WATER QUALITY MONITORING
SOUTH BRANCH RARITAN RIVER
TEWKSBURY TOWNSHIP, HUNTERDON COUNTY

Prepared for the Tewksbury Township Environmental Commission
Under a Grant From
The New Jersey Department of Environmental Protection
Office of Environmental Service
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93-074

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Project Title:

Water Quality Monitoring: South Branch Raritan River

Purpose:

To assess water quality in the South Branch Raritan River and a selected tributary within Tewksbury Township's (Hunterdon County's) boundaries, utilizing macroinvertebrates to develop an index of biotic integrity. This is part of a watershed-wide monitoring effort aimed at establishing baseline parameters which can be used to "red flag" existing, as well as future areas of degradation. In addition, as part of this study, existing land-use and possible sources of degradation (Point and non-point source pollution) will be identified and mapped.

Introduction:

The Tewksbury Township, (Hunterdon County) study, funded by an N.J.D.E.P., Office of Environmental Service (O.E.S.) grant, is being conducted as part of a watershed-wide water quality monitoring program sponsored by the South Branch Watershed Association. A copy of the action plan for this program entitled, "South Branch Raritan River Monitoring Quality Control/Quality Assurance Plan, 1994, (QC/QA Plan)" is contained in the Supplement found in the Appendix.

In addition to sampling the benthic macroinvertebrate community at two selected sites, the Tewksbury Township Environmental Commission also conducted a pilot landuse inventory to identify and subsequently map potential pollution impacts affecting that portion of the South Branch within the township's borders, and Frog Hollow Brook, the only township tributary.

Methods:

In addition to the "Training Program" outlined in the QC/QA Plan, which provided "hands-on" instruction regarding sampling protocol (Protocol I, EPA Manual) followed by an insect identification workshop, a separate mapping workshop relative to conducting land use surveys and identification of potential sources of pollution was conducted for members of the Tewksbury Township Environmental Commission. This training included interpretation and use of aerial quad maps, a standardized listing of potential impacts, and a guided stream walk conducted by the Field Supervisor (Robert W. Stewart, Retired Principal Fisheries Biologist, N.J. Division of Fish, Game and Wildlife) to point out actual potential sources of pollution.

During the period of June 18 through July 5, 1994, sampling of the benthic macroinvertebrate community was conducted at nine sites in the main stem of the South Branch of the Raritan River and in two of its tributaries (See Figure I for location of these sampling sites). The purpose of this sampling was two-fold in nature; the primary objective was to establish baseline data on the indigenous benthic macroinvertebrate community, while at the same time to train a team of select volunteers in the methodology and application of Protocol I as outlined in the EPA Manual. To achieve these objectives, as well as to maintain Quality Control/Quality Assurance (QC/QA) the services of a qualified professional were obtained ("Field Supervisor*' Robert W. Stewart, retired Principal Fisheries Biologist, New Jersey Division of Fish, Game and Wildlife). The Field Supervisor completed the 'Physical Characterization/Water Quality Field Data" Sheet (Appendix Figure I); "Habitat Assessment Field Data" Sheet (Appendix Figure II); and determined the water velocity using the "Floating Body Technique" (Appendix Figure III), and then collected the baseline benthic macroinvertebrate samples. The procedure used at each site was to collect a single riffle-habitat benthic macroinvertebrate sample utilizing the travelling kick net method and covering a minimum distance of 30 feet for a duration of 5 minutes.' The only exception to this was in Frog Hollow Brook, where a two minute duration sample was collected. A separate team of volunteers (representing each of the participating municipalities) accompanied the "Field Supervisor" at each sampling site (except Packer's Island, Clinton Township), and under his supervision duplicated the aforementioned sampling procedure, with their sample being taken home for subsequent identification (order/family). The teams' results can then be compared with the identified baseline data, as a measure of their proficiency.

The sorted (removal of extraneous debris) baseline macroinvertebrate sample collected at each sampling site was placed in a one-quart mason jar containing 70% isopropyl alcohol, labelled and stored in a refrigerator at the SBWA office until taken to RMC Environmental Services, Inc. 3450 Schuykill Road, Spring City, Pennsylvania 19475 for subsequent identification to genus and species, as prescribed under Protocol III in the EPA Manual.

The identified benthic macroinvertebrate field data was then sent to the NJ Department of Environmental Protection, Division of Science and Research, Bureau of Water Monitoring, where they were subjected to New Jersey's Water Quality Screening Statistical Analysis.

On July 17 and July 19, 1994, members of the Tewksbury

Township Environmental Commission conducted stream walks along those portions of the main stem of the South Branch of the Raritan and Frog Hollow Brook within the township. Potential sources of pollution were listed on "Point Source Pollution Inventory Sheets" (Appendix Table IV through VI, respectively). This information was then plotted on the Land Use Map (Figure II).

Findings:

South Branch Below Vernoy Road Bridge, Tewksbury Township

Physical Characterization/Water Quality Field Data (Appendix Figure I)

Analysis indicated the following:

The upstream riparian zone is primarily field and pasture with some single family residential development (Figure II). Local watershed erosion was considered to be moderate. The potential for NPS pollution is present but no direct evidence was observed at this site.

The estimated river width at the study site is 55 feet with an average riffle depth of 10 inches. Water velocity was calculated at 1.87 feet/second and the canopy cover is "partly open."

Sediment/substrate examination revealed no evidence of pollution other than some sand/silt deposition. The inorganic substrate components consisted of 10% boulder, 40% cobble, 30% gravel, 15% sand, and less than 1% silt.

The organic substrate compounds consisted of approximately 5% detritus.

Water temperature was 70 degrees Fahrenheit and this portion of the South Branch is classified as "Trout Maintenance" by the State (N.J.D.E.P.).

No evidence of any identifiable source of water pollution was observed.

Habitat Assessment Field Data (Appendix Figure II) analysis provided a score of 100 (Table III) which is 83% of the control, indicating that habitat is "Adequate." The NJIS score of 30 (Table I) indicates that water quality is "Non-Impaired."

Frog Hollow Brook, Tewksbury Township

Physical Characterization/Water Quality Field Data (Appendix Figure I):

Analysis indicated the following:

The entire upstream watershed of this relatively small brook consists primarily of forest land interspersed with single family residential development (having wells and septic systems) which in a few cases are encroaching on the headwater wetlands (springs). In addition, there is a horse farm containing a paddock, which extends acros the brook. Frog Hollow Road parallels the brook throughout its entire watershed, with all of the stormwater drainage being discharged into the brook. These are considered to be "Obvious Sources" of NPS pollution (Figure II).

The estimated width of the brook is 11 feet with an average riffle depth of 3 inches. The canopy cover is "Shaded."

Sediment/substrate examination revealed no evidence of pollution other than the deposition of sand and silt. The inorganic substrate components consisted of 15% boulder, 14% cobble, 30% gravel, 24% sand, and 10% silt.

The organic substrate components consisted of 5% detritus.

Water temperature was 68 degrees Fahrenheit, and this site is clasified by the State (N.J.D.E.P.) as "Trout Production" waters. No evidence of any identifiable source of water pollution was observed at this site.

