Strawbridge Lake Watershed
Stormwater Best Management Practices Evaluation

Monitoring Network Design and Rationale

Sampling Locations: Attachment A provides a detailed map showing the approximate location of sampling locations 1-6. Location 1 can be found on Hooten Creek just upstream of the Upper Basin (39°57.336′ N, 74°56.768′ W), and Location 2 can be found on the North Branch Pennsauken Creek just upstream of the Lower Basin (39°57.116′ N, 74°58.020′ W). Location 3 is at the outlet weir of the Upper Basin (39°57.092′ N, 74°57.214′ W); Location 4 is at the outlet weir of the Middle Basin (39°56.934′ N, 74°57.562′ W), and Location 5 is at the outlet weir of the Lower Basin (39°57.118′ N, 74°58.099′ W). Location 6 is immediately downstream of the Kings Highway crossing of Pennsauken Creek (coordinates to be determined).

Temporal and Spatial Aspects:

Surface Water Sampling

Surface water quality samples will be collected from sampling locations 1-5 once every two weeks from May 2005 through September 2005 following 48 hours of no precipitation. Surface water sampling will be conducted so that the samples are representative of the cross section of the stream. A single grab sample will be collected at all locations with a stream width of six feet or less (i.e., at the outlet weir of each of the basins). At stream locations with a width greater than six feet, three subsurface grab samples will be collected at equidistant points across the stream. These grab samples then will be composited in a larger volume container from which the desired volume will be transferred to the sample bottles. A dedicated large volume container will be assigned to each sample location. Prior to each sampling event, the large volume containers will be decontaminated using the following procedures: 1) distilled/deionized water rinse, 2) non-phosphate detergent wash, 3) distilled/deionized water rinse, 4) air dry, and 5) distilled/deionized water rinse.

Soil Sampling

Soil samples will be collected from the stream bank at least once during the project at each of the sampling locations (1-5) in accordance with the sampling procedures outlined in Attachment B by the Rutgers Cooperative Research & Extension Soil Testing Laboratory. If additional funding for this project is secured, additional rounds of soil sampling will be conducted during the study period.

Biological Sampling

Samples of the benthic macroinvertebrate community will be collected using a multihabitat sampling approach, concentrating on the most productive habitat of the stream (i.e., riffle/run areas) plus coarse particulate organic matter (CPOM) or leaf litter. Benthic macroinvertebrates will be collected from Location 1, 2, and 6 once in either early summer (i.e., late June) or late summer (i.e., late August) as described in Attachment C.

Basis for Sampling Locations:

Surface water quality sampling will be conducted to assess the tributary inputs of nutrients and bacteria to Strawbridge Lake (i.e., Locations 1 and 2), as well as the movement of nutrients and bacteria from basin to basin (i.e., Locations 3, 4, and 5) to evaluate the effectiveness of the BMPs in improving the quality of water in Strawbridge Lake. Soil sampling will be conducted throughout the study area since NJDEP has suggested that the soils in the watershed have high levels of phosphorus. Biological sampling will be conducted so that the benthic macroinvertebrate community upstream (i.e., Locations 1 and 2) and downstream of Strawbridge Lake (i.e., Location 6) can be characterized, compared, and evaluated for biological integrity.

Monitoring Parameters

Surface water quality sample collection, as well as *in situ* measurements of pH, temperature, dissolved oxygen, stream width, stream depth, and stream velocity, will be conducted by the Rutgers Cooperative Research & Extension Water Resources Program. Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment D. Samples will be analyzed for ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, total Kjeldahl nitrogen, total phosphorus, dissolved orthophosphate phosphorus, and total suspended solids by New Jersey Analytical Laboratories (NJDEP Certified Laboratory #11005).

We acknowledge that Rutgers Cooperative Research & Extension is not certified to perform testing for pH, temperature, and dissolved oxygen. These *in situ* measurements are being taken by Rutgers Cooperative Research & Extension for their own research purposes, and these data will not be submitted as part of the final report. Only the data analyzed by the identified NJDEP certified laboratory will be submitted as part of this study.

