

**Biological and Aquatic Life Use Attainment Assessment of
Moon Brook**

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DRAFT

prepared by

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Current Assessment

1. *Description of water body:*

- Moon Brook and its watershed are located in the City of Rutland in Rutland County.
- The main stem of Moon Brook from its confluence with Otter Creek to a point 2.9 miles upstream (just below pond) is listed as impaired due to non-support of aquatic life designated uses (poor biological condition). The listing is based primarily on assessments of fish and macroinvertebrate communities within the reach of Moon Brook designated as impaired.
- The listed cause of impairment is “undefined” related to “urban runoff, erosion, and land development”.
- The entire length of Moon Brook and its tributaries are Class B waters designated as coldwater fish habitat pursuant to the Vermont Water Quality Standards.
- Headwater section above river mile 3.2 can be evaluated using the Coldwater Index of Biotic Integrity (CWIBI) for fish and the Small High Gradient (SHG) stream type for macroinvertebrates. It is somewhat unclear exactly where the stream would naturally transform into a larger warm water valley stream which would be expected to support more warm water species, due to several on-stream ponds. At present, the lower 2.9 miles of stream below Combination Pond will be evaluated using the Mixed Water Index of Biotic Integrity (MWIBI) for the fish community, and the warm water moderate gradient (WWMG) stream type for the macroinvertebrate community.
- The headwaters drain East Mountain, flowing through a residential area below Town Line Road. The Rutland City landfill is located approximately adjacent to river mile 3.3. From there the stream travels through a wooded area until flattening out just upstream of the Combination Pond at RM 2.9. From there the watershed becomes abruptly urban with dense residential housing. A second on-stream pond, Piedmont Pond, is situated at river mile 2.4. Moving downstream the number of streets in the drainage increases rapidly. The stream crosses under Rt. 7 at river mile 1.2 and finally below Forest St. (RM 0.3) the brook flattens out into a field before entering Otter Creek. Mussey Brook enters Moon Brook just above Forest St. at approximately river mile 0.4.
- Mussey Brook is a tributary to Moon Brook. It drains the southeast portion of the Moon Brook watershed. Mussey Brook contains two on-stream ponds, both larger than the ponds on Moon Brook. The Mussey Brook watershed is slightly less urbanized in its mid and upper portions than Moon Brook.

2. *Description of data used to characterize impairment:*

- **Fish community** – Twelve samples from 6 sites were sampled and assessed for community health between 1986 - 2005. Four samples rated *poor*, 6 samples rated *fair*, one rated *good* and one sample rated very good. All 9 assessments below Combination Pond above Stratton Drive were rated *fair* or *poor*, failing to meet the Class B standards. The only site that meets the standards are RM 3.2 and 3.3, above Combination Pond and above the reach designated as impaired. All fish samples reported here are considered valid.
- **Macroinvertebrate community** –thirteen samples from 6 sites; 9 samples rated poor or fair, 2 rated good, and 2 rated very good. All 6 samples taken at and below RM 0.9 (Howe Industrial Park) failed to meet the Class B standard. The site at RM 1.5 rated good in 2001, while the site at RM 2.9 rated poor

in 1991. Site RM 2.9 is located immediately below Combination Pond and reflects the immediate effects of the pond on stream biota. All assessments at RM 3.2, above Combination Pond, and 2 assessments at RM 3.3 since 1991 were rated good or very good. The 2001 assessment at RM 3.3 showed a decrease in biological integrity (very good to good) compared to the 1991 sample.

