Village of Sea Cliff
and
Hempstead harbor Protection Committee

Glenwood Road/ Powerhouse Drain Stormwater Pollution Abatement plan

January 2012

Cashin Associates, P.C.

Glenwood Landing/Powerhouse Drain Stormwater Pollution Abatement Plan

Village of Sea Cliff
Hempstead Harbor Protection Committee

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LIST OF ABBREVIATIONS AND ACRONYMS

BCY	billion colonies per year
BMP	best management practice
CA	Cashin Associates, P.C.
CB	catch basin
CBI	catch basin insert
CCMP	LIS Comprehensive Conservation and Management Plan
CEA	Critical Environmental Area
CF	cubic feet
County	Nassau County
CR	County Road
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DO	dissolved oxygen
DOS	New York State Department of State
DPW	Department of Public Works
EPF	Environmental Protection Fund
F Coli	fecal coliform
FEMA	Federal Emergency Management Agency
GIS	Geographical Information System
GR/PD	Glenwood Road/Powerhouse Drain
GPS	Global Positioning System
GCWWTP	Glen Cove Wastewater Treatment Plant
HHPC	Hempstead Harbor Protection Committee
HMP	Hempstead Harbor - Harbor Management Plan
HS	hydrodynamic systems
IDDE	Illicit Discharge Detection and Elimination
IPM	Integrated Pest Management
LB	leaching basin
LISS	Long Island Sound Study
MS4	Municipal Separate Storm Sewer System
MF	media filter
NC	Nassau County
NCDOH	Nassau County Department of Health
NCDP	Nassau County Department of Parks, Recreation and Museums
NCDPW	Nassau County Department of Public Works
NCPC	Nassau County Planning Department
NEMO	Nonpoint Education of Municipal Officials
NEPA	National Environmental Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NSCC	North Shore Country Club
NWI	National Wetlands Inventory
NYCRR	New York Code of Rules and Regulations
NYNHP	New York Natural Heritage Program
NYS	New York State

NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSSMDM	NYS Stormwater Management Design Manual
NYSOPRHP	NYS Office of Parks, Recreation, and Historic Preservation
OBDSTP	Oyster Bay District Sewage Treatment Plant
OBSD	Oyster Bay Sewer District
PWL	Priority Waterbodies List
RINA	Regionally Important Natural Area
SCFWH	Significant Coastal Fish and Wildlife Habitat
SPDES	State Pollution Discharge Elimination System
SRLF	State Revolving Loan Fund
SWCD	Soil and Water Conservation District
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TEA-21	Transportation Enhancement Act for the 21st Century
tiff	tagged image file format
TN	total nitrogen
TOBAY	Town of Oyster Bay
TNH	Town of North Hempstead
TP	total phosphorus
TSS	total suspended solids
UIS	underground infiltration systems
USACOE	US Army Corps of Engineers
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
UUFSS	Ultra-Urban Filter with Smart Sponge Plus 4 Antimicrobial (Abtech)
VRH	Village of Roslyn Harbor
VSC	Village of Sea Cliff
WQI	Water Quality Inlet
WQIP	Hempstead Harbor Water Quality Improvement Plan
WQSE	Water Quality Storm Event
WQV	Water Quality Volume
WV	wet vault

EXECUTIVE SUMMARY

Background, Description, Purpose, and Goal of Plan

The *Water Quality Improvement Plan for Hempstead Harbor* (1998) divided Hempstead Harbor's watershed into 12 subwatersheds and then assessed the impacts of each subwatershed on the harbor's water quality. The Glenwood Road/Powerhouse Drain (GR/PD), located in Subwatershed #8 at the end of Glenwood Road was identified as a major contributor of pollutant loads to the harbor, outfalls into Hempstead Harbor influencing this critical natural resource's water quality and biological systems.

The *Glenwood Road/Powerhouse Drain Pollution Abatement Plan* provides measures and strategies to reduce the pollutant loads generated in this subwatershed and to help prevent pollutant loads from reaching the harbor. The goal of this Plan is to identify target stormwater abatement projects and mitigation strategies that, when implemented, will enhance and improve protection of the water quality in the harbor. This Plan was partially funded by a grant from the New York State Department of State (DOS) through the Environmental Protection Fund (EPF).

The specific goals of the *Glenwood Road/Powerhouse Drain Pollution Abatement Plan* are as follows:

- Improve the quality of water discharging from GR/PD into Hempstead harbor
- Provide a comprehensive framework of guidance by which government entities, citizens, and non-governmental organizations improve the water quality discharging from this subwatershed
- Identify and encourage educational programs that promote source reduction of pollutants within the subwatershed
- Recommend modifications and additions to improve local laws and practices or the increased enforcement of existing ordinances to control nonpoint source pollution
- Provide a process to measure the improvement in water quality in the subwatershed
- Develop prioritized list of actions to reduce pollutant loads

- Develop an implementation strategy to successfully execute water quality improvement projects

Study Area

The study area for this plan is the GR/PD subwatershed. The 448-acre subwatershed is located in the northwest portion of the Town of Oyster Bay and the northeast portion of the Town of North Hempstead. The GR/PD subwatershed is located on the north shore of Nassau County, NY along the east side of Hempstead Harbor and includes portions of the Towns of Oyster Bay and North Hempstead and the Incorporated Villages of Sea Cliff and Roslyn Harbor. The boundaries of the subwatershed study area are provided in Section 2.1 and shown on Map 1 in this report.

Methodology

The methodology of the plan's development involved several steps and tasks as follows:

- Providing inventory, description, and assessment of existing subwatershed conditions
- Gathering relevant information regarding the Powerhouse Drain and its subwatershed from applicable agencies and resources
- Identifying drainage areas, pollution sources and pollutant loads
- Suggesting source control pollution reduction measures including Best Management Practices ("BMPs") for neighborhood stewardship, hotspot pollution prevention and municipal good housekeeping that can produce long-term, nonpoint source pollution control and water quality improvement
- Identifying target pollutant abatement projects or other actions to reduce pollutant loads
- Establishing a framework for implementing the recommendations and identifying project funding sources

Recommendations

Mitigation strategies and recommendations are measures that address existing pollutant load issues through measures that will reduce the amount of pollution contributed to the subwatershed and projects that will remove the pollutant loads within the subwatershed so that they are not

discharged into the harbor in storm runoff. The strategies and recommendations in this Plan include:

- Pollutant source reduction measures for neighborhoods and hotspots and recommended educational focus
- Municipal good housekeeping recommendations and priority focus for maintenance of existing stormwater control facilities
- Target pollution removal projects for each drainage area in the subwatershed. The proposed projects include installing upgradient infiltration structures in six drainage areas, installing water quality inlets in eight drainage areas, reconstructing a drainage swale, encouraging filter buffer planting along the creek segment and constructing bioretention systems in two locations
- Funding sources for corrective subwatershed impact measures and a framework for undertaking implementation of the recommendations of this Plan

1.0 INTRODUCTION

The Glenwood Road/Powerhouse Drain Stormwater Pollution Abatement Plan (Plan) identifies stormwater mitigation projects that, when implemented, will enhance and improve protection of the water quality in Hempstead Harbor (harbor). The specific objectives in the preparation of this Plan are as follows:

- Delineate the subwatershed boundary through review of area topography
- Map and assess the existing storm drainage infrastructure associated with the outfalls
- Delineate drainage areas based on drainage infrastructure and locations that provide opportunities for abatement measures
- Review Town of Oyster Bay, Town of North Hempstead and Nassau County GIS data to identify potential available lands to locate stormwater management measures
- Review municipal roles, local laws and programs
- Identify potential mitigation strategies and general management measures including non-structural source control BMPs
- Define structural abatement projects with conceptual designs and construction cost estimates
- Prepare a Stormwater Abatement Plan document that assesses the findings of the field delineation and discusses the target projects and management strategies

A watershed is defined as the area of land that drains to a particular outfall or other waterbody. A subwatershed is a defined portion of the watershed. Topography is the key element affecting this area of land. The boundary of the watershed is defined by the highest elevations surrounding the waterbody. A drop of water falling outside of the boundary could not theoretically surface drain to the identified watershed. Development activities in a watershed can change the surface cover and topography and consequently limit the surface area of the watershed that drains to the waterbody; development activities can also increase the quantity of runoff into the waterbody by increasing the impervious cover. In turn, the development deposits

additional pollutants on the watershed surface, allows the increased runoff to carry the larger pollutant loads into the waterbodies, and subsequently affects the health of the waterbodies.

Hempstead Harbor and its subwatersheds are located along the north shore of Long Island in the Town of Oyster Bay (TOBAY) and the Town of North Hempstead (TNH). The harbor is connected to the Long Island Sound (the Sound). Conditions in the harbor are closely tied to the Long Island Sound ecosystem and the outflow from the harbor along Long Island's North Shore affects the Sound's water quality and ecosystem.

Runoff is carried into the harbor from outfalls along the shoreline and from tributaries. The Glenwood Road/Powerhouse Drain subwatershed includes a piped system that extends east along residential and commercial streets. A small tributary runs between Kissam Lane and Glenwood Road.

Characterization of the subwatershed includes a review of geographic setting components such as topography, surface hydrology, subwatershed limits, drainage areas, land use, municipal lands, natural resources and jurisdictional boundaries; and water quality components including classifications, designated uses, impairments, prior studies, and monitoring results.

The stormwater infrastructure and pollution mitigation projects section includes a description of the mapping methodology used to locate and assess the stormwater infrastructure, an assessment of the subwatershed infrastructure, a pollutant load analysis, the identification of potential stormwater mitigation measures, and detailed target project descriptions along with general municipal management strategies.

The Plan will guide long-term development of the mitigation measures, target projects, and management strategies to improve water quality from the Glenwood Road/Powerhouse Drain subwatershed.

2.0 SUBWATERSHED CHARACTERIZATION

The subwatershed characterization includes a delineation of the subwatershed that contributes surface runoff to the Harbor and a description of the available information or factors that have been identified as contributing to the deterioration of water quality of the waterbodies.

The subwatershed characterization describes the following aspects of the study area:

- Subwatershed boundaries through delineation of the lands that drain to the surface waters
- Geographic setting including physical conditions, drainage areas, land use, and jurisdictional boundaries
- Water quality characterization through review of existing records and data
- Stormwater drainage infrastructure from visual assessments

2.1 SUBWATERSHED AREA DESCRIPTION

Hempstead Harbor and its subwatersheds are located along the north shore of Long Island in the Town of Oyster Bay (TOBAY) and the Town of North Hempstead (TNH). The harbor is connected to the Long Island Sound (the Sound). Conditions in the harbor are closely tied to the Long Island Sound ecosystem and the inflow from the harbor along the Long Island's North Shore affects the Sound's water quality and ecosystem.

The Glenwood Road/Powerhouse Drain (GR/PD) subwatershed is located at the mid section of the eastern shoreline of the harbor centered on the hamlet of Glenwood Landing. Additional communities with land area within the GR/PD subwatershed include the hamlet of Glen Head to the east, the Village of Sea Cliff (VSC) to the north and the Village of Roslyn Harbor (VRH) to the south. The GR/PD subwatershed is 448 acres in area. A subwatershed boundary for the GR/PD outfalls was included in Nassau County Geographical Information System (GIS) drainage data. The subwatershed is generally defined as encompassed by Shore Road to the west, Grove Street to the south, Glen Cove Avenue to the east, and Littleworth Lane (near the Sea Cliff Elementary school) to the north. The subwatershed boundary also includes a segment

of the North Shore Country Club property on the west. The subwatershed boundary was adjusted in this Plan to reflect changes to drainage patterns resulting from the installation of roads and drainage infrastructure systems. The subwatershed boundary was adjusted to remove areas that drain to a neighboring subwatershed and to include areas now found to drain to the GR/PD subwatershed. In locations along the eastern portion of the subwatershed, the subwatershed boundary was adjusted due to changes in drainage patterns based on the drainage infrastructure. Along the northern limits, the subwatershed boundary was adjusted to account of several small outfalls north of the GR/PD outfalls. The adjusted subwatershed boundary is shown on Map 1 and on all of the maps included in this report.

The GR/PD outfalls are fed by an extensive piped drainage and swaled system that outfall to the harbor of the west side of Shore Road across from Glenwood Road. Although the system is mainly piped, there is a small tributary segment located between Kissam Lane and Glenwood Road that extends west from a wetland located east of Cody Lane and enters the piped drainage system at the northeast corner of Glenwood Road and Kissam Lane. This piped drainage system extends to the north on Glen Cove Avenue to the intersection with Plymouth Drive South. In addition, drainage from a portion of the north section of the subwatershed is collected in a piped system that overflows to a swale system located on the North Shore Country Club property. The northern segment of the swale is located within a VSC easement. Overflow drainage is carried through the swale and over golf course property to an inlet pipe. It is then piped to an outfall on Kissam Lane and into the piped system of Kissam Lane that is connected to the Powerhouse Drain outfall.

Field evaluation of the subwatershed examined alterations to the topographic drainage pattern that limit the amount of surface runoff that may be expected to enter the waterbodies and tributaries. The surface drainage area is defined as the area from which direct surface runoff or drainage through infrastructure systems may outfall into the waterbodies and tributaries. Areas outside of the surface drainage area but within the subwatershed boundary are described as self-contained. Runoff in these areas is collected in drainage structures such as recharge basins, leaching basins or in low points that infiltrate to groundwater. Although groundwater has the

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STORMWATER POLLUTION ABATEMENT PLAN

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0 500 1,000 Feet

MAP 1
WATERSHED BOUNDARY

ability to transport some pollutants to surfaces waters, this Plan focuses on the direct contribution to surface outfalls. The surface drainage area is described further in Section 3.1.2 of this Plan.

2.2 GEOGRAPHIC SETTING

This section includes descriptions of the geographic factors that determine the subwatershed boundaries, affect the conditions of the runoff, and impact the recommendations and strategies for water quality improvements.

2.2.1 TOPOGRAPHY

The general landform of the GR/PD subwatershed can be described as moderate steep to steep, except for the north portion where the topography becomes nearly level and a narrow strip along the shoreline. The rolling moraine ranges from nearly level in some locations to steep in others. The elevation ranges from mean sea level (MSL) at the harbor to 180 feet above MSL at the northern subwatershed boundary at Littleworth Lane. The subwatershed extends approximately 8,500 feet in length from the harbor outfall to the further boundary at Littleworth Lane. The width of the subwatershed varies, but ranges from approximately 1,000 feet wide at its northern limit to 4,000 feet wide at its widest point. The major drainage systems extend east from the harbor and generally follow the topography of adjacent roads. Grading associated with construction of area roads and housing subdivisions has altered the drainage pattern throughout the subwatersheds. The topography and stormwater runoff patterns were assessed using United States Geological Survey (USGS) topographic maps and NYS GIS data and are shown on Map 2.

2.2.2 SURFACE HYDROLOGY

The surface waters that contribute to the GR/PD subwatershed include a single narrow channelized freshwater stream and freshwater wetland. The waterbodies are located between Kissam Lane and Glenwood Road. The wetland, which is located east of Cody Lane, overflows

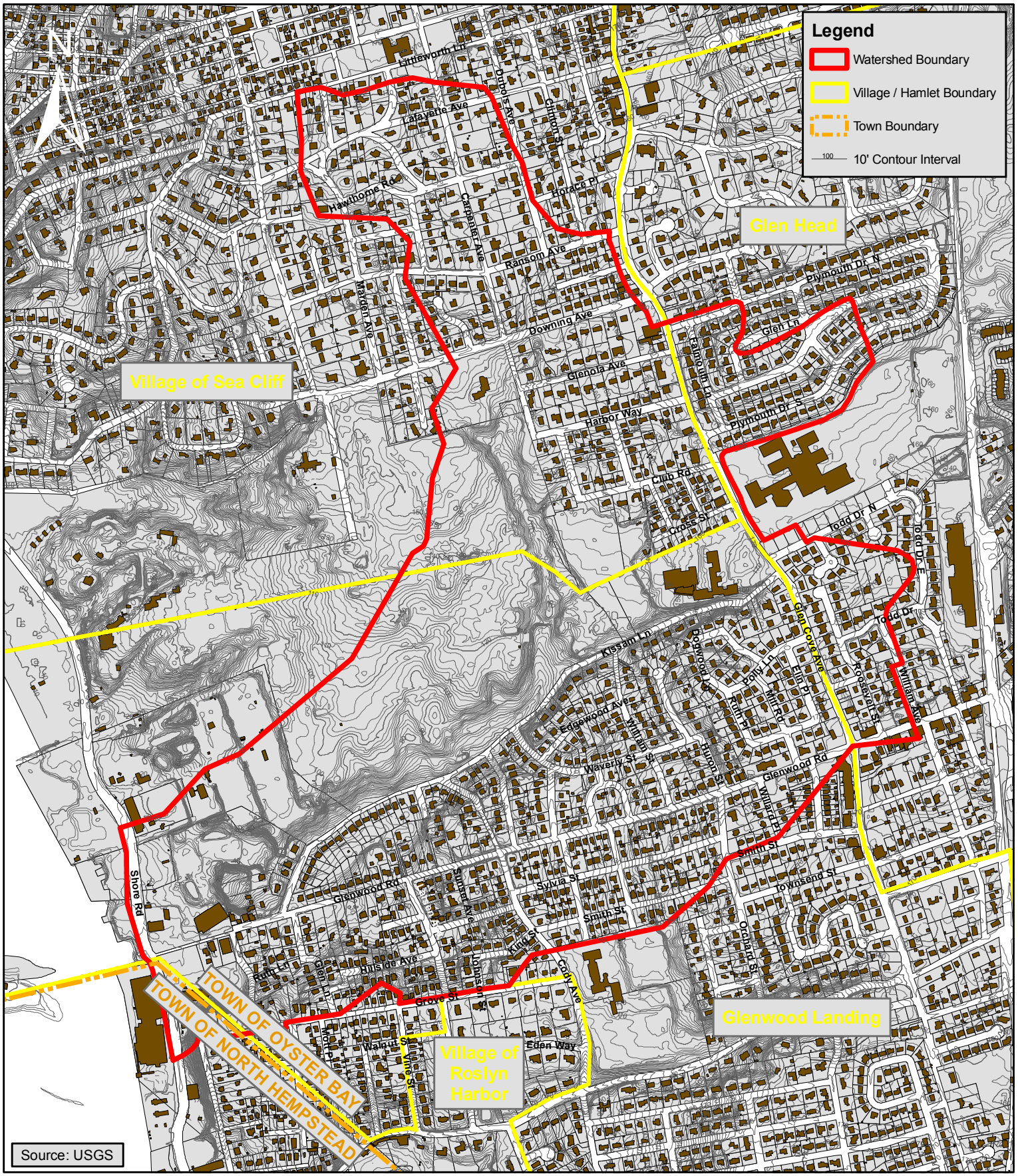
into the stream segment that then enters the piped drainage system at the northeast corner of Glenwood Road and Kissam Lane.

Historically an open canal extended from the existing Powerhouse Drain outfall to a large pond that is reported to have been located where the Post Office presently sits. Several springs fed that pond and additional springs fed a pond along Kissam Lane. These waterbodies were filled in over time but the springs continue to flow. At times, surface seeps become apparent along some of the roads. The WQIP discussed in Section 2.2.9 states that the Powerhouse Drain outfall discharges more than one million gallons per day even in dry weather. A portion of the dry weather flow is likely from these springs as well as from the channelized stream segment discussed in the paragraph above.

Preparation of this Plan included identification of drainage infrastructure and connectivity, along with the locations of topographic high points, to determine the limits of the subwatershed and drainage areas contributing runoff to the infrastructure that discharges into the harbor. Following data collection and input, drainage areas were delineated to identify the actual area contributing runoff to segments of the drainage system where mitigation measures will be proposed in the following Plan sections. The delineation is discussed further in Section 3.1 Stormwater Drainage Infrastructure.

2.2.3 SOILS

Soils within the subwatershed were reviewed using the *Soil Survey of Nassau County, New York* (Soil Conservation Service, 1987). Within the majority of the subwatershed's developed areas, the soils are generally identified as Urban land mixed with either Montauk (UnB) or Riverhead (UrB, UrC) complex soils on slopes that range from 3%-15%. UnB soils are found where there is a mix of urbanized areas and deep, well-drained Montauk Soils on gently sloping hills. Montauk soils have a dense, slowly permeable substratum that hinders efficient infiltration of liquids. UrB and UrC soils are found where there is a mix of urbanized areas and deep, well-drained Riverhead soils on gently sloping to strongly sloping hills and ridges. The major



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0 500 1,000 Feet

MAP 2
TOPOGRAPHY

limitation of Riverhead soils for residential development is the moderately steep or steep slopes. Removal of the canopy and ground cover (vegetation) creates a severe erosion hazard during construction. Urban lands (Ug) have at least 85% of the surface covered with asphalt, or other impervious materials. Ug soils include land near the GR/PD outfalls and several small areas within the northern and eastern limits of the subwatershed. Urban lands have no designated hydrologic groups. Riverhead soils are within hydrologic group B and Montauk Soils are within hydrologic group C, which are less well drained than "B" soils.

Within the developed portion of the subwatershed there is one small area of Scio Silt Loam (SdB) with a slope range form 3-8% centered on the Glenwood Road and Kissam Lane intersection. Scio Silt Loam deposits contain a large amount of silt or very fine sand and are located on the lower portion of long gentle slopes. Scio soils are generally moderately well drained soils of hydrologic group B.

The golf course soils are comprised of Riverhead Sandy Loam (RdB, RdC, and RdD) with a slope range from 3-25%. Riverhead Sandy Loam consists of deep, well-drained soils that formed in glacial outwash deposits. Riverhead soils are within hydrologic group B.

The shoreline is typically urban lands; a parcel located north of the GR/PD outfalls is designated Urban land-Udipsamment, wet substratum complex (Uw). Udipsamment soils are predominantly loamy sand or sand commonly located in areas of man-made cuts and fills, and some will contain dredged or pumped fill materials. Udipsamment soils are found near level tidal areas. Udipsamment soils are generally excessively drained to moderately well drained soils. No hydrologic group as been assigned to Udipsamment soils. Soils are shown on Map 3.

2.2.4 GROUNDWATER

According to the Nassau County Department of Public Works Water Table Elevation Map (September 1992), groundwater beneath the subwatershed varies from approximately mean sea level (MSL) at the western subwatershed boundary near Hempstead Harbor to 50'-60' above

MSL at the eastern subwatershed boundary. Based on review of area topography and groundwater elevations, the depth to groundwater varies from less than ten feet at the eastern subwatershed boundary to greater than 100 feet at the upper limits of the subwatershed. The shallow depth to groundwater near the outfalls in Hempstead Harbor will impact the ability to identify mitigation measures that are appropriate to this location while the upper limits of the subwatershed will allow a greater selection of mitigation measures but will not treat the greater storm flows from the lower areas.

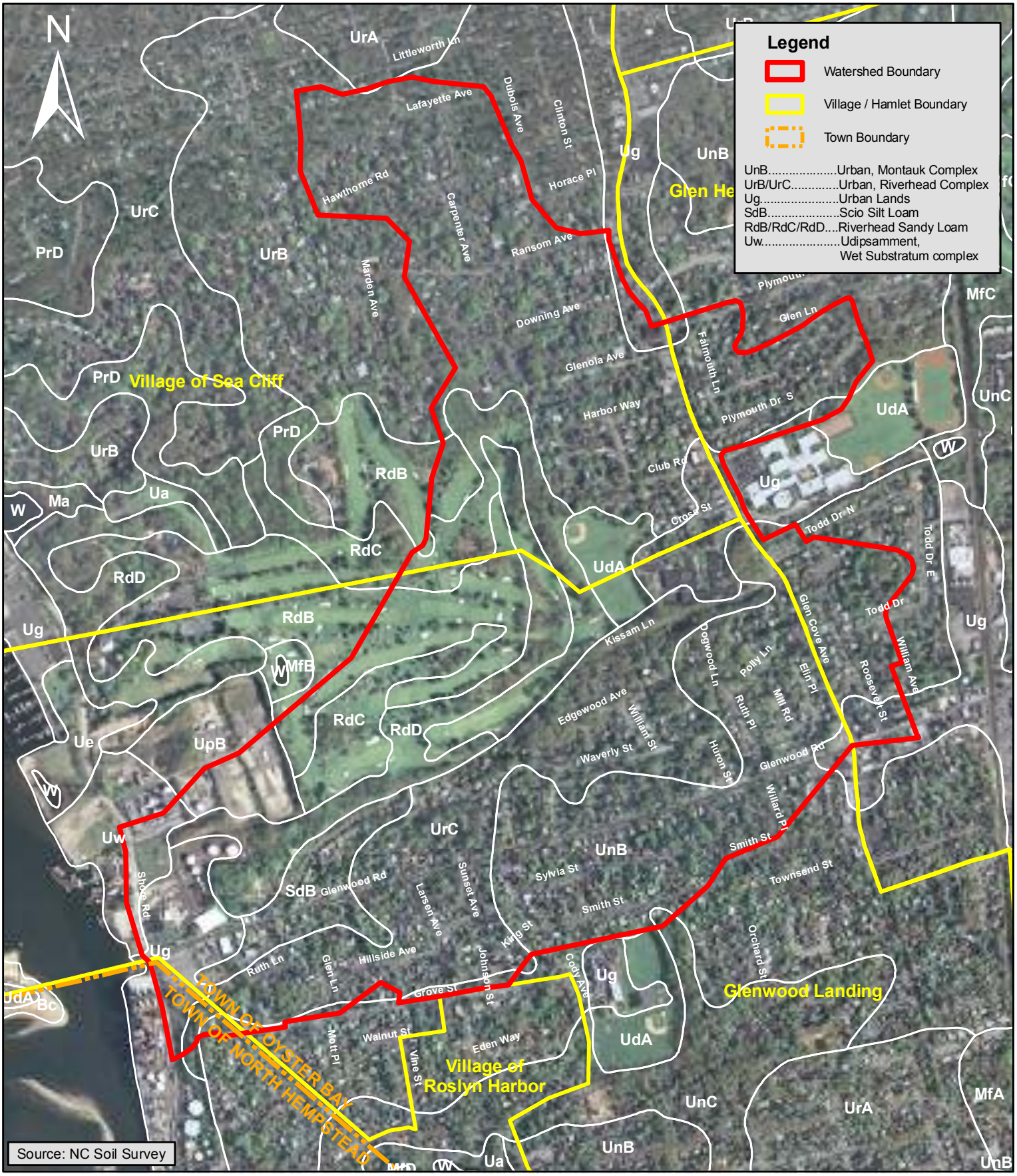
2.2.5 LAND USE

Land use plays an important role in relation to stormwater quality. Typically, heavily developed sites with large areas of impervious surfaces, such as commercial sites, and small residential properties with limited vegetated areas generate more runoff than sites that maintain large areas of vegetative cover or pervious surfaces. For that reason, land use is a consideration in the development of a Stormwater Abatement Plan.