Habitat Assessment Field Data (Appendix Figure II) analysis provided a score of 99 (Table III) which is 82% of the control, indicating that the habitat is "Adequate." The NJIS score of 30 (Table II) indicates that water quality is "Non-Impaired."

Figure II portrays current land use patterns in Tewksbury Township (South Branch Raritan Drainage) with potential sources of water pollution identified. The major potential source of pollution in this section of the South Branch is from storm water drainage containing sediments and possible contaminants (oils, grease, fertilizer, etc.) originating from the adjacent Vernoy Road, cultivated fields and the town of Vernoy). In addition, stabilizing vegetation along portions of the riverbank has been destroyed by fishermen gaining access to the river. During flood flows these denuded areas are being eroded, thus producing sediment loading in the downstream watershed.

As in the South Branch, the major source of contamination in Frog Hollow Brook is from stormwater drainage. Frog Hollow Road parallels the brook throughout its entire length and stormwater run-off from the road is discharged into the brook through a system of drainage pipes. The brook's entire watershed is contained within a natural gorge draining a portion of Fox Hill Mountain (elevation 1035'). Consequently, all stormwater drainage falling within the basin rapidly drains toward the brook and subsequently into the South Branch. Under these conditions, any development (roadways, homes, farms, logging, etc.) can have a direct impact on water quality in Frog Hollow Brook.

Discussion:

Water quality in the South Branch Raritan above and through Tewksbury Township, including Frog Hollow Brook, is currently excellent, based upon the benthic macroinvertebrate community (Tables I and II, respectively). However, this does not mean there is no reason for concern. Erosion of the banks of the South Branch and Frog Hollow Brook resulting from floodwaters is increasing. This was visually observed during the Habitat Assessment Evaluation (Table III).

Development (housing, commercial, business, etc.) in Mount Olive and Washington Townships is currently proceeding at a rapid pace. Construction of single family homes in Washington Township in the very headwaters of Frog Hollow Brook is currently in progress with actual encroachment upon riparian wetlands being observed. This development resulting in the replacement of vegetative cover with impervious cover is producing less ground water infiltration and increasing surface run-off. Even with detention basins, the net result is rainfall being discharged via surface run-off rather than being stored in the ground water table. This results in increased run-off during storm events, followed by reduced flows during periods of drought. Needless to say, this has an adverse impact on both habitat as well as water quality in

nearby streams.

Fish population data was collected by the N.J. Division of Fish, Game and Wildlife, Bureau of Freshwater Fisheries Lab in 1970 and again in 1994. Although still showing that Frog Hollow Brook supports a reproducing trout population (Rainbow Trout), the data indicates that the native Eastern Brook Trout population may have been eliminated. Brook Trout are more intolerant to changes in water quality (particularly temperature and sediment loading) than Rainbow Trout. The presence of warm water species (Largemouth Bass and Bluegill Sunfish) during the 1994 sampling further substantiates the probability of higher summer water temperatures occurring in the brook. The most probable cause is a reduction in ground water discharge (ground water temperature is generally about 55 degrees Fahrenheit) in conjunction with a corresponding increase in surface run-off (surface run-off generally mimics the air temperature) during this critical period.

Recommendations:

1 Any further encroachment on the riparian stream corridor of Frog Hollow Brook must be avoided. This can best be achieved by creating a "Greenbelt" (Minimum target width of 25 feet on either side of center line of brook), similar to that developed by West Windsor Township, Mercer County (See Bibliography in Appendix), along its entire length (at the very least within the township's boundaries). This is still possible due to the fact that the existing topography has prevented development for the most part. In those areas currently developed (entrance roads and farms), the landowners shoud be asked to participate by providing conservation easements.

2 Upland landowners should be contacted and informed of the advantages of becoming a partner in New Jersey's "Forest Stewardship Program" (See Bibliography in Appendix). Properly managed forests will enhance water quality in nearby streams.

3 Any construction in the Frog Hollow Brook watershed, requiring a stormwater management plan, should be required to provide facilities designed to enhance groundwater discharge.

For example, construct "Retention Basins" planted with hydrophytic vegetation to create a wetland environment, rather than simple "Detention Basins" which only hold water for a short period prior to releasing to the downstream watershed. In the case of single-family landowner construction, provisions for on-site stormwater retention

such as berms, vegetative buffers, etc., should be mandated through local ordinances.

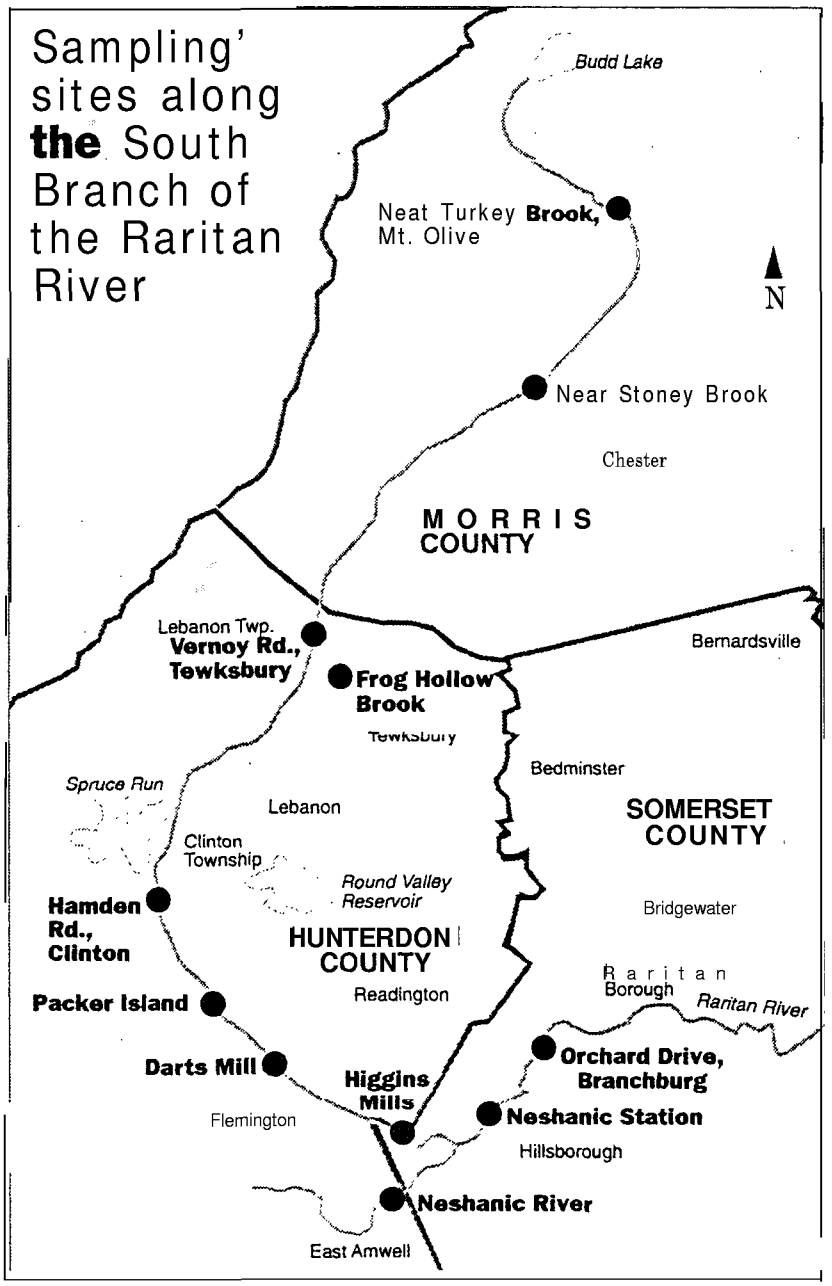
4. Since Tewksbury Township cannot control activities in upstream municipalities, efforts in the South Branch must be directed toward stabilizing eroding banks along that portion of the river within the township's borders. This can best be accomplished by working in cooperation with the Ken Lockwood Gorge Chapter of "Trout Unlimited" which has already initiated this type of program in cooperation with the U.S. Soil Conservation Service.

