APPENDIX C. EXAMPLE MONITORING PROGRAMS

This appendix contains three examples of nonpoint source monitoring programs that are considered by many nonpoint source experts to be good programs for the objectives they address. These examples should not be copied indiscriminately for use in every other similar watershed, but should only be used as references for designing good monitoring programs for similar situations.

C.1 St. Albans Bay, Vermont Rural Clean Water Program

The St. Albans Bay, Vermont, monitoring and evaluation program was funded at $1.6 million over 11 years (1980-1990), a price well beyond reach for many watersheds of similar size (33,344 acres) (Smolen et al., 1986). The program had three objectives (Vermont RCWP Coordinating Committee, 1986):

- Document changes in the water quality of specific tributaries within the watershed resulting from implementation of manure management practices.

- Measure changes in suspended sediment and nutrients entering St. Albans Bay resulting from implementation of water quality management programs within the watershed.

- Evaluate trends in the water quality of St. Albans Bay and the surface waters within the St. Albans Bay watershed during the period of the St. Albans Bay RCWP Watershed Project.

To achieve these objectives, the monitoring strategy for the St. Albans Bay Watershed included long-term water quality monitoring, related long-term monitoring, and short-term intensive studies. The monitoring sites for all sampling are shown in Figure C-1 and listed in Table C-1.

C.1.1 Long-term Water Quality Monitoring

The long-term monitoring in St. Albans Bay included four monitoring levels. Level 1 Bay Sampling was designed to determine long-term water quality trends in St. Albans Bay over the life of the project (four monitoring stations in the bay). Level 2 Tributary Sampling was designed to determine the long-term water quality trends for the major tributaries including the Bay and the St. Albans City wastewater treatment plant (six monitoring stations located throughout the watershed). Level 3 monitoring was designed to evaluate the effect of best manure management practices on the quality of surface runoff from individual fields (two monitoring stations located in the headwaters of the Jewett Brook subwatershed), while Level 4 was designed to supplement the Level 2 monitoring by sampling additional tributaries to St. Albans Bay and to isolate subunits within the Level 2 subwatersheds (four monitoring stations) (Vermont RCWP Coordinating Committee, 1984). Table C-2 lists the variables monitored for each level of the long-term monitoring.

C.1.2 Related Long-Term Monitoring

Precipitation and other climatological data were collected in the St. Albans Bay Watershed at four locations. Biological monitoring was conducted in St. Albans Bay and in bay tributaries. Bay biological monitoring corresponded to the long-term Level 1 stations. Tributary biological monitoring

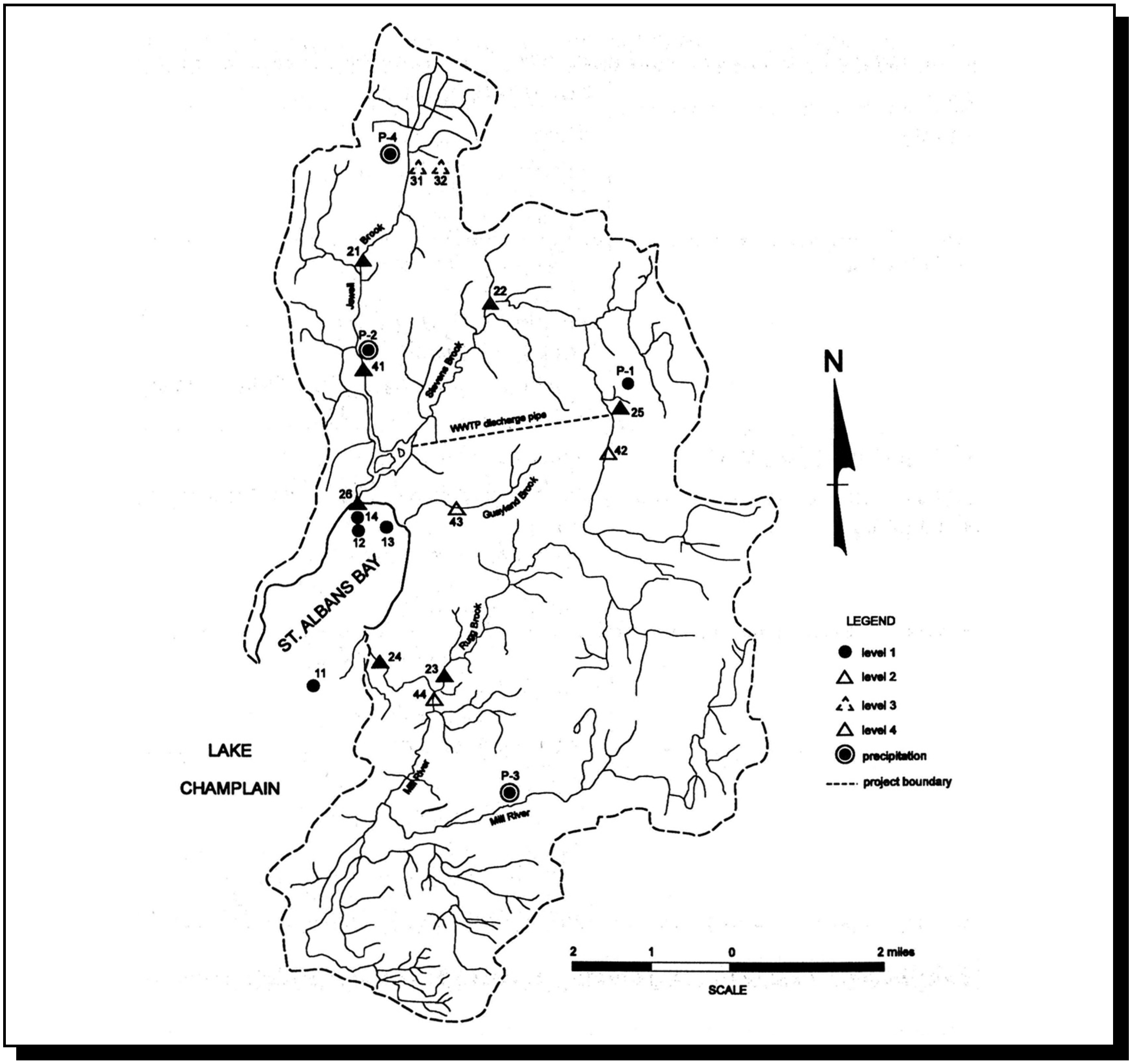

Figure C-1. St. Albans Bay Watershed, Franklin County, Vermont, sampling locations. (Source: USEPA, 1982c)

was conducted at five locations. A cooperative program was developed to collect land use and agricultural activity information from each farm in the watershed. Both baseline information and daily field log data were collected and entered into a geographic information system. Table C-3 lists the parameters monitored for each of the related long-term monitoring efforts.

C.1.3 Short-term Intensive Studies

The short-term intensive studies included three components: wetland influences, bay and wetland sediment, and bay circulation. Stevens Brook wetland was sampled to determine the effects of the

Table C-1. St. Albans Bay watershed, Franklin County, Vermont, sampling station summary.

