Nassau County
Stormwater
Management Program

STORMWATER RUNOFF IMPACT ANALYSIS

PROCEDURES MANUAL

FINAL – October 1, 2007

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Nassau County
Stormwater Management Program

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1.0 EXECUTIVE SUMMARY

In accordance with the Nassau County Stormwater Management Program, this *Stormwater Runoff Impact Analysis Procedures Manual* (Manual) has been developed to provide a procedure to assess and rank all of the subwatersheds in Nassau County in an organized and consistent manner. This Manual provides guidance and standardization of stormwater impact analysis procedures to all regulators, planners and designers involved in stormwater management to achieve the required regulatory standard of reducing pollutants in stormwater to the maximum extent practicable. This Manual proves Nassau County is leading by example via taking steps necessary to improve the quality of the Long Island Sound and the County's streams, ponds lakes, estuaries, and bays.

The methods presented herein closely follow procedures in Center for Watershed Protection (CWP) manuals and publications. This Manual modifies procedures to address field conditions and issues specific to Nassau County. The two main components of the Manual are: 1) Subwatershed Assessment; and 2) Candidate Site Assessment and Recommendations.

The first component of the Manual, Subwatershed Assessment, addresses the review of existing conditions of the subwatershed, and includes sections for Drainage Infrastructure Mapping, Subwatershed Vulnerability Analysis, Stream Assessment, and Comparative Analysis. The methodology for Drainage Infrastructure Mapping addresses the review of existing records documents, and the inputting of the data into the County GIS. A procedure for GPS field verification and collection of additional infrastructure data is then presented. Field data is inputted into the GIS. The Subwatershed Vulnerability Analysis uses County GIS data to determine impervious area, assign vulnerability classifications, and assess pollutant loads. The Stream Assessment includes a field review of the stream corridor to inspect and document specific field conditions. The

Comparative Analysis assigns "metrics" based on the data collected which are then used to classify each subwatershed.

The second component of the Manual, Candidate Site Assessment and Recommendations, provides a methodology to identify applicable stormwater management practices (SMP) and siting locations to reduce pollutant loads and improve watershed water quality. This component includes sections on water quality objectives, site assessment, SMP selection, pollutant load reduction analysis, subwatershed improvement calculations and preparation of a Stormwater Impact Analysis Report.

2.0 INTRODUCTION

This section includes a discussion of the background of stormwater analysis that has lead to the need for the Manual and a discussion of the scope and objectives of the final Manual. The Manual will allow members of the MS4's inter-municipal coalition to produce consistent Impact Analyses that classify subwatersheds, standardize data collection and assessment and provide a restoration action methodology. The final subwatershed reports produced using the Manual will allow the County to review and rank subwatersheds based on consistent criteria.

2.1 BACKGROUND

Polluted stormwater runoff is often transported to Municipal Separate Storm Sewer Systems (MS4s) and ultimately discharged into local surface waters without treatment. Such pollutant discharges impair the waterways, thereby discouraging recreational use of the resource, contaminating drinking water supplies, and interfering with the suitability of the habitat for fish, other aquatic organisms, and neighboring wildlife.

In 1990, the United States Environmental Protection Agency (USEPA) promulgated rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater program. The Phase I NPDES program required operators of medium and large MS4s (i.e., those generally serving populations of 100,000 or greater) to implement a stormwater management program to control polluted discharges from the MS4s. In 1999, the USEPA promulgated Stormwater Phase II regulations extending coverage of the NPDES program to certain smaller MS4s based on their designation as Urbanized Areas according to the 2000 United States Census. The New York State Department of Environmental Conservation (NYSDEC) acts as the NPDES permit-issuing authority for New York State and has issued requirements for two State Pollutant Discharge Elimination System (SPDES) General Permits for stormwater runoff, one for MS4s in urbanized areas (GP-02-02) and one for construction activities (GP-02-01).

Phase II programs for MS4s consist of six minimum control measures as follows:

- Public Education and Outreach on Stormwater Impacts;
- Public Involvement and Participation;
- Illicit Discharge Detection and Elimination;
- Construction Site Stormwater Runoff Control;
- Post-Construction Stormwater Management in New Development and Redevelopment; and
- Pollution Prevention/Good Housekeeping for Municipal Operations.

The County has developed a Stormwater Management Program (NCSWMP) as required for coverage under the SPDES general permit No.GP-02-02. The County has formed an inter-municipal coalition with the local Towns, Cities and Villages to implement the NCSWMP. This consortium includes 57 municipalities in the County. The NCSWMP includes a listing of Stormwater Management Practices (SMP's) that will be implemented by the County and its municipal partners in order to achieve the regulatory standard of reducing pollutants in stormwater to the maximum extent practicable.

2.2 OBJECTIVES AND SCOPE

An objective of this Manual is to provide guidance and standardization of stormwater impact analysis procedures to all regulators, planners and designers involved in stormwater management to achieve the required regulatory standard of reducing pollutants in stormwater to the maximum extent practicable. This Manual provides the necessary protocol required by municipalities with respect to their stormwater management plans. The plan should:

- develop a defensible method to classify subwatersheds;
- provide a framework for the organization and integration of data collected during subwatershed assessments; and
- provide a method for prioritization of subwatersheds for restoration action.

As part of SPDES Phase II, Nassau County has undertaken the development of a procedure to assess the subwatersheds within its jurisdiction in a systematic manner with the goal of establishing management criteria for each subwatershed. The Center for Watershed Protection (CWP) classifies watersheds into five watershed management units. These include catchment area, subwatershed, watershed, subbasin, and basin. According to the CWP, the subwatershed-scale is preferred for assessment studies and is therefore the scale used for this analysis.

The assessment procedures developed will be applicable to subwatersheds in any jurisdiction within the County, allowing an individual jurisdiction to rank its own subwatersheds while at the same time providing a context wherein a single subwatershed can be ranked within the entire County. Although not specifically required under SPDES Phase II, assessing and ranking the subwatersheds will provide a basis for identifying high priority subwatersheds on which restoration efforts can initially focus. The results of the assessment and ranking procedures will identify sites with the greatest restoration potential and/or sites with significant pollutant load removal potential. This is particularly important since funding for such projects will be limited. The identified higher priority locations can be addressed first, while the lower priority locations can then subsequently be addressed based upon remaining available funding.

The County's efforts consist of three main tasks, discussed in detail throughout the remainder of this Manual. The first task involves the mapping of the existing drainage infrastructure connected to identified outfalls and drainage areas of the subwatersheds. The second task involves the development of a methodology, the Subwatershed Assessment, to assess and analyze the vulnerability and condition of a subwatershed. Finally, the third task involves identification of candidate sites for installation of stormwater treatment devices, along with a pollutant removal analysis related to the installation. The Final Stormwater Runoff Impact Analysis Report will include a discussion of and the results of all of these tasks.

3.0 SUBWATERSHED ASSESSMENT

The Subwatershed Assessment focuses on categorizing the examined subwatersheds utilizing modified versions of processes developed by the Center for Watershed Protection (CWP). The CWP processes were created to be a rapid planning tool to assist in delineating subwatersheds, estimating impervious cover, assessing stream corridors and providing guidance on classification of individual subwatersheds. The County has also included a methodology for estimating pollutant loads generated in each subwatershed. The final product will allow the subwatersheds to be prioritized with respect to implementation of protective actions. Most of the information necessary to conduct the Stream Assessment is available from Nassau County (County) Geographic Information System (GIS) records.

The rationale of the County Stream Assessment is to provide a standard methodology that can be used by any municipality to assess and classify the subwatersheds within its jurisdiction.

The objective of the Stream Assessment is to assess all the subwatersheds within the County, utilizing a standard methodology so that subwatersheds can be classified as to: 1) the impact of stormwater runoff contributed by the subwatershed; and 2) the potential of restoring or improving water quality associated with the subwatershed.

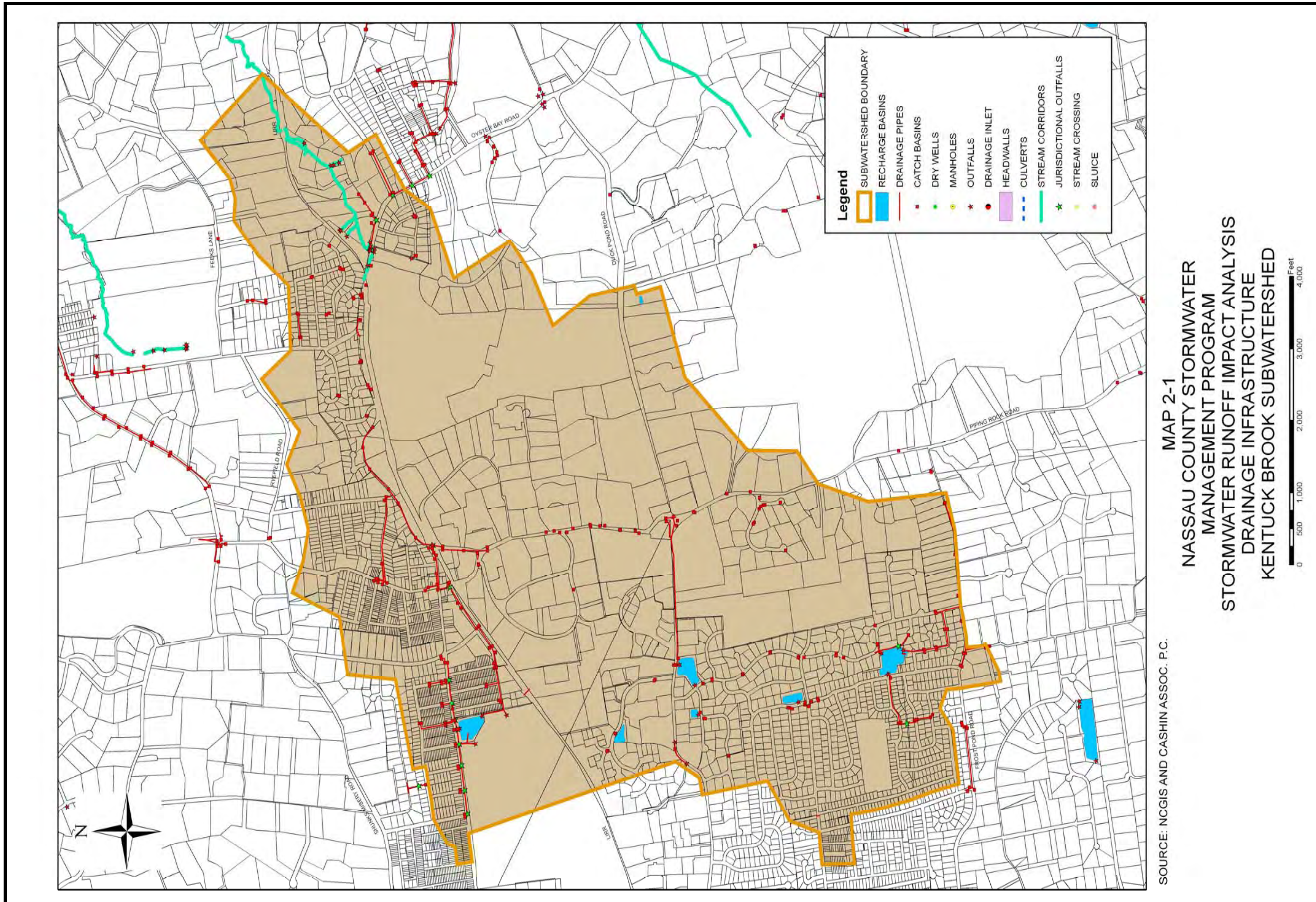
Steps 1-8 for conducting a Stream Assessment and the associated descriptions of the procedures for each step are outlined in Figure 3-1 including the final component (Step 8) Candidate Site Assessments and Recommendations.

FIGURE 3-1 STORMWATER RUNOFF IMPACT ANALYSIS PROCEDURE		
Step 1	Resource Mapping and Drainage Infrastructure Mapping	Compilation and collection of existing data, including drainage infrastructure.
Step 2	Subwatershed Delineation	Review existing delineation and modify for specific jurisdiction.
Step 3	Total Impervious Cover (IC) Determination	Calculate IC using CWP model for GIS data and formulas.
Step 4	Subwatershed Assessment and Classification	Classify each subwatershed based on GIS and impervious data.
Step5	Pollutant Load Calculation	Perform "Simple Method" calculations.
Step 6	Stream Assessment	Perform a physical site assessment of the stream corridor.
Step 7	Subwatershed Comparative Analysis and Ranking	Classify and rank each subwatershed based on compilation of the collected data.
Step 8	Candidate Site Assessments and Recommendations	Compile data, summarize findings and identify potential restoration actions.

3.1 DRAINAGE INFRASTRUCTURE MAPPING

The initial steps in being able to reduce the level of pollutants from stormwater runoff are to understand and map the existing stormwater collection system and determine the subwatershed boundaries. Because there are no specific NYSDEC requirements for mapping, it is important for municipalities that do not already have a stormwater map to determine the most appropriate procedure to create a functional stormwater map based on their needs and drainage infrastructure. An example of the Drainage Infrastructure Map that will be included in the Stormwater Runoff Impact Analysis Reports is included on the following page.

The general procedure to map the existing stormwater collection system begins with collecting all available existing data such as as-built and design drawings, both paper and digital. The next step is to combine the existing data onto a preliminary drainage system map. Field data collection and verification is then conducted using the preliminary map


MAP 2-1
NASSAU COUNTY STORMWATER
MANAGEMENT PROGRAM
STORMWATER RUNOFF IMPACT ANALYSIS
DRAINAGE INFRASTRUCTURE
KENTUCK BROOK SUBWATERSHED
Legend
SUBWATERSHED BOUNDARY
RECHARGE BASINS
DRAINAGE PIPES
CATCH BASINS
DRY WELLS
MANHOLES
OUTFALLS
DRAINAGE INLET
HEADWALLS
CULVERTS
STREAM CORRIDORS
JURISDICTIONAL OUTFALLS
STREAM CROSSING
SLUICE
0 500 1,000 2,000 3,000 4,000
Feet
SOURCE: NCGIS AND CASHIN ASSOC. P.C.
OYSTER BAY ROAD
DUCK POND ROAD
PIPING ROCK ROAD
FEEKS LANE
N

as a base. A final map that includes existing drainage collection structures (i.e., catch basins, drop inlets, etc.), conveyance structures (i.e., manholes, pipes, etc.), and outfall locations is then created. These procedures describe the approach and methodologies used to evaluate and map the existing stormwater system within the County and can also be used as a guide by other local municipalities.

3.1.1 Existing Data Collection

There are multiple sources of information that can potentially provide data on the various stormwater infrastructure systems within a subwatershed, which can make it difficult to map all of the components in a subwatershed. Mapping of all components is critical because it allows the subwatershed to be fully and accurately characterized and may identify projects where multi-jurisdictional solutions can be implemented. It is recommended that the Nassau County GIS database be used in creating a preliminary map.

3.1.1.1 Geographic Information System (GIS) Data Collection

Nassau County has developed a GIS database containing most of the information necessary to analyze a subwatershed located in Nassau County including: topography, jurisdictional and property boundaries, outfall data, drainage infrastructure data, land use, surface waters, drainage ways and hydrology, property lines and parcels, roads, structures, parking lots and stormwater hot spots. ESRI Arcmap software, version 9.0 or greater, is used to access the database and create the base for a preliminary drainage system map in the North American Datum of 1983 (NAD 83) coordinate system. This base can then be plotted and used as the preliminary drainage system map. Aerial photography from the New York State Geographic Information Systems Clearinghouse web site: www.nysgis.state.ny.us or the Google Earth web site: www.earth.google.com or the Microsoft Earth live search web site: www.maps.live.com can be used to assist in the preparation of the preliminary map.

If a municipality does not have GIS resources, the Aerial Photography data can be used as a base for development of the preliminary map.

A municipality should prepare a request to Nassau County to obtain the County's GIS data. In order to request the necessary GIS information, the municipality must be licensed with Nassau County. The information can be requested via correspondence to the Nassau County Department of Information Technology. A sample request letter is included in Appendix A of this Manual.

Towns and Villages may also have GIS files of the existing drainage infrastructure within their jurisdiction. This data can be combined with County GIS data to serve as a base for the mapping effort. The sample request letter can be modified for submittal to other municipalities.

3.1.1.2 As-Built Record Documents Data

Data Collection

The next step is to obtain the relevant data (e.g., pipe information, structure type, etc.) from the Nassau County as-built record drawings (hard copies only) and ultimately transfer it to GIS. As-built drawing information is migrated and indexed into a GIS that allows for streamlined workflow processes. Nassau County as-built record drawings may include some of the road and drainage projects and subdivision developments that have been constructed in a subwatershed. Generally, larger subdivisions (5+ units) in Towns and Villages are permitted through the County, and records may therefore be on file. It should be noted that as-built records may provide information on structure sizes and on recharge basin overflow mechanisms that may not be readily apparent in the field. The process to obtain County as-built records is as follows:

1. Call the NCDPW Engineering Department and request an appointment to review the as-built maps.

2. The NCDPW Engineering Department is located on the 2nd floor of the NCDPW building at 1194 Prospect Avenue, Westbury, NY 11590.
3. The as-built maps are organized into three books commonly referred to as the "black books" (newer County records), "big blue book" (older County records), and the "big red book" (Town and Village municipal records).
4. Compile a list of the plans that include the subject subwatershed area and fill out a freedom of information request form (FOIL). The Plan Request Form is a standard excel sheet provided in Appendix A and on the CD attached to this Manual. A blank FOIL request form is included with the Plan Request Form in Appendix A.
5. Submit the plan list and FOIL request to the NCDPW Engineering Department.
6. The request will be processed and the available plans will be delivered from the plans vault in Mineola to the NCDPW Prospect Avenue 2nd floor office.
7. The County will notify the requestor when the plans are available for review or pick-up. The requestor must return to the NCDPW Prospect Avenue 2nd floor office to review the plans and upon County approval the requestor may borrow the plans, under the conditions set by the County, for scanning purposes.

Towns and Villages may have access to as-built records or maps that include roads under their jurisdiction and subdivision developments that have been constructed in a subwatershed. Generally small subdivisions (<5 units) within the Towns and Villages are permitted through the municipality and related records may be on file. These records may be paper products (not computerized) and the data will therefore require mapping using AutoCAD or the GIS system.

New York State Department of Transportation (NYSDOT) records can also be accessed through a FOIL request. The request is made via a letter to NYSDOT describing the State roads within the project area. A sample NYSDOT FOIL Request letter is included in Appendix A. NYSDOT will provide any and all available record information related to the subject request.

Organizing Data:

When developing the as-built inventory, the following steps must be followed to ensure system-wide uniformity in the data model:

1. Organize as-built drawings using a digital database index.
2. Identify the most recent as-built drawings for each road segment.
3. Field verify and locate infrastructure.
4. Migrate appropriate stormwater attributes from paper copies to GIS.

Transferring to GIS:

These records are paper products (not computerized) and the data must therefore be ultimately transferred to GIS format. The following steps outline the procedure to transfer paper data to AutoCAD, field verify the data and ultimately transfer the data to the required County GIS format:

1. Scan the paper drawings into a Tagged Image File (TIFF) format.
2. Import the TIFF files into Autodesk Autocadd to create a CADD base drawing.
3. From the base map created in Section 3.1.1.1, export the property line and any drainage infrastructure layers into the CADD drawing via a Drawing Exchange Format (dxf) file using the Arcmap Export command, which will place the dxf file in the correct coordinate system. The drainage infrastructure layers should be xreferenced into the CADD drawing.
4. Align the TIFF file with the xreferenced dxf file.
5. Digitize the drainage infrastructure from the imported TIFF files into the CADD drawing using different layers for each different type of feature and different sized feature (i.e., catch basins, manholes, pipes, etc.)

6. Use the digitized record CADD drawing as a reference for field verification and use a handheld Global Positioning System (GPS) to locate infrastructure missing from the County's original GIS data and also missing from the digitized record drawings.
7. Process the GPS data into the base CADD drawing using different layers for each different type of drainage structure.
8. Create separate drawings for the different structures and add the data to the Arcmap base map. Add the CADD drawings to the Arcview base map and export to a shape file using the Arcview drawing coordinate system, which creates shape files of the individual drainage structures with projection files.
9. Use the standard County GIS layers as the basis for the required columns and headings in the database file associated with each of the shape file layers. The added layers will be merged with County's original GIS drainage structure layers creating one complete shape file layer per drainage structure type. Appendix C contains a copy of the County's GIS standards.
10. Add a column labeled "origin" to all GIS layers. This column will be used to label the origin of the data. The original GIS layers from the County will receive the label "Nassau County" in this cell. Layers that came from Nassau County digitized maps will receive the label "Nassau County record drawings" in its cell. Layers that came from GPS data will have the label "subcontractor's name + GPS" in its cells. Data manually gathered by the subcontractor without benefit of GPS will have "subcontractor's name" entered in the cells.
11. Use the merge command in Arcmap to merge all common layers from the different sources (i.e., merge all the manhole layers to one manhole layer, merge all the catch basin layers to one layer, etc.). The end result shall be a layer for each type of drainage structure with all the original data intact and all of the additional data accumulated in the format of the original shape file layer, with a column denoting the origin of the data.

12. Write a meta data file for all generated shape file layers and provide the layers to the County GIS department.

3.1.1.3 Other Data

Additional useful information available from sources other than the County's GIS database includes:

Information	Potential Sources
Aerial Photography	NYSDOS web site: www.nysgis.state.ny.us Google Earth web site: www.earth.google.com Microsoft Earth live search web site: www.maps.live.com
Preserved Lands and Land Identified for Acquisition	Municipal records and Master Plans
Floodplains	FEMA maps
Land Ownership	Nassau County tax records
Non-County or unmapped Drainage Infrastructure	County, Town or Village records, Municipal records, field investigation

3.1.1.4 Field Data Collection and Verification

Drainage infrastructure can be completely identified through field verification. The structure should be located in the field using a GPS unit. In addition, mapped information will not be available for all existing structures in the subwatershed being studied, particularly for structures that were installed on an individual basis in response to localized emergency drainage problems. Additionally, some mapping may simply not be able to be retrieved. Therefore, field verification of a number of structures will most likely be a necessary task in order to obtain a complete database of information related to the area under study.

Upon opening the structure, the structure type can be determined (leaching basin, catch basin, manhole, etc.) along with structure size, depth, material, casting type, catchment at bottom, pipe sizes, pipe inverts and pipe direction.

3.1.1.4.1 Outfall Location/Stream Assessment

The outfall locations should be identified during the Stream Assessment as described in Section 3.3.

3.1.1.4.2 Upgradient Infrastructure

Inlet structures, manholes, culverts, pipes, swales, etc. not indicated in any of the data sources discussed previously must be identified along with detailed information regarding existing structure conditions as discussed below. Additional outfalls may also be discovered during this phase of the work.

Structures should be opened and the interior inspected for conditions including:

- Type of structure – leaching basin, catch basin, manhole, etc.;
- Condition of structure;
- Type of opening – curb opening, grate, solid cover;
- Construction material;
- Depth of structure; Depth of sediment storage space;
- Amount of sediment in structure;
- Amount of water in structure;
- Pipe locations, sizes, inverts; and
- Condition of area around structure (e.g., damaged or sunken pavement, upgradient ponding of runoff, etc.).

A sketch of the piping in the basin is extremely useful. Locations of high points in roads and flow direction arrows should also be included in these sketches.

If outfalls are identified the following information should be collected:

- Size;
- Condition;
- Information regarding any illicit connection suspected; and
- Information regarding any illicit discharge suspected (color, odor, oily sheen, sediments, etc.).

3.1.1.4.3 GPS Structure Location

The location of all identified upgradient infrastructure should be collected with a global positioning system (GPS). Procedures included below are general procedures as actual GPS unit collection methods may vary. It is recommended that real-time kinematic (RTK) GPS technology be used to accurately obtain x, y, and z coordinates at centimeter-level accuracy. Real-time differential (RTD) GPS technology obtains the x and y coordinates at meter-level accuracy, which is accurate enough for planning purposes and is more cost-effective than RTK for planning and management projects.

For outfalls and other upgradient structures located in areas with no identifiable land use, location with a GPS unit will provide accurate location data. In developed areas, the structures may be able to be located relative to location of buildings along the roadway, which provides a check of the accuracy of the system used.

NYSDEC includes in their definition of outfalls locations where jurisdiction between municipalities changes, even if the location is in the middle of a pipe run. These locations should be included in the identification of outfall locations using GPS.

Personnel who will be assigned to conduct the GPS structure locations should be familiar with the operation of the GPS unit and data collection procedures prior to starting the field work. Ensure that the unit's batteries are charged and storage volume available is adequate for the data that will be collected. Existing GPS units are normally set properly and should not require special procedures prior to collecting data for this project. New units should be initialized according to the manufacturers' directions and checked for accuracy prior to conducting the field work.

The following procedure is used to verify structure locations and locate new structures with a GPS unit:

1. Hold unit directly above structure at its center. Depending on the GPS unit, structures that are not accessible may be entered manually based on locations derived from field notes and maps. All measurements to inverts, bottoms, etc. should be measured from that point perpendicularly down.
2. Verify that the GPS unit has acquired an adequate signal and ceases to adjust its location. This may require holding the unit over the structure for a few seconds, depending on the unit and/or the signal. Enter the data in accordance with the unit instructions and add the identification number and enter that information.
3. Each item identified is assigned an identification number that matches the identification number assigned on the data collection sheet as described in Section 3.3.3.4. For example, the first outfall (OT-1) identified in the first reach (RCH 1) of White's Creek (100) would be called RCH 100-1 OT-1. The field personnel enter "100-1 OT-1" into the GPS unit. Enter the structures reach, identification and number. The locations of all other structures or locations identified on data collection sheets should be collected with the GPS unit. In addition, the locations of other structures, such as catch basins (CB) or manholes (MH), should also be identified (for example, 100-1 CB-1 or 102-2 MH-4) and entered into the GPS unit.

4. If jurisdictional outfalls are not readily apparent in the field, the jurisdictional outfalls can be manually entered based on jurisdictional boundary maps. This ensures an accurate location and jurisdiction identification.
5. All entered data should be downloaded daily and saved to a computer with the GPS unit's software already installed on it to minimize the potential for data loss.
6. Proceed with integrating the GPS data into the GIS data files following the procedures outlined in Section 3.1.1.2 *Transferring to GIS* Items 7 through 12.

The technology for transferring GPS data into the GIS data files is rapidly growing. Mobile GIS is the combination of GIS software, GPS, and mobile computing devices. A mobile GIS allows you to visualize information in a digital map, collect information where you observe it, and interact directly with the world around you, while improving productivity and data accuracy. More and more cost effective choices are becoming available for field spatial data collection and therefore a mobile GIS should be considered in performing stormwater mapping.

3.2 SUBWATERSHED VULNERABILITY ANALYSIS

3.2.1 Subwatershed Boundary Delineation

The drainage basins for water in Nassau County are the South Shore Estuary on the south shore and the Long Island Sound on the north shore. Nassau County has defined the watersheds based on the bay or inlet to which tributaries drain. Watershed examples are the East Bay watershed located between the Meadowbrook Parkway and the Wantagh Parkway on the south shore and the Oyster Bay Harbor/Mill Neck Creek watershed located between Locust Valley and Oyster Bay Cove on the north shore. Subwatersheds are the tributaries that drain to the watersheds. For East Bay, the tributaries include East Meadow Brook, Simmond Creek, Cedar Swamp Creek, Newbridge Creek, and Bellmore

Creek. For Oyster Bay Harbor and Mill Neck Creek the tributaries include Tiffany Creek, Whites Creek and Mill River which drain directly into the harbor and Francis Ponds/Beaver Brook, Kentuck Brook and Bailey Arboretum Brook which drain into Mill Neck Creek. Where applicable, the subwatersheds can be further defined by catchment area or reach.

Subwatershed Boundary Delineation is contained in and defined by the Nassau County GIS database. Review of infrastructure and topography should be conducted to ascertain the accuracy of the subwatershed boundaries. Municipalities can add additional subwatersheds that have not been defined for areas within their jurisdiction. Nassau County has not mapped subwatersheds where County roads do not extend through the area. This is generally south or north of the Counties most seaward road. Therefore, the subwatersheds may include additional catchment areas between the limits of the County-defined subwatersheds and the South Shore Estuary or the Long Island Sound. Towns and Villages should define subwatersheds to their jurisdiction limits.

A completed map example, entitled Contours should be included in the Stormwater Runoff Impact Analysis Reports, and is included on page 21. This map shows the subwatershed boundary along with the drainage infrastructure and topography that is used to define the subwatershed limits.