The predominant land uses in the GR/PD subwatershed are single-family residential housing and recreation. The majority of the residential use is on lots between one-quarter acre and one-half acre in size located within the southern and eastern sections of the subwatershed. The recreational land use is the North Shore County Club, which contains large swathes of lawn and wooded area along the western side of the subwatershed. Secondary uses include commercial development mainly located along the western and eastern portion of Glenwood Road and along Glen Cove Avenue; institutional uses include local primary and secondary schools. Industrial land use is limited to along Shore Road extending north and south from Glenwood Road. Land use from the Nassau County Tax Map Database is shown on Map 4.

2.2.6 MUNICIPAL LANDS

There are no lands held in municipal ownership within the GR/PD subwatershed. In prior studies, TOBAY identified several parcels for possible acquisition as discussed in Section 2.2.9



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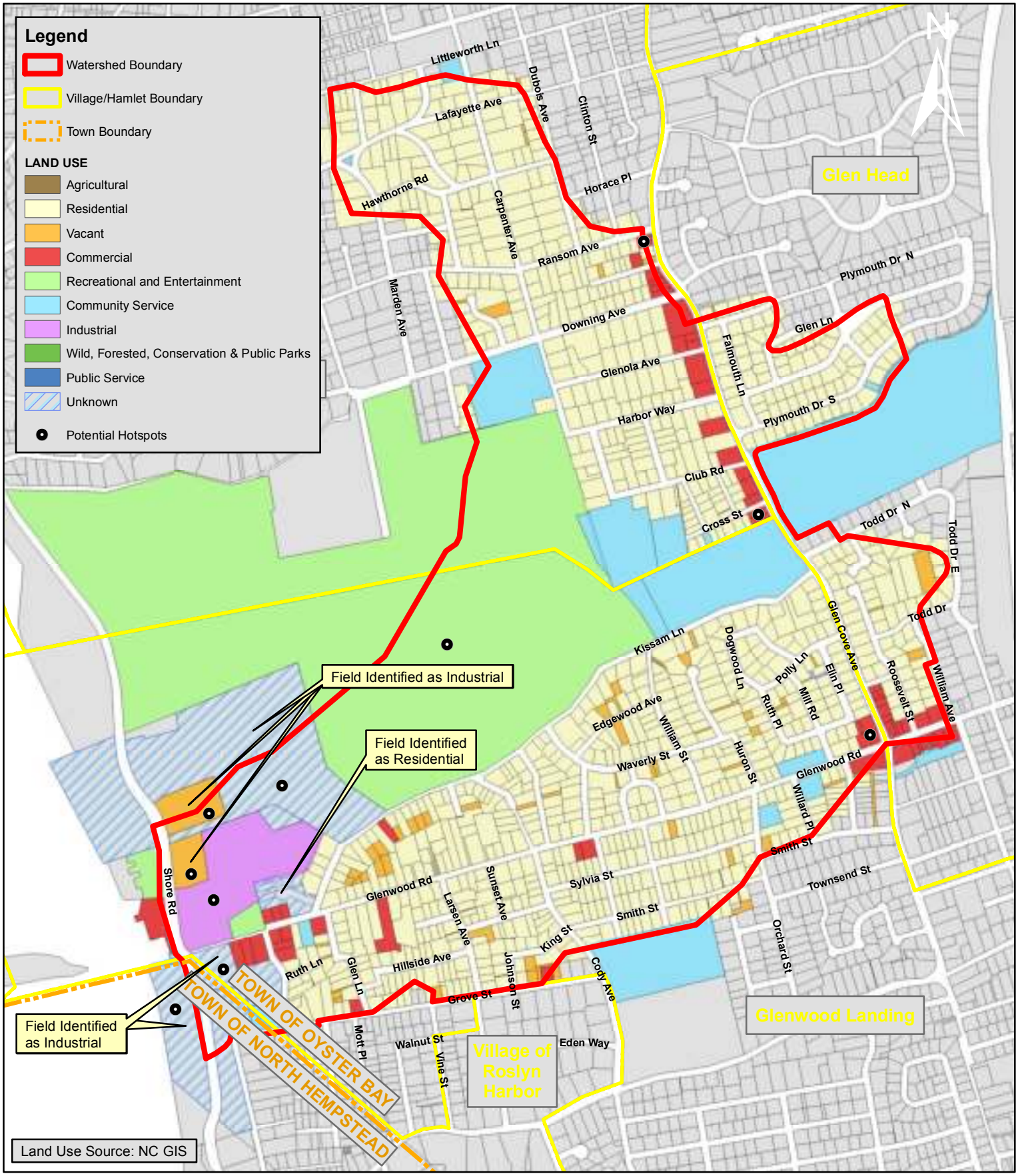
MAP 3
SOILS



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0 500 1,000 Feet

MAP 4
LAND USE

of this Plan. The acquisitions were typically directed toward increasing public space along the harbor, but in several instances, use for stormwater mitigation was identified as well. There are several institutionally owned properties including school properties located in the center of the subwatershed adjacent to Glen Cove Avenue, a firehouse at the Grove Street and School House Hill Road intersection and several churches throughout the subwatershed. This information is shown on Map 5.

2.2.7 NATURAL RESOURCES

The natural resources section of this Plan includes descriptions of the wetland habitats, living resources, endangered species and significant environmental areas within or immediately adjacent to the GR/PD subwatershed

Tidal Wetlands

Tidal wetlands are ecologically important and environmentally productive, supporting a diversity of species. Tidal wetlands provide a number of valuable stormwater mitigation functions including flood control, shore protection, sediment reduction, and pollution mitigation.

The tidal wetlands were inventoried and mapped by the NYSDEC in 1979. There are no tidal wetlands within the GR/PD subwatershed. According to the NYSDEC Tidal Wetlands maps, the following category of tidal wetlands is located at the GR/PD outfall to Hempstead Harbor.

- **Littoral Zone (LZ)**: Underwater lands and open water up to a maximum depth of six feet at mean low water.

Freshwater Wetlands

There are no National Wetland Inventory (NWI) or NYSDEC-mapped freshwater wetlands within or immediately adjacent to the GR/PD subwatershed. However a small, approximately 0.17 acre, wetland depression was identified behind residential properties south of Woodmere Avenue and Kissam Lane. This wetland feeds the small stream discussed below. The wetland

depression is wooded and contains several invasive species. Several of the surrounding properties have pavement or roof drains that are piped to outfall to this depression.

Surface Waters

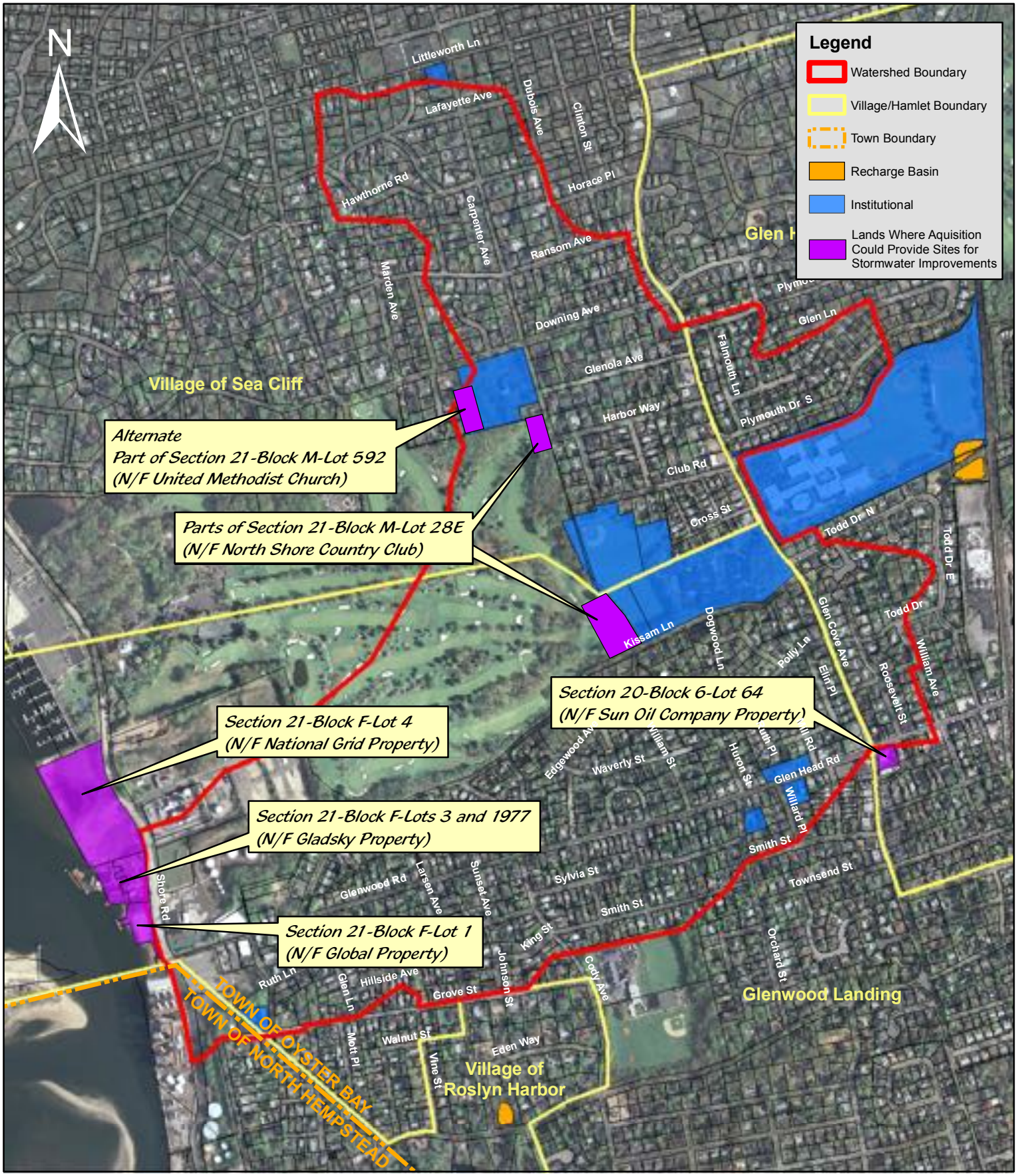
A small stream flows west behind residential properties on Kissam Lane and Glenwood Road from the small wetland depression discussed above and into the stormwater system on Glenwood Road east of the Kissam Lane intersection. The stream runs through several residential properties and along the rear property boundary of the remainder. The stream is channelized in the western segment. This segment has either steep earth sideslopes or timber, stone or brick walls. Generally, the adjacent residential properties are grassed to the stream edge or vegetated with ornamental species such as English ivy, privet, or azalea. The upstream eastern segment has a less channelized, shallower cross section for most of its length and is vegetated with natural planting for a portion of the length, but is piped beneath some of the properties in this segment.

Sensitive Environmental Areas

Sensitive environmental areas are locations that have been identified to provide environmental benefit such as NYS Bird Conservation Areas, Audubon Important Bird Areas, NYS Regionally Important Natural Areas, NYS Significant Coastal Habitats, NYS Significant Coastal Fish and Wildlife Habitats, NMFS Essential Fish Habitat, Long Island Sound Study Stewardship Initiative Areas, and National Wildlife Refuges. There are no sensitive environmental areas identified within the GR/PD subwatershed. The subwatershed is adjacent to, and the subwatersheds storm drainage system outfalls to, Hempstead Harbor, which includes a sensitive tidal wetland area where several rare bird species have been observed and that provides a productive area for marine finfish and shellfish. Hempstead Harbor has received the following sensitive environmental area designations.

New York State Significant Coastal Fish and Wildlife Habitat

Hempstead Harbor is considered by the New York State Department of State (NYSDOS) to be a Significant Coastal Fish and Wildlife Habitat. This habitat consists of the open



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0 500 1,000 Feet

MAP 5
PUBLIC LANDS AND
LAND IDENTIFIED FOR PUBLIC AQUISITION

water area in the harbor, extending out to Mott Point on the west, and to a breakwater approximately one-half mile north of Mosquito Cove on the east.

Hempstead Harbor is a valuable waterfowl wintering area and supports a diverse assemblage of other bird species throughout the year. Several rare bird species have been observed visiting the harbor including peregrine falcon, roseate tern, black tern, piping plover, short-eared owl, least tern, common tern, bald eagle, northern harrier, sedge wren, American bittern, black skimmer, sharp-shinned hawk, coopers hawk, northern goshawk, common nighthawk, red-headed woodpecker, horned lark, golden-winged warbler, vesper sparrow, grasshopper sparrow, and seaside sparrow.

The harbor is also a productive area for marine finfish and shellfish. The harbor provides nursery and feeding habitat for stripped bass, scup, bluefish, Atlantic silversides, Atlantic menhaden, weakfish, windowpane flounder, winter flounder, summer flounder, and blackfish. It also supports a healthy population of baitfish including American sandlance, mummichog, striped killifish, and bay anchovy. Shellfish resources in the harbor include blue mussel, soft clam, ribbed mussel, oysters, and razor clams. Hempstead Harbor also contains extensive hard clam populations as indicated by a 2008 shellfish survey, but the area is not presently certified for shellfishing. Improvements in water quality could potentially allow the certification of portions of the harbor for shellfishing in the near future.

According to the NYSDOS, any activity that would substantially degrade the water quality in Hempstead Harbor would adversely affect the biological productivity of this area. Vegetated upland buffer zones should be protected or established to further reduce water quality impairment from upland sources. Alternative strategies for the protection of shoreline property should be examined, including innovative, vegetation-based approaches.

Essential Fish Habitat

Hempstead Harbor is designated by the National Marine Fisheries Service as containing Essential Fish Habitat for 15 species of fish. Important species of finfish that are known to be present in the harbor during at least part of their life cycle include striped bass, bluefish, winter flounder, summer flounder, blackfish, weakfish, windowpane flounder, and scup.

Important Bird Area of New York State

Audubon NY has designated Little Neck Bay to Hempstead Harbor an Important Bird Area (IBA) of New York State as a waterfowl wintering area. Water pollution from various sources, including contaminants, oil spills, suburban runoff, excessive sedimentation, and sewage and storm water discharges, is identified on the IBA profile as a major factor affecting aquatic resources on which waterfowl and other waterbirds rely.

Stewardship Initiative Study

The Long Island Sound Study has identified Hempstead Harbor as a Stewardship Initiative Area. Stewardship Initiative Areas are sites identified to have ecological and/or recreational values and their designation strives to protect and enhance these locations.

2.2.8 JURISDICTIONAL BOUNDARIES

The piped drainage infrastructure within the GR/PD subwatershed that outfalls to Hempstead Harbor is located mainly within the TOBAY hamlets of Glenwood Landing and Glen Head. The subwatershed extends north into VSC jurisdiction. Drainage infrastructure in the VSC includes numerous individual leaching basins and a drainage system that overflows into a swale on the NSCC property and flows south toward an outfall onto Kissam Lane. The VSC has a drainage easement for the northern portion of the swale on the NSCC property. The TNH and VRH have limited areas of their jurisdictions within the southwestern portion GR/PD subwatershed. Land within the VRH includes the southern side of about 500’ of Grove Street but that road right-of way itself is under Nassau County jurisdiction. The TNH has approximately 3.5 acres within the

subwatershed. Roads within the North Hempstead boundary are under Nassau County jurisdiction. Nassau County has jurisdiction over all or part of Shore Road, Glenwood Road, Schoolhouse Road, Grove Street, Kissam Lane, Cody Avenue, and Glen Cove Avenue. The storm drainage systems under these roads are under the jurisdiction of the County and all improvements on these roads will require agreement from and coordination with the County. The surface runoff from and drainage systems under the County roads and TOBAY or VSC roads are all interconnected and carry the combined runoff to the outfalls at Hempstead Harbor. Nassau County, TOBAY and the VSC, along with the TNH and the VRH contribute surface runoff to the subwatershed and are all members of the Hempstead Harbor Protection Committee.

2.2.9 PRIOR WATER QUALITY AND LAND USE PLANNING STUDIES

The following paragraphs provide a summary of recommendations and information that are included in previous planning studies that are related to or discuss stormwater abatement recommendations for the GR/PD subwatershed.

Long Island Sound Study

The *Long Island Sound Study (LISS)*, a cooperative effort between the USEPA, New York and Connecticut, works to protect and improve the health of the Long Island Sound. It has identified pollutant loading to waterbodies contiguous to the Long Island Sound, such as Hempstead Harbor, as a source of concern. The *LISS* planning effort includes the 1994 *Long Island Sound Comprehensive Conservation and Management Plan* (CCMP) and the 2003 LIS Agreement. These documents listed several high priority issues for the Sound including pathogen contamination, floatable debris, living resources and habitat management, and land use and development. The CCMP developed specific recommendations for actions to improve water quality, protect resources, and monitor progress. Also, in 2006 the LISS designated Hempstead Harbor as one of its 33 inaugural Stewardship Sites. Stewardship Sites are sites around the Sound with significant recreational and ecological values.

Water Quality Improvement Plan (WQIP) for Hempstead Harbor, Nassau County New York

Coastal Environmental Services May 1998

Powerhouse Drain is listed as a subcomponent of Subwatershed # 8 - Sea Cliff in this plan. The following paragraph is taken from the WQIP:

> The Powerhouse storm drain, located north of the LILCO (Due to utility acquisitions, parcel ownership was transferred from LILCO to LIPA to Keyspan and currently to National Grid) facility in Glenwood Landing, is a tributary system that consists of three parts: a stream between Kissam Lane and Glenwood Road, the Glenwood Road storm drainage line and Kissam Lane storm drainage line. The system provides storm drainage for approximately 3.5 square miles of Glenwood Landing and discharges more than 1 million gallons per day even in dry weather (NCDH, 1977). Although this system has historically been a major contributor of bacteria to the Harbor, the 1986 Surface Water Quality Assessment Report (NCDH) identified no direct sewage violations that would explain the high coliform bacteria levels. The report stated that the department believed private septic systems were likely the cause.

The WQIP ranked the entire Subwatershed #8 as second overall in total nonpoint source pollutant loading to the harbor for six of the parameters studied: total nitrogen, total phosphorus, total suspended solids, zinc, lead, and hydrocarbons.

Glenwood Landing Redevelopment and Revitalization Plan, Town of Oyster Bay, New York (October 2002)

This Plan identified parcels that were determined to provide opportunities for additional open space, and in some cases, their use for stormwater abatement was also referenced. These parcels are located outside of the GR/PD subwatershed but in close proximity to the GR/PD outfalls and may offer some opportunities for stormwater abatement measures. The following are the identified properties that have not been acquired and the Redevelopment and Revitalization Plan discussion of each.

KeySpan (currently National Grid) properties located south of Tappen Beach and west of Shore Road (NCTM parcel: Section 21, Block F, Lots 4, 9, and 1947)

The 2009 New York State Open Space Conservation Plan (NYSDEC and NYSOPRHP 2009) recommended that these parcels be acquired for open space or that easements be obtained to allow the continuation of a waterfront greenway.

The northernmost KeySpan (Keyspan has since been acquired by National Grid) parcel contains a tidal pond. This parcel should be acquired by TOBAY and revegetated, preserved, and utilized as a natural, passive park that provides public access to the waterfront. The park might include a hiking trail and/or a boardwalk along the shoreline, connected to the adjoining Tappen Beach property, and park benches that could be utilized by hikers and joggers that frequent the area. The site could also be designed to include a man-made vegetated wetland, vegetated swales, or other "natural" stormwater treatment structures.

If the northernmost KeySpan parcel is not acquired by TOBAY, the on-site wetland should be preserved and efforts should be made to secure a public access easement along the waterfront. The future use of this parcel would preferably be recreational or open space, consistent with the target cleanup levels and use constraints set forth in the latest NYSDEC remediation report (September 2001).

The southernmost KeySpan property should be acquired and preserved as well, in order to serve as an extension of the public parkland. If not acquired, this parcel could be developed consistent with the requirements of the proposed Waterfront-A Zoning District. The property is currently devoid of vegetation and should be significantly revegetated, preferably with indigenous plant species that are adapted to the specific conditions of the site. A small restaurant may be a suitable use along the front of this property, if: 1) it is combined with facilities that provide for public access to the waterfront; and 2) environmental conditions are in compliance with NYSDEC cleanup standards for such a use.

(Note: The parcel was devoid of vegetation when this 2002 report was completed but significant portions have revegetated over time. The site should be assessed for invasives species and, if warranted, should be revegetated, with native plant species that are adapted to the specific conditions of the site.)

Gladsky Property (NCTM parcel: Section 21, Block F, Lot 3 and 1977)

This parcel could be developed pursuant to the uses outlined in the proposed Waterfront-A District. During site plan review it is very important that potential environmental degradation and nuisance externalities that might otherwise occur from future on-site activities (i.e., potential impacts associated with noise, smoke, fumes, spills and leaks of fuel or other materials) be properly contained and that adequate wastewater and stormwater controls be implemented. In addition, it is very important to protect the aesthetic quality of the area by maintaining the existing tree and shrub line along the frontage of the parcel and/ or enhancing the parcel with landscaping sufficient to reduce potential visual and audio impacts of the proposed operation. The screening should include a pattern of plantings that creates a buffer area of approximately 20-25 feet as opposed to just a row of trees across the frontage of the property. In addition, evergreen species should be used to supplement deciduous plantings so that year-round visual protection is provided. The proposed site plan for this property indicates the presence of a 10-foot wide utility easement along the frontage of the parcel, parallel with Shore Road, to which the property owner will have to comply. In addition, supplies, machinery, and equipment should be kept within enclosed structures as much as practicable.

TOBAY should utilize the land use techniques that are at its disposal, such as requiring performance and maintenance bonds to guarantee the suitability of certain improvements or the survival of plant materials, or that restrictive covenants be filed which require or prevent certain actions and reinforces enforcement capability (e.g., stormwater shall be retained on-site by installation of appropriate runoff control measures and silt fences shall be erected to prevent siltation during site preparation and construction). Regardless of

restrictions placed on the use of this parcel, enforcement will be critical for ensuring that planning objectives are met.

TOBAYs SEA Fund Committee has recommended to the Town Board that this property be acquired for public open space and/or recreation and TOBAY continues to pursue this acquisition. According to the Glenwood Landing Redevelopment and Revitalization Plan, the draft 2001 New York State Open Space Plan recommended that this lot be acquired. The 2009 plan does not address this plan, but to date, the lot has not been acquired and TOBAY continues to pursue the acquisition.

Exxon-Mobil (now Global Partners LP) (Wharf/Offloading Facility) (NCTM parcel: Section 21, Block F, Lot 1)

This parcel is currently used as a fuel offloading station. Future use of this parcel should conform to the mandates of the proposed Waterfront-A zoning district with emphasis on preserving views of the harbor from the vantage of Shore Road and creating an aesthetically pleasing development. At present, the property is generally devoid of vegetation. Additional landscaping would greatly improve the appearance of this site. However, new landscaping should be strategically located so as not to restrict significant views of the harbor.

2.3 WATER QUALITY CHARACTERIZATION

The primary objective of most water quality monitoring programs in New York State is to prevent human health impacts from exposure to pathogenic bacteria and viruses (e.g., the hepatitis and Norwalk viruses, and Salmonella bacteria). Pathogen exposure can result from either direct contact with contaminated water or the consumption of tainted shellfish. Water quality testing for these pathogens typically entails testing for the presence of coliform and/or enterococcus bacteria, which are generally non-pathogenic, but are relatively easy to measure. Because coliform and enterococci bacteria co-exist with the pathogens of primary concern mentioned above, these bacteria serve as indicators of the possible presence of pathogens.

Alterations in stream and stormwater system discharge occur as a result of seasonal and yearly fluctuations in precipitation, seasonal changes in groundwater levels, and increased urbanization. Removal of vegetation, compaction of soils, and construction of impervious surfaces are examples of human activities that can significantly impact normal hydrologic processes. These activities can cause waters to become stagnant or turbulent, decrease soil permeability, cause erosion and soil deposition, improve or aggravate flooding conditions, increase or decrease water and pollutant residence times, and affect natural water quality functions such as the settling of soil particles. Waterbodies that are classified with a best usage that allows greater human contact (e.g. water supply for drinking, food processing, contact recreation, fish propagation and shellfishing) must meet a higher standard than waters that are classified for lesser human contact, such as fish survival.

2.3.1 WATER QUALITY CLASSIFICATIONS AND DESIGNATED USES

The NYSDEC has designated Hempstead Harbor as a priority waterbody with adverse impacts upon aquatic life. A priority waterbody designation means that specified uses are precluded, impaired, stressed or threatened. See *Table 2-1: NYSDEC Water Quality Classifications* for the identified best usages for the waterbodies and *Table 2-2: Hempstead Harbor Use Impairments* for the identified impacts to the waterbodies. The causes of this impairment are identified as priority organics (PCBs), pathogens, low dissolved oxygen, nutrients, and oil and grease caused by sources including storm sewers and urban runoff.

Table 2-1: NYSDEC Water Quality Classifications summarizes Hempstead Harbor's NYSDEC general water quality classifications in terms of their best usage. While Table 2-1 identifies "best usages," the actual usage of the waters is dependent upon the impairments to the quality of the waters. The numerous parameters that commonly characterize water quality include taste, color, suspended solids, oils, refuse, thermal discharges, phosphorus, nitrogen, and dissolved solids. A common example of this is Class "SA" waters that have a best usage for shellfishing, but are closed because of impacts to the water quality from high bacteria levels.

Table 2-1: NYSDEC Water Quality Classifications (6 NYCRR Part 701 and Part 925).