- All macroinvertebrate samples are considered valid. An additional 4 samples collected in the late 1980's, show some improvement has occurred in Moon Brook from river mile 1.2-1.8. In 1988 both these sites were rated poor. In 2001 site RM 1.5 rated good.
 - The aquatic biota did not meet its designated use for Class B waters from the mouth upstream to Combination Pond. Fish and/or macroinvertebrate data failed the Class B standard more often than not below Combination Pond. Up stream of the pond (RM 3.2 and 3.3 sites) the stream consistently meets Class B standards for aquatic life use. It is assumed that standards are met in the remaining 1.3 miles above the RM 3.3 site.
 - The available data indicates that the level of impairment is moderate to severe at and below RM 1.2. From RM 1.2 to RM 1.8 impairment is moderate, and at RM 2.9 deviation from applicable biocriteria for both communities is high; this may be in part due to the close proximity of this site to Combination Pond. This site has not been assessed since 1991.
 - The weight of evidence from the combined 18 current biological samples taken from 1991-2005 clearly show impairment to the aquatic biota of the stream from the mouth to below Combination Pond at RM 2.9. Both macroinvertebrate and fish assessments were used to list this river reach.
 - Biomonitoring should continue at selected sites to monitor future watershed improvements. These sites include RM 0.3 or 0.9, 1.5, 2.8 above Piedmont Pond at 3.3.
 - A single biological sample from Mussey Brook was taken in 2002. The fish assemblage was sampled at RM 0.1 in 2002. The MWIBI score was 25 (poor).
3. *Stressor Identification:* DEC has relied primarily on biological inference and assessment site habitat observations to identify the stressors that are the most likely significant contributors to the observed impairments. Assessment of the characteristics of the biological communities and physical habitat are inconclusive in regards to the identification of a single most significant stressor responsible for the impairment. The primary stressor(s) remains "undefined". It is highly probable that multiple factors related to watershed development, erosion and urban runoff resulting in alterations to the biological, chemical and physical characteristics of the stream are contributing to the impairment.

4. *Summary statement-Overall “weight-of-evidence” summary of findings:*

- Biological assessment data from Moon Brook provide the basis for impairment designation of the lower 2.5 miles of the main stem of Moon Brook. The data are of high quality and are representative of current conditions.
- Data and site characteristics infer that the impairment is a result of undefined factors related to erosion, land development and urban runoff.

5. *Confidence:*

- DEC has a high degree of confidence in the application of biological assessments to Moon Brook and in the conclusions drawn from those assessments.
- DEC is confident in the generic attribution of stressor as “undefined” but related to chemical, physical and biological alterations resulting from watershed development, erosion and urban runoff.

Moon Brook Biological Assessment – Discussion:

The portion of Moon Brook between the mouth and 2.9 miles upstream has been identified by the State of Vermont as impaired pursuant to the Clean Water Act, Section 303(d). The primary impairment is due to aquatic life use support.

Current Assessment

The macroinvertebrate and fish assemblages of Moon Brook were sampled at 6 sites on 18 occasions from 1991-2002. All biological assessments at the two upper-most sites: river mile 3.2 and 3.3 meet the biological Class B WQS, rating between good and excellent during the period 1988-2002. Only a single sample (macroinvertebrate from RM 1.5) from the remaining four downstream stations, has met the Biological Class B WQS. Both Fish and Macroinvertebrate assessments scored fair-poor at RM 0.3, 0.9. At RM 1.5 fish have scored fair-poor over two years and the macroinvertebrates scored good once. At RM 2.3 both communities scored poor in 1991. The current biological integrity of Moon Brook appears to drop below acceptable standards at some point below Combination Pond at RM 2.9.

While the upper site 3.3 has consistently met the Class B biocriteria with a good or better rating the reach of stream habitat appears to be over-widening, the substrate is high in percent sand, and rated as poor in substrate embeddedness (see phys-chem-habitat table).

The on-stream ponds are likely altering the temperature of the brook. In 1991 the temperature was taken at site 2.7, 2.3, 0.7 and 0.3. The temperature at station 2.3 was 17 °C, which was elevated compared to both above (9°C) and below (6°C). The riparian canopy was also lowest in the mid reach stations of stream, which can directly expose the stream to sunlight also increasing stream temperature. The increase in temperature is likely responsible for eliminating brook trout at station 2.9 when sampled in 1991. Additionally since no more than two brook trout were ever recorded at any one site downstream, the increase in water temperature brought about by the pond may at times extend to the mid and lower reaches as well. The assemblages at and below RM 2.9 are composed primarily eurythermal (tolerating wide temperature range) species, with a few warmwater species. Except for brown trout, all fish species collected are considered native to this brook.

