CENTENNIAL BROOK STORMWATER MANAGEMENT EVALUATION

Prepared For:
Lake Champlain Basin Program
54 West Shore Rd
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PART 2: Individual Watershed Stormwater Management Evaluations

The findings of this project are presented in the following individual watershed evaluations. The intent of reporting results in watershed format is to facilitate the incorporation of these findings into comprehensive watershed management plans for each of the project watersheds. These evaluations are not comprehensive management plans and should not be viewed as such. The intent is for these evaluations to serve to focus planning efforts and to provide a basis for evaluating specific implementation activities that will most likely result in environmental benefits in the form of minimized pollutant loadings to the target watersheds and to Lake Champlain and restoration of impaired riparian and aquatic habitat and the biologic communities that those habitats support. Above all, it is the hope of this project that these findings will stimulate the development of comprehensive multi-jurisdictional watershed planning efforts within the project area, resulting in watershed management conducted across political boundaries with full investment by local and regional authorities.

This project has assembled and/or created a number of Geographical Information System (GIS) data layers relevant to watershed planning in the project area (see Part I). Information from these data layers is presented in a series of figures attached to each watershed evaluation. These data layers with their associated data tables, will be available to local and regional planners. It should be recognized that the pollutant projections presented here are planning estimates and caution should be exercised when interpreting these values.

This project recognizes that local governments in the project area have made tremendous commitments to protecting and preserving the natural resources associated with surface waters. Local and regional planning, zoning, and conservation commissions have established a strong record of environmental concern. In order to fully realize effective watershed management, it is critical that individual missions, goals, objectives, and policies be consolidated under the umbrella of comprehensive watershed planing and management. It is hoped that the findings of this project will assist those responsible for planning and environmental management in the project area in their efforts to restore, protect, and preserve the aquatic resources of these highly vulnerable developing watersheds.

implementation would be 64% and 52% respectively of existing loads. Capital cost estimates range from $15,103-$144,335 for this strategy. Implementation recommendations, estimated treatment efficiencies and loading reductions, and estimated capital and annualized capital costs are summarized in **Table 3-3.** Estimated annualized capital costs for phosphorus and suspended solids loading reductions at individual sites range from $13 - $534 per kg/yr for phosphorus and $0.02 - $0.67 per kg/yr for suspended solids. Conversion of the UVM basin would be considerably less than the projected cost.
Two additional permitted discharges are listed, UVM East Campus 1,2 because the targeting methodology indicates a significant pollutant load even after treatment due to the size of the drainages. Because a high level of treatment exists (wetpond) for these loads already it is suggested that any further increase in pollutant reduction might be handled by modification of the outlet structure to handle smaller design storms than as currently permitted. These two permits are not included in the implementation strategy.

Recommendations: The following recommendations, deriving from the findings of this evaluation, are made as technical suggestions that, if implemented, have a high likelihood of positively influencing water quality goals for the watershed. They are not intended to replace the development of a fully comprehensive watershed management plan.

1. The most significant recommendation that can be made here is for the establishment of a watershed planning process that will be able to incorporate the findings of this evaluation into a comprehensive watershed management plan. Such a plan would institutionalize stormwater and watershed management policies across political boundaries. Such a plan would also necessarily address the implementations issues such as prioritization and financing (Schueler, 1996).

2. The lower portion of Centennial Brook, with a cumulative impervious surface area of 25 percent, is the most impacted area of the watershed. Aquatic habitat and biota are impaired. Most of the sewered impervious areas are located in the headwaters of the mainstem and tributaries. Riparian habitat along the main stem is good condition throughout. It is likely that measures to reduce the magnitude of peak flows as well as to reduce the release of sediments and suspended solids to this portion of the watershed will result in improved habitat and biological integrity. Therefore:

- Additional feasibility studies for BMP implementation recommendations for targeted sewersheds (**Table 3-3**), prioritized by estimated Total Suspended Solids loading (**Table 3-2**), should be initiated (see implementation plan).

- Efforts to reduce discharges from significant sources of nonpoint sediment, such as eroding or unstable banks identified by this or other evaluations, should be pursued. Opportunities to implement stream and riparian habitat restoration and improvement activities should be fully explored. Programs such as the Youth Conservation Corps and the USFWS Partnership program are likely resources for implementing watershed restoration activities. Cooperative efforts between landowners and various State, private, and Federal Agencies should be encouraged and coordinated.

3. Resources should be allocated to provide for coordination of activities, including the acquisition of implementation resources, related to urban watershed management. VTDEC and USEPA are currently funding a limited service position to provide this function. If multi-jurisdictional urban watershed management is to be effective in the future, this function must be maintained, ideally through institutionalized regional planning.

4. Continued monitoring of watershed condition should be conducted. BMP implementation effectiveness should be monitored. While VTDEC plans to maintain a minimal level of biological monitoring at many of the sites previously monitored, its resources are limited. Monitoring issues should be developed through the watershed planning process that should evolve at the regional or local level (Brown, 1996).

5. A watershed management educational strategy should be developed and implemented for the Bartlett Brook watershed. Generalized materials related to watershed protection are available from various private and governmental organizations. The educational strategy should, among other things, address the means by which residents of the watershed will be exposed to the appropriate materials (Lake Champlain Committee, 1992; Drinkwin, 1995).

Centennial Brook Resources

Proposed Storm Drainage Improvements for Centennial Woods Alternative. 1982. Trudell Consulting Engineers, Inc., Williston, VT.

Changes in Water Quality and Discharge Associated with a Beaver Dam in Centennial Woods. 1982. Susan Heald and Karin LaMotte, School of Forestry, University of Vermont, Burlington, VT.

Centennial Brook-MCHV Heated Discharge. 1986. Memorandum from Biomonitoring and Aquatic Studies Section to Permits, Compliance and Protection Division, Agency of Natural Resources, State of Vermont.

The Potential Effect of Spring Flooding on Red-winged Blackbirds, Salamanders and Small Mammals in Centennial Woods, Burlington, VT. 1990. Jeffrey Severson, Botany Department, University of Vermont, Burlington, VT.

A Water Quality Monitoring Program for Centennial Brook, Burlington, Vermont. 1992. Diane Fellows, Senior Thesis, Environmental Program, University of Vermont, Burlington, VT.

Centennial Brook Stormwater Management Evaluation

Watershed Description

Centennial Brook was named following the acquisition of Centennial Woods at the centennial celebration of the University of Vermont in 1904. A wool pullery was once located near the mouth of the brook. The watershed was managed for timber by the Winooski Lumber Company. The land between Williston Road, White St and the airport was converted from forest to farm land in the early 19th century.

Centennial Brook is a small (3.22 km2) forested watershed located about equally in Burlington and S.Burlington (**Figure 3.1**). The watershed possesses significant natural area and recreational values for these communities. The stream has its headwaters at the airport and flows west and north to the Winooski River. Beaver ponds and wetlands are abundant throughout the watershed.

Land Use

In 1995 the land use of the watershed was approximately 40% forested, 40% residential and 20% commercial. Significant change in land use is not expected in the future although commercial lands will continue to change in type of use. The developed areas of the watershed are designated a Regional Growth Center. The watershed is 25% impervious (**Table 3-1, Figure 3.2**).

Table 3-1. Centennial Brook: Current and Projected Land Use as percent watershed area. Projected land use is indicated in terms of zoning or planning categories.