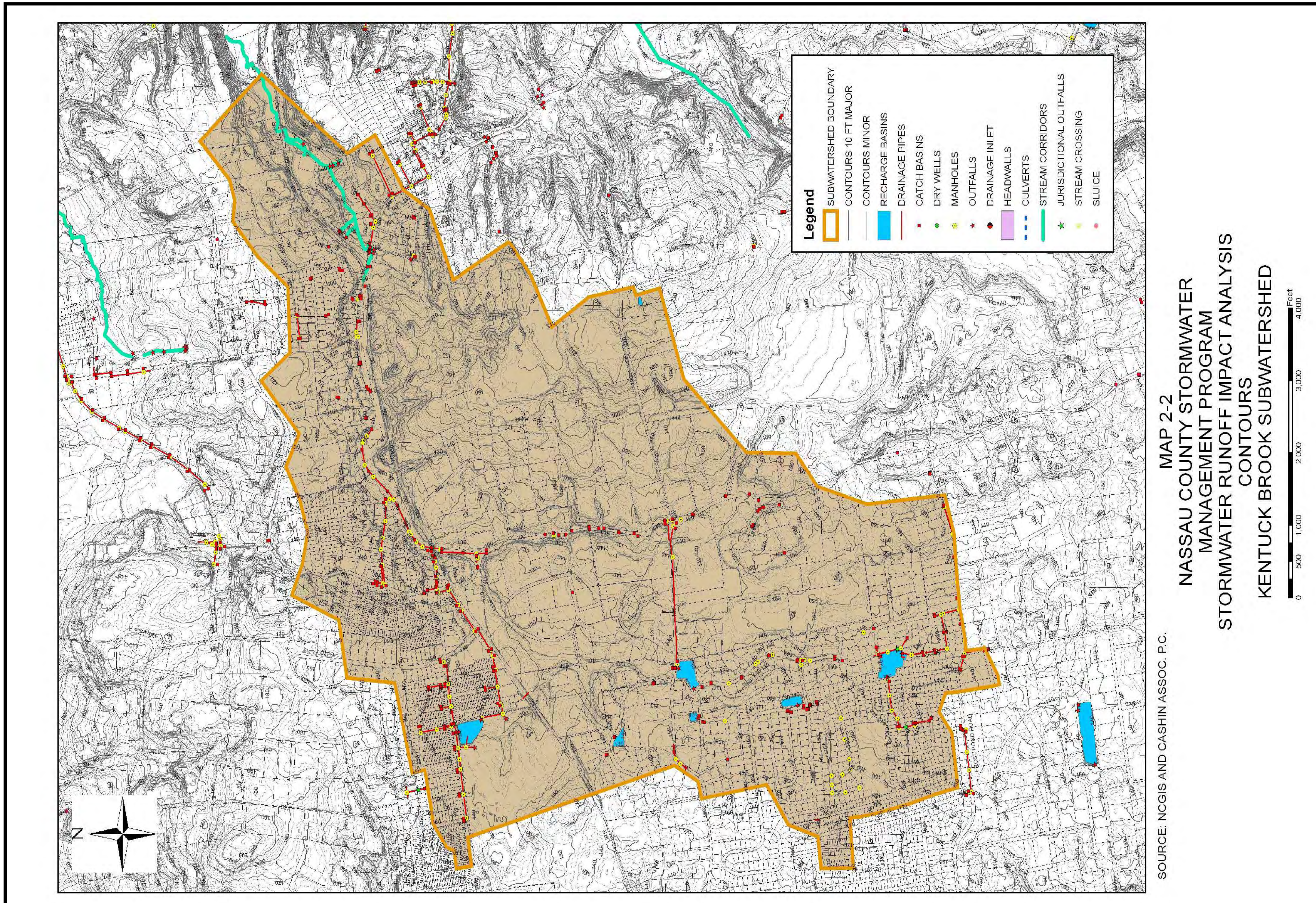
3.2.2 Impervious Cover Assessment

Impervious cover alters the hydrology of urban subwatersheds by reducing the amount of rainfall percolating into the ground, thereby increasing the amount of stormwater runoff. Impervious cover also serves as an indicator of the intensity of subwatershed development and can be used to estimate the current and future quality of subwatersheds.

Extensive research has documented a distinct relationship between the percentage of impervious cover in a subwatershed and the impairment of stream quality in that subwatershed. Stream research generally indicates that sensitive stream elements are lost from the system at about 10% impervious cover. A second threshold appears to exist at around 25% to 30% impervious cover, where most indicators of stream quality have been noted to shift to a poor condition (e.g., diminished aquatic diversity, diminished water quality, and diminished habitat scores). Using the findings of this research, the Center for Watershed Protection (CWP) developed a simple Impervious Cover Model (ICM) that can be used to categorize subwatersheds into specific management units having unique characteristics. The ICM will be discussed in further detail later in this Manual.

Total Impervious Cover (TIC) is defined as all impermeable surfaces within a subwatershed that do not allow water infiltration including paved streets, parking lots, sidewalks, driveways, roofs and other miscellaneous surfaces. The majority of the information necessary to evaluate TIC is available from County GIS data and can be calculated as described later in this Manual.

The impervious areas directly linked to surface waters via storm drainage systems or overland flows are referred to as Effective Impervious Areas (EIA's). EIA's are essentially a subset of the TIC, and, as they are directly connected to surface waters, they have a more immediate and negative impact on surface water quality. However, determining EIA's requires a complete mapping and review of existing storm drainage systems. Additionally, there may be numerous sites where runoff is entering the system via illicit discharges (e.g., there are several known locations where municipal parking lots are connected to the drainage system). Furthermore, existing storm drainage infrastructure may not be operating at its anticipated design capacity due to damage or defects. Therefore, in order to produce a simple methodology to assess County subwatersheds while keeping information generation requirements to a minimum, usage of TIC (i.e., based on the CWP's Impervious Cover Model (ICM)) is recommended as opposed to usage of EIA's.


Legend
SUBWATERSHED BOUNDARY
CONTOURS 10 FT MAJOR
CONTOURS MINOR
RECHARGE BASINS
DRAINAGE PIPES
CATCH BASINS
DRY WELLS
MANHOLES
OUTFALLS
DRAINAGE INLET
HEADWALLS
CULVERTS
STREAM CORRIDORS
JURISDICTIONAL OUTFALLS
STREAM CROSSING
SLUICE
MAP 2-2
NASSAU COUNTY STORMWATER
MANAGEMENT PROGRAM
STORMWATER RUNOFF IMPACT ANALYSIS
CONTOURS
KENTUCK BROOK SUBWATERSHED
0 500 1,000 2,000 3,000 4,000
Feet
SOURCE: NCGIS AND CASHIN ASSOC. P.C.
N

The TIC percentage is used to assign the subwatershed classification. Figure 3-2 presents a simple urban stream classification model that categorizes streams into one of four categories: sensitive, impacted, non-supporting and urban drainage. Each subwatershed classification has unique characteristics that are described in the Subwatershed Vulnerability Classification shown below. A sample of a completed subwatershed Impervious Calculation is shown in Section 3.2.2.7.

FIGURE 3-2 SUBWATERSHED VULNERABILITY CLASSIFICATION	
Sensitive Streams	These streams have a subwatershed impervious cover of 0% to 10%. Sensitive streams are generally of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects. Since impervious cover is so low, they do not experience frequent flooding and other hydrological changes that accompany urbanization. It should be noted that some sensitive streams located in rural areas may have been impacted by prior poor grazing and cropping practices that may have severely altered the riparian zone, and consequently, may not have all the properties of a sensitive stream. Once riparian management improves, however these streams are often expected to recover. The main goal for sensitive subwatershed management is to maintain the biodiversity and channel stability.
Impacted Streams	Streams in this category possess subwatershed impervious cover ranging from >10% to 25% and have clear signs of degradation due to urbanization within the subwatershed. The streams exhibit changes to their hydrology with increased runoff and more frequent over bank flooding. Elevated storm flows begin to alter stream geometry and both erosion and channel widening are clearly evident. Streams banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream. Impacted streams often have good stream repair potential due to moderate degradation, intact stream corridor and available land to install upgradient restoration practices. The main goals for impacted subwatershed management are to limit the degradation of the stream habitat and maintain the biological community.
Non-Supporting	Streams in this category have subwatersheds with >25% to 60%

Streams	impervious cover and are dominated by urban stormwater runoff and increased flooding. The streams are generally channels for the conveyance of stormwater runoff and can no longer support the biological community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, down cutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water recreation is no longer possible due to the presence of high bacterial levels. Streams generally display increases in nutrient loads to downstream receiving waters, even if effective urban BMPs are installed and maintained. The biological quality of non-supporting streams is generally considered poor, and is dominated by pollution-tolerant insects and fish. Although these streams may have potential for partial repair, pre-development biological conditions cannot be achieved. These streams should be managed to prevent bank erosion, improve the stream corridor and improve water quality. The goals for non-supporting subwatershed management is to minimize the downstream pollutant levels, alleviate flooding conditions, and improve the aesthetics of the corridor.
Urban Drainage Streams	Streams in this category have subwatersheds with impervious area exceeding 60% are completely dominated by stormwater runoff and retain few elements of their natural hydrology. Streams in these locations are often channelized with structural sidewalls or flow is carried in closed conduits. The stream corridor is essentially eliminated so that the primary function of the waterway is as a conduit for floodwaters. Water quality indicators are poor, channels are highly unstable and habitat and aquatic diversity are eliminated. Aquatic diversity improvement potential is poor, but water quality conditions potentially may be improved. The goals for urban drainage subwatershed management are to reduce pollutant loads, minimize downstream pollutant levels and to minimize the downstream flows to alleviate flooding.

The impervious cover model predicts **potential** rather than **actual** stream quality. Thus, the reference condition for a sensitive stream is a high quality, non-impacted stream within a given subwatershed. It should be anticipated that some individual stream reaches may depart from the predictions of the impervious cover model.

While there are some limitations to the application of the Impervious Cover Model, impervious cover still provides one of the best tools for evaluating the health of a subwatershed. Impervious cover serves not only as an indicator of urban stream quality, but also as a valuable management tool in possibly reducing the cumulative impacts of development within subwatersheds.

As discussed below, Nassau County GIS data can be used to calculate the portion of TIC contributed by the area of buildings, roads and parking lots in the subwatershed, while driveway and sidewalk portions of TIC are estimated via standardized formulas.

3.2.2.1 GIS Data

Data necessary to calculate the impervious cover of various surfaces in the subwatershed including buildings, roads, parking lots, sidewalks and driveways can be obtained from the County GIS data. The following table outlines the information necessary to complete the impervious cover calculations and provides an example of the forms used record the data.

FIGURE 3-3 IMPERVIOUS COVER AND POLLUTANT LOAD INFORMATION REQUIREMENTS

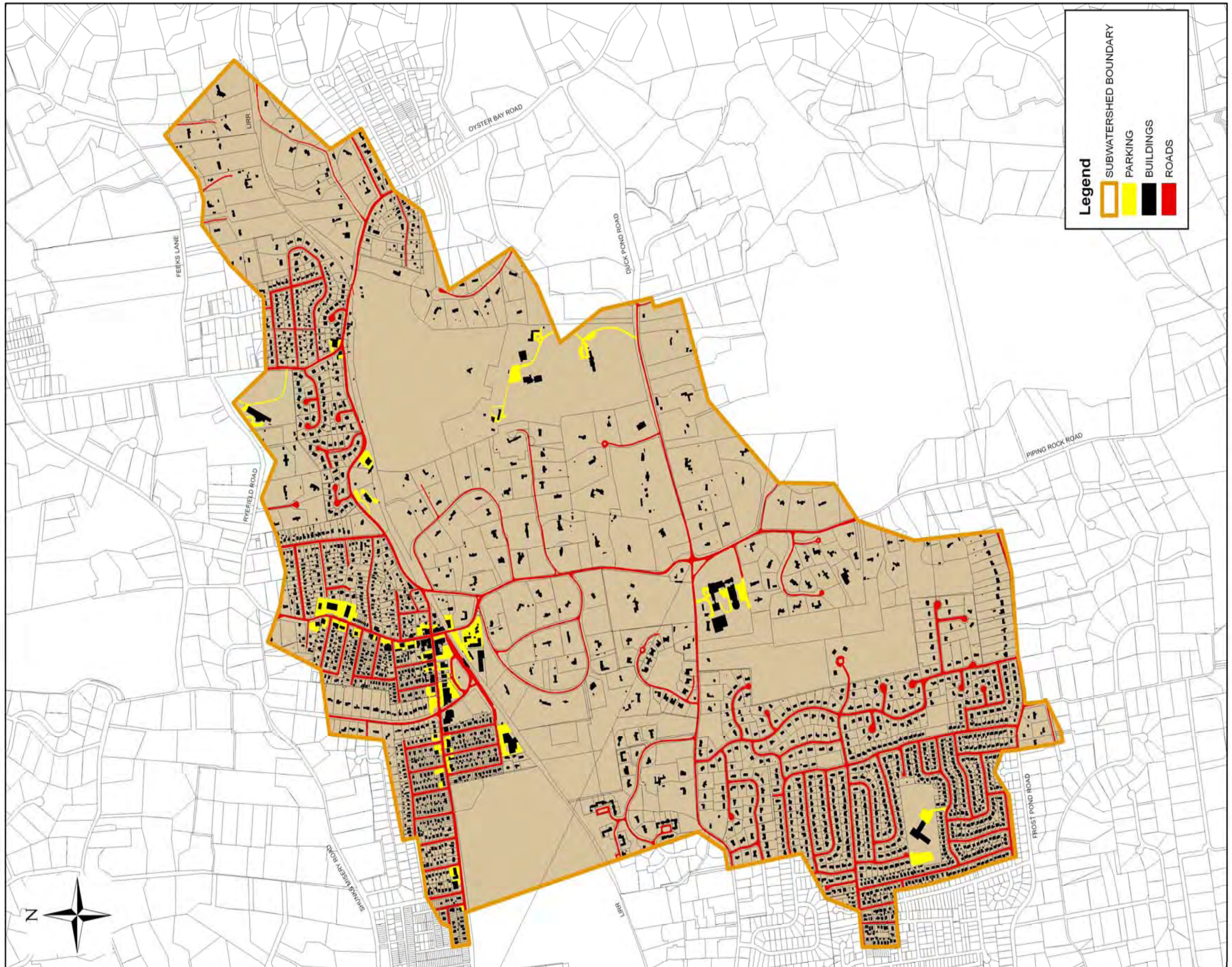
For each subwatershed:

1. Total area of each subwatershed
2. Break down of land use by subwatershed/land use
    a. Residential
    b. Commercial
    c. Industrial
    d. Other- municipal, recreational, preserve, etc.
3. Area of roads by subwatershed
4. Check that total of # 2 and #3 equals #1.
5. Area of Buildings
6. Area of Parking Lots
7. Single map for each subwatershed land use and impervious areas shown
8. Length of roads by subwatershed
9. Quantity of each lot size residences

Tble 3-4 provides a single sheet to compile all of the GIS information necessary to complete the impervious area calculations. No information is necessary for the boxes marked with an X.

3.2.2.2 Buildings, Roads and Parking Lots

The GIS Data Table shown in Table 3-4 is used to quantify the Total Impervious Cover from the GIS mapping layers for buildings, roads, parking lots and residential lots within the defined subwatershed. An example of an Impervious Area Map showing the buildings, roads and parking areas that will be included in the Stormwater Runoff Impact Analysis Reports is presented on the following page.



MAP 2-3
NASSAU COUNTY STORMWATER
MANAGEMENT PROGRAM
STORMWATER RUNOFF IMPACT ANALYSIS
IMPERVIOUS AREAS
KENTUCK BROOK SUBWATERSHED

0 500 1,000 2,000 3,000 4,000 Feet

SOURCE: NCGIS AND CASHIN ASSOC. P.C.

TABLE 3-4 GIS DATA TABLE

Name of Subwatershed	(Name/ID No. of Subwatershed)
Tributary to	Name
Adjacent Land Use	Name

Impervious Information

	Area		Building Area		Parking Lot Area		Length of Roads		Number of Residences
Residential	0	Acres	0	Acres					0
Commercial	0	Acres	0	Acres	0	Acres			
Industrial	0	Acres	0	Acres	0	Acres			
Roadway (Pavement)	0	Acres							
Other (Parks, Municipal, (ROW-Pvmt), Etc.)	0	Acres	0	Acres	0	Acres			
Total Subwatershed	0	Acres	0	Acres	0	Acres	0	LF	

Residential Lots	Quantity in Subwatershed
43561 +	0
21781 - 43560 SF	0
10891 - 21780 SF	0
5446 - 10890 SF	0
0 - 5445 SF	0
Total Number	0

Assumed Percentage of Roadway With Sidewalks (%)	0
Sidewalk Width (FT)	0
Assumed Sides of Roadway With Sidewalk	0

3.2.2.3 Driveway Areas

As residential driveways potentially represent a large percentage of impervious area, a method to calculate that area must be included in the analysis. Current Nassau County GIS data does not include driveway information. As field measurement of driveways would entail an exhaustive effort, a calculation based on lot size, quantity and impervious driveway factors can be utilized for this component of Impervious Area.

TABLE 3-5 IMPERVIOUS DRIVEWAY FACTORS

Residential Density (Lot size - acres)	Average Driveway Area (SF)	Nassau County Criteria
2	3,212	1 - 2+ Acres (AC)
1	2,073	1/2 - 1 AC
1/2	1,152	1/4 - 1/2 AC
1/4	652	1/8 - 1/4 AC
1/8	432	0 - 1/8 AC
Source : Cappiella and Brown, 2001; WVA Table 4: Average Driveway Areas in the Chesapeake Bay Region		

Impervious driveway area can be estimated by a methodology included in the CWP's January 2002 publication entitled "Watershed Vulnerability Analysis" (WVA) in which an average square footage area for driveways is assigned based on lot size. The data was developed by Cappiella and Brown in 2001. The above table presents residential density and corresponding average driveway areas from CWP WVA Table 4 in the first two columns. The Nassau County Criteria column assigns driveway area units based on typical County property size ranges.

TABLE 3-6 AVERAGE RESIDENTIAL DRIVEWAY AREAS CALCULATION				
Subwatershed	***NAME***			
Tributary to	***NAME OF BAY OR ESTUARY***			
Residential ≤ 1/8 acre (432 SF)	Units		Acres	
Residential > 1/8 acre to ≤ 1/4 acre (652 SF)	Units		Acres	
Residential > 1/4 acre to ≤ 1/2 acre (1,152 SF)	Units		Acres	
Residential > 1/2 acre to ≤ 1 acre (2,073 SF)	Units		Acres	
Residential > 1 acre (3,212 SF)	Units		Acres	
Total Acres Driveways Impervious	Units		Acres	

The Nassau County GIS Data is used to identify and compile the number of lots in each size range in the subwatershed being studied. The Average Driveway Area from Table 3.5 is then applied to each parcel and totaled to determine the total driveway area in the subwatershed. The table for this calculation is included as an excel spreadsheet on the accompanying CD.

3.2.2.4 Sidewalks

Sidewalks represent a potentially large percentage of impervious area within a subwatershed and, as such, a calculation for sidewalk area is necessary.

The easiest method to assess sidewalk area is by review of aerial photography. The area of sidewalk can be roughly estimated by reviewing the entire subwatershed and assessing: 1) the percentage of streets that appear to have sidewalks (this can range from 0% to 100%); 2) the typical sidewalk width (usually 4 feet); and 3) the number of sides of the street that have sidewalk (typically both sides). Table 3-7 presents the sidewalk area calculation format.

TABLE 3-7 SIDEWALK AREA CALCULATION	
Subwatershed	***NAME***
Tributary to	***NAME OF BAY OR ESTUARY***
Linear feet of road	
Assumed percentage roads with sidewalks	
Sidewalk width	
Sides sidewalk	
Total Sidewalk Area (Acres)	
Calculation: (LF of road x % with sidewalks x average width x average sides)/43,560	

3.2.2.5 Total Impervious Cover

The areas of buildings, roads, parking lots, driveways and sidewalks are then added together to get the total area of impervious cover (TIC) in the subwatershed. The TIC is then divided by the total subwatershed area and multiplied by 100 to determine the imperviousness percentage of the subwatershed. Table 3-8 presents the impervious area calculation format.

TABLE 3-8 IMPERVIOUS AREA CALCULATION		
Subwatershed	**NAME**	
Tributary to	**NAME OF BAY OR ESTUARY**	
Adjacent Land Use		
Total Subwatershed Area	Acres	
IMPERVIOUS AREAS		
Buildings Area	Acres	
Roads Area	Acres	
Parking Lot Area	Acres	
Sidewalks Area - See Table	Acres	
Driveway Area Total - See Table	Acres	
TOTAL IMPERVIOUS AREA	Acres	
TOTAL % IMPERVIOUS	%	
Vulnerability Classification		

3.2.2.6 Subwatershed Vulnerability Classification

Upon completion of impervious area assessment, the subwatershed is assigned a vulnerability classification. The vulnerability classification designations are:

- Sensitive (<10% impervious);
- Impacted (10%-25% impervious);
- Non-supporting (>25%-60% impervious cover); and
- Urban Drainage (> 60% impervious).

These classifications are described in detail in Section 3.2.2 (Figure 3-2). The first three categories are in accordance with the *CWP Urban Stormwater Restoration Manual 1: An Integrated Framework to Restore Small Urban Watersheds*. An Urban Drainage classification was added to account for those subwatersheds where most of the stream corridor itself has been modified to handle storm flows and reduce flooding conditions.

As most of Nassau County has little additional development potential, the Subwatershed Vulnerability Classification herein assesses the subwatersheds based upon existing conditions. If it were determined that a subwatershed had significant development potential, a build-out analysis could be conducted and the vulnerability classification modified for the future build-out conditions.

3.2.2.7 Impervious Cover and Subwatershed Vulnerability Assessment Example

The completed example provided for the Impervious Cover and Subwatershed Vulnerability Analysis is for Kentuck Brook located on Nassau County's north shore. The County's GIS data was used to ascertain the following information. The Kentuck Brook subwatershed is approximately 1,516 acres in size of which 880 acres are residential, 25 acres are commercial, and 1 acre is industrial. There is approximately 144,600 linear feet of road. The impervious areas include approximately 96 acres of buildings, 19 acres of parking lots and 85 acres of roads. Of the 1,783 residences in the subwatershed, 1,485 are on lots smaller than ½ acre in size.

GIS data is also used in estimates for additional paved surfaces in the subwatershed including residential driveways and sidewalks. Based on the GIS data on residential lots and average driveway areas, the driveway areas are estimated to account for approximately 18 acres of the subwatershed. Sidewalks are estimated to be located along 40% of the subwatershed roads and total approximately 11 acres.

The total impervious area of the subwatershed is approximately 229 acres or 15% of the subwatershed. 15% impervious falls within the vulnerability classification of Impacted Streams. As described in Section 3.2.2, impacted streams have clear signs of degradation due to urbanization within the subwatershed. The streams exhibit changes to their hydrology with increased runoff and more frequent over bank flooding. Elevated storm flows begin to alter stream geometry and both erosion and channel widening are clearly evident. Streams banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream. Impacted streams often have good stream repair potential due to moderate degradation, intact stream corridor and available land to install upgradient restoration practices. The main goals for impacted subwatershed management are to limit the degradation of the stream habitat and maintain the biological community.

Name of Subwatershed: Kentuck Brook (ID No. 104)

Tributary to:	**Mill Neck Creek**
Adjacent Land Use:	**Low Density Residential**

Impervious Information

	Area		Building Area		Parking Lot Area		Length of Roads		Number of Residences
Residential	880	Acres	18	Acres					1,783
Commercial	25	Acres	8	Acres	11	Acres			
Industrial	1	Acres	0.5	Acres	0.5	Acres			
Roadway (Pavement)	85	Acres							
Other (Parks, Municipal, (ROW-Pvmt), Etc.)	525	Acres	70	Acres	8	Acres			
Total Subwatershed	1,516	Acres	96	Acres	19	Acres	144,593	LF	

Residential Lots	Quantity in Subwatershed
43,561 +	187
21,781 – 43,560 SF	111
10,891 – 21,780 SF	379
5,446 – 10,890 SF	816
0 – 5,445 SF	290
Total Number	1,783

Assumed Percentage of Roadway With Sidewalks (%)	40
Sidewalk Width (FT)	4
Assumed Sides of Roadway With Sidewalk	2

* Source NCGIS Database Dated July 24, 2006

EXAMPLE 3-10 KENTUCK BROOK IMPERVIOUS COVER CALCULATIONS TABLE

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
Impervious Cover Calculations
Table 2-3

Impervious Driveway Factors		
Residential Lot Area (AC)	Average Driveway Area (SF)	NC criteria
2	3212	1-2+ AC
1	2073	1/2-1 AC
1/2	1152	1/4-1/2 AC
1/4	652	1/8 - 1/4 AC
1/8	432	0-1/8 AC
Source : Cappiella and Brown, 2001		
WVA Table 4: Average Driveway Areas in the Chesapeake Bay Region		

Average Residential Driveway Area Calculation				
Subwatershed:	Kentuck Brook (ID No. 104)			
Tributary to:	Mill Neck Creek			
Residential > 1 acre - 3212 SF	Units	187	Acres	2
Residential > 1/2 acre to ≤ 1 acre - 2,073 SF	Units	111	Acres	1
Residential > 1/4 acre to ≤ 1/2 acre - 1,152 SF	Units	379	Acres	4
Residential > 1/8 acre to ≤ 1/4 acre - 652 SF	Units	816	Acres	8
Residential ≤ 1/8 acre - 432 SF	Units	290	Acres	3
Total Acres Driveways Impervious	Units	1783	Acres	18

Sidewalk Area Calculation	
Subwatershed:	Kentuck Brook (ID No. 104)
Tributary to:	Mill Neck Creek
Linear feet of road	144593
Assumed percentage with Sidewalks	40
Sidewalk Width	4
Sides Sidewalk	2
Total Acres Sidewalk	11
Calculation : LF of road x % with sidewalks x 4 ft w x 2 sides	

Impervious Area Calculation		
SubWatershed:	Kentuck Brook (ID No. 104)	
Tributary to:	Mill Neck Creek	
Adjacent Land Use:	Low Density Residential	
Total Subwatershed Area	Acres	1516
Impervious areas		
Buildings Area	Acres	96
Roads Area	Acres	85
Parking Lot Area	Acres	19
Sidewalks Area - See Table	Acres	11
Driveway Area Total - See Table	Acres	18
TOTAL IMPERVIOUS AREA	Acres	229
TOTAL % IMPERVIOUS	%	15%
Classification	6	

Impervious Area Notes
1. GIS Data Table is source for areas of buildings, roads and parking lots.
2. Sidewalk area calculations are based on percentage of sidewalk area estimated by preparer
3. Impervious Driveways Factors Table - Average Driveway Areas Souce: WVA Table 4, Cappiella and Brown

Initial Subwatershed Classification		
8	Sensitive Stream	0-10% impervious
6	Impacted Stream	>10%- to 25% impervious
4	Non-Supporting Stream	> 25%- 60% impervious
2	Urban Drainage Stream	> 60% impervious
Source: WVA Figure 4 and Table 2		

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3.2.3 Urban Storm Pollutant Load Calculation

Stormwater runoff deposits contaminants into receiving waters. Human activities, particularly land development, generally have an overriding effect on natural contaminant inputs to stormwater discharges. Land development alters stormwater drainage characteristics within a subwatershed, which can have a profound effect on water quality of the receiving waterbodies. Development results in the replacement of permeable natural land surfaces (i.e., woodlands, meadows, etc.) with impervious surfaces such as roadways, buildings, walkways and pavements. Even in areas cleared for development in which subsequent landscaping is performed, the replacement vegetation generally has a lower capacity for absorbing rainwater than the original vegetation, especially with respect to turf areas. Any development generally increases the amount of runoff generated on a given parcel of land. The augmented volume of runoff from developed properties results in an increase in the amount of pathogens and other deleterious substances carried from the land surface to receiving waters. The major pollutants found in stormwater runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, and pathogens.

Estimates of pollutant loads are a critical factor in the decision-making process with respect to expenditure of limited financial resources targeted for pollutant load reduction. Nassau County desired a stormwater pollutant modeling method usable by all local municipalities for quantitatively assessing the impacts of development and urbanization upon water quality. Model results can be used to assess the benefits of implementing stormwater treatment practices. With this in mind, the County designated a methodology having a measure of accuracy and reliability, using readily available information, while at the same time minimizing cost expenditures related to the assessment effort. The results of the pollutant load calculations will be factored into the Subwatershed Vulnerability Analysis to classify the subwatersheds and watersheds in the County.

The Simple Method for estimation of pollutant loads was originally developed by the Center for Watershed Protection in 1987 as a planning tool for small urban subwatersheds. This method is based on straightforward empirical relationships and estimates pollutant loads as the product of mean pollutant concentration and runoff depths over a specified time period (in this case annually). Analysis of larger subwatersheds would require rigorous and complex computerized modeling techniques incorporating additional extensive information (such as background and erosional pollutant sources, infiltration rates, evaporation rates, channel roughness, streamflow, soil type, etc.).

3.2.3.1 Pollutants of Concern

Nassau County has identified a number of pollutants associated with stormwater runoff to be of concern for the County's subwatersheds. The pollutants identified by the County are carried in large quantities in storm runoff from roads and paved surfaces. Impervious surfaces act as a "trap and conveyance" mechanism for the pollutants, ultimately resulting in deposition of the pollutants into nearby waterbodies. These pollutants negatively affect the surface water quality.

<u>Total Suspended Solids</u> – Total Suspended Solids include silts and sediments, constituting the largest mass of pollutant loadings to surface waters. This pollutant is exported in greatest quantities from construction sites in addition to being generated from areas of insufficient vegetative cover, stream channel erosion, street sanding operations, and vehicle tires. Many other types of contaminants (including toxic chemicals, trace metals, nutrients, and pathogens) associate closely with sediment particles, especially fine-grained particles suspended in the stormwater flow. Thus, the fate of sediment loads carried by stormwater in large measure also dictates the fate of these sediment-associated contaminants. Even the suspended sediment by itself has adverse impact upon the environment, including increased turbidity and reduced light penetration, which in turn reduces submerged aquatic vegetation survival. Upon reaching slower moving, open-water areas, suspended sediment particles settle to the bottom where they can smother the benthic community, change the composition of the waterbody floor, fill impoundments and decrease overall aesthetic values of the waterbody.

Phosphorus and Nitrogen – Phosphorus and nitrogen, usually referred to as nutrients, are two elements necessary for plant growth. Nonpoint sources of phosphorus and nitrogen are recognized causes of water quality degradation in many waterbodies. These nutrients, washed into waterbodies via stormwater runoff, typically originate in lawn fertilizers and animal wastes from pets, geese, small mammals and horses. The effect of nitrogen and phosphorus creates water quality problems in many coastal and inland areas, specifically by causing cultural eutrophication. Eutrophication is typified by rampant algal and plant growth leading to diminished water quality, resulting in aesthetic impairments and undesirable swimming conditions. As the accumulated plant mass decomposes, it causes a bloom of bacteria that feeds on the plant mass, which results in a reduction of the dissolved oxygen level (a condition known as hypoxia) in the water. Oxygen deprivation can cause mobile animals to leave an area, which is one reason areas low in oxygen often have low numbers of fish. Hypoxia can stunt growth or even kill.