Waterbody	Water Index Number	Water Classification	Best Usage
Hempstead Harbor, north, and tidal tribs (1702-0022)	LIS-HH	SA	**The best usages of Class SA waters are shell fishing for market purposes, primary and secondary contact recreation, and fishing. These waters shall be suitable for fish propagation and survival.**
Hempstead Harbor, south, and tidal tribs (1702-0022)	**LIS-HH**	**SB**	**The best usage of Class SB waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival. Dissolved oxygen shall not be less than 5.0 mg/l at any time.**

2.3.2 WATERBODY USE IMPAIRMENTS

Impairments to water bodies are often described in terms of their effects on the fish and game population of the water bodies. SA-designated waters within Hempstead Harbor are NYSDEC uncertified shellfishing lands. Uncertified shellfishing lands are areas where the NYSDEC has prohibited shellfishing harvesting for food uses in accordance with NYSDEC regulation 6 NYCRR Part 41. The GR/PD subwatershed is contributing pollutant laden runoff to the harbor that can be contributing to the pollutant loads that are resulting in prohibition of shellfish harvesting.

The New York State Department of Health (NYSDOH) issues health advisories concerning the consumption of sport fish caught in New York State waters. The NYSDOH has issued no specific advisories for Hempstead Harbor. There are NYSDOH general advisories issued for all waters of the Long Island Sound west of Wading River. The precautionary general health advisories limiting consumption of certain migratory fish species are issued due to the potential for elevated PCB levels due the possible range for these species and are not related to any know contamination in the Hempstead Harbor.

The *NYSDEC Atlantic Ocean/Long Island Sound Waterbody Inventory and Priority Waterbody List* lists both the Hempstead Harbor, north and south and their tidal tributaries as impaired segments of the Atlantic Ocean/Long Island Sound watershed. Table 2-2 below presents a summary of the use impairment, pollution sources, and types of pollution types for each segment. Surface runoff from land surfaces is a source for the pollutant loads identified in Hempstead Harbor and the GR/PD outfalls can be contributing to these loads.

Table 2-2: Hempstead Harbor Use Impairments

Waterbody	Uses Impacted	Pollution Type	Pollution Source
Hempstead Harbor , north, and tidal tribs (SA waters)	**- Shellfishing** **- Public Bathing** **- Aquatic life** **- Recreation** **-** Fish Consumption	**- Pathogens** **- DO/ Oxygen Demand** **- Nutrients (Nitrogen)** - Aesthetics (floatables) **-** Priority Organics (PCBs in migratory fish)	**- Municipal (Glen Cove WWTP)** **-Urban/Storm Runoff** **- Boat Pollution** **- Landfill/Land Disposal** **- Failing on-site septic systems** **-Migratory fish species**
Hempstead Harbor , south, and tidal tribs (SB waters)	**- Public Bathing** **- Recreation** **- Aquatic life** - Fish Consumption	**- Pathogens** **- DO/ Oxygen Demand** **- Nutrients (Nitrogen)** **- Priority Organics (PCBs in migratory fish)** **- Aesthetics (floatables)** **- Metals**	**-Urban/Storm Runoff** **- Boat Pollution** **-Migratory fish species -** **Landfill/Land Disposal** **- Municipal (Glen Cove WWTP)** **-Failing on-site septic systems**

Bold indicate **MAJOR** use impacts and known pollutant types and sources. Non-bold indicate suspected or possible impacts, pollutant types or sources.
Source: NYSDEC Atlantic Ocean/Long Island Sound Waterbody Inventory and Priority Waterbody List – Draft dated 06/14/2011 (north) and 08/17/2010 (south)

It should be noted that certain measures that should reduce levels of the identified pollutants included on the NYSDEC Waterbody Inventory and shown on Table 2.2 have been implemented including:

- the capping of landfills located on the western side of the harbor in the Town of North Hempstead
- a vessel waste No Discharge Zone

- a TMDL to reduce nitrogen loadings and address low dissolved oxygen in the western Long Island Sound
- a TMDL to address shellfishing impairments
- upgrade in wastewater treatment at the Glen Cove WWTP

2.3.3 WATER QUALITY TMDL STUDIES AND MONITORING PROGRAMS

The following are summaries of prior studies, reports, and water monitoring data that are related to Hempstead Harbor:

Final Report for Shellfish Pathogen TMDLs for 27 303D-Listed Waters (Shellfish Pathogen TMDL)

Hempstead Harbor in its entirety was included on the New York State's 2003 *303(d) List of Impaired Water* (NYSDEC). In accordance with the USEPA Water Quality Planning and Management Regulations (40 CFR, Part 30), this necessitates the development of a Total Maximum Daily Load (TMDL) for pathogens. The *Shellfish Pathogen TMDL* established the maximum amount of pathogens that the northern portion of Hempstead Harbor is capable of assimilating while still meeting the classified water quality standard. In 2007, the NYSDEC released the *Shellfish Pathogen TMDL*, which includes the northern portion of Hempstead Harbor and its tidal tributaries. The completion of the *Shellfish Pathogen TMDL* allowed for the delisting of the northern portion of Hempstead Harbor and its tidal tributaries from the *303(d) List of Impaired Waterbodies*. The southern portion of Hempstead Harbor and its tidal tributaries remain on the 2010 *303(d) List* requiring the development of a TMDL.

The *Shellfish Pathogen TMDL* evaluated the various pathogen sources and their contribution to Hempstead Harbor. The *Shellfish Pathogen TMDL* notes that the harbor is designated as Vessel Waste No-Discharge Zones (NDZ), and due to the requirements of that designation, it is assumed that vessel-derived human waste is not a major source of coliform bacteria.

According to the *Shellfish Pathogen TMDL*, the existing annual fecal coliform (FC) load to Hempstead Harbor was estimated to be 26,198,105 billion FC/year, and the majority of that load

was from residential/urban land. Of the residential/urban lands load, the major source is noted to be domestic pets (24,246,979 billion FC/year). Waterfowl are estimated to contribute 16,233 billion FC/year. According to the *Shellfish* Pathogen *TMDL*, to meet the target TMDL in Hempstead Harbor a 95% reduction in current pathogen loads is required. It should be noted that the numbers included in the *Shellfish Pathogen TMDL* are not based on actual testing results and sources and quantities may change when specific testing results are available.

A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound (December 2000)

This *TMDL* was prepared for all tributary management areas to the Long Island Sound in Connecticut and New York. According to the *TMDL*, to meet the target TMDL for Long Island Sound New York Management Areas, a 58.5% reduction in current nitrogen loads is required. The TMDL identified a total nitrogen waste load allocation for baseline end-of pipe loads of 220 lbs/day and Waste Load Allocation (WLA) end-of-pipe load of 80 lbs per day for the TOBAY portion of Management Zone 10 that includes the GR/PD subwatershed.

Coalition to Save Hempstead Harbor (CSHH)/Hempstead Harbor Protection Committee (HHPC) Monitoring Program

The CSHH is a citizen group formed in 1986 to keep focus on the needs of the harbor. The HHPC was formed in 1995 and is the first watershed-based, inter-municipal coalition on Long Island. These organizations have worked together to conduct water-quality monitoring in the harbor in the vicinity of the GR/PD outfalls. The HHPC website (**www.hempsteadharbor.org**) contains monitoring data and reports dating to 2001 with data that extends back to 1995. The CSHH conducts the monitoring for precipitation, water temperature, pH, salinity, air temperature, water clarity, turbidity, dissolved oxygen, nitrogen and chlorine. In addition, CSHH collects mid-harbor samples for enterococci and fecal coliform for analysis by Nassau County Department of Health, and the data for these samples as well as bacteria for harbor beaches are reviewed in annual monitoring reports. In 2009 The CSHH began sampling near the

GR/PD outfall to Hempstead Harbor to provide base data for assessing water quality improvements realized through implementation of recommendations identified in this Plan. The CSHH collects samples at a monthly to bimonthly rate and tests for dissolved oxygen (D.O.), salinity, water temperature, and pH. They also occasionally collects samples and test for nitrite, nitrate and ammonia

2.4 INTER-GOVERNMENTAL COORDINATION AND INSTITUTIONAL MANAGEMENT

Jurisdiction of the GR/PD subwatershed is shared by multiple levels of government. Because of jurisdictional land area, TOBAY and the VSC exercise primary authority over land-use decisions pertaining to this subwatershed. The TNH and the VRH have jurisdiction over limited area along the south boundary of the GR/PD subwatershed and Nassau County has jurisdiction over a number of roads within the subwatershed. There are a number of federal, state, county, and local private entities that have management and usage responsibilities in the subwatershed.

2.4.1 INTERMUNICIPAL JURISDICTIONS

The following sections provide a brief description of the roles played by public agencies that could be involved in implementing the recommendations of this study. As discussed, the subwatershed extends through several local municipal governments with jurisdiction over land use within their boundaries. Implementation measures for many of the projects proposed herein extend across municipal boundaries and impact additional agencies with jurisdiction over specific lands or properties. Implementing any improvement in the subwatershed will likely require approvals from several of the levels of government described below.

2.4.1.1 Federal

- United States Environment Protection Agency (USEPA)

USEPA's mission is to safeguard human health by protecting the integrity of the environment. USEPA pursues this goal by developing legislation and national environmental protection programs and by administering funding to states and municipalities for the development and implementation of environmental plans, policies, projects, and programs. USEPA sponsors a number of programs that advocate the protection of natural resources such as surface water quality, including various Clean Water Act (CWA) programs, and publishes a variety of environmental protection and planning guidance documents to provide technical support and educational assistance to the public.

- United States Army Corp of Engineers (USACOE)

  USACOE's mission with regards to the waters of the United States is to provide services for planning, design, building, and operating water resources and other civil works projects including navigation and dredging, flood control, environmental protection and disaster response. The USACOE reviews and permits projects proposed in navigational waters to ensure compliance with federal environmental laws

2.4.1.2 New York State

- New York State Department of Environmental Conservation (NYSDEC)

  The NYSDEC manages the state's recreational and commercial fisheries, tidal and freshwater wetlands, and other natural resources common to the coastal environment. NYSDEC is responsible for the preservation of water quality throughout New York State, especially through administration of the State Pollutant Discharge Elimination System ("SPDES") permit program. The SPDES program includes municipal stormwater systems, construction sites greater than one acre in area, and oversight of spill remediation activities. NYSDEC also oversees the implementation of the National Shellfish Sanitation Program requirements, including enforcement activities with regard to the illegal taking of shellfish from uncertified waters and the establishment of water quality criteria for shellfishing waters.

- New York State Department of State (NYSDOS)

  NYSDOS provides technical and financial assistance to governments, businesses, and private organizations for the improvement of waterfronts, and specifies policies on issues that affect coastal areas. The NYSDOS is responsible for administering the Federal Coastal Zone Management Act of 1972 and the State Waterfront Revitalization Act of 1981, including its responsibility for reviewing Local Waterfront Revitalization Plans ("LWRPs"), Harbor Management Plans ("HMPs"), and various coastal projects for consistency with the state's Coastal Management Plan. NYSDOS also administers part of the state's Environmental Protection Fund ("EPF"), which has partially provided the funding to undertake this plan.

- New York State Department of Health (NYSDOH)

  NYSDOH identifies waterbodies that have compromised water quality that may have adversely affected the suitability of fish for human consumption, including Hempstead Harbor.

2.4.1.3 Nassau County

- Nassau County Department of Public Works (NCDPW)

  NCDPW is the agency responsible for maintaining the county roadways and corresponding drainage infrastructure within the subwatershed. The manner in which the county plans, engineers, constructs, and maintains its stormwater infrastructure and roads can have significant and lasting effects on local water quality. Virtually all of the major roads within the GR/PD subwatershed are county roads, including Shore Road, Glenwood Road, Kissam Lane, Glen Cove Avenue, Cody Street and Grove Street.

  Nassau County is a regulated small MS4 within a Designated Urbanized Area as identified by the NYSDEC. As a regulated MS4 under SPDES Phase II, NC is required to develop and implement a Stormwater Management Program (SWMP) that must

include a written Stormwater Management Program Plan (SWMP Plan). NCDPW has been charged with managing the development, implementation and enforcement of the NC SWMP Plan. NC has established an inter-municipal coalition of its' towns, cities and villages to implement the SWMP on a regional scale. The Towns of North Hempstead and Oyster Bay and the Villages of Sea Cliff and Roslyn Harbor are all members of the Nassau County Stormwater Coalition. Coalition resident and business educational materials are developed for distribution to area residents through coalition members and a suspected illicit discharge reporting telephone number is maintained by Nassau County.

- Nassau County Department of Health (NCDOH)

  NCDOH conducts a sampling program during the summer season to monitor enterococci levels that determine whether the waters at public bathing beaches are suitable for swimming. For CSHH mid-harbor samples, the NCDOH continues to use fecal coliform along with enterococci to facilitate comparisons with historical data.

  NCDOH also provides requirements, approvals and permitting for on-site sewage disposal systems. NCDOH does not currently require inspection or maintenance of existing on-site sanitary systems. Lack of a program to inspect existing systems and require subsequent maintenance may result in lack of identification and improvement of failing systems that are contributing pathogen loads to surface waters.

- Nassau County Planning Commission (NCPC)

  The NCPC has discretionary approval authority over subdivisions.

- Nassau County Parks and Recreation (NCDP)

  The NCDP is responsible for county-owned park and preserve facilities. There are no such facilities in the GR/PD subwatershed.

2.4.1.4 Town of Oyster Bay and Town of North Hempstead

TOBAY and the TNH are regulated small MS4s within Designated Urbanized Areas as identified by the NYSDEC. As regulated MS4s under SPDES Phase II, the Towns are required to develop and implement Stormwater Management Plans ("SWMPs"). The Towns have the authority to regulate land use activities in their respective unincorporated communities. The Towns also regulate the use of underwater lands and the placement of structures on underwater lands within their respective boundaries. Departments within the Town that influence land use include:

Town of Oyster Bay	**Town of North Hempstead**
Town Board – Supervisor and Councilmembers	Town Board – Supervisor and Councilmembers
Department of Planning and Development	Department of Planning and Environmental Protection
Zoning Appeals Board	Board of Zoning and Appeals
Department of Public Works	Department of Public Works/Highways
Department of Parks	Department of Parks and Recreation
Department of Public Safety	Department of Public Safety
Department of Environmental Resources	
Department of Highways	

2.4.1.5 Villages of Sea Cliff and Roslyn Harbor

Each village is a regulated small MS4 within a Designated Urbanized Area as identified by the NYSDEC. As a regulated MS4 under SPDES Phase II, each Village is required to develop and implement a SWMP. The villages each have the authority to regulate land-use activities in their respective incorporated communities. Departments and boards within each village vary by individual Village, but generally include the following:

- Village Board of Trustees– Mayor and Trustees
- Planning Board and/or Zoning Board of Appeals
- Public Work Department

2.4.1.6 Citizen/Civic Groups and Organizations

In addition to federal, state, county, and local governmental groups, a variety of private organizations have been created to oversee, protect, and preserve significant environmental features that are important to their region or municipality. Private organizations that have interest in the GR/PD subwatershed include Coalition to Save Hempstead Harbor (CSHH), Glenwood / Glen Head Civic Association, the United Civic Council of Glen Head and Glenwood Landing and other civic groups and local property owner associations.

2.5 LOCAL LAW ASSESSMENT

The codes for the four municipalities with land use control in the GR/PD subwatershed were reviewed for local laws that can impact stormwater management and pollution prevention within the subwatershed. The local laws are included on *Tables 2-3: Local Law Assessment*. The laws have been divided by their impact either on stormwater control or pollution prevention, and a short description of the impact is included in parentheses.

TABLE 2-3
LOCAL LAW ASSESSMENT

NASSAU COUNTY			
Stormwater Management		**Pollution Prevention**	
Code No.	**Code Title**	**Code No.**	**Code Title**
59	Environmental Program	15	Land Preservation (pollution reduction)
XII	Department of Public Works (stormwater control)	63	Migratory Waterfowl (feeding ban)
		68	Plastic bag Reduction & Recycling

			(debris control)
		72	Fertilizer Law (nutrient reduction)
		IX	Department of Health (nutrient and bacteria control)

TOWN OF OYSTER BAY			
Stormwater Management		**Pollution Prevention**	
Code No.	**Code Title**	**Code No.**	**Code Title**
93	Building Construction	103	Dogs and Other Animals (pet waste control)
110	Environmental Quality Review (pollutant and drainage control review)	145	Landscaping (debris control)
121	Floodplain Damage Prevention (storm control management)	165	Storage and Handling of Oils (hydrocarbon control)
246	Zoning (stormwater runoff control)	205	Streets and Sidewalks (sediment and debris control)
204	Stormwater Management and Erosion & Sediment Control (stormwater runoff control)	225	Trees (erosion control)
		181	Prohibition of Illicit Discharges, Activities & Connections to Separate Storm Drain Systems
		182	Property Maintenance, Industrial and Commercial (drainage structure maintenance requirements)
TOWN OF NORTH HEMPSTEAD			
Stormwater Management		**Pollution Prevention**	
Code No.	**Code Title**	**Code No.**	**Code Title**
2	Administration and Enforcement (Building Construction Requirements)	14	Dogs (pet waste control)
7	Building Code	20A	Environmental Planning and Control of trees (erosion control)
20	Environmental Quality Review (pollutant and drainage control review)	25	Grading and Soil Removal (erosion control)
21	Floodplain Management Regulations (storm control management)	29	Underground Storage of Flammable and Other Hazardous Liquids (Pollutant discharge control)
28	Housing & Rehabilitation Code (stormwater and erosion control)	34	Littering and Dumping (debris control)
46A	Stormwater Management and Erosion and Sediment Control (stormwater runoff	35	Deposit of Materials (debris control)

	control)		
70	Zoning (stormwater runoff control	45	Sand Bank and Pit Excavation (erosion and sediment control)
		47B	Storm Sewers (illicit discharge removal and prevention)
		47	Sewers (nutrient and bacteria control)

VILLAGE OF SEA CLIFF			
Stormwater Management		**Pollution Prevention**	
Code No.	**Code Title**	**Code No.**	**Code Title**
48	Building Construction Administration (drainage system requirements)	36	Animals, Fowl and Insects(pet waste control)
60	Environmental Quality Review (pollutant and drainage control review)	110	Streets and Sidewalks (sediment and debris control)
107	Site Plan Review(drainage system requirements)	112	Subdivision of Lands (drainage system requirements)
138	Zoning (stormwater runoff control)	115	Swimming pools (chemical discharge control)
109	Stormwater Management and Control (stormwater runoff control)	71	Refuse and Cesspool Waste (nutrients and bacteria control)
		70	Gardeners and Landscapers (debris and hydrocarbon control)
		81	Littering (debris control)
		103	Sewers and Sewer Disposal (nutrients and bacteria control)
		121	Tree Preservation and Protection (erosion control)
		109	Stormwater Management and Control (illicit discharge prohibited)
VILLAGE OF ROSLYN HARBOR			
Stormwater Management		**Pollution Prevention**	
Code No.	**Code Title**	**Code No.**	**Code Title**
232	Subdivision of Lands (drainage system requirements)	251	Trees (erosion control)
275	Zoning (stormwater runoff control)	135	Illicit Discharge Activities and Connection to Separate Storm Sewer Systems (pollutant discharge)
210	Site Plan Review(drainage system requirements)	227	Streets and Sidewalks (sediment and debris control)
100	Building Construction Administration (drainage system requirements) (flood damage protection)	132	Gardeners and Landscapers (debris and hydrocarbon control)
226	Stormwater Management and Erosion and	165	Nuisance (pollutant control)

	Sediment Control (stormwater runoff control)		
117	Environmental Quality Review (pollutant and drainage control review)	92	Animals (pet waste control)

Under the New York State Pollutant Discharge Elimination System (SPDES) Phase II program, pollutant discharges from stormwater systems are the responsibility of the County and its 67 Towns, Villages, and Cities. As the largest municipality, Nassau County has taken the lead in coordinating the NC SWMP and acting as a clearinghouse of information for concerned parties. The NC SWMP is a comprehensive inter-municipal program to reduce the levels of contaminants in Nassau County's stormwater runoff and educate the public about their impacts on storm water. The NC SWMP provides inter-municipal support and coordination for local municipalities that are developing and implementing stormwater management programs The Nassau County Department of Public Works Water Engineering Unit is in charge of implementing the plan, including water testing, education, and pollution prevention measures. the six elements of the NC SWMP are public education, public involvement, illicit discharge detection and elimination, construction site storm water runoff control and post-construction storm water management, and pollution prevention and good housekeeping for municipal operations.

All of the GR/PD subwatershed municipalities have adopted local laws for Stormwater Management and Erosion and Sediment Control and for Illicit Discharge Detection and Elimination (IDDE) as required under the NYSDEC SPDES MS4 program. The municipalities also have adopted codes that require dog waste clean-up, hazardous waste storage and discharge control, and various codes to control debris and waste disposal, erosion, pollutant sources control, building standards, and environmental quality review that should reduce the amount of pollutants deposited on subwatershed surfaces.

The Hempstead Harbor Protection Committee is currently developing a Waterways Local Law that will develop model coordinated ordinance and enforcement measures for surface water use for communities within the Hempstead Harbor watershed. This study will include analysis of the legal and institutional factors affecting harbor management, development of a model waterways

local law and development of strategies for adoption by the municipalities. This report will include an extensive discussion of the existing local laws and their impacts on stormwater management and pollution prevention.

Currently, NCDOH approves and permits on-site sanitary systems for all development in the County. Failing on-site systems have been identified as a possible source of pollutant loads in Hempstead Harbor. There is currently no municipal ordinance that requires that existing on-site sanitary systems receive regular inspections to determine if systems are operating properly and whether maintenance is required.

Currently the success of local laws in reducing of pollutants being deposited on subwatershed land surfaces and carried to surface waters has not been quantified and the effect on pollutant discharges has not been measured. Methods to assess the success of the implementation of the ordinances may include:

- monitoring the summons issued for violations of ordinances, such as for pet waste disposal or littering violations,
- increased surveillance for site erosion, illicit discharges or hazardous materials spills; and,
- water quality testing to monitor reductions in pollutant levels may be necessary to provide a reasonable assessment of the ordinances effectiveness in pollutant reduction.

3.0 STORMWATER DRAINAGE INFRASTRUCTURE AND POLLUTION ABATEMENT PROJECTS

This section describes the drainage infrastructure and drainage systems within the GR/PD subwatershed, assesses potential pollutant loads, and identifies specific target structural projects to mitigate existing pollutant loads.

NYSDEC has assigned a shellfish pathogen TMDL for portions of Hempstead Harbor. The shellfish pathogen TMDL requires a reduction of shellfish pathogen loads by 95% in portions of Hempstead Harbor by September 30, 2022, in order to meet water quality classification requirements. In accordance with the NYSDEC SPDES General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s) **(**Permit No. GP-0-10-002), the MS4 Phase II program requires municipalities develop programs with six components to reduce pollutants of concern defined by the TMDL program. The six components include:

- Public Education and Outreach
- Public Involvement / Participation
- Illicit Discharge Detection and Elimination, SWMP Development / Implementation
- Construction Site Stormwater Runoff Control
- Post-Construction Stormwater Management
- Pollution Prevention / Good Housekeeping for Municipal Operations

Development of the shellfish pathogen TMDL requires that the SPDES program specifically address pathogen reduction in its six components by addressing pathogen environmental threats and sources such as septic systems, geese and pets wastes.

In addition, according to LISS data, in 2005 elevated pathogen levels resulted in 310 beach closure days in the NYS portion of the Long Island Sound. The LISS –CCMP

seven-part strategy to reduce pathogen levels includes four elements that can be addressed in the GR/PD subwatershed to reduce pathogen discharges including:

- non-point source reductions,
- individual on-site systems/discharges improvements,
- public education efforts, and
- monitoring and assessment of water quality changes.

In accordance with the NYSDEC SPDES General Permit For Stormwater Discharges from Construction Activity (Permit No. GP-0-10-001), the MS4 Phase II program requires municipalities develop programs for issuing general permits for stormwater discharge from construction activities. A requirement for granting of these permits is that permit applicants prepare Stormwater Pollution Prevention Plans (SWPPPs) with water quality goals for the removal of 80% of Total Suspended Solids (TSS) and 40% of Total Phosphorus (TP) from runoff from new development. The NYS Stormwater Management Design Manual (NYSSMDM) provides guidance on meeting this requirement. The NYSDEC has recognized that these removal rates are difficult to achieve in developed watersheds where little land area is available to site remediation efforts. Chapter 9 of the NYSSMDM includes additional provisions for stormwater management practices for redevelopment projects that provide a balance between 1) maximizing improvements in site design that can reduce the impacts of stormwater runoff, and 2) providing a maximum level of on-site treatment that is feasible given the redevelopment project site constraints.

The final paragraphs of this section include a brief description of additional management strategies that can be implemented to further aid in reducing pollutant generation, achieving the TMDL load reduction, and improving the subwatershed by alternate means (e.g. implementing watershed management plans, maintaining existing drainage infrastructure, and preserving land).

3.1 STORMWATER DRAINAGE INFRASTRUCTURE

As described in Section 2.1, the subwatershed was initially delineated using surface topography. Stormwater drainage systems installed to collect stormwater runoff from the network of roads, subdivisions, and commercial development have substantially altered the drainage patterns within the subwatershed. Mapping and assessment of the outfalls and upgradient drainage infrastructure are necessary to determine the drainage areas that continue to contribute surface stormwater runoff to Hempstead Harbor.