	Ag/Open	Forest	Res/Dev	Com/Ind	Urban/ Mixed	Regional Growth Center	*Impervious Surface Area*
1995		40%	40%	20%			*25%*
Projected		40%		20%		40%	

Soils

Adams-Windsor sandy loams are abundant in the developed residential regions and could provide excellent sites for municipal storm drain retrofits utilizing infiltration best management practices. Few soil sites for wetpond/wetland treatment exist. The current abundance of natural ponds/wetlands provides treatment of stormwater prior to discharge to the Winooski River. Existing stormwater sediment basins also provide sites for stormwater wetpond retrofits. Highly erodible soils are common in the lower stream channel and are frequently released during storm events due to the large volume of water discharged to the stream. Stream channel enlargement is evident in the lower main channel (**Figures 3.3-5**).

Riparian Corridor and Biological Evaluation

The riparian corridor from the mouth to the headwaters is in very good shape with the exception of the southeastern tributaries adjacent to Williston Road (**Figure 3.6**). This good riparian habitat quality is not reflected by the macroinvertebrate biological community largely due to the scouring effects of stormwater flows. Sedimentation in this sand plain brook is severe. Stormwater scouring moves large amounts of sediment downstream. Silt deposits appear to be low probably due to the large number of manmade and natural ponds in the watershed. Fish populations appear to be in satisfactory health which is reflective of the high quality corridor habitat. Significant decreases in insect density and richness below stormwater inputs

indicates the degrading effects of high flows, scouring and sediment. The stream does not currently meet the Class B standard for biological integrity at the assessed sites (**Figure 3.7**).

Watershed Management

1. Have in place the appropriate watershed planning and management infrastructure for the Centennial Brook watershed such that comprehensive watershed management issues become an integral part of local planning processes. Watershed management should emphasize stream buffer protection, land acquisition, and watershed restoration.

2. Ensure the maintenance and protection of any existing high quality biological communities and habitats.

3. Restore impaired aquatic and riparian habitat such that biological integrity consistent with Class B water quality standards is attained.

4. Establish consistent inter-jurisdictional (South Burlington, Burlington) stormwater management and stream protection policies throughout the Centennial Brook watershed.

5. Ensure that watershed residents are aware of watershed management issues and are well educated in the principles of stream and watershed protection.

Existing Zoning

The portion of Centennial Brook located in S.Burlington has the same conservation buffer as Bartlett and Muddy Brooks; the brook is protected by a 50' setback (50'/side) conservation buffer where development is precluded; variances are allowed. The S. Burlington Natural Resources Committee reviews all proposed development adjacent to the buffer. All wetlands of the brook have a 50' additional buffer.

The portion of the brook in Burlington has no designated buffer zone although the Burlington Conservation Board has adopted a stormwater water quality policy (City of Burlington, 1995).

In addition to zoning, the 40 acre University of Vermont Centennial Woods Natural Area straddles the main reach of the stream. **Figure 3.8** shows features of the watershed such as wetlands, parks, Natural Heritage sites, 100 yr floodplain and biological natural areas.

Education Strategy

An education strategy for urban nonpoint source pollution should include the following actions: 1) informational mailings and public service announcements to watershed residents on clean stream habits, 2) public involvement in cleanup, erosion and habitat restoration projects, 3) storm drain stenciling, 4) school natural history programs and, 5) citizen monitoring (Drinkwin, 1995; Lake Champlain Committee, 1992).

Implementation Strategy

There are 3 storm sewersheds and one discharge permit targeted in this watershed (**Table 3-2, Figures 3.9-3.13**). Infiltration BMP's are recommended for the Airport Pkwy-White St storm sewer and the Staples Plaza storm sewer (map 4,5; Part 1). A wetpond is recommended for the Williston Rd-Dorset St storm sewer (map 4; Part 1). TSS and TP reduction to the stream from BMP implementation at these three sites would be 19,915 kg/yr and 25 kg/yr respectively. The University of Vermont School of Medicine permitted storm water basin could be modified to a wetpond with a net TSS and TP reduction of 3,727 kg/yr and 5 kg/yr respectively.

Overall sediment and phosphorus reduction from the targeted sewersheds to the stream resulting from full

Table 3-2. Significant Stormwater Discharges in the Centennial Brook Watershed: Discharges are targeted based on estimated exceedence of annual loading thresholds for: suspended solids (4,536 kg/year); total phosphorus (6.8 kg/year); total metals (5.4 kg/year); total PAHs (36 kg/year); fecal coliform (500,000 colonies/yr). Existing treatment structures are indicated. *Italics indicate stormwater discharges with VTDEC stormwater permits.* EIA% is the percent surface area as Effective Impervious Surface Area. Loadings are calculated from the means of ranges in export coefficients taken from the literature. See Part 1 of this report for loading calculation methods.

Recwater	Storm sewershed	Treatment (Appendix 4)	EIA%	Loading kg/yr
		Highest Total Suspended Solids		
Centennial	Williston Rd..-Dorset St	CB	80.4	15,647
Centennial	Airport Pkwy-White St	CB	15.0	7,923
Centennial	*UVM East Campus 2*	*CB/DP*	42.6	7,570
Centennial	Staples Plaza 2	CB	100	7,115
Centennial	*UVM East Campus 1*	*CB/DP*	11.5	7,105
Centennial	*UVM School of Medicine*	*CB/SB/WL*	43.9	6,213
		Highest Total Phosphorus		
Centennial	Williston Rd..-Dorset St			25
Centennial	Airport Pkwy-White St			12
Centennial	*UVM East Campus 2*			12
Centennial	Staples Plaza 2			11
Centennial	*UVM East Campus 1*			11
Centennial	*UVM School of Medicine*			10
		Highest Total PAH (Commercial Landuses Only)		
Centennial	Williston Rd..-Dorset St			168
Centennial	Airport Pkwy-White St			85
Centennial	*UVM East Campus 2*			81
Centennial	Staples Plaza 2			76
Centennial	*UVM East Campus 1*			76
Centennial	*UVM School of Medicine*			67
		Highest Total Metals		
Centennial	Williston Rd..-Dorset St			19
Centennial	Airport Pkwy-White St			10
Centennial	*UVM East Campus 2*			9
Centennial	Staples Plaza 2			9
Centennial	*UVM East Campus 1*			9
Centennial	*UVM School of Medicine*			8

Table 3-3. Centennial Brook Watershed: Stormwater BMP implementation treatment and capital costs estimates for targeted sewersheds.
All estimates are based on a mean of a range of export coefficients for TP and TSS.