Fecal Coliform and Other Pathogens – Pathogens include bacteria, viruses and other microorganisms that can cause human illnesses such as hepatitis A. Common pathogens include bacteria such as *E. coli*, an enteric (intestinal) bacterium, usually not harmful in and of itself. *E. coli* is easily detected and its presence indicates the possible presence of other pathogens that are both more serious and more difficult to detect. The suspected causes of this impairment originate in the feces of pets and waterfowl carried in stormwater runoff. *E. coli* bacteria levels in undiluted urban runoff typically exceed public health standards for primary contact in-water recreational activities. In addition, since bacteria multiply rapidly in warm weather, these levels may be increased by twenty-fold in summer months.

Petroleum Compounds (Hydrocarbons) – Oils and grease contain an array of hydrocarbon compounds, some of which can be toxic to aquatic life even at low concentrations. The major source of hydrocarbons in urban runoff is through the leakage of crankcase oil and other lubricating agents from motor vehicles, and from facilities that service motor vehicles (e.g., repair shops and gasoline stations). Hydrocarbon concentrations are typically highest in runoff from parking lots, roadways, and service stations. Illegal disposal of waste oil onto streets and into storm sewers also contributes to this problem on a local level.

Floatable Debris – Besides the obvious negative aesthetic effects and impacts, trash can impact aquatic life through either ingestion or entanglement. Marine mammals, turtles, birds, fish and crustaceans have been affected by entanglement in or ingestion of debris. Entanglement can cause wounds, loss of limbs, strangulation and loss of ability to swim. Ingestion can cause intestinal tract blockage. Ingestion of sharp items can damage mouths, intestinal tracts and stomachs. Buoyant floatables, which are transported through the waterbody into the marine environment, and items manufactured from synthetics, which persist in the environment for long periods of time, tend to be more harmful than settleable elements and materials that biodegrade quickly. Elements of floatable trash that represent significant threats to human health include items which contain toxic substances, discarded medical wastes, broken glass and human or pet wastes. Human actions, such as littering, are a major contributing factor to floatables pollution. Such debris is washed into waterbodies via both storm drainage systems and overland flow.

The dumping of larger trash items such as furniture, appliances, automobiles, and shopping carts can create physical barriers to the stream flow and may increase shoreline erosion.

3.2.3.2 Assessment Methodology

In order to quantify and rank pollutant loading from subwatersheds, a planning level estimation method is required. Pollutant loading calculations are performed using the Simple Method outlined in *New York State Stormwater Management Design Manual* (NYSSMDM) dated October 2001. The Simple Method calculations estimate the water quality storm event (WQSE), or "first flush", for each subwatershed drainage area. The WQSE is estimated to carry 90% of pollutant loads to surface waters. Capturing, detaining and filtering this runoff will significantly reduce the pollutant quantities reaching the surface waters. Actual final design criteria and calculations used to determine mitigation measures and pollution removal rates will be dependent on the types of pollutants found in the runoff and a detailed analysis of the land use, impervious cover, soil types, hydrology and topography of the site. The Simple Method is generally recommended for sites up to 1 square mile (640 acres). Subwatersheds that exceed the 640 acres in size can be divided into a number of reaches necessary to result in correctly sized units for proper evaluation.

FIGURE 3-11 WATER QUALITY STORM EVENTS (WQSE) CALCULATION
Water Quality Storm Events (WQSE) were sized using the NYSSMDM Sizing Criteria 90 % rule where as: WQv = ((P)(Rv)(A))/12
WQv = water quality volume (in acre feet) Rv = 0.05+0.009(I) I= impervious cover (in percent) P= 90% rainfall event number = 1.2 inches on Long Island A= site area in acres

Pollutant Loading Calculations are performed using the "Simple Method" from Watershed Protection Research Monograph No. 1: Impacts of Impervious Cover on Aquatic Systems (CWP March 2003). The Simple Method estimates chemical component pollutant loads as a product of annual runoff volume and pollutant concentration. The calculation is shown in the table below:

FIGURE 3-12 "SIMPLE METHOD" POLLUTANT LOAD CALCULATION FOR TSS, TP, TN, OIL AND GREASE
L = 0.226*R*C*A
L = Annual Load (lbs) R = Annual Runoff (inches) C = Pollutant Concentration (mg/l)(see Figure 3-15 below) A = Area (Acres) 0.226 = Unit Conversion factor

TSS = Total Suspended Solids   TP = Total Phosphorus   TN = Total Nitrogen

The "Simple Method" to estimate pollutant loads for fecal coliform has a different unit conversion factor to account for different units. This calculation is shown below:

FIGURE 3-13 "SIMPLE METHOD" POLLUTANT LOAD CALCULATION FOR FECAL COLIFORM
L = 103*R*C*A
L = Annual Load (Billion Colonies) R = Annual Runoff (inches) C = Pollutant Concentration (#/100 ml)(see Figure 3-15 below) A = Area (Acres) 103 = Unit Conversion factor

Current standardized pollutant load calculations such as the "Simple Method" do not provide a coefficient for floatable debris (also called gross pollutants or trash). Pollutant loading for floatable debris is still in an early stage. Several studies from California and New Mexico provide coefficients for floatable debris, but these studies were concentrated in large urban subwatersheds with channelized waterbodies. Based on the studies reviewed and discussions regarding floatable debris in waterbodies, coefficients for volume (cubic feet per acre) of floatable debris were established. In general, urban and commercial areas were identified as contributing the highest floatable debris loads consisting of organic matter (twigs and leaves), plastics, paper, Styrofoam, and cigarette butts. The volume of floatable debris (assumed to be 5 mm and larger in size) for Nassau County subwatersheds is estimated to be 8 cubic feet per acre for commercial areas and roads and 5 cubic feet per acre for residential, industrial, and any other land uses. Findings have also shown that there is great variability in floatable debris levels from one drainage area to another. The floatable debris pollutant load data should be used in conjunction with the trash and debris data sheets developed during the Stream Assessment to identify locations and subwatersheds with the greatest floatable debris loads.

FIGURE 3-14 POLLUTANT LOAD CALCULATION FOR FLOATABLE DEBRIS
FD = C x A
FD = Floatable Debris C= Pollutant Concentration (See Figure 3-15 below) A= Area (Acres)

Pollutant loading calculation results will be on a table as shown on Table 3-17 Water Quality Storm Event Volume (WQV) and Annual Pollutant Load Estimate. The pollutant coefficient concentrations for the ‘C’ value in the loading calculation are included on Figure 3-15 shown below. These concentrations have been assembled by the sources noted for the pollutants that have been identified as a concern for Nassau County subwatersheds.

FIGURE 3-15 POLLUTANT COEFFICIENT CONCENTRATIONS FOR CONSTITUENTS IN STORMWATER

Constituent	Units	Median Concentration/ Other**	Pollutant Concentration by Land Use			
			Residential	Commercial	Roadways	Industrial
Total Suspended Solids	mg/l	54.5[1]	100.0[4]	75.0[4]	150.0[4]	120.0[4]
Total Phosphorus	mg/l	0.26[1]	0.40[4]	0.20[4]	0.50[4]	0.40[4]
Total Nitrogen	mg/l	2.0[1]	2.2[4]	2.0[4]	3.0[4]	2.5[4]
Oil and Grease	mg/l	3.0[2]*	3.3[4]	5.0[4]	8.0[4]	4.0[4]
Fecal Coliform	MPN/100 ml	5,000[5]	7,750[5]	3,000[5]	1,700[5]	2,400[5]
Floatable Debris	cf/ac	5[6]	5[6]	8[6]	8[6]	5[6]

* Represents a Mean Value
** Median concentration coefficients are from the National Median Concentration and have been used for the "Other" land use category.
Source:
1: Pooled NURP/USGS (Smullen and Cave, 1998)
2: Crunkilton *et al.* (1996)
3: Schueler (1999)
4. Stormwater Center (www.stormwater.net/monitoring%20and%20assessment/simple%20meth/…) accessed 2/13/07
5. NPDES Database Summary (University of Alabama/CWP, 2003)
6. Cashin Associates, P.C. developed value modified from Caltrans Phase I Gross Solids Removal Pilot Study.

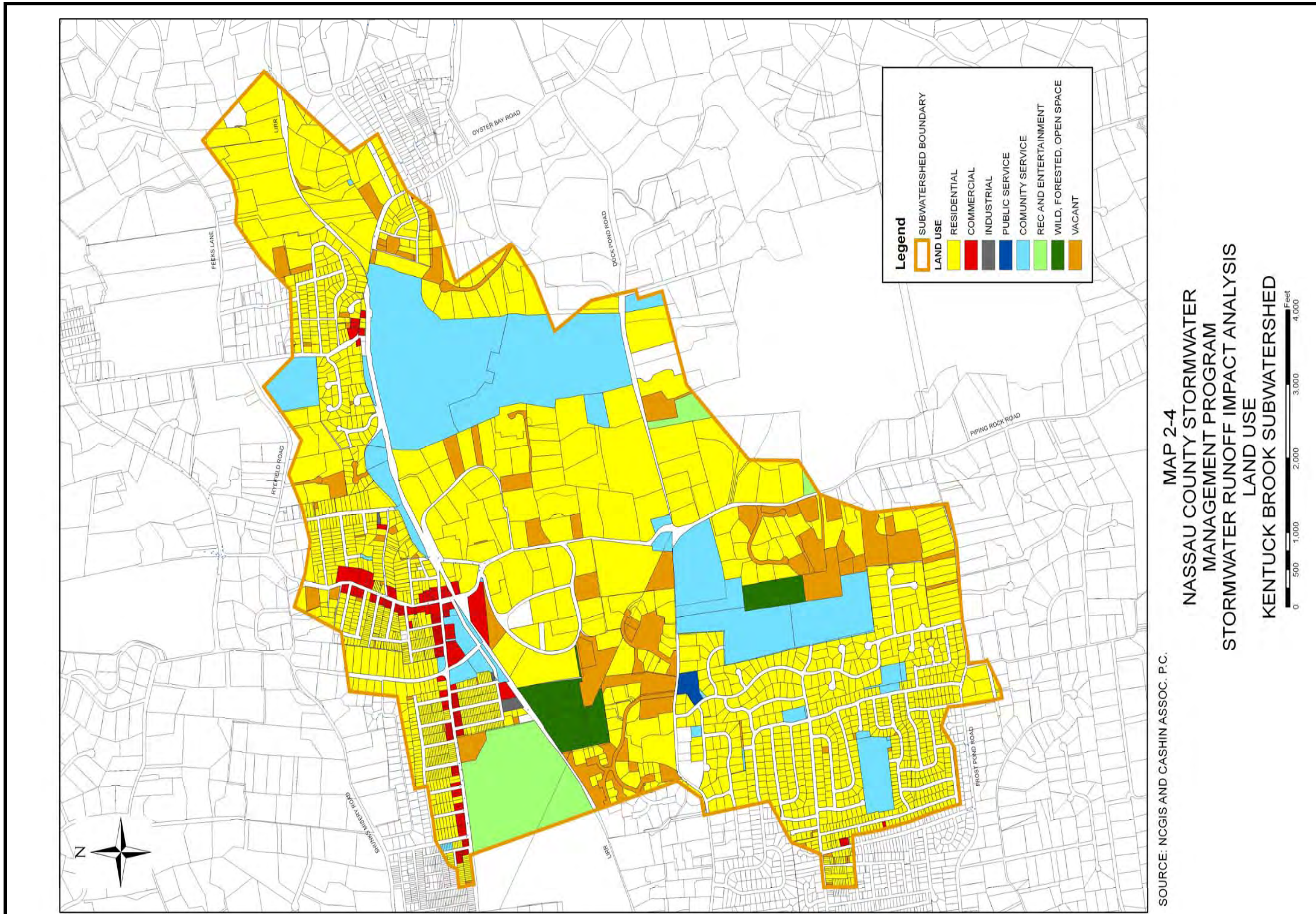
Other pollutants such as copper, zinc, iron and pesticides may be of additional concern to other municipalities. These constituents can be calculated in a similar fashion after identifying a corresponding pollutant coefficient. The NYSDEC and the CWP are sources for such additional pollutant constituent coefficients.

Annual runoff (R) required for the pollutant load calculations is calculated as shown on Figure 3-16.

FIGURE 3-16 ANNUAL RUNOFF CALCULATION
R = P*Pj*Rv
R = Annual Runoff (inches) P = Annual Rainfall (inches) (42") Pj = Fraction of annual rainfall events that produce runoff (typ. 0.9) Rv = Runoff coefficient Rv= 0.05+0.9(Ia) Ia = impervious fraction (from TIC calculation)

3.2.3.3 Annual Pollutant Loads Estimate Procedures

Existing land use data is included in the Nassau County GIS data. Each category of land use contributes certain pollutants in runoff generated within the confines of the involved land. For example, residential properties have higher nitrogen and phosphorus levels, roads and parking lots have higher oil and grease and sediment levels, and parks may have higher coliform levels from wildlife. In order to simplify the impervious cover/pollutant load calculation procedure, the land use categories should be modified to the following general categories; roads, residential, commercial, industrial and other. The "other" category includes all land not identified in one of the other four categories such as parks, municipal lands, road right-of-ways, preserves, etc. The areas of each of these general categories are input into the pollutant load calculations. An example of the Land Use Map that will be included in the Stormwater Runoff Impact Analysis Reports is included on the following page.


Legend
SUBWATERSHED BOUNDARY
LAND USE
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
PUBLIC SERVICE
COMUNITY SERVICE
REC AND ENTERTAINMENT
WILD, FORESTED, OPEN SPACE
VACANT
OYSTER BAY ROAD
DUCK POND ROAD
FEEKS LANE
RYEFIELD ROAD
PIPING ROCK ROAD
FROST POND ROAD
LIRR
N
0 500 1,000 2,000 3,000 4,000 Feet
SOURCE: NCGIS AND CASHIN ASSOC. P.C.
MAP 2-4
NASSAU COUNTY STORMWATER
MANAGEMENT PROGRAM
STORMWATER RUNOFF IMPACT ANALYSIS
LAND USE
KENTUCK BROOK SUBWATERSHED

An Excel table is provided in the Manual CD and is shown below (Table 3-17). Data is required to be entered on two rows, contributory area and impervious area, to complete the table. The Contributory Area is taken from the GIS Data Table - Area Column discussed in Section 3.2.2.2. The impervious area row is completed as follows:

- Residential Column: Add Building Area from GIS Data Table - Residential Row and the Driveway Area Total from Impervious Area Calculation on the Impervious Cover Calculation Table
- Commercial Column: Add Building Area and Parking Lot Area from GIS Data Table - Commercial Row.
- Industrial Column: Add Building Area and Parking Lot Area from GIS Data Table - Industrial Row.
- Roadway: Add Roadway Area from the GIS Data Table - Roadway Row and Sidewalk Area from Impervious Area Calculation on the Impervious Cover Calculation Table.
- Other: Add Building Area and Parking Lot Area from GIS Data Table - Other Row.

The annual pollutant load calculations can be used to rank the loads between subwatersheds to identify subwatersheds contributing the greatest pollutant load. Table 3-17 shows a column that assigns a severity rank to each pollutant. Each pollutant was assigned a severity rank from 1 (lowest severity) to 6 (highest severity) based on the following:

1. **Floatable debris**. This was rated lowest because it is the easiest to mitigate.
2. **Total phosphorus (TP).** This was rated second lowest because it is usually the least abundant pollutant and usually originates from nonpoint sources such as stormwater runoff from lawn fertilizers and animal waste which make it more difficult to mitigate.
3. **Total nitrogen (TN).** This was rated in the middle because it is more abundant than total phosphorus. It usually originates from similar nonpoint

sources as total phosphorus such as stormwater runoff from lawn fertilizers and animal waste which make it as difficult to mitigate.

4. **Total suspended solids (TSS).** This was rated fourth because although it constitutes the largest mass of pollutant loading it can also be lowered by improving vegetative cover which can act as a filter that removes some of the pollutants out of stormwater runoff.
5. **Oil and grease.** This was rated the second most severe because it constitutes a large variety of hydrocarbon compounds that can be toxic even in small doses. The main sources of oil and grease are from parking lots, roadways, and various vehicle service stations.
6. **Fecal coliform (F. Coli).** This was rated the most severe pollutant because it, along with other pathogens, can cause serious human illnesses, some of which are easy to detect and others that are not. These pollutants originate from pet and waterfowl feces which is difficult to control.

The pollutant loads are multiplied by the severity points and added together to determine a single value for pollutant load in the subwatershed. This value is divided by 100 and rounded to the nearest whole number and entered into the Pollutant Load column of the Subwatershed Comparative Analysis Table discussed in Section 3.4. The pollutant loads are also used to assess anticipated pollutant reduction following SMP implementation as discussed in Section 4 of this Manual.

TABLE 3-17 WATER QUALITY STORM EVENT (WQSE) VOLUME & ANNUAL POLLUTANT LOAD ESTIMATE

Subwatershed		**(Name/ID No. of Subwatershed)**							
Tributary To		Name							
Land Use		**Residential**	**Commercial**	**Industrial**	**Roadway**	**Other**	**TOTAL**		
Contributory Area	Acres	0	0	0	00	0	**0**		
Impervious Area	Acres	0	0	0	0	0	**0**		
Impervious Area	%	0	0	0	0	0	0		
Water Quality Storm Event Volume	WQv-acre-feet	0	00	0	0	0	0		
Water Quality Storm Event Volume	WQv-Cubic Feet	0	0	0	0	0	0		
Annual Rainfall	inches	42	42	42	42	42	42		
Annual Runoff	inches	3	27	25	36	7	6		
Total Nitrogen (TN)	coefficient mg/l	2	2	3	3	2		SEVERITY PTS.	TOTAL
	lbs	0	0	0	0	0	**0**	3	0
Total Suspended Solids (TSS)	coefficient mg/l	100	75	150	120	55			
	lbs	0	0	0	0	0	**0**	4	0
Total Phosphorus (TP)	coefficient mg/l	0	0	0	1	0			
	lbs	0	0	0	0	0	**0**	2	0
Fecal Coliform (F Coli)	coefficient mpn/100 ml	7,750	3,000	2,400	1,700	5,000			
	billion colonies	0	0	0	0	0	**0**	6	0
Floatable Debris	coefficient CF/AC	5	8	5	8	5			
	CF	0	0	0	0	0	**0**	1	0
Oil and Grease	coefficient mg/l	3	5	4	8	3			
	lbs	0	0	0	0	0	**0**	5	0
							0		**0**
								SCORE	**0**

SOURCE:
"C" Value Source; See Table
Impervious Area is based on NCGIS Impervious Area Data from building areas, parking areas, and road areas

3.2.3.4 Pollutant Load Calculation Example

The completed example provided shows the Water Quality Storm Volume and Annual Pollutant Load Estimate for Kentuck Brook. The County GIS data was used to calculate the subwatershed land uses and associated contributory areas. The Kentuck Brook subwatershed has approximately 880 acres of residential land use, 25 acres of commercial land use, 1 acre of industrial land use, and 85 acres of roads. The remaining acreage is grouped into the other category and includes such land uses as parks, open space and municipal lands.

The annual water quality storm volume for the total Kentuck Brook subwatershed is approximately 25.60 acre feet or 1,115,258 cubic feet. The pollutant load calculations generated for Kentuck Brook subwatershed show that the highest levels of TN (2059 lbs), TP (343 lbs), TSS (82,351 lbs) and Oil & Grease (5490 lbs) are coming from the roadways. The highest F Coli level (1.88 billion colonies) is from the "Other" category which includes parks, open space and municipal properties. Floatable debris (4400 CF) is highest from the residential properties.

The Severity Points, Totals and Score shown on Table 3-17 and Example 3-18 are computed for use in the Pollutant Load row of the Subwatershed Comparative Analysis Table as shown in Table 3-30 of this Manual. In addition, the method for inserting the Severity Score into the Pollutant Load row is discussed in Section 3.4, paragraph *Pollutant Load Severity* of this Manual.

EXAMPLE 3-18 WATER QUALITY STORM EVENT VOLUME & POLLUTANT LOAD ESTIMATE

Subwatershed		**Kentuck Brook (ID No. 104)**							
Tributary To		Mill Neck Creek							
Land Use		**Residential**	**Commercial**	**Industrial**	**Roadway**	**Other**	**TOTAL**		
Contributory Area	Acres	880	25	1	85	525	**1,516**		
Impervious Area	Acres	18	19	1	85	78	**200**		
Impervious Area	%	2	75	69	100	15	13		
Water Quality Storm Event Volume	WQv-acre-feet	6	2	0	8	10	26		
Water Quality Storm Event Volume	WQv-Cubic Feet	260,652	80,209	4,025	34,926	420,445	1,115,258		
Annual Rainfall	inches	42	42	42	42	42	42		
Annual Runoff	inches	3	27	25	36	7	6		
Total Nitrogen (TN)	coefficient mg/l	2	2	3	3	2		SEVERITY PTS.	TOTAL
	lbs	1,125	315	20	2,059	1,649	**5,167**	3	15,501
Total Suspended Solids (TSS)	coefficient mg/l	100	75	150	120	55			
	lbs	51,118	11,798	1,184	82,351	44,938	**191,389**	4	765,558
Total Phosphorus (TP)	coefficient mg/l	0	0	0	1	0			
	lbs	204	31	3	343	214	**797**	2	1,593
Fecal Coliform (F Coli)	coefficient mpn/100 ml	7,750	3,000	2,400	1,700	5,000			
	billion colonies	1.81	0.22	0.01	0.53	1.88	**4.44**	6	27
Floatable Debris	coefficient CF/AC	5	8	5	8	5			
	CF	4,400	203	7	676	2,626	**7,912**	1	7,912
Oil and Grease	coefficient mg/l	3	5	4	8	3			
	lbs	1,687	787	32	5,490	2,474	**10,469**	5	52,344
							215,738		**842,934**
								SCORE	**556**

SOURCE:
"C" Valve Source; See Table
Impervious Area is based on NCGIS Impervious Area Data from building areas, parking areas, and road areas

3.3 STREAM ASSESSMENT

The stream assessment is a tool for locating potential pollutant sources and environmental problems in a stream corridor along with possible locations where restoration opportunities and mitigation measures can be implemented. The assessment will aid in identifying issues such as point and non-point source pollution, bank erosion, and other ecological degradation. The assessment involves walking the stream corridor, ranking conditions observed, photographing stream reaches for general conditions at each outfall, noting circumstances and changes, and taking some simple measurements of infrastructure. The assessment focuses on stormwater and illicit discharge impacts to the stream corridor.

The stream assessment procedure described herein is modified from the Center for Watershed Protection Urban Subwatershed Restoration Manual Series *Manual 10 Unified Stream Assessment: A User's Manual (Version 2.0),* February 2005 (CWP Manual 10 USA). A second publication that provides useful information that was also reviewed in connection with the preparation of this Manual is the Maryland Department of Natural Resources *Stream Corridor Assessment Survey (SCA) Survey Protocols* (www.dnr.state.md.us/streams/stream_corridor.html).

3.3.1 Assessment Objectives

A stream corridor survey can have a range of objectives, from identifying outfalls to assessing the environmental health of a stream. Knowing the objectives of the stream assessment is critical as that determines the scope of information that will need to be collected, which in turn determines the effort necessary to collect the information. The issues that should be addressed for Nassau County subwatersheds include reaches, outfall locations, potential illicit discharges, channel erosion, impacted buffers, fish passage barriers, channelized stream segments, trash dumping, and any other unusual conditions.

Outfall mapping is a major component of SPDES Minimum Control Measure 3 – Illicit Discharge Detection and Elimination and Minimum Control Measure 5 – Post-Construction Stormwater Control. The primary objective of a stream survey for outfall mapping is to confirm the location, size, and type of drainage structures that have been identified in the review of existing documents and to identify new structures that are not shown on existing documents. The survey is also used to identify possible illicit discharges. The secondary objective is to obtain information that would be needed or useful in prioritizing modifications to the structures to reduce impacts on the stream and in assessing the feasibility and constraints to siting or implementing best management practices to achieve water quality improvements. Additional data sheets will provide information on other stream conditions encountered. Blank copies of the data sheets that are used to record the field data as it is observed are included in Appendix A and on the CD.

The survey requires that entire length of stream be inspected. New outfalls should be located on a field map to the best of the survey team's ability and a GPS reading should be taken if a GPS unit is being used. When a structure is encountered, the survey will seek to:

- provide the location and characteristics of outfalls;
- provide sufficient information so that a preliminary determination of both the severity and correctability of any problem can be made;
- identify possible illicit discharges; and
- provide sufficient information so that restoration can be prioritized.

When other impacts are encountered, the survey will seek to:

- provide the location and characteristics of the problem;
- provide sufficient information so that a preliminary determination of the severity of, correctability of and accessibility to the problem can be made; and
- provide sufficient information so that an appropriate restoration measure can be identified.

3.3.2 Survey Preparation

3.3.2.1 Training

The field team must be trained on assessment methods before going out into the field. Each survey team member should be assigned a particular task for the survey. This ensures consistency and facilitates organization of the effort. After a day in the field, the procedures should be reviewed to ensure that data is being collected correctly and that procedures are being followed correctly.

Survey members should be instructed on safe stream survey practices prior to going into the field. Likely hazards should be discussed and individuals should be instructed to use judgment and to err on the side of caution should any problem arise as the survey is conducted. The survey should be conducted by a team of two or more for safety and efficiency reasons. Surveyors should wear high visibility safety vests.

Surveyors are to be given information regarding ticks, Lyme disease and poison ivy. Team members are to be instructed regarding proper clothing to be worn in the field (long sleeve shirts and long pants). They are to be advised that if they have any concerns about safety during the survey, they should stop immediately and proceed to an alternate location.

3.3.2.2 Private Property

Although properties may be privately owned, Nassau County maintains jurisdiction over the flowing water and can access the stream corridor as necessary to review and assess stream conditions. As assessments are being completed in accordance with the Nassau County program, survey teams can access private properties for their surveys.

The survey team should always respect private property. Where necessary, the survey team should obtain permission to cross private property to access a stream. If asked questions by a property owner, the team should provide a brief description of the project, provide a Nassau County Department of Public Works contact telephone number, and advise the property owner to contact DPW for more information. If the property owner refuses access to the survey team, the team is to immediately leave the property.

The survey team should be aware that property owners may be able to provide useful information regarding the stream corridor based upon their personal observations (e.g., recent changes and/or modifications to the stream, past conditions, alternate access, etc.).

Property owner notification may be desired by the municipality. Survey teams can be provided with a letter on municipal letterhead describing the project and providing a contact name and telephone number, or the property owners can be mailed a flyer describing the project and the time period when their property may be accessed.

3.3.2.3 Equipment

The survey team should be equipped with the following:

- map and aerial of the subwatershed (developed as part of Mapping Resources as discussed in Section 3.1);
- known locations of previously identified stormwater outfalls (developed as part of Mapping Resources as discussed in Section 3.1);
- data collection sheets (in Appendix A and CD);
- site number board;
- clipboard; pencils; tape measure; brush clippers;
- camera, spare battery, spare memory card;
- bug spray and tick repellant; soap or antibacterial wipes; hip boots with reinforced soles; water and food; and
- cell phone or 2-way radio.

3.3.2.4 Field Maps and Data Sheets

Each day in the field, the survey team will prepare a survey plan indicating team members, where the team will be surveying, and the expected times of start and finish. The plan should indicate that multiple streams will be surveyed if that is the day's plan. A copy of the survey plan is to be left with office personnel knowledgeable of the survey.

An aerial photograph or site map that includes known outfall locations should be printed at a scale that will allow notes to be entered on the sheet and that will allow the survey team to accurately determine locations in the field. The scale will vary depending upon the size and length of the stream and surrounding land use conditions. Using scannable size field sheets will allow the field sheets to be scanned and included in the report's stream data collection sheet and photograph appendix. Standard 8 ½" x 11" or 11" x 17" size were found to be easiest to handle in the field, but sheet size can be dependant upon available scanners.

As mentioned previously, the data collection sheets for each type of condition should be carried by the survey team. Adequate numbers of the sheets should be estimated based on the known stream conditions from any previously collected data. Data sheets should be completed by the team at each location in as much detail as possible to avoid missing any data and to avoid possible confusion with other sites. Copies of data collection sheets are included in Appendix A and on the CD.

3.3.3 Stream Survey

3.3.3.1 General

In general, due to the linear form of Long Island, the streams in Nassau County tend to be shorter in length than in other areas of the country. As such, the numbering system has been simplified as discussed below.

The survey should start at the downstream end and work upstream. When a stream branches, the survey team should continue upstream along the largest branch first and then return to the location of the branch to continue upstream on the remaining branch.

The stream is assigned an identification number based on the stream and the reach. The ID number identifies streams by assigning a number starting with 100 and reaches should be numbered starting at -1 for the lowest reach. Nassau County Bureau of Water Management personnel can provide the next available number to use for stream identification. For example, Kentuck Brook was assigned identification number 104, it has only one reach (RCH 104-1), and seven outfalls were located. Therefore, the identification number of the last outfall would be RCH 104-1 OT 7. Each location where an outfall or other data sheet is completed should be numbered starting at 1 for each stream (i.e., OT 1, OT 2, MISC 1, etc.). Photographs taken should be noted by number on the data sheet.

3.3.3.2 Locating Sites

A site, as defined for this section and the following sections, is defined to mean a location such as an outfall, eroded area, trash accumulation, etc. for which a data sheet is being prepared. The location of the site should be noted on the field maps of the stream as a large dot using the visible structures or road locations on the map as a frame of reference. A Site ID number should be assigned and included next to the dot on the field map. The GPS location should also be noted. Where the problem exists over an extended length of the stream, such as channel erosion, the length should be noted by a line and assigned a single Site ID number.