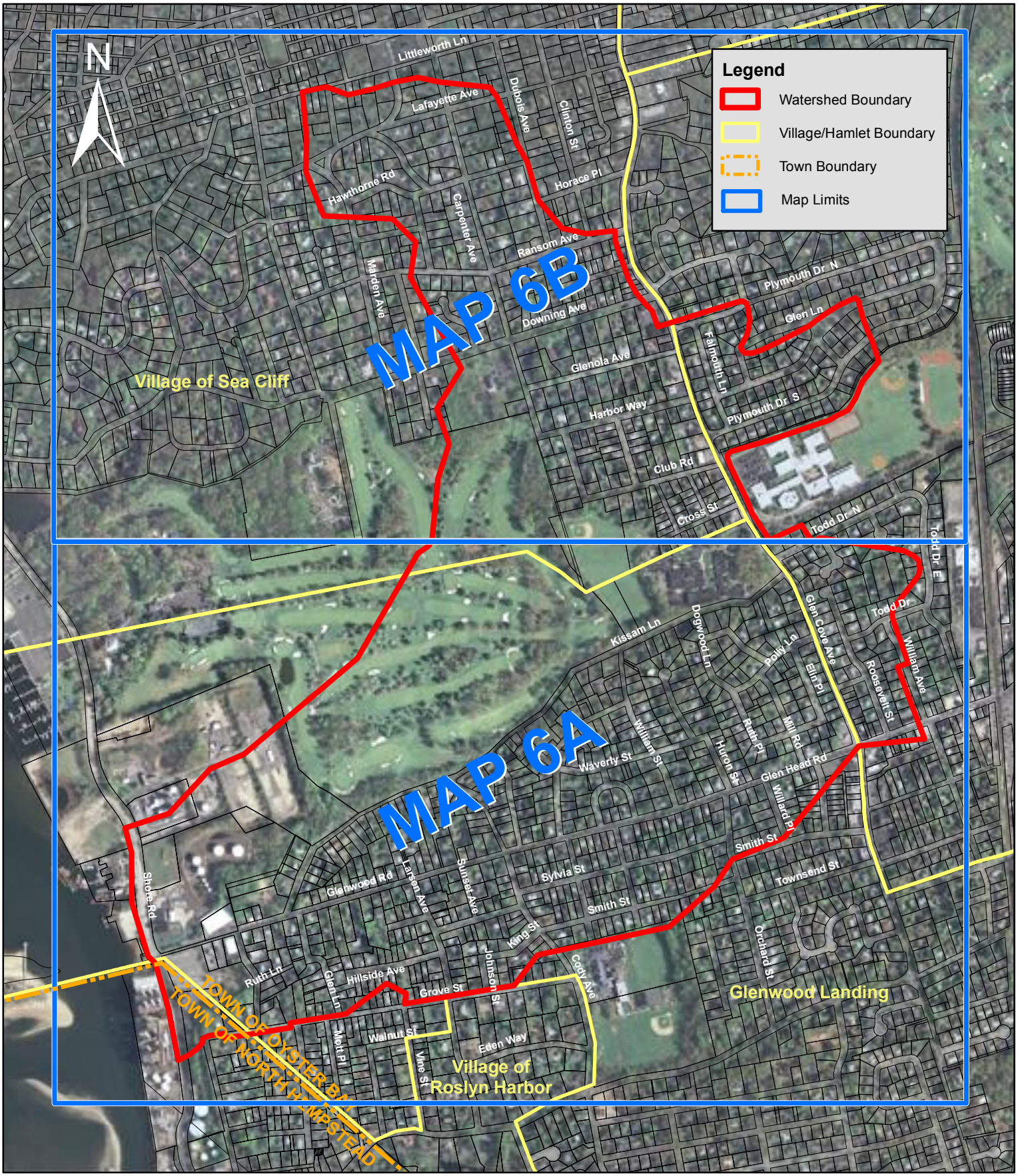
3.1.1 INFRASTRUCTURE SURVEY AND MAPPING METHODOLOGY

The Nassau County Geographic Information System (GIS) data for stormwater infrastructure that includes mapping of catch basin and drainage inlets, manholes, outfalls, and drywells was utilized as the base mapping for field assessment of the drainage system. The subwatershed drainage structures were field located by visual reconnaissance. Each field-located structure was assessed by the field personnel. Accessible structures were visually inspected to confirm that upgradient structures were contributing surface runoff to Hempstead Harbor. The inspection included a determination of the sizes and connectivity of the structures and analysis of the surrounding topography. The size and connectivity of the drainage structures were determined by inspecting the interior of the accessible structures to observe existing piping and direction of flows. In some instances, if a structure was not accessible due to a field condition, assumptions as to condition were made. The surface area that contributes runoff to the various pipe runs was determined by locating and mapping road high points and interconnected infrastructure. In addition, the condition of the interior of each accessible structure was noted, including odors, growth and condition. If new structures were identified their locations were mapped, data collected and the information downloaded to the GIS program upon return to the office. The drainage structure identification numbers are included on the Subwatershed Drainage Structure Identification Table in Appendix C. This table includes the identification number assigned during field reconnaissance (i.e., CA16 or OT3), the NC GIS data identification

number (i.e., NC-32066), or the Town of Oyster Bay identification number (i.e., 273-CW32) for each structure. Where structures not currently included on the NC GIS or TOBAY data were field identified during the reconnaissance, the NC GIS and TOBAY columns are noted as "NONE". Where NC GIS data indicated a structure, but one was not identified during field reconnaissance, the Field Reconnaissance ID column is noted as "NF" for not found.

Each drainage area identified has an assigned identification number. The *Table 3-4: Drainage Area Stormwater Assessment* included in Section 3.4.2 of this Plan contains a description of each drainage area along with street location, system description, structure identification numbers, land use, contributing area, jurisdiction's water quality volumes ("WQVs"), and structure maintenance requirements. The Map 6 is a key map that shown the portion on the subwatershed shown on Maps 6A and B. The detailed drainage areas and infrastructure systems are shown on Maps 6A and 6B.

Nine outfalls were indentified during the field assessment. The first OT1 is included in the Nassau County GIS data. OT2, located adjacent to OT1, appears to part of the NC drainage system. OT3 drains from the private North Shore Country Club property to the drainage system on Kissam Lane. OT4 and OT5 discharge to the stream segment located between Kissam Lane and Glenwood Road. These outfalls appear to connect to CA-115- and CA-116 located at the north end of Betty Lane. Betty Lane appears to be a private entrance road to six residences located off Glenwood Road. OT6 through OT9 discharge to the stream segment and appear to be outfalls from private residences.



VILLAGE OF SEA CLIFF /HEMPSTEAD HARBOR PROTECTION COMMITTEE
GLENWOOD ROAD / POWERHOUSE DRAIN
STORMWATER POLLUTION ABATEMENT PLAN

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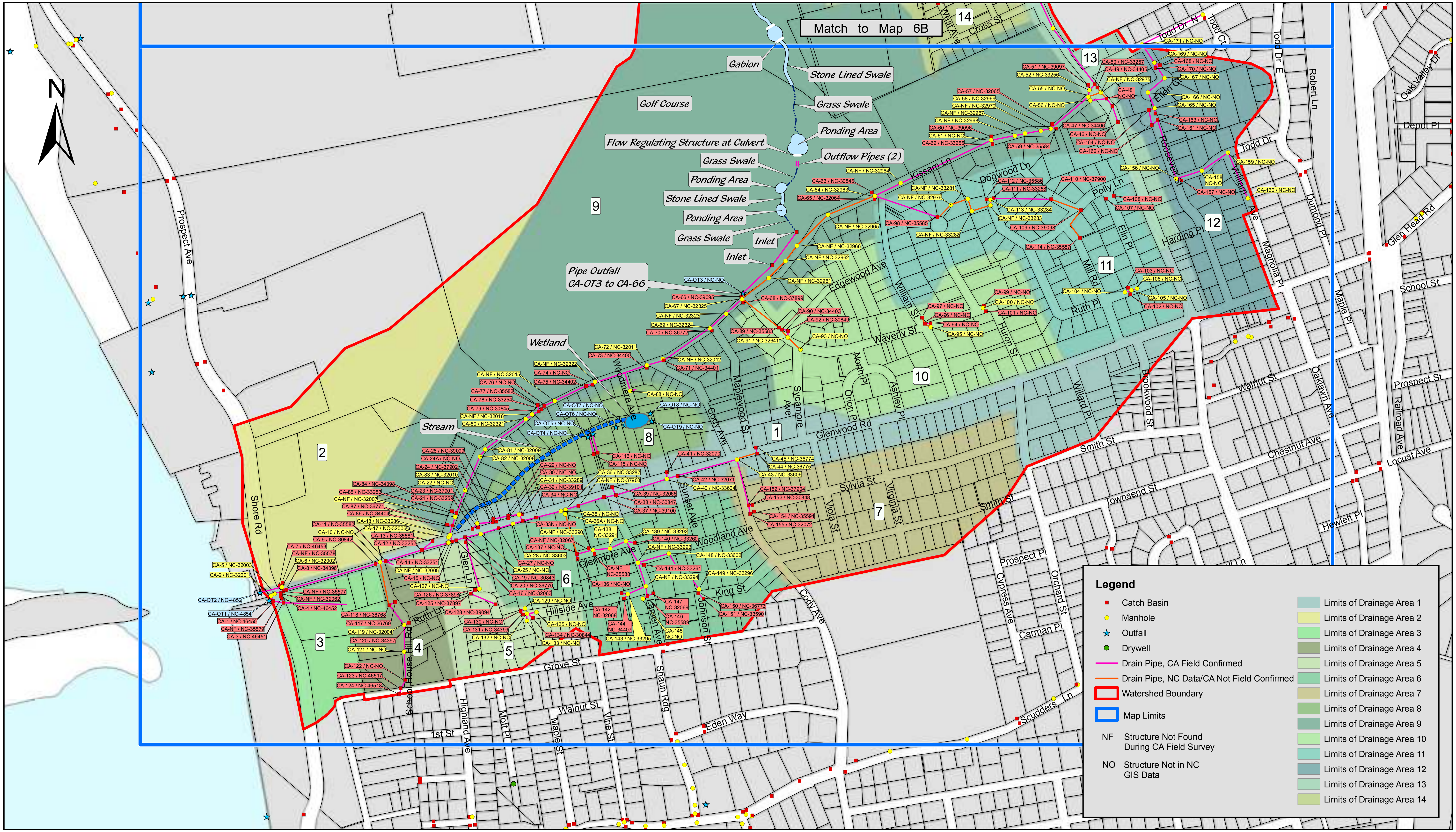
0 500 1,000 Feet

MAP 6
DRAINAGE AREAS KEY



VILLAGE OF SEA CLIFF /HEMPSTEAD HARBOR PROTECTION COMMITTEE
GLENWOOD ROAD / POWERHOUSE DRAIN
STORMWATER POLLUTION ABATEMENT PLAN

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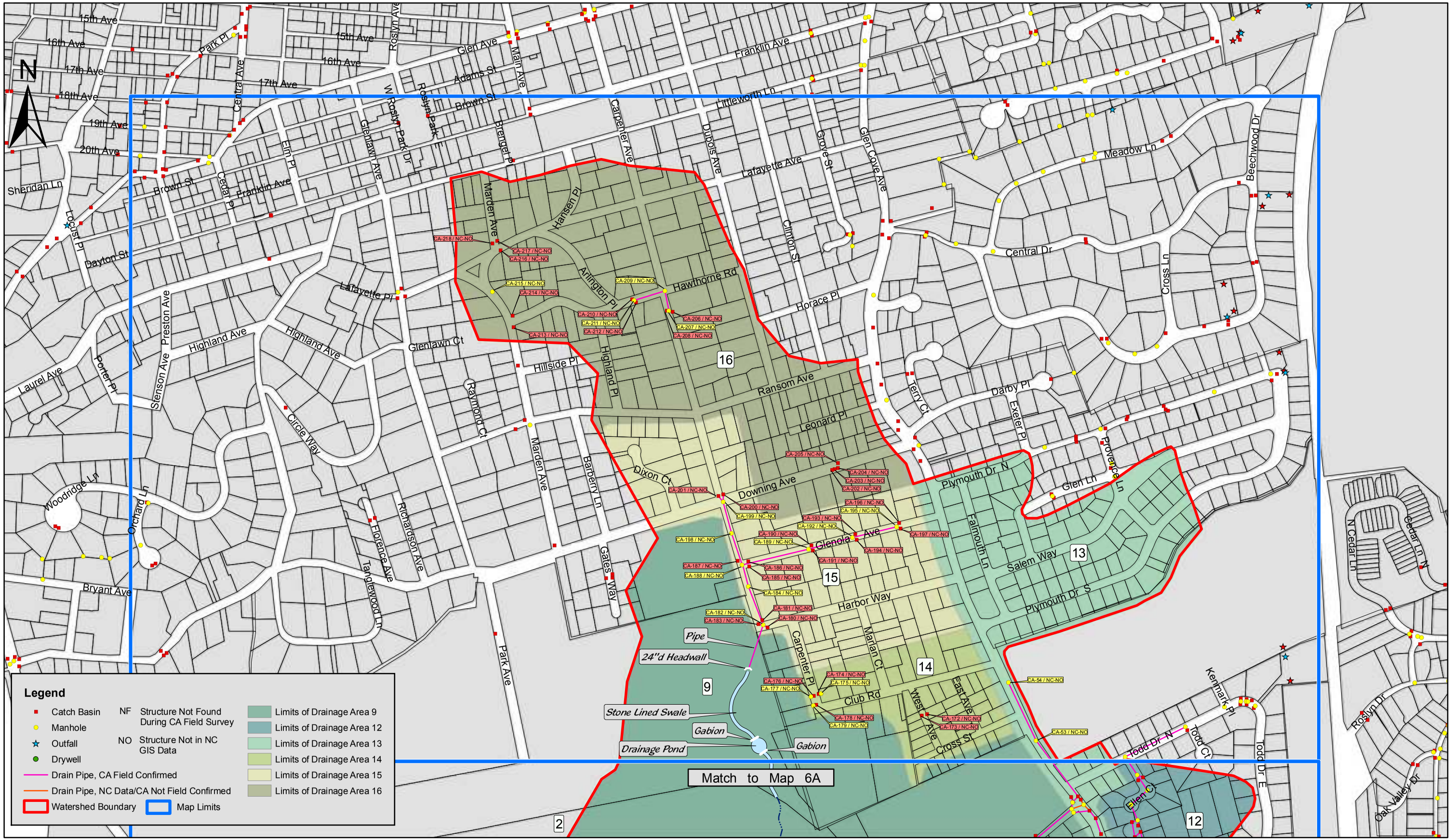
MAP 6A
DRAINAGE AREAS



VILLAGE OF SEA CLIFF /HEMPSTEAD HARBOR PROTECTION COMMITTEE
GLENWOOD ROAD / POWERHOUSE DRAIN
STORMWATER POLLUTION ABATEMENT PLAN

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0 250 500 Feet

MAP 6B
DRAINAGE AREAS

3.1.2 DRAINAGE AREA DELINEATION

As discussed in Section 2.1, the GR/PD subwatershed boundary included in the NC GIS drainage data was adjusted by analyzing the area topography, natural drainage pattern, lands that have the potential to drain to the GR/PD outfalls and the existing roads and drainage infrastructure to determine patterns of flow within the subwatershed. The adjusted subwatershed boundary is shown on all Plan Maps 1 through 7. The subwatershed is 448 acres in area.

The drainage area delineation was completed by reviewing the drainage infrastructure, the road drainage patterns, topography and the elevation high points within the subwatershed. Drainage areas were delineated based on the ability to separate the flow patterns and WQVs for future pollutant removal recommendations and the identification of potential specific areas within the subwatershed where mitigation measures may be proposed and project identified. These drainage areas are shown on Maps 6A and 6B. The drainage areas were assigned identification numbers that are shown on the maps and on the associated tables of this section. These maps and tables also include detailed drainage infrastructure information and piping information.

The drainage areas are discussed in the following section of this Plan to identify pollutant loads, assessment conditions, identify mitigation and management recommendations, and target specific pollution load reduction projects.

3.2 POLLUTION POTENTIAL

A subwatershed's potential to generate pollution that reaches waterbodies is based on assessing several conditions, including identifying sources that generate pollutants and the potential for the pollutant to be carried in runoff. Pollutant sources are based on assessment of land uses, while runoff potential is based on the assessment of the

imperviousness of the catchment area. Potential pollutant load calculations consider the land uses and impervious areas within a subwatershed.

3.2.1 POLLUTANTS OF CONCERN

The GR/PD subwatershed is a mix of primarily medium-density residential and recreational (private golf course) land use. Hempstead Harbor is currently not certified for shellfishing harvesting. According to the ***NYSDEC Atlantic Ocean/Long Island Sound Waterbody Inventory and Priority Waterbody List – 2002*** (PWL), the major pollutant sources contributing to the closure of the waterbody for shellfishing and swimming are storm sewers, urban runoff, and boat pollution. Secondary sources that are potentially capable of contributing to the closures are the Glen Cove Wastewater Treatment Plant (GCWWTP), and failing on-site septic systems. As described in Section 2.3.3 of this Plan, the *Shellfish Pathogen TMDL* identities sources of pathogen pollution into northern Hempstead Harbor as the GCWWTP (a point source), residential/urban lands (a non-point source which includes domestic pets as a major source) and rural land, forest and waterfowl (secondary non-point sources).

As of March 1, 2008, Nassau County assumed responsibility for the operation of the City of Glen Cove's Waste Water Treatment Plant (GCWWTP). According to the Nassau County website, this Plant is permitted for 5.5 MGD and has been upgraded to meet the requirements associated with protecting the Long Island Sound from hypoxia or low dissolved oxygen. The GCWWTP currently treats approximately 3.0 MGD leaving a surplus capacity of over 2.5 MGD, which could be used to sewer some of the communities in the North Shore that are currently served by cesspools. Potential future southern expansion of the GCWWTP sewer district, through the installation of a sewer main along Shore Road, may offer the opportunity for connection to the GCWWTP in the GR/PD subwatershed and the removal of individual on-site septic systems and cesspools, which may be improperly operating, and discharging improperly treated septic wastes to groundwater or to surface waters.

The pollutants of concern for waters where usage includes fishing, shellfishing, boating, recreation and aesthetic values are described below. Both the PWL and the *Shellfish Pathogen TMDL* identified pathogens, including total coliform and fecal coliform, as a primary pollutant of concern in the Hempstead Harbor subwatersheds. The PWL lists priority organics (i.e., PCBs in migratory fish) and pathogens, as known pollutants of concern for the Hempstead Harbor subwatersheds; however, the sources of the priority organics are located outside the GR/PD subwatershed so are not discussed further in this report. Other suspected or possible pollutants of concern include in the PWL are silts and sediments, dissolved oxygen/oxygen demand, nutrients (nitrogen), oil and grease (hydrocarbons), metals, and aesthetics (floatables). Many of the pollutants of concern are typically related to the residential land uses and roadways predominant in this subwatershed. The following is a discussion of potential pollutants in the Hempstead Harbor watersheds.

Fecal Coliform and Pathogens – Pathogens include bacteria, viruses, and other microorganisms that can cause human illnesses. Common pathogens include bacteria such as *E. coli*. *E. coli* is an enteric (intestinal) bacterium, usually not harmful in and of itself. It is easily detected and its presence is used to indicate the possible presence of pathogens that are both more serious and more difficult to detect. Bacteria levels in undiluted urban runoff exceed public health standards for primary contact in-water recreational activities almost without exception. Pathogens of concern include the hepatitis A virus, salmonella, Norwalk virus, Norwalk-like virus, vibrio bacteria and other pathogens associated with sewage and animal waste. Exposure pathways include consumption of shellfish that have acquired the pathogens through filter feeding of surrounding waters containing the pathogens and swimming or other contact with waters with elevated levels of pathogens. The primary suspected cause of this impairment within the GR/PD subwatershed is stormwater runoff from urban lands carrying pet, wildlife and waterfowl wastes. Improperly operating sanitary systems have also been identified as a suspected source in the PWL. There are no municipal wastewater treatment plants within the GR/PD subwatershed. All properties within the subwatershed

have on-site sanitary systems. As no monitoring of the individual systems is currently required, the number of failing systems and level of pollutant contribution are not known.

Total Suspended Solids (TSS) (Silts and Sediments) – TSS includes mineral and organic silts and sediments that constitute the largest mass and volume of pollutant loads to surface waters. TSS can be exported in the greatest quantities from construction sites with inadequate sediment and erosion controls. After development is complete, the greatest loads are exported from larger, intensively developed subwatersheds with high percentages of impervious surfaces such as the GR/PD subwatershed. Many other types of contaminants (including hydrocarbons, nutrients, and pathogens) associate closely with sediment particles, especially fine-grained particles that are suspended in the stormwater flow. Thus, the fate of sediment loads carried by stormwater in large measure dictates the fate of these sediment-associated contaminants. The suspended sediment itself can have adverse impacts on the environment, including increased turbidity and reduced light penetration, which in turn can decrease submerged aquatic vegetation survival. After reaching slower moving, open-water areas, suspended sediment particles settle to the bottom where they may smother the benthic community, change the composition of the substrate, fill impoundments and navigation channels, and decrease aesthetic values of the water body. The major contributors to this impairment within the GR/PD subwatershed are erosion from unvegetated soils, construction operations, road sanding operations and general sediments deposits carried in road runoff.

Large-scale deposition of soil can inhibit natural pollutant filtering processes of waterbodies because the materials silt-up stream channels and wetlands, decrease flood storage capacity and inhibit growth of aquatic vegetation. Heavy sediment loads can reduce the effectiveness of stormwater pollution treatment devices, and inhibit the natural functions of water bodies, including fish and wildlife feeding, breeding, and cover uses. In addition, mineral soil particulate matter, organic debris, and man-made pollutants can act in concert to increase the level of turbidity in streams, rivers and shallow, low-energy

coastal systems. The resultant decrease in water clarity diminishes sunlight penetration and inhibits photosynthesis in submerged aquatic vegetation.

Nutrients and Dissolved Oxygen – Nutrients usually refer primarily to phosphorus and nitrogen, two elements that are necessary for plant growth. Nonpoint sources of phosphorus and nitrogen are the recognized causes of water quality degradation in many water bodies. The fertilizing effects of nitrogen and phosphorus have created water quality problems in many coastal and inland areas. They cause cultural eutrophication. Eutrophication is typified by rampant plant growth leading to diminished water quality, which can cause problems including aesthetic impairments, and undesirable swimming conditions. Nighttime respiration by plant growth and bacterial decomposition of dead vegetation reduces the level of dissolved oxygen in the water. Oxygen deprivation can cause mobile animals to leave an area, which is one reason areas low in oxygen (hypoxic) often have low numbers of fish. In cases that are more serious and for species that cannot flee, hypoxia can stunt growth or kill. The major contributors to this impairment within the GR/PD subwatershed are runoff from cultivated (lawns and landscaped) areas and pet and waterfowl wastes. Improperly operating sanitary systems may also be contributors but as discussed under Fecal Coliforms and Pathogens, the number of failing systems and level of pollutant contribution are not known. .

Phosphorus discharge regulations are set through the New York State Pollutant Discharge Elimination System (SPDES). According to the NYSDEC Stormwater Design Manual, the New York State Recommended Guidance Value for phosphorus is 20 ug/l.

Petroleum Compounds (Oils and Grease) - Petroleum compounds (oils and grease) contain an array of hydrocarbon compounds, some of which can be toxic to aquatic life 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. Specific site uses that are identified to generate high pollutant loads on impervious surfaces are defined as "hotspots." Hydrocarbon hotspots within the GR/PD subwatershed include several industrial uses with vehicle facilities along Shore Road and several service stations on Glen Cove Avenue. Physical assessment of the drainage systems and containment methods at each potential hotspot site is necessary to determine the actual potential for a site to contribute to the pollutant loads in municipal drainage systems and in surface waters. Illegal disposal of waste oil onto streets and into storm drains can also contribute to the problem on a local level. Municipal ordinances prohibit disposal of waste oils into storm drains or gutters, although the level of compliance is not known. Area roads and parking lots that drain to roads could be major contributors to this pollutant in the GR/PD subwatershed.

Floatables (Large Scale Debris and Trash) – Large-scale debris or trash (floatables) have the potential for additional negative effects on the subwatershed. Besides the obvious negative aesthetic effects, 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 block intestinal tracts and sharp items can damage mouths, intestinal tracts, and stomachs. Buoyant floatables transported through the waterbody into the marine environment and items manufactured from synthetics that persist in the environment for long periods of time tend to be more harmful than settleable elements and materials that biodegrade quickly. Human littering and dumping are major contributing factors to large-scale debris pollution. Littering is a major pollutant source in commercial areas. There is limited commercial usage within the GR/PD subwatershed. Trash is not expected to be a major pollutant in the GR/PD subwatershed, but the actual amount has not been quantified. The dumping of larger debris, such as furniture, appliances, automobiles, and shopping carts, can create physical barriers to the stream flow and increase shoreline erosion but is not an identified issue within the GR/PD subwatershed.

3.2.2 IMPERVIOUS COVER AND POLLUTION RUNOFF POTENTIAL

Stormwater runoff carries pollutants to receiving waters. Human activities, in particular the creation of impervious surfaces (such as paved parking lots, driveways and roadways), have an overriding effect on contaminant inputs in stormwater discharges. Land development alters stormwater drainage characteristics within a watershed, which can have a profound effect on water quality of receiving waterbodies. Development results in the replacement of permeable natural land surfaces (e.g., woodlands, meadows, etc.) with impervious surfaces such as roadways, buildings, walkways, and pavements. Even in areas cleared for development that are subsequently replaced with landscaping, the planted vegetation generally has a lower capacity for absorbing rainwater than the original vegetation; this is especially true with respect to turf areas. The overall consequence of these conditions is that development generally increases the amount of runoff generated on a given parcel of land. The augmented volume of runoff from developed properties can result in an increase of pathogens and other deleterious substances carried from the land surface to receiving waters.

The pollutant loads in runoff were estimated by utilizing the "Simple Method" as discussed below in Section 3.2.3. The Simple Method formula requires an estimate of the impervious surface contributing runoff to an outfall. The method for estimating the impervious surface in the drainage areas is the use of the impervious cover factor tables included in the *NYS Stormwater Management Design Manual* (NYSSMDM). The impervious cover factor table percentages are estimated by calculating the area of each land use within each catchment area and assigning impervious cover factors as identified on NYSSMDM Table 4.2 Land Use and Impervious Cover (2008). *Table 3-1: Land Use and Impervious Cover* includes the impervious cover estimates for each drainage area.