Rec. Wat.	Sewershed	BMP	TP Pre BMP Kgs/year	TP Post BMP Kgs/year	TP Reduction Kgs/year	TSS Pre-BMP Kgs/year	TSS Post-BMP Kgs/year	TSS Reduction Kgs/year	Capitol Cost Low dollars	Capitol Cost High dollars
Centennial	Staples Plaza 2	Infiltration	11	4	7	7115	2134	4981	$1,680	$10,083
Centennial	Airport Pky-White	Infiltration	12	5	7	7923	2377	5546	$9,586	$57,515
Centennial	Willis. Rd.-Dorset	Wetpond	25	14	11	15647	6259	9388	$2,270	$45,403
Centennial	UVM Medicine	Wetpond	10	5	5	6212	2485	3727	$1,567	$31,334
		TOTALS	58	28	30	36897	13255	23642	$15,103	$144,335

	Capital Costs/kg						*Annualized Capital Costs*			
Sewershed	TP Cost Low Dollars/kg	TP Cost High Dollars/kg	TSS Cost Low Dollars/kg	TSS Cost High Dollars/kg	Annual TP Costs $/kg 30 yrs @ 5% Low	Annual TP Costs $/kg 30 yrs @ 5% High	Annual TSS costs $/kg 30 yrs @ 5% Low	Annual TSS costs $/kg 30 yrs @ 5% High	Total Annualized Costs 30 Years @ 5% Low	Total Annualized Costs 30 Years @ 5% High
Staples Plaza 2	$240	$1,440	$0.34	$2	$16	$94	$0.02	$0.13	$109	$656
Airport Pky-White	$1,369	$8,216	$1.73	$10	$89	$534	$0.11	$0.67	$624	$3,741
Willis. Rd.-Dorset	$206	$4,128	$0.24	$5	$13	$269	$0.02	$0.31	$148	$2,954
UVM Medicine	$313	$6,267	$0.42	$8	$20	$408	$0.03	$0.55	$102	$2,038
AVERAGE	$503	$4,811	$0.64	$6	$33	$313	$0.04	$0.40	$982	$9,389

Figure 3.1: Centennial Brook watershed showing: roads, surface waters, impervious surface areas, permitted wastewater and stormwater discharges, stormwater lines, nonpoint sources such as eroding stream banks, EPA hot land uses (gasoline service areas), underground storage tanks, and biological monitoring sites.

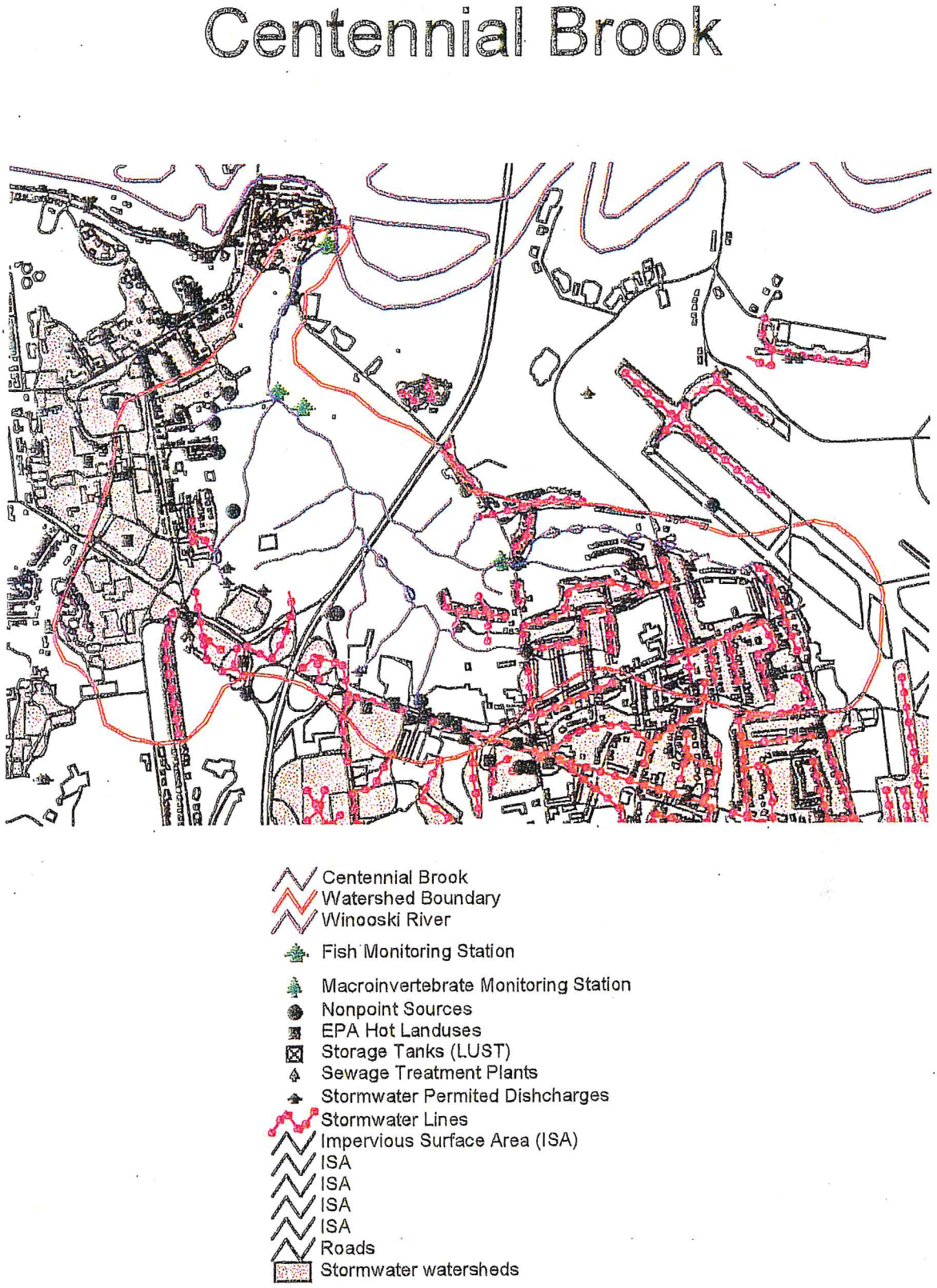
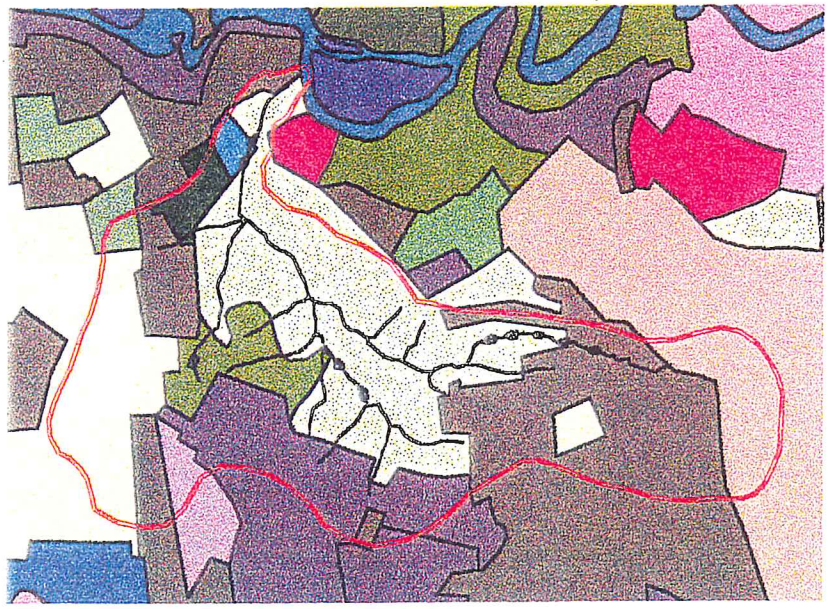
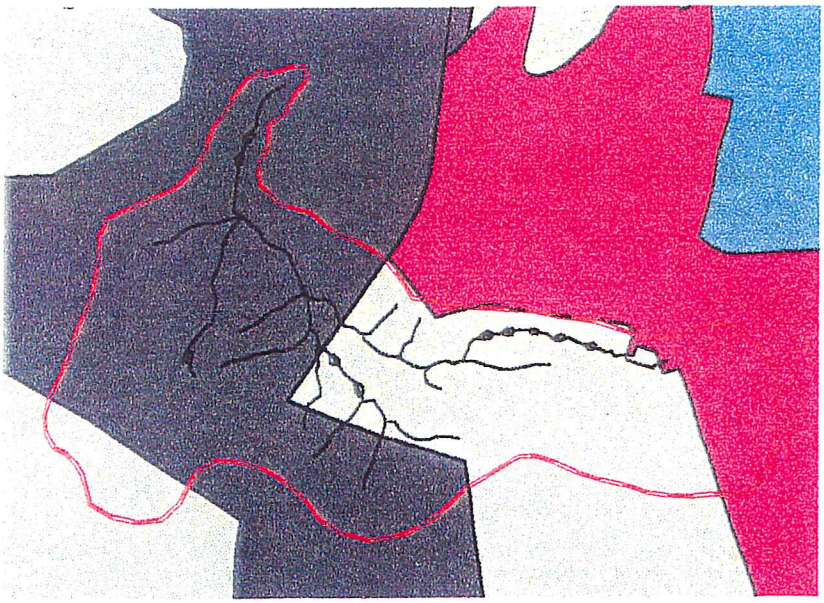