3.3.3.3 Photographing Sites

A photograph of the number board showing the reach identification number should be in the first photograph taken of a reach. It should be understood that all ensuing photographs belong to that site until the next photograph of a reach identification number is evident.

A site number board identifying the stream number, reach number and site number for each photograph is useful to identify site location after returning from the field. At least four photographs should be taken: one showing the outfall looking upstream; one showing the outfall looking downstream; one showing the details of the outfall; and one showing the outfall and the area behind and to either side of it. If necessary, more photographs should be taken to adequately document site conditions. It is extremely important to identify the viewing direction and the photograph number on the field map. On the field map, a circle should be drawn with the photograph number at the camera location and an arrow should indicate the viewing direction of the photograph. A person, ruler or scalable object should be included in the photograph to provide a frame of reference.

The photographs should be organized and placed in the database as soon as possible after the survey work. This minimizes possible confusion and problems with faulty recollection of survey team members.

3.3.3.4 Data Sheets

The data sheets included in Appendix A are taken from CWP Manual 10 USA which provides detailed information on completing the data sheets. The information included herein for completing the data sheets is summarized from that document. Examples are included from actual field data sheets developed during the preparation of this Manual. An explanation of the information included on each sheet is included in the sheet description paragraphs below.

The data sheets used to assess the subwatershed include Stormwater Outfall (OT), Severe Bank Erosion (ER), Impacted Buffers (IB), Utility Impacts (UT), Trash and Debris (TR), Stream Crossing (SC), Channel Modification (CM), Miscellaneous Features (MI), Reach Level Assessment (RCH), and a Photo Inventory Record Sheet. Each data sheet has a general header section that provides space to include the stream, reach, date of survey, site identification number, GPS coordinates and photo identification number.

The ***Stormwater Outfall (OT)*** data sheets are used to assess all pipes and channels that discharge storm drainage to a stream. A specific form was developed for this data sheet to include additional information deemed pertinent to Nassau County. That form is included in Appendix A and on the CD. In addition, illicit discharges and restoration opportunities such as daylighting and stabilization should be assessed. The form includes basic information like bank location, material, closed pipe or open channel size, condition, odors, stains, etc. that are easily understandable. Where water is flowing, additional data regarding the flow condition is requested. The final section includes an opinion on the restoration potential including the potential for a stormwater retrofit and severity of the outfall. A space for a sketch of the outfall and additional notes is also provided. The best time to survey outfalls is during the winter and early spring while vegetation is relatively bare. Many outfalls will not be visible later in the year during vegetation growth periods. Suspected illicit discharge will be most noticeable in dry weather when outfalls are generally dry.

The OT data sheet example shown is for Bellmore Creek. The first section of the data sheet includes standard information identifying the subwatershed (Bellmore Creek, which was assigned an identification number of 108) reach number (108-3, the third reach of Bellmore Creek), outfall number (OT-17, the 17^{th} outfall in reach 108-3), date (February 6, 2007), assessment personnel (A. Savino), photograph identification numbers (234,227). The second section of the data sheet identifies the type and condition of outfall. Bellmore Creek Reach 3 Outfall 17, located on the right bank – facing downstream, is a concrete, single, open, parabolic channel. The channel is 4' wide at the top, in good condition, with moderate flow, a flow line stain and no odor. There was no dense vegetation (observation was in February, so this may be misleading), no pool, no benthic growth or other concerns. The moderate flow observed was clear without turbidity or floatables. Restoration recommendations included in the final section of the data sheet identify the need for further discharge investigation. The outfall severity was low (1) as no dry weather flow was observed, the outfall correctability and accessibility were both moderately-low as heavy equipment might be needed for repairs but the site was determined to be moderately accessible by foot and by vehicle. Notes were added to the data sheet identifying the water company yard adjacent to the outfall and the use of the channel to discharge water out of the pipe. A photograph of the operation was taken and identified in this section.

EXAMPLE 3-19 OUTFALL DATA COLLECTION SHEET

Watershed/subshed: BELLMORE CREEK **OT-** 17

Assessed by: A. SAVINO **Date:** 2-6-07

Survey Reach ID: 108-3 **Time:** **Photo ID #:** 234, 227

Lat. ° ' " **Long.** ° ' " **LMK:** **GPS ID:**

Type of Outfall:	**Bank:**	**Type:**	**Material:**	**Shape:**	**Dimensions:**
● Stormwater	O Left	O Closed Pipe	● Concrete	O Circular	Diameter:
O Sewage Overflow	● Right	● Open Channel	O PVC/Plastic	O Elliptical	(For Open Channel)
O Industrial	O Other:	O Other:	O Metal	O Trapezoid	Depth:
O Pumping Station		● Single	O Brick/Stone	● Parabolic	Width Top: 4'
O Agricultural		O Double	O Earthen	O Other:	Width Bot:
O Other:		O Triple	O Other:		

Submerged:	**Flow:**	**Condition:** (Pipe/Wall)	**Odor:** ● No	**Deposits/Stains:**
● No	O No	● Good	O Gas	O No
O Partially	O Trickle	O Chipped/Cracked	O Sewage	O Oily
O Fully (Visible)	● Moderate	O Exposed Rebar	O Rancid/Sour	● Flow Line
O Fully (Not Visible)	O Substantial	O Corrosion	O Sulfide	O Paint
O Other:	O Other:	O Other:	O Other:	O Other:

Veggie Density:	**Pool Quality:**		**Pipe Benthic Growth:**	**Other Concerns:**
● No	● No	O Oils	● No	O Excess Trash:
O Normal	O Good	O Suds	O Brown	O Excessive Sedimentation
O Inhibited	O Odors	O Algae	O Orange	O Bank/Wall Erosion
O Excessive	O Colors	O Float.	O Green	O Needs Regular Maintenance
O Other:	O Other:		O Other:	O Other:

For Flowing Only:

Color:	● Clear O Brown O Grey O Yellow O Green O Orange O Other:
Turbidity:	● None O Slight Cloudiness O Cloudy O Opaque O Other:
Floatables:	● None O Sewage (Toilet Paper, etc.) O Petroleum (Oil Sheen O Other:

Potential Restoration Candidate: O No

● Discharge Investigation

O Storm Water Retrofit: if yes → Is storm water currently controlled? O Yes O No O Not Investigated

O Local Stream Repair — Land use description & area available:

O Outfall Stabilization

O Stream Daylighting: if yes → Length of vegitative cover from outfall:

O Other: — Type of existing Vegetation: Slope:

Outfall Severity

Heavy Discharge with distinct color and/or strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor/localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
5	4 3 2	(1) *

Outfall Correctability

Easily repairable, no heavy equipment needed	Moderately repairable, some heavy equipment needed	Difficult to repair, heavy equipment and planning needed
5	(4) 3 2	1

Outfall Accessability

Easily accessable by foot and by vehicle	Moderately accessable by foot and by vehicle	Difficult to access by foot, not accessable by vehicle
5	(4) 3 2	1

Adjacent Land Use: PRIVATE WATER COMPANY YARD + PUMPING STATION

Possible Utility Conflicts:

Notes: * NORMALLY NO DRY WEATHER DISCHARGE, HOWEVER TODAY (WATER COMPANY) THEY WERE PUMPING WATER OUT OF PIPE AS SEEN IN PHOTO # 227

The ***Severe Bank Erosion (ER)*** data sheet is used to assess the most severe erosion of stream banks and locations where potential stream repair and stabilization opportunities exist. The data sheets identify areas where the erosion is noticeably worse than the remainder of the reach and at locations where infrastructure or property loss is evident. Severe bank erosion is expected in urban subwatersheds. Where the erosion condition is normal for the reach length, the condition can be noted on the Reach Level Assessment (RCH) form. The form asks for basic information on the erosion location, eroded area dimensions, ownership and land use. The final section includes a space for information on the potential for restoration including the erosion severity, ability to access the location, and threat to property or infrastructure. A space for a sketch of the erosion and additional notes is also provided.

The ER data sheet example shown is for Clements Brook. The first section of the data sheet is completed as shown for the OT data sheets. This is the first (ER-1) severely eroded bank location observed in Reach 1 (107-1) of Clements Brook (Subwatershed 107). The second section describes the observed conditions. The observed erosion includes down cutting, bank failure, and slope failure (all noted as past activity) in addition to channelization along the right bank facing downstream for approximately 130' in length. The land ownership was unknown, but the area was noted to be developed. The final section of the data sheet identifies bank stabilization as a potential restoration action for the site and notes that a parking lot for a local business is being threatened by the erosion. A note has been added that a concrete block retaining wall is collapsed. The site was assigned a moderately-high severity rating because of the past down cutting and stream widening. Generally, a channelized segment receives a low rating but, in this case, the wall appears to have collapsed, increasing the potential for further erosion.

EXAMPLE 3-20 SEVERE BANK EROSION DATA COLLECTION SHEET

Severe Bank Erosion **ER**

WATERSHED/SUBSHED: CLEMENTS BROOK		**DATE:** 1/ 22/ 07	**ASSESSED BY:** A. SAVINO
SURVEY REACH: 107-1	**TIME:** __:__ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 13 – 18	
SITE ID: (*Condition-#*)	*START* LAT __° __' __" LONG __° __' __" LMK __		**GPS:** (*Unit ID*)
ER- 1	*END* LAT __° __' __" LONG __° __' __" LMK __		

PROCESS: ■ Currently unknown
■ Downcutting (PAST) ☐ Bed scour
☐ Widening ■ Bank failure (PAST)
☐ Headcutting ☐ Bank scour
☐ Aggrading ■ Slope failure (PAST)
☐ Sed. deposition ■ Channelized

BANK OF CONCERN: ☐ LT ■ RT ☐ Both (*looking downstream*)
LOCATION: ☐ Meander bend ☐ Straight section ■ Steep slope/valley wall ☐ Other:

DIMENSIONS:
Length (*if no GPS*) LT___ft and/or RT ≈130 ft Bottom width ___ft
Bank Ht LT___ft and/or RT___ft Top width ___ft
Bank Angle LT___° and/or RT___° Wetted Width ___ft

LAND OWNERSHIP: ☐ Private? ☐ Public ■ Unknown **LAND COVER:** ☐ Forest ☒ Field/Ag ■ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ■ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ■ Yes (Describe): PARKING LOT FOR P.C. RICHARDS

EXISTING RIPARIAN WIDTH: ■ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ■ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		~~But~~ PAST downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	(4)	3	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	(4)	3	2	1

NOTES/CROSS SECTION SKETCH:
CONCRETE BLOCK RETAINING WALL COLLAPSED.

REPORTED TO AUTHORITIES ☐ YES ☒ NO

The ***Impacted Buffers (IB)*** data sheets are used to assess locations with inadequate stream buffers that can filter surface flows before they enter the stream and locations where revegetation or management practices can be targeted. This information is easily tracked on an aerial photograph of the stream corridor where wide areas of wooded vegetation will be obvious. Local municipal buffer ordinances may set minimum buffer widths. The review should identify areas where buffers longer than 100' in length are lacking, such as sites that have unvegetated earth, mown lawns or paved and stone areas that extend to or are close to the water's edge. Areas with little buffer vegetation may likely be showing signs of erosion as well. Sites that should be identified as potential management sites include public lands and large parcels such as schools and golf courses. While buffer impacts at existing commercial sites, small residential lots and roads in close proximity to the stream offer fewer opportunities for management, these locations should still be recorded.

The IB data sheet example is for White's Creek. The first section of the data sheet is completed as shown for the OT data sheets. This is the first (IB-1) impacted buffer location observed in Reach 1 (100-1) of White's Creek (Subwatershed 100). The second section describes the observed conditions. The observed buffer impacts include a left bank with too little width available to provide an adequate buffer and adjacent institutional land use and impervious parking area. The right bank is noted to have woods and bare ground. The stream itself is not shaded but wetlands were observed. The field assessor was not able to make a determination on whether there is restoration potential but noted that site features exist which severely limit available planting areas.

EXAMPLE 3-21 IMPACTED BUFFER DATA COLLECTION SHEET

Impacted Buffer **IB**

WATERSHED/SUBSHED: WHITES CREEK **DATE:** 2/19/06 **ASSESSED BY:** ANTHONY SAVINO

SURVEY REACH: 100-1 **TIME:** ___:___ AM/PM **PHOTO ID:** (*Camera-Pic #*) /#

SITE ID: (*Condition-#*) IB-1
START LAT ___° ___' ___" LONG ___° ___' ___" LMK ____
END LAT ___° ___' ___" LONG ___° ___' ___" LMK ____
GPS: (*Unit ID*)

IMPACTED BANK: ■ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ■ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE: (*Facing downstream*)

	Private	Institutional	Golf Course	Park	Other Public
LT Bank	☐	■	☐	☐	☐:
RT Bank	☐	☐	☐	☐	■: WOODED

DOMINANT LAND COVER:

	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	■	☐	☐	☐	☐	☐	☐:
RT Bank	☐	■	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ■ None ☐ Partial ☐ Full **WETLANDS PRESENT?** ☐ No ■ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐ Active reforestation ☐ Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ no ■ Other: UNKNOWN

RESTORABLE AREA

	LT BANK	RT
Length (ft):	____	____
Width (ft):	____	____

REFORESTATION POTENTIAL: (*Circle #*)

Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting		Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate		Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
5	4	3	2	(1)

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver) ☐ Other:

NOTES: LEFT BANK HAS LITTLE IF ANY BUFFER.
RIGHT BANK HAS EXPECTED FOR URBAN AREA BUFFER.

The ***Utility Impacts (UT)*** data sheets are used to evaluate locations where water quality, habitat and stability of the stream corridor may be impacted by utilities. The data to be collected includes basic information on the type, location and structural condition of the utility, in addition to noting the severity of the impact. The UT data sheet also is to include information regarding evidence of discharge and potential management opportunity for the involved location.

The UT data sheet example is for Bellmore Creek. The first section of the data sheet is completed as shown for the OT data sheets. This is the first (UT-1) utility in the stream corridor location observed in Reach 2 (108-2) of Bellmore Creek (Subwatershed 108). The second section describes the observed conditions. The observed utility included a leaking water main. The 500'+ of exposed 4" to 18" diameter smooth metal pipe is located along the stream bank and in the floodplain. The assessor could not determine if the pipe created a fish barrier, but noted that the pipe appeared corroded and cracked and had the potential for open valves. The assessor observed the liquid being discharged and noted that it was clear with no odor, but that orange staining and high levels of algae were observed throughout the area. The final section of the data sheet identifies the potential restoration as being structural repairs and pipe testing. As the pipe was observed to be leaking, the location is assigned the highest impact severity (5). The assessor has noted that he did not report the leak to local authorities.

EXAMPLE 3-22 UTILITY IMPACTS DATA COLLECTION SHEET

Utility Impacts **UT**

WATERSHED/SUBSHED: BELLMORE CREEK **DATE:** 1/26/07 **ASSESSED BY:** A. SAVINO

SURVEY REACH ID: 108-2 **TIME:** ___:___ AM/PM **PHOTO ID:** (*Camera-Pic #*) # 95-119

SITE ID: (*Condition-#*) UT-1 LAT ___° ___' ___" LONG ___° ___' ___" LMK: ____ **GPS:** (*Unit ID*)

TYPE:
- [ ] Leaking sewer
- [ ] Exposed pipe
- [ ] Exposed manhole
- [x] Other: LEAKING WATER MAIN

MATERIAL:
- [ ] Concrete
- [ ] Corrugated metal
- [x] Smooth metal
- [ ] PVC
- [ ] Other:

LOCATION:
- [x] Floodplain
- [x] Stream bank
- [ ] Above stream
- [ ] Stream bottom
- [ ] Other:

POTENTIAL FISH BARRIER: [ ] Yes [ ] No UNKNOWN

PIPE DIMENSIONS: Diameter: 4"-18" in; Length exposed: >500 ft

CONDITION: [ ] Joint failure [x] Pipe corrosion/cracking [ ] Protective covering broken [ ] Manhole cover absent [x] Other: OPEN VALVES?

EVIDENCE OF DISCHARGE:

COLOR	[ ] None [x] Clear [ ] Dark Brown [ ] Lt Brown [ ] Yellowish [ ] Greenish [ ] Other:
ODOR	[x] None [ ] Sewage [ ] Oily [ ] Sulfide [ ] Chlorine [ ] Other:
DEPOSITS	[ ] None [ ] Tampons/Toilet Paper [ ] Lime [ ] Surface oils [x] Stains [ ] Other:

POTENTIAL RESTORATION CANDIDATE [x] Structural repairs [x] Pipe testing [ ] Citizen hotlines [ ] Dry weather sampling [ ] no [ ] Fish barrier removal [ ] Other:

If yes to fish barrier, Water Drop: ________ (in)

UTILITY IMPACT SEVERITY: (*Circle #*)

Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure.		A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.		Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.
(5)	4	3	2	1

Leaking= [x] 5

NOTES: EXTREMELY HIGH LEVELS OF ALGAE AND ORANGE STAINING THROUGHOUT ENTIRE AREA.

REPORTED TO LOCAL AUTHORITIES [ ] Yes [x] No

The ***Trash and Debris (TR)*** data sheet is used to identify locations in the stream corridor where trash and debris are evident. The information collected includes the location, type, materials, source and amount of trash observed and an estimate of the effort required to clean the location.

The TR data sheet example is for Bellmore Creek. The first section of the data sheet is completed as shown for the OT data sheets. This is the second (TR-2) location with trash and debris deposits in the stream corridor observed in Reach 3 (108-3) of Bellmore Creek (Subwatershed 108). The second section describes the observed conditions. The trash and debris observed includes plastics, tires, paper and metals of unknown source in addition to larger illegally dumped items such as shopping carts, lawn furniture, wood and glass from commercial and residential uses. The materials were observed in the stream and along both the right and left bank of the adjacent riparian area. The land appeared to be either public or of unknown ownership. The assessor estimated that it would require approximately 7-8 pick-up truck loads to remove the materials. The potential restoration effort would be to remove the trash and debris and clean up the stream corridor. The assessor made a determination that the clean-up could be done by volunteers and the local government with trash bags and other materials or equipment, but that no dumpster could be located within 100’ of the area. The clean-up potential was rated as 2 (5 being the least debris, 1 the most) due to the large amount of trash and debris spread over a large area. The assessor noted that he did not report the debris to local authorities.

EXAMPLE 3-23 TRASH AND DEBRIS DATA COLLECTION SHEET

Trash and Debris **TR**

WATERSHED/SUBSHED: BELLMORE CREEK **DATE:** 2/1/07 **ASSESSED BY:** A. SAVINO

SURVEY REACH ID: 108-3 **TIME:** __:__ AM/PM **PHOTO ID:** (*Camera-Pic #*) /# 178-192

SITE ID: (*Condition-#*) TR-2 **LAT** __°__'__" **LONG** __°__'__" **LMK** __ **GPS:** (*Unit ID*)

TYPE:
☐ Industrial
☒ Commercial
☒ Residential

MATERIAL:
☒ Plastic ☒ Paper ☒ Metal
☒ Tires ☐ Construction ☐ Medical
☐ Appliances ☐ Yard Waste SHOPPING CARTS
☐ Automotive ☐ Other: WOOD, GLASS, LAWN/FURNITURE

SOURCE:
☒ Unknown
☐ Flooding
☒ Illegal dump
☐ Local outfall

LOCATION:
☒ Stream
☒ Riparian Area
☒ Lt bank
☒ Rt bank

LAND OWNERSHIP:
☒ Public ☒ Unknown
☐ Private

AMOUNT (*# Pickup truck loads*): 7-8

POTENTIAL RESTORATION CANDIDATE ☒ Stream cleanup ☐ Stream adoption segment ☒ Removal/prevention of dumping
☐ no ☐ Other:

If yes for trash or debris removal

EQUIPMENT NEEDED: ☐ Heavy equipment ☒ Trash bags ☒ Unknown

WHO CAN DO IT: ☒ Volunteers ☒ Local Gov ☐ Hazmat Team ☐ Other

DUMPSTER WITHIN 100 FT: ☐ Yes ☒ No ☐ Unknown

CLEAN-UP POTENTIAL: (*Circle #*)

A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access		A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe.	A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials	
5	4	3	(2)	1

NOTES:

REPORTED TO AUTHORITIES ☐ YES ☒ NO

The ***Stream Crossing (SC)*** data sheet is used to assess all structures that cross the stream and the potential of the crossing to be a fish migration barrier. At each identified crossing, including roads, railroad lines, and dams, the information collected includes location, diameter, materials, condition and restoration potential. The stream crossings are also assessed for the potential to be a fish migration barrier and the potential to mitigate that impact.

The SC data sheet example is for Bellmore Creek. The first section of the data sheet is completed as shown for the OT data sheets. This is the seventh (SC-7) stream crossing observed in Reach 3 (108-3) of Bellmore Creek (Subwatershed 108). The second section describes the observed conditions. The stream crossing observed was a road crossing for the Southern State Parkway. The structure is a single, concrete box culvert. The barrel height is approximately 3.5’ and the culvert is 200’ length by 6-7’ wide with a flat slope. There is evidence of some sediment deposition. The assessor did not identify any potential for restoration at the culvert.

EXAMPLE 3-24 STREAM CROSSING DATA COLLECTION SHEET

Stream Crossing **SC**

WATERSHED/SUBSHED: BELLMORE CREEK	**DATE:** 2/6/07	**ASSESSED BY:** A. SAVINO
SURVEY REACH ID: 108-3	**TIME:** __:__ AM/PM	**PHOTO ID:** (*Camera-Pic #*) /# 271, 287
SITE ID: (*Condition-#*) SC-7	**LAT** __°__'__" **LONG** __°__'__" **LMK**___	**GPS** (*Unit ID*)

TYPE: ■ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

FOR ROAD/RAILROAD CROSSINGS ONLY

SHAPE: ☐ Arch ☐ Bottomless ■ Box ☐ Elliptical ☐ Circular ☐ Other:

 # BARRELS: ■ Single ☐ Double ☐ Triple ☐ Other:

MATERIAL: ■ Concrete ☐ Metal ☐ Other:

ALIGNMENT: ☐ Flow-aligned ☐ Not flow-aligned ■ Do not know

DIMENSIONS: (*if variable, sketch*)
Barrel diameter: — (ft)
Height: ≈ 3½ (ft)
Culvert length: ≈ 200 (ft)
Width: ≈ 6-7 (ft)
Roadway elevation: ? (ft)

CONDITION: (*Evidence of...*) ☐ Cracking/chipping/corrosion ☐ Downstream scour hole ■ Sediment deposition ☐ Failing embankment ☐ Other (*describe*):

CULVERT SLOPE: ■ Flat ☐ Slight (2° – 5°) ☐ Obvious (>5°)

POTENTIAL RESTORATION CANDIDATE ■ no
☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit ☐ Local stream repair ☐ Other:

IS SC ACTING AS GRADE CONTROL ☐ No ☐ Yes ☐ Unknown

If yes for fish barrier

EXTENT OF PHYSICAL BLOCKAGE: ☐ Total ☐ Partial ☐ Temporary ☐ Unknown

CAUSE: ☐ Drop too high Water Drop: ____ (in) ☐ Flow too shallow Water Depth: ____ (in) ☐ Other:

BLOCKAGE SEVERITY: (*circle #*)

A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present.	A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish.	A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls.
5 4	3	2 1

NOTES/SKETCH: ROAD CROSSING IS SOUTHERN STATE PARKWAY

REPORTED TO AUTHORITIES ☐ YES ☒ NO

The ***Channel Modification (CM)*** data sheet assesses the extent of stream channel modification including channelization, bank armoring, channel lining, and flood plain encroachment. The information collected includes type of modification, materials, dimensions, site conditions, flow, severity and potential for restoration.

The CM data sheet example is for Bellmore Creek. The first section of the data sheet is completed as shown for the OT data sheets. This is the first (CM-1) channel modification observed in Reach 3 (108-3) of Bellmore Creek (Subwatershed 108). The second section describes the observed conditions. The channel modification observed was a 250’ length concrete channel that is 7’- 14’ wide by 7’ high. The channel was observed to have 8-12” depth perennial flow with some evidence of sediment deposition and a connection to the floodplain, but no vegetation. Water company facilities were observed in the vicinity of the channel. The assessor noted that the channel severity was in the mid-range, but did not observe any restoration potential.

EXAMPLE 3-25 CHANNEL MODIFICATION DATA COLLECTION SHEET

Channel Modification **CM**

WATERSHED/SUBSHED: BELLMORE CREEK **DATE:** 2/6/07 **ASSESSED BY:** A. SAVINO

SURVEY REACH ID: 108-3 **TIME:** __:__ AM/PM **PHOTO ID:** (*Camera-Pic #*) /# 228-244

SITE ID: (*Condition-#*) CM-1

START LAT __°__'__" LONG __°__'__" LMK ____

END LAT __°__'__" LONG __°__'__" LMK ____

GPS: (*Unit ID*)

TYPE: ☐ Channelization ☐ Bank armoring ☒ concrete channel ☐ Floodplain encroachment ☐ Other:

MATERIAL:			**DIMENSIONS:**	
☒ Concrete ☐ Gabion	Does channel have perennial flow?	☒ Yes ☐ No	Height	≈ 7 (ft)
☐ Rip Rap ☐ Earthen	Is there evidence of sediment deposition?	☒ Yes ☐ No	Bottom Width	≈ 7 (ft)
☐ Metal	Is vegetation growing in channel?	☐ Yes ☒ No	Top Width:	≈ 14 (ft)
☐ Other:	Is channel connected to floodplain?	☒ Yes ☐ No	Length:	≈ 250 (ft)

BASE FLOW CHANNEL

Depth of flow ≈ 8-12 (in)

Defined low flow channel? ☐ Yes ☐ No

% of channel bottom _____%

ADJACENT STREAM CORRIDOR

Available width LT_____(ft) RT_____(ft)

Utilities Present? ☒ Yes ☐ No WATER COMPANY

Fill in floodplain? ☐Yes ☐ No

POTENTIAL RESTORATION CANDIDATE ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell

☒ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

CHANNELIZATION SEVERITY: (*Circle #*)	A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel.	A moderate length (> 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel.	An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area.
	5 4	(3)	2 1

NOTES:

The ***Miscellaneous Features (MI)*** data sheet tracks unusual or notable conditions not included on the other data sheets. The information may include, but is not limited to, construction activities, unstructured crossings (such as from ATV use), failed restoration practices, livestock with access to the stream, fish kills, unusual deposits, log jams, wetlands or high quality habitats, water quality conditions, or stream sampling gauges or gauging stations. The recorded condition may be noted to require additional investigation or possible restoration recommendations may be included.

The MI data sheet example is for Kentuck Brook. The first section of the data sheet is completed as shown for the OT data sheets. This is the first (MI-1) miscellaneous feature observed in Reach 1 (104-1) of Kentuck Brook (Subwatershed 104). The second section describes the observed conditions. The miscellaneous feature observed at this location was a possible underground spring with moderate flow. No other data was collected for this feature, although photographs were taken.

EXAMPLE 3-26 MISCELLANEOUS FEATURES DATA COLLECTION SHEET

Miscellaneous **MI**

WATERSHED/SUBSHED: KENTUCK BROOK	**DATE:** 1 / 9 / 07	**ASSESSED BY:** A. SAVINO
SURVEY REACH ID: 104-1	**TIME:** __:__ AM/PM	**PHOTO ID:** (*Camera-Pic #*) /# 5+6
SITE ID: (*Condition-#*) **MI-**1	**LAT**__°____'____" **LONG**___°____'____" **LMK:** ____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ■ Discharge Prevention ☐ Other:

DESCRIBE: POSSIBLE SPRING FROM UNDERGROUND WITH MODERATE FLOW?

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☒ No

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:** __:__ AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**____	**LAT**__°____'____" **LONG**___°____'____" **LMK:** ____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:** __:__ AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**____	**LAT**__°____'____" **LONG**___°____'____" **LMK:** ____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

The ***Reach Level Assessment (RCH)*** data sheet gauges the overall reach conditions and can be used to rank restoration priorities. Within suburban and urban locations, reaches can be defined by road/stream crossings and by branches. The data sheet includes space for a sketch that is used to reference all individual data sheets within the reach. Survey reaches are named with the next available number that is provided by the Nassau County Bureau of Water Management. The information collected includes land use, substrate material, water clarity, vegetative cover and shading, channel dimension and dynamics. The RCH data sheet also provides a means to assess the overall stream condition by means of general criteria for habitat parameters that can be assessed in the field.

The RCH data sheet example is for Bellmore Creek Reach 1. The RCH data sheets are completed after the reach is walked and the individual data sheets completed. The first section of the data sheet is completed with the reach identification (108-1), subwatershed name, date, assessor(s) and locations of the beginning and end of the reach. The second section describes the general overall conditions observed as the reach was walked, including the weather condition (no rain in last 24 hours), clear at present, the substrate (sand and gravel), water clarity (suspended matter, milky and stained), the amount of vegetation in the stream (some), wildlife (fish), shading (partially shaded), and channel dynamics (unknown, but channelized with varied height). The reach accessibility was determined to be moderate (based on a rating ranging from 5 to 1, this reach received a 3). The assessor described two major problems identified, one being suspended orange matter between Lakeview Road and Sunrise Highway and the other being a potential illicit discharge at OT-11. The third section of the RCH data sheet includes a rating of factors based on a numerical rating from 0-20 for four factors that may influence overall stream condition and overall buffer and floodplain condition. Totaling the points allows the reach to be rated for instream condition, buffer/floodplain condition and total reach condition. Bellmore Creek Reach 1 (108-1) received an instream rating of 55 of 80, a buffer/floodplain rating of 60/80 and a total rating of 115 of 160. The total of 115 puts Bellmore Creek

Reach 1 in the Suboptimal range (123-81). The creek corridor in this reach contains preserved areas with large buffers and wooded vegetation, therefore placing it in the Suboptimal range.