Pollutants accumulate on imperious surfaces and each rainfall event that generates runoff washes up to 90% of the accumulated pollutants into the receiving waters. The subwatersheds' various surfaces and land uses are the primary sources of most pollutants including sediments, waterfowl and pet wastes, hydrocarbons from vehicle oil and grease,

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
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Table 3-1
Land Use and Impervious Cover

DRAINAGE AREA	Total Area	Medium-Density Residential Area *(typically generally 1/4 ac to 1/2 ac)* /Institutional Areas		Commercial/ Industrial Areas		Open Urban Land/Cultivated Areas *(Park Land, Recreational Areas, Golf Courses, Schools)*		Road Right-of Ways		Drainage Area Average Percent Impervious
		(28% impervious)		(70% impervious)		(9% impervious)		(75% impervious)		
	acres	acres	percent	acres	percent	acres	percent	acres	percent	
Area 1 - Glenwood Road	**26.9**	**18**	67	**2**	7.5	**0**	0	**6.9**	25.7	**43.2**
Area 2 - Shore Road North	**26.4**	**0**	0	**24.3**	92.1	**0**	0	**2.1**	8	**70.4**
Area 3 - Shore Road South	**7.2**	**0**	0	**5.6**	77.8	**0**	0	**1.6**	22.3	**71.1**
Area 4 - Schoolhouse Hill	**5.6**	**2.6**	46.5	**2**	35.8	**0**	0	**1**	17.9	**51.4**
Area 5 - Glen Lane	**8.1**	**6.5**	80.3	**0**	0	**0**	0	**1.6**	19.8	**37.3**
Area 6 - Larsen Avenue	**21.7**	**18.7**	86.2	**0**	0	**0**	0	**3**	13.9	**34.5**
Area 7 - Cody Lane	**20.1**	**14.8**	73.7	**0**	0	**0**	0	**5.3**	26.4	**40.4**
Area 8 - Creek Segment	**8.9**	**8.9**	100	**0**	0	**0**	0	**0**	0	**28.0**
Area 9 - Kissam Lane	**125.5**	**17.6**	14.1	**0**	0	**101.7**	81.1	**6.2**	5	**14.9**
Area 10 - Waverly Street	**24.0**	**20.2**	84.2	**0**	0	**0**	0	**3.8**	15.9	**35.4**
Area 11 - Elin, Mill, Ruth, Huron	**25.1**	**18.8**	75	**0**	0	**0**	0	**6.3**	25.1	**39.8**
Area 12 - Roosevelt Street	**15.7**	**12.6**	80.3	**1**	6.4	**0**	0	**2.1**	13.4	**37.0**
Area 13 - Glen Cove Avenue	**39.1**	**26.2**	67.1	**5.1**	13.1	**0**	0	**7.8**	20	**42.9**
Area 14 - Club Road	**12.4**	**9.5**	76.7	**0**	0	**0**	0	**2.9**	23.4	**39.0**
Area 15 - Carpenter Avenue	**29.5**	**23.8**	80.7	**0**	0	**0**	0	**5.7**	19.4	**36.1**
Area 16 - Sea Cliff Streets	**51.9**	**41.3**	79.6	**0**	0	**0**	0	**10.6**	20.5	**37.6**
WATERSHED TOTAL	**448.1**	**239.5**	53.5	**40**	9	**101.7**	22.7	**66.9**	15	**34.5**

Note: Acres and Percentages exceed 100% due to rounding

Sources: Land Use Areas - Nassau County Tax Data

% Impervious Factors - NYSSMDM Table 4.2 Land Use & Impervious Cover (2008), Road Right-of Ways added as 75%

vegetative matter, litter, and debris. In addition, unvegetated surfaces erode, oils are dumped to storm structures, excessive amounts of fertilizer and pesticides are applied to lawns and gardens, sanitary systems age and their function decreases, and salts and sands are applied to roads in winter.

The following factors are additional indicators of increased runoff potential:

- Water bodies located close to pollutant sources
- Shoreline areas lacking adjacent upland vegetated buffers
- Steep slopes
- High waterfowl populations
- High-density residential development with lot sizes less than 1 acre per unit
- Septic systems in excess of 1-2 systems per acre
- Flows that are extreme for the channel condition
- Soils with poor percolation properties
- Maintenance practices that are not routinely undertaken
- Erodable soils without well-established vegetation
- Storage facilities that are not self-contained

A number of the factors included in this list are related to the conditions found in locations within the GR/PD subwatershed including the waterbody location, steep slopes, high-density residential development, and septic systems. The following paragraphs of this section of the Plan estimate the pollutant loads generated in each drainage area. Section 3.5 and 3.6 of this Plan identify methods to reduce pollutant loads through the implementation of stormwater mitigation projects, the incorporation of runoff management practices and strategies, and the continuation of educational programs for area residents and businesses.

3.2.3 POLLUTION LOAD ANALYSIS

Typically, water turbidity is at its highest during and immediately after the "first flush" of a storm event as a result of increased stormwater and pollutant load discharge. The "first

flush" refers to the initial rainfall event that washes the majority of the surface pollutant deposits into the waterbodies. The "first flush" is also referred to as the water quality storm event (WQSE). In order to quantify pollutant loading from drainage areas, a watershed planning-level method to estimate pollutant loads was utilized. For Long Island, the volume of storm water produced by a water quality storm event (WQSE) defined by the NYSDEC as a 1.3-inch rainfall event is the required design standard. The WQSE is used to calculate the water quality volume (WQV) that will be used as the basis for identifying storm abatement projects that will reduce the pollutant loads outfalling into Hempstead Harbor from the GR/PD subwatershed. Pollutant loading calculations were developed using the "Simple Method" outlined in the publication *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs* and at the NYSDEC Stormwater Webpage "Tools – Stormwater Technical Standards" (www.dec.ny.gov/chemical/29085.html). This "Simple Method" methodology is also utilized in the Nassau County Stormwater Management Program's *Stormwater Runoff Impact Analysis Procedures Manuals* for urban storm pollutant load calculations.

The "Simple Method" calculations estimate the WQV for each drainage area. Capturing and infiltrating, or detaining and filtering, the identified runoff quantities will significantly reduce the pollutants reaching the surface waters. Actual final design criteria and calculations used to determine mitigation measures and pollution removal rates will be dependent on a detailed analysis of the land use, impervious cover, soil types, hydrology and topography of the site. Annual total drainage area pollutant load calculation results are shown on *Table 3-2A: Annual Pollutant Load Estimates.* The pollutant loads generated from road runoff have also been calculated separately and are shown on *Table 3-2B: Annual Road Runoff Pollutant Load Estimates*.

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
Stormwater Pollution Abatement Plan

Table 3-2A
Annual Watershed Pollution Load Estimate

Drainage Area	Contributory Area	Contributory Area	Impervious Area	Water Quality Volume	Water Quality Volume	Annual Rainfall	Annual Runoff	Total Nitrogen (TN) c = 2.0 mg/l	Total Suspended Solids (TSS) c = 54.5 mg/l	Total Phosphorus (TP) c= 0.26 mg/l	Oil and Grease c = 3.0 mg/l	Fecal Coliform c= 5000MPN/100 ml
								ESTIMATED AVERAGE ANNUAL LOAD				
	SF	Acres	%	WQv-acre-feet	WQv-Cubic Feet	inches	inches	lbs	lbs	lbs	lbs	billion colonies
Area 1 - Glenwood Road	1,132,560	26.9	43.2	1.278	55,677	42	16.58	202	5,494	27	303	2,297
Area 2 - Shore Road North	1,131,388	26.4	70.4	1.955	85,161	42	25.84	309	8,403	41	463	3,514
Area 3 - Shore Road South	313,632	7.2	71.1	0.538	23,444	42	26.08	85	2,314	12	128	968
Area 4 - Schoolhouse Hill	243,936	5.6	51.4	0.311	13,544	42	19.37	50	1,337	7	74	559
Area 5 - Glen Lane	352,836	8.1	37.3	0.338	14,737	42	14.57	54	1,455	7	81	608
Area 6 - Larsen Avenue	945,252	21.7	34.5	0.847	36,914	42	13.63	134	3,642	18	201	1,523
Area 7 - Cody Lane	875,556	20.1	40.4	0.900	39,225	42	15.63	143	3,870	19	214	1,619
Area 8 - Creek Segment	387,684	8.9	28.0	0.291	12,684	42	11.42	46	1,252	6	69	524
Area 9 - Kissam Lane	5,465,832	125.5	14.9	2.506	109,164	42	6.97	396	10,771	52	593	4,504
Area 10 - Waverly Street	1,045,440	24.0	35.4	0.959	41,789	42	13.95	152	4,123	20	227	1,724
Area 11 - Elin, Mill, Ruth, Huron	1,093,356	25.1	39.8	1.110	48,347	42	15.43	176	4,770	23	263	1,995
Area 12 - Roosevelt Street	683,892	15.7	37.0	0.651	28,350	42	14.46	103	2,798	14	154	1,170
Area 13 - Glen Cove Avenue	1,704,144	39.1	42.9	1.846	80,390	42	16.47	292	7,932	38	437	3,317
Area 14 - Club Road	540,144	12.4	39.0	0.539	23,461	42	15.16	85	2,315	12	128	968
Area 15 - Carpenter Avenue	1,285,020	29.5	36.1	1.199	52,209	42	14.18	190	5,152	25	284	2,154
Area 16 - Sea Cliff Streets	2,260,764	51.9	37.599	2.184	95,124	42	14.68	345	9,386	45	517	3,925
WATERSHED TOTAL ANNUAL POLLUTANT LOAD ESTIMATES								**2,762**	**75,014**	**366**	**4,136**	**31,369**

Sources : Pollutant Coefficient "c" Valves - NYSDEC Stormwater Management Design Manual, Table 2.1, 2003; except F Coliform - NPDES Database Summary (University of Alabama/CWP, 2003)
Impervious Area: See Table 3-1 of this Report

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
Stormwater Pollution Abatement Plan

Table 3-2B
Annual Road Runoff Pollutant Load Estimate

Drainage Area	Road ROW Area	Road ROW Area	Impervious Area	Water Quality Volume	Water Quality Volume	Annual Rainfall	Annual Runoff	Total Nitrogen (TN) c = 2.0 mg/l	Total Suspended Solids (TSS) c = 54.5 mg/l	Total Phosphorus (TP) c= 0.26 mg/l	Oil and Grease c = 3.0 mg/l	Fecal Coliform c= 5000MPN/100 ml
								ESTIMATED AVERAGE ANNUAL LOAD				
	SF	Acres	%	WQv-acre-feet	WQv-Cubic Feet	inches	inches	lbs	lbs	lbs	lbs	billion colonies
Area 1 - Glenwood Road	300,564	6.9	75.0	0.542	23,607	42	27.41	86	2,330	12	129	974
Area 2 - Shore Road North	91,476	2.1	75.0	0.165	7,185	42	27.41	27	709	4	40	297
Area 3 - Shore Road South	69,696	1.6	75.0	0.126	5,474	42	27.41	20	541	3	30	226
Area 4 - Schoolhouse Hill	43,560	1.0	75.0	0.079	3,421	42	27.41	13	338	2	19	142
Area 5 - Glen Lane	69,696	1.6	75.0	0.126	5,474	42	27.41	20	541	3	30	226
Area 6 - Larsen Avenue	130,680	3.0	75.0	0.236	10,264	42	27.41	38	1,013	5	56	424
Area 7 - Cody Lane	230,868	5.3	75.0	0.416	18,133	42	27.41	66	1,790	9	99	749
Area 8 - Creek Segment	0	0.0	75.0	0.000	0	42	27.41	0	0	0	0	0
Area 9 - Kissam Lane	270,072	6.2	75.0	0.487	21,212	42	27.41	77	2,093	10	116	876
Area 10 - Waverly Street	165,528	3.8	75.0	0.298	13,001	42	27.41	48	1,283	7	71	537
Area 11 - Elin, Mill, Ruth, Huron	274,428	6.3	75.0	0.495	21,554	42	27.41	79	2,127	11	118	890
Area 12 - Roosevelt Street	91,476	2.1	75.0	0.165	7,185	42	27.41	27	709	4	40	297
Area 13 - Glen Cove Avenue	339,768	7.8	75.0	0.613	26,686	42	27.41	97	2,633	13	145	1,101
Area 14 - Club Road	126,324	2.9	75.0	0.228	9,922	42	27.41	36	979	5	54	410
Area 15 - Carpenter Avenue	248,292	5.7	75.0	0.448	19,501	42	27.41	71	1,925	10	106	805
Area 16 - Sea Cliff Streets	461,736	10.6	75.0	0.833	36,266	42	27.41	132	3,579	18	197	1,497
WATERSHED TOTAL ANNUAL POLLUTANT LOAD ESTIMATES								**837**	**22,590**	**116**	**1,250**	**9,451**

Sources : Pollutant Coefficient "c" Valves - NYSDEC Stormwater Management Design Manual, Table 2.1, 2003; except F Coliform - NPDES Database Summary (University of Alabama/CWP, 2003)
Impervious Area: See Table 3-1 of this Report

WQVs were sized using the NYSSMDM Sizing Criteria 90 % rule whereas:

WQV = ((P) (Rv) (A))/12
WQV = Water quality volume (in acre feet)
Rv = 0.05+0.009(I)
I = Impervious Cover (Percent) (as described above)
P = 90% rainfall event number per chart = 1.3 inches on Long Island
A = Site area in acres

The Simple Method estimates pollutant loads as a product of annual runoff volume and pollutant concentration whereas:

L = 0.226*R*C*A
L = Annual Load (lbs)
R = Annual Runoff (inches) (See below)
C = Pollutant Concentration (mg/l) (see below)
A = Area (Acres)
0.226 = Unit Conversion factor

The Simple Method estimates pollutant loads for bacteria with a different unit conversion factor to account for different units. Fecal coliform calculations were developed using the conversion factor outlined on the Stormwater Managers Resource Center website (www.stormwatercenter.net) on the monitor/assess page under Simple Method.

$L = (1.03*10^{-3})*R*C*A$	
L = Annual Load (Billion Colonies)	
R = Annual Runoff (inches) (See Below)	
C = Pollutant Concentration (mg/l)*	
A = Area (Acres)	
$(1.03*10^{-3})$ = Unit Conversion factor	
*The pollutant concentrations for 'C' for TSS, TP, TN, and oil and grease are taken from **NYSSMDM (2008) Table 2.1 - National Median Concentrations for Chemical Constituents in Stormwater.** The pollutant concentration for "C" for Fecal Coliform is taken from **NPDES Database Summary (University of Alabama/CWP) (2003)**.	
Total Suspended Solids (TSS)	54.5 mg/l
Total Phosphorus (TP)	0.26 mg/l
Total Nitrogen (TN)	2.00 mg/l
Oil and grease	03.0 mg/l
Fecal Coliform (FC)	5,000 MPN/100 ml

Annual runoff was calculated as:

R = P*Pj*Rv
R = Annual Runoff (inches)
P = Annual Rainfall (Inches) (42" for Long Island)
Pj = Fraction of annual rainfall events that produce runoff (typically 0.9)
Rv = Runoff coefficient
Rv = 0.05+0.9(Ia)
Ia = impervious fraction – See Table 3-1

Based on the Simple Method calculations, the annual pollutant loads for the GR/PD subwatershed is estimated for the entire drainage area and for the road right-of ways only as shown below.

ANNUAL POLLUTANT LOADS	
DRAINAGE AREA TOTAL	**ROADS RIGHT-OF WAYS ONLY**
2,768 lbs of total nitrogen	837 lbs of total nitrogen
75,200 lbs total suspended solids	22,590 lbs total suspended solids
367 lbs total phosphorus	116 lbs total phosphorus
4,146 lbs of oil and grease	1,250 lbs of oil and grease
31,448 billion colonies fecal coliform	9,451 billion colonies fecal coliform

The distinction between total drainage area and road right-of-way is made as mitigation measures to reduce pollutant loads fall into two categories: structural measures that remove pollutants carried by storm runoff and source control actions that reduce the pollutant loads generated. Structural measures are generally implemented by municipal jurisdictions that construct and maintain the measures on public streets, while source control actions can be implemented by individual property owners and residents within the subwatershed to reduce the amount of pollutants generated.

The total annual pollutant load estimate for the subwatershed drainage area is shown on Table 3-2A along with annual pollutant loads estimates for each drainage area. Table 3-2B shows the annual pollutant loads estimated to be generated from the roads within the subwatershed only. The runoff from roads represents approximately 30% of the potential pollutant load from the entire subwatershed. The selection of an abatement action and the size of the area to be treated (drainage area or road area) will include consideration of the ability for private properties and individual lots to contain runoff on site.

3.3 RECOMMENDATIONS FOR MITIGATION STRATEGIES AND SOURCE CONTROL BEST MANAGEMENT PRACTICES

3.3.1 MITIGATION STRATEGIES

The following recommendations address mitigation strategies and methods to remove pollutants in runoff and to assess the levels of reduction that are achieved.

Develop consistent regulations for municipalities within the GR/PD subwatershed and the larger Hempstead Harbor Watershed.

A unified means for jurisdictional controls should be developed to prevent nonpoint source pollution such as a Waterways Local Law, Watershed Protection Overlay Zones or inter-municipal agreements. The implemented regulation would be a consistent set of laws, programs, practices, and enforcement actions to be followed by all of the municipalities in the Hempstead Harbor area for the purposes of controlling and managing water dependent uses in the harbor area, and to reduce and or eliminate significant pollution of Hempstead Harbor from nonpoint sources within certain areas of the watershed.

Work on development of consistent regulations for municipalities in the Hempstead Harbor watershed is being addressed as an additional component of the NYSDOS EPF grant that has provided funding toward the preparation of this Plan. The task, entitled Development of Coordinated Ordinances (a Waterways Local Law) and Enforcement Measures for Surface Water Use, is assessing the adequacy of local laws, programs and practices through comprehensive

review of independent actions taken by individual municipalities to manage the harbor uses within their own jurisdiction, developing a Model Waterways Local Law, and will provide a strategy for adoption of the local law by the Hempstead Harbor communities.

Implement pollutant source control BMPs where behavioral changes can result in significant pollution reductions in the subwatershed.

Activities conducted within the subwatershed are sources for the pollutants that enter the harbor. Changes to activities that place the pollutants on subwatershed surfaces can result in removing significant pollutant load reductions. In the GR/PD subwatershed, particular attention should be given to pet waste, landscape fertilizer use and erosion as significant sources of pollutants that can be reduced through behavioral changes. *Section 3.3.2: Pollution Source Control Best Management Practices* identifies strategies that can reduce the levels of pollutants deposited on subwatershed surfaces.

Assess individual subwatershed hotspots and, where necessary, provide specific recommendations on methods to reduce deposits and prevent runoff into waterbodies or municipal drainage systems.

Identified potential hotspots within the subwatershed including the industrial vehicle yards along Shore Road, gas stations along Glen Cove Avenue, the North Shore Country Club golf course, the North Shore School District bus maintenance facility, commercial parking lots and dumpsters, other turf areas, swimming pools and area roadways are shown on Map 4. *Section 3.3.2: Pollution Source Control Best Management Practices* includes a section on Hotspot Pollution Prevention that identifies strategies that can reduce the levels of pollutants deposited on hotspot surfaces and carried to area waterbodies.

Undertake a program in install structural pollution abatement actions in the subwatershed.

The impervious character of the densely developed residential and commercial subwatershed results in a stormwater flowing into Hempstead Harbor that carries with it

potentially high pollutant loads that affect harbor's water quality. Undertaking a program to reduce the pollutant loads will result in improved harbor water quality over time. *Section 3.4.3: Structural Pollutant Abatement Actions* below identifies structural pollution abatement projects for implementation. As the TMDL discussed in Section 2.3.3 identified the need to reduce harbor pathogen levels by 95% in the northern portion of the harbor, priority should be given to the measures that will result in the highest levels of pathogen reduction.

Undertaking additional dye testing or analysis should be considered to confirm connections between drainage areas where connections could not be confirmed from visible inspection of structures. Locations where connections require additional confirmation are included on Table 3-5 which is discussed in Section 3.4 of this Plan.

Additional mitigation measures and projects should be identified that can further reduce pollutant loads following results of monitoring, adoption and/or enforcement of source control BMPs, and implementation of target projects.

Continue Educational Programs and Efforts to Target Community Source Control Measures.

Source control BMPS require the coordinated efforts of all members of the subwatershed community. These efforts can extend beyond the GR/PD subwatershed to include the entire Hempstead Harbor watershed. The educational efforts need to reach a wide audience and to be repeated regularly as members of the communities change. Section 3.3.2 contains source control BMP strategies and includes a table that lists stewardship practices, and identifies the affected community members by land use and the pollutants reduced. These programs can be coordinated with ongoing programs by the Hempstead Harbor Protection Committee and educational efforts by the Nassau County Stormwater Coalition of MS4 municipalities.

The municipalities in the subwatershed and the larger harbor watershed also need to address educational efforts for municipal employees. These efforts can be coordinated with the educational efforts required by municipalities under the MS4 program and the required adoption of municipal operation and maintenance and good housekeeping programs.

Expand subwatershed sampling and analysis to establish existing GR/PD subwatershed conditions and assess improvements over time and project implementation.

The existing program to establish baseline water quality and actual pollutant levels in subwatershed runoff should be expanded to be able to assess the improvements that are being made. To understand the flow condition, both dry weather and wet weather sampling and analysis should be conducted either monthly or seasonally to assess existing subwatershed conditions. At a minimum, sampling should include a dry weather event at locations where there is perennial flow and two wet weather events at quarterly intervals to establish the existing baseline. Sampling and analysis should continue periodically as mitigation measures are implemented to assess improvements over time. Sampling locations should include the powerhouse drain outfalls (OT1 and OT2), the creek segment prior to entrance to piping at Glenwood Road(near west end drainage area 8), and the golf course outfall (OT3) on Kissam Lane. Sampling locations are shown on Map 7A, which is included in Section 3.4.2.

As pathogen levels have been identified as a concern in the TMDL discussed in Section 2.3.3, an investigation of pathogen levels in the GR/PD subwatershed should be conducted. DNA/bacteroides testing is recommended to determine the source of bacteria such human from septic systems verses animal from pet wastes or waterfowl. Additional pollutant sampling and analysis should include total and dissolved solids, nitrogen, phosphorus, and hydrocarbons, which are the pollutants most closely associated with the residential and roadway uses within the subwatershed. Testing methods and protocols should follow standard protocol identified for tributaries to Hempstead Harbor or the LIS

for comparison purposes. Testing data should be maintained in a central database inventory as is currently done for water sampling for the Hempstead Harbor Water Monitoring Program on the Hempstead Harbor Protection Committee website.

3.3.2 POLLUTION SOURCE CONTROL BEST MANAGEMENT PRACTICES (BMPs)

Pollutants in stormwater can also be reduced by reducing the amount of pollutants at their source where they are deposited on the land surface and carried in stormwater runoff to the surface waters. Pollution source control and prevention BMPs include control strategies and good housekeeping measures implemented by the subwatersheds' municipalities, local property owners, residents and businesses to achieve pollutant load reductions. Source control measures are important because structural pollution abatement actions can be costly for projects that treat limited stormwater volumes and due to the large percentage of impervious area within the GR/PD subwatershed, implementation of structural measures, which include the practices described in Section 3.4.1 of this Plan, alone will most likely not provide sufficient pollutant load reduction to meet NYSDEC water quality standards and the TMDL requirements for northern Hempstead Harbor. In addition, the developed character of this subwatershed makes it difficult to locate land area on which to site adequate structural measures.

Table 3-3: Pollution Source Reduction Measures is a listing of pollutant source reduction measures for neighborhoods, hotspots and municipal good housekeeping operations that can reduce or control pollutants generated in the GR/PD subwatershed. As the subwatershed contains a mix of residential, commercial, industrial, park/golf course and municipal land use, a wide range of educational programs and efforts are required to address all pollutant sources. The data presented has been developed from the referenced Center for Watershed Protection documents. Table 3-3 includes the name of the reduction practice, a description of the reason it was included in this plan and the general

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
NEIGHBORHOOD STEWARDSHIP										
P	**Fertilizer Use Reduction**	**Impacts:** • Maintenance practices of lawn and landscape areas have potential to contribute pollutant loads to surface waters. **Recommendations:** • Encouraging the use of organic and slow-release fertilizers and reducing the amount of fertilizer application by soil testing reduces the potential for nutrients to runoff lawns and landscaped areas to water bodies.	• Develop seasonal media campaigns and education materials • Encourage retail store demonstrations and educational opportunities • Provide free or low-cost soil tests	X			X		**N, P**	**N-1, N-7, MO-8***
P	**Pesticide Use Reduction**	**Impacts:** • Maintenance practices of lawn and landscape areas have potential to contribute pollutant loads to surface waters. **Recommendations:** • Encouraging the use of safer products and reducing the amount of pesticides applied by soil testing, IPM and pest analysis reduces the potential for runoff to water bodies.	• Develop seasonal media campaigns and educational materials • Encourage retail store demonstrations and educational opportunities • Provide local opportunities for pest and disease identification clinics	X			X		**C**	**N-2, MO-8***
	Xeriscaping	**Impacts:** • Excess irrigation can runoff and carry pollutants to waterbodies. **Recommendations:** • Reduce irrigation needs by using	• Develop seasonal water conservation media campaigns and education materials • Plant local	X	X				**N, P,C**	**N-3, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		plant materials appropriate to the site conditions, including soil type and rainfall amounts, reduces the need for additional irrigation that can runoff sites carrying sediments, fertilizers and pesticides to waterbodies.	demonstration gardens • Impose mandatory outdoor water restrictions							
	Natural Landscaping & Shoreline Filter Restoration	**Impacts:** • Lawns adjacent to surface waters allow greater runoff than site vegetated with taller materials and perennials, shrubs and trees, which provide additional absorption. **Recommendations:** • Landscape with taller and native materials, especially in natural areas along creeks and wetlands to improve habitat.	• Develop educational materials • Plant local demonstration gardens • Develop a backyard habitat program • Organize native plant sales • Distribute native seedlings or seed mixes.	X			X		**S, N, P**	**N-4, MO-8***
	Yard Waste Composting	**Impacts:** • Disposal of yard wastes in creeks, wetlands, along curblines, and in drainage systems can wash nutrients, organic maters and bacteria into surface waters. **Recommendations:** • On-site composting or municipal collections of bagged materials reduce pollutant loads to waterbodies.	• Develop an education program for composting and mulching mowers usage • Distribute fall leaf collection bags • Distribute free or discounted compost bins • Provide regular yard waste collection	X					**S, N, P, B**	**N-6, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
			• Increase access to municipally composted materials • Ban collection of grass clippings.							
P	**Soil Erosion Repair/Soil Reclamation**	**Impacts:** • Compacted soils and unvegetated soils can increase erosion and contribute sediment in runoff. **Recommendations:** • Stabilize locations where soils have eroded by revegetation or other cover materials and stabilization methods to prevent further erosion. • Due to the age of sections of the watershed, soil reclamation of compacted soils may be needed to improve soil condition to improve vegetation viability.	• Develop educational materials • Provide free or reduced cost soil testing • Provide access to free compost and to technical assistance • Enforce ESC, water quality and/or nuisance ordinances.	X	X	X	X	X	**S**, N, P, B	N-7, N-8, MO-8*