Figure 3.2: Centennial Brook watershed 1995 actual land use; and future land use as defined by zoning designation.





Centennial Brook Watershed
Land Use 1995
0
1100
1130
1190
1200
1210
1250
1252
1260
1270
1281
1300
1330
1370
1373
1400
1410
1412
1440
1460
1470
1480
1481
1482
1500
1510
1600
1700
1720
1730
1734
1735
1736
1737
1740
1790
2100
2200
2430
3000
3300
4100
4200
4300
5100
5200
5210
6000
6100
7200
7400

Centennial Br
Watershed
Future Landuse
1200
1500
1600
1700
1730
2100
3000
4000
7000
7500

Figure 3.3: Centennial Brook generalized soils map.

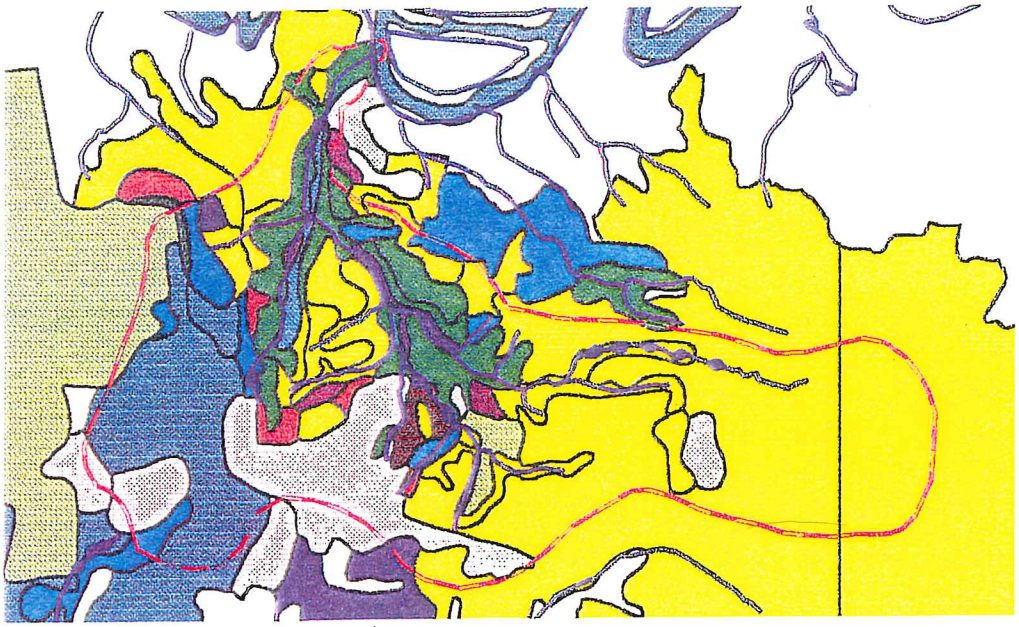
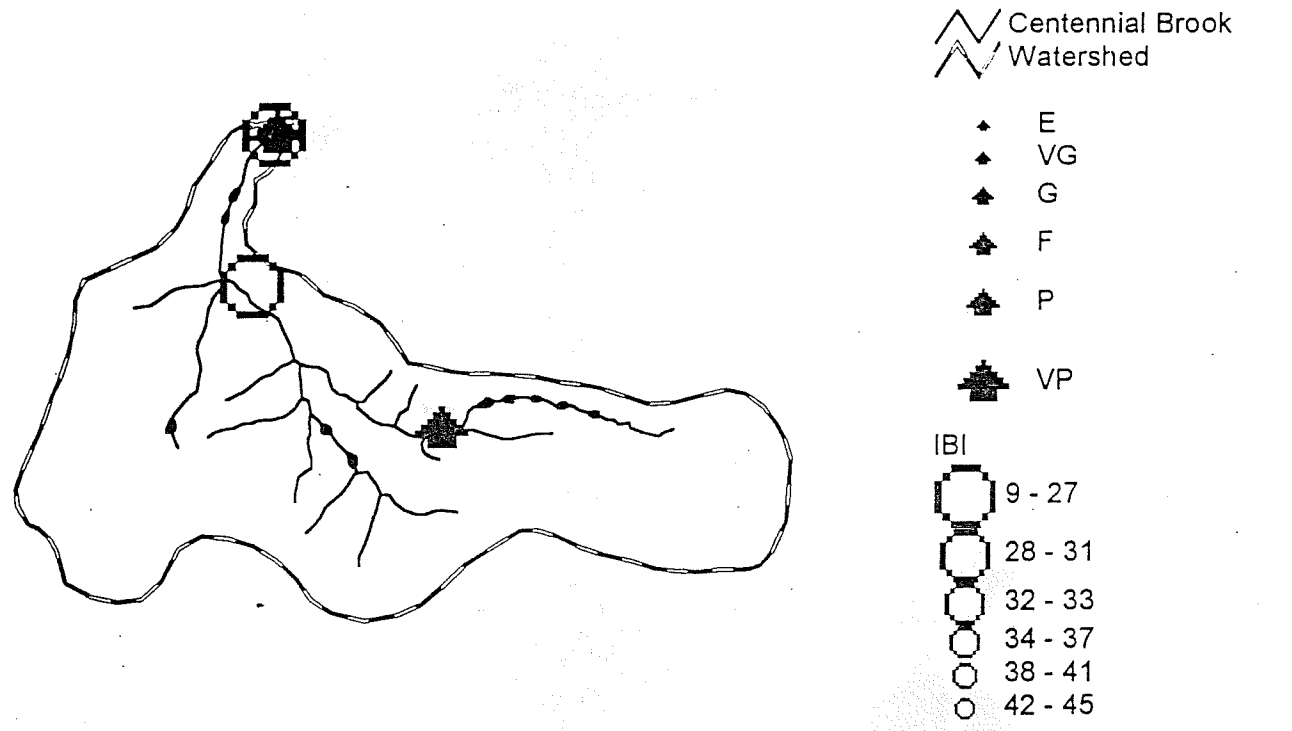