The macroinvertebrate community also illustrates the above temperature influence of the pond; as well as alterations in the brooks energy flow. At 2.9 no Plecoptera species (generally coldwater obligates) were recorded in 1991, and they are generally less common at all lower stations. Other specific coldwater obligate taxa which decrease or are eliminated are *Dolophilodes sp*, *Rhyacophila spp*, *Oulimnius latiusculus*, *Epeorus sp*, and *Peltoperla sp*. The only EPT species present at 2.9 were two moderately temperature tolerant filter feeding caddis. These two species dominated the community reflecting an overall shift in the functional group composition at station 2.9 to that of filter-feeding (71%). The resulting shift in functional feeding groups at 2.9 is evident in the lowest PPCS-f (0.24) recorded.

It appears that some recovery to the macroinvertebrate community occurs as you move downstream from the ponds to about RT 7. The overall number of species and EPT species both increase, and the functional group composition becomes more similar to the expected model for the stream. Increased levels of silt suspended when collecting samples becomes more pronounced however from station 1.5 to the lower stations. The lower stations 0.9 and 0.3 also show a tendency toward greater amounts of either filamentous or blue green algae. The macroinvertebrate community becomes low in EPT taxa, and the Bio Index value is at or above 5.00. These community metrics indicate that siltation and nutrients maybe responsible for the impaired biological condition in the lower brook. The extremely low numbers of EPT taxa also point toward a potential of sporadic toxic spills/slugs from urban activities.

Restoration of Moon Brook could be verified by monitoring the fish, and macroinvertebrate assemblages at a subset of established sampling sites. Theoretically, fish community IBI values under improving conditions would rise at least into the good range. This would probably be manifest through shifts from the current dominance of tolerant, generalist species to an assemblage with a greater proportion of benthic insectivores and top carnivores (brook trout). Similarly the macroinvertebrate community should recover to expected levels of structural and functional integrity based on what is found in reference streams.

Table 1. Biological sampling stations on Moon and Mussey Brooks, Rutland. “M” - macroinvertebrate, “F”-fish.

Location	Station	Community	Description	Latitude	Longitude	Drainage Area (km ²)	Elevation (Ft)	USGS Map No.
Moon Brook	0.3	MF	Below Forester St. Bridge.	433540	725855	21.0	521	26B
	0.9	MF	Above bridge to Howe Center Industrial Park.	433552	725828	14.0	537	26B
	1.5	MF	Below footbridge in recreation area off B St., above Rt. 7 about 0.3 miles.	433600	725804	13.0	540	26B
	2.8	MF	Located adjacent to Catherine St.	433638	725708		623	26B
	2.9	MF	Below Sharon St. 20m. below a small on-stream pond.	433650	725712	4.2	640	26B
	3.2	M	Old field area above upper pond.	433702	725706	3.5	641	26B
	3.3	MF	Adjacent to old landfill, access from Charter Hill Dr.	433702	725705	3.5	645	26B
Mussey Brook	0.1	F	Upstream from Park St. bridge.	433538	725847	6.3	535	26B

Table 2. Fish community metrics from Moon Brook sites evaluated using the Mixed Water Index of Biotic Integrity (MWIBI) and Cold Water IBI (CWIBI)¹.

Sites (RM)	Date	MWIBI and Assessment	Number of Species	Number of Intolerant Species	Number of Benthic Insectivore Species	% White Sucker and Creek Chub	% Generalist Feeders	% Insectivores	% Top Carnivores	% Anomalies	Density (#/100m ²)
0.3	9/30/1986	* Fair	11	1	2	24	88	11	1	0	18
	10/6/1993	* Fair	10	1	2	11	95	4	<1	2	103
	9/28/2005	* Fair	9	1	3	39	76	24	0	0	31
0.9	9/21/1991	29 - Fair	9	1	2	46	58	41	1	0	74
	09/25/2002	23 - Poor	8	1	1	66	78	19	3	0.0	12
	10/1/2004	25 - Poor	8	2	2	46	61	37	2	3.7	22
1.2	10/4/1988	27 - Fair	11	1	2	36	66	34	<1	0	280
1.5	10/23/2001	29 - Fair	14	3	3	49	78	20	1	0.3	81
	09/25/2002	23 - Poor	8	1	1	60	80	20	0	0.0	18
2.8	9/28/2005	25 - Poor	9	0	1	57	66	33	1	0	143
3.3	10/23/2001	33 - good	2	60	40	60	7	3			
	9/05/2005	very good²	1	100	0	100	19	3			