Type of Monitoring	Station Description
Level 1: Long-term Bay and Biological	Station 11: Outer Bay Station 12: Inner Bay Station 13: Beach Station 14: Off Bridge (new)
Level 2: Long-term Tributary	Station 21: Jewett Brook Station 22: Stevens Brook Station 23: Rugg Brook Station 24: Mill River Station 25: St. Albans Wastewater Treatment Plant Station 26: Stevens Wetland
Level 3: Manure Management Evaluation	Station 31: Larose ditch - below site Station 32: Larose ditch - above site
Level 4: Additional Tributary	Station 41: Jewett Brook Station 42: Stevens Brook Station 43: Guayland Brook Station 44: Mill River
Meteorological	P-1: St. Albans Radio Station P-2: Dunsmore Farm P-3: Franklin Ford Tractor P-4: LaRose Farm
Biological	Station 21: Jewett Brook Station 22: Rugg Brook Station 23: Mill River Station 22A: Stevens Brook above STP outfall Station 22B: Stevens Brook below STP outfall

wetland on water entering St. Albans Bay from point and nonpoint sources. Fifteen sampling stations were located within the wetland along the brook channels. Station 26 served as a site for continuous monitoring of the wetland outlet. Fifteen sampling stations were located within the bay and contiguous wetland to determine the chemical and physical properties of the sediments. Six of these stations were used for within-year temporal studies. Sediment phosphorus release studies were also conducted at these sites. Wind, water current, and concentration data were collected in St. Albans Bay to determine the effect of bay circulation on water quality. A model was developed to predict phosphorus concentrations in the bay under different loading rates and meteorological conditions.

Table C-4 lists the parameters monitored for each of the short-term studies.

C.1.4 Sampling and Analytic Techniques

Table C-5 summarizes the frequency and type of sample collected for long-term water quality monitoring, although not all stations were sampled throughout the 10-year study. The methods used to determine each water quality parameter are given in Table C-6.

Table C-2. Long-term variables monitored for each level in the St. Albans Bay watershed.

Variable	Long-term Monitoring Level			
	1	2	3	4
Turbidity	●	●		●
Total Suspended Solids	●	●	●	●
Volatile Suspended Solids	●	●	●	●
Total Phosphorus	●	●	●	●
Ortho-Phosphorus	●	●	●	●
Ammonia-Nitrogen	●	●	●	●
Total Kjeldahl Nitrogen	●	●	●	●
Nitrite + Nitrate as Nitrogen	●	●	●	●
Chlorophyll *a*	●			
Fecal Coliform	●	●		●
Fecal Streptococcus	●	●		●
Temperature	●	●		●
Dissolved Oxygen	●	●		●
pH	●	●		●
Conductivity	●	●		●
Secchi Disc	●			
Flow				●

Table C-3. Monitored variables for related long-term monitoring in the St. Albans Bay watershed.

Type of Monitoring	Variables
Meteorological	Continuous precipitation and streamflow Continuous temperature (Level 3 only) Wind speed and direction (Bay only)
Biological	Fish species and abundance, benthic invertebrates, periphyton, macroinvertebrates
Land Use	Land use - field by field, activity dates Livestock - type, number, housing, dates Manure management - type, capacity, fields, dates Fertilizer - type, amount, field, dates Pesticide/agrichemicals - type, amount, field, dates Milkhouse - type, disposal Barnyard - size, paving, use schedule Drainage - type, fields Soils, topography, streams, farm and watershed boundaries

Table C-4. Monitored variables for the short-term intensive studies in the St. Albans Bay watershed.

Type of Monitoring	Variables	
Wetland Influences	Temperature Dissolved Oxygen Discharge Chloride Total Suspended Solids Volatile Suspended Solids	Total Phosphorus Ortho-phosphorus Total Kjeldahl Nitrogen Ammonia-Nitrogen Nitrate + Nitrite as Nitrogen pH
Bay and Wetland Sediments	Redox potential Porosity Grain size distribution % organic matter Iron	Total phosphorus NH_4Cl phosphorus NH_4Ac phosphorus NaOH phosphorus HCl phosphorus
Bay Circulation	Total phosphorus Chloride	Water velocity and direction Wind speed and direction

Table C-5. Water quality sampling schedule for the St. Albans Bay watershed.

Level	Variables	Sample Type	Season	Sample Frequency
1	All	Grab	October-April	Monthly
			May-July	Biweekly
			August-September	Weekly
2	Fecal coliform Fecal streptococcus	Grab	All	Weekly
	Temperature Turbidity pH Dissolved oxygen	In situ	All	Biweekly
	Solids Nitrogen Phosphorus	Composite	All	2-48 hour and 1-72 hour Weekly
3	All	Composite	All	4 hour
4	All	Grab	May-February	20 days (avg.)
			March-April	Weekly

Table C-6. Methods of water quality analysis used in the St. Albans Bay RCWP.

Variable	Storage	Preservation/Method of Analysis	Reference
pH	in situ	Orion 399A meter	Method 150.1[b]
Dissolved Oxygen	in situ	YSI 51B meter	Method 360.1[b]
Conductance/Temperature	in situ	YSI 33 S-C-T meter	Method 120.1[b]
Turbidity	cool, 4°C	Hach Ratio Turbidimeter (NTU)	Method 180.1[b]
Total Suspended Solids[a]	cool, 4°C	Gravimetric filtration	Method 160.2[b]
Volatile Suspended Solids	cool, 4°C	Filter ignition at 550 °C	Method 160.4[b]
Total Phosphorus	cool, 4°C acid (pH≤2)	Persulfate digestion	Method 365.2[b]
Orthophosphate[a]	cool, 4°C	Ascorbic acid	Method 365.2[b]
Nitrate + Nitrite-N[a]	cool, 4°C acid (pH≤2)	Cd-Cu reduction sulfanilamide	Method 353.3[b]
Ammonia-N	cool, 4°C acid (pH≤2)	Boric acid distillation	Method 350.2[b]
Total Kjeldahl Nitrogen	cool, 4°C acid (pH≤2)	Macro-digestion with sulfuric acid	Bremner 1965
Chemical Oxygen Demand	cool, 4°C acid (pH≤2)	Potassium dichromate oxidation	Oceanography International Corp.
Fecal Coliform	cool, 4°C	Membrane filtration	Method 909A[c]
Fecal Streptococci	cool, 4°C	Membrane filtration	Method 909C[c]

[a] Filtration through glass fiber filter.
[b] USEPA, 1974.
[c] American Public Health Administration, 1975.

C.2 BELLEVUE, WASHINGTON NATIONWIDE URBAN RUNOFF PROGRAM

The Nationwide Urban Runoff Program (NURP) was designed such that each project met minimum monitoring requirements to support national analyses. Thus, the monitoring programs were very similar for all projects in NURP. The Bellevue, Washington, monitoring program is one example.