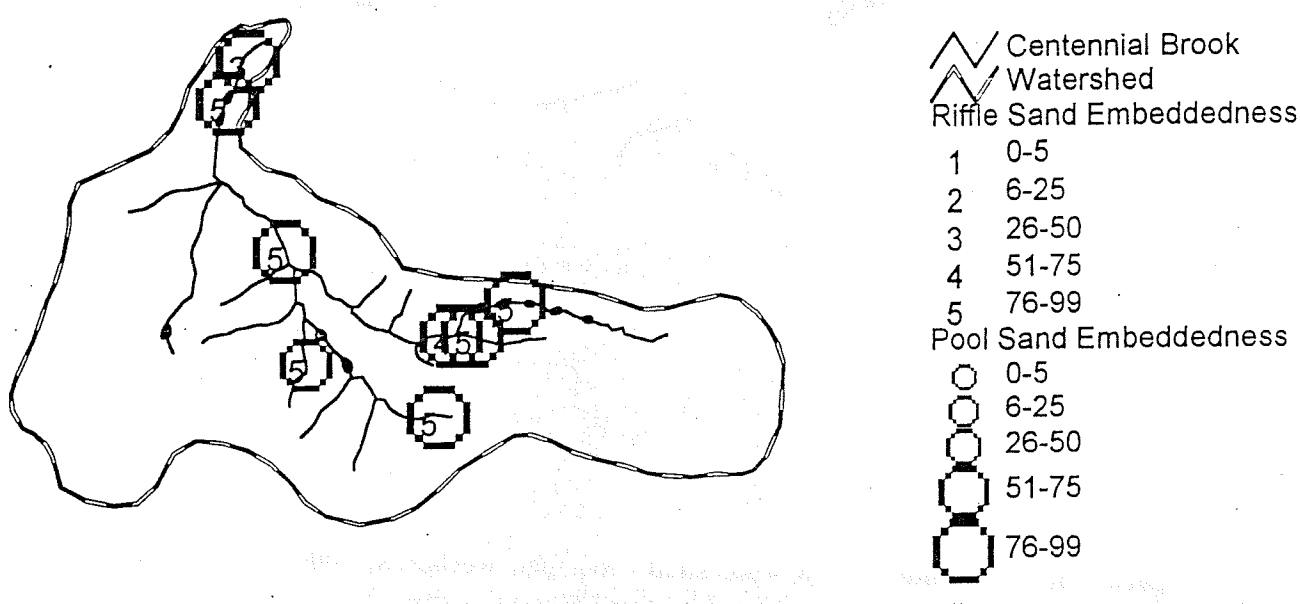
Figure 3.4: Centennial Brook watershed - areas of highly erodible soils. These soils are easily displaced.

Figure 3.5: Centennial Brook watershed - wetpond/wetland soils.

Figure 3.6: Centennial Brook Riparian Corridor Evaluation. Evaluation was conducted using the Riparian Corridor Evaluation methodology (Petersen, 1992). A series of measurements and observations are recording while walking the stream channel.

Figure 3.7: Centennial Brook watershed - biological condition. Fish and macroinvertebrate community measures of integrity. A macroinvertebrate biotic index (BI) rating of less than good is indicative of sub-Class B condition. A fish Index of Biotic Integrity (IBI) rating of less than 31 is indicative of sub-Class B condition.





Watershed measure of pool and riffle sedimentation. A high degree of sand embeddedness indicates excessive erosion and impairs aquatic habitat and the biological communities that are supported by that habitat.

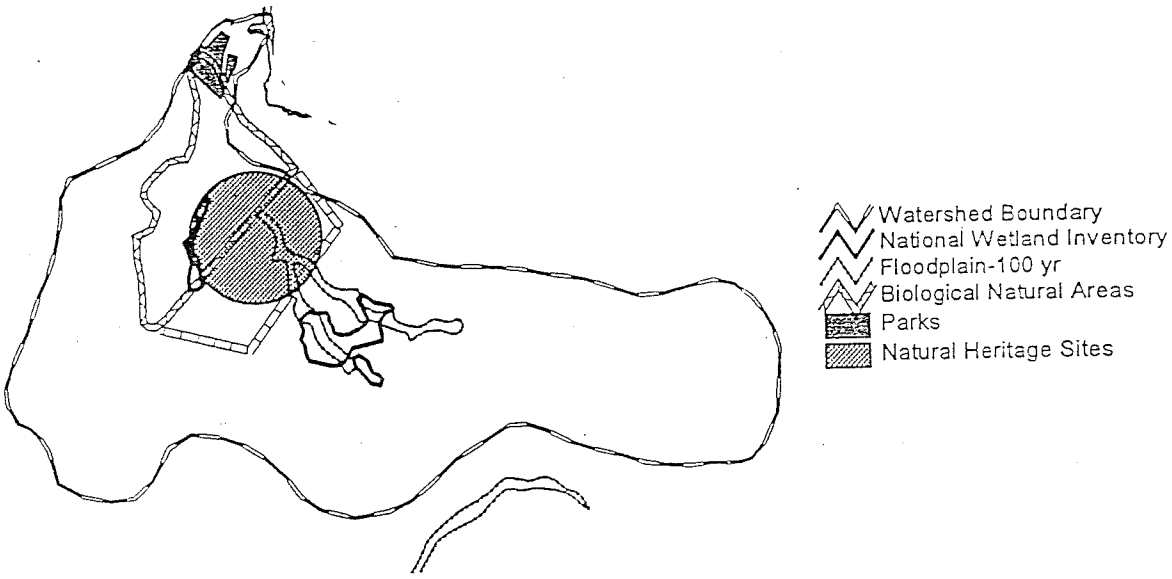


Figure 3.8: Centennial Brook watershed - mapped wetlands, 100 yr. floodplain, biological natural areas, parks, and Natural Heritage sites.