EXAMPLE 3-27 REACH ASSESSMENT DATA COLLECTION SHEET – Page 1

Reach Level Assessment **RCH**

SURVEY REACH ID: 108-1 **WTRSHD/SUBSHD:** BELLMORE CREEK **DATE:** 1/24/07 **ASSESSED BY:** A. SAVINO

START **TIME:** ___:___AM/PM **LMK:** ____
LAT ___°___'___" **LONG** ___°___'___"
DESCRIPTION:

END **TIME:** ___:___AM/PM **LMK:** ____
LAT ___°___'___" **LONG** ___°___'___"
DESCRIPTION:

GPS ID:

RAIN IN LAST 24 HOURS ☐ Heavy rain ☐ Steady rain ■ None ☐ Intermittent ☐ Trace

PRESENT CONDITIONS ☐ Heavy rain ☐ Steady rain ☐ Intermittent ■ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy

SURROUNDING LAND USE: ☐ Industrial ☐ Commercial ☐ Urban/Residential ■ Suburban/Res ■ Forested ☐ Institutional ☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:

AVERAGE CONDITIONS *(check applicable)*

BASE FLOW AS % CHANNEL WIDTH ☐ 0-25% ☐ 25-50 % ☐ 50%-75% ☐ 75-100%

DOMINANT SUBSTRATE
☐ Silt/clay (fine or slick) ☐ Cobble (2.5 –10")
■ Sand (gritty) ☐ Boulder (>10")
■ Gravel (0.1-2.5") ☐ Bed rock

WATER CLARITY ☐ Clear ■ Turbid *(suspended matter)* ■ Stained *(clear, naturally colored)* ■ Opaque *(milky)* ☐ Other *(chemicals, dyes)*

AQUATIC PLANTS IN STREAM Attached: ☐ none ■ some ☐ lots; Floating: ☐ none ■ some ☐ lots

WILDLIFE IN OR AROUND STREAM (Evidence of) ■ Fish ☐ Beaver ☐ Deer ☐ Snails ☐ Other:

STREAM SHADING (water surface)
☐ Mostly shaded (≥75% coverage)
☐ Halfway (≥50%)
■ Partially shaded (≥25%)
☐ Unshaded (< 25%)

CHANNEL DYNAMICS
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
■ Unknown ☐ Sed. deposition ■ Channelized

CHANNEL DIMENSIONS *(FACING DOWNSTREAM)*
Height: LT bank VARIES (ft)
RT bank ____ (ft)
Width: Bottom ____ (ft)
Top ____ (ft)

REACH ACCESSIBILITY

Good		Fair		Difficult
Good: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required.
5	4	(3)	2	1

REACH SKETCH AND SITE IMPACT TRACKING

Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow

NOTES: *(biggest problem you see in survey reach)* SUSPENDED ORANGE MATTER FROM LAKEVIEW RD. TO SUNRISE HWY (PHOTO'S #42-59) AND POSSIBLE ILLICIT DISCHARGE FROM OT-11

REPORTED TO AUTHORITIES ☐ YES ☒ NO

EXAMPLE 3-28 REACH ASSESSMENT DATA COLLECTION SHEET

Page 2

OVERALL STREAM CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
IN-STREAM HABITAT *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
VEGETATIVE PROTECTION *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	(5) 4 3	2 1 0
BANK EROSION (facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 (7) 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
FLOODPLAIN CONNECTION	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) not able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) not able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
OVERALL BUFFER AND FLOODPLAIN CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
VEGETATED BUFFER WIDTH	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
FLOODPLAIN VEGETATION	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN HABITAT	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN ENCROACH-MENT	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: 55 /80 + **Buffer/Floodplain:** 60/80 = **Total Survey Reach** 115 /160

In smaller subwatersheds, ***Photo Inventory Record Sheets*** may be useful for identifying photos so that locations can be easily referenced and a site description added for each photo. For larger subwatersheds, the actual photograph location and number is to be included on the field maps as discussed in Section 3.3.3.3.

3.3.3.5 Restoration Potential Assessment

The final section of each data sheet includes a space for identifying potential for implementation of restoration practices. This field assessment aids in prioritizing future restoration work and provides a starting point for future detailed evaluations. Several factors must be considered when assessing the restoration or mitigation potential including:

- Severity of the impact – how severe a specific impact is in relation to other impacts in the subwatershed.
- Correctability of the impact - how easily an impact can be corrected or mitigated based on ability, space and cost to implement a corrective measure. Can the project be quickly and easily corrected, is some construction and environmental permitting necessary, or does the project require an extended permitting process, major equipment and long construction period?
- Accessibility to the impact - ability to access the site to perform required restoration activity. How difficult will it be for construction equipment to access the site?

Information that can aid in identifying restoration potential can also be included in notes on the data sheets.

3.3.4 Information Management

A Stream Assessment effort can generate hundreds of forms and data sheets. It is critical that they be compiled into a well-organized database that can be accessed over an extended period to review field conditions and restoration feasibility. The data sheets, field maps and photographs from each subwatershed should be organized into a master binder that is divided by reach segment and should include all the data sheets completed for the reach from the downstream end continuing upstream. Field maps and photo inventory forms should be added to the front of each reach segment followed by the Reach Level Assessment (RCH) form and then the individual assessment forms starting with Outfalls (OT) and ending with Miscellaneous (MI) in the order as they are described above. The photographs, printed and numbered to match the photo inventory form or as noted on the field maps, should follow the data sheets. All of field data should be assembled in a document and included as Appendix A to the actual Stormwater Runoff Impact Analysis and Candidate Site Assessment Report. The final Candidate Site Assessment and Recommendations Report will include all of the vulnerability analysis, pollutant load calculations, maps, stream assessment synopsis and restoration recommendations as described in Section 4 of this Manual and it will also include an Appendix A containing all stream assessment data sheets and photographs. The binder should be titled with the waterbody name and the municipality of jurisdiction (i.e.: White's Creek, Nassau County or Francis Pond, Village of Upper Brookville).

It is recommended that the report with all figures, field maps, data sheets and photographs files (either scanned or program files) be placed in a folder titled the same as the report. This folder will therefore include all data generated for that subwatershed, including calculations, field maps and photographs. This provides a backup of the hard copies of the Report and Appendix and allows for easy duplication of information that can be shared between overlapping jurisdictions. A CD of information should be submitted to the County with the report.

The CWP Manual 10 USA provides a specially modified Access database program which can be used to input and organize the data and allow for import into GIS systems. While the process included herein does not use the database, municipalities can create their own databases by inputting the collected data sheet information into a computerized database using the CWP or other database program.

3.4 STREAM CORRIDOR "METRICS" AND SUBWATERSHED COMPARATIVE ANALYSIS

The purpose of classifying and screening subwatersheds is to provide a basis for identifying priority subwatersheds on which planning efforts and implementation funding can focus. This procedure allows the subwatersheds most impacted and offering the greatest restoration potential to be identified. During the screening process, consideration should be given to those subwatersheds contributing the greatest pollutant loads to estuaries. The data developed on the Metrics Table and the data sheets is used to develop the Restoration Projects Map described in Section 4.0 of this Manual.

Stream Corridor "metrics", a term used by the CWP in their stream assessment manual, describes the process of synthesizing the data from the previously discussed data sheets to examine the frequency of a problem or restoration opportunity and to develop an overall evaluation of the reach condition. The metrics allow for comparative analysis of a restoration potential of a reach or subwatershed. One example of stream corridor metrics is the number of suspected illicit discharge outfalls per stream or reach. The identification of a high number of suspected illicit discharge outfalls would warrant additional investigation to locate and repair illicit discharges. Another example of using stream corridor metrics is the examination of severely eroded banks. The total length of eroded banks as a fraction of the overall reach length can identify reaches where stormwater flows may be significantly damaging the stream banks. Further investigation into upstream outfalls can identify locations where heavy storm runoff may be detained.

The restoration goal should be considered in selecting metrics and ranking the subwatershed or reach. Nassau County has focused on pollution reduction as a primary restoration goal. Although not included herein, communities can add additional metrics suited to other restoration objectives, such as downstream flooding reduction, fish habitat restoration, or stream buffer reconstruction, for subwatersheds in their jurisdiction. Discussions of metrics for other subwatershed restoration goals are included in the CWP Manual 10 USA. Several metrics are necessary to aid in ranking the subwatersheds and identifying those sites with the greatest restoration potential. The metrics are generally derived from GIS data and the field data sheets. Other metrics could be generated from available water quality standards, aerial photography and stakeholder input.

Table 3-30 Subwatershed Comparative Analysis lists the metrics used to screen subwatersheds for the restoration goal of pollution reduction based on data developed through the procedures described in this Manual. The metrics included on Table 3-30 are collected from the Subwatershed Vulnerability Analysis (Section 3.2 of this report) and Stream Assessment (Section 3.3 of this report). Points are added based on the restoration potential. The Total Score on the Comparative Analysis Table is calculated as shown in Figure 3-29.

FIGURE 3-29 SUBWATERSHED COMPARATIVE ANALYSIS CALCULATION

The following steps to calculate the **Total Score** for a Subwatershed are included in the Excel file for Subwatershed Comparative Analysis Table. Inserting the quantities for each metric and the number of reaches in the shaded boxes will complete the table.

- Multiple **scoring criteria points** by **reach quantity** to obtain the **metric value** for each metric for each reach.
- Add **metrics values** for each reach to determine individual **Reach Total**
- Add **Reach Totals** to determine **Subwatershed Total**
- Divide **Subwatershed Total** by number of reaches, add **Pollutant Load** value to **Subwatershed Total,** then divide by **Impervious Cover Classification** Value to determine **Total Score**

Note: **Rank** can be used when multiple subwatersheds are analyzed to determine the relative condition of each subwatershed within the set.

The following is a description of the metrics included in Table 3.30 including the reason for inclusion and method and points for ranking.

Outfalls: includes the actual number of outfalls, piped or channelized, identified in each reach. Outfalls suggest that storage retrofits may be necessary. Two points are added to each reach for each identified outfall.

Suspected Illicit Discharge and/or Hot Spot Locations: includes locations where drainage may enter a stream channel either through concentrated, piped or channelized flow (illicit discharge) or surface flow from a land use identified as a potential hot spot such as:

- commercial sites such as laundries, heavy construction yards, automotive facilities;
- industrial sites such as waste management facilities and industrial equipment facilities;
- municipal sites such as highway yards and landfills; and
- transportation facilities such as airports, railroads, petroleum terminals.

Illicit discharges and hot spot locations suggest potential for source control, discharge prevention and on-site retrofits. Eight points are added for each site that is suspected to be an illicit discharge.

WQ Retrofit/Restoration Candidates: includes identified water quality improvement retrofit or restoration sites within the subwatershed or reach. The ability to site a retrofit or restoration action increases the score for a specific outfall. Add one point for each outfall where a potential restoration or retrofit action is identified during the field assessment.

Infrastructure Investigations Required: includes locations where additional drainage infrastructure investigation is required. Outfall investigations identify locations where additional infrastructure may exist requiring restoration or retrofit actions. Add one point for each separate location where additional investigation is required.

Severe Bank Erosion: Number of severe bank erosion sites. A site with bank erosion will contribute significant sediment loads to a subwatershed. Add one point for each separate identified incidence of severe erosion.

Inadequate Buffers: The number of separate locations with inadequate vegetated buffer along stream bank including areas with pavement or mown lawns up to the water edge and areas with grassed or vegetated buffers less than 10' width. Inadequate buffer locations are locations where surface runoff carrying pollutants may not be filtered prior to entering the waterbody. Add five points for each 5% of the stream that has inadequate buffers.

Road Crossings: number of locations where roads cross the stream corridor. Road crossings represent locations where polluted road runoff may enter the stream either through existing infrastructure or via surface runoff. These locations have the potential for storage retrofits, stream repairs and culvert modifications. Add one point for each identified crossing.

Channelized Segments: These are locations where the stream has been channelized with hard structures such as concrete or gabions. Channelized segments suggest locations where stream flow moves quickly and keeps pollutants suspended in the flow. Channelized segments represent the need to focus on pollutant reduction through flood reduction. Add one point for each 5% of the stream channel that is channelized.

Publicly-Owned Lands: Public lands have greater potential for site restoration practices. Add one point for each 10% of the stream channel that abuts public lands.

TABLE 3-30 SUBWATERSHED COMPARATIVE ANALYSIS

	Unit Criteria	Scoring Criteria	(Name/ID No. of Subwatershed)				
			Reach ID#		Reach ID#		Reach ID#
Stream Assessment Quantification	**Unit**	**Points**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty x Pts**
Outfall	per outfall	2	0	0	0	0	
Suspected Illicit Discharge or Hot Spot Locations	per location	8	0	0	0	0	
WQ Retrofit/Restoration Candidates	per location	1	0	0	0	0	
Infrastructure Investigations Required	per location	1	0	0	0	0	
Severe Bank Erosion	per location	1	0	0	0	0	
Inadequate Buffers	per 5% of reach	5	0	0	0	0	
Road Crossings	per location	1	0	0	0	0	
Channelized Segments	per 5% of reach	1	0	0	0	0	
Public Ownership of the Stream Corridor	per 10% of reach	1	0	0	0	0	
Livestock Encroachment or High Waterfowl Populations	per location	5	0	0	0	0	
Threatened Infrastructure	per location	3	0	0	0	0	
Trash Accumulation In Stream	per location	5	0	0	0	0	
Stream Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	
Buffer/Floodplain Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	
Reach Total	**No. of Reaches**	0	**0**		**0**		
Subwatershed Total			**0**				
Impervious Cover Classification	Sensitive, Impacted, Non-supporting, Urban	8,6,4,2	**#DIV/0!**				
Pollutant Load			**#DIV/0!**				
Total Score			**#DIV/0!**				
RANK							

Livestock Access/Encroachment, High Waterfowl and/or Pet Populations: These are locations where livestock, such as horses, are grazed in a field immediately adjacent to the stream corridor, locations where wildlife are observed to congregate, such as parks and fields adjacent to the stream corridor, and locations where pet walking is observed to be concentrated. High livestock, waterfowl and pet populations contribute high fecal coliform loads to surface runoff. Add five points for each separate identified location.

Threatened Infrastructure: These are locations where infrastructure appears to be failing such as undermined headwalls, sunken leaching basins and broken pipe segments. Failing infrastructure presents opportunities to include stormwater pollutant reduction retrofits in the reconstruction. Add three points for each separate identified location.

Stream Corridor Condition: This rating is based on the Reach Level Assessment conducted during the Subwatershed Assessment. This rating rates each reach from poor to optimal for stream conditions. A higher score, out of a total possible 80 points, represents a stream corridor with fewer impacts to the stream corridor environment. As the Comparative Analysis is ranking based on negative conditions and Stream Corridor Condition is rated on positive conditions, this score is converted to a negative value in the Reach Subtotal Column for that metric.

Buffer/Floodplain Condition: This rating is based on the Reach Level Assessment conducted during the Subwatershed Assessment. This rating rates each reach from poor to optimal for buffer and floodplain conditions. A higher score, out of a total possible 80 points, represents a stream corridor with fewer impacts to the buffer and floodplain environment. As the Comparative Analysis Table is ranking based on negative conditions and Stream Corridor Condition is rated on positive condition, this score is converted to a negative value in the Reach Subtotal Column for that metric.

Impervious Cover Classification Score: This score is taken from the Impervious Cover Calculation Table completed as described in Section 3.2. It is based on the percentage of impervious area within the subwatershed. Points should be assigned as follows: Sensitive = 8 points; Impacted = 6 points; Non-supporting = 4 points; Urban = 2 points.

Pollutant Load Severity: Those sites estimated to contribute the largest pollutant loads also have the greatest restoration potential. The Water Quality Storm Volume and Pollutant Load Estimate Table include columns that automatically assign severity rank (1-least severe to 6-most severe) and multiply by the assigned rank to calculate a total score for the subwatershed. This value should be divided by 100 and entered into this column on the Comparative Analysis Table.

The Subwatershed Comparative Analysis uses the metrics previously discussed to screen the subwatersheds or reaches to produce a ranking of the pollution reduction potential of each subwatershed or reach. This ranking aids in identifying the reaches and subwatersheds that merit focus for restoration actions. It should be noted that the decision on metrics and ranking scores is based on professional judgment and is somewhat subjective. A subwatershed with a high score should be reviewed to determine if it has specific factors that restrict implementation of reasonable restoration actions. Examples of additional factors that that can limit restoration potential are conditions such as limited locations to site structural measures due to lack of open space or dense development or existing development within the stream corridor or floodplain. The final report should address conditions that are not adequately reflected in the Comparative Analysis.

The Comparative Analysis Table can be used to compare rankings of each of the reaches within a single subwatershed. The table can be expanded to included additional subwatersheds. A municipality, or other separate MS4, can track all of their subwatersheds and reaches in this manner. The County will input the data from individual reports into a Comparative Analysis Worksheet to track subwatersheds in the entire County.

Example 3-32 shows the Subwatershed Comparative Analysis Table completed for Kentuck Brook. The values in the Quantity column were taken from the Data Collection Sheets and observed field conditions and each is multiplied by the scoring criteria points assigned. For example, the Kentuck subwatershed has 13 identified outfalls multiplied by 2 points per outfall for a score of 26. Scores of each metric are added for a Reach Total of 25. The negative factors assigned to Stream Condition subtotal and Buffer/Floodplain Condition subtotal account for the lower Reach Total score. If the stream had more than one reach, all reach scores should be added for the Subwatershed Total. With one reach, Kentuck Brook's total is 25. When divided by the number of reaches, then adding the pollutant load value (shown on Example 3-18 (the Excel table formula divides the value by 100)), then dividing that value by the Impervious Cover Classification Value (shown on Example 3-10) the final Kentuck Creek final score is 5.

The ranking system developed weighs the estimates on impervious cover and pollutant loads and the findings from the actual stream assessment data collection. Most streams that have low impervious cover and pollutant loads estimates will have large number of stream assessment factors that fall into the optimal to suboptimal range, although a limited number of the factors will fall outside that range. While the ranking can be subjective due to the many additional factors involved in assessing the subwatershed condition and the feasibility of SMP's, the general rankings are defined as follows:

FIGURE 3-31 FINAL SUBWATERSHED RANK

RANK	NUMERICAL VALUE	DESCRIPTION
Optimal/Sensitive	0-15	Optimal/Sensitive streams are estimated to have low impervious cover and pollutant loads. The stream assessment has shown overall stream condition generally falls into the optimal to

		suboptimal categories for instream habitat, bank condition, vegetative cover and floodplains, and overall buffer and floodplain condition fall into the optimal to suboptimal categories for buffer width and floodplain vegetation. Individual categories may be below this range. Optimal/Sensitive streams typically retain good to excellent water quality, have stable channels, excellent habitat structure and fish and insects community biodiversity. They generally do not have frequent flooding events.
Suboptimal/Impacted	16-30	Suboptimal/Impacted streams are estimated to have mid-range levels of impervious cover and pollutant loads. The stream assessment has shown overall stream condition generally falls into the suboptimal category for instream habitat, bank condition, vegetative cover and floodplains, and overall buffer and floodplain condition fall into the suboptimal category for buffer width and floodplain vegetation. Individual categories, however, may fall either above or below the suboptimal range. Suboptimal/Impacted streams typically have signs of moderate degradation including hydrological changes such as increased storm flows, more frequent flooding, and isolated areas of bank erosion or failure. Water quality and biodiversity have declined with sensitive fish and aquatic insect species disappearing. Suboptimal/Impacted streams still have vegetated buffers, wetland/non-wetland habitats and lack of floodplain encroachment
Marginal/Non-supporting	31-45	Marginal/Non-supporting streams are estimated to have relatively high levels of impervious cover and pollutant loads. The stream assessment has shown overall stream condition generally falls into the marginal category for instream habitat, bank condition, vegetative cover and floodplains, and overall buffer and floodplain condition fall into the marginal category for buffer width and floodplain vegetation. Individual categories, however, may fall either above or below the marginal range. Marginal/Non-supporting streams typically have signs of significant degradation including hydrological changes such

		as active erosion and channel widening, disruptions in streambank cover vegetation and entrenched streams. Marginal/Non-supporting streams have impacted buffers, floodplain encroachment and modified buffer vegetation lacking the species mix and mature vegetation of higher quality streams.
Poor/Urban	46+	Poor/urban streams are estimated to have extremely high levels of impervious cover and pollutant loads. The stream assessment has shown overall stream condition generally falls into the poor category for instream habitat, bank condition, vegetative cover and floodplains, and overall buffer and floodplain condition fall into the poor category for buffer width and floodplain vegetation. Individual categories, however, may fall above the poor range. Poor/urban streams typically lack stable habitat, have unvegetated stream banks, have high storm flows, and active erosion that is a threat to property and infrastructure. Poor/urban streams typically have narrow turf grass buffers zones with significant floodplain encroachment such as fill or man-made structures that reduce floodplain function.

The subwatershed score is used to assess the conditions of the specific subwatershed in relation to other subwatersheds in the County. In addition, the table identifies specific candidate sites categories where SMP mitigation measures should be directed. In Example 3-32 - Kentuck Brook- Subwatershed Comparative Analysis the Total Score was 5. A score of 5 places Kentuck Brook in the Optimal/Sensitive category. Further work in this watershed should focus on maintaining this score through maintainence the stream corridor and floodplain conditions along with reducing any pollutant loads. The candidate site assessment for Kentuck Brook should focus on outfall and hot spot mitigation because these metrics have the greatest number of locations (outfalls) and the greatest scoring criteria (suspected illicit discharge or hot spot locations) in the subwatershed.

EXAMPLE 3-32 KENTUCK BROOK
SUBWATERSHED COMPARATIVE ANALYSIS

	Unit Criteria	Scoring Criteria	Kentuck Brook (ID No. 104)		
			104-1		Reach ID#
Stream Assessment Quantification	**Unit**	**Points**	**Qty**	**Qty x Pts**	**Qty x Pts**
Outfall	per outfall	2	13	26	
Suspected Illicit Discharge or Hot Spot Locations	per location	8	1	8	
WQ Retrofit/Restoration Candidates	per location	1	1	1	
Infrastructure Investigations Required	per location	1	1	1	
Severe Bank Erosion	per location	1	0	0	
Inadequate Buffers	per 5% of reach	5	0	0	
Road Crossings	per location	1	2	2	
Channelized Segments	per 5% of reach	1	1	1	
Public Ownership of the Stream Corridor	per 10% of reach	1	0	0	
Livestock Encroachment or High Waterfowl Populations	per location	5	0	0	
Threatened Infrastructure	per location	3	1	3	
Trash Accumulation In Stream	per location	5	0	0	
Stream Condition Subtotal (RCH)	from RCH sheet.	80	72	-9	
Buffer/Floodplain Condition Subtotal (RCH)	from RCH sheet.	80	67	-8	
Reach Total	**No. of Reaches**	1	**25**		
Subwatershed Total			**25**		
Impervious Cover Classification	Sensitive, Impacted, Non-supporting, Urban	8,6,4,2	**6**		
Pollutant Load			**6**		
Total Score			**5**		
RANK					

4.0 CANDIDATE SITE ASSESSMENT AND RECOMMENDATIONS

This section focuses on identifying potential stormwater management practices that will reduce pollutant loads generated within a subwatershed. The information compiled from GIS data, drainage infrastructure mapping and stream assessment is used to identify potential candidate sites for installation of stormwater treatment practices. The Assessment Report should include a listing of the candidate sites along with the potential SMP or SMP's that appear to have potential to be located at the site.

This Manual also includes a methodology to assess the pollutant reduction that would be realized for each SMP and to assess the total load reduction and subwatershed improvement if all identified SMP's are installed. Accurate SMP selection and pollutant reduction analysis requires more specific data for each individual site to accurately locate, identify and size SMP's and assess the actual pollutant load reductions than is compiled via the procedures in this Manual. A detailed assessment may be conducted at a later date as part of the SMP engineering design. A subwatershed may have additional stream or subwatershed impacts, such as flooding or habitat reduction, or other potential mitigation measures, such as nonstructural options including increased maintenance and public education, but these are not included in the site assessment procedure described in this Manual.

Impairments can be identified from New York State documents and from the vulnerability analysis and pollutant load calculations prepared for a particular subwatershed on a site specific level. Stormwater best management practices (SMP's) are described in detail in the New York State Stormwater Design Manual (SWDM). Chapter 5 of the SWDM includes a list of the practices that are acceptable to NYSDEC for water quality treatment. For new development, NYSDEC requires the use of the acceptable practices to achieve removal of 80% of Total Suspended Solids (TSS) and 40% of Total

Phosphorus (TP). For retrofit or redevelopment projects, NYSDEC has identified an interim strategy (more comprehensive guidance may be adopted at a later date) that provides flexibility in removal levels based on review of individual projects and sites. The NYSDEC identifies additional allowable practices and requires a best effort to achieve the new development pollutant removal levels. The Stormwater Management Practices (SMP) Figure (Figure 4-1) in this chapter identifies additional retrofit/reconstruction practices that can be used to reduce pollutant loads that have not been verified by the NYSDEC. NYSDEC SWDM Chapter 6 provides detailed information on the performance criteria of each group of stormwater management practices and Chapter 7 includes a series of screening process matrices used to select preferred SMP’s or a series of SMP's for each candidate site identified. The Chapter 7 SMP selection matrices are included as Appendix B to this Manual. In September 2007, the Center for Watershed Protection published ***Manual 3: Urban Stormwater Retrofit Practices.*** Manual 3 outlines the basics of retrofits and presents methods to find, design and deliver retrofits to meet a wide range of subwatershed objectives.

4.1 WATER QUALITY OBJECTIVES

Waterbodies should be reviewed for inclusion on the NYS Section 303(d) List of Impaired/TMDL (Total Maximum Daily Load) Waters, Waterbody Inventory/Priority Waterbody List (WI/PWL) or NYS Section 305b Water Quality Report. The 303(d) list can be viewed at the internet address http://www.dec.ny.gov/chemical/31290.html. The 303(d) list identifies waterbodies where impairment has been identified including the specific impairment and the source of the impairment. For example, the East Bay on Long Island’s south shore has been identified as having impairments for silt/sediment, phosphorus and pathogens from urban/storm runoff. The NYSDEC is currently preparing TMDL reports for specific pollutants for many of the Long Island subwatersheds. When a TMDL report for a specific pollutant and subwatershed has been completed, it will provide subwatershed load reduction levels for the specific pollutant. The NYSDEC requires that new development contain 80% of TSS and 40% of TP in

SMP's. NYSDEC recognizes that attaining these criteria in retrofit or redevelopment projects may not be feasible, but requires that good faith attempts be made to attain those levels. A vulnerability analysis may identify additional pollutants of concern based on land use, including oil, grease and sediments from road and parking areas, nutrients from lawn areas, bacteria from large waterfowl populations, stabling or pets, and floatable debris from commercial areas.

4.2 POTENTIAL CANDIDATE SITE ASSESSMENT AND SMP SELECTION

The process of determining which specific SMP is capable of providing the mitigation required for a specific subwatershed is based on analysis of the pollutants of concern, site conditions and findings of the drainage infrastructure mapping, subwatershed vulnerability analysis and stream assessment described in Section 3. The information developed in Section 3 should provide adequate information on the pollutants of concern and should also help to identify potential candidate sites for SMP treatment options.

Chapter 7 of the SWDM contains a series of matrices that can be used as screening tools to identify the best SMP for a particular site. Screening factors included in the matrices are land use, physical feasibility, subwatershed or regional factors, stormwater management capabilities, and community and environmental factors. As the SWDM was developed for new construction, the matrices may not always be applicable to site conditions found in the developed subwatersheds of Nassau County. The matrices do, however, provide a starting point to assess solutions and are included herein for easy reference.

The availability of land area for implementation of a treatment option at a candidate site is a critical consideration for Nassau County subwatersheds. Where land area is limited with no available option to acquire land, treatment options may be restricted to practices that can be located within the streets' right-of-way or beneath the road surface.

4.2.1 Subwatershed Drainage Areas

The impervious area and pollutant load calculations completed in Section 3.2 assess the entire subwatershed. Identification of potential SMP candidate sites in the subwatershed requires additional analysis using the data compiled during the vulnerability analysis and the field assessment identifying the drainage area for each outfall. The drainage area analysis procedure is discussed in Section 4.4. Using the area topography and drainage infrastructure, the land area that drains to an outfall is determined. In densely developed subwatersheds, actual mapping of the drainage area of each outfall may require further assessment during the design phase. For the initial assessment, the outfall and upgradient drainage infrastructure can give a reasonable sense of the area that contributes to the outfall and can be used to identify potential SMP's and candidate sites. During this analysis, self-contained areas within the subwatershed are also identified and are removed from the subwatershed area and pollutant load calculations. In addition, areas that surface drain to the waterbody may also be identified. These surface drainage areas are generally located immediately adjacent to the waterbody.

Self-contained areas are defined as areas, including roads, subdivision developments, and commercial and industrial sites, that no longer contribute the water quality volume of runoff to the waterbody. Self-contained areas typically infiltrate the runoff in upgradient recharge basins and other drainage infrastructure. When the water quality storm runoff volume is contained in drainage infrastructure, there must be either no overflow/bypass or an overflow/bypass mechanism must be designed to contain the water quality storm volume to be described as self-contained. Self contained areas are subtracted from the overall pollutant loads calculated as shown on Example 4-10.

Surface drainage areas are generally the land remaining along the shoreline having no concentrated flow. These areas may range from undeveloped woodland parcels to areas impacted by development with impervious surfaces or lawn areas. These areas are not analyzed further, but non-structural SMP measures such as vegetated buffers and fertilizer use reduction, when appropriate, can reduce pollutant loads from these areas.