Bellevue (25 square miles, 1982 population about 75,000) is located in the Puget Sound lowlands on the west side of the Cascade Mountains and immediately east of Lake Washington (Figure C-2) (USEPA, 1982c). Land use is primarily residential and mean annual precipitation, mostly rain, is about 42 inches. Bellevue is hilly, with moderate slopes predominating. Drainage is carried by a system of separate storm sewers (i.e., separate from sanitary wastes), open channels, and streams into Lake Washington through Mercer Slough (Figure C-3) (USEPA, 1982c). Some drainage flows east into Lake Sammamish through Phantom Lake and another stream.

The project objectives were (USEPA, 1982c):

- *To apply uniformly, in selected drainage basins, a variety of management practices that are available to and achievable by local units of government.*
- *To improve standard practices and operations by varying the frequency and manner of application, developing management programming methods, and altering monitoring and inspection practices for greater responsiveness to water quality needs.*
- *To test, analyze, and document the impact of local management practices on storm water quality, isolating causal factors and their impacts on water quality and evaluating and developing functional relationships between the quantity and quality of runoff and the hydrologic and cultural characteristics of the basins involved.*
- *To develop, test, and document methods of source control of common urban storm water pollutants.*
- *To document temporal changes in storm runoff and constituent concentrations within several drainage basins of differing land use.*
- *To develop and document means of incorporating best management practices into the institutional and operational framework of local government agencies.*
- *To expand the toxic metals, sediment, herbicides and pesticides, and other databases for various land use categories, contributing to the data base of storm water quality modeling efforts nationally.*
- *To develop methods for estimating storm and annual loads of water quality constituents from unsampled watersheds in each urban-study area.*
- *To evaluate methods of transferring the data to ungaged watersheds in other regions.*

C.2.1 Monitoring Approach

Monitoring activities took place in three catchment areas (Figure C-3) (USEPA, 1982c): (1) Surrey Downs, (2) Lake Hills, and (3) 148th Avenue. Three groups participated in the monitoring efforts: the U.S. Geological Survey (USGS), the City of Bellevue, and the municipality of Metropolitan Seattle (Metro). Two of the three study catchments, Surrey Downs and Lake Hills, were single-family residential areas of similar size. These two basins were used to investigate the effectiveness of street sweeping for reducing the amount of pollutants in storm runoff. The third catchment, 148th Avenue, contained

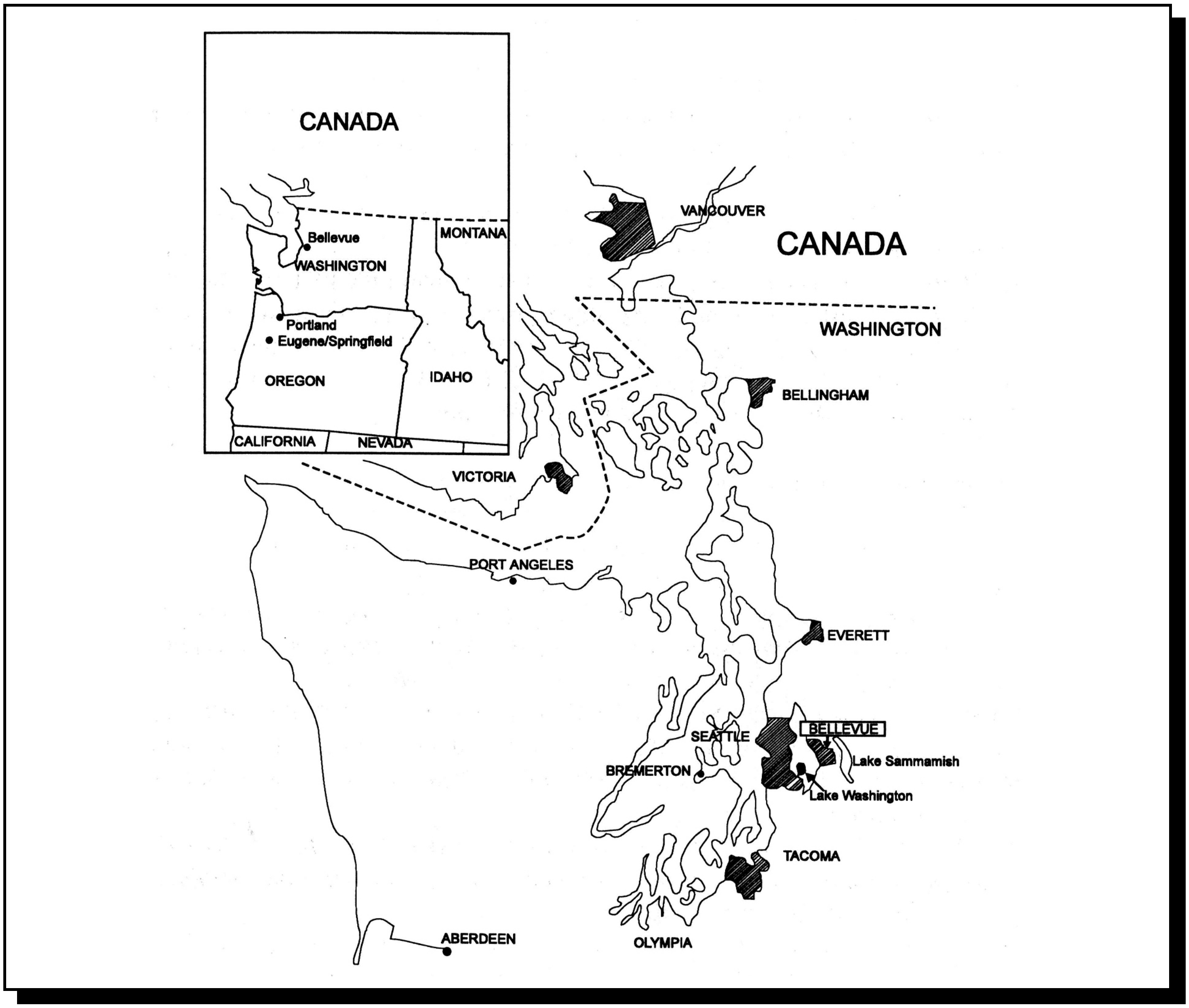

Figure C-2. State locus of Bellevue, Washington, NURP. (Source: USEPA, 1982c)

a divided 4-lane arterial street. The data from this site were used to investigate the effects of detention basins on the runoff quality. The monitoring activities also allowed investigators to:

- Define pollutant hydrographs for each of the three catchments during approximately 12 storms per year.
- Determine the effectiveness of street cleaning equipment for various levels of effort under the actual conditions encountered.
- Describe the quantities and characteristics of sewerage system particulates in the study area.
- Obtain a continuous mass balance relationship between total runoff yields and all the sources of urban runoff pollution.
- Analyze samples for the 129 EPA toxic or "priority" pollutants.