5. Continued participation in the South Branch Watershed Association's Water Quality Monitoring Program is essential in order to achieve an integrated basin-wide network of trained Water Stewards to promote the conservation of water quality in the South Branch of the Raritan Watershed.

References Cited:

United States Environmental Protection Agency (EPA) "Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish," EPA/440/4-89/001, 1989.

FIGURE I: GIS MAP Showing Sampling Locations



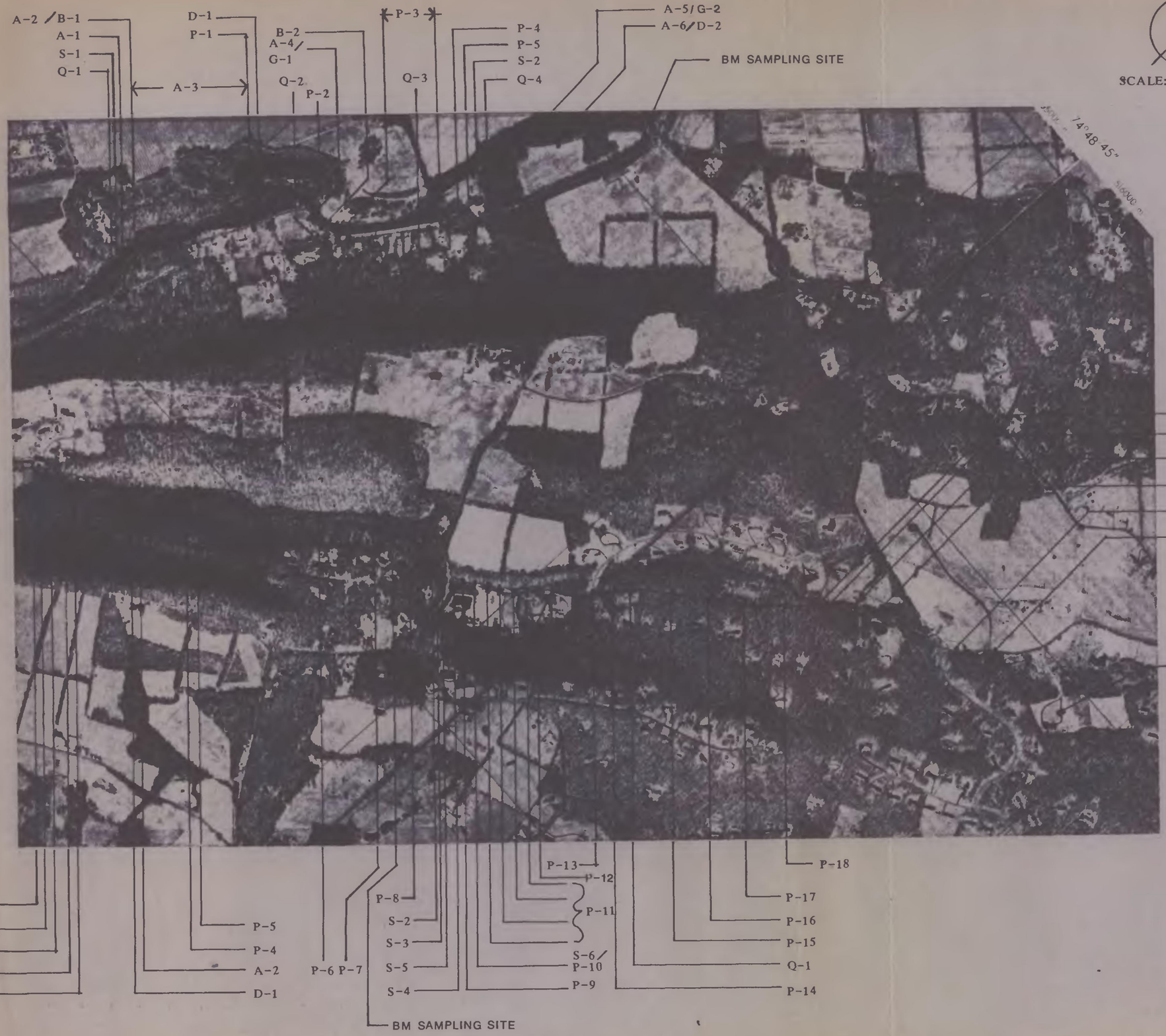
Source: South Branch Watershed Association C-N map by Mike Scott and Andre Malok

FIGURE II: Land Use Map of Tewksbury Township
(South Branch Raritan Drainage)
Showing Potential Sources of Water Pollution

LAND USE MAP OF TEWKSBURY TOWNSHIP

(S. BRANCH RARITAN RIVER DRAINAGE)
SHOWING POTENTIAL SOURCES OF WATER POLLUTION

SCALE: 1"=1000'



SOUTH BRANCH RARITAN LEGEND

A (1-6)	Access areas - cars, people, animals
B (1-2)	Eroding Banks
C (-)	Active Construction
D (1-2)	Dams
E (-)	Eroding tributaries or drainage ditches that are entering the waterway
G (1-2)	Garbage dump areas
M (-)	Manure storage areas
P (1-5)	Pipes
R (-)	Rip-Rap, Stone baskets, concrete walls
S (1-2)	Manmade structures (Boat ramp, foot bridge)
T (-)	Failing Septic Tanks
W (-)	Waterbody - pond
Q (1-4)	Utility Crossing

FROG HOLLOW BROOK LEGEND

A (1-3)	Access areas - cars, people, animals
B (-)	Eroding Banks
C (1)	Active Construction
D (1)	Dams
E (-)	Eroding tributaries or drainage ditches that are entering the waterway
G (1)	Garbage dump areas
M (-)	Manure storage areas
P (1-20)	Pipes
R (-)	Rip-Rap, Stone baskets, concrete walls
S (1-8)	Manmade structures (Boat ramp, foot bridge)
T (-)	Failing Septic Tanks
W (1-2)	Waterbody - pond
Q (1)	Utility Crossing

INVENTORY PREPARED BY: MARY M. ACE
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SOUTH BRANCH WATERSHED ASSOCIATION, INC.

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TEWKSBURY TOWNSHIP ENVIRONMENTAL COMMISSION

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TABLE I

SOUTH BRANCH RARITAN RIVER
ONE-EIGHTH OF A MILE BELOW VERNOY ROAD BRIDGE, TEWKSBURY TWP.