4.2.2 Site Location Assessment

Using the data developed per the methodology presented in prior sections of this Manual, potential sites for stormwater treatment device options can be identified. The following locations should be reviewed for their SMP siting potential:

- Existing recharge basins with available excess capacity for ponds, wetlands, extended detention facilities or infiltration practices;
- Land immediately upstream of road culverts may be suitable for extended detention facilities and filtering practices;
- Land immediately adjacent to or below existing outfalls may be suitable for filtering practices;
- Existing drainage channels may be suitable for weirs or other similar devices allowing for sediment deposit detention practices or for ultra-urban retrofits;
- Road rights-of-way may have space for extended detention facilities, infiltration facilities, filtering practices, open channels or ultra-urban retrofits;
- Municipal open space can be enhanced with the development of ponds, wetlands, extended detention practices, or filtering practices;
- Large parking lots can provide space for filtering practices, infiltration practices, or ultra-urban retrofits; and
- Roadways can provide space for ultra-urban retrofits such as dry detention facilities or, when space is limited, water quality inlets or catch basin inserts and filters.

4.2.3 Stormwater Management Practices

Potential SMP's are included in Figure 4-1. The Figure includes the NYSDEC approved SMP's from the SWDM and also includes an ultra-urban retrofit/renovation section. The ultra-urban retrofit/renovation section includes general categories of products that can reduce pollutant loads from sites that were constructed prior to SPDES Phase II requirements. These are sites where meeting NYSDEC SWDM is not feasible due to site constraints. For manufactured practices, known manufacturers have been identified. For retrofit/renovation practices, NYSDEC-verified SMP manufacturers have been identified. The NYSDEC-verified practices may be updated as new products enter the market. A current list can be viewed at www.dec.ny.gov/chemical/29089.html.

FIGURE 4-1 STORMWATER MANAGEMENT PRACTICES ACCEPTABLE FOR WATER QUALITY

Group	Practice	Description
Ponds	Micropool Extended Detention Pond	Pond that treats the majority of the water quality volume (WQV) through extended detention and incorporates a micropool at the outlet of the pond to prevent sediment resuspension.
	Wet Pond	Pond that provides storage for the entire WQV in the permanent pool.
	Wet Extended Detention Pond	Pond that treats a portion of the WQV by detaining storm flows above a permanent pool for a specified minimum detention time.
	Multiple Pond System	A group of ponds that collectively treat the WQV.
	Pocket Pond	A stormwater wetland design adapted for the treatment of runoff from small drainage areas having little or no base flow available to maintain water elevations and relies on ground water to maintain a permanent pool.
Wetlands	Shallow Wetland	A wetland that provides water quality treatment entirely in a wet shallow marsh.
	Extended Detention Wetland	A wetland system that treats some fraction of the WQV by detaining storm flows above the marsh surface.
	Pond/Wetland System	A wetland system that treats a portion of the WQV in the permanent pool of a wet pond preceding the marsh for a specified minimum detention time.
	Pocket Wetland	A shallow wetland design adapted for the treatment of runoff from small drainage areas that has variable water levels and relies on groundwater for its permanent pool.
Infiltration Practices	Infiltration Trench	An infiltration practice that stores the WQV in the void spaces of a gravel trench before it is infiltrated into the ground.
	Infiltration Basin	An infiltration practice that stores the WQV in a shallow depression before it is infiltrated it into the ground.
	Dry Well	An infiltration practice similar in design to the infiltration trench, best suited for treatment of rooftop runoff.
Filtering Practices	Surface Sand Filter	A filtering practice that treats stormwater by settling out larger particles in a sediment chamber and then filtering stormwater through a sand matrix.
	Underground Sand Filter	A filtering practice that treats stormwater as it flows through underground settling and filtering chambers.

	Perimeter Sand Filter	A filter that incorporates a sediment chamber and filter bed as parallel vaults adjacent to a parking lot.
	Organic Filter/Media Filter	A filtering practice that uses an organic medium such as compost, perlite, zeolite, or granulated carbon in place of sand in the filter. Manufacturers: Aqua Shield, Contech Stormwater Solutions, CDS Technologies
	Bioretention System	A shallow depression that treats stormwater as it flows through a soil matrix, and is then returned to the storm drain system. Manufacturers: Filterra, Linear Bioretention Trench
Open Channels	Dry Swale	An open drainage channel or depression explicitly designed to detain and promote the filtration of stormwater runoff into the soil media.
	Wet Swale	An open drainage channel or depression designed to retain water or intercept groundwater for quality treatment.
Ultra-Urban Retrofit/Redevelopment	Catch Basin Filter	Small, passive, gravity-powered devices that are fitted below the grate of a drain inlet that intercept and contain litter, vegetation, petroleum hydrocarbons and coarse sediment, ranging from fabric sacks to media filter inserts. These devices have not been NYSDEC verified. Manufacturers: Contech Stormwater Solutions, CDS Technologies, Aqua Shield
	Hydrodynamic Structure	This variety of stormwater inlet, also known as a swirl separator, is a modification of the traditional oil-grit separator and includes an internal component that creates a swirling motion as stormwater flows through a cylindrical chamber. The design allows sediments, with attached hydrocarbons, to settle out as stormwater moves in this swirling path. Additional compartments or chambers are sometimes present to trap oil and other floatables. NYSDEC has verified several proprietary models. Manufacturers: Aqua Shield, BaySaver, CDS Technologies, Contech Stormwater Solutions, Hydro International, Rinker Stormceptor
	Water Quality Inlet (WQI) / Wet Vault	Underground structures that provide temporary storage for stormwater runoff and provide for removal of floatable wastes and suspended solids through the use of a series of settling chambers and separation baffles. Wet vaults maintain a permanent water pool. NYSDEC has verified several proprietary models of wet vault. Manufacturers: Crystal Stream Technologies, Hancor, Contech Stormwater Solutions
	Dry Ponds/Recharge Basins	Open holding basins designed to moderate peak flows and drain completely between storm events. Not listed as a NYS verified practice.
	Underground Dry Detention Facilities	Underground holding chambers which provide storage in tanks and vaults designed to dry out between storms. Chambers allow stormwater to infiltrate into underlying soils, promoting pollutant treatment and recharge. Not listed as a NYS verified practice. Manufacturers: CDS Technologies, Contech Stormwater Solutions

	Porous Pavement	Pavement that allows stormwater to infiltrate into underlying soils, promoting pollutant treatment and recharge. Not listed as a NYS verified practice.
	Deep Sump Catch Basin	Storm drain systems designed to catch debris and coarse sediment. Not listed as a NYS verified practice.
	On-Line Storage in Storm Drain Network	A drainage system designed to contain stormwater in a storm drain network. Not listed as a NYS verified practice.
	Proprietary Filters	Proprietary Filters are forms of media filters developed by specific manufacturers. NYSDEC has verified their performance criteria for redevelopment applications. NYSDEC has verified several proprietary models. Manufacturers: AquaShield, CDS Technologies, Contech Stormwater Solutions
	Filter Strip/Grass Channel	Practices that capture and temporarily store the WQV and pass it through a filter bed of sand, organic matter, soil or other media. Filtered runoff may be collected and returned to the drainage system. Grassed or vegetated open channels capture and treat the WQV within dry or wet cells formed by check dams or other means. Not listed as a NYS verified practice.

4.3 SMP IMPLEMENTATION CANDIDATE SITE LIST

In order to develop an implementation candidate site list, field conditions upstream of each outfall must be reviewed. Factors to consider during review are included in SWDM Chapter 7 matrices, included in Appendix B of this Manual. The preferred SMP's, including ponds, wetlands, infiltration practices, filters, and open channels, are included in SWDM Chapter 7. The potential to site these preferred practices should be assessed first. When existing development precludes the use of a preferred SMP, the ultra-urban retrofit/renovation measures should then be considered.

If there is surface drainage locations identified where sheet flows are contributing runoff to a watercourse, SMP's should be identified for those locations as well. For example, vegetated buffers may be identified as a SMP where cultivated lawns slope to the shoreline of a stream or pond.

Following identification of potential SMP's and siting locations, the reviewer should consider the following factors for each location and practice:

- Pollutant removal capability - types and percentages of pollutant reduction;

- Additional subwatershed improvements - flooding reduction, stream bank restoration, buffer enhancement, etc.;
- Construction costs - including design, construction and maintenance;
- Implementation ability factors - equipment accessibility, land acquisition, permitting requirements, groundwater depth; and
- Public benefit - amenity improvement, educational factor, improvement to a downstream priority or sensitive environment.

4.4 POLLUTANT LOAD REDUCTION ANALYSIS

The following description of pollutant load reduction analysis procedures is based on the Center for Watershed Protection manual titled *Urban Stormwater Restoration Manual Series Urban Stormwater Retrofit Practices, Appendix B: Defining Retrofit Pollutant Load Reduction* published in August 2007. This step can be completed during the actual SMP design phase when more accurate site data will be available allowing for an accurate estimate of the pollutant load reduction.

When a preferred SMP and site location is identified, the area contributing to the outfall is assessed and the water quality volume and pollutant loads are calculated using the procedures described in Section 3.2.3 of this Manual. The results of these calculations are then used to estimate the pollutant load reduction based on the proposed SMP efficiency percentages in Figure 4-3 or provided by proprietary manufacturers. The pollutant loads calculated to be removed by each SMP in the subwatershed are then tallied to provide the estimated total annual pollutant load removal and the percentage of removal for each subwatershed. The Excel tables necessary to complete the pollutant load reduction calculations are included in the Manual CD. Table 4-6 - Pollutant Load Reduction Analysis is shown in Step 5 below. Figure 4-2 presents the steps involved in estimating pollutant removal quantities.

FIGURE 4-2 POLLUTANT LOAD REDUCTION ANALYSIS PROCESS	
Step 1	Define Outfall Drainage Area Boundaries and Self-Contained Areas
Step 2	Estimate Site Impervious
Step 3	Calculate Existing Pollutant Loads
Step 4	Identify Pollutant Removal Percentage
Step 5	Calculate Pollutant Reduction and Percent Removal

Step 1: Define Outfall Drainage Area Boundary and Self-Contained Areas - This procedure is similar to the mapping of a subwatershed boundary. The outfall drainage area boundary is determined by reviewing the drainage infrastructure and topography to determine the land area contributing runoff to the outfall. This is completed for each outfall identified and is defined by the OT number (i.e.; OT-7 drainage area). The same procedure is used to identify self-contained areas. The total existing self-contained area is subtracted from the subwatershed area. If the data available is not sufficient to adequately determine if an area is self-contained, that area should be included in the drainage area and noted that additional research is needed to determine if the area is self-contained. The remaining areas along the stream corridor are generally defined as surface drainage areas.

Step 2: Estimate Site Impervious – The impervious surface area contributing to each outfall is estimated as described in Section 3.2.2 of this Manual using the NCGIS data and calculations for each outfall drainage area. Examples 4-7 and 4-8 show the impervious area calculation for Kentuck Brook OT -2 and OT-3 using modified versions of Table 2-2 and 2-3 found in appendix A of this manual.

Step 3: Calculate Existing Pollutant Loads – Outfall drainage area pollutant loads are estimated as described in Section 3.2.3.2 of this Manual using the outfall drainage area boundaries and impervious cover for each outfall drainage area described above.

Example 4-9 shows the water quality storm event volume and pollutant load calculation for Kentuck Brook OT-2 and OT-3 using a modified version of Table 2-4 found in Appendix A of this manual. The pollutant loads calculated for each candidate site are entered into the pollutant load row of Table 4-6.

Step 4: Identify Pollutant Removal Percentage - Insert the general and specific pollutant removal percentages shown on Figure 4-3 or provided by the proprietary device manufacturer for the proposed SMP device selected for each candidate site into the SMP % Pollutant Reduction row of Table 4-6.

Pollutant load reduction rates shown on Figure 4-3 are based on the median removal rates contained in the *Center for Watershed Protection Urban Subwatershed Restoration Manual Urban Stormwater Retrofit Practices (CWP Manual 3) Appendix D* for general SMP categories and for bioretention and on the *National Pollutant Removal Performance Database for Stormwater Treatment Practices*, March 2000 prepared by the CWP for the USEPA Office for Science and Technology for specific SMP's unless noted otherwise.

FIGURE 4-3 SMP MEDIAN POLLUTANT REMOVAL EFFICIENCY (%)						
	TN	**TSS**	**TP**	**Bacteria** (F. Coliform)	**Oil and Grease**[2]	**Trash**[3]
Stormwater Dry Ponds	**25**	**50**	**20**	**35**	**70**	**80**
Quality Control Pond	5	3	19	-	-	-
Dry Extended Detention Pond	31	61	20	-	-	-
Stormwater Wet Ponds	**30**	**80**	**50**	**70**	**80**	**90**
Wet Extend Detention Pond	35	80	55	-	-	-
Multiple Pond System	N/A	91	76	-	-	-
Wet Pond	32	79	49	-	-	-
Stormwater Wetlands	**25**	**70**	**50**	**60**	**75**	**90**
Shallow Marsh	26	83	43	-	-	-
Extended Detention Wetland	56	69	39	-	-	-
Pond/Wetland System	19	71	56	-	-	-
Submerged Gravel Wetland	19	83	64	-	-	-
Filtering Practices	**30**	**85**	**60**	**40**	**85**	**90**
Organic Filter	41	88	61	-	-	-
Perimeter Sand Filter	47	79	41	-	-	-
Surface Sand Filter	32	87	59	-	-	-
Vertical Sand Filter	5	58	45	-	-	-
Bioretention	49	N/A	65	-	-	-
Infiltration Practices	**40**	**90**	**65**	**40**	**90**	**90**
Infiltration Trench	42	N/A	90	-	-	-
Infiltration Basin	50	90	70	90	75	
Pervious Pavement	83	95	65	-	-	-
Dry Ponds/Recharge Basin [1]	60	90	65	90		
Underground Dry Infiltration [1]	60	90	65	90		
W. Q. Channels/ Swales	**55**	**80**	**25**	**0**	**80**	**0**
Ditches	9	31	16	5	-	-
Grass Channel	NA	68	29	-	-	-
Dry Swale	92	93	83	-	-	-
Wet Swale	40	74	28	-	-	-

Ultra Urban Retrofit/Redevelopment						
Proprietary Practices	Use Manufacturer's removal performance rates for the specific device					
Catch Basin Filters						
Hydrodynamic Structure		66				
Water Quality Inlet		82	NA			
Media Filters		81	38			
On-line Storage						
Deep Sump Catch Basin						

Source: Pollutant removal rates for each SMP category and for bioretention are from *Center for Watershed Protection Urban Subwatershed Restoration Manual 3: Urban Stormwater Retrofit Practices Appendix D, median rates*.
Pollutant removal rates for TSS, TP, TN, bacteria, and hydrocarbons for specific devices are from *National Pollutant Removal Performance Database for Stormwater Treatment Practices* unless noted otherwise. No general data was located for spaces labeled NA or for blank spaces. Either the SMP does not provide removal of the pollutant or published data is not available except as noted in 2 and 3 below.
[1] Pollutant Removal Percentage from USDOT FHWA Stormwater Best Management Practices in an Ultra Urban Setting: , Fact Sheet – Infiltration Basin
[2] Oil and Grease, also referred to as hydrocarbons, removals rates are within 15% of TSS removal rates (i.e., 75% TSS removal, 60% hydrocarbon removal)
[3] Unless the SMP is specifically for trash it is assumed that trash is collected with the capture rate for TSS.

Step 5: Calculate Pollutant Reduction and Percent Removal - The annual pollutant load for the outfall drainage area pre-SMP installation is multiplied by the removal rate to obtain the outfall drainage area post-SMP pollutant load reduction and is shown in the Pollutant Reduction row for each pollutant on Table 4-6.

FIGURE 4-4

POST-SMP POLLUTANT LOAD REDUCTION CALCULATION

$$L_{smp} = Lpre * RR$$

L_{smp} = Pollutant load removed by the proposed SMP (lbs/annually).

L_{pre} = Pollutant load exported from the site before SMP installation. See Step 3 this section (lbs/annually).

RR = Pollutant Removal Rate for SMP from Figure 4-3.

The total pollutant removal for the outfall drainage areas for each pollutant is calculated by totaling the reduction for each Candidate Site and calculating the overall percentage removal based on the Drainage Area Total Pollutant Load.

A single drainage area or volume of runoff treated by more than one SMP connected in series is referred to as a "treatment train". Generally, secondary treatments remove pollutants at lower percentages than included on Figure 4-3 as the initial treatment has already removed a portion of the load. When a treatment train of two or more practices is proposed, the following calculation is used to determine the total pollutant removal rate:

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Following selection of SMP's for specific outfalls and analysis of the pollutant load reduction for each SMP, the pollutant load reduction for each subwatershed is quantified. The outfalls where SMP's are proposed are entered into Table 4-6 along with the treated water volume and the SMP or treatment train percentage pollutant removal rate for each pollutant. The total annual pounds (billion colonies for fecal coliform) are calculated to identify the level of improvement that can be anticipated if the measures are implemented.

TABLE 4-6 POLLUTANT REDUCTION ANALYSIS

Tributary to		Name								
Adjacent Land Use		Name								
Location		Subwatershed Area Pollutant Load (Enter Data from Table 2-4)	Existing Self-contained Areas Pollutant Load and Reduction	Candidate Site 1	Candidate Site 2	Candidate Site 3	Candidate Site 4	Candidate Sites Total Pollutant Load Reduction	Drainage Area Total Pollutant Load	Drainage Area Pollutant Reduction (%)
Outfall										
Stormwater Management Practice										
Total Nitrogen (TN)	pollutant load (lbs)	0								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0	0	#DIV/0!
	Pollutant Reduction (lbs)		0	0	0	0	0			
Total Suspended Solids (TSS)	pollutant load (lbs)	0								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0	0	#DIV/0!
	Pollutant Reduction (lbs)		0	0	0	0	0			
Total Phosphorus (TP)	pollutant load (lbs)	0								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0	0	#DIV/0!
	Pollutant Reduction (lbs)		0	0	0	0	0			
Fecal Coliform (F Coli)	Pollutant load (billion colonies)	0.00								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0.00	0.00	#DIV/0!
	Pollutant Reduction (bc)		0.00	0.00	0.00	0.00	0.00			
Floatable Debris (Trash)	pollutant load (CF)	0								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0	0	#DIV/0!
	Pollutant Reduction (CF)		0	0	0	0	0			
Oil and Grease (Hydrocarbons)	pollutant load (lbs)	0								
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%	0	0	#DIV/0!
	Pollutant Reduction (lbs)		0	0	0	0	0			

4.5 SUBWATERSHED IMPROVEMENT CALCULATION EXAMPLE

The completed examples shown in Example 4-7 GIS Data thru Example 4-10 Subwatershed Pollutant Reduction Analysis is for Kentuck Brook. The Candidate Site Assessment identified six outfalls for potential SMP's. The locations include two swales, two pipe outfalls and two road grate outfalls. If the SMP's discussed in the Kentuck Brook Candidate Site Assessment, including swale revegetation, water quality inlets and catch basin inserts, are implemented and perform as anticipated, it is estimated that the pollutants loads from Kentuck Brook can be reduced by the following amount:

Pollutant	Load Removal	Percent Removal
Total Nitrogen (TN)	x lbs	x %
Total Suspended Solids (TSS)	x lbs	x %
Total Phosphorus (TP)	x lbs	x %
Fecal Coliform (F Coli)	x billion colonies	x %
Trash (Floatable Debris)	x lbs	x %
Oil & Grease (Hydrocarbons)	x lbs	x %

The information generated on candidate sites should be included on a map that identifies the outfalls and the drainage areas, shows the locations of the proposed SMP's and identifies the type of proposed SMP (I.e.; WQI, wet swale, etc.). An example of the SMP Candidate Site Map for Kentuck Brook is included on page 113.

EXAMPLE 4-7 KENTUCK BROOK OUTFALL OT 2 & OT 3
GIS DATA

Outfall(s)	OT 2 & OT 3
Tributary to	Kentuck Brook Reach 104-1
Adjacent Land Use	Resdential

Impervious Information

	Area		Building Area		Parking Lot Area		Length of Roads		Number of Residences
Residential	17.7	Acres	2.9	Acres					100
Commercial	0.0	Acres	0.0	Acres	0.0	Acres			
Industrial	0.0	Acres	0.0	Acres	0.0	Acres			
Roadway (Pavement)	0.0	Acres							
Other (Parks, Municipal, (ROW-Pvmt), Etc.)	0.3	Acres	0.0	Acres	0.0	Acres			
Total Subwatershed	18	Acres	3	Acres	0	Acres	527	LF	

Residential Lots	Quantity in Subwatershed
43561 +	0
21781 - 43560 SF	0
10891 - 21780 SF	17
5446 - 10890 SF	66
0 - 5445 SF	17
Total Number	100

Assumed Percentage of Roadway With Sidewalks (%)	50
Sidewalk Width (FT)	4
Assumed Sides of Roadway With Sidewalk	2

EXAMPLE 4-8 KENTUCK BROOK OUTFALL OT 2 & OT 3
IMPERVIOUS AREA CALCULATION

Impervious Driveway Factors

Residential Lot Area (AC)	Average Driveway Area (SF)	NC criteria
2	3212	1-2+ AC
1	2073	1/2-1 AC
1/2	1152	1/4-1/2 AC
1/4	652	1/8 - 1/4 AC
1/8	432	0-1/8 AC
Source : Cappiella and Brown, 2001		
WVA Table 4: Average Driveway Areas in the Chesapeake Bay Region		

Average Residential Driveway Area Calculation

Outfall	OT 2 & OT3			
Tributary to:	Kentuck Brook Reach 104-1			
Residential > 1 acre - 3212 SF	Units	0	Acres	0.00
Residential > 1/2 acre to ≤ 1 acre - 2,073 SF	Units	0	Acres	0.00
Residential > 1/4 acre to ≤ 1/2 acre - 1,152 SF	Units	17	Acres	0.17
Residential > 1/8 acre to ≤ 1/4 acre - 652 SF	Units	66	Acres	0.65
Residential ≤ 1/8 acre - 432 SF	Units	17	Acres	0.17
Total Acres Driveways Impervious	Units	100	Acres	1

Sidewalk Area Calculation

Outfall	OT 2 & OT3
Tributary to:	Kentuck Brook Reach 104-1
Linear feet of road	527
Assumed percentage with Sidewalks	50
Sidewalk Width	4
Sides Sidewalk	2
Total Acres Sidewalk	0
Calculation : LF of road x % with sidewalks x 4 ft w x 2 sides	

Impervious Area Calculation

Outfall	OT 2 & OT3	
Tributary to:	Kentuck Brook Reach 104-1	
Adjacent Land Use:	Resdential	
Total Subwatershed Area	Acres	18
Impervious areas		
Buildings Area	Acres	3
Roads Area	Acres	0
Parking Lot Area	Acres	0
Sidewalks Area - See Table	Acres	0
Driveway Area Total - See Table	Acres	1
TOTAL IMPERVIOUS AREA	Acres	4
TOTAL % IMPERVIOUS	%	22%

Impervious Area Notes

1. GIS Data Table is source for areas of buildings, roads and parking lots.
2. Sidewalk area calculations are based on percentage of sidewalk area estimated by preparer
3. Impervious Driveways Factors Table - Average Driveway Areas Souce: WVA Table 4, Cappiella and Brown

EXAMPLE 4-9 KENTUCK BROOK OUTFALL OT 2 & OT 3
POLLUTANT LOAD CALCULATION

Outfall		OT 2 & OT 3					
Tributary To		Kentuck Brook Reach 104-1					
Land Use		**Residential**	**Commercial**	**Industrial**	**Roadway**	**Other**	**TOTAL**
Contributory Area	Acres	18	0	0	0	0	**18**
Impervious Area	Acres	3	0	0	0	0	**3**
Impervious Area	%	16	0	0	0	0	16
Water Quality Storm Event Volume	WQv-acre-feet	0	0	0	0	0	0
Water Quality Storm Event Volume	WQv-Cubic Feet	15224	0	0	0	61	15285
Annual Rainfall	inches	42	42	42	42	42	42
Annual Runoff	inches	7	2	2	2	2	7
Total Nitrogen (TN)	coefficient mg/l	2	2	3	3	2	
	lbs	**66**	**0**	**0**	**0**	**0**	**66**
Total Suspended Solids (TSS)	coefficient mg/l	100	75	150	120	55	
	lbs	**2986**	**0**	**0**	**0**	**7**	**2992**
Total Phosphorus (TP)	coefficient mg/l	0	0	0	1	0	
	lbs	**12**	**0**	**0**	**0**	**0**	**12**
Fecal Coliform (F Coli)	coefficient mpn/100 ml	7750	3000	2400	1700	5000	
	billion colonies	**0.11**	**0.00**	**0.00**	**0.00**	**0.00**	**0.11**
Floatable Debris	coefficient CF/AC	5	8	5	8	5	
	CF	**89**	**0**	**0**	**0**	**1**	**90**
Oil and Grease	coefficient mg/l	3	5	4	8	3	
	lbs	**99**	**0**	**0**	**0**	**0**	**99**

SOURCE:
"C" Valve Source; See Table
Impervious Area is based on NCGIS Impervious Area Data from building areas, parking areas, and road areas

EXAMPLE 4-10 KENTUCK BROOK OUTFALL OT 2 & OT 3
POLLUTANT LOAD REDUCTION CALCULATION

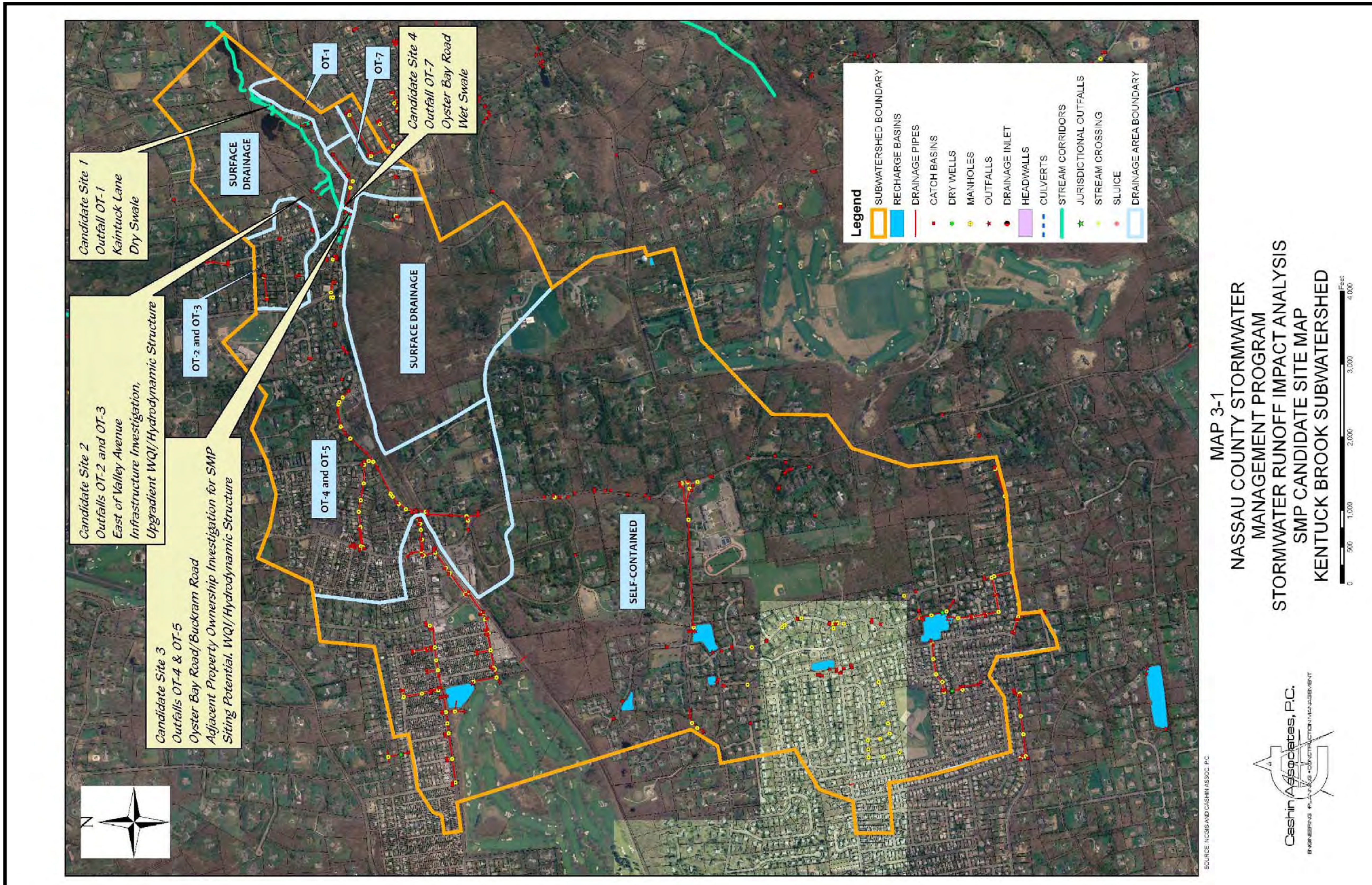
Kentuck Brook Reach 104-1												
Mill Neck Creek/Oyster Bay Harbor												
Location		Subwatershed Area Pollutant Load (Enter Data from Table 2-4)	Existing Self-contained Areas Pollutant Load and Reduction	Candidate Site 1	Candidate Site 2	Candidate Site 3	Candidate Site 4	Candidate Sites Total Pollutant Load Reduction	Drainage Area Total Pollutant Load	Drainage Area Pollutant Reduction (%)
Outfall				OT 1	OT 2 & OT 3	OT 4 & OT 5	OT 7			
Stormwater Management Practice				Dry Swale	WQI	WQI	Wet Swale			
Total Nitrogen (TN)	pollutant load (lbs)	5167	3537	23	66	1062	45	39	1,630	2%
	SMP Pollutant Reduction %		100%	92%	0%	0%	40%			
	Pollutant Reduction (lbs)		3537	21	0	0	18			
Total Suspended Solids (TSS)	pollutant load (lbs)	191389	143463	1001	2992	43358	1897	40342	47,926	84%
	SMP Pollutant Reduction %		100%	93%	82%	82%	74%			
	Pollutant Reduction (lbs)		143,463	931	2,453	35,554	1,404			
Total Phosphorus (TP)	pollutant load (lbs)	797	585	4	12	172	8	6	212	3%
	SMP Pollutant Reduction %		100%	83%	0%	0%	28%			
	Pollutant Reduction (lbs)		585	3	0	0	2			
Fecal Coliform (F Coli)	Pollutant load (billion colonies)	4.44	3.36	0.02	0.11	0.94	0.04	0.00	1.08	0%
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (bc)		3.36	0.00	0.00	0.00	0.00			
Floatable Debris (Trash)	pollutant load (CF)	7912	5037	51	90	1136	70	1105	2,875	38%
	SMP Pollutant Reduction %		100%	93%	82%	82%	74%			
	Pollutant Reduction (CF)		5,037	47	74	932	52			
Oil and Grease (Hydrocarbons)	pollutant load (lbs)	10469	7136	47	99	2247	94	1664	3,333	50%
	SMP Pollutant Reduction %		100%	78%	67%	67%	59%			
	Pollutant Reduction (lbs)		7,136	37	66	1,505	55			

4.6 STORMWATER RUNOFF IMPACT ANALYSIS REPORT AND MAP

The information generated through the process described in this Manual should be collected into a single report with a map that identifies the locations of the proposed SMP's. An example of the SMP Candidate Sites Map is included on the following page. A Table of Contents for this report is included in Appendix A and is on the report CD. The report should include a written description of the findings including the subwatershed characterization of the drainage area, outfalls and drainage system, land use, topography, roads jurisdictions, etc. and associated maps. All of the tables used or prepared should be included. These include the impervious cover area, subwatershed classifications, subwatershed pollutant load calculations, stream assessment findings, drainage infrastructure findings, stormwater management practices assessment, drainage area calculations and potential load reduction calculations. All data sheets and calculation tables should be included in an Appendix.

