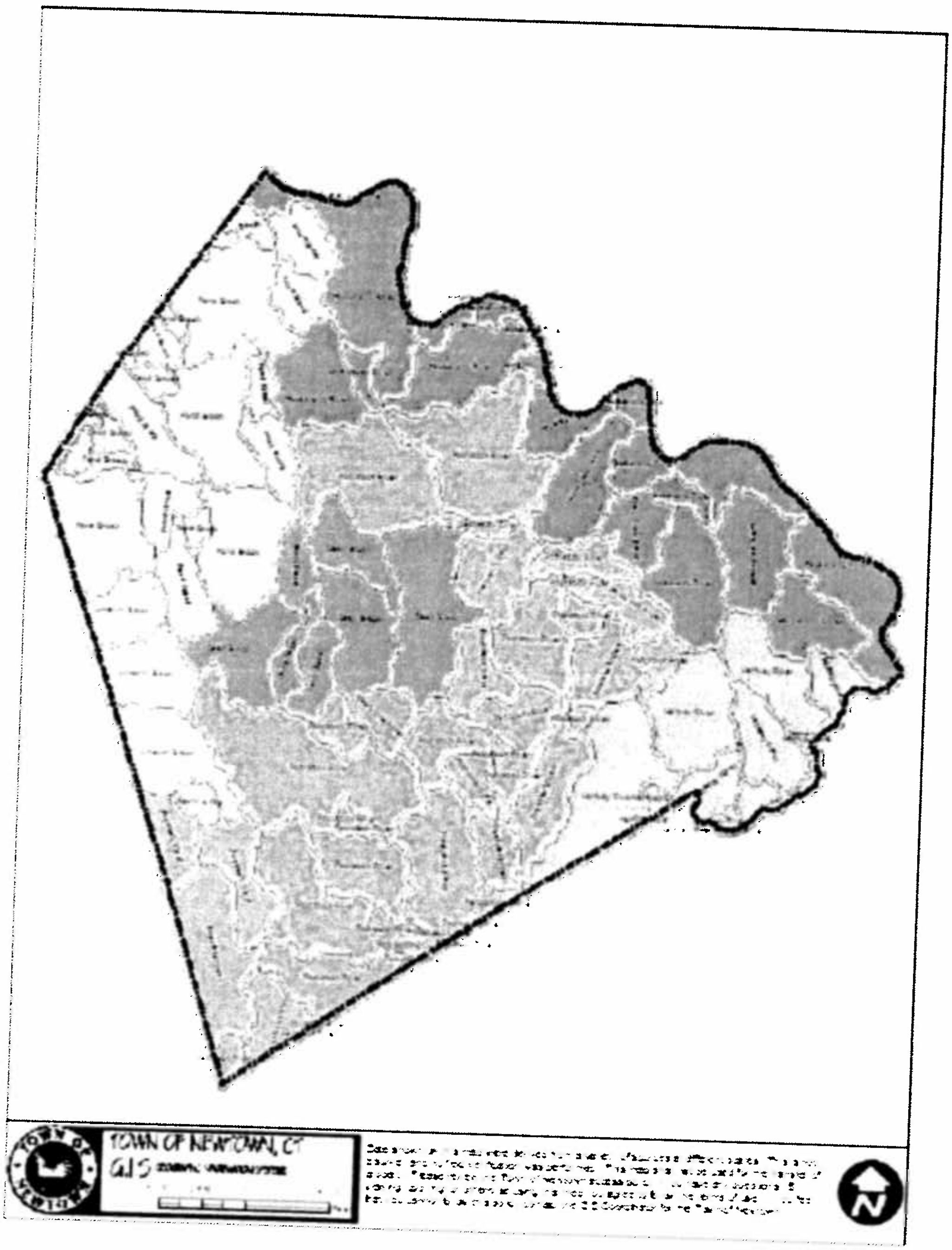
Table 8- Number of trout caught during single pass trout population sampling at areas sampled in the Deep Brook WTMA, 1991-2008. Sites are arranged in order from upstream to downstream.