FAMILY	FTV	NO- IND.
Chironomidae	6	17
Elmidae	4	20
Hydropsychidae	4	15
Ephemerellidae	1	24
Gammaridae	4	2
Caenidae	7	10
Psephenidae	4	2
Lumbricidae	10	1
Tricorythidae	4	3
Baetidae	4	2
Perlidae	1	5

Taxa: 11 Population: 100

Dominant Family(s)	%CDF
Ephemerellidae	24.00

FBI: 3.86

Scraper/Filtering Collector Ratio: 0.08

Shredder/Total Ratio: 0.39

E+P+T: 6 : Ephemeroptera - 4 : Plecoptera - 1 : Trichoptera - 1

%EPT: 58.00 EPT/C: 3.41

NJIS Rating (30): Non-Impaired (See Appendix Table IV for Scoring Criteria)

TABLE II

SOUTH BRANCH RARITAN RIVER
FROG HOLLOW BROOK, TEWKSBURY TOWNSHIP

FAMILY	FTV	NO. IND.
Elmidae	4	14
Philopotamidae	3	6
Hydropsychidae	4	11
Limnephilidae	4	2
Ephemerellidae	1	31
Tipulidae	3	6
Chironomidae	6	11
Perlodidae	2	2
Leuctridae	0	8
Siphlonuridae	7	1
Glossosomatidae	0	1
Peltoperlidae	1	1
Leptophlebiidae	2	2
Psephenidae	4	2
Baetidae	4	2

Taxa: 15 Population: 100

Dominant Family(s)	%CDF
Ephemerellidae	31.00

FBI: 2.73

Scraper/Filtering Collector Ratio: 0.20

Shredder/Total Ratio: 0.44

E+P+T: 10 : Ephemeroptera - 4 : Plecoptera - 2 : Trichoptera - 4

%EPT: 66.00 EPT/C: 6.00

NJIS Rating (30): Non-Impaired

TABLE III

Comparison by Site of NJIS Rating versus Habitat Assessment Values

SAMPLING SITE	NJIS RATING	Habitat Assessment * Primary	** Secondary	*** Tertiary	Total	Proportion of Control
1. Mt. Olive Township	30	56	38	27	121	100%
2. Washington Township	30	52	36	23	111	92%
3. Tewksbury Township	30	39	34	27	100	83%
4. Clinton Township	21	36	17	22	75	62%
5. Readington/ Raritan Twp	30	32	30	24	86	71%
6. Raritan Township	30	40	21	21	82	68%
7. Readington Township	27	38	21	15	74	61%
8. Bridgewater Township	30	32	11	18	61	50%
9. Branchburg Township	30	38	22	18	78	65%
10. East Amwell Township Neshanic River	24	41	26	23	90	75%
11. Tewksbury Township Frog Hollow Brook	30	51	29	19	99	82%

NOTES ON TABLE III:

1) See Figure I for Location of Sites.

2) Mt. Olive Township Site (South Branch below confluence with Turkey Brook) was selected as Study Referance Site (Control).

Criteria: >90% Comparable to control
75-89% Adequate
60-73% Somewhat Limiting
<59% Limiting

TABLE III CONTINUED:

CONDITION/PARAMETER:

* **Primary** -- Substrate and **Instream** Cover
1. Bottom substrate and Available Cover
2. Embeddedness
3. Flow/Velocity

** **Secondary** -- Channel Morphology
4. Channel Alteration
5. Bottom Scouring and Deposition
6. Pool/riffle, Run/Bend Ratio

*** **Tertiary** -- Riparian and Bank Structure
7. Bank Stability
8. Bank Vegetation
9. Streamside Cover

APPENDIX

FIGURE I: Taken from the EPA Manual (E.P.A./440/4 - 89/001)

PHYSICAL CHARACTERIZATION/WATER QUALITY
FIELD DATA SHEET

PHYSICAL CHARACTERIZATION

RIPARIAN ZONE/INSTREAM FEATURES

Predominant Surrounding Land Use:

Forest Field/Pasture Agricultural Residential Commercial Industrial Other _____

Local Watershed Erosion: None Moderate Heavy

Local Watershed NPS Pollution: No evidence Some Potential Sources Obvious Sources

Estimated Stream Width _____ m Estimated Stream Depth: Riffle _____ m Run _____ m Pool _____ m

High Water Mark _____ m Velocity _____ Dam Present: Yes No Channelized: Yes No

Canopy Cover: Open Partly Open Partly Shaded Shaded

SEDIMENT/SUBSTRATE:

Sediment Odors: Normal Sewage Petroleum Chemical Anaerobic H2S Other _____

Sediment Oils: Absent Slight Moderate Profuse

Sediment Deposits: Sludge Sawdust Paper Fiber Sand Relict Shells Other _____

Are the undersides of stones which are not deeply embedded black? Yes No

Inorganic Substrate Components			Organic Substrate Components		
Substrate Type	Diameter	Percent Composition in Sampling Area	Substrate Type	Characteristic	Percent Composition in Sampling Area
Bedrock			Detritus	Sticks, Wood, Coarse Plant Materials (CPOM)	
Boulder	>256-mm (10 in.)				
Cobble	64-256-mm (2.5-10 in.)				
Gravel	2-64-mm (0.1-2.5 in.)		Muck-Mud	Black, Very Fine Organic (FPOM)	
Sand	0.06-2.00-mm (gritty)				
Silt	.004-.06-mm		Marl	Grey Shell Fragments	
Clay	<.004-mm (slick)				

WATER QUALITY

Temperature _____ C Dissolved Oxygen _____ pH _____ Conductivity _____ Other _____

Instrument(s) Used _____

Stream Type: Coldwater Warmwater

Water Odors: Normal Sewage Petroleum Chemical None Other _____

Water Surface Oils: Slick Sheen Globs Flecks None

Turbidity: Clear Slightly Turbid Turbid Opaque Water color _____

WEATHER CONDITIONS

PHOTOGRAPH NUMBER

OBSERVATIONS AND/OR SKETCH:

APPENDIX

Figure II: Taken from the EPA Manual (E.P.A./440/4 - 89/001)