Soil sampling will be conducted by the Rutgers Cooperative Research & Extension Water Resources Program in accordance with the methods outlined in Attachment B. The samples will be analyzed for Level 1 Fertility, which includes nutrients (i.e., P, K, Ca, Mg, Cu, Mn, Zn, B, and Fe) and pH, by the Rutgers Cooperative Research & Extension Soil Testing Laboratory.

Biological sampling will include benthic macroinvertebrate grab type sampling using a Surber Square Foot Bottom Sampler, along with the collection of CPOM. Physicochemical measurements will include *in situ* pH, temperature, dissolved oxygen, stream width, stream depth, and stream velocity. Benthic macroinvertebrate sampling and identification will be conducted by Rutgers Cooperative Research & Extension Water Resources Program. The Water Resources Program will also measure temperature, pH, and dissolved oxygen and will make stream width, stream depth, and stream velocity determinations in accordance with the procedures specified in Attachment D.

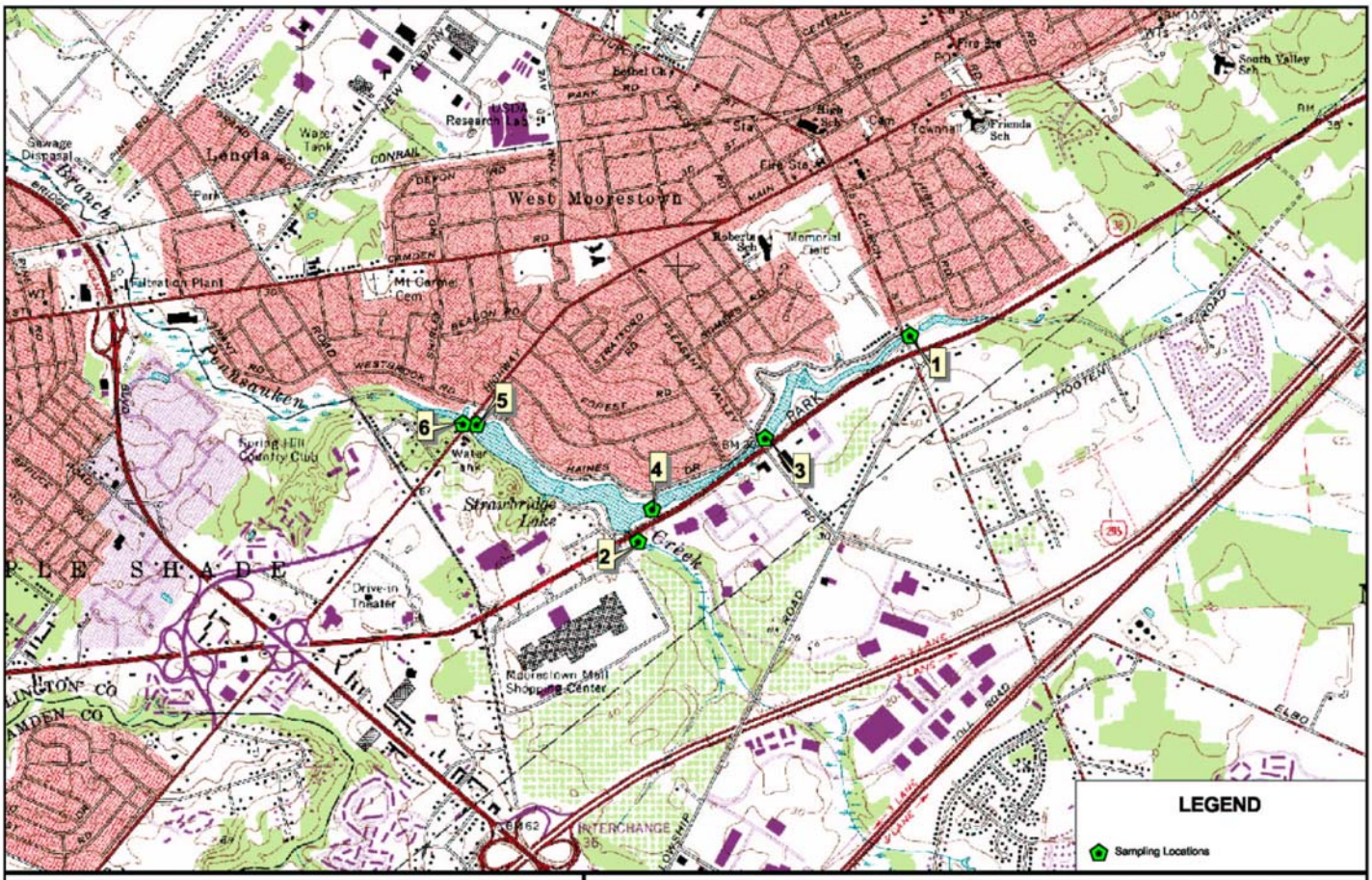
Schedule*

Task	Date
Submit quality assurance work plan	May 2005
Conduct surface water quality sampling	May 2005 – September 2005
Conduct soil sampling	Once during May 2005 – September 2005
Conduct biological sampling	Either Early June 2005 or late August 2005
Submit data and summary report to NJDEP	February 2006

* All scheduling is subject to the natural occurrence of appropriate stream flow conditions (i.e., non-flooding conditions).

ATTACHMENT A

Sampling Locations
Strawbridge Lake Watershed
Stormwater Best Management Practices Evaluation



Attachment A
Sampling Locations
Strawbridge Lake Watershed
Stormwater Best Management Practices Evaluation

DATA SOURCE: USGS 7.5' Topographic Quadrangle, Moorestown-NJ

ATTACHMENT B

Soil Sampling Procedures

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS COOPERATIVE EXTENSION
New Jersey Agricultural Experiment Station

SOIL TESTING LABORATORY
P.O. Box 902, Milltown, NJ 08850
(732) 932-9295 FAX (732) 932-9292

Soil Sampling Instructions - lawn, shrubs, flowers, trees, or home vegetable or fruit garden

Taking a soil sample is a critical step in the process of soil analysis. If a soil is not properly sampled, the analytical results will be of little use, and may actually be detrimental to understanding the plants' situation. Therefore, please follow these directions to the best of your ability.

Planning