1. Calculated as numbers captured during first electrofishing run /100m²

2 MWIBI Range: 9-25 (Poor), 27-29 (Fair), 33-35 (Good), 37 (Very Good), 41-45 (Excellent)

2 CWIBI Range: 9-25 (Poor), 27 (Fair), 33 (Good), 36 (Very Good), 42-45 (Excellent)

* No IBI was calculated due to lack of accurate reference for soft bottomed sites

3. No CWIBI was calculated since only one species was present. Best professional judgment was used in making the assessment.

Table 4 Fish community metrics from Mussey Brook site RM 0.1, evaluated using the Mixed Water Index of Biotic Integrity (MWIBI)¹.

Date	MWIBI and Assessment	Number of Species	Number of Intolerant Species	Number of Benthic Insectivore Species	% White Sucker and Creek Chub	% Generalist Feeders	% Insectivores	% Top Carnivores	% Anomolies	Density (#/100m ²)
09/25/2002	25 - poor	7	1	2	55	59.	41	0	0.0	27.5
10/01/2004	27 - fair	8	1	3	32	36	64	0	4.0	12.9

1. MWIBI Range: 9-25 (Poor), 27-29 (Fair), 33-35 (Good), 37 (Very Good), 41-45 (Excellent)

Table 3. Macroinvertebrate Community Metric data from sampling sites from Moon Brook 1991-2001.

Site (RM)	Date	Density	Richness	EPT	PMA-O1	BI (0-10)	Oligochaeta%	Ept/ Ept&Chiro	PPCS-F1	Community Assessment
0.3	9/12/1991	357	28.00	3.50	57.4	5.75	1.1	0.58	0.71	Poor
	10/6/1993	214	26.00	4.50	30.9	5.60	32.6	0.11	0.48	Poor
	9/20/1994	743	44.50	11.00	41.0	5.04	2.2	0.25	0.65	F-Poor
	9/25/1996	1247	42.00	9.50	44.6	4.99	4.2	0.31	0.77	F-Poor
	10/4/2001	716	31.50	9.00	61.2	5.38	2.5	0.81	0.64	F-Poor
	10/06/2004	1460	27.0	5.0	55.0	5.42	5.5	0.78	0.79	Poor
0.9	9/12/1991	550	35.00	5.00	43.0	6.00	6.2	0.30	0.48	Poor
1.5	10/4/2001	3552	48.00	19.00	62.0	4.84	0.3	0.79	0.66	G-VGood
	10/6/2004	2608	37.0	10.0	62.8	4.68	0.5	0.77	0.63	Fair
2.8	9/28/2005	757	22.0	3.0	57.0	5.58	0.0	0.60	0.55	Poor
2.9	9/12/1991	3150	24.00	2.00	49.8	6.44	0.0	0.74	0.24	Poor
3.2	10/4/2001	969	40.00	21.00	70.2	3.05	3.1	0.91	0.71	Ex-Vgood
3.3	9/12/1991	902	49.50	19.50	64.8	3.29	1.1	0.62	0.66	Vg-Good
	10/4/2001	691	38.50	16.50	57.2	2.14	1.3	0.90	0.46	Good

Table 4. Percent composition of the major orders and functional feeding groups of the macroinvertebrate community from Moon Brook sites.