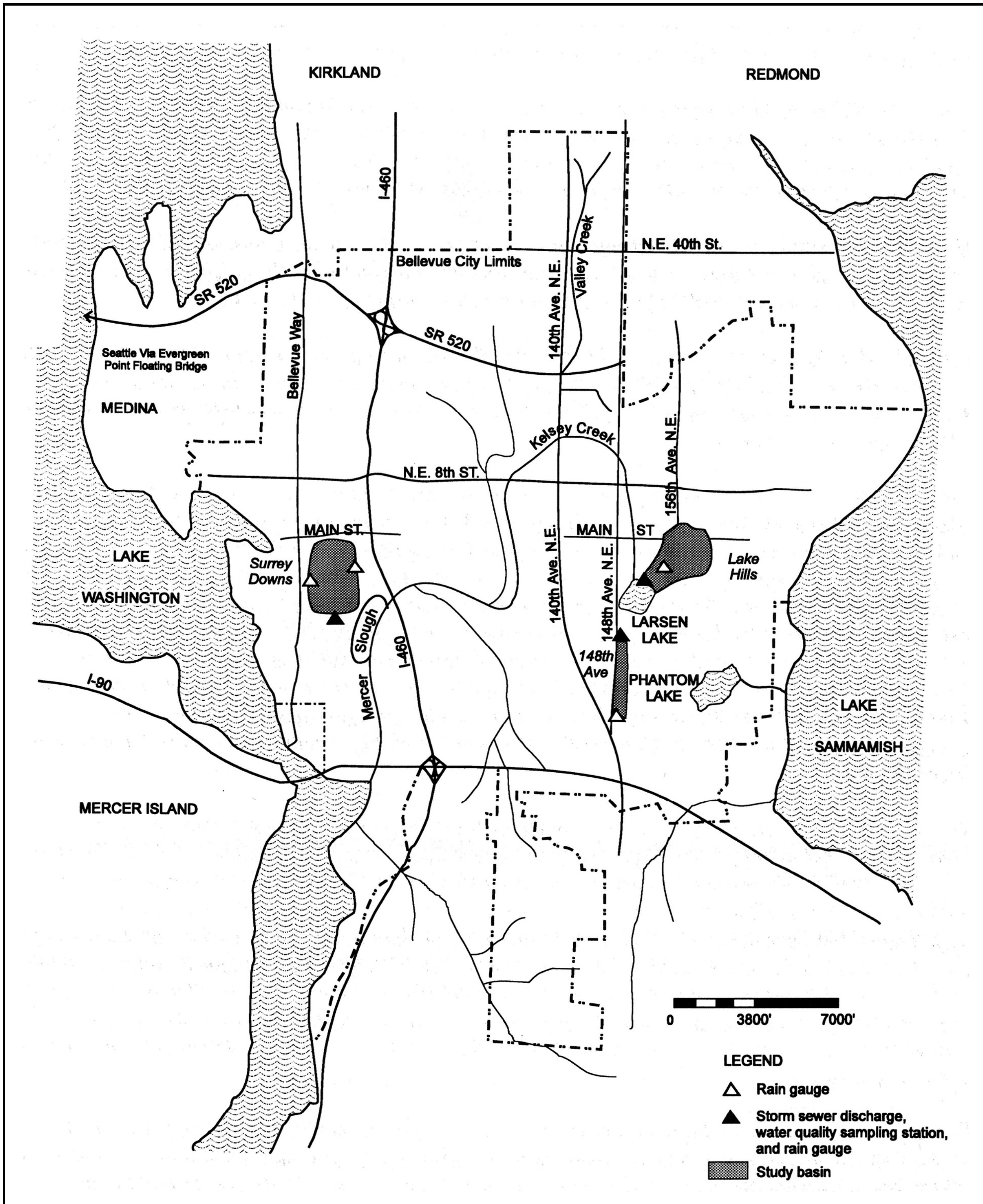

Figure C-3. Bellevue, Washington, NURP stream systems and sampling sites. (Source: USEPA, 1982c)

The following, taken from NURP project summaries (USEPA, 1982c), describes in some detail the sampling approaches and equipment used to meet the monitoring objectives.

The area comprising the Surrey Downs catchment consisted of single family homes and the Bellevue Senior High School. Slopes in the basin were generally moderate, with the exception of the steep slopes on the west side. Surrey Downs was relatively isolated from neighboring communities by the lack of easy vehicular access and convenient "short cuts" through this residential neighborhood.

The Lake Hills catchment contained single family residences and the St. Louise Parish Church and School. Although there were relatively isolated residential areas within the catchment, two through-streets, which carry more traffic than a typical residential street, cross the area.

The 148th Avenue catchment contained 4,960 feet of 148th Avenue, a four-lane, divided arterial street, and some adjacent land with sidewalks, apartments, parking lots, office buildings, and grassy swales that were used as detention basins. A little over one-fourth of the catchment area was taken up by the 148th Avenue street surface.

USGS sample collection and management procedures were essentially the same at all three sites. A digital paper punch recorder recorded: (1) clock time, (2) a number code which indicated if a sample was taken by the automatic sampler, (3) accumulated precipitation in up to three rain gages, and (4) up to two stages for computing discharge. Data were recorded at 5-minute intervals whenever the gage exceeded a [preset] threshold or whenever there was measurable precipitation. Precipitation was measured with tipping-bucket rain gages. Three gages were operated for the Surrey Downs catchment and two each were operated for the Lake Hills and 148th Avenue catchments. Rainfall and dry deposition quality samples were collected at one location in each catchment. Discrete runoff samples were taken during storms for defining the temporal variation of water quality during storm hydrographs. Samples were taken at a preset time interval (5 to 50 minutes) once the stage exceeded a preset threshold.

The Manning composite sampler [used by Bellevue to collect composite flow and proportional stormwater runoff samples] *was triggered at pre-determined increments of flow (300 and 500 cubic feet, the former to obtain more subsamples when small events were expected). The Manning flowmeters used an ultrasonic transducer to sense relative stage. Stage was converted to discharge by a programmed microprocessor in the flowmeter and presented on a circular flow chart as a percentage of maximum rated flow. The microprocessor was programmed from a stage/discharge rating developed by the USGS. Storm samples were removed from the samplers as soon as possible after storms, typically within two or three hours. Samples were kept on ice until pH, conductivity and turbidity were measured in-house. Subsamples were preserved and sent to a contract lab in Seattle for the remaining chemical analysis.*

To obtain street surface particulate samples, the City of Bellevue used the following procedures. Because the street surfaces were more likely to be dry during daylight hours (necessary for good sample collection), collection did not begin before sunrise nor continue after sunset, unless additional personnel were available for traffic control. Subsamples were collected in a narrow strip about six inches wide from one side of the street to the other (curb-to-curb). In heavily traveled streets where traffic was a problem, some subsamples consisted of two separate half-street strips (curb-to-crown). A pick-up truck was used to carry the equipment components, consisting of a generator, tools, fire extinguisher, vacuum hose and wand, and two wet-dry vacuum units during sample collection. The truck had warning lights, including a roof-top flasher unit.

To carry out the catch basin sampling tasks, all catch basins in each study area were surveyed for location, length, size and slope of pipes, and depth of catchment. Another survey was done to record the dimensions of each catch basin. Sediment volume was then calculated from a measurement of sediment depth.