- **Sample separately the areas used for different types of plants**. For example, keep samples taken from lawn areas separate from samples taken from flower and shrub areas. Samples from areas with rhododendron, azalea, and other acid-loving plants should be kept separate from samples taken from areas with other types of shrubs. That is, *most samples should represent only one type of planting*. If more than three types of plantings are selected, the sample probably represents none of them well.
- Also sample separately areas that have received different lime and/or fertilizer treatments in the past.
- Do not sample areas that have been limed or fertilized within the past 6 weeks unless trouble is evident.
- Where poor growth exists, separate samples should be taken from both good and bad areas, if possible.
- To obtain a representative sample, plan to collect 10 - 15 subsamples at random locations within each area to be sampled (Exception: in areas smaller than 100 sq ft, 5 - 10 subsample locations will be adequate).
- Each sample must be submitted in a separate soil test kit with the appropriate soil test questionnaire.

Sampling procedure

1. The best time to sample soils is when the moisture content is right for tilling: not too wet, not too dry.
2. Use a trowel, spade, auger, or soil tube to obtain thin vertical slices or cores of soil from the surface to a depth of 6 - 7". If using a trowel or spade, insert the blade into the soil to a depth of 6 - 7"; remove soil and throw it aside. Reinsert the blade to take a thin (½") slice of soil, and lift the slice from the ground. Using a knife, cut from the center of this slice a 1" wide core from top to bottom. Place the core (subsample) in a clean bucket or other container.
3. Repeat this procedure at 10 - 15 locations within the sampling area, placing the subsamples together in the container.
4. If the soil is very wet when samples are taken, the soil should be spread out on clean paper or plastic to air-dry (**do not heat** to dry). Drying will also reduce mailing costs.
5. Mix the subsamples for a sampling area together in the container, breaking up large soil aggregates or clods. The goal is to provide a representative sample.
6. Place ½ - 1 pint of the soil in the plastic bag provided. Seal the plastic bag with a rubber band or twist tie, and place the sample in the cloth mailer bag. Excess soil can be returned to the sampling holes.
7. Repeat for any separate areas that you wish to have tested (to be submitted in a separate mailing kit). Do not place more than one sample in a sample bag.