The SMP Candidate Sites Map should include NC aerial photography, the subwatershed boundary, the drainage infrastructure system, and the outfalls and drainage areas where SMPs are proposed. An example of this map is shown on the following page.

When possible the report should be scanned into a .pdf document that can be copied to CD. This will allow for easy data sharing with other jurisdictions at a later date. The complete report should be organized into a bound document with the report CD included in a pocket in the report. The Appendix data can be bound into a separate document(s) if necessary. An example of a completed report is included on the report CD.


Candidate Site 1
Outfall OT-1
Kaintuck Lane
Dry Swale
Candidate Site 2
Outfalls OT-2 and OT-3
East of Valley Avenue
Infrastructure Investigation,
Upgradient WQI/Hydrodynamic Structure
Candidate Site 3
Outfalls OT-4 & OT-5
Oyster Bay Road/Buckram Road
Adjacent Property Ownership Investigation for SMP
Siting Potential. WQI/Hydrodynamic Structure
Candidate Site 4
Outfall OT-7
Oyster Bay Road
Wet Swale
OT-1
OT-7
OT-2 and OT-3
OT-4 and OT-5
SURFACE DRAINAGE
SURFACE DRAINAGE
SELF-CONTAINED
N
Legend
SUBWATERSHED BOUNDARY
RECHARGE BASINS
DRAINAGE PIPES
CATCH BASINS
DRY WELLS
MANHOLES
OUTFALLS
DRAINAGE INLET
HEADWALLS
CULVERTS
STREAM CORRIDORS
JURISDICTIONAL OUTFALLS
STREAM CROSSING
SLUICE
DRAINAGE AREA BOUNDARY
MAP 3-1
NASSAU COUNTY STORMWATER
MANAGEMENT PROGRAM
STORMWATER RUNOFF IMPACT ANALYSIS
SMP CANDIDATE SITE MAP
KENTUCK BROOK SUBWATERSHED
0
500
1,000
2,000
3,000
4,000
Feet
Cashin Associates, P.C.
SOURCE: NCGIS AND CASHIN ASSOC. P.C.

Nassau County Stormwater Management Program

Stormwater Runoff Impact Analysis

Appendix A
Typical Table and Form Models

(Forms are included on CD)

SAMPLE REQUEST FOR GIS RECORDS

Date

Central Program Analyst
Nassau County Department of Information Technology
160 Old Country Road.
Mineola, NY 11501
Attn: Department Secretary

RE: Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
Town Geographic Information Systems (GIS) Records

Dear Sirs:

Requestor and Municipality is working in the *name of subwatershed(s)* in connection with the above referenced project which entails the mapping of drainage infrastructure in subwatersheds of Nassau County in accordance with the Stormwater Runoff Impact Analysis Procedures Manual developed by the NCDPW – Bureau of Water Management. We are currently licensed to access the Nassau County GIS data.

The study areas is *describe location(s)* and are shown on the attached figure (*attach figure*). The required information includes, at a minimum, subwatersheds, storm drainage infrastructure, land use, buildings, property lines, pavements, roads, jurisdictional boundaries, topography and environmental information (*edit list if necessary)*.

Provide name and contact information

encl.

cc: NCDPW-Bureau of Water Management
170 Cantiague Rock Road
Hicksville, NY 11801

THOMAS R. SUOZZI
COUNTY EXECUTIVE

PETER J. GERBASI, P.E.
COMMISSIONER

COUNTY OF NASSAU
DEPARTMENT OF PUBLIC WORKS
1194 PROSPECT AVENUE
WESTBURY, NEW YORK 11590-2723
TEL 571-6819
Fax # 571-9657

FREEDOM OF INFORMATION REQUEST FORM

DETAILS OF APPLICANT:

NAME: ______________________ *TELEPHONE #* ____________________

FIRM NAME: __________________ fax: __________________________

ADDRESS: _______________________ TOWN/VILLAGE: ____________________

STATE: __________________ ZIP CODE: _________________________

DETAILS OF REQUEST:

Describe in detail below the information you are requesting:

____

____

____

____

____

Pending Litigation: YES:_______NO:_________

Date of Incident ______________Case Name/Number_______________________

For department Use Only:
Approved: __________ Denied _____ Records are out of Nassau County Jurisdiction
Denied _____ An Investigation was completed by the Nassau County Department of Public Works and no records were found
Denied _____Confidential Disclosure Denied_________ Other

____
Gary J. Yansick, Director of Management Analysis II Date

Notice: You have the right to appeal a denial of this request: All appeals must be made to the Nassau County Records Appeals Officer, Lorna B. Goodman, Office of the County Attorney. One West St. Mineola, NY 11501. The records appeals officer will respond to your request within ten (10) days after the receipt of the appeal.

NYSDOT FOIL REQUEST

date

NYSDOT Claims, Room 4(A)10
250 Veterans Memorial Highway
Hauppauge, NY 11788

RE: Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis - Capital Project No. 82010B
Freedom of Information Law Request: NYS Road Segments in the *insert location*

Dear Sirs:

Requestor/municipality has been retained in connection with the above referenced project, which entails the mapping of drainage infrastructure in various areas of *insert municipality*.

Accordingly, *Requestor/municipality* requests the available data and information, including, but not limited to, infrastructure maps, final design plans, as-built drawings, design approval documents, drainage reports, and GIS mapping or data layers for the following New York State road segments (see attached maps):

Town of *insert name*:

1. *insert list of New York State roads in subwatershed(s)*

Provide name and contact information

encl.

cc: NCDPW-Bureau of Water Management
170 Cantiague Rock Road
Hicksville, NY 11801

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
NCDPW Engineering Department
Map File List of Requested Plans
Table 2-1

(Name/ID No. of Subwatershed)

COUNTY FILE # (BROWN / BLACK BOOK)		**OLD COUNTY FILE #** (BLUE BOOK)		**MUNICIPALITY FILE #** (RED BOOK)	

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
GIS Data
Table 2-2

Name of Subwatershed	(Name/ID No. of Subwatershed)
Tributary to	Name
Adjacent Land Use	Name

Impervious Information

	Area		Building Area		Parking Lot Area		Length of Roads		Number of Residences
Residential	0	Acres	0	Acres					0
Commercial	0	Acres	0	Acres	0	Acres			
Industrial	0	Acres	0	Acres	0	Acres			
Roadway (Pavement)	0	Acres							
Other (Parks, Municipal, (ROW-Pvmt), Etc.)	0	Acres	0	Acres	0	Acres			
Total Subwatershed	0	Acres	0	Acres	0	Acres	0	LF	

Residential Lots	Quantity in Subwatershed
43561 +	0
21781 - 43560 SF	0
10891 - 21780 SF	0
5446 - 10890 SF	0
0 - 5445 SF	0
Total Number	0

Assumed Percentage of Roadway With Sidewalks (%)	0
Sidewalk Width (FT)	0
Assumed Sides of Roadway With Sidewalk	0

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
Impervious Cover Calculations
Table 2-3

Impervious Driveway Factors		
Residential Lot Area (AC)	Average Driveway Area (SF)	NC criteria
2	3212	1-2+ AC
1	2073	1/2-1 AC
1/2	1152	1/4-1/2 AC
1/4	652	1/8 - 1/4 AC
1/8	432	0-1/8 AC
Source : Cappiella and Brown, 2001		
WVA Table 4: Average Driveway Areas in the Chesapeake Bay Region		

Average Residential Driveway Area Calculation				
Subwatershed:	(Name/ID No. of Subwatershed)			
Tributary to:	Name			
Residential > 1 acre - 3212 SF	Units	0	Acres	0.00
Residential > 1/2 acre to ≤ 1 acre - 2,073 SF	Units	0	Acres	0.00
Residential > 1/4 acre to ≤ 1/2 acre - 1,152 SF	Units	0	Acres	0.00
Residential > 1/8 acre to ≤ 1/4 acre - 652 SF	Units	0	Acres	0.00
Residential ≤ 1/8 acre - 432 SF	Units	0	Acres	0.00
Total Acres Driveways Impervious	Units	0	Acres	0

Sidewalk Area Calculation	
Subwatershed:	(Name/ID No. of Subwatershed)
Tributary to:	Name
Linear feet of road	0
Assumed percentage with Sidewalks	0
Sidewalk Width	0
Sides Sidewalk	0
Total Acres Sidewalk	0
Calculation : LF of road x % with sidewalks x 4 ft w x 2 sides	

Impervious Area Calculation		
SubWatershed:	(Name/ID No. of Subwatershed)	
Tributary to:	Name	
Adjacent Land Use:	Name	
Total Subwatershed Area	Acres	0
Impervious areas		
Buildings Area	Acres	0
Roads Area	Acres	0
Parking Lot Area	Acres	0
Sidewalks Area - See Table	Acres	0
Driveway Area Total - See Table	Acres	0
TOTAL IMPERVIOUS AREA	Acres	0
TOTAL % IMPERVIOUS	%	#DIV/0!
Classification	#DIV/0!	

Impervious Area Notes
1. GIS Data Table is source for areas of buildings, roads and parking lots.
2. Sidewalk area calculations are based on percentage of sidewalk area estimated by preparer
3. Impervious Driveways Factors Table - Average Driveway Areas Souce: WVA Table 4, Cappiella and Brown

Initial Subwatershed Classification			
	8	Sensitive Stream	0-10% impervious
	6	Impacted Stream	>10%- to 25% impervious
	4	Non-Supporting Stream	> 25%- 60% impervious
	2	Urban Drainage Stream	> 60% impervious
Source: WVA Figure 4 and Table 2			

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
Subwatershed Comparative Analysis
Table 2-5

	Unit Criteria	Scoring Criteria	(Name/ID No. of Subwatershed)									
			Reach ID#		Reach ID#		Reach ID#		Reach ID#		Reach ID#	
Stream Assessment Quantification	**Unit**	**Points**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**
Outfall	per outfall	2	0	0	0	0	0	0	0	0	0	0
Suspected Illicit Discharge or Hot Spot Locations	per location	8	0	0	0	0	0	0	0	0	0	0
WQ Retrofit/Restoration Candidates	per location	1	0	0	0	0	0	0	0	0	0	0
Infrastructure Investigations Required	per location	1	0	0	0	0	0	0	0	0	0	0
Severe Bank Erosion	per location	1	0	0	0	0	0	0	0	0	0	0
Inadequate Buffers	per 5% of reach	5	0	0	0	0	0	0	0	0	0	0
Road Crossings	per location	1	0	0	0	0	0	0	0	0	0	0
Channelized Segments	per 5% of reach	1	0	0	0	0	0	0	0	0	0	0
Public Ownership of the Stream Corridor	per 10% of reach	1	0	0	0	0		0		0		0
Livestock Encroachment or High Waterfowl Populations	per location	5	0	0	0	0	0	0	0	0	0	0
Threatened Infrastructure	per location	3	0	0	0	0	0	0	0	0	0	0
Trash Accumulation In Stream	per location	5	0	0	0	0	0	0	0	0	0	0
Stream Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	0	0	0	0	0	0
Buffer/Floodplain Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	0	0	0	0	0	0
Reach Total	**No. of Reaches**	0	**0**		**0**		**0**		**0**		**0**	
Subwatershed Total			**0**									
Impervious Cover Classification	Sensitive, Impacted, Non supporting, Urban	8,6,4,2	**#DIV/0!**									
Pollutant Load			**#DIV/0!**									
Total Score			**#DIV/0!**									
RANK												

Nassau County Stormwater Management Program
Stormwater Runoff Impact Analysis
Subwatershed Comparative Analysis
Table 2-5

	Unit Criteria	Scoring Criteria	(Name/ID No. of Subwatershed)									
			Reach ID#		Reach ID#		Reach ID#		Reach ID#		Reach ID#	
Stream Assessment Quantification	**Unit**	**Points**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**	**Qty**	**Qty x Pts**
Outfall	per outfall	2	0	0	0	0	0	0	0	0	0	0
Suspected Illicit Discharge or Hot Spot Locations	per location	8	0	0	0	0	0	0	0	0	0	0
WQ Retrofit/Restoration Candidates	per location	1	0	0	0	0	0	0	0	0	0	0
Infrastructure Investigations Required	per location	1	0	0	0	0	0	0	0	0	0	0
Severe Bank Erosion	per location	1	0	0	0	0	0	0	0	0	0	0
Inadequate Buffers	per 5% of reach	5	0	0	0	0	0	0	0	0	0	0
Road Crossings	per location	1	0	0	0	0	0	0	0	0	0	0
Channelized Segments	per 5% of reach	1	0	0	0	0	0	0	0	0	0	0
Public Ownership of the Stream Corridor	per 10% of reach	1	0	0	0	0		0		0		0
Livestock Encroachment or High Waterfowl Populations	per location	5	0	0	0	0	0	0	0	0	0	0
Threatened Infrastructure	per location	3	0	0	0	0	0	0	0	0	0	0
Trash Accumulation In Stream	per location	5	0	0	0	0	0	0	0	0	0	0
Stream Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	0	0	0	0	0	0
Buffer/Floodplain Condition Subtotal (RCH)	from RCH sheet.	80	0	0	0	0	0	0	0	0	0	0
Reach Total	**No. of Reaches**	0	**0**		**0**		**0**		**0**		**0**	
Subwatershed Total			**0**									
Impervious Cover Classification	Sensitive, Impacted, Non supporting, Urban	8,6,4,2	**#DIV/0!**									
Pollutant Load			**#DIV/0!**									
Total Score			**#DIV/0!**									
RANK												

Watershed/subshed:			OT-
Assessed by:		Date:	
Survey Reach ID:	Time:	Photo ID #:	
Lat. ° ' " Long. ° ' " LMK:			GPS ID:

Type of Outfall:	Bank:	Type:	Material:	Shape:	Dimensions:
O Stormwater	O Left	O Closed Pipe	O Concrete	O Circular	Diameter:
O Sewage Overflow	O Right	O Open Channel	O PVC/Plastic	O Elliptical	(For Open Channel)
O Industrial	O Other:	O Other:	O Metal	O Trapezoid	Depth:
O Pumping Station		O Single	O Brick/Stone	O Parabolic	Width Top:
O Agricultural		O Double	O Earthen	O Other:	Width Bot:
O Other:		O Triple	O Other:		

Submerged:	Flow:	Condition: (Pipe/Wall)	Odor: O No	Deposits/Stains:
O No	O No	O Good	O Gas	O No
O Partially	O Trickle	O Chipped/Cracked	O Sewage	O Oily
O Fully (Visible)	O Moderate	O Exposed Rebar	O Rancid/Sour	O Flow Line
O Fully (Not Visible)	O Substantial	O Corrosion	O Sulfide	O Paint
O Other:	O Other:	O Other:	O Other:	O Other:

Veggie Density:	Pool Quality:		Pipe Benthic Growth:	Other Concerns:
O No	O No	O Oils	O No	O Excess Trash:
O Normal	O Good	O Suds	O Brown	O Excessive Sedimentation
O Inhibited	O Odors	O Algae	O Orange	O Bank/Wall Erosion
O Excessive	O Colors	O Float.	O Green	O Needs Regular Maintenance
O Other:	O Other:		O Other:	O Other:

For Flowing Only:		
	Color:	O Clear O Brown O Grey O Yellow O Green O Orange O Other:
	Turbidity:	O None O Slight Cloudiness O Cloudy O Opaque O Other:
	Floatables:	O None O Sewage (Toilet Paper, etc.) O Petroleum (Oil Sheen O Other:

Potential Restoration Candidate: O No

O Discharge Investigation	
O Storm Water Retrofit: if yes →	Is storm water currently controlled? O Yes O No O Not Investigated
O Local Stream Repair	Land use description & area available:
O Outfall Stabilization	
O Stream Daylighting: if yes →	Length of vegitative cover from outfall:
O Other:	Type of existing Vegetation: Slope:

Outfall Severity

Heavy Discharge with distinct color and/or strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor/localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
5 4	3	2 1

Outfall Correctability

Easily repairable, no heavy equipment needed	Moderately repairable, some heavy equipment needed	Difficult to repair, heavy equipment and planning needed
5 4	3	2 1

Outfall Accessability

Easily accessable by foot and by vehicle	Moderately accessable by foot and by vehicle	Difficult to access by foot, not accessable by vehicle
5 4	3	2 1

Adjacent Land Use:

Possible Utility Conflicts:

Notes:

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID (*Condition-#*): **OT-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____	**GPS:** (*Unit ID*)

BANK: ☐LT ☐RT ☐ Head	**TYPE:**	**MATERIAL:**	**SHAPE:** ☐ Single	**DIMENSIONS:**	**SUBMERGED:**
FLOW: ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:	☐ Closed pipe	☐ Concrete ☐Metal ☐ PVC/Plastic ☐Brick ☐ Other:	☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other:	Diameter:_____(in)	☐ No ☐ Partially ☐ Fully
	☐ Open channel	☐ Concrete ☐ Earthen ☐ Other:	☐ Trapezoid ☐ Parabolic ☐ Other:	Depth: _____(in) Width (Top):_____(in) " (Bottom):_____(in)	*NOT APPLICABLE*

CONDITION:	**ODOR:** ☐ NO	**DEPOSITS/STAINS:**	**VEGGIE DENSITY:**	**PIPE BENTHIC GROWTH:** ☐ None
☐ None ☐ Chip/Cracked ☐ Peeling Paint ☐ Corrosion ☐ Other:	☐Gas ☐ Sewage ☐Rancid/Sour ☐ Sulfide ☐ Other:	☐ None ☐Oily ☐ Flow Line ☐ Paint ☐Other:	☐ None ☐ Normal ☐ Inhibited ☐ Excessive ☐ Other:	☐ Brown ☐ Orange ☐ Green ☐ Other: **POOL QUALITY:** ☐ No pool ☐ Good ☐Odors ☐Colors ☐Oils ☐ Suds ☐ Algae ☐ Floatables ☐ Other:

FOR FLOWING ONLY		
	COLOR:	☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:
	TURBIDITY:	☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque
	FLOATABLES:	☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other:
OTHER CONCERNS:	☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation ☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other:	

POTENTIAL RESTORATION CANDIDATE ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization
☐ no ☐ Storm water retrofit ☐ Other:

If yes for daylighting:
Length of vegetative cover from outfall: ___________ft Type of existing vegetation:_____________________ Slope: ___________°

If yes for stormwater:
Is stormwater currently controlled? Land Use description:________________________________
☐ Yes ☐ No ☐ Not investigated Area available:

OUTFALL SEVERITY: *(circle #)*	Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream.	Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized.	Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems.
	5 4	3 2	1

SKETCH/NOTES:

REPORTED TO AUTHORITIES: ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH:	**TIME:**___:____AM/PM	**PHOTO ID** (CAMERA-PIC #): /#	
SITE ID: (*Condition-#*) **ER-_____**	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____		**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream)*
LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*) LT______ft and/or RT________ft
Bank Ht LT______ft and/or RT_________ft
Bank Angle LT_______° and/or RT_______°

Bottom width _______ft
Top width __________ft
Wetted Width _______ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY(*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3	2 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3	2 1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Impacted Buffer **IB**

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH: **TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **IB-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

IMPACTED BANK: ☐ LT ☐ RT ☐ Both

REASON INADEQUATE: ☐ Lack of vegetation ☐ Too narrow ☐ Widespread invasive plants ☐ Recently planted ☐ Other:

LAND USE: (*Facing downstream*)	Private	Institutional	Golf Course	Park	Other Public
LT Bank	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐:

DOMINANT LAND COVER:	Paved	Bare ground	Turf/lawn	Tall grass	Shrub/scrub	Trees	Other
LT Bank	☐	☐	☐	☐	☐	☐	☐:
RT Bank	☐	☐	☐	☐	☐	☐	☐:

INVASIVE PLANTS: ☐ None ☐ Rare ☐ Partial coverage ☐ Extensive coverage ☐ unknown

STREAM SHADE PROVIDED? ☐ None ☐ Partial ☐ Full

WETLANDS PRESENT? ☐ No ☐ Yes ☐ Unknown

POTENTIAL RESTORATION CANDIDATE ☐ no

☐Active reforestation ☐Greenway design ☐ Natural regeneration ☐ Invasives removal ☐ Other:

RESTORABLE AREA

	LT (BANK)	RT
Length (ft):	_________	_________
Width (ft):	_________	_________

REFORESTATION POTENTIAL: (*Circle #*)

Impacted area on public land where the riparian area does not appear to be used for any specific purpose; plenty of area available for planting	Impacted area on either public or private land that is presently used for a specific purpose; available area for planting adequate	Impacted area on private land where road; building encroachment or other feature significantly limits available area for planting
5 4	3 2	1

POTENTIAL CONFLICTS WITH REFORESTATION ☐ Widespread invasive plants ☐ Potential contamination ☐ Lack of sun ☐ Poor/unsafe access to site ☐ Existing impervious cover ☐ Severe animal impacts (deer, beaver) ☐ Other:

NOTES:

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **SC-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____	**GPS** (*Unit ID*)

TYPE: ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

FOR ROAD/ RAILROAD CROSSINGS ONLY

SHAPE: ☐ Arch ☐ Bottomless ☐ Box ☐ Elliptical ☐ Circular ☐ Other:

 # BARRELS: ☐ Single ☐ Double ☐ Triple ☐ Other:

MATERIAL: ☐ Concrete ☐ Metal ☐ Other:

ALIGNMENT: ☐ Flow-aligned ☐ Not flow-aligned ☐ Do not know

DIMENSIONS: (*if variable, sketch*)
Barrel diameter: _________(ft)
Height: _________(ft)
Culvert length: _________(ft)
Width: _________(ft)
Roadway elevation:_________(ft)

CONDITION: (*Evidence of…*)
☐ Cracking/chipping/corrosion ☐ Downstream scour hole
☐ Sediment deposition ☐ Failing embankment
☐ Other (*describe*):

CULVERT SLOPE: ☐ Flat ☐ Slight ($2^o – 5^0$) ☐ Obvious ($>5^o$)

POTENTIAL RESTORATION CANDIDATE ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit
☐ no ☐ Local stream repair ☐ Other:

IS SC ACTING AS GRADE CONTROL ☐ No ☐ Yes ☐ Unknown

If yes for fish barrier

EXTENT OF PHYSICAL BLOCKAGE:
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

CAUSE:
☐ Drop too high Water Drop: ______ (in)
☐ Flow too shallow Water Depth:______ (in)
☐ Other:

BLOCKAGE SEVERITY: *(circle #)*

A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present.	A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish.	A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls.

5 4 3 2 1

NOTES/SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Channel Modification

CM

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **CM-**_____	*START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____	**GPS:** (*Unit ID*)

TYPE: ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

MATERIAL: ☐ Concrete ☐ Gabion ☐ Rip Rap ☐ Earthen ☐ Metal ☐ Other:	Does channel have perennial flow?	☐ Yes ☐ No	**DIMENSIONS:** Height ________________(ft)
	Is there evidence of sediment deposition?	☐ Yes ☐ No	Bottom Width ________________(ft)
	Is vegetation growing in channel?	☐ Yes ☐ No	Top Width: ________________(ft)
	Is channel connected to floodplain?	☐ Yes ☐ No	Length: ________________(ft)

BASE FLOW CHANNEL

Depth of flow _____________(in)

Defined low flow channel? ☐ Yes ☐ No

% of channel bottom __________%

ADJACENT STREAM CORRIDOR

Available width LT_________(ft) RT________(ft)

Utilities Present? ☐ Yes ☐ No

Fill in floodplain? ☐Yes ☐ No

POTENTIAL RESTORATION CANDIDATE ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell ☐ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

CHANNEL-IZATION SEVERITY: (*Circle #*)	A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel.	A moderate length (> 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel.	An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area.
	5 4	3	2 1

NOTES:

TR

WATERSHED/SUBSHED:		**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**____:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#	
SITE ID: (*Condition-#*) **TR-**_____	**LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK** _____		**GPS:** (*Unit ID*)

TYPE:	**MATERIAL:**	**SOURCE:**	**LOCATION:**	**LAND OWNERSHIP:**
☐ Industrial ☐ Commercial ☐ Residential	☐ Plastic ☐ Paper ☐ Metal ☐ Tires ☐ Construction ☐ Medical ☐ Appliances ☐ Yard Waste ☐ Automotive ☐ Other:	☐ Unknown ☐ Flooding ☐ Illegal dump ☐ Local outfall	☐ Stream ☐ Riparian Area ☐ Lt bank ☐ Rt bank	☐ Public ☐ Unknown ☐ Private **AMOUNT** (*# Pickup truck loads*):

POTENTIAL RESTORATION CANDIDATE ☐ Stream cleanup ☐ Stream adoption segment ☐ Removal/prevention of dumping
☐ no ☐ Other:

If yes for trash or debris removal	**EQUIPMENT NEEDED :** ☐ Heavy equipment ☐ Trash bags ☐ Unknown	**DUMPSTER WITHIN 100 FT:** ☐ Yes ☐ No ☐ Unknown
	WHO CAN DO IT: ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other	

CLEAN-UP POTENTIAL: (*Circle #*)	A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access	A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe.	A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials
	5	4 3	2 1

NOTES:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **UT-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

TYPE:	**MATERIAL:**	**LOCATION:**	**POTENTIAL FISH BARRIER:**	**PIPE DIMENSIONS:**
☐ Leaking sewer ☐ Exposed pipe ☐ Exposed manhole ☐ Other:	☐ Concrete ☐ Corrugated metal ☐ Smooth metal ☐ PVC ☐ Other:	☐ Floodplain ☐ Stream bank ☐ Above stream ☐ Stream bottom ☐ Other:	☐ Yes ☐ No	Diameter: _____in Length exposed: _____ft
			CONDITION: ☐ Joint failure ☐ Pipe corrosion/cracking ☐ Protective covering broken ☐ Manhole cover absent ☐ Other:	

EVIDENCE OF DISCHARGE:		
	COLOR	☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other:
	ODOR	☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other:
	DEPOSITS	☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other:

POTENTIAL RESTORATION CANDIDATE ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no ☐ Fish barrier removal ☐ Other:

If yes to fish barrier, Water Drop: ________ (in)

UTILITY IMPACT SEVERITY: (*Circle #*)			
	Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure.	A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event.	Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel.
Leaking= ☐ 5	5	4 3	2 1

NOTES:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

WATERSHED/SUBSHED:	**DATE:** ___/_____/___	**ASSESSED BY:**
SURVEY REACH ID:	**TIME:**___:____AM/PM	**PHOTO ID:** (*Camera-Pic #*) /#
SITE ID: (*Condition-#*) **MI-**_____	**LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____	**GPS:** (*Unit ID*)

POTENTIAL RESTORATION CANDIDATE ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

DESCRIBE:

REPORTED TO LOCAL AUTHORITIES ☐ Yes ☐ No

Reach Level Assessment

RCH

SURVEY REACH ID: ______	WTRSHD/SUBSHD:	DATE: ___/_____/___	ASSESSED BY:

START TIME:____:____AM/PM LMK: ______ LAT____°______'______" LONG ____°______'______" DESCRIPTION:	*END* TIME:____:____AM/PM LMK: ______ LAT____°______'______" LONG ____°______'______" DESCRIPTION:	GPS ID:

RAIN IN LAST 24 HOURS ☐ Heavy rain ☐ Steady rain ☐ None ☐ Intermittent ☐ Trace

PRESENT CONDITIONS ☐ Heavy rain ☐ Steady rain ☐ Intermittent ☐ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy

SURROUNDING LAND USE: ☐ Industrial ☐ Commercial ☐ Urban/Residential ☐ Suburban/Res ☐ Forested ☐ Institutional ☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:

AVERAGE CONDITIONS *(check applicable)*

BASE FLOW AS % CHANNEL WIDTH	☐ 0-25% ☐ 50%-75% ☐25-50 % ☐ 75-100%
DOMINANT SUBSTRATE	☐ Silt/clay (fine or slick) ☐ Cobble (2.5 –10") ☐ Sand (gritty) ☐ Boulder (>10") ☐ Gravel (0.1-2.5") ☐ Bed rock
WATER CLARITY	☐ Clear ☐Turbid *(suspended matter)* ☐ Stained *(clear, naturally colored)* ☐ Opaque *(milky)* ☐ Other *(chemicals, dyes)*
AQUATIC PLANTS IN STREAM	Attached: ☐ none ☐ some ☐ lots Floating: ☐ none ☐ some ☐ lots
WILDLIFE IN OR AROUND STREAM	(Evidence of) ☐ Fish ☐ Beaver ☐ Deer ☐ Snails ☐ Other:
STREAM SHADING (water surface)	☐ Mostly shaded (≥75% coverage) ☐ Halfway (≥50%) ☐ Partially shaded (≥25%) ☐ Unshaded (< 25%)
CHANNEL DYNAMICS ☐ Unknown	☐ Downcutting ☐ Widening ☐ Headcutting ☐ Aggrading ☐ Sed. deposition ☐ Bed scour ☐ Bank failure ☐ Bank scour ☐ Slope failure ☐ Channelized
CHANNEL DIMENSIONS *(FACING DOWNSTREAM)*	Height: LT bank ____________(ft) RT bank ____________(ft) Width: Bottom ____________(ft) Top ____________(ft)

REACH ACCESSIBILITY

Good: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required.