Site (RM)	Date	Coleoptera	Diptera	Ephemeroptera	Plecoptera	Trichoptera	Oligochaeta	Other	Gatherer	Filterer	Pred	ShrdDetrit	ShrdHerb	Scraper
0.3	9/12/1991	24.2	38.3	0.2	0.2	32.1	1.1	3.9	20.5	36.0	2.8	10.9	4.4	25.4
	10/6/1993	18.6	36.8	0.5	0.0	3.3	32.6	8.1	37.2	4.6	15.9	5.4	10.8	25.6
	9/20/1994	14.9	64.8	3.2	0.2	10.6	2.2	4.0	22.6	32.3	3.4	5.6	16.7	19.1
	9/25/1996	18.1	53.2	4.5	1.5	11.6	4.2	6.9	33.9	25.2	7.6	2.4	3.3	25.8
	10/4/2001	20.6	20.8	2.4	0.8	50.8	2.5	2.1	12.8	51.1	9.7	1.1	1.5	23.0
	10/6/2004	7.7	30.4	0.0	1.4	50.1	5.5	4.9	16.7	56.7	7.7	1.9	5.2	
0.9	9/12/1991	6.9	56.4	0.9	0.0	20.2	6.2	9.3	45.2	20.9	11.8	5.0	9.3	6.9
1.5	10/4/2001	25.0	22.1	2.6	1.8	46.1	0.3	2.1	14.4	43.5	8.9	0.3	3.5	27.1
	10/6/2004	9.2	42.9	0.2	10.4	35.1	0.5	1.7	24.7	41.3	7.2	0.5	15.2	11.0
2.9	9/12/1991	2.3	28.0	0.0	0.0	68.9	0.0	0.8	17.9	71.4	3.1	0.8	4.6	2.3
3.2	10/4/2001	20.1	10.5	4.6	18.3	43.0	3.1	0.3	9.9	27.6	22.6	16.7	0.9	20.4
3.3	9/12/1991	29.1	31.8	14.5	4.3	18.0	1.1	1.2	30.2	14.5	12.9	4.3	1.2	30.2
	10/4/2001	40.3	9.9	4.1	6.2	36.7	1.3	1.6	8.1	17.8	25.1	4.6	0.2	41.1

Table 5. Physical Chemical measures and habitat observations taken at time of macroinvertebrate sampling from Moon Brook sites 1991-2004.

* Pebble Ct method used for % composition estimates starting in 2004.

Site (RM)	Date	% Boulder	% Cobble	% C.Gravel	% Gravel	% Sand	Silt rating 0-5	% Embeddedness	% Canopy	% Filamentous	% Bl.Gr.	% Moss
0.3	9/12/1991	10	50	20	10	10	0	25-50	80	0	100	0
	10/6/1993	15	40	20	15	10	3	0-5	80	0	50	0
	9/20/1994	15	50	15	15	15	3	25-50	90	0	50	0
	9/25/1996	30	50	10	5	5	3	5-25	80	0	0	5
	10/4/2001	10	56	15	9	9	3	25-50	70	30	25	30
	10/6/2004*	9	73	11	5	2	3	25-50	70	2	0	2
0.9	9/12/1991	0	40	15	15	15	0	50-75	80	100	0	0
1.5	10/4/2001	1	20	40	30	10	3	5-25	50	30	30	5
	10/6/2004*	2	31	50	15	2	2	25-50	40	20	0	0
2.8	9/12/1991	10	60	10	10	10	0	25-50	20	0	50	0
3.2	10/4/2001	5	25	40	20	10	2	50-75	50	35		
3.3	9/12/1991	25	20	15	15	25	0	>75	100	0	0	10
	10/4/2001	10	40	25	20	15	2	>75	100	0	0	1

Table 6. Temperature and Chemical measures taken at time of macroinvertebrate sampling from Moon Brook sites 1991-2004.

Site (RM)	Date	Time	Temp ° C	pH st.u.	Alk mg/l	Cond uohms	Cl mg/l	Na mg/l	Fe ug/l	Mn ug/l	TN mg/l	TP ug/l	DP ug/l
0.3	9/12/1991	0945	11.5	8.01	135	518							
	10/6/1993	0900	6.5	7.77	110	463							
	9/20/1994	1400	12.5	7.98	134	522							
	9/25/1996		10.5	7.76	125	501							
	10/4/2001	0800	12	7.86	171	673							
	10/6/2004	1517	9.3	7.89	139	641	108	63.1	309.0	25.3	0.53	10	11
0.9	9/12/1991	0920	11	8.06	128	518							
1.5	10/4/2001	0930	12	8.11	143	638							
	10/6/2004	1423	10.2	8.27	135.0	691	127	74.1	71.2	29.0	0.69	12	6
2.9	9/12/1991	0835	17	8.01	107	400							
3.2	10/4/2001	1030	12	8.31	136	538							
3.3	9/12/1991	0745	8.5	8.31	110	437							
	10/4/2001	1045	12	8.31	136	538							