Year Sampled	Brown Trout			Brook Trout			Stocked Trout	Total Wild Trout	meters sampled	W Trout/ km
	Age 0 <12cm	Age 1 12-21cm	Age2+ >21cm	Age 0 <12cm	Age 1 12-21cm	Age2+ >21cm				
Upper areas (above train trestle/below Wasserman Way)										
1991	47	9	0	5	5	0	0	66	100	660
2000	0	3	6	0	10	3	0	22	210	105
Middle area (old STP bridge up to steel I-beam)										
1998	10	29	8	0	29	2	0	79 [1]	400	198
2000	29	50	7	19	12	1	0	118	400	295
2001	105	46	4	29	67	1	0	252	400	630
2002	26	66	9	15	33	3	0	152	400	380
2003	129	41	12	8	37	0	0	227	400	568
2004	57	70	13	9	7	1	1	157	400	393
2005	35	43	7	3	17	1	0	107 [3]	400	268
2006	33	27	9	0	7	1	0	77	400	193
2007	15	38	11	1	2	0	0	67	400	168
2008	27	29	11	1	1	3	0	76	400	190
2008(RW)	4	0	0							
Lower area (upstream from mouth)										
1998	23	21	4	13	36	2	3	99	598	166
2003	158 [2]	24	5	83 [2]	36	1	1	307	598	513

[1] Includes one 20 cm tiger trout.
[2] Age 0 numbers were expanded up from a 344-m subsample.
[3] Includes one 19 cm tiger trout.

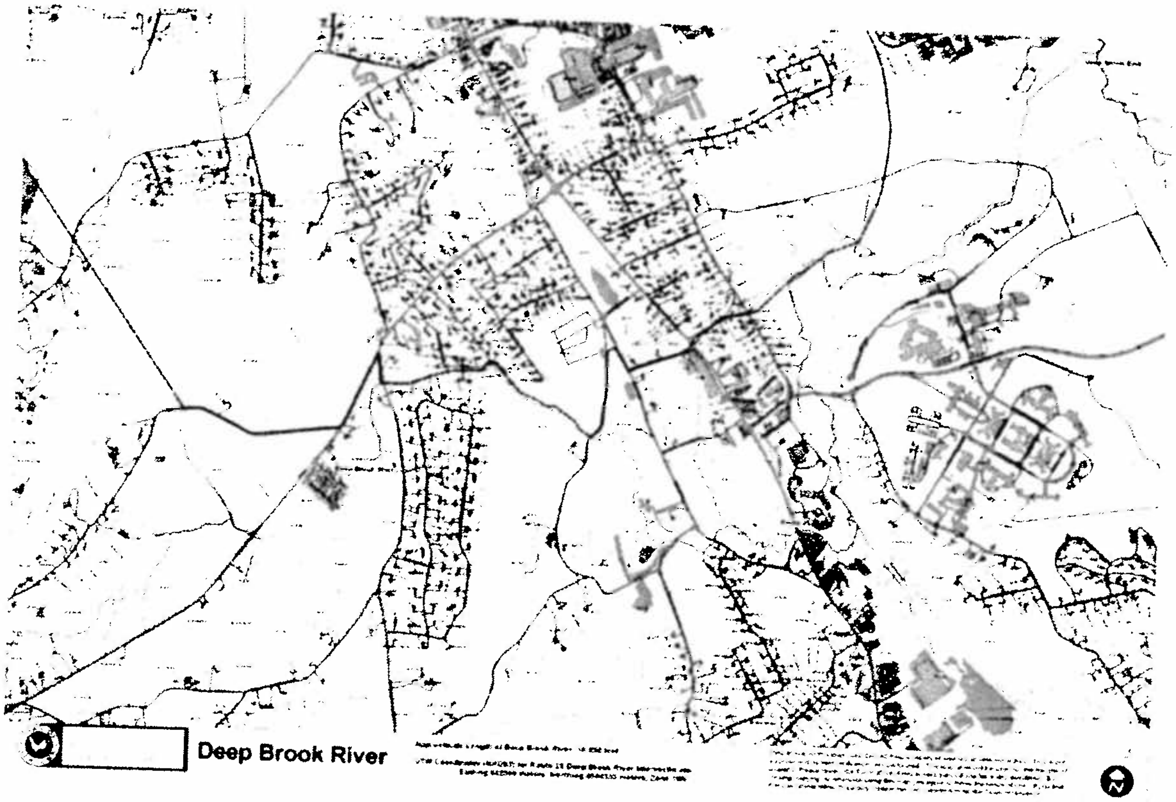
Appendix 2.