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
P	**Septic System Maintenance**	**Impacts:** • Improperly operating septic systems can contribute to bacteria and nutrient loads in waterbodies. • Factors linked to system failure include small lot sizes, aging systems, poor soils, high water tables, and proximity to waterbodies. **Recommendations:** • Educational efforts regarding impacts of improperly operating systems. • Implement programs to require regular inspection and repair of systems.	• Develop educational materials and media campaigns • Require mandatory system inspection and performance certification • Offer free or reduced-cost septic system inspections.	X					**N, P, B**	**N-9, MO-8***
	Pool Water Discharges	**Impacts:** • Discharging chlorinated pool water into surface waters can be toxic to aquatic life. **Recommendations:** • Discharge only when necessary and allow chlorine breaks down over 7 to 10 days prior to discharge, and discharge to pervious area. • Filter backwash should be directed toward a septic tank or pit. No discharge to surface waters.	• Educational Materials on proper discharge • Develop ordinance and fines for improper discharge.	X					**C**	**N-10, H-15, MO-8***
	Safe Vehicle Washing	**Impacts:** • Washing vehicles on impervious surfaces allows detergents to runoff and pollutant waterbodies.	• Provide educational materials • Implement a storm drain marking	X	X	X	X	X	**S, H, N, P, M, C**	**N-11, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		Recommendations: • Encourage use of phosphorus-free and/or non-toxic detergents and cleaning products or use of a commercial car wash that recycles wash water. • Require charity car wash events take place on self-contained pavements.	program • Modify code or ordinance nuisance codes							
	Driveways & Pavement Sweeping	**Impacts:** • Hosing of pavements and use of leaf blowers to dispose of sediments in gutters carries sediments and pollutants to waterbodies. **Recommendations:** • Sweeping or vacuuming and disposing of sediments in trash removes pollutants from runoff.	• Provide educational materials • Conduct media campaign • Provide contractor training	X	X				**S, H, N, P, M,**	**N-12, MO-8***
	Pavement De-icing Use Reduction and Modification	**Impacts:** • Indiscriminate application of de-icing materials increases sediments, toxins and nutrients carried to surface waters. **Recommendations:** • Minimize de-icing materials by clearing pavements manually and using environmentally (and pet) friendly products sparingly.	• Provide educational materials and informational brochures at point-of-sale.		X			X	**S, C**	**N-13, MO-8**
	Household Hazardous Waste Collection	**Impacts:** • Improper disposal can result in pollutants discharges to surface	• Develop media campaign • Increase number of	X					**H, C, M**	**N-14, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
	Program And Recycling	waters. **Recommendations:** • Collection of these materials can reduce the amount of materials illegally disposed of on streets and into storm drains.	collection events and/or locations • Provide directory to HHW collection locations.							
	Car Fluids Recycling	**Impacts:** • Improper storage and changing of automotive fluids on driveways and streets can result in spills and illegal dumping of waste fluids. **Recommendations:** • Encourage use of commercial automotive operations that require stringent control and recycling practices. • Provide information on BMPs and local laws for at home operations.	• Develop educational brochure for point-of-sale locations • Implement storm drain marking program • Develop directory of disposal locations.	X	X				**M, H, C**	**N-15, MO-8**
	Downspout Disconnection	**Impacts:** • Numerous roof drains on residential properties discharge to gutters. **Recommendations:** • Encourage installation of drywells, rain gardens or rain barrels that allow for infiltration or reuse of roof drainage on-site to reduce volume of flow into street systems.	• Develop educational materials • Provide discounted rain barrels • Construct demonstration projects.	X					**S, N, P, M, B**	**N-16, MO-8***
	Impervious Cover Reduction	**Impacts:** • Impervious cover increases watershed runoff.	• Develop educational materials • Modify local land use	X	X	X		X	**S, M**	**N-17, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		Recommendations: • Reduce pervious surfaces by eliminating unused pavements, converting to pervious pavements and/or increasing natural landscape areas.	ordinances to require a percentage of pervious pavement.							
P	**Pet Waste Clean-up**	**Impacts:** • Pet waste from public streets and from lands adjacent to surface waters is carried to surface waterbodies and is potentially a major source of bacteria and pathogens in the harbor. **Recommendations:** • Educate public on the levels of pathogens pet waste contributes to waterbodies and enforce of pet waste codes in effect in all municipalities. • Consider additional educational efforts for property owners adjacent to surface waters. • Increase enforcement of pet waste disposal ordinances.	• Increase code enforcement • Develop media campaign and educational materials • Install pet waste stations and signage • Implement storm drain marking.	X					**N, P, B**	**N-18, MO-8***
P	**Stormwater Practice Maintenance**	**Impacts:** • On-site drainage systems that are not inspected and maintained may not be providing pollutant removal. **Recommendations:** • Conduct maintenance activities to ensure that the stormwater practices are operating properly.	• Develop educational materials • Distribute maintenance reminders • Provide civic association seminars • Implement inspection		X	X		X	**S, N, P, M, B**	**N-19, MO-8***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		• Provide maintenance reminders due to ownership and management changes.	requirements.							
	Bufferscaping along creek, wetland and drainage swales	**Impacts:** • Lawns extending to creek edges allow nutrients to drain into waterbodies. **Recommendations:** • Planting of taller grasses and natural vegetation along creeks, waterbodies shoreline and swales provides filtering of pollutants in runoff prior to entering waterbodies and improves habitat.	• Develop educational materials • Provide civic association seminars • Adopt a buffer requirements ordinance • Inspect and enforce buffer boundary requirements • Post stream boundary signs.	X			X		**S, H N, P, B, M**	**N-20, MO-8***
	Storm Drain Marking	**Impact:** • Residents may dump materials in storm drains, not understanding where storm drains discharge. **Recommendations:** • A program to physically identify drainage inlets that carry runoff the surface waters can reduce use of inlets for oils, pet waste, debris and trash disposal.	• Implement storm drain marking program - this can be conducted with local community members under municipal oversight.					X	**S, M, B, H, C**	**N-21, MO-8***
HOTSPOT POLLUTION PREVENTION										
P	**Vehicle Maintenance and Repair , Fueling,**	**Impacts:** • Vehicular facilities such as gas stations, service stations, bus depots,	• Employee training • Conduct site inspections and code		X	X	X	X	**S, N, H, C, M**	**H-1, H-2, H-3, H-4, H-5,**

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
	Washing, Storage, and Loading Areas	fleet operations, car washes and vehicle parking areas have the potential to contribute sediments, hydrocarbons, chemicals and toxins to surface waters. **Recommendations:** • Proper secondary containment and facilities operation can significantly reduce polluted runoff from these sites. • All facilities should follow applicable laws for containment and clean up.	enforcement • Separate containment system installation and maintenance • Proper disposal methods.							**H-7**
	Outdoor Storage	**Impacts:** • Outdoor storage of landscape materials, chemicals and fertilizers may allow spills and runoff into storm system. **Recommendations:** • Protect materials stored outdoors from rainfall and in areas with secondary containment systems.	• Employee education • Minimize outdoor storage • Site inspections and code enforcement • Separate secondary containment system installation and maintenance.		X		X	X	**S, N, P, H, C**	**H-6**
	Spill Prevention and Response	**Impacts:** • Without a system to report spills, they may go unreported and undetected. **Recommendations:** • Development of spill prevention programs for commercial and industrial sites, such as gas stations and utility facilities, and roadways.	• Maintain updated spill prevention and response plans as required by NPDES • Require employee training		X	X		X	**N, P, H, C**	**H-7**

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
	Dumpster & Waste Management	**Impacts:** • Rainfall into dumpsters can carry bacteria, nutrients, chemicals and debris to runoff. • Improper disposal can result in sediments and trash being carried into storm system. **Recommendations:** • Require proper dumpster operation and placement on a self-contained pad.	• Require employee training • Require secondary containment • Establish proper operation procedures • Conduct site inspections and code enforcement		X	X			**N, P, B, C**	**H-8**
P	**Construction Project Erosion and Sediment Controls**	**Impacts:** • Construction projects that disturb the ground surface areas have the potential to allow erosion and sediment runoff. **Recommendations:** • Sediment and erosion control measures should be employed for all private projects as well as for municipal projects, such as road reconstruction and utility repair, to prevent sediment runoff to water bodies.	• All construction sites should be required to prevent off-site erosion and provide sediment and runoff control • State mandated SWPPP plans are required for sites disturbing over one acre.	X	X	X	X	X	**S, C**	**H-9**
	Building Maintenance or Remodeling Control	**Impacts:** • Construction projects that do not disturb surface area still have the potential to allow pollutant runoff through the use of hazardous materials, improper operations.	• Provide educational materials to licensed contractors or distribute with permits • Employee training	X	X	X	X	x	**S, H, M, C**	**H-10, MO-2***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		Recommendations: • Require proper control measures to prevent pollutant runoff.	program • Require proper operation procedures.							
P	**Parking Lot Maintenance**	**Impacts:** • Maintenance operation such as power washing, resealing, and resurfacing can deliver sediments, nutrients, hydrocarbons to drainage systems. **Recommendations:** • Removal of loose debris before cleaning, covering drainage inlets, working in dry weather and avoiding use of soaps and cleaning agents can reduce pollutant discharges.	• Provide educational handouts and ordinance requirements to licensed contractors during permits issuance.		X				**S, N, P, H**	**H- 11**
	Turf and Golf Course Management	**Impacts:** • Intensively managed turf areas may have poor management practices that generate pollutant such as sediments, nutrients, pesticides. **Recommendations:** • Follow turf best management and integrated pest management practices (IPM) to reduce pollutant levels.	• Require lawn care contractor licensing • Distribute educational materials with license renewal • Establish and enforce employee training requirements.				X	X	**S, N, P**	**H-12, MO-7***
P	**Landscape and Grounds Management**	**Impacts:** • Intensively managed turf areas may have poor management practices that generate pollutant such as sediments, nutrients, pesticides. **Recommendations:**	• Require landscape contractor licensing • Distribute educational materials with license renewal • Establish and enforce		X	X		X	**S, N, P**	**H-13, MO-7***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		• Follow landscape best management and IPM practices to reduce pollutant levels.	employee training.							
MUNICIPAL POLLUTION PREVENTION AND GOOD HOUSEKEEPING										
	Street Repair and Maintenance	**Impacts:** • Deteriorated street surfaces can cause increased sedimentation. • Regular maintenance activities without proper BMPs can increase pollutants that can be carried in runoff to surface waters. **Recommendations:** • Applicable BMPs and erosion and sedimentation control measures should be used to prevent pollution deposits and runoff.	• Establish and enforce employee pollution prevention program training • Undertake annual street repair projects • Require erosion and sedimentation control measures.					X	**S, H, C, N, P, M**	**MO-3***
P	**Street Sweeping Operations**	**Impacts:** • Sediments on streets contribute significant sediment and hydrocarbon load to surface waters. **Recommendations:** • Municipal programs to clean streets can be adjusted to focus on watershed streets particularly after winter storm events when salt and sand materials have been utilized.	• Establish and enforce employee pollution prevention training • Adjust sweeping schedule to follow snowfall events in watershed areas.					X	**S, H, B, M**	**MO-4***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
	Develop safe pavement deicing programs	**Impacts:** • Indiscriminate or over application of de-icing materials increases sediments, toxins and nutrients carried to surface waters. **Recommendations:** • Alternative de-icing methods and materials exist than can reduce salt and sediment usage. • Develop and implement a BMP program for winter roads clearing.	• Provide employee BMPs training for winter road maintenance operations • Investigate methods and materials to reduce salt and sand usage.					X	**S, C**	
P	**Storm Drain Maintenance**	**Impacts:** • Lack of maintenance results in storm water structures that are full of sediment and debris increasing surface flows and pollutant discharges. **Recommendations:** • Regular maintenance operations maintain a functioning storm system and reduce pollutant loads. • Tracking cleans can identify a pattern of underperforming systems.	• Develop a program to regularly clean storm basin • Track storm system maintenance in accordance with MS4 program requirements.					X	**S, H**	**MO-5***
	Stormwater Hotline Response	**Impacts:** • The ability to report spills and illicit discharges can reduce the amount of pollutants that enter surface waters. **Recommendations:** • As required by the NYSDEC SPDES Phase II Program Nassau County	• Provide education materials for spill and illicit discharge reporting.		X	X	X	X	**S, H, C, B**	**MO-6***

Table 3-3
Pollution Source Reduction Measures

Priority Measures	Pollutant Source Reduction Stewardship Practice	Impact Description and Reduction Recommendations	Outreach & Implementation Means	Land Use					Pollutant Reduced	CWP Source Control Profile Sheet See Appendix A
				Residential	Commercial	Industrial	Park/Golf Course	Municipal		
		maintains a telephone number to report suspected illicit discharges. • The NYSDEC spill hotline is 800-457-7362.								
	Stormwater Management Practice Maintenance	**Impacts:** • Improper maintenance of new alternative storm management practices such as water quality inlets, bioretention basin, will reduce the amount of pollutant load captured. **Recommendations:** • As new alternative storm management practices are installed, such as water quality inlets, bioretention basin, education on the additional and modified maintenance practices will be required.	• Provide employee training and seminars on maintenance operations as new stormwater practices are implemented.					X	**S, N, P, M**	**MO-9***
P	**Employee Training**	**Impacts:** • All components require proper operation and maintenance by staff to ensure proper operation and pollution reduction. **Recommendations:** • Providing employee with proper training that describes both the correct BMP procedures and the impacts of improper operations can reduce pollutant discharge to surface waters.	• Provide employee training programs and seminars.					X	**S, N, P, H, B, M, C**	**MO-10***

Source: Center for Watershed Protection. 2005. Urban Subwatershed Restoration Manual No. 8 Pollution Source Control Practices. February. (See Appendix A for Profile Sheets N or H).

Table 3-3
Pollution Source Reduction Measures

Center for Watershed Protection. 2008. Urban Subwatershed Restoration Manual No. 9 Municipal Pollution Prevention/ Good Housekeeping Practices. September. (* - for MO profiles see complete manual at www.cwp.com)

Pollutant Legend: S - sediments; H – hydrocarbons; N – nitrogen; P – phosphorus; B – Bacteria (fecal coliform), M – Metals, C – Chemicals/Pesticides/Toxin

Underlined Pollutant is a major contributor.

recommendations, means to implement the measure, the affected land use, the pollutants that will be reduced and the CWP Profile Sheet ID.

Table 3-3: Pollution Source Reduction Measures is divided into three categories. The first, Neighborhood Stewardship, presents strategies that municipal governments or agencies can implement or encourage to effect community-wide behavioral changes by property owners, residents and businesses that can reduce pollutant load generation and improve good housekeeping measures to remove pollutants prior to entering waterways such as fertilizer and pesticide reduction and septic system maintenance. Additional information on these management measures is provided on Appendix A Source Control Profile Sheets N-1, N-2, and N-9 along with other measures as appropriate for an individual site.

The second category on Table 3-3 is Hotspot Pollution Prevention that includes measures that hotspots locations can utilize to reduce the amount of pollutants that are deposited on the ground surfaces with the potential to be washed into surface water during storm events. Hotspots are locations where concentrated pollutant discharges are possible based on the known correlation between the land use and pollutant potential. Potential hotspots identified within the GR/PD subwatershed are:

- gas stations along Glen Cove Avenue (hydrocarbons)
- industrial and commercial yards along Shore Road such as the National Grid facilities (hydrocarbons and sediments)
- North Shore Country Club golf course (sediments, pesticides and nutrients)
- North Shore School District bus maintenance facility (hydrocarbons)
- commercial parking lots and dumpsters (sediments and hydrocarbons)
- swimming pools (chemicals)
- roadways (sediments and hydrocarbons)
- turf and landscape areas (sediments, pesticides and nutrients)
- construction sites (sediments)

.

Additional information on these management measures is provided on Appendix A Source Control Profile Sheets H-1, H-2, H-3, and H-4.

The third category on Table 3-3 is Municipal Pollution Prevention and Good Housekeeping, which includes measures that municipalities can implement to reduce the pollutant loads deposited on road surfaces and carried to surface waters through runoff and drainage systems. Municipalities are required to develop pollution source control and good housekeeping programs in accordance with the New York State SPDES MS4s Program. Detailed information on these management measures are referenced to the Center for Watershed Protection *Manual No. 9 Municipal Pollution Prevention/Good Housekeeping Practices* which contains detailed information for implementing these practices.

The HHPC and the CSHH have implemented numerous citizen and municipal efforts to reduce pollutant loads to Hempstead Harbor. The HHPC website (www.hempsteadharbor.org) document page includes an extensive listing of compiled data regarding the harbor and watershed. The compiled data includes harbor and watershed history, facts about the harbor, educational materials, technical reports and management plans, water quality monitoring data, phase II compliance efforts, published articles and editorials, ongoing and completed harbor improvement projects, meeting minutes, presentation records, press releases and information on development within the watershed. The Hempstead Harbor Water Quality Improvement Plan (WQIP) includes description of many harbor-wide source control strategies for reducing pollution sources that contribute pollutant loads to the harbor.

3.4 STRUCTURAL POLLUTANT ABATEMENT

The following paragraphs describe structural BMPs that can mitigate the pollutant load, potential structural pollutant abatement alternatives that are available to address the

issues identified in the GR/PD subwatershed and recommendations for locations of specific target projects.

3.4.1 STRUCTURAL BEST MANAGEMENT PRACTICES (BMPs) FOR POLLUTANT ABATEMENT

The potential for use of the structural BMPs described below have been assessed based on the site characteristics of the GR/PD subwatershed, a developed, suburban area with an extensive road system and landscaped properties, where retrofit and reconstruction actions will account for the majority of measures proposed. Section 3.4.2 and the associated Table 3.5 describes recommended structural BMP implementation actions and abatement projects for each drainage area. Cost estimate of constructing each of the BMPs are discussed in Section 3.4.3 with construction costs for each recommended actions included on Table 3.5.

BMPs selection is dependent upon the identified pollutants of concern. Road runoff with heavy sediment and hydrocarbon loads requires different mitigation measures than residential areas with fewer roadways but more landscaped areas and domestic pets that produce increased soluble pollutant loads of phosphorus, nitrogen and fecal bacteria. The identified recommended practices have been selected in accordance with the NYSSMDM and *NYS Verified Proprietary Stormwater Management Practices,* unless noted otherwise.

Stormwater Infiltration Practices

Infiltration practices are designed to capture, retain, filter and infiltrate runoff through the soil layer where pollutant removal processes occur. Infiltration practices have moderate to high removal capabilities for particulate and soluble urban pollutants. Design parameters can enhance the removal rates, but particles can rapidly clog some infiltration methods. A means to remove the accumulated sediments should be addressed prior to installation. Dry wells, infiltration trenches, and recharge basins can be utilized in urban

and developed areas to provide the capacity needed for treating the WQV. Porous pavements provide an alternative infiltration practice generally restricted to smaller low-volume parking areas, particularly where depth to groundwater precludes other infiltration practices. If the system is designed in accordance with NYSSMDM, captures and infiltrates the WQV to groundwater and does not allow collected pollutants to wash out, these systems can be considered to remove the pollutant loads in the treated volume from entering surface waters.

Traditional Stormwater Filtering Systems

These traditional filtering practices are designed to detain, filter and release stormwater through porous materials, such as sand, soil, or organic materials. These systems are called traditional filtering systems as opposed to the proprietary practices identified under Alternative Management Practices, which provide filtering of pollutants and are suitable for retrofit and redevelopment sites. During the filtering process, sediment particles and attached pollutants, such as hydrocarbons, are removed. Removal of soluble pollutants, such as nutrients and bacteria, is limited by the filtration period and filtering material. Traditional filtering systems include bioretention basins, sand or organic filters, dry swales and wet swales that can detain, filter and release the WQSE. Grass filter strips can be used to filter small areas. These devices are suitable for retrofit sites where high impervious cover exists such as many locations within the GR/PD subwatershed and have the potential to remove bacteria or nutrients from runoff, but their use may be precluded or limited because of lack of available space for adequately sized systems.

Constructed Ponds and Wetlands

Constructed stormwater ponds and wetlands provide moderate to high soluble and particulate pollutant removal capacity through both settling and biological uptake. Wetlands and ponds require significant dedication of land that may not be available in developed communities such as the GR/PD subwatershed unless appropriate lands can be identified and acquired.

Alternative Management Practices (Water Quality Inlets And Other Proprietary Practices)

With the increased awareness of the effect of storm runoff on the surrounding waterbodies, the development of numerous technologies to deal with pollutant removal has ensued. Many of the practices are designed for retrofit of existing stormwater structures and are best suited for urban areas and road ROWs where sediment and hydrocarbons are of greatest concern. These devices can be located beneath pavement reducing the need for land acquisition. New products are available that address bacteria removal. Currently, in locations where soluble pollutants, such as fertilizers pesticides, and bacteria are the concern, these devices may not provide pollutant removal although new products are continuing to enter the market and undergo verification. The NYSDEC verifies that proprietary practices, including hydrodynamic systems, wet vaults, media filters, catch basin inserts and underground infiltration systems, meet the performance criteria for redevelopment applications. NYSDEC requires that all proprietary practices proposed for use on a redevelopment project must be evaluated and accepted for removal efficiency using one of the following stormwater management practice evaluation systems: the U.S. Environmental Protection Agency (EPA) Environmental Technology Verification Program, the State of Washington Technology Assessment Protocol - Ecology (TAPE), the Technology Acceptance Reciprocity Partnership Protocol (TARP), New Jersey Corporation for Advance Technology (NJCAT) or the State of Maryland Proprietary Practice acceptance program.. The percentages of pollutant removal for these practices included in Section 3.4.3 are based on the median verified removal levels. It is important to note that many of the manufacturers of these practices claim removal of several pollutants including sediments, hydrocarbons/oil and grease, nutrients, bacteria and metals; however, most of the technologies have only been verified for sediment removal. Use of these technologies for removal other pollutants will require selection of a specific verified unit. Some of these emerging technologies, such as catch basin inserts, can also provide an interim measure to reduce pollutant levels in stormwater runoff until long-term solutions can be implemented. The general categories of new technology are:

- *Hydrodynamic Systems (HS).* These devices, a form of water quality inlet (WQI), remove sediments and attached hydrocarbons using gravity or vortex separators that move water in a circular, centrifugal manner to accelerate the separation and deposition of sediments from storm flow. These systems can be designed to function offline to allow high flow storm events to bypass the system. These devices are suitable for highly impervious retrofit sites such as can be found in the GR/PD subwatershed and have the longest history of use of the emerging technologies. These systems are not known to remove high levels of nutrients or pathogens. These types of devices have been installed in other locations in the Hempstead Harbor watershed by the VSC, NC and the NYSDOT.

- *Media Filters.* Media Filters (MF), a form of WQI, are flow through, surface or subsurface practices that contain filter beds of adsorptive media that promote settling of sediments as well as adsorption and absorption of other pollutants that are attracted to the characteristics of the specific filter media. The proprietary filter media can be a combination of materials, including fabrics, organic medium, sand, or charcoal, that can trap particulates and soluble pollutants dependent on the filtration period. These systems can be designed to function offline to allow high flow storm events to bypass the system. These devices are suitable for highly impervious retrofit sites such as can be found in the GR/PD subwatershed and they have the potential to remove bacteria or nutrients from runoff, but lack of available space for an adequately sized system may preclude or limit their use in the subwatershed.

- *Wet Vaults.* Wet vaults (WV), a form of WQI, are watertight structures that include a permanent water pool and promote settlement sediments and separation of oils through detention and the use of internal baffles, screens or chambers. These systems can be designed to function offline to allow high flow storm events to bypass the system. These devices are suitable for highly impervious retrofit sites such as can be found in the GR/PD subwatershed. These systems are not known to remove high levels of nutrients or pathogens. WVs are similar to HSs and can be used in their

place if the size and configuration of the unit required is better suited to WV manufacturer design.

- *Underground Infiltration Structures/System (UIS).* These systems can be standard leaching basin structures or newer prefabricated pipe and vault systems to capture and infiltrate runoff. When designed as offline systems, these devices have the potential to perform at an acceptable treatment level when they are designed to the technical specifications of standard infiltration systems and can be considered a standard infiltration practice when they incorporate all required design guidance and requirements as defined in the NYSSMDM. These devices are suitable for highly impervious retrofit sites such as can be found in the GR/PD subwatershed. If the system is designed in accordance with NYSSMDM, captures and infiltrates the WQV to groundwater and does not allow collected pollutants to wash out, these systems can be considered to remove all pollutant loads in the treated volume from entering surface waters.

- *Catch Basin Insert.* Catch Basin Inserts (CBI) contain a pollutant removal medium that is suspended in existing basins. Stormwater is treated as it passes through the insert. CBIs are suitable for small drainage areas and ultra-urban retrofit sites. Most of these units have only received third party evaluation for sediment removal, although manufacturers may identify specific units or components that provide additional pollutants removal. The Abtech Ultra-Urban Filter with Smart Sponge Plus 4 Antimicrobial (Abtech UUFSS) was the only catch basin insert identified as receiving third party evaluation for E. coli and enterococcus removal with tested efficiencies of 51% and 43% respectively. These devices have not been included as an alternative practice in the NYSSMDM but are used in many locations to provide interim pollutant removal capacity until long-term solutions can be implemented. Maintenance of CBIs is a concern because the small holding capacity makes frequent inspection and pollutant removal necessary to ensure the operation of the unit. These devices require monitoring to determine the actual pollutant removal capabilities.

Proper disposal of contaminated materials captured by the CBI must also be performed. CBIs are included only as alternative/additional abatement actions for many of the drainage areas as shown on Table 3.5.

Alternative Disinfectants and Oxidants Systems

A last category of practices is disinfectant methods using ultraviolet or ozone treatment for the removal of bacteria from stormwater. These practices have rarely been used in stormwater applications and are not included in the NYSSMDM. These practices require that additional pollutant removal practices as discussed above be implemented to remove sediments, hydrocarbons and nutrients from the runoff. If bacteria are identified at levels where installation of other practices will be ineffective in lowering bacteria levels, then these practices could be considered, however, these systems are expensive to install and operate. In addition, in locations where algae have been identified as an additional water quality issue, the disinfectant systems can provide control of single cell algae growth.