Submitting the sample(s)

- Fill out the soil test questionnaire included with the soil testing kit.
  - Please provide a complete address, including zip code, and a phone number.
  - If you submit more than one sample, make sure to give a sample identification name (for example, "front yard" or "driveway border") on the appropriate line of the questionnaire for each sample. The sample ID will be printed on the report for you to distinguish between samples. Keep a record of serial numbers, sample ID, areas sampled, and date mailed.
  - If you select any test other than the Level 1, additional payment must be made for the special tests. Enclose a check in the envelope or provide the *Visa/Mastercard* information requested.
  - Fill out the reverse side to obtain recommendations, selecting **only one** type of planting (See "*Planning*"). Check off the appropriate selections under "Growing conditions".
- Place the completed questionnaire in the envelope attached to the mailing bag. Mail at first class rate (minimum). For several sample kits, it may be less expensive to package them together into a box or sturdy envelope. **For delivery services,** the actual location address of the Soil Testing Laboratory is: **Rutgers Soil Testing Lab, 16 Ag Extension Way, OTC – Cook College, New Brunswick, NJ 08901**

Results

- A soil test report will be mailed for each sample, typically within five working days of the lab receiving the sample. If special tests are requested, allow for 10-day turn-around time.
- For assistance with soil test report or soil/plant problems, consult with your county agent of Rutgers Cooperative Extension after you receive your Soil Test Report. Copies of your soil test report are forwarded to the RCE office in your county. Be prepared to discuss the types of plants, site conditions, and soil amendments used.

It should be recognized that soil tests aid in diagnosing only those troubles that result from a deficiency or an excess of lime and certain plant nutrients. Other factors may have an equal or greater influence on plant growth. These include soil drainage, rainfall, insects, diseases, and others. In the case of lawns, nitrogen fertilization and mowing height and frequency are very important to the health and appearance of the grass.

Visit the Rutgers Cooperative Extension website at *www.rce.rutgers.edu*

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ATTACHMENT C

Biological Sampling Procedures and Analysis

Biological Sampling Procedures and Analysis

Sampling Procedures:

Samples will be collected using a multi-habitat sampling approach, concentrating on the most productive habitat of the stream (i.e., the riffle/run areas), plus coarse particulate organic matter (CPOM) or leaf litter. This sampling method minimizes habitat or substrate variation between sampling sites, and includes all likely functional feeding groups of macroinvertebrates in the stream. Three grab type samples will be collected at each sampling site. Given the nature of the substrate at the sampling sites, a Surber Square Foot Bottom Sampler will be used to collect the grab samples. These samples will be sorted in the field, composited (i.e., the contents from the three grab samples from each site will be combined into a single container), and preserved in 80% ethanol for later subsampling, identification and enumeration.

A composite collection of a variety of CPOM forms (e.g., leaves, needles, twigs, bark, or fragments of these) will be collected. It is difficult to quantify the amount of CPOM to be collected in terms of weight or volume, given the variability of its composition. Collection of several handfuls of material is usually adequate, and the material is typically found in depositional areas, such as in pools and along snags and undercut banks. The CPOM sample will be processed using a U.S. Standard No. 30 sieve, and added to the composite of the grab samples for each site.