HABITAT ASSESSMENT FIELD DATA SHEET

Habitat Parameter	Category			
	Excellent	Good	Fair	Poor
1. *Bottom substrate available cover[a]	Greater than 50% rubble, gravel, submerged logs, undercut banks, or other stable habitat. 16-20	30-50% rubble, gravel or other stable hrbitrt. Adequate hrbitrt. 11-15	10-30% rubble, gravel or other stable habitat. Habitat availability less than desirable. 6-10	Less than 10% rubble gravel or other stable habitat. Lack of habitatis obvlour. O-S
2. Embeddedness[b]	Gravel, cobble, and boulder particles are between 0 and 25% surrounded by fine sediment 16-20	Gravel, cobble, rnd boulder particlesare between 25 and SO % surrounded by fine sediment 11-15	Gravel, cobble, snd boulder particles are between 50 and 75% surrounded by fine sediment b-10	Gravel, cobblr, and boulder particles are over 75 % surrounded by fine sediment 0-5
3. ≤0.15 cms (5cfs) * Flow[a] at rep. low flow or >0.15 cms (5cfs) * Velocity/depth	Cold >0.05 cms (2 cfs) Warm >0.15 cms (5 cfs) 10-20 slow (<0.3 m/s), deep (>0.5 m); slow, shallow (<0.5 m); fast (>0.3 m/s), deep; fast, shallow habitats all present. 16-20	0.03-0.05 cms (I-2 cfs) 0.05-0.15 cms (2-5 cfs) 11-15 Only 3 of the 4 habitat categories present (missing riffles or run8 receive lower score thrn missing pools). 11-15	0.01-0.01 CBS (.5-1 cfs) 0.03-0.05 cas (1-2 cfs) i-10 Only 2 of the 4 habitat categories present (missing riffles/runs receive lower score). 6-10	<0.01 cms (.5 cfs) <0.03 cms (1 cfs) 0-5 Dominated by one velocity/depth category (usually pool). 0-5
4. • Channelalteration[a]	Little or no enlargement of islands or point bars, and/or no channelization. 12-15	Some new increase In bar formation, ● ortAy from coarse gravel; and/or some channelization present. 8-11	Moderate deposition of new gravel, coarse sand on old snd newbars; pools partially filled w/silt; and/or embankments on both banks. 4-t	Heavy deposits of fine ● rtorlal, increased bar development; most pools filled w/silt; and/or ● stmsAvr channelization. O-1
5. Bottom scouring and deposition[a]	Less tbrn 5% ofthe bottom affected by scouring and deposition. 12-15	5-30% affected. scour at conrtrictions and where grades steepen. Some deposition in pools. 8-11	30-50% affected. Deposits rnd scour at obstructions, constrictions and bends. Somefilling of pools. 4-7	More than 50% of the bottom changing nearly year long. Pools almost absent due to deposition. Only large rocks inriffle ● q-rod. 0-3

(a) From Bell 1912.
(b) From Platts it al. 1983.
Note: • = Habitat parameters not currently incorporated into BIOS.

FIGURE II (CONTINUED)

HABITAT ASSESSMENT FIELD DATA SHEET (cont.)

Habitat Parameter	Category: Excellent	Good	Fair	Poor
6. Pool/riffle, run/bond ratio[a] (distance between riffles divided by stream width)	S-7. Variety of habitat. Deep riffles and pools. 12-15	7-15. Adequate depth in pools rnd riffles. Bends provide habitat. 8-11	15-25. Occassional riffle or bond. Bottom contours provide some habitat. 4-7	>25. Essentially a straight stream. Generally all flat water or shallow riffle. Poor habitat. 0-3
7. Bank stability[a]	Stable. No ● vidonco of erosion or bank failure. Side slopes generally <30%. Little potential for future problem. 9-10	Moderately stable. Infrequent, small areas of ● rorlori mostly healed over. Side slopes up to 40% on one bank. Slight potential in ● xtfa8r floods. 6-6	Moderately unstable. Moderate frequency and size of ● roatonri areas. Side slopes up to 60% on some banks. High ● ro8fon potential during extreme high flow. 3-5	Unstable. Many eroded areas. Side slopes >60% common. "Raw" areas frequent along straight sections rnd bends. 0-2
8. Bank vegetative stability[b]	Over 80% of the streambank surfaces covered by vegetation or boulders and cobble. 9-10	50-79% of the streambank surfaces covered by vegetation, gravel or larger material. 6-8	25-49% of the stream-bank surfaces covered by vegetation, gravel, or larger ● rtorlrl. 3-5	Less than 25% of the streambank surfaces covered by vegetation, gravel, or larger ● aterial. 0-2
9. Streamside cover[b]	Dominant vegetation is shrub. 9-10	Dorinrnt vegetation is of tree form. 6-O	Dorinrnt vegetation is grass or forbes. 3-5	Over 50% of the stream-bank has no vegetation and dominant ● rterirl is soil, rock, bridge ● aterials, culverts, or ● inetailings. O-1
Column Totals	____	____	____	____

Score _____

APPENDIX

FIGURE **III:**

FLOATING BODY TECHNIQUE TO DETERMINE WATER FLOW VELOCITY

Taken from: **Water Quality Indicators Guide: Surface Waters**
United States Department of Agriculture,
Soil Conservation Service
Issued September, 1989
page **47**

The Floating Body Technique -measures water flow velocity, which is calculated by measuring the time taken for a marker to travel a known distance downstream.

Procedure: A stretch of watercourse should be selected which is approximately straight. The compass direction of this stretch should be measured. Using the compass direction, a 90 degree angle is laid out so it crosses the stream. This is most conveniently done by locating a landmark on the distant side of the stream, and moving up or downstream to locate (and mark) the point at which a 90 degree angle exists. A distance should then be measured downstream to the other end of the straight stretch, and a similar 90 degree angle laid out. The marker or dye is tossed into the stream above the initial point and then timed to see how long it takes to get from one point to the other. If dye is used, the time is measured until the front part of the dye stain arrives. **Velocity is calculated as distance divided by time.**

When the velocity-measured is the peak velocity of the stream (usually at the surface in the center), it is possible to calculate an approximate average for velocity for the stream, assuming typical cross section. A common average is **85%** of the maximum current velocity.

Accuracy: This technique can be moderately accurate. The major sources of error are caused by the marker floating out of the desired path. If the maximum current velocity is desired, the marker may tend to end up in eddies along the **way,** rather than staying in the maximum velocity portion of the stream. This source of error can be reduced by making repeated measurements or by using dye as the marker. Calculations of average stream velocity from a measured maximum velocity are in error if the correction factor is inappropriate. Deviations from the **85%** factor mentioned above are common.

Application Notes: This technique is inexpensive. A crew size of one is suitable for slow moving streams, but **a** crew size of two is necessary to signal when the marker has passed the ending point if the stream moves too fast for one crew member to move from the starting point to the ending point'. It is most appropriate where streams are relatively large and have a smooth slope.

APPENDIX

TABLE I

CRITERIA FOR SCREENING WATER QUALITY IN NEW JERSEY STREAMS

Scoring Criteria for Rapid Bioassessments

	6	3	0
1. Taxa Richness (Total Families)	>10	10- 5	4-o
2. EPT Families	> 5	5- 3	2-o
3. Percent Dominance (%CDF)	<40	40-60	>60
4. Percent EPT (%CDF)	>35	35-10	<10
5. Hilsenhoff Biotic Index (FBI)	o-4	4-6	6-10

Biological Condition	Total Score
Non-Impaired	24 - 30
Moderately Impaired	9 - 21
Severely Impaired	0 - 6

Attributes

Non-Impaired: Benthic community comparable to other undisturbed streams within the region. A community characterized by a maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals.

Moderately-Impaired: Macroinvertebrate richness is reduced, in particular EPT taxa. Taxa composition changes result in reduced community balance and intolerant taxa become absent.

Severely Impaired: A dramatic change in the benthic community has occurred. Macroinvertebrates are dominated by a few taxa which are very abundant. Tolerant taxa are the only individuals present.