3.4.2 TARGET POLLUTION ABATEMENT ACTIONS

The following includes a brief description of the potential and issues of each drainage area with regard to the identification of mitigation measures to reduce pollutant loads. *Table 3-4 - Drainage Area Stormwater Assessment* includes detailed data regarding each drainage area. Table 3-4 identifies each drainage area by the identification number used on Maps 6A and 6B. The table includes the drainage area identification, drainage system, discharge condition, outfalls, drainage structures, acreage, land use, drainage area WQV, road data, road area WQV, municipal jurisdiction and structures needing cleaning, repair or illicit discharge investigation. *Table 3-5 Target Structural Pollution Abatement Actions* contains an assessment of potential mitigation measures based on review of field conditions and the Table 3-4 data. Section 3.4.1 provided an assessment of source control strategies that can reduce the pollutants generated in the GR/PD subwatershed based on the conditions found in this subwatershed. Section 3.4.2 of this Plan offers a

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Table 3-4
Drainage Area Stormwater Assessment

Drainage Area	System	Discharge Condition	Outfalls	Drainage Structures (CA ID number; add't. NC ID)	Acreage	Land Use	Total Drainage Area WQV - CF	Road Length - LF	ROW/ Pav't Width±	Road Row WQV - CF	Municipal Jurisdiction	Structure Cleaning (C)/Repair (R), Illicit Discharge (ID) Detection Required
Area 1 - Glenwood Road	Piped	Direct discharge to outfall, natural seeps and creek drainage into system	OT1, OT2	6-19,21-45; NC-32005, -32062, -35577, -35578, -35579, -37903	**26.0**	Residential, Commercial	55,677	6,050	50/32	23,607	County, TOBAY	R-8-9,14,16,18-19, 25-28,32,41 IDD-29, 31-33 (sewage odor)
Area 2 - Shore Road North	Piped	Surface drain to Area 1		0	**46.9**	Industrial	85,161	1,200	100/60	7,185	County, TOBAY	0
Area 3 - Shore Road South	Piped	Surface drain to Area 1		1-5	**7.2**	Industrial	23,444	700	100/60	5,474	County, TNH, TOBAY	R-4
Area 4 - Schoolhouse Hill	Piped	System connects to Area 1 pipe		117-124	**5.6**	Residential, Commercial	13,544	900	50/32	3,421	County, TOBAY	R-117-119,121
Area 5 - Glen Lane	Piped	System connects to Area 1 pipe		20,125-128,129-135	**8.1**	Residential	14,737	1,400	50/32	5,474	TOBAY	0
Area 6 - Larsen Avenue	Piped	System connects to Area 1 pipe		136-151; NC-32067, -33294	**21.7**	Residential	36,914	2,600	50/32	10,264	TOBAY, VRH	0
Area 7 - Cody Lane South	Piped	System connects to Area 1 pipe		152-155	**20.1**	Residential	39,225	4,600	50/32	18,133	TOBAY	0
Area 8 - Creek Segment	Channel	System connects to Area 1 pipe	OT4 -OT9	115-116	**8.9**	Residential	12,684	0	NA	0	TOBAY	C-115
Area 9 - Kissam Lane	Piped, Swale	System connects to Area 1 pipe	OT3	57-88; NC-32007, -32015, -32016, -32322, -32323, -32961, -32962, -32964, -32965, -32966, -32967, -32968, -32970	**127.2**	Residential, Recreational	109,164	6,300	50/32	21,212	County, TOBAY, VSC	R-58,71,74-75,78-81,85-87
Area 10 - Waverly Street	Piped	System connects to Area 9 pipe		89-97,99-101	**24.0**	Residential	41,789	3,350	50/32	13,001	TOBAY	C- 89-91,93-94,96-97,101 , R-89,91-92,95,99-100
Area 11 - Elin, Mill, Ruth, Huron	Piped	System connects to Area 9 pipe		98,102-114; NC-32976, -33281, -33282, -33283	**25.1**	Residential	48,347	5,500	50/32	21,554	TOBAY	C-114

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Table 3-4
Drainage Area Stormwater Assessment

Drainage Area	System	Discharge Condition	Outfalls	Drainage Structures (CA ID number; add't. NC ID)	Acreage	Land Use	Total Drainage Area WQV - CF	Road Length - LF	ROW/ Pav't Width±	Road Row WQV - CF	Municipal Jurisdiction	Structure Cleaning (C)/Repair (R), Illicit Discharge (ID) Detection Required
Area 12 - Roosevelt Street	Piped	System connects to recharge basin outside watershed w/ possible overflow to Area 9		156-171	**15.7**	Residential, Commercial	28,350	1,800	50/32	7,185	TOBAY	0
Area 13 - Glen Cove Avenue	Piped	System connects to Area 9 pipe		46-56; NC-32975	**37.4**	Residential, Commercial	80,390	5,300	50/32	26,686	County, TOBAY	R-49,56
Area 14 - Club Road	Piped	Self-contained		172-179	**12.4**	Residential	23,461	2,500	50/32	9,922	VSC	0
Area 15 - Carpenter Avenue	Piped	System outfall to golf course swale and to Area 9 pipe		180-201	**29.5**	Residential	52,209	4,950	50/32	19,501	VSC	0
Area 16 - Sea Cliff Streets	Leaching Pools	5 small self-contained areas/Unconnected to GR/PD outfall		202-218	**51.9**	Residential	95,124	9,250	50/32	36,266	VSC	0

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Table 3-5
Structural Pollution Abatement Actions

DRAINAGE AREA	TARGET POLLUTION ABATEMENT ACTIONS AND PRIORITY RANK	CONST. COST	Implementation Considerations	ALTERNATIVE/ADDITIONAL POLLUTION ABATEMENT ACTIONS	CONST. COST	Implementation Considerations
Area 1 - Glenwood Road	Reconstruct Glenwood Road storm drain pipe system to separate Area 1 flow to outfall separately from drainage areas for side streets. **PRIORITY 3**	$1,500,000	Construction will require significant road reconstruction and tied to reconstruction need, Nassau County Jurisdiction, Utility coordination	Install UIS for DA WQV	$500,000	Depth to groundwater, Nassau County Jurisdiction, Units can be located in street. Treat DA WQV due to small lot size and high impervious
				Install CBI filters	$46,800	Limited capacity, Requires frequent inspection and maintenance. Best as temporary E&SC measure.
	HS at outfall for DA WQV. **PRIORITY 3**	$325,000	Space available for units required, Unit can be located in street, Flow will require splitting to several units, Nassau County Jurisdiction.	UV Treatment for pathogens	$5,500,000	Installation cost, Operation and maintenance costs, Site availability for system, Additional pre-treatments needed, Nassau County Jurisdiction, Assume treat entire subwatershed WQV.
Area 2 - Shore Road North	HS at outfall for road WQV. **PRIORITY 2**	$43,000	Space available for units required, Unit can be located in street, Nassau County jurisdiction, Can locate in street, Treat road runoff only as private properties should be contained on site.	Install UIS for road WQV	$65,000	Depth to Groundwater, Nassau County Jurisdiction, Units can be located in street.
	Bioretention swales along road for part of road WQV. **PRIORITY 4**	$72,000	Tie to streetscape improvements, provide sediment trap at entrance, requires adequate space. Size for 1/3 of WQV.	Require private properties to provide on-site containment of WQV	$240,000	May need to be tied to site redevelopment, Depth to groundwater.
				Infiltration/Detention Basin for road WQV	$65,000	Property acquisition required. Can reduce large storm flows. Treat road as larger sites should contain on site.
				Install larger HS to treat DA WQV	$457,000	Additional measure if source control is not effective.
				Install additional infiltration/detention to treat DA WQV	$680,000	Additional measure if source control is not effective.
Area 3 - Shore Road South	HS at outfall for DA WQV. **PRIORITY 2**	$140,000	Space available for units required, Nassau County jurisdiction, Private property piped to road system.	Install UIS for road WQV	$48,000	Depth to Groundwater , Nassau County Jurisdiction, Units can be located in street.
				Install CBI filters	$5,400	Limited capacity, Requires frequent inspection and maintenance. Best as temporary E&SC measure.
				Require private properties to provide on-site containment or install WQIs	$0	May need to be tied to site redevelopment, Depth to groundwater.
Area 4 - Schoolhouse Hill	HS at outfall for DA WQV. **PRIORITY 2**	$78,000	Space available for units required, Nassau County jurisdiction, can locate in street. Treat DA due to small lot sizes, site slope and high impervious.	Install UIS for DA WQV	$120,000	Depth to groundwater, Nassau County Jurisdiction, Units can be located in street. Treat DA WQV due to small lot size and high impervious
				Install CBI filters	$10,800	Limited capacity, Requires frequent inspection and maintenance. Best as temporary E&SC measure.

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
Stormwater Abatement Plan

Table 3-5
Structural Pollution Abatement Actions

DRAINAGE AREA	TARGET POLLUTION ABATEMENT ACTIONS AND PRIORITY RANK	CONST. COST	Implementation Considerations	ALTERNATIVE/ADDITIONAL POLLUTION ABATEMENT ACTIONS	CONST. COST	Implementation Considerations
Area 5 - Glen Lane	HS at outfall for DA WQV. **PRIORITY 2**	$82,000	Install prior to outflow into Area 1. Determine if adequate space available for installation, can locate in street. Treat DA WQV due to small lot sizes, site slope and high impervious.	Install UIS for DA WQV	$130,000	Depth to Groundwater , Nassau County Jurisdiction. Treat DA WQV due to small lot size and high impervious.
				Install CBI filters	$7,200	Limited capacity, Requires frequent inspection and maintenance
Area 6 - Larsen Avenue	HS at outfall for DA WQV. **PRIORITY 2**	$202,000	Install prior to outflow into Area 1. Determine if adequate space available for installation, can locate in street. Treat DA due to small lot sizes, site slope and high impervious.	Install UIS for DA WQV.	$325,000	Depth to Groundwater , Nassau County Jurisdiction. Treat DA WQV due to small lot size and high impervious.
				Install CBI filters.	$19,800	Limited capacity, Requires frequent inspection and maintenance.
Area 7 - Cody Lane South	Install UIS for road WQV. **PRIORITY 1**	$168,000	Infiltration will remove sediments, nutrients and pathogens. Treat road as larger sites should contain on site. Site on residential streets.	Install HS for road WQV.	$108,000	Install prior to outflow into Area 1. Determine if adequate space available for installation, can locate in street. Treat road as larger sites should contain on site.
				Install larger HS to treat DA WQV.	$112,000	Additional measure if source control is not effective.
				Install additional UIS to treat DA WQV.	$176,000	Additional measure if source control is not effective.
				Install CBI filters.	$10,800	Limited capacity, Requires frequent inspection and maintenance.
Area 8 - Creek Segment	Repipe CA115 and 116 to Area 1 and remove OT 4 and OT5. **PRIORITY 4**	$25,000		Install CBIs on inlet CA115 & CA116.	$3,600	Alternative if can not re-pipe.
	Encourage planting of filtering buffer along creek and wetland shoreline. **PRIORITY 1**	$105,000	Lawns extend up to creek and wetland edge likely contributing large nutrient loads to creek. Approximately $3000 per shoreline residence.			
	Investigate source for OT6-OT9 for potential ID. **PRIORITY 4**	$0	Outfall from home could potentially be illicit discharges because of improperly connected sanitary flow (i.e., washing machine discharge) or could be roof runoff.			

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
Stormwater Abatement Plan

Table 3-5
Structural Pollution Abatement Actions

DRAINAGE AREA	TARGET POLLUTION ABATEMENT ACTIONS AND PRIORITY RANK	CONST. COST	Implementation Considerations	ALTERNATIVE/ADDITIONAL POLLUTION ABATEMENT ACTIONS	CONST. COST	Implementation Considerations
Area 9 - Kissam Lane	Install HS for road WQV. **PRIORITY 3**	$126,000	Install prior to outflow into Area 1. Determine if adequate space available for installation. Majority of drainage area is golf course treated separately. This WQI may need to be sized for area that drain to Area 9 including 10-13, 15.	Install UIS for road WQV.	$186,000	Depth to Groundwater, Nassau County Jurisdiction. Majority of drainage area is golf course treated separately. Possible infiltration basin if property acquisition possible.
				Install larger HS to treat DA WQV.	$399,000	Additional measure if source control is not effective. This HS may need to be sized for area that drain to Area 9 including 10-13, 15.
	Install MF at OT3 for GC/swale. **PRIORITY 3**	$165,000	Golf Course/swale runoff may contain high levels of pathogens and nutrients. Requires coordination with NSCC.	Install additional UIS to treat DA WQV.	$812,000	Additional measure if source control is not effective. This WQI may need to be sized for area that drain to Area 9 including 10-13, 15.
				Install CBI filters.	$41,400	Limited capacity, Requires frequent inspection and maintenance.
Area 10 - Waverly Street	Install UIS for road WQV. **PRIORITY 1**	$100,000	Infiltration will remove sediments, nutrients and pathogens. Treat road as larger sites should contain on site	Install CBI filters.	$28,800	Maintenance schedule for CBI's needs to be addressed prior to installation.
				Install additional UIS to treat DA WQV.	$266,000	Additional measure if source control is not effective.
Area 11 - Elin, Mill, Ruth, Huron	Install UIS for road WQV. **PRIORITY 1**	$166,000	Infiltration will remove sediments, nutrients and pathogens. Treat road as larger sites should contain on site	Install CBI filters.	$19,800	Maintenance schedule for CBI's needs to be addressed prior to installation.
				Install additional UIS to treat DA WQV.	$259,000	Additional measure if source control is not effective.
Area 12 - Roosevelt Street	Conduct dye testing and potential overflow mechanism improvements. **PRIORITY 4**	$0	Confirm that overflow is only after recharge basin reaches capacity. Reconstruct overflow to reduce discharges. Examine potential to expand recharge basin capacity to reduce overflows.			
Area 13 - Glen Cove Avenue	Install upgradient infiltration structures for road WQV. **PRIORITY 1**	$235,000	Infiltration will remove sediments, nutrients and pathogens. Treat road as larger sites should contain on site. Site on residential streets.	Install additional UIS to treat DA WQV.	$448,000	Additional measure if source control is not effective.
				Install CBI filters.	$27,000	Maintenance schedule for CBI's needs to be addressed prior to installation.

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Road / Powerhouse Drain
Stormwater Abatement Plan

Table 3-5
Structural Pollution Abatement Actions

DRAINAGE AREA	TARGET POLLUTION ABATEMENT ACTIONS AND PRIORITY RANK	CONST. COST	Implementation Considerations	ALTERNATIVE/ADDITIONAL POLLUTION ABATEMENT ACTIONS	CONST. COST	Implementation Considerations
Area 14 - Club Road	None Identified.			Install UIS structures to treat for road WQV.	$90,000	Connection to drainage to surface waters not determined. Improvements suggested if flooding is an issue. Treat road as larger sites should contain on site.
				Install additional infiltration to treat DA WQV.	$116,000	Additional measure if source control is not effective.
Area 15 - Carpenter Avenue	Reconstruct swale to improve infiltration capability and reduce flow velocity. **PRIORITY 1**	$300,000	Improvements include underdrain system, improved swale surface and stepped elevations with infiltration ponding area. Improvements must be coordinated with NSCC and any improvements they propose.	Install CBI filters.	$25,200	Maintenance schedule for CBI's needs to be addressed prior to installation.
				Install additional UIS to infiltrate part of DA WQV.	$172,000	Additional measure if source control is not effective.
	Install HS for road WQV. **PRIORITY 1**	$116,000	Install sediment and trash HS in road structure prior to outfall to swale to reduce trash on NSCC. Treat road as larger sites should contain on site.	Construct Infiltration/Detention Basin.	$175,000	Property acquisition required. Can reduce large storm flows. Treat road as larger sites should contain on site.
Area 16 - Sea Cliff Streets	None Identified.			Install additional UIS for road WQV.	$21,000	WQV from area does not drain to surface waters. Improvements suggested if flooding is an issue. Estimate for 2/3 WQV.
				Construct biofiltration on island at Marden and Hansen intersection.	$37,000	WQV from area does not drain to surface waters. Improvements suggested if flooding is an issue. Sizes for 1/3 of WQV.
				Install additional UIS to treat DA WQV.	$775,000	Additional measure if source control is not effective.

Table Legend: HS- Hydrodynamic Separator, MF - Media Filter, CBI - Catch Basin Insert, UIS - Underground Infiltration System/Structure, DA WQV - Drainage Area Water Quality Volume (see table 3.4 for volume), Road WQV - Road Right-of-Way Water Quality Volume (see Table 3.4 for volume)

detailed discussion of recommended target structural abatement measures and alternatives or additional measures for each drainage areas.

The target structural abatement projects have been identified based on review of the existing conditions within the GR/PD subwatershed and the specific drainage areas. The subwatershed is a densely developed area with little available land for location of mitigation actions such as wetlands and bioretention basins. The subwatershed consists of densely developed residential areas with limited commercial and industrial use on Glenwood Road and Shore Road close to the outfall. The mitigation measures are presented on Table 3-5, which includes the recommended target alternative, based on an assessment of the drainage area, site conditions and pollutants of concern, and alternative actions that were considered. Table 3-5 also ranks the priority of the Target Abatement Action. The priority rankings are from 1 thru 4, with 1 having the highest priority. The considerations for the priority ranking are discussed in Section 3.5.

The target pollutant abatement projects and mitigation strategies locations are shown on Maps 7A and 7B. The abatement project recommendations are conceptual and the mitigation measures may be modified based on additional site conditions identified during further site analysis that is beyond the scope of this Plan. The use of CBI inserts is included as an alternative in all appropriate drainage areas but is not recommended as a long-term solution to water quality improvement due to maintenance effort required and relative short life span of a CBI unit. Table 3.5 also contains conceptual construction costs for each recommendation.

Drainage Area 1 - Glenwood Road – The main drainage pipe extends from the powerhouse drain outfalls (OT1/NC-4854 and OT2/ NC-4852) east along Glenwood Road and collects runoff from the other drainage areas in the subwatershed. These outfalls are under Nassau County jurisdiction. The drainage system is in poor condition with twelve structures (CA-4/NC-46452, CA-8/NC-34396, CA-9/NC-30842, CA-14/NC-33251, CA-16/NC-32063, CA-18/NC-33286, CA-19/NC-30843, CA-26/NC-39099, CA-

27/NC-none, CA-28/NC-33603, CA-32/NC-39101, and CA-41/NC-32070) identified as needing repairs and four structures (CA-29/NC-none, CA-31/NC-33289, CA-32/NC-39101, and CA-33/NC-none) identified as having sewage odors. The land uses in this drainage area are commercial and industrial at the western end close to the outfalls and residential further east. Glenwood Road, Glen Cove Avenue, Kissam Lane, Schoolhouse Hill Road and Shore Road are under the jurisdiction of Nassau County. The remainder of the area roads are under TOBAY jurisdiction. There is little vacant land available to site pollution mitigation measures. Several parcels located along the west side of Shore Road adjacent to Area 2 and identified below may potentially be used to provide treatment of a percentage of this drainage area if they are acquired.

The following abatement action is included on Table 3-5 and has been assigned a priority level of 3 due to the complexity of project and the inter-jurisdictional agreements necessary.

- When the drainage system is reconstructed, it is recommended that the Area 1 system be piped separately from the drainage systems that carry flow from the other drainage areas into Area 1. Drainage Areas 1-9 discharge into the Glenwood Road system. This will allow each smaller drainage area to be treated individually, reducing the flow and footprint for each area where a WQI is recommended.
- Install a HS on the Area 1 outfall pipe prior to discharge to Hempstead Harbor.

Alternative or additional drainage area abatement action recommendations include the following projects, which are also included on Table 3-5.

- No structures are located on Glenwood Road east of Sycamore Avenue, installation of infiltration structures to collect the drainage area runoff would reduce the amount of pollutant load to the harbor.
- If other pathogen removal efforts are unsuccessful and an UV treatment system is required for pathogen removal, the system would need to be located near the western end of this Area near OT1. Property to site the facility will need to be acquired.

Match to Map 7B

Drainage Area 9
Future Property Acquisition to
Install Stormwater Infiltration Basin
(Part of Parcel Section 21, Block M, Lot 28E)
(Alternative Action)

Drainage Area 8
Illicit Discharge Investigation
for Outfalls CA-OT6 - CA-OT9
Priority 4

Drainage Area 9
Install MF Prior to
Outfall CA-OT3
Priority 3

Drainage Area 12
Investigate Connection.
Confirm Overflow or
Redesign Connection for
Large Storm Events Only.
Priority 4

Drainage Area 13
Install UIS
Priority 1

Drainage Area 2
Property Acquisition for
Site Stormwater Infiltration or
Filter Measures for Shore Road
(Parcels Section 21,
Block F, Lots 1,3,1977,4)

Drainage Area 8
Install Pipe to Connect Stuctures
CA-115 and CA-116 to Area 1.
Remove Outfalls CA-OT4 and CA-OT5
Priority 4

Drainage Area 8
Encourage Buffer Planting of
Filtering Vegetation Along Stream
Shoreline and Wetland Edge
Priority 1

Drainage Area 11
Install UIS
Priority 1

Drainage Area 2
Install HS at
Discharge to Area 1.
Priority 2
Bioretention Swale
Incorporated with
Street Improvements.
Priority 4

Drainage Area 9
Install HS at
Discharge to Area 1
Priority 3

Drainage Area 10
Install UIS
Priority 1

Drainage Area7
Install UIS
Priority 1

Drainage Area 3
Install HS at
Discharge to Area 1
Priority 2

Drainage Area 5 &
Drainage Area 6
Install HS at
Discharge to Area 1
Priority 2

Drainage Area 1
Reconstruct Pipe System to
Separate Area 1 Flow from
Other Drainage Areas.
Install HS for Area 1 Flow
Priority 3

Drainage Area 4
Install HS at
Discharge to Area 1
Priority 2

Develop Unified Jurisditional
Controls for Hempstead
Harbor-Wide Watershed

Continue Education Programs
and Efforts for Watershed
Pollution Source Reductions

Assess Potential Hotspots
for Pollutant Discharges

Conduct Sampling and Analysis
Program for Pollutant Load
Improvement Assessment

Encourage and/or Require
Pollution Source Control
Best Management Practices

Legend

- Catch Basin
- Manhole
- Outfall
- Drywell
- Drain Pipe, CA Field Confirmed
- Drain Pipe, NC Data/CA Not Field Confirmed
- Watershed Boundary
- Property Aquisition
- Map Limits
- Structural Target Project
- Mitigation Strategy
- Proposed Sampling Location
- Limits of Drainage Area 1
- Limits of Drainage Area 2
- Limits of Drainage Area 3
- Limits of Drainage Area 4
- Limits of Drainage Area 5
- Limits of Drainage Area 6
- Limits of Drainage Area 7
- Limits of Drainage Area 8
- Limits of Drainage Area 9
- Limits of Drainage Area 10
- Limits of Drainage Area 11
- Limits of Drainage Area 12
- Limits of Drainage Area 13
- Limits of Drainage Area 14

UIS Underground Infiltration Structure
HS Hydrodynamic System
MF Media Filter

VILLAGE OF SEA CLIFF /HEMPSTEAD HARBOR PROTECTION COMMITTEE
GLENWOOD ROAD / POWERHOUSE DRAIN
STORMWATER POLLUTION ABATEMENT PLAN

Cashin Associates, P.C.
ENGINEERING • PLANNING • CONSTRUCTION MANAGEMENT

0 250 500 Feet

MAP 7A
MITIGATION STRATEGIES AND TARGET POLLUTION ABATEMENT ACTIONS

Drainage Area 16
No Target Actions Identified

Drainage Area 15
Future Property Acquisition to
Install Stormwater Infiltration Basin
(Part of Section 21, Block M, Lot 28E)
(Alternative Action)
Alternate Location
(Part of Section 21, Block M, Lot 592)
(Alternative Action)

Drainage Area 15
Install HS to Remove
Trash and Sediment
from Swale Flow
Priority 1

Drainage Area 15
Reconstruct Swale in
Village of Sea Cliff Easement
to Increase Infiltration Capacity
Priority 1

Drainage Area 13
Install UIS
Priority 1

Drainage Area 14
No Target Actions Identified

Pipe
24"d Headwall
Stone Lined Swale
Gabion
Drainage Pond
Gabion

Match to Map 7A

Legend

- Catch Basin
- Manhole
- Outfall
- Drywell
- Drain Pipe, CA Field Confirmed
- Drain Pipe, NC Data/CA Not Field Confirmed
- Watershed Boundary

UIS Underground Infiltration Structure
HS Hydrodynamic System
NF Not Found
NI Not Indentified

- Property Aquisition
- Map Limits
- Limits of Drainage Area 9
- Limits of Drainage Area 12
- Limits of Drainage Area 13
- Limits of Drainage Area 14
- Limits of Drainage Area 15
- Limits of Drainage Area 16
- Structural Target Project

VILLAGE OF SEA CLIFF /HEMPSTEAD HARBOR PROTECTION COMMITTEE
GLENWOOD ROAD / POWERHOUSE DRAIN
STORMWATER POLLUTION ABATEMENT PLAN

Cashin Associates, P.C.
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0 250 500 Feet

MAP 7B
MITIGATION STRATEGIES AND TARGET POLLUTION ABATEMENT ACTIONS

Drainage Area 2 - Shore Road, north of Glenwood Road Intersection – Runoff along Shore Road north of the Glenwood Road intersection surface drains south to the drainage inlets at the intersection with Glenwood Road. There are no drainage structures within the public right-of-way in Area 2. The land use in this drainage area is industrial along Shore Road and recreation as the area extends into the NSCC golf course. Shore Road in under the jurisdiction of Nassau County.

The following abatement action recommendations are included on Table 3-5 and have been assigned priority levels of 4 and 2 respectively. The recommended abatement actions are:

- the installation of bioretention swales along Shore Road north of the Glenwood Road intersection in conjunction with a streetscape improvement project for this segment of road
- the installation of a HS north of the inlets at the intersection with Glenwood Road to collect and treat the road runoff WQV and pipe the flow into the existing structures in Drainage Area 1.

The alternative or additional drainage area abatement action recommendations are:

- the installation of upgradient UISs along the northern section of Shore Road,
- Site improvement should be required to provide on-site stormwater containment and stabilized driveways where several private properties located along Shore Road that either are pitched to allow stormwater runoff onto the Shore Road or are unpaved and track soil and sediment onto the road on-site containment.
- Acquire parcels located along the west side of Shore Road (Sect 21 - Blk F - Lot 4, Lot 3&1977, and Lot 1) and use to provide stormwater runoff treatment, through measure such as a bioretention basin, constructed wetland or detention basin.
- Install additional or larger HSs if source control and target projects are not effective as described on Table 3-5.