5 4 3 2 1

REACH SKETCH AND SITE IMPACT TRACKING

Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow

NOTES: *(biggest problem you see in survey reach)*

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Overall Stream Condition				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
In-stream Habitat *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Vegetative Protection *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Bank Erosion (facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Floodplain Connection	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Overall Buffer and Floodplain Condition				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
Vegetated Buffer Width	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Floodplain Vegetation	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Floodplain Habitat	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Floodplain Encroach-ment	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach _____ **/160**

Photo Inventory

(By Camera)

Project: ______________

Group: _______________

Camera: _____________

This field sheet is to be completed AS photos are taken in the field. The intent is to force us to organize pictures taken on a camera basis. Fill out one sheet per camera (add sheets as needed). Only fill in Date/Reach/Location ID when you start in a new spatial or temporal location.

Date	Stream/ Reach	Location ID	Photo #	Description

Date	Stream/ Reach	Location ID	Photo #	Description

Comments:

(BACK)

Nassau County Stormwater Management Program
Candidate Site Assessment
GIS Data
Table 3-1

Outfall(s)	Location
Tributary to	Name
Adjacent Land Use	Name

Impervious Information

	Area		Building Area		Parking Lot Area		Length of Roads		Number of Residences
Residential		Acres		Acres					0.00
Commercial		Acres		Acres		Acres			
Industrial		Acres		Acres		Acres			
Roadway (Pavement)		Acres							
Other (Parks, Municipal, (ROW-Pvmt), Etc.)		Acres		Acres		Acres			
Total Subwatershed	0.00	Acres	0.00	Acres	0.00	Acres		LF	

Residential Lots	Quantity in Subwatershed
43,561 +	
21,781 - 43,560 SF	
10,891 - 21,780 SF	
5,446 - 10,890 SF	
0 - 5,445 SF	
Total Number	0.00

Assumed Percentage of Roadway With Sidewalks (%)	
Sidewalk Width (FT)	
Assumed Sides of Roadway With Sidewalk	

Nassau County Stormwater Management Program
Candidate Site Assessment
Impervious Cover Calculations
Table 3-2

Impervious Driveway Factors		
Residential Lot Area (AC)	**Average Driveway Area (SF)**	**NC criteria**
2	3,212	1-2+ AC
1	2,073	1/2-1 AC
1/2	1,152	1/4-1/2 AC
1/4	652	1/8 - 1/4 AC
1/8	432	0-1/8 AC
Source : Cappiella and Brown, 2001		
WVA Table 4: Average Driveway Areas in the Chesapeake Bay Region		

Average Residential Driveway Area Calculation				
Outfall	Location			
Tributary to:	Name			
Residential > 1 acre - 3212 SF	Units	0	Acres	0.00
Residential > 1/2 acre to ≤ 1 acre - 2,073 SF	Units	0	Acres	0.00
Residential > 1/4 acre to ≤ 1/2 acre - 1,152 SF	Units	0	Acres	0.00
Residential > 1/8 acre to ≤ 1/4 acre - 652 SF	Units	0	Acres	0.00
Residential ≤ 1/8 acre - 432 SF	Units	0	Acres	0.00
Total Acres Driveways Impervious	Units	0	Acres	0

Sidewalk Area Calculation	
Outfall	**Location**
Tributary to:	Name
Linear feet of road	0
Assumed percentage with Sidewalks	0
Sidewalk Width	0
Sides Sidewalk	0
Total Acres Sidewalk	0
Calculation : LF of road x % with sidewalks x 4 ft w x 2 sides	

Impervious Area Calculation		
Outfall	**Location**	
Tributary to:	Name	
Adjacent Land Use:	Name	
Total Subwatershed Area	Acres	0
Impervious areas		
Buildings Area	Acres	0
Roads Area	Acres	0
Parking Lot Area	Acres	0
Sidewalks Area - See Table	Acres	0
Driveway Area Total - See Table	Acres	0
TOTAL IMPERVIOUS AREA	Acres	**0**
TOTAL % IMPERVIOUS	%	**#DIV/0!**

Impervious Area Notes
1. GIS Data Table is source for areas of buildings, roads and parking lots.
2. Sidewalk area calculations are based on percentage of sidewalk area estimated by preparer
3. Impervious Driveways Factors Table - Average Driveway Areas Souce: WVA Table 4, Cappiella and Brown

Nassau County Stormwater Management Program
Candidate Site Assessment
Water Quality Storm Event (WQSE) Volume and Pollutant Load Estimates
Table 3-3

Outfall(s)		Location					
Tributary To		Name					
Land Use		**Residential**	**Commercial**	**Industrial**	**Roadway**	**Other**	**TOTAL**
Contributory Area	Acres	0	0	0	0	0	**0**
Impervious Area	Acres	0	0	0	0	0	**0**
Impervious Area	%	0	0	0	0	0	0
Water Quality Storm Event Volume	WQv-acre-feet	0	0	0	0	0	0
Water Quality Storm Event Volume	WQv-Cubic Feet	0	0	0	0	0	0
Annual Rainfall	inches	42	42	42	42	42	42
Annual Runoff	inches	2	2	2	2	2	2
Total Nitrogen (TN)	coefficient mg/l	2	2	3	3	2	
	lbs	0	0	0	0	0	**0**
Total Suspended Solids (TSS)	coefficient mg/l	100	75	150	120	55	
	lbs	0	0	0	0	0	**0**
Total Phosphorus (TP)	coefficient mg/l	0	0	0	1	0	
	lbs	0	0	0	0	0	**0**
Fecal Coliform (F Coli)	coefficient mpn/100 ml	7,750	3,000	2,400	1,700	5,000	
	billion colonies	0.00	0.00	0.00	0.00	0.00	**0.00**
Floatable Debris	coefficient CF/AC	5	8	5	8	5	
	CF	0	0	0	0	0	**0**
Oil and Grease	coefficient mg/l	3	5	4	8	3	
	lbs	0	0	0	0	0	**0**

SOURCE:
"C" Valve Source; See Table
Impervious Area is based on NCGIS Impervious Area Data from building areas, parking areas, and road areas

Nassau County Stormwater Management Program
Canidate Site Assessment
Pollutant Reduction Analysis
Table 3-4

Tributary to		**Name**								
Adjacent Land Use		**Name**								
Location		**Subwatershed Area Pollutant Load (Enter Data from Table 2-4)**	**Existing Self-contained Areas Pollutant Load and Reduction**	**Candidate Site 1**	**Candidate Site 2**	**Candidate Site 3**	**Candidate Site 4**	**Candidate Sites Total Pollutant Load Reduction**	**Drainage Area Total Pollutant Load**	**Drainage Area Pollutant Reduction (%)**
Outfall										
Stormwater Management Practice										
Total Nitrogen (TN)	pollutant load (lbs)	0						0	0	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (lbs)		0	0	0	0	0			
Total Suspended Solids (TSS)	pollutant load (lbs)	0						0	0	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (lbs)		0	0	0	0	0			
Total Phosphorus (TP)	pollutant load (lbs)	0						0	0	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (lbs)		0	0	0	0	0			
Fecal Coliform (F Coli)	Pollutant load (billion colonies)	0.00						0.00	0.00	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (bc)		0.00	0.00	0.00	0.00	0.00			
Floatable Debris (Trash)	pollutant load (CF)	0						0	0	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (CF)		0	0	0	0	0			
Oil and Grease (Hydrocarbons)	pollutant load (lbs)	0						0	0	#DIV/0!
	SMP Pollutant Reduction %		100%	0%	0%	0%	0%			
	Pollutant Reduction (lbs)		0	0	0	0	0			

Cashin Associates, P.C.

Nassau County
Stormwater Management Program

Name of Creek Subwatershed Stormwater Runoff Impact Analysis And Candidate Site Assessment

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Cashin Associates, P.C.

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Nassau County Stormwater Management Program

Stormwater Runoff Impact Analysis

Appendix B
NYSDEC
Stormwater Design Manual
Chapter 7 SMP Selection Chapter

This chapter presents a series of matrices that can be used as a screening process to select the best SMP or group of SMPs for a development site. It also provides guidance for best locating practices on the site. The matrices presented can be used to screen practices in a step-wise fashion. The screening factors include:

1. Land Use
2. Physical Feasibility
3. Watershed/ Regional Factors
4. Stormwater Management Capability
5. Community and Environmental Factors

The five matrices presented here are not exhaustive. Specific additional criteria may be incorporated depending on local design knowledge and resource protection goals. Furthermore, many communities may wish to eliminate some of the selection factors presented in this section. Caveats for the application of each matrix are included in the detailed description of each.

More detail on the proposed step-wise screening process is provided below:

Step 1 Land Use

Which practices are best suited for the proposed land use at this site? In this step, the designer makes an initial screen to select practices that are best suited to a particular land use.

Step 2 Physical Feasibility Factors

Are there any physical constraints at the project site that may restrict or preclude the use of a particular SMP? In this step, the designer screens the SMP list using Matrix No. 2 to determine if the soils, water table, drainage area, slope or head conditions present at a particular development site might limit the use of a SMP.

Step 3 Watershed Factors

What watershed protection goals need to be met in the resource my site drains to? Matrix No.3 outlines SMP goals and restrictions based on the resource being protected.

Step 4 Stormwater Management Capability

Can one SMP meet all design criteria, or is a combination of practices needed? In this step, designers can screen the SMP list using Matrix No. 4 to determine if a particular SMP can meet water quality, channel protection, and flood control storage requirements. At the end of this step, the designer can screen the SMP options down to a manageable number and determine if a single SMP or a group of SMPs is needed to meet stormwater sizing criteria at the site.

Step 5 Community and Environmental Factors

Do the remaining SMPs have any important community or environmental benefits or drawbacks that might influence the selection process? In this step, a matrix is used to compare the SMP options with regard to cold climate restrictions, maintenance, habitat, community acceptance, cost and other environmental factors.

Section 7.1 Land Use

This matrix allows the designer to make an initial screen of practices most appropriate for a given land use (Table 7.1).

Rural. This column identifies SMPs that are best suited to treat runoff in rural or very low density areas (e.g., typically at a density of less than ½ dwelling unit per acre).

Residential. This column identifies the best treatment options in medium to high density residential developments.

Roads and Highways. This column identifies the best practices to treat runoff from major roadways and highway systems.

Commercial Development. This column identifies practices that are suitable for new commercial development

Hotspot Land Uses. This last column examines the capability of an SMP to treat runoff from designated hotspots (see Appendix A). An SMP that receives hotspot runoff may have design restrictions, as noted.

Ultra-Urban Sites. This column identifies SMPs that work well in the ultra-urban environment, where space is limited and original soils have been disturbed. These SMPs are frequently used at redevelopment sites.

Table 7.1 Land Use Selection Matrix

SMP Group	SMP Design	Rural	Residential	Roads and Highways	Commercial/ High Density	Hotspots	Ultra Urban
Pond	Micropool ED	❍	❍	❍	◗	①	●
	Wet Pond	❍	❍	❍	◗	①	●
	Wet ED Pond	❍	❍	❍	◗	①	●
	Multiple Pond	❍	❍	◗	◗	①	●
	Pocket Pond	❍	◗	❍	◗	●	●
Wetland	Shallow Wetland	❍	❍	◗	◗	①	●
	ED Wetland	❍	❍	◗	◗	①	●
	Pond/Wetland	❍	❍	●	◗	①	●
	Pocket Wetland	❍	◗	❍	◗	●	●
Infiltration	Infiltration Trench	◗	◗	❍	❍	●	◗
	Shallow I-Basin	◗	◗	◗	◗	●	◗
	Dry Well[1]	◗	❍	●	◗	●	◗
Filters	Surface Sand Filter	●	◗	❍	❍	②	❍
	Underground SF	●	●	◗	❍	❍	❍
	Perimeter SF	●	●	◗	❍	❍	❍
	Organic SF	●	◗	❍	❍	②	❍
	Bioretention	◗	◗	❍	❍	②	❍
Open Channels	Dry Swale	❍	◗	❍	◗	②	◗
	Wet Swale	❍	●	❍	●	●	●

❍: Yes. Good option in most cases.
◗: Depends. Suitable under certain conditions, or may be used to treat a portion of the site.
●: No. Seldom or never suitable.
①: Acceptable option, but may require a pond liner to reduce risk of groundwater contamination.
②: Acceptable option, if not designed as an exfilter.
1: The dry well can only be used to treat rooftop runoff

Section 7.2 Physical Feasibility Factors

This matrix allows the designer to evaluate possible options based on physical conditions at the site (Table 7.2). More detailed testing protocols are often needed to confirm physical conditions at the site. Five primary factors are:

Soils. The key evaluation factors are based on an initial investigation of the NRCS hydrologic soils groups at the site. Note that more detailed geotechnical tests are usually required for infiltration feasibility and during design to confirm permeability and other factors. Appendix H describes geotechnical testing requirements for New York State.

Water Table. This column indicates the minimum depth to the seasonally high water table from the bottom elevation, or floor, of an SMP.

Drainage Area. This column indicates the minimum or maximum drainage area that is considered optimal for a practice. If the drainage area present at a site is slightly greater than the maximum allowable drainage area for a practice, some leeway is warranted where a practice meets other management objectives. Likewise, the minimum drainage areas indicated for ponds and wetlands should not be considered inflexible limits, and may be increased or decreased depending on water availability (baseflow or groundwater), mechanisms employed to prevent clogging, or the ability to assume an increased maintenance burden.

Slope. This column evaluates the effect of slope on the practice. Specifically, the slope guidance refers to how flat the area where the practice is installed must be and/or how steep the contributing drainage area or flow length can be.

Head. This column provides an estimate of the elevation difference needed for a practice (from the inflow to the outflow) to allow for gravity operation.

Table 7.2 Physical Feasibility Matrix

SMP Group	SMP Design	Soils	Water Table	Drainage Area (acres)	Site Slope	Head (ft)
Pond	Micropool ED	HSG A soils may require pond liner.	2 foot separation if hotspot or aquifer	10 min[1]	No more than 15%	6 to 8 ft
	Wet Pond			25 min[1]		
	Wet ED Pond					
	Multiple Pond					
	Pocket Pond	OK	below WT	5 max[2]		4 ft
Wetland	Shallow Wetland	HSG A soils may require liner	2 foot separation if hotspot or aquifer	25 min	No more than 8%	3 to 5 ft
	ED Wetland					
	Pond/Wetland					
	Pocket Wetland	OK	below WT	5 max		2 to 3 ft
Infiltration	Infiltration Trench	$f_c > 0.5$ inch/hr; additional pretreatment required over 2.0 in/hr (See Section 6.3.3)	3 feet, 4 feet if sole source aquifer.	5 max	No more than 15%	1 ft[6]
	Shallow I-Basin			10 max[3]		3 ft
	Dry Well			1 max[4]		1 ft
Filters	Surface SF	OK	2 feet[5]	10 max[2]	No more than 6%	5 ft
	Underground SF			2 max[2]		5 to 7ft
	Perimeter SF			2 max[2]		2 to 3 ft
	Organic SF			5 max[2]		2 to 4 ft
	Bioretention			5 max[2]		5 ft
Open Channels	Dry Swale	Made Soil	2 feet	5 max	No more than 4%	3-5 ft
	Wet Swale	OK	below WT	5 max		1 ft

Notes:
1: Unless adequate water balance and anti-clogging device installed
2: Drainage area can be larger in some instances
3: May be larger in areas where the soil percolation rate is greater than 5.0 in/hr
4: Designed to treat rooftop runoff only
5: If designed with a permeable bottom, must meet the depth requirements for infiltration practices.
6: Required ponding depth above geotextile layer.

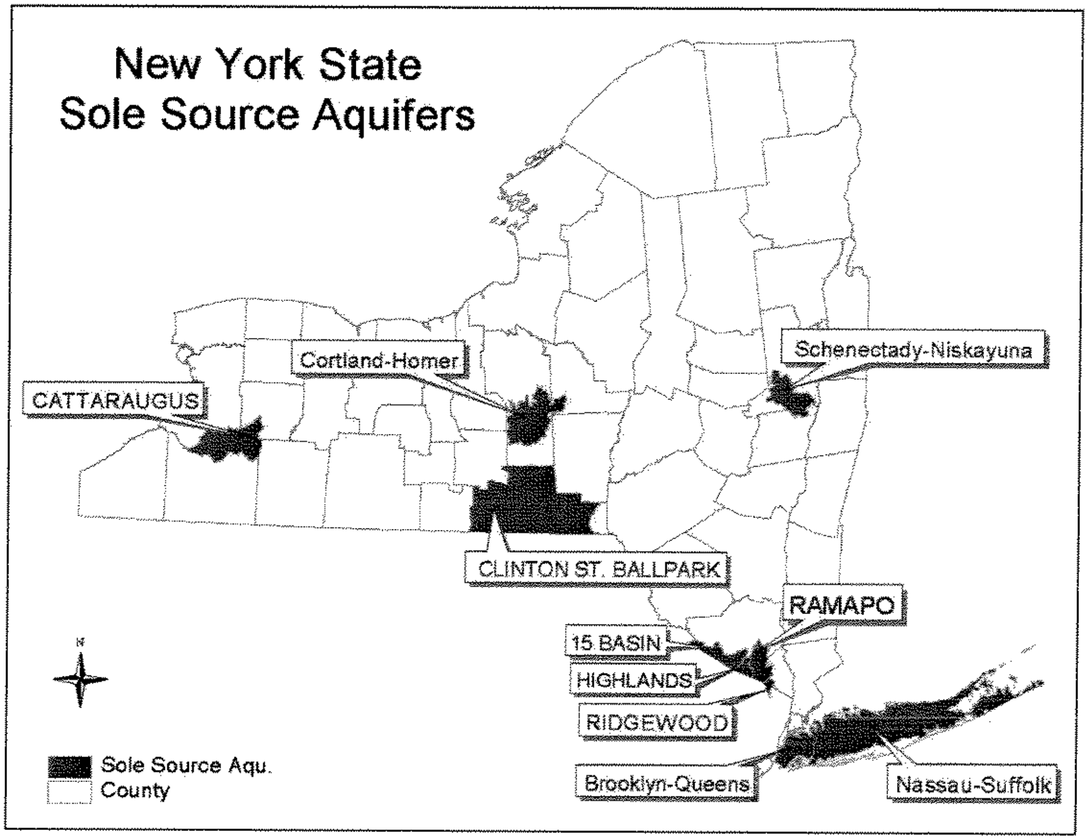
Section 7.3 Watershed/Regional Factors

The choices made by the designer should be influenced to some extent by the resource being protected, and the region of New York State where the site is located. The following matrices (Tables 7.3a and 7.3b) present some design considerations for six watershed or regional factors in New York:

Sensitive Streams. The guidance presented here should apply to all trout waters and Class N waters, and any streams that support high biodiversity and water quality, and have a low density of development.

Aquifers. In sole source aquifers, special care should be taken to select practices and incorporate design considerations that protect the groundwater quality. Figure 7.1 depicts sole source aquifers in the State of New York.

Figure 7.1 Sole Source Aquifers in New York State



Lakes. Lakes are of particular concern in New York, which has many natural lake systems and borders on two Great Lakes. The information in this matrix focuses on phosphorous removal, which is an important concern in most lake systems. It is important to note, however, that many lakes in New York State have other important issues to address. Some lakes, such as Onondaga Lake, have other specific concerns, such as toxics and metals. Each community should also take these goals into consideration when reviewing site plans.

<table>
<tr><th colspan="4">Table 7.3a Watershed/ Regional Selection Matrix-1</th></tr>
<tr><th>SMP Group</th><th>Sensitive Stream</th><th>Aquifer</th><th>Lakes</th></tr>
<tr><td>Ponds</td><td>Emphasize channel protection.
Restrict in-stream practices.
In trout waters, minimize permanent pool area, and encourage shading.</td><td rowspan="2">May require liner if HSG A soils are present.
Pretreat 100% of WQ_v from hotspots.
Provide a 2' separation distance to water table.</td><td rowspan="2">Encourage the use of a large permanent pool to improve phosphorus removal.</td></tr>
<tr><td>Wetlands</td><td>Require channel protection.
Restrict in-stream practices.
Restrict use in trout waters.</td></tr>
<tr><td>Infiltration</td><td>Strongly encourage use for groundwater recharge.
Combine with a detention facility to provide channel protection.</td><td>Provide 100' horizontal separation distance from wells and 4' vertical distance from the water table.</td><td>OK. Provides high phosphorus removal.</td></tr>
<tr><td>Filtering Systems</td><td>Combine with a detention facility to provide channel protection.</td><td>Excellent pretreatment for infiltration or open channel practices.</td><td>OK, but designs with a submerged filter may result in phosphorus release.</td></tr>
<tr><td>Open Channels</td><td>Combine with a detention facility to provide channel protection.</td><td>OK, but hotspot runoff must be adequately pretreated</td><td>OK. Moderate P removal.</td></tr>
</table>

Reservoirs. For drinking water reservoirs, and in particular for unfiltered water supplies such as the New York City Reservoir system, turbidity, phosphorous removal, and bacteria are of particular concern. A particular reservoir may have other specific concerns, which should be identified as part of a Source Water Assessment.

Estuary/Coastal. In New York State, coastal or estuary areas include the South Shore Estuary Reserve, Peconic Estuary, NY/NJ Harbor, and Hudson River Estuary. In these areas, nitrogen is typically a concern due to potential eutrophication. In addition, bacteria control is important to protect shellfish beds.

Cold Climates. Many portions of New York State experience cold or very snowy winters. This matrix summarizes some of the design considerations in these cold climate areas. For more detailed information, consult Chapter 6, which provides cold climate design guidance for each group of SMPs.

<table>
<tr><th colspan="4">Table 7.3b Watershed/Regional Selection Matrix-2</th></tr>
<tr><th>SMP Group</th><th>Reservoir</th><th>Estuary/Coastal</th><th>Cold Climates</th></tr>
<tr><td>Ponds</td><td rowspan="2">Encourage the use of a large permanent pool to improve sediment and phosphorous removal.

Promote long detention times to encourage bacteria removal.</td><td rowspan="2">Encourage long detention times to promote bacteria removal.

Provides high nitrogen removal.

In flat coastal areas, a pond drain may not be feasible.</td><td>Incorporate design features to improve winter performance.</td></tr>
<tr><td>Wetlands</td><td>Encourage the use of salt-tolerant vegetation.</td></tr>
<tr><td>Infiltration</td><td>Provide a separation distance from bedrock and water table

Pretreat runoff prior to infiltration practices.</td><td>OK, but provide a separation distance to seasonally high groundwater.

In the sandy soils typical of coastal areas, additional pretreatment may be required (See Section 6.3.3)</td><td>Incorporate features to minimize the risk of frost heave.

Discourage infiltration of chlorides.</td></tr>
<tr><td>Filtering Systems</td><td>Excellent pretreatment for infiltration or open channel practices.

Moderate to high coliform removal</td><td>Moderate to high coliform removal

Designs with a submerged filter bed appear to have very high nitrogen removal</td><td>Incorporate design features to improve winter performance.</td></tr>
<tr><td>Open Channels</td><td>Poor coliform removal for wet swales.</td><td>Poor coliform removal for grass wet swales.</td><td>Encourage the use of salt-tolerant vegetation.</td></tr>
</table>

Section 7.4 Stormwater Management Capability

This matrix examines the capability of each SMP option to meet stormwater management criteria (Table 7.4). It shows whether an SMP can meet requirements for:

Water Quality. The matrix summarizes the relative pollutant removal of each practice for nitrogen, metals, and bacteria. All of the practices approved for water quality achieve at least 80% TSS and 40% TP removal. For more detailed information, consult Appendix A, which describes the application of the Simple Method in New York State. Pollutant removals are based a comprehensive pollutant removal database produced by the Center for Watershed Protection (Winer, 2000).

Channel Protection. The matrix indicates whether the SMP can typically provide channel protection storage. The finding that a particular SMP cannot meet the channel protection requirement does not necessarily imply that the SMP should be eliminated from consideration, but is a reminder that more than one practice may be needed at a site (e.g., a bioretention area and a downstream ED pond).

Flood Control The matrix shows whether an SMP can typically meet the overbank flooding criteria for the site. Again, the finding that a particular SMP cannot meet the requirement does not necessarily mean that it should be eliminated from consideration, but rather is a reminder that more than one practice may be needed at a site (e.g., a bioretention area and a downstream stormwater detention pond).

Table 7.4 Stormwater Management Capability Matrix

SMP Group	SMP Design	Water Quality			Channel Protection	Flood Control
		Nitrogen	Metals	Bacteria		
Pond	Micropool ED	❍	❍	❍	❍	❍
	Wet Pond				❍	❍
	Wet ED Pond				❍	❍
	Multiple Pond				❍	❍
	Pocket Pond				❍	❍
Wetland	Shallow Wetland	❍	◗	❍	❍	❍
	ED Wetland				❍	❍
	Pond/Wetland				❍	❍
	Pocket Wetland				❍	❶
Infiltration	Infiltration Trench	❍	❍	❍	●	●
	Shallow I-Basin				❷	❷
	Dry Well				●	●
Filters	Surface Sand Filter	❍	❍	◗	❶	●
	Underground SF				●	●
	Perimeter SF				●	●
	Organic SF				●	●
	Bioretention				❶	●
Open Channels	Dry Swale	◗	❍	●	●	●
	Wet Swale				●	●

❍: Good option for meeting management goal
Good pollutant removal (>30% TN, >60% Metals, >70% Bacteria)
◗: Fair pollutant removal (15-30% TN, 30-60% Metals, 35-70% Bacteria)
●: Cannot meet management goal.
Poor pollutant removal (<15% TN, <30 Metals, <35% Bacteria)
❶: In most cases, cannot meet this goal, but the design may be adapted to add storage.
❷: Generally cannot meet this goal, except in areas with soil percolation rates greater than 5.0 in/hr

Section 7.5 Community and Environmental Factors

The last step assesses community and environmental factors involved in SMP selection. This matrix employs a comparative index approach (Table 7.5.). An open circle indicates that the SMP has a high benefit and a dark circle indicates that the particular SMP has a low benefit.

Ease of Maintenance. This column assesses the relative maintenance effort needed for an SMP, in terms of three criteria: frequency of scheduled maintenance, chronic maintenance problems (such as clogging) and reported failure rates. It should be noted that **all SMPs** require routine inspection and maintenance.

Community Acceptance. This column assesses community acceptance, as measured by three factors: market and preference surveys, reported nuisance problems, and visual orientation (i.e., is it prominently located or is it in a discrete underground location). It should be noted that a low rank can often be improved by a better landscaping plan.

Affordability. The SMPs are ranked according to their relative construction cost per impervious acre treated.

Safety. A comparative index that expresses the relative safety of an SMP. An open circle indicates a safe SMP, while a darkened circle indicates deep pools may create potential safety risks. The safety factor is included at this stage of the screening process because liability and safety are of paramount concern in many residential settings.

Habitat. SMPs are evaluated on their ability to provide wildlife or wetland habitat, assuming that an effort is made to landscape them appropriately. Objective criteria include size, water features, wetland features and vegetative cover of the SMP and its buffer.

Table 7.5 Community and Environmental Factors Matrix

SMP Group	SMP List	Ease of Maintenance	Community Acceptance	Affordability	Safety	Habitat
Ponds	Micropool ED	◗	◗	○	○	◗
	Wet Pond	○	○	○	●	○
	Wet ED Pond	○	○	○	●	○
	Multiple Pond	○	○	◗	●	○
	Pocket Pond	●	◗	○	◗	●
Wetlands	Shallow Wetland	◗	○	◗	○	○
	ED Wetland	◗	◗	◗	◗	○
	Pond/Wetland	○	○	◗	●	○
	Pocket Wetland	●	●	○	○	◗
Infiltration	Infiltration Trench	●	○	◗	○	●
	Shallow I-Basin	●	●	◗	○	●
	Dry Well	●	◗	◗	○	●
Filters	Surface SF	◗	◗	●	○	●
	Underground SF	●	○	●	◗	●
	Perimeter SF	●	○	●	○	●
	Organic SF	◗	○	●	○	●
	Bioretention	◗	◗	◗	○	◗
Open Channels	Dry Swale	○	○	◗	○	●
	Wet Swale	○	◗	○	○	◗

Note: ○ High, ◗ Moderate, ● Low

Nassau County Stormwater Management Program

Stormwater Runoff Impact Analysis

Appendix C
Nassau County
Geographic Information System
Geographic Data Standards

The latest copy of this separate document should be obtained from the Nassau County Department of Information technology