Some experimental design work was done in 1979 and early 1980 to determine the concentrations of some pollutant constituents. Grab samples of supernatant and sediment were taken from selected catch basins in each study area and submitted to a contract lab for chemical analysis. During 1980, two complete catch basin inventories were made; recording sediment depth, and thus mass loading in the system. Monthly inventories were scheduled for 1981. After December, 1980, spot checks of fifteen to twenty-five selected catch basins in each study area were made after each significant storm event. This information, along with storm and street loading data allowed characterization of flushing and deposition within the sewerage system.

For the toxicant inventory portion of the study, stormwater runoff samples were collected as flow proportioned composites using a Manning S300T automated sampler (all teflon and glass contact surfaces) activated by ultrasonic flowmeters, except for the volatile samples which were collected as grabs early in the storm events. Samplers and containers were cleaned between events according to USEPA protocols using "Micro" brand soap and nitric acid; the hydrochloric acid and methylene chloride rinses were not used. Deionized distilled water blanks were taken through each sampler before use and have proven to be completely clean of organic and metal contaminants. Street surface dust samples were collected as described above using a stainless steel vacuum and PVC flexible hose. No special cleaning protocol was applied to the vacuum. Some sample contamination could have occurred from the PVC hose, but no functional alternatives [have] been found for collecting the dust samples. Interstitial water samples from the stream-bed in Kelsey Creek were collected through aluminum standpipes set in the stream gravel, using a Manning S3000T sampler to draw the water up from the perforated base of the standpipe. This sampling was in conjunction with the "Ecological Impacts of Stormwater Runoff in Urban Streams" project of the University of Washington.

C.2.2 Equipment

For the City's street sampling task various vacuum and hose lengths were tested. Relative air flows and suction pressures in the hose were monitored for different test set-ups. Both one- and two-vacuum configurations and 1.5 inch hoses in lengths varying from 10 to 35 feet were tested, along with a Vacu-Max unit. The standard "reference" system was two vacuums and a 35-foot hose. The best suction and higher air velocities were observed with two vacuums and short hose lengths (10 feet), but the short hose length would require that the vacuums be dismounted from the truck at each subsampling location. The longer hose, with the two vacuums, was judged adequate, and resulted in great cost and time savings.

Two industrial vacuum cleaners (2-hp) with one secondary filter and a primary dacron filter bag were used. The vacuum units were heavy duty and made of stainless steel to reduce contamination of the samples. The two 2-hp vacuums were used together by using a wye connector at the end of the hose. This combination extended the useful length of the 1.5 inch hose to 35 feet and increased the suction.

C.3 Conestoga Headwaters, Pennsylvania Rural Clean Water Program

The following are the key elements of the ground water monitoring program of the Pennsylvania Rural Clean Water Program (Pennsylvania RCWP Coordinating Committee, 1984):

There were four components to the monitoring strategy and which included three scales or levels of monitoring [Figure C-4]. *The first component, the regional network, consisted of general monitoring on a regional scale and included the entire 188 square-mile area. The second component involved more detailed monitoring in a small watershed area of about 5.8 square miles (Little Conestoga Creek basin).*

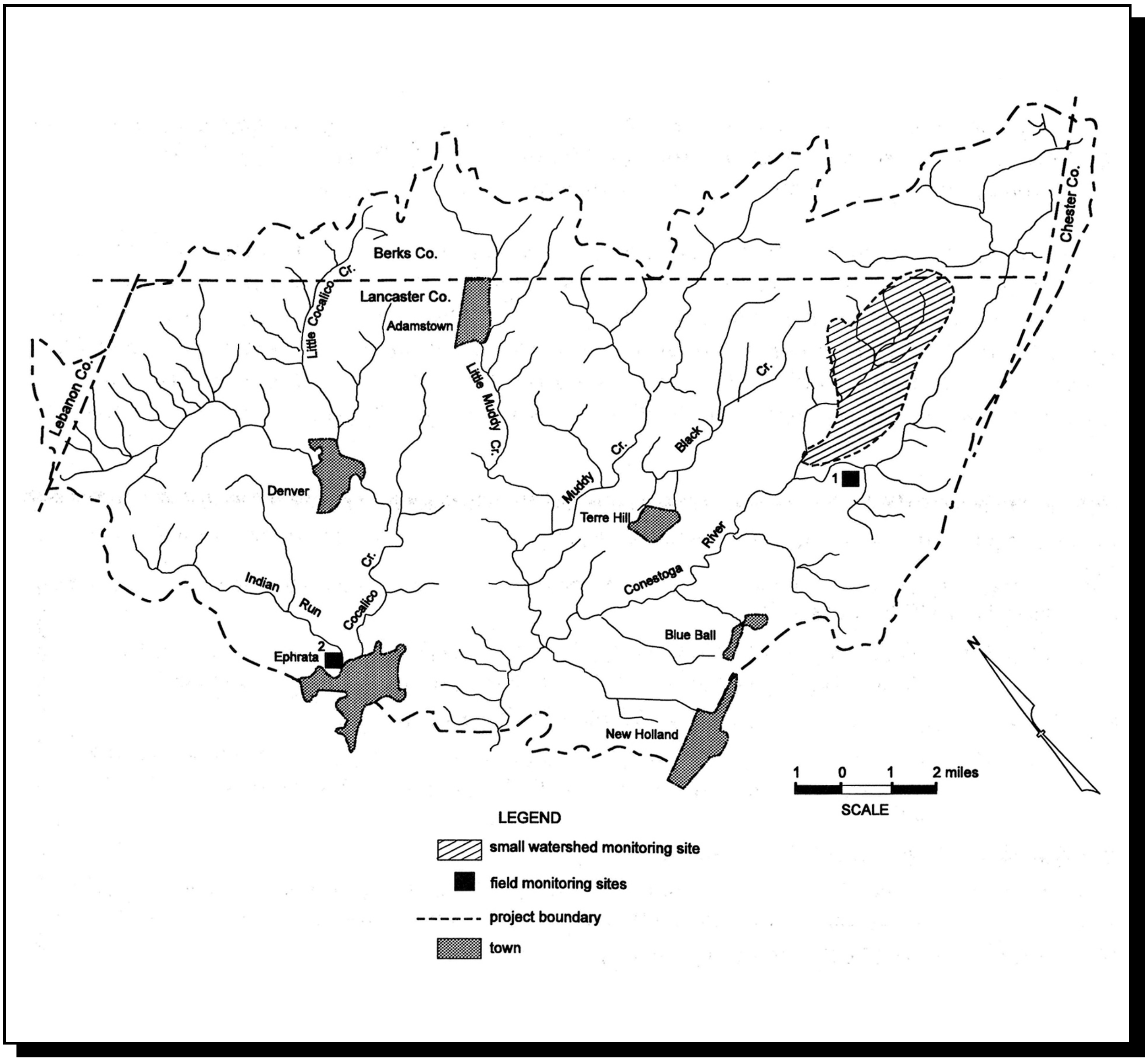

Figure C-4. Location of Conestoga River headwaters area and four monitoring components of the Pennsylvania RCWP. (Source: Pennsylvania RCWP Coordinating Committee, 1984)

The third and fourth components consisted of intensive monitoring on a field scale. Both field sites were on farms.