Targeted Stormwater Sewersheds
Centennial Brook Watershed

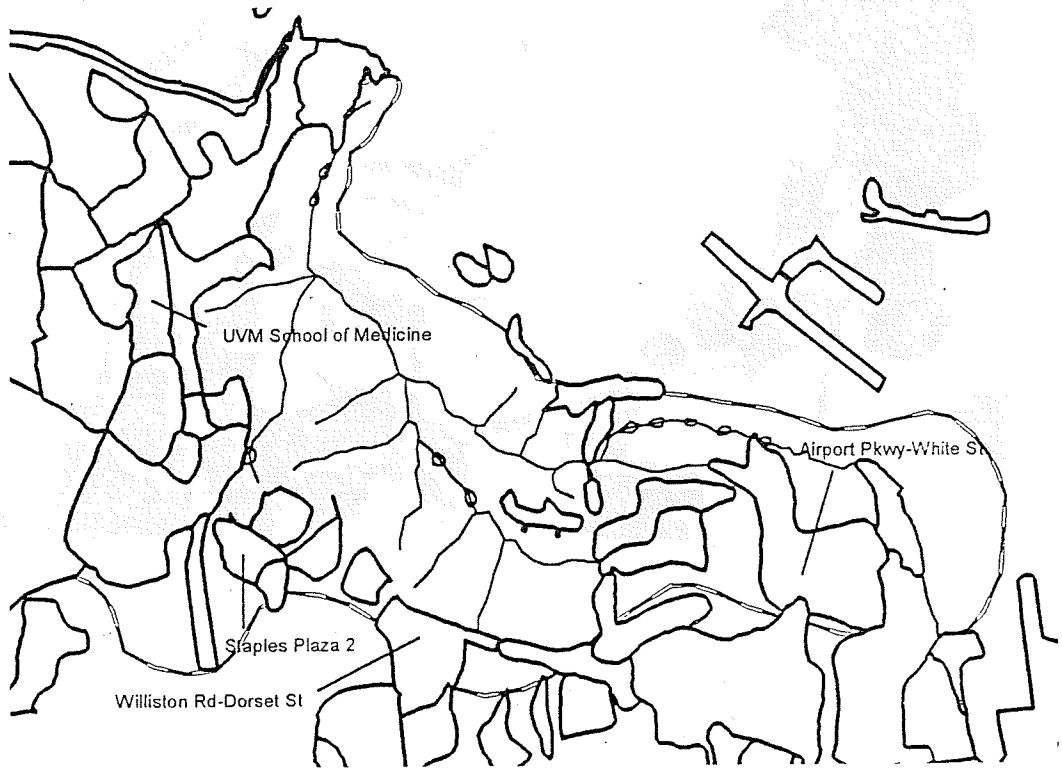


Figure 3.9: Targeted Stormwater Sewersheds in Centennial Brook Watershed - Sewersheds were targeted based on exceedences of loading thresholds as described in Table 2.2. BMP recommendations are made for each targeted sewershed. Four sewersheds in the Centennial Brook watershed have been targeted.

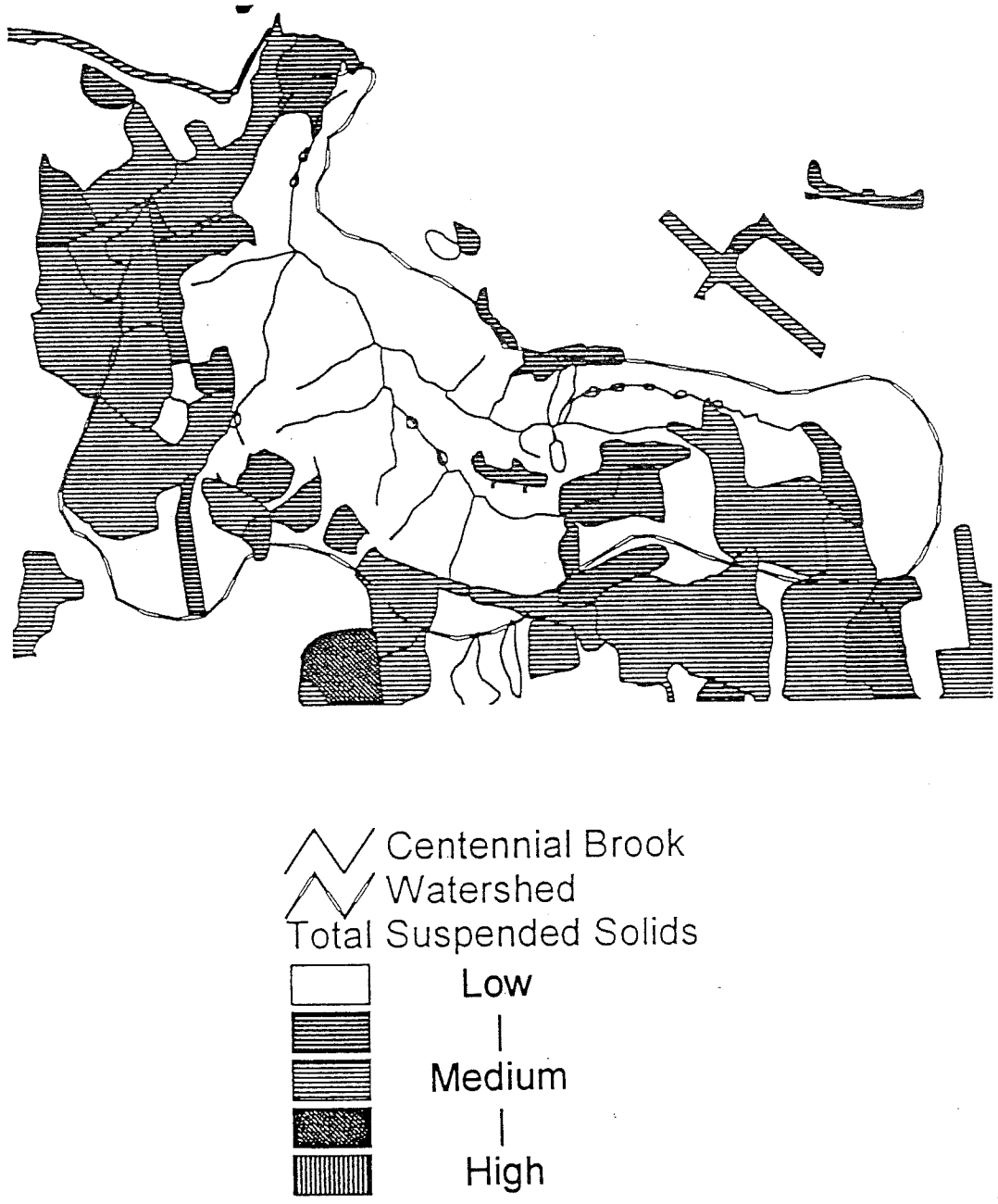


Figure 3.10: Estimated total suspended solids loading from sewersheds in the Centennial Brook watershed.