A 100-organism subsample of the benthic macroinvertebrate composite sample from each sampling site will be taken in the laboratory according to the methods outlined in the Rapid Bioassessment Protocol used by the NJDEP Bureau of Freshwater and Biological Monitoring. With the exception of chironomids and oligochaetes, benthic macroinvertebrates will be identified to genus. Chironomids will be identified to subfamily as a minimum, and oligochaetes will be identified to family as a minimum.

A habitat assessment will be conducted concurrent with the benthic macroinvertebrate sampling in accordance with the methods used by the NJDEP Bureau of Freshwater and Biological Monitoring. The measurement of physicochemical parameters will also be conducted concurrent with the benthic macroinvertebrate sampling. Surface water sampling for the measurement of pH, temperature, and dissolved oxygen will be conducted on a representative cross section of the steam. At least four subsurface grab samples will be collected across an established transect. These grab samples will be composited, and an appropriate volume will be transferred to sample bottles for in situ measurement of pH, temperature, and dissolved oxygen. Stream width, stream depth, and stream velocity will be measured in accordance with the methods outlined in Attachment D.

Data Analysis:

The NJDEP Bureau of Freshwater and Biological Monitoring uses several community measures of biometrics adapted from the Rapid Bioassessment Protocols to evaluate the biological condition of sampling sites within the Ambient Biomonitoring Network in New Jersey. These community measures include taxa richness, EPT index, %EPT, %CDF, and Modified Family Biotic Index. This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey Impairment Score

Biological Sampling Procedures and Analysis (continued)

(NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired, and is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams.

To determine the similarity among the sampling sites with respect to species composition, the Percentage Similarity Index will be calculated for all pair wise comparisons of the sampling sites. Also, the benthic macroinvertebrates will be separated into the four broad functional feeding groups to evaluate community structure. In addition, the Shannon diversity index will be calculated to evaluate community structure.

Other metrics may be utilized. If the above metrics are not utilized, or if different metrics or indices are used, these changes will be discussed with NJDEP for approval. In addition, the findings from the habitat assessment will be used to interpret survey results and identify obvious constraints on the attainable biological potential of the site.

The final report will include a characterization of the aquatic biota, in particular the benthic macroinvertebrate community, occurring in the immediate vicinity of the Strawbridge Lake Watershed.

ATTACHMENT D

Stream Flow Measurement Procedure

Stream Flow Measurement Procedure

Stream width, depth, velocity, and flow determinations will be made in conformance with the following procedures:

1. A measuring tape is extended across the stream, from bank to bank, perpendicular to flow. Meter calibration is checked.

2. Using a Marsh-McBirney, Inc. Model 2000 Flo-Mate Portable Water Flow meter, velocity and depth measurements are made at points along the tape. Normally depth is measured using a rod calibrated in tenths of a foot. In shallow streams, a yardstick may be used to measure depth. Velocities are measured at approximately 0.6 depth (from the surface) where depths are less than 2.5 feet and at 0.2 and 0.8 depth (from the surface) in areas where the depth exceeds 2.5 feet.

3. The stream cross section is divided into segments with depth and velocity measurements made at equal intervals along the cross section. The number of measurements will vary with site conditions and uniformity of stream cross section. Each cross section is divided into equal parts depending upon the total width and uniformity of the section. At a minimum, velocities are taken at quarter points for very narrow sections. In general, velocity and depth measurements are taken every one to five feet. A minimum of ten velocity locations is used whenever possible. The velocity is determined by direct readout from the Marsh-McBirney meter set for 5 second velocity averaging.

4. Using the field data collected, total flow, average velocity, and average depth can be computed. Individual partial cross-sectional areas are computed for each depth and velocity measurement. The mean velocity of flow in each partial area is computed and multiplied by the partial cross-sectional area to produce an incremental flow. Incremental flows are summed to calculate the total flow. The average velocity for the stream can be computed by dividing the total flow by the sum of the partial cross-sectional areas. The average depth for the stream can be computed by dividing the sum of the partial cross-sectional areas by the total width of the stream. The accuracy of this method depends upon a number of factors, which include the uniformity of the steam bottom, total width, and the uniformity of the velocity profile.