All four components were designed to permit the comparison of water quality before and after the implementation of BMPs. As such, they included pre-BMP and post-BMP monitoring periods. Although the basic strategy was the same, each component addressed a slightly different problem [Table C-7]. *All four components addressed the problem of nutrients in ground water and surface water; three addressed the sediment problem in surface water; and two addressed the pesticide problem in ground and surface waters. Since the single most important source of water quality problems appeared to be the excess of nutrients, nutrient management BMPs were emphasized in most of the monitoring components.*

C.3.1 Regional Network:

The monitoring schedule for the regional network consisted of three one-year monitoring periods: (1) a pre-BMP period; (2) an early post-BMP period; and (3) later post-BMP period [Table C-8]. *The quality of ground and surface waters, as well as precipitation, were monitored.*

The 43 ground water sites included 42 private domestic, and farm wells and one spring. Of the 43 ground water sites, 33 were located in carbonate rocks [Figure C-5]. *This difference in geology (carbonate vs. noncarbonate areas) played an important role in the quality of water. The areas having the highest levels of nutrients, sediment, pesticides, and bacteria in water consistently coincided with areas underlain by carbonate rocks. This was probably due to the greater number of farms in the carbonate areas and the greater permeability of the carbonate rocks. Because of the greater problems*

Table C-7. Specific problems to be addressed for each monitoring component of the Pennsylvania RCWP.

REGIONAL NETWORK (188 mi^2)	
Problem:	What is the composite effect of all implemented BMPs on sediment, nutrients, and pesticides in streams and nutrients and pesticides in ground water?
SMALL WATERSHED SITE-LITTLE CONESTOGA CREEK (5.8 mi^2)	
Problem:	What is the effect of a typical combination of BMPs (with emphasis on nutrient management) on sediment and nutrients in the creek and nutrients in ground water?
FILED SITE 1 - DAIRY FARM (21.7 acres)	
Problem:	What is the effect of manure storage and terracing on sediment, nutrients, and pesticides in runoff and nutrients and pesticides in groundwater?
FIELD SITE 2 - HOG/STEER FARM (55 acres)	
Problem:	What is the effect of nutrient management on nutrients in runoff and ground water?

(Source: Pennsylvania RCWP Coordinating Committee, 1984)

in the carbonate areas, the regional network, as well as the other three monitoring components, were concentrated in the carbonate areas.

C.3.2 Small Watershed Site:

In addition to ground water, surface water, and precipitation data, data on nutrients in soils and manure were collected [Table C-9]. *More detailed land-use data were also collected. One gage, four additional base-flow sites, and all the ground water sites were located in the eastern end of the basin where BMP implementation was projected to be greatest* [Figure C-6].

C.3.3 Field Site 1

In addition to the same data that was collected at the small watershed site (with the exception of base-flow data), data were obtained from lysimeters [Table C-10]. *The locations of the data collection facilities at one field site are shown in* [Figure C-7].

C.3.4 Field Site 2

The planned schedule, approach, and data collection were similar to those for field site 1 [Table C-11]. *The only significant difference was that data collection concentrated on nutrients at field site 2 since nutrient management BMPs were planned for this component. The locations of the data collection*

Table C-8. Monitoring plan for regional network of the Pennsylvania RCWP.

SCHEDULE

1982 - 1983 Pre-BMP
1985 - 1986 Early Post-BMP
1988 - 1989 Later Post-BMP

APPROACH

Compare concentrations and/or loads of sediment, nutrients, and pesticides before and after BMP implementation.

WATER QUALITY DATA COLLECTION

2 Stream Gages - sediment, nutrients, and pesticides for major storms

4 Base-flow Sites - monthly sediment, nutrients, and pesticides

43 Ground Water Sites - nutrients and pesticides in spring; summer, and fall

3 Precipitation Gages

LAND USE DATA

Aerial photograph analysis for distribution of major land uses for each of the 3 time periods.

Types and locations of BMPs implemented.

(Source: Pennsylvania RCWP Coordinating Committee, 1984.)

facilities [at this field site] *are shown in* [Figure C-8]. *Field site 2 was in a carbonate area and was monitored for two years for pre-BMP monitoring.*