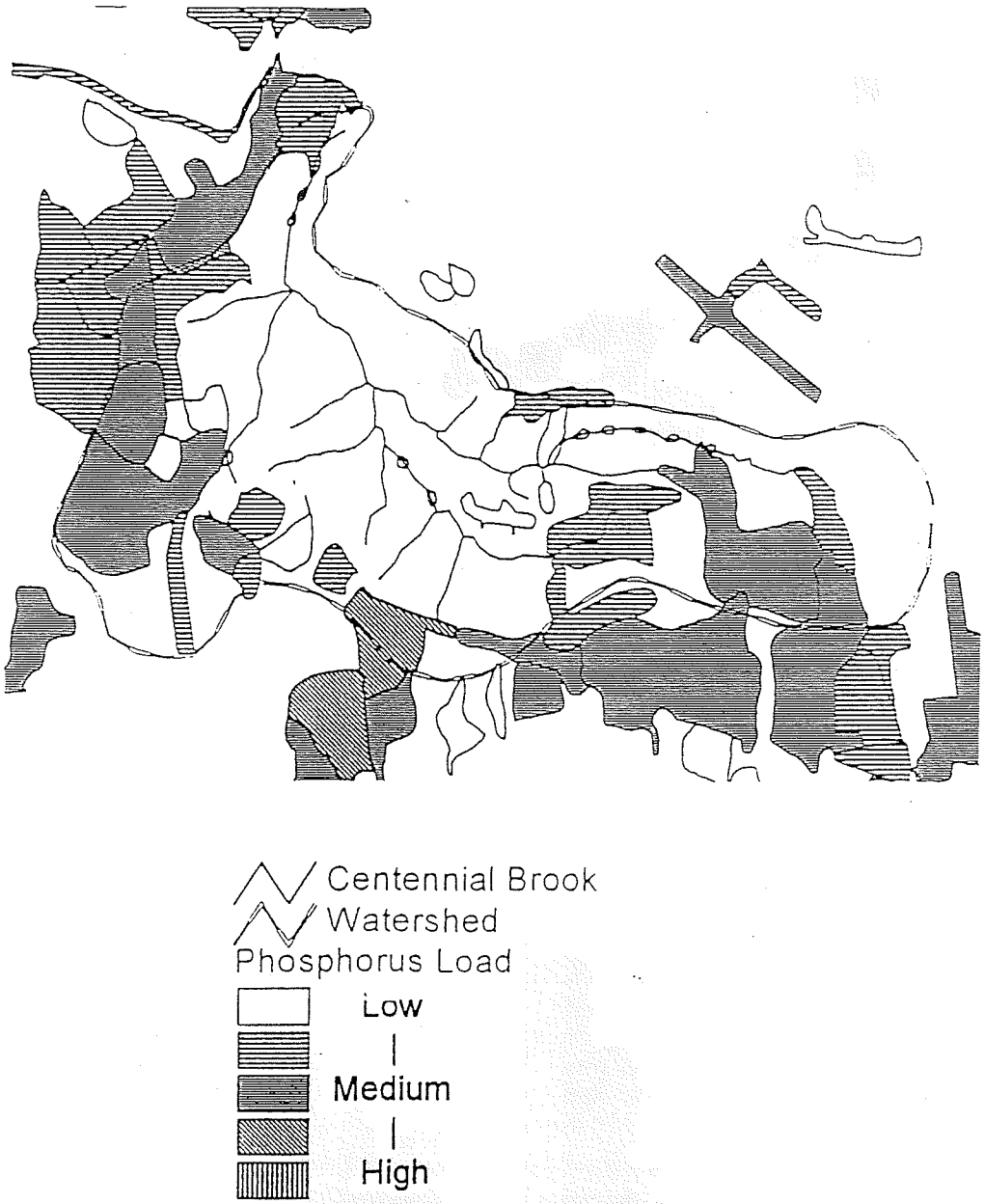
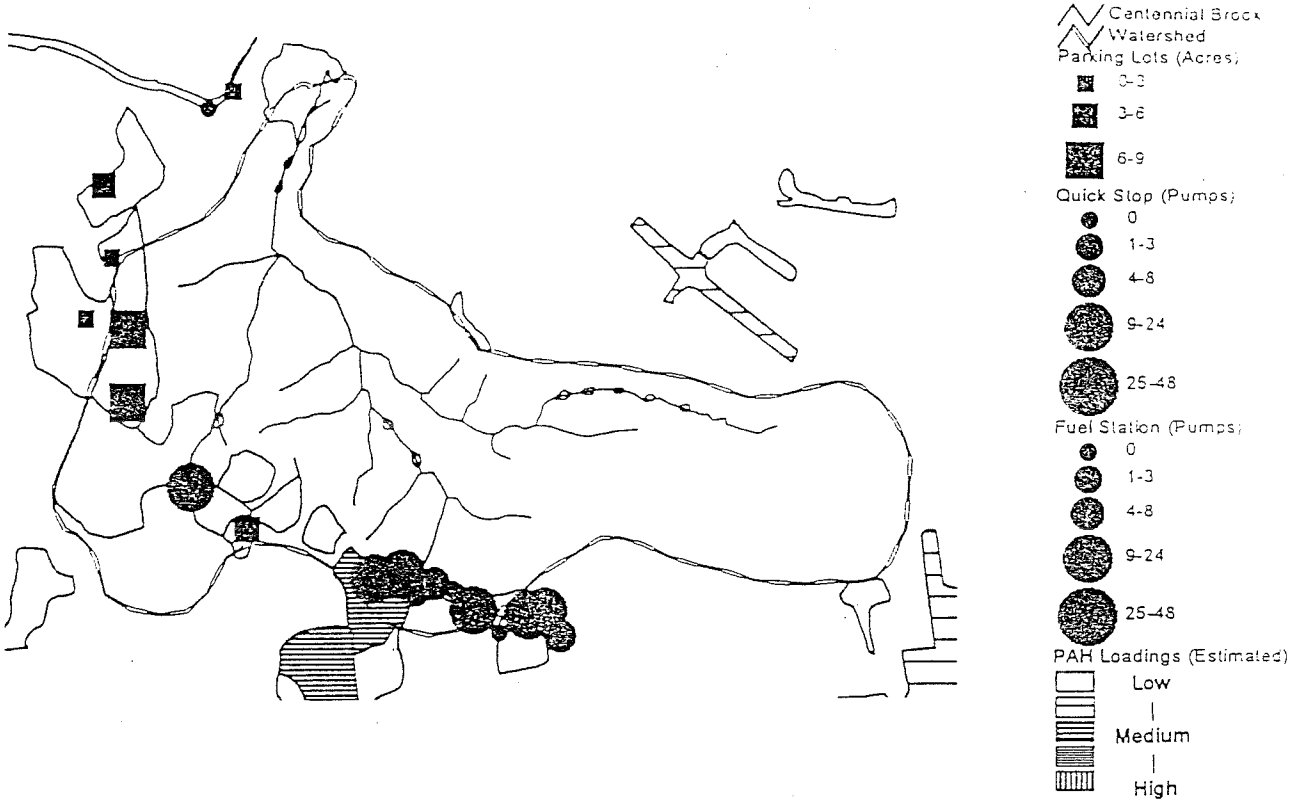
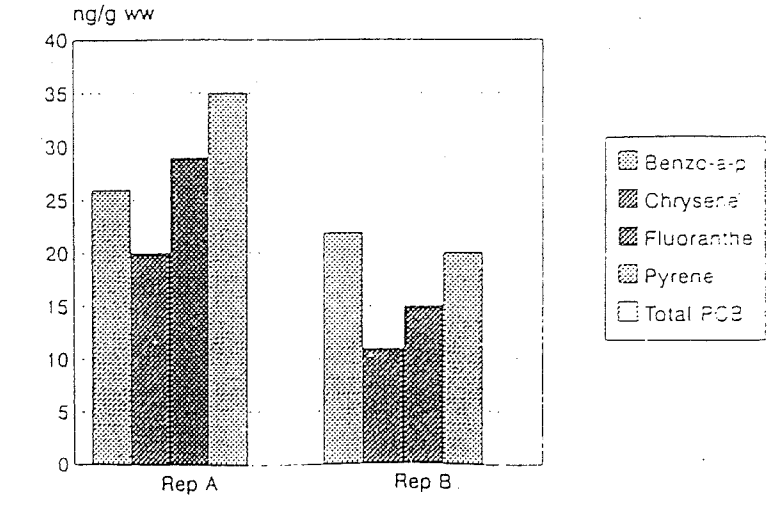


Figure 3.11: Estimated total phosphorus loading from sewersheds in the Centennial Brook watershed.