Based on 100 organism subsamples
Including the hydropsychid family

APPENDIX

TABLE II

DIVISION OF FISH GAME AND SHELLFISHERIES

Electrofishing Data

Stream: Frog Hollow Brook Drainage: Raritan Date: 8/13/70

Length of Stretch: 600' Mean Width: 3'-5' Mean Depth 1'

Temperature: 66 F Dissolved Oxygen: _____ pH: _____

Type of Bottom: Rock and Gravel (Moderate Gradient)

Location: Beavers Road Bridge -- North of Califon

Township: Tewksbury County: Hunterdon

Fish Collected

Species	Number	Weight
Brook Trout	1	0.1
Brook Trout "0"	4	0.1
Rainbow Trout	2	0.2
Rainbow Trout "0"	32	0.2
Blacknose dace	25	0.1

REMARKS: Trout Production

*Courtesy of N.J.D.E.P. Division of Fish, Game & Wildlife, Bureau of Freshwater Fisheries Lab, PO Box 394, Lebanon, NJ 08833

APPENDIX

TABLE III

DIVISION OF FISH GAME AND SHELLFISHERIES

Electrofishing Data

Stream: Frog Hollow **Brook** Drainage: Raritan Date: 8/17/94

Length of Stretch: 300' Mean Width: 3'-5' Mean Depth 1'

Temperature: **66** F Dissolved Oxygen: _____ PH: _____

Type of Bottom: Rock and Gravel

Location: Beavers Road Bridge -- North of Califon

Township: Tewksbury County: Hunterdon

Fish Collected

Species	Number	Weight
Rainbow Trout "yoy"	**17**	
Rainbow Trout -- Inter	1	
Blacknose **Dace**	**13**	
Largemouth Bass	1	
Bluegill Sunfish	**5**	

REMARKS: _____

*Courtesy of N.J.D.E.P. Division of Fish, Game & Wildlife, Bureau of Freshwater Fisheries Lab, PO Box **394**, **Lebanon**, NJ 08833

APPENDIX

TABLE IV: Frog Hollow Brook from Township Border with Borough of Califon Upstream to Intersection of Frog Hollow Road and Beaver's Road

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
	Beginning at	Califon/Tewksbury Twp. Line
S-1	Left	Bridge over Indian Lane -- 4" Pipe in Concrete Structure discharges into Frog Hollow
P-1	Left	Culvert -- Pipe under Frog Hollow discharges down bank into Frog Hollow
P-2	Left	.1 mile from Township Line
P-3	Left	.2 mile from Township Line
A-1	Left	Access to Creek near P-3
A-2	Left	Near Old Road off Frog Hollow (Opposite side from creek side of Frog Hollow)
D-1	Left	.4 mile from Township Line 'Natural Dam" in Stream, situation created by fallen trees, natural debris collected
P-4	Left	.5 mile from Township Line
P-5	Left	.5 mile from Township LIne Near old road into woods on side of Frog Hollow opposite creek
P-6	Left	.6 mile from Township Line
P-7	Left	.7 mile from Township Line

(CONTINUED)

APPENDIX

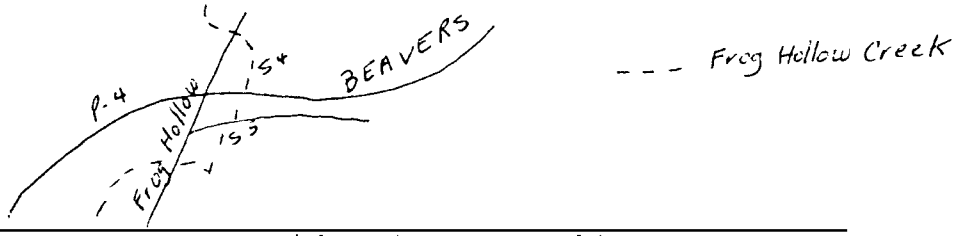
TABLE IV: (CONTINUED): Frog Hollow Brook from Township Border with Borough of Califon Upstream to Intersection of Frog Hollow Road and Beaver's Road

Township: Tewksbury **Stream Name:** Frogl l o w **Date:** 7/19/94

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
P-8	Left	.8 mile from Township Line Pipe under road
s-2	Left	8 mile from Township Line -- Private residential wooden bridge crosses stream to access property
s-3	Right	Stone Arch Bridge over Frog Hollow Creek crosses road here

Frog Hollow/Beavers Road Intersection



s-4	Right	Bridge (Stone Arch) over Frog Hollow Creek at Beavers Rd./Frog Hollow Rd. intersection. Bridge is on Beavers Road
s-5	Right	Small stone structure built by S-4 (above) drains off Beavers Road into Frog Hollow Creek

APPENDIX

TABLE V: **Frog Hollow Brook from** Intersection of Frog Hollow Road and Beavers Road upstream to Washington Township Border

Township: Tewksbury **Stream:** Frog Hollow Creek **Date:** 7/17/94

POINT SOURCE POLLUTION INVENTORY SHEET

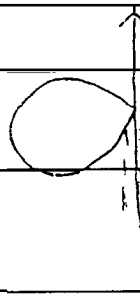
Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
		Begin just beyond intersection of Beavers/Frog Hollow (Going toward Washington Township)
P-9		At intersection Frog Hollow/Beavers -- Storm Drain
S-6		Frog Hollow Creek crosses under Frog Hollow Road
P-10	Right	Llama Farm -- Pasture Drain discharges into creek, some erosion
P-11		Storm Drain
P-12		Storm Drain
P-13		At Bridge Hollow/Frog Hollow Road intersection storm drains (no bridge) drain under road
P-14		Storm Drain
Q-1		Getty Pipe -- WMS Telecommunications -- .4 mile from Beavers/Frog Hollow intersection
P-15 P-16 P-17 P-18		Four Storm Drains along straight flat stretch of Frog Hollow Road connected by one pipe discharges into creek
s-7		Private wooden bridge

APPENDIX

TABLE V: **(CONTINUED): Frog Hollow Brook from** Intersection of Frog Hollow Road and Beavers Road upstream to Washington Township Border

Township: Tewksbury Stream: Frog Hollow Creek **Date:** 7/17/94

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
A-3	Right at S-7 Bridge	Access -- farm animals, horses
P-19		By country lane (private road)
W-1		Private pond interrupts Frog Hollow Creek
S-8		Small stone bridge just above Summer Lane Creek crosses back under road
P-20		Storm Drains at entrance to the Meadows and pipe under road at Meadows sign. At this location, wet along stream on south side.
C-1		Home under construction Block Lot 37, between Frog Hollow and construction, it appears to be wet.