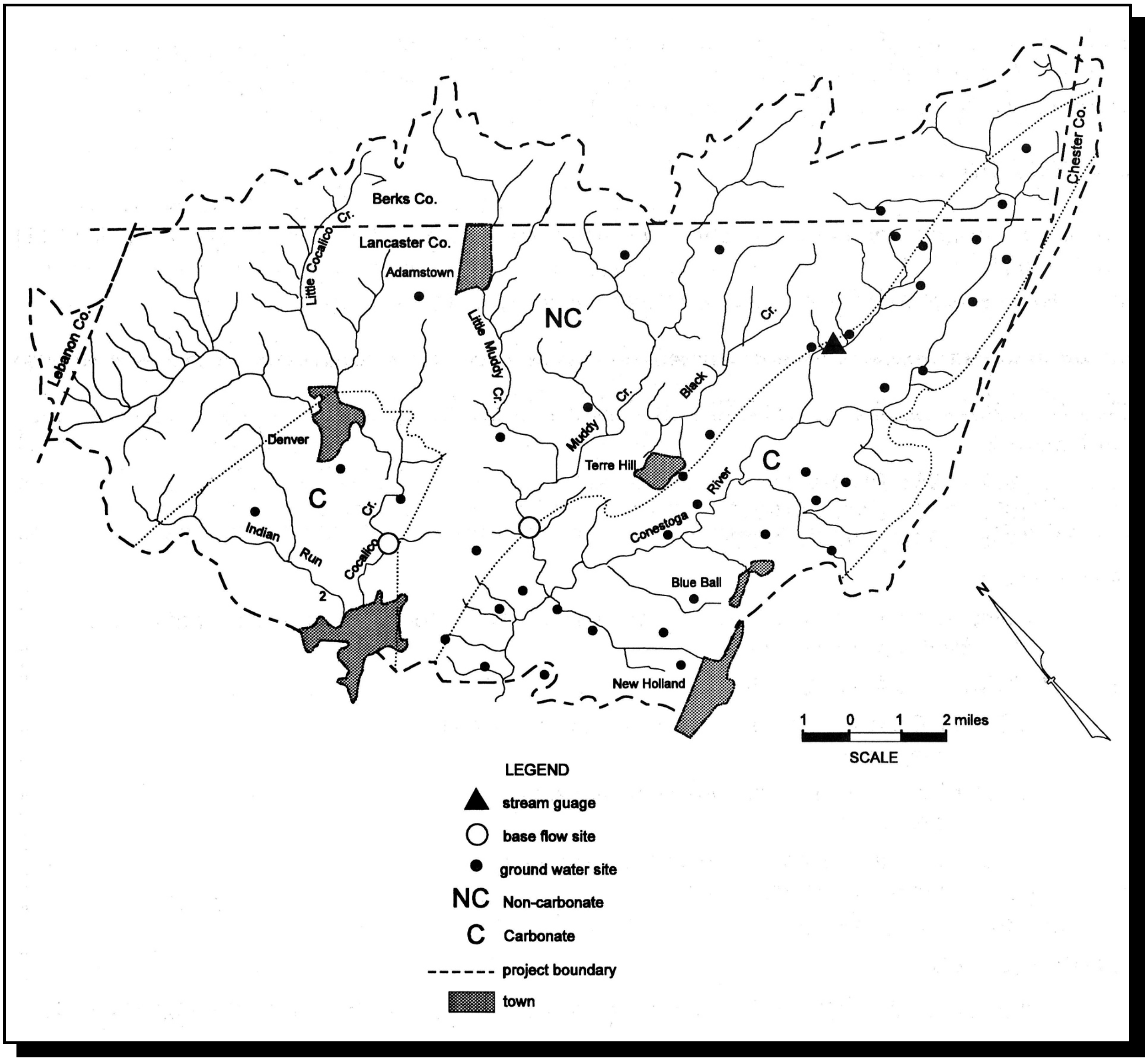

Figure C-5 Location of monitoring facilities for the regional network of the Pennsylvania RCWP. (Source: Pennsylvania RCWP Coordinating Committee, 1984)

Table C-9. Monitoring plan for small watershed site of the Pennsylvania RCWP.

SCHEDULE

1982 - 1985 Pre-BMP
1985 - 1986 BMP
1986 - 1988 Post-BMP

APPROACH

Compare concentrations and loads of sediment and nutrients before and after BMP implementation

WATER-QUALITY DATA COLLECTION

2 Stream Gages - sediment and nutrients for major storms
7 Base-flow Sites - sediment and nutrients every 3 weeks
5-10 Ground Water Sites - nutrients 4 times per year
Soil - spring, fall
Manure - spring
1 Precipitation Gage

LAND-USE DATA

Monthly report from each farmer, including information on:

Plowing	Planting
Harvesting	Field conditions
Liming	Fertilizing
Manure spreading	Pesticide application

(Source: Pennsylvania RCWP Coordinating Committee, 1984)

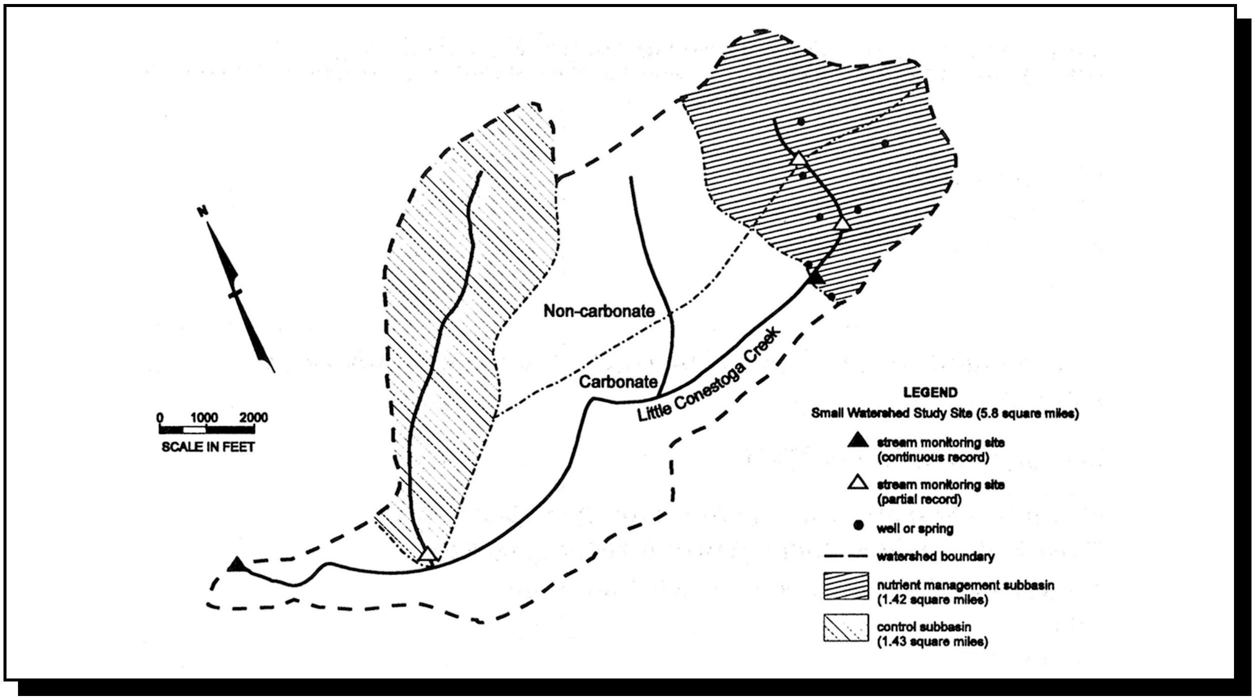

Figure C-6. Location of monitoring facilities for the small watershed site of the Pennsylvania RCWP. (Source: Pennsylvania RCWP Coordinating Committee, 1984)