Watershed Map of Newtown, CT



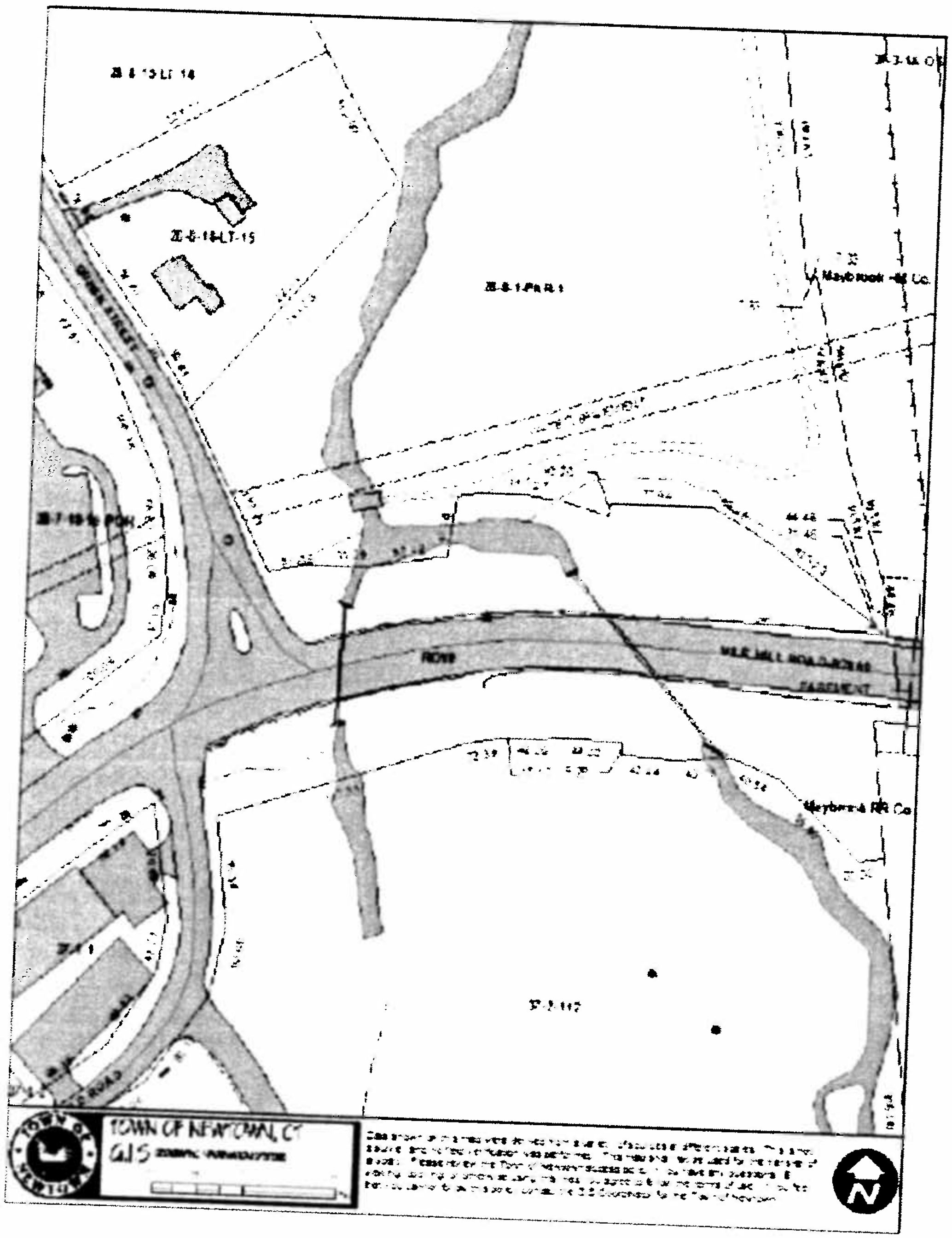
Appendix 3.

Deep Brook



Appendix 4.

Embrace-A-Stream Sampling Location



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