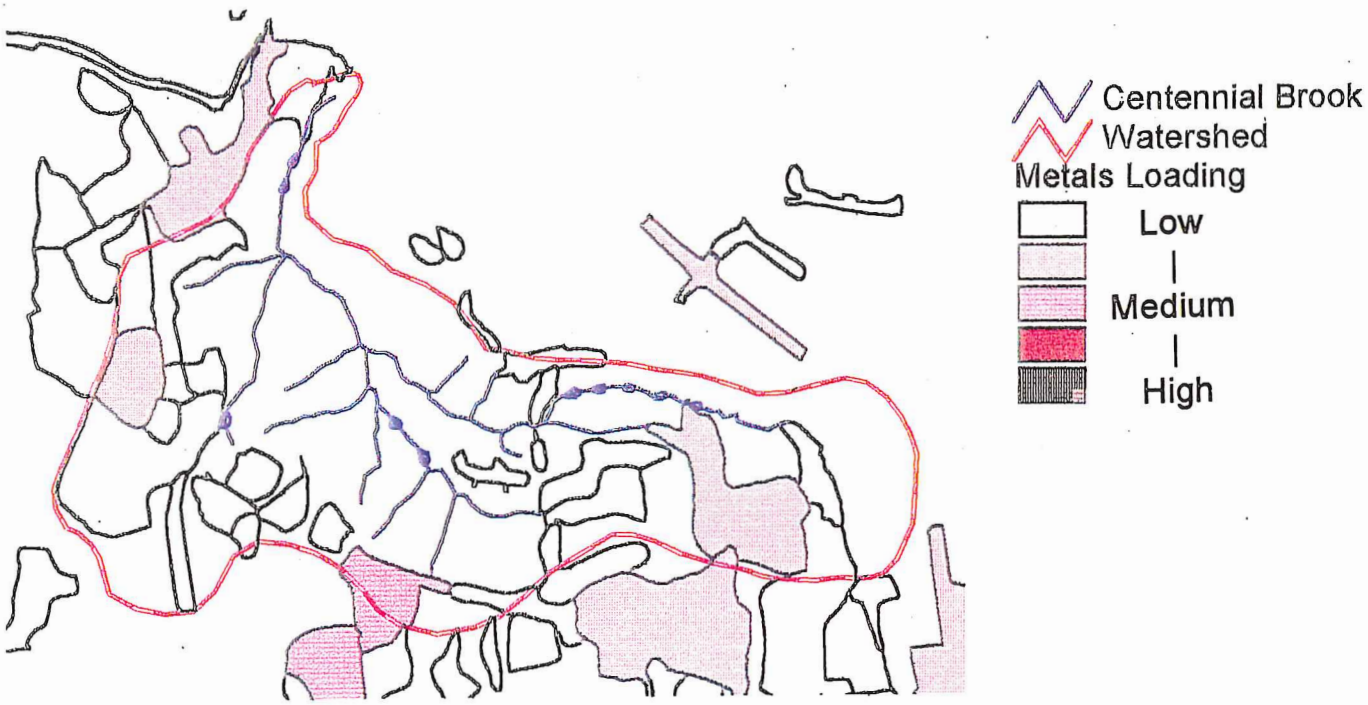
Figure 3.12: Estimated total PAH loading from sewersheds in the Centennial Brook watershed. Graph at bottom shows concentrations of PAHs in sediments at the mouth of the Centennial watershed. Samples collected in 1995. Potential sources of PAHs are identified as EPA hot spots - parking lots and gasoline service areas.

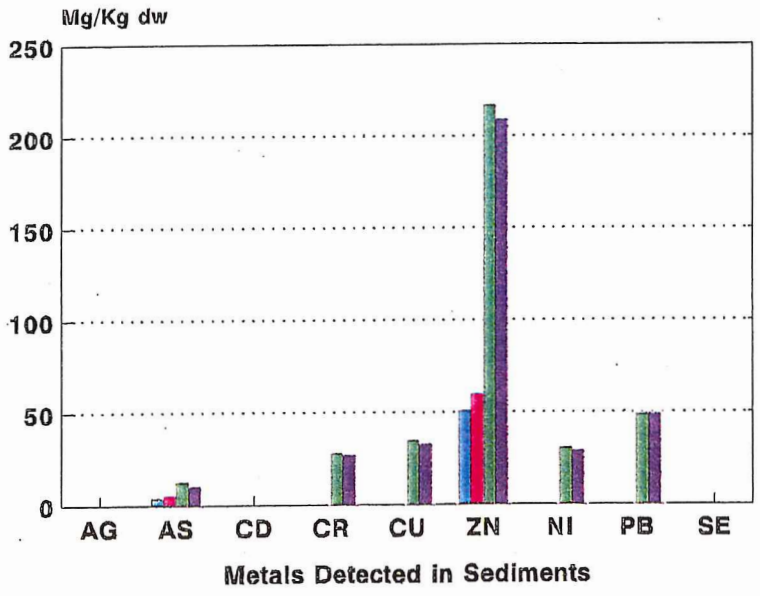




(Detected in Mussels)

Figure 3.13: Estimated total metals loading from sewersheds in the Centennial Brook watershed. Graph at bottom shows concentrations of metals in whole (2mm) and fine fraction (63u) sediments at the mouth of the Centennial watershed. Samples collected in 1995.





Soils

- AdA
- AdA
- AdA - AdB
- AdB - AdD
- AdD - AdE
- AdE - Au
- Au - BlA
- BlA - Br
- Br - Cv
- Cv - DdA
- DdA - EwA
- EwA - FaC
- FaC - FaE
- FaE - FsB
- FsB - Fu
- Fu - HlB
- HlB - HlE
- HlE - HnB
- HnB - Le
- Le - Lf
- Lf - MuD
- MuD - MyB
- MyB - MyC
- MyC - Rk
- Rk - ScB
- ScB - TeE
- TeE - W
- W - Wo

Land Use 1995

- 0
- 1100-Residential
- 1130-Residential-Single Family
- 1190-Residential-Other
- 1200-Commercial
- 1230-Commercial Services
- 1250-Government
- 1252-Military
- 1260-Institutional
- 1270-Educational
- 1281-Museum
- 1300-Industrial
- 1330-Industrial-Stone
- 1370-Industrial-Mining
- 1373-Sand/Gravel
- 1400-Transportation
- 1410-Transportation-Air
- 1412-Transportation-Air
- 1440-Transportaiton-Road
- 1460-Utilities
- 1470-Utilities
- 1480-Utilities
- 1481-Utilities
- 1482-Utilities
- 1500-Industrial
- 1510-Industrial Park
- 1600-Mixed Use
- 1700-Outdoor Built
- 1720-Outdoor Built
- 1730-Outdoor Recreation
- 1734-Ski Area
- 1735-Golf Course
- 1736-Campground
- 1737-Parks
- 1740-Cemetaries
- 1790-Other outdoor built
- 2100-Cropland
- 2200-Orchards
- 2430-Other Agriculture
- 3000-Brush
- 3300-Mixed Brush-grass
- 4100-Broadleaf Forest
- 4200-Coniferous Forest
- 4300-Mixed Forest
- 5100-Rivers
- 5200-Lakes/Ponds
- 5210-Lakes/Ponds
- 6000-Wetlands
- 6100-Forested Wetland
- 7200-Beaches/River banks
- 7400-Exposed Rock

Future Landuse

- 1200-Commercial
- 1500-Industrial
- 1600-Mixed Use
- 1700-Outdoor Built
- 1730-Outdoor Recreation
- 2100-Cropland
- 3000-Brush
- 4000-Forest
- 7000-Growth Center
- 7500-Subregional Growth Center