APPENDIX

TABLE VI: South Branch Raritan from Township Border with Borough of Califon upstream to Washington Township Border

Township: Tewksbury **Stream:** South Branch **Date:** 7/17/94

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
Q-1	Left	Notation only -- no stream impact. Gas line -- Big Fink Test Station. South side of Vernoy Road .1 mile from Califon/Tewksbury Line
S-1	Left (pipe flowing when surveyed)	Small stone bridge over a tributary flowing into South Branch (Drain Pipe)
A-1	Left	Trout Unlimited Sign -- Well-used path .2 mi. from Township Line
A-2	Left (Same Location)	Access to Stream - "Fishing Bank"
B-1		Eroding Banks -- appears to be well-used, .3 mil. from Township Line
A-3	Left	Lawns mowed close to stream. Series of small lots close to water begins at .4 mi. from Tewksbury Twp. Line
P-1	Left	Drains into South Branch
D-1		Stones piled in stream form small dam .4 mi. from Township Line
P-2	Left	Drains into South Branch

(CONTINUED)

APPENDIX

TABLE VI: (CONTINUED):
South Branch Raritan from Township Border with Borough of Califon upstream to Washington Township Border

Township: Tewksbury **Stream:** South Branch **Date:** 7/17/94

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
A-4		S. Branch fishing access New Jersey Conservation Association 6 mi. from Tewksbury Twp. Line
G-1		Garbage Can -- Public Use -- Overflowing. Potential for garbage to enter stream here.
Q-2		Columbia Gas Line on old railroad bed .7 mi. from Township Line
B-2	Left	Across from Tree Farm
P-3	Left	Series of Storm Drains -- connected
Q-3	Left	Located where railroad bed leaves road on creek side of road .9 mi. from Califon/Tewksbury Line.
P-4	Left	Both pipes drain into South Branch. Very close to Q-3.
P-5	Left	(See note for P-4)
s-2	Left (Pipe flowing when surveyed)	Stone Bridge over road at curve. Tributary into S. Branch 1 mile from Township Line.
A-5	Left	Access with trash barrel

(CONTINUED)

APPENDIX

TABLE VI: (CONTINUED)
South Branch Raritan from Township Border with Borough of Califon upstream to Washington Township Border

Township: Tewksbury **Stream:** South Branch **Date:** 7/17/94

POINT SOURCE POLLUTION INVENTORY SHEET

Map #	Location R or L Bank Going Downstream	Description of Point Pollution & Comments
Q-4	Left	#35 petroleum pipe appears to cross stream here. WMS Telecommunication Co. High fiber optic burial here at 1.05 mi. from Township Line
G-2	Left	Garbage has potential for entering stream here. Public access to overflowing garbage can.
D-2	Left	(Partial stone dam in stream)
A-6	Left	Point where water sample taken 1.3 mi. from Tewksbury/Califon Line.

SUPPLEMENT

SOUTH BRANCH RARITAN RIVER WATER MONITORING QUALITY CONTROL QUALITY ASSURANCE PLAN

1994

Mission Statement: To promote the conservation of water quality in the South Branch of the Raritan Watershed.

Objective: To obtain baseline benthic macroinvertebrate data to be used as an indicator of water quality in the South Branch Raritan River using a core group of volunteers.

Objective: To fully train volunteers in the methodology and application of E.P.A.'s Rapid Bioassessment Protocol I.

Objective: To make sure the program is unified, consistent, and replicable so that meaningful data can be collected.

Introduction: The South Branch Watershed Association (SBWA) first initiated the idea of utilizing trained volunteers to monitor water quality on a watershed-wide basis in 1992. The Ken Lockwood Chapter of "Trout Unlimited", a local sportsman's association, had previously initiated a monitoring program in 1991 at ten sampling sites along the main stem of the South Branch Raritan River, so the two groups decided to combine their efforts. The sampling procedure employed by this organization at each site was as outlined in E.P.A.'s manual (EPA/440/4-89/001) entitled "Rapid Bioassessment Protocols for Use in Streams and Rivers"; and specifically under Protocol III. Consequently, by expanding upon Trout Unlimited's efforts, it was anticipated that a basin-wide monitoring program could be developed,

Monitoring Advisory Committee: The initial effort was to establish a steering committee comprised of the following people: Marie Kneser, **S.B.W.A.;** Donna Drewes, **North Jersey Resource Conservation & Development Council;** Walter Schuerer (replaced by Robert Bennett in 1994), **Ken Lockwood Chapter of "Trout Unlimited";** John Beckley, **Hunterdon County Health Department;** and Robert W. Stewart, retired principal fisheries biologist, **N.J. Division of Fish, Game & Wildlife.**

Additional Technical Assistance was also provided by a large advisory board (Table I).

The steering committee's responsibility was to develop program goals and objectives, provide vision, and obtain the necessary technical assistance and resources as required.

Trained Volunteers - "Water Stewards": Environmental Commissions members from Mt. Olive, Washington, Tewksbury, Readington, Raritan, Alexandria, Branchburg, Delaware and East Amwell Townships, Ken Lockwood Chapter of Trout Unlimited's members, and interested citizens were involved through a broad solicitation effort. The river landowners in Hunterdon County and Morris County are invited to participate.

The Water Stewards will be split into teams of three to help guarantee that someone will be available to monitor on the specific monitoring dates.

All of the Water Stewards will be trained in a consistent manner to insure that the assessments are conducted properly and to insure standardization. The field data sheets will be filled out as completely and as accurately as possible to support analysis conclusions. All deviations from the recorded procedures will be noted by the Water Stewards.

Sites and their Selection: The sampling locations were carefully selected to ensure that the habitat at each station was comparable and were verified in the field. The Committee which selected the monitoring sites was composed of Robert Stewart, Jim Kurtenbach, Marie Kneser, and Walter Scheuerer. (see Figure I for Sampling Site locations.

The stations with the greatest habitat constraints will be noted in the final report. A "site-specific" control is generally thought to be most representative of "best attainable" conditions for a particular waterbody. The control area for the South Branch Raritan River is near the headwaters of the River.

The biotic assemblages of a stream are dependent on that stream's ecosystem. The United States is divided into 76 ecoregions as classified by Omerric (1987). The South Branch lies within the Northern Piedmont Region. The ecoregions represent different geographic patterns which in studies by (Larsen, et al., 1986), Arkansas, (Rohm, et al., 1987), and Oregon (Hughes, et al., 1987; Whittier, et al., 1988), have shown that similar biotic communities are present throughout a given ecoregion.

Training Program: (For a further explanation of procedures for collecting the samples See Collection of Samples section). Trainers from the Department of Environmental Protection & Energy, U.S. Environmental Protection Agency, RMC Environmental Services and the Ken Lockwood Chapter of Trout Unlimited met prior to the training workshops to make sure the procedures they will be teaching are consistent.

Each trainer works one-on-one with each Water Steward to confirm his/her ability to collect the samples consistently as well as to insure consistency with regard to habitat assessment sheets, site identification names, and labelling procedures. The introductory training workshop emphasized the application and use of Protocol I, outlined in the U.S. Environmental Protection Agency's manual (E.P.A./440/4-89/001) entitled, "Rapid Bioassessment protocols for Use in Streams and Rivers." Retraining workshops will be provided on an annual basis just prior to the water quality sampling days.

Baseline Data: The parameters which will be recorded will be the indigenous benthic macroinvertebrate community by the laboratory, and the prior and present weather conditions, and water temperature. A habitat assessment will be done by the Water Stewards. The habitat assessment and characterization is important for the proper interpretation of the collected samples.

The steering committee, after reviewing all of the "Protocols" described in the E.P.A. manual, decided that Protocol I (with laboratory identification being made to the level of Protocol III) was best suited for use in this volunteer monitoring program.

E.P.A.'s sampling Protocol I, which utilizes the benthic macroinvertebrate community as an indicator of water quality was selected because:

1 Benthic macroinvertebrates are good indicators of localized conditions because of their limited migration patterns or sessile mode of life; they are particularly well suited for assessing site specific impacts (upstream-downstream studies).

2 Macroinvertebrate communities integrate the effects of short-term environmental variations. (Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.)