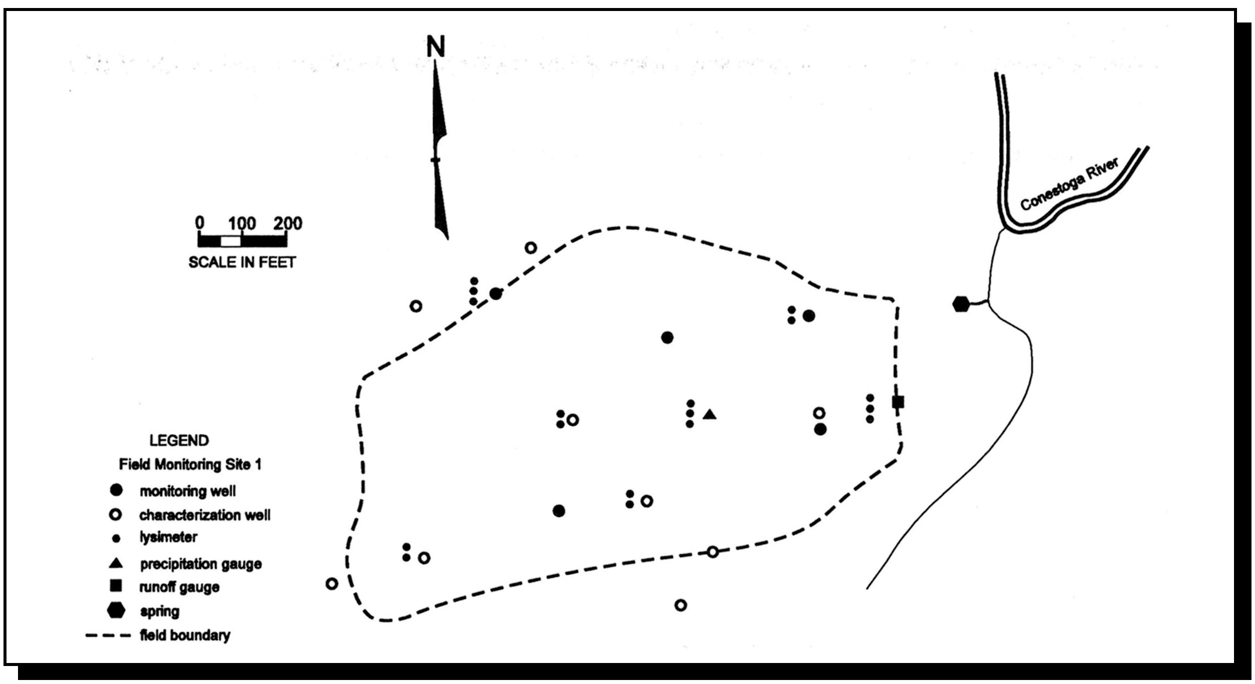

Figure C-7. Location of monitoring facilities for field site 1 of the Pennsylvania RCWP. (Source: Pennsylvania RCWP Coordinating Committee, 1984)

Table C-10. Monitoring plan for field site 1 of the Pennsylvania RCWP.

SCHEDULE

1982 - 1984	Pre-BMP
1984 - 1985	BMP
1985 - 1987	Post-BMP

APPROACH

Compare concentrations and loads of sediment, nutrients, and pesticides before and after BMP implementation.

WATER-QUALITY DATA COLLECTION

1 Runoff Gage - sediment and nutrients for major storms (pesticides for selected storms)

7 Groundwater Sites - nutrients monthly and 4 storms per year (pesticides less frequently)

5-10 Lysimeters - nutrients 4 storms per year (pesticides for selected storms)

Soil - spring, fall

Manure - spring

1 Precipitation Gage

LAND-USE DATA

Biweekly reports from farmer, including information on:

Plowing	Planting
Harvesting	Field conditions
Liming	Fertilizing
Manure spreading	Pesticide application

(Source: Pennsylvania RCWP Coordinating Committee, 1984)

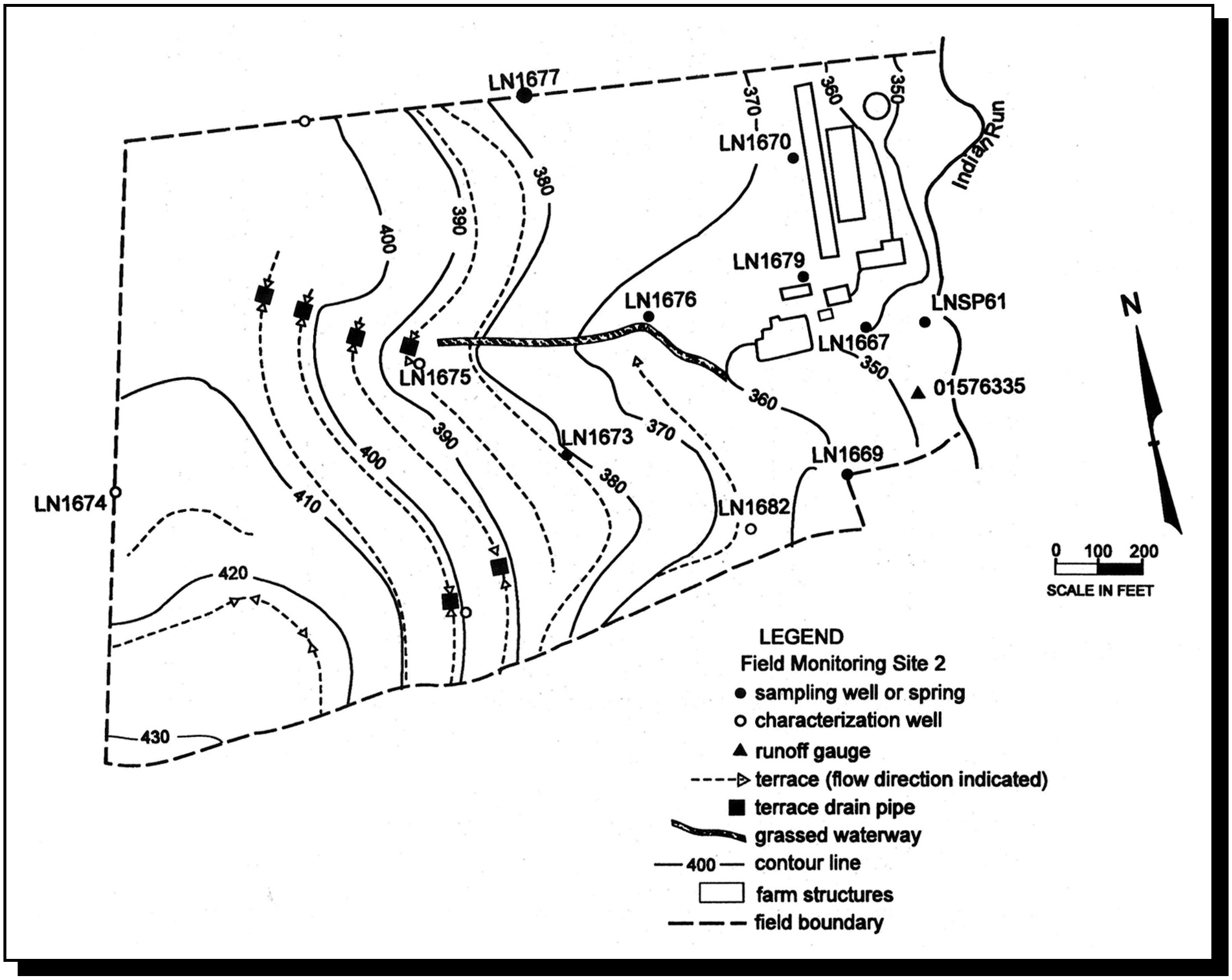

Figure C-8. Field site 2, Lancaster County, Pennsylvania, Pennsylvania RCWP. (Source: Pennsylvania RCWP Coordinating Committee, 1984)

Table C-11. Monitoring plan for field site 2 of the Pennsylvania RCWP.

SCHEDULE

1984 - 1986	Pre-BMP
1984	BMP
1986 - 1988	Post-BMP

APPROACH

Compare concentrations and loads of nutrients before and after BMP implementation.

WATER-QUALITY DATA COLLECTION

1 Runoff Gage - nutrients for major storms
5-10 Groundwater Sites - nutrients monthly and 4 storms per year
5-10 Lysimeters - nutrients 4 storms per year
Soil - spring, fall
Manure - spring
1 Precipitation Gage

LAND-USE DATA

Biweekly report from farmer, including information on:

Plowing	Planting
Harvesting	Field conditions
Liming	Fertilizing
Manure spreading	

(Source: Pennsylvania RCWP Coordinating Committee, 1984)