3. Degraded conditions can often be detected by a "trained volunteer" with only a cursory examination of the macroinvertebrate community. (Macroinvertebrates are relatively easy to identify to family or order; with further identification to species and functional feeding group being performed by a private laboratory.)

4. Benthic macroinvertebrates are abundant in most streams.

5. New Jersey's Department of Environmental Protection

& Energy (D.E.P.E.), Water Quality Monitoring Element, currently utilizes benthic macroinvertebrate sampling in their statewide monitoring efforts, as does the E.P.A.

6 "Kick net samples are used in the Rapid Bioassessment Protocols (RBPs) because they have been shown to provide good statistical replication (Pollard 1981)." EPA Manual. The kick net technique is not suitable for streams that lack cobble substrate.

Equipment: All nets being used have a mesh size net of 900 microns. All the nets are uniform in size and shape. The samples from each site are being stored in Mason Jars in 70% Isopropyl Alcohol (common rubbing alcohol). Other equipment includes: white tray, quart size mason jars, watch, floating item for water velocity procedure, compass, and a tape measure.

Procedures for Collection of Samples:

The samples will be collected June - August representing the typical summer flow. Samples will not be collected after a significant rain event. All field benthic macroinvertebrate sampling will be conducted utilizing the following procedures:

1 Once the stream sampling site has been selected (in cooperation with the SBWA Water Monitoring Steering Committee), the first step will be to complete the 'Physical Characterization/Water Quality" and "Habitat Assessment" field sheets. (These are Figures 5.1-1 and 5.2-1 respectively, outlined in the EPA's 'Rapid Bioassessment Protocols for Use in Streams and Rivers" Manual EPA/440/4-89/001, May, 1989)

Stream velocity will be estimated utilizing the "Floating Body Technique" (Water Quality Indicators Guide: Surface Waters, U. S. Department of Agriculture, Soil Conservation Service, Sept. 1989).

2 Collect one riffle-habitat benthic macroinvertebrate sample'at each sampling site utilizing the traveling kick net method. (Facing downstream, place net on a stream bottom perpendicular to the current and kick vigorously. Continue this procedure while moving slowly forward, **making sure that the net makes contact with the stream bottom.)** Sample a section of riffle approximately 30 feet for a duration of 5 minutes. *Duration is the critical factor in standardizing sampling efforts at each site.

3 Place the collected sample into a white sorting tray and carefully remove as much extraneous debris as possible.

Be sure to remove all attached macroinvertebrates prior to discarding debris (rinse thoroughly in collecting tray and check with field magnifying glass).

4. Fill Mason Jar with (70% Isopropyl Alcohol and place entire collected sample in it. The container is to be labelled and returned to the SBWA office as soon as possible. The SBWA will deliver the samples to the laboratory. The laboratory will keep the collected sample at the lab for future comparison if necessary.

A "Field Supervisor" selected by the committee (Robert W. Stewart, retired Principal Fisheries Biologist, New Jersey Division of Fish, Game and Wildlife) will oversee collection of field sampling data in order to ensure compliance with sampling protocols.

The Water Stewards will be trained how to accurately label their collected samples. All abbreviations for labelling have been standardized.

Identification of Macroinvertebrates: RMC Environmental Services will identify the collected specimens using the U.S. EPA protocol III. A copy of "Pollution Tolerance Classifications of Macroinvertebrates in New Jersey Streams by John M. Kurtz which is used by the laboratory can be obtained at the S.B.W.A. office.

Final Analysis Report: This document will include a map of the monitoring sites. The Field Supervisor will issue a report which will provide a technical summary of the data collected during the yearly field sampling period.

Long Term Objectives for Data Usage:

-- To invoke a sense of stewardship for the aquatic environment by providing the volunteers with information and facts that they can use to make intelligent decisions and initiate constructive actions to protect and improve water quality in the South Branch of the Raritan Watershed.

-- To train the Water Stewards how to identify the macroinvertebrates to their family level, which will help the monitoring committee to screen monitoring sites and "red flag" pollution problems.

-- Conduct land use inventories to identify the pollution impacts affecting the river and its tributaries. Currently, a pilot land use inventory is being done by the Tewksbury Township Environmental Commission for the South Branch Raritan River where it runs along Tewksbury

Township9 border. The inventory also includes the Frog Hollow Brook subwatershed which drains into the South Branch.

-- To develop a Geographic Information System (GIS) map of the watershed (including current land use patterns and potential sources of pollution) incorporating all of the field data collected. Currently, the Hunterdon County Health Dept. is compiling the watershed GIS map and loading it into their system. The monitoring sites of T.U. and SBWA programs will be put into this system using the county's Global Positioning System unit.

-- Sponsor hands-on workshops and meetings with township officials to help them understand the data that has been collected, and to give them more information which they can use to protect and preserve the water resource.

-- To have the completed GIS map incorporated into the "Master Plan" for each participating municipality within the watershed.

-- If applicable, to organize and complete at least one stream remediation project in each of the participating municipalities within the watershed.

SOUTH BRANCH WATERSHED ASSOCIATION'S MONITORING ADVISORY COMMITTEE

ORGANIZATION:	CONTACT:
Department of Environmental Protection & Energy	
-Science & Research	Judy Lewis
Division of Fish, Game and Wildlife	
-Bureau of Freshwater Fisheries	Pat Hamilton
-Retired Principal Fisheries Biologist	*Robert Stewart
Environmental Protection Agency Region II Division of Env. Services Surveillance & Monitoring Branch	*James Kurtenbach
Soil Conservation Service	
-Resource Conservation & Development Council	*Donna Drewe.s
-SCS Morris County	Randy Brockaway
-Somerset/Union SCD	Ernie Thurlow
NJ Water Supply Authority	Rocco Ricci
U.S. Geological Survey	William R. Bauersfeld
Trout Unlimited	
-South Branch Project	Tom Lopezzo
-Ken Lockwood Preserve	*Robert Bennett
Rutgers University	
-Aquatic Vegetation	Dr. Don Riemer
Hunterdon County Planning Board	*Caroline Swartz, P.P.
Hunterdon County Board of Health	*John Beckley
Upper Watershed Association	
-Geographical Information System	David Peifer
Elizabethtown Water Company	
-Environmental Specialist	Anthony Matarazzo
-Superintendent of Plant Operations	Glenn Johansen
Amy S. Greene Envir. Consultants	Amy s. Greene
Current Watershed Monitoring Guides	Terry Martin, Raymond Kappel
SBWA member & Chemist	Michael Porubcan

*Steering Committee Members

BIBLIOGRAPHY

New Jersey's Forest Stewardship Program brochure is available through NJ Forest Stewardship Coordinator Gregory McLaughlin, Rutgers Cooperative Extension, Department of Natural Resources, PO Box 231, Cook College, New Brunswick, NJ 08903 (Phone: (908) 932-8243)

Rapid Bioassessment Protocols For Use In Streams and Rivers: Benthic Macroinvertebrates And Fish, United States Environmental Protection Agency, Office of Water, EPA/440/4-89-001, May 1989.

The West Windsor Township Greenbelt Plan is available through West Windsor Township, 271 Clarksville Road, PO Box 38, Princeton Junction, NJ 08550 (Phone: (609) 799-2400 or Fax: (609) 275-4850)