Drainage Area 3 - Shore Road, south of the Glenwood Road Intersection - Drainage along Shore Road South drains north to the drainage inlets at the corner of Glenwood Road. There are no drainage structures within the public right-of-way in this drainage area. The land uses in this drainage area are industrial and commercial. Shore Road in under the jurisdiction of Nassau County.

The following target abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 2 due to the relative ease of implementation and pollutant removal potential.

- The property at the southeast corner of the Glenwood Road and Shore Road intersection has a series of leaching pools that appear to be piped into a NC drainage structure at that intersection which is within Drainage Area 1. According to the current Nassau County Drainage Requirements, private property owners are required to obtain a County Drainage Connection Permit and a waiver from site storage requirements. Recommended improvements include requesting that the private property owner install a HS to collect and treat the drainage area runoff and piped flow from the private property prior to discharge to the existing NC drainage structure in Area 1.

The alternative or additional drainage area abatement action recommendations included on Table 3.5 are:

- Installation of upgradient infiltration structures on Shore Road south of the Glenwood Road intersection to allow a portion of the runoff to be infiltrated to groundwater.
- If the private property at the southeast corner should undergo redevelopment or improvement approvals should include requiring the property owners to provide on-site infiltration of stormwater runoff to the maximum extent practicable prior to connection to the municipal system.

Drainage Area 4 - Schoolhouse Hill *Road*– Drainage along Schoolhouse Hill Road flows north to Glenwood Road in a piped drainage system. Schoolhouse Hill and Grove

Street are under the jurisdiction of Nassau County and Ruth Lane is under TOBAY jurisdiction. The drainage system is in poor condition with four structures (CA-117/NC-36769, CA-118/NC-36768, CA-119/NC-32004, and CA-121/NC-none) identified as needing repairs. The structures generally convey runoff and do not provide infiltration. The land uses in this drainage area are commercial and small lot residential.

The following target abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 2 due to the relative ease of implementation and pollutant removal potential.

- Install a HS on Schoolhouse Hill Road prior to connection to Area 1 to treat the drainage area runoff.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install upgradient infiltration structures on Ruth Lane and Schoolhouse Hill Road
- Install CBIs in the existing inlet structures on Schoolhouse Hill Road.

Drainage Area 5 - Glen Lane - Drainage along Glen Lane flows north to Glenwood Road in a piped drainage system. Glen Lane and Hillside Avenue are under the jurisdiction of TOBAY. The structures generally convey runoff and do not provide infiltration. The land use in this drainage area is small lot residential.

The following target abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 2 due to the relative ease of implementation and pollutant removal potential.

- Install a HS in Glen Lane prior to connection to Area 1 to treat the drainage area runoff.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install upgradient infiltration structures along the roadway on Glen Lane south of the piped system and on Hillside Avenue east of the piped system
- Install CBIs in the existing inlet structures on Glen Lane and Hillside Avenue.

Drainage Area 6 - Larsen Avenue - Drainage along Larsen Avenue flows north to Glenwood Road in a piped drainage system. The land use in this drainage area is residential. Larsen Avenue and all other roads in this area are under the jurisdiction of TOBAY. The structures convey runoff from several adjoining streets and do not provide infiltration. The connection to the Glenwood Road drainage system appears to be via a pipe run between residential properties (Lots 20-027-340 - 107 Glenwood Road, 20-027-341- 107 Glenwood Road, 20-027-321 - 4 Glenmore Avenue and 20-027-348 - Glenmore Avenue).

The following abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 2 due to the relative ease of implementation and pollutant removal potential.

- Install a HS at the western end of Glenmore Avenue prior to the piping between the residential properties discuss above.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Installation of infiltration structures along the roadway segments on Larsen Avenue and Johnson Street south of the piped system and on King Street and Woodland Avenue east of the piped system
- Install CBIs in the existing inlet structures of the piped drainage system.

Drainage Area 7 - Cody Lane, south of Glenwood Road – Drainage along this section of Cody Lane flows north to Glenwood Road in a piped drainage system. The piped system

also conveys drainage from Sylvia Street, Smith Street, Viola Street, and Virginia Street, which surface drain west to this system. The land use in this drainage area is residential. Cody Lane south of Glenwood Road is under the jurisdiction of Nassau County; all other roads in this area are under the jurisdiction of TOBAY.

The following abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 1 due to the ease of implementation and high pollutant removal potential.

- Install infiltration structures on Sylvia Street, Smith Street, Viola Street, and Virginia Street to treat the road runoff WQV.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install a HS in Cody Avenue prior to connection to the Area 1 drainage system to treat the road drainage area runoff,
- If runoff from adjacent properties is identified install additional infiltration structures to capture the larger drainage area WQV
- Install CBIs in the existing inlet structures of the piped drainage system.

Drainage Area 8 - Creek Segment –Drainage in this area is through a narrow creek segment that begins at a small wetland area and ends as the creek flows into the Glenwood Road piping system. The creek and wetland are located along the rear of residences on Glenwood Road and Kissam Lane. Several outfalls (OT4 – OT9) were identified along this creek segment. These outfalls were not previously identified nor included in Nassau County or TOBAY data. They appear to originate from the private residential properties where they are located. OT 4 and OT5 appear to connect to drainage structures in the driveways (CA-115/NC-none and CA-116/NC-none). The sources of OT6 thru OT9 could not be determined. These outfalls may carry roof runoff or connect to sump pumps to drain basements, however in some cases these types of outfalls have been found to allow wastewater discharge from washing machine. The

surrounding land use is residential and a majority of the lots have lawn extending to the edge of the creek.

The following abatement action recommendations are included on Table 3-5 and have been assigned priority levels of 1 for the buffer planting and 4 for the illicit discharge collection and structure repiping.

- Encourage residents to reduce fertilizer use on their lawns and to install a 10'-wide buffer planting of 6"-12" height grasses and herbaceous plants along the creek shoreline to filter runoff from lawn areas
- Illicit discharge detection investigations should be conducted on all of the outfalls (OT4-OT9) to the creek. OT6 through OT9 are private residential properties outfalls into the creek where the source could not be determined. If the sources are determined to be other that roof or sump pump runoff, mitigation actions should be developed to reduce the discharge or the pollutant levels.
- OT4 and OT5 are connected to road drainage inlets on Betty Court (CA-115/NC-none and CA-116/NC-none), which based on the property line data appears to be a private street. These structures should be re-piped to connect to the Glenwood Road system to prevent road runoff from being discharged to the creek.

The alternative or additional drainage area abatement action recommendation included on Table 3-5 is:

- Install CBIs in existing structures CA 115 and CA 116 as is described on Table 3-5

Drainage Area 9 - Kissam Lane –Area 9 includes the drainage infrastructure in Kissam Lane and runoff from the NSCC golf course. Land use in this area is residential and recreational. Kissam Lane in under the jurisdiction of Nassau County; Cody Avenue and Maplewood Street are under TOBAY jurisdiction. The Kissam Lane piping system extends from Glen Cove Avenue west to Glenwood Road where it discharges into Area 1. The drainage system is in poor condition with eleven structures (CA-87/NC-36771, CA-86/NC-34404, CA-85/NC-33253, CA-84/NC-34398, CA-80/NC-32321, CA-79/NC-

30845, CA-78/NC-33254, CA-75/NC-34402, CA-74/NC-none, CA-71/NC-34401, and CA-58/NC-32969) identified as needing repairs. Drainage areas 10, 11, 13 and 15 discharge into the Kissam Lane system.

The following abatement action recommendations are included on Table 3-5 and have been assigned a priority level of 3 due to the moderate complexity of project and the inter-jurisdictional agreements necessary.

- The recommended abatement action is to install a HS prior to the pipe connection to Area 1 to treat the road runoff. This HS may need to be designed to accommodate or allow bypass of the capacity from the areas that drain into the Kissam Lane system including Areas 10, 11, 12, 13 and 15.
- The second recommended abatement action is to install a media filter (MF) prior to the OT3 outfall to reduce the nutrients and pathogens in the runoff. This outfall was not previously identified and appears to belong to the private property owner (NSCC) but runoff from VSC (Drainage area 15) enters this drainage area and is carried in this system. The runoff flows directly from OT3 onto Kissam Lane near Waverly Street into a drainage inlet (CA 66) in the piped system that drains to the Hempstead Harbor outfalls. The drainage system through the NSCC golf course to OT 3 is shown on Maps 6A and 6B. Runoff from Drainage Area 15 is discharged into a swale system located in a VSC easement on the NSCC property. The runoff is piped from drainage structures in Area 15 through a 24" diameter headwall into a stone-lined swale system. A small infiltration pond and grassed swale are located at the southern end of the easement midway through the golf course. A large amount of trash and debris accumulates in the pond. Runoff continues to flow south over the golf course turf area, into several ponded areas and swales to a piped system. The piped system discharges runoff from the NSCC (OT 3). Golf course runoff can also be collected in this system. The VSC stated that this system does not overflow on a regular basis, only during extremely large storm events.

Additional measures to treat the Area 15 runoff that enters the NSCC property are included Area 15 discussion below.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install infiltration structures for road runoff Cody Avenue and Maplewood Street and as possible along Kissam Lane to provide infiltration of a portion of the drainage area WQV
- Install CBIs in the existing inlet structures of the piped drainage system.
- In the future, if NSCC golf course land becomes available or changes in use are proposed, the County should investigate acquisition of a portion of the property (Parcel 21-M-28E) for the installation of an bioretention or recharge basin on the north side of Kissam Lane across from William Street to infiltrate a portion of the storm flow from the eastern segment of Kissam Lane and part of Glen Cove Avenue.

Drainage Area 10 - Waverly Street - Runoff along Waverly Street flows northeast and is collected to a piped drainage system that connects to the system on Kissam Lane - Area 9. The land use in this are is residential. Waverly Street and all other roads within this area are under the jurisdiction of TOBAY. The drainage area also includes portions of Sycamore Avenue, North Place, Orion Place, Ashley Place, William Street and Edgewood Avenue, which are also under TOBAY jurisdiction. Eight structures in this area were observed to be sediment-filled and require cleaning (CA-89/NC-35583, CA-90/NC-34403, CA-93/NC-none, CA-94/NC-none, CA-96/NC-none, CA-97/NC-none, and CA-101/NC-none. Six structures require minor repairs (CA-89/NC-33583, CA-91/NC-32641, CA-92/NC-30849, CA-95/NC-none, CA-99/NC-none, and CA-100/NC-none).

The following abatement action recommendations are included on Table 3-5 and has been assigned a priority level of 1 due to the ease of implementation and high pollutant removal potential.

- Installation of UISs along Waverly Avenue upgradient of the piped system to collect and infiltrate stormwater runoff will reduce the amount of pollutant load into the piped system.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 is:

- Install additional UISs on the Sycamore Avenue, Edgewood Avenue, North Place, Orion Place, Ashley Place, William Street and Huron Street where no structures currently exist to infiltrate the larger drainage area WQV
- Install CBIs in the existing inlet structures of the piped drainage system.

Drainage Area 11 - Elin, Mill, Ruth, Dogwood, Polly and Huron - Runoff from the streets in this drainage area flows north and is conveyed to a piped drainage system that drains into Area 9. The piped system runs along the property lines between several properties. The land use in this area is residential. All roads in this area are under the jurisdiction of TOBAY. One inlet structure in this area was observed to be sediment-filled and in need of cleaning (CA-114/NC-35587). The drainage area includes portions of Mill Road, Ruth Place, Elin Place, Dogwood Lane, Polly Lane and the northern portion of Huron Street.

The following abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 1 due to the ease of implementation and high pollutant removal potential.

- Install UISs to infiltrate the road runoff WQV on Huron Street, Dogwood Lane, Ruth Place, Mill Road, Elin Place and Polly Lane .

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install additional UISs on the street identified above to infiltrate the larger drainage WQV

- Install CBIs in the existing inlet structures of the piped drainage system.

Drainage Area 12 - Roosevelt Street - Runoff along Roosevelt Street flows north and is collected to a piped drainage system that connects to the system on Ellen Court that flows to a recharge basin located outside of the subwatershed limits. Structure CA-49/NC-34405 on Glen Cove Avenue was observed to have a pipe extending toward a structure in Ellen Court (a connecting structure on Ellen Court was not observed) which could allow overflow from the piping system to flow into the drainage system along Kissam Lane. Roosevelt Street and all other roads within this area except for Glenwood Road and Glen Cove Avenue are under the jurisdiction of TOBAY. Glenwood Road and Glen Cove Avenue is under Nassau County jurisdiction. The land use in this area is residential.

The following abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 4 due to limited discharge and pollutant removal potential.

- This overflow should be confirmed. If the existing structure allows overflows before the recharge basin reaches capacity, the piping system should be reconstructed to minimize the overflows and increase the infiltration in the recharge basin.

There are no alternative or additional drainage area abatement action recommendations for Drainage Area 12.

Drainage Area 13 - Glen Cove Avenue - Runoff along Glen Cove Avenue is piped to the intersection with Kissam Lane where it enters the Drainage Area 9 system. The land use in this drainage area is commercial and residential. Glen Cove Avenue in under the jurisdiction of Nassau County; all other roads in this area are under the jurisdiction of TOBAY. Runoff from the neighborhood on the east side of Glen Cove Avenue, that includes portions of Plymouth Drive South, Salem Way, Falmouth Lane, Glen Lane and Plymouth Drive North, drains toward the Glen Cove Avenue piping system. These neighborhood roads are under the jurisdiction of TOBAY.

The following abatement action recommendation is included on Table 3-5 and has been assigned a priority level of 1 due to the ease of implementation and high pollutant removal potential.

- Install UISs to infiltrate the road runoff WQV on Plymouth Drive North, Plymouth Drive South, Salem Way and Falmouth Lane, all residential roads under TOBAY jurisdiction (74% of roads) and on Glen Cove Road, which is under NC jurisdiction (26% of roads).

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install additional UISs on the street identified above to infiltrate the larger drainage area WQV
- Install CBIs in the existing inlet structures of the piped drainage system.

Drainage Area 14 - Club Road - Runoff from Area 14 is collected into drainage structures at the intersection of Carpenter Place and Club Road and midway on West Avenue. The land use in this area is residential. Roads in this area are under the jurisdiction of VSC. This drainage area is self-contained as the drainage structures have no direct connection to surface waters and infiltrate to groundwater. If the systems overflow due to clogging or extreme storm events, there is the potential that runoff from major storms could surface flow to the drainage swale on NSCC property in Drainage Area 9. Drainage Area 14 is estimated to have an insufficient capacity in the existing drainage infiltration structures (8 leaching rings/catch basins/manholes) to contain the calculated road runoff WQV of 9922 CF as shown on Table 3.4. If all of the existing structures provided leaching and are a typical size of 10’ diameter with 8’ depth, the existing capacity is estimated to be approximately 4500 CF. However, at this time, it is not determined that the existing system is overflowing and draining to a system connected to surface waters, and no target abatement actions are identified or recommended.

The following alternative or additional drainage area abatement action recommendation is only required if flooding in this area is identified.

- Investigate the existing system capacity and install additional UISs to increase the storage volume in this drainage area.

Drainage Area 15 - Carpenter Avenue - Area 15 has a piped system that overflows to the swale in the VSC easement on the NSCC property described in Area 9. The land use in this area is residential. Roads within this drainage area are under the jurisdiction of VSC. Runoff is collected from Glenola Avenue, Harbor Way, and portions of Carpenter Avenue, Carpenter Place, and Marlan Court.

The following abatement action recommendations are included on Table 3-5 and have been each been assigned a priority level of 1 due to the ease of implementation and high pollutant removal potential.

- Install a HS in the structure that outfalls to the headwall to collect trash and sediments and remove them from the swale system.
- Reconstruct the existing swale within the VSC easement to increase the infiltration capacity for Area 15 runoff.

The alternative or additional drainage area abatement action recommendations included on Table 3-5 are:

- Install additional infiltration structures on Harbor Way, Downing Avenue and Carpenter Avenue to infiltrate a portion of the WQV.
- Install CBIs in the existing inlet structures of the piped drainage system.
- In the future, if golf course land becomes available or changes in use are proposed, the VSC should investigate acquisition of a portion of the property (Parcel 21-M-28E) at the corner of Carpenter Avenue and Harbor Way for the installation of a bioretention or recharge basin. An alternate location that can be considered for acquisition to locate a bioretention or recharge basin is the western undeveloped portion of the United

Methodist Church property (Parcel 21-M-592) at the intersection of Carpenter Avenue and Downing Avenue.

Drainage Area 16 - Sea Cliff Streets - Runoff from Area 16 is collected into drainage structures at the intersection of Carpenter Avenue and Hawthorne Road, midway on Downing Avenue and on Marden Avenue at Hawthorne and Hansen Place. The land use in Drainage Area 16 is residential. These streets are under the jurisdiction of VSC. This drainage area is self-contained as the drainage structures have no direct connection to surface waters and infiltrate to groundwater. If the existing systems overflow due to clogging or extreme storm events, there is the potential that surface runoff may drain through Area 15 and into the swale on the NSCC property in Area 9.

Drainage area 16 is estimated to have an insufficient capacity in the existing drainage infiltration structures (20 leaching pools/catch basins/manholes) to contain the calculated road runoff WQV of 36,266 CF as shown on Table 3.4. If all of the existing structures provided leaching and are a typical size of 10' diameter with 8' depth, the existing capacity is estimated to be approximately 11,000 CF. However, at this time, it is not determined that the existing system is overflowing and draining to a system connected to surface waters, and no target abatement actions are identified or recommended. .

The following alternative or additional drainage area abatement action is only required if flooding in this drainage area is identified.

- Investigate the existing system capacity and install additional infiltration structures to increase the storage volume in this drainage area. Additional UISs can be installed throughout the area and the existing triangle at the Marden Avenue and Hansen Place intersection can provide space for a biofiltration basin.

3.4.3 TARGET ACTION COSTS AND IMPLEMENTATION RECOMMENDATIONS

The following paragraphs include a discussion of estimated conceptual construction costs for the target structural project alternatives and implementation considerations. The order in which projects and actions are initiated should be based on several key components including, but not limited to, the following:

1) Severity of the problem
2) Goals and objectives of the project and the assumed or known effectiveness of the project or action
3) Technical feasibility
4) Timing
5) Planned or necessary road reconstruction work
6) Availability of funding
7) Other planned local and regional planning efforts and implementation projects

Section 3.3.2 Source Control Best Management Practices includes a discussion of non-structural management strategies, such as actions to reduce the pollutant loads generated (e.g., fertilizer use reduction) or to provide measures that will remove pollutants prior to entering surface waters (e.g., vegetated buffer installation). Source control best management practices are important to consider in highly developed subwatersheds such as GR/PD, where adequate space to site structural mitigation measures is limited.

Average costs for various structural measures have been estimated to provide a cost comparison basis for review of the implementation actions. Costs do not include design and engineering, land acquisition, demolition, permitting or unusual site conditions. The median pollutant removal rates and construction costs are estimated from data provided in the Center for Watershed Protection's *Urban Subwatershed Restoration Series Manual*

3 – Urban Stormwater Retrofit Practices – Appendices (August 2007), unless noted otherwise.

For UIS practices, the cost to install leaching basins was utilized. The cost is based on professional knowledge of bid costs for this type of work and is estimated upon the installation of a 10' diameter structure. Each installed leaching basin, including asphalt pavement and concrete curb restoration, averages $8.75 per cubic foot of storage volume. Newer shallow horizontal systems should have slightly higher construction costs and are good alternatives where depth to groundwater is a design issue. Infiltration practices, including shallow horizontal systems, are estimated to have median removal rates of 90% TSS, 65% TP, 40% TN, 90% FC and 90% hydrocarbons because the entire WQV is removed from surface waters.

WQI, an alternative management practice, costs vary widely based on type, manufacturer, size and site conditions. The Federal Highway Administration publication *"Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring"* provides costing information based on impervious acres. According to the data included in that document, the adjusted 2011 cost per impervious acre is estimated to be $7,920 to $21,440 for the WQI. For the conceptual construction cost estimates included in this document, an average cost of $18,000 per impervious acre is assumed. Installation costs vary based on site conditions, but are estimated to be 50% of the cost of the unit in this area. The specific WQIs pollutant type and percentage removal vary dependent on the manufacturer and the system design. For this plan, a HS or WV system is assumed to provide a removal rate of 80% for sediments and hydrocarbons. These units typically do not provide significant removal of nutrients and bacteria. MFs, another form of WQI, have median removal rates of 85% TSS, 60% TP, 30% TN, 40% FC, and 85% hydrocarbons, but as discussed in Section 3.4.1 are difficult to site where space is limited.

An average cost for bioretention basins, a traditional filtering system as described in Section 3.4.1, in small urban retrofit areas (less than a half acre of contributing drainage area) is estimated at an average cost range of $35 per cubic foot treated. Bioretention basins are used to remove both nutrients and bacteria from runoff. A bioretention basin requires a means for removal of sediment be sited prior to the basin to prevent sediments from clogging the filtering medium. Bioretention basins are estimated to have median removal rates of 60% TSS, 5% TP, 45% TN, 50% FC and 90% hydrocarbons.

The cost for swale improvements, a traditional filtering system as described in Section 3.4.1, to improve filtering capacity and slow velocity is estimated to be $15.00 per cubic foot stormwater treated. Swales are estimated to have median removal rates of 80% TSS, 5% TP, 55% TN, and 80% hydrocarbons. The same data found that swales did not remove bacteria.

The cost for construction of a recharge basin, an infiltration practice, to infiltrate runoff to groundwater is estimated to cost $9.00 per CF of volume stored. These costs do not include the cost of acquiring land to site the basin. A recharge basin without a detention function is estimated to have median removal rates of 90% TSS, 65% TP, 40% TN, 90% FC and 90% hydrocarbons, the same as for the infiltration system discussed above.

Catch basin inserts (CBI) are best used to provide short-term pollutant removal until permanent measures can be installed, as the units clog easily and require frequent cleaning and replacement. As discussed in Section 3.4.1, most CBI units have only received third party evaluation for sediment removal. The Abtech UUFSS was only catch basin insert identified as receiving third party evaluation for E. coli and enterococcus removal with tested efficiencies of 51% and 43% respectively. The cost to install a CBI in a suitable structure is $1000 - $2500 per unit-installed dependent on the type and manufacturer of the unit. $1800 per unit was used for this estimate. For this plan, the CBI is assumed to be the Abtech UUFSS with average removal rates of 70% TSS and 40% FC.

To date ultraviolet (UV) disinfection systems have rarely been used on the east coast to treat stormwater runoff for bacteria removal. As TMDLs are adopted that require efforts to remove substantial percentages of pathogens (95% in Hempstead Harbor), they may be used more often. UV systems remove 99% of bacteria. They do not remove the other pollutants discussed in this Plan, and sediment removal is required prior to passing the UV system to operate properly. The construction cost for a system is estimated to be $7.25 per cubic foot of water treated. This cost is taken from a February 2010 presentation to the HHPC by Fuss & O'Neil. Costs do not include land acquisition for siting the facility, design and engineering, permitting, operating, power, staffing or maintenance.

Table 3-5 identifies each drainage area, the recommended mitigation action, estimated construction costs and design issues and considerations as well as potential mitigation alternatives or additional actions. The estimated total construction cost to implement the target projects discussed herein is $4,100,000.

Table 3-6: Target Project Annual Pollutant Load Reduction includes the pollutants loads that will be removed for each drainage area if the target projects are implemented. Implementation of source control BMPs as discussed in Section 3.2.2 will also be important in the reduction of pollutant loads but cannot be quantified. The proposed monitoring program will be important in assessing the actual load reductions in the subwatershed.

3.5 IMPLEMENTATION SCHEDULE

Implementation of pollution abatement plans typically requires a period of several years. Implementation timeframes will vary based on numerous factors including availability of funding, public input, permitting, agency coordination, land acquisition, and technical

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Table 3-6
Target Actions Annual Pollutant Load Reduction

Drainage Area	Total Drainage Area				Road Area				Estimated Average Annual Pollutant Load Removal				
	Contributory Area	Impervious Area	Impervious Acres	Water Quality Volume	Road ROW Area	Impervious %	Impervious Acres	Water Quality Volume	TSS	TN	TP	O&G	FC
	Acres	%	Acres	WQv-Cubic	Acres	%	Acres	WQv-Cubic	lbs	lbs	lbs	lbs	billion colonies
Area 1 - Glenwood Road	26.9	43.2	11.6	55,677	6.9	75.0	5.2	23,607	0.0	4,395.2	0.0	242.4	0.0
Area 2 - Shore Road North	26.4	70.4	18.6	85,161	2.1	75.0	1.6	7,185	4.1	711.8	0.1	44.2	50.5
Area 3 - Shore Road South	7.2	71.1	5.1	23,444	1.6	75.0	1.2	5,474	0.0	1,851.2	0.0	102.4	0.0
Area 4 - Schoolhouse Hill	5.6	51.4	2.9	13,544	1.0	75.0	0.8	3,421	0.0	1,069.6	0.0	59.2	0.0
Area 5 - Glen Lane	8.1	37.3	3.0	14,737	1.6	75.0	1.2	5,474	0.0	1,164.0	0.0	64.8	0.0
Area 6 - Larsen Avenue	21.7	34.5	7.5	36,914	3.0	75.0	2.3	10,264	0.0	2,913.6	0.0	160.8	0.0
Area 7 - Cody Lane	20.1	40.4	8.1	39,225	5.3	75.0	4.0	18,133	26.4	1,611.0	5.9	89.1	674.1
Area 8 - Creek Segment	8.9	28.0	2.5	12,684	0.0	75.0	0.0	0	0.0	1,674.4	0.0	92.8	0.0
Area 9 - Kissam Lane	125.5	14.9	18.7	109,164	6.2	75.0	4.7	21,212	23.1	2,030.2	6.0	112.5	350.4
Area 10 - Waverly Street	24	35.4	8.5	41,789	3.8	75.0	2.9	13,001	19.2	1,154.7	4.6	63.9	483.3
Area 11 - Elin, Mill, Ruth, Huron	25.1	39.8	10.0	48,347	6.3	75.0	4.7	21,554	31.6	1,914.3	7.2	106.2	801.0
Area 12 - Roosevelt Street	15.7	37.0	5.8	28,350	2.1	75.0	1.6	7,185	10.8	638.1	2.6	36.0	267.3
Area 13 - Glen Cove Avenue	39.1	42.9	16.8	80,390	7.8	75.0	5.9	26,686	38.8	2,369.7	8.5	130.5	990.9
Area 14 - Club Road	12.4	39.0	4.8	23,461	2.9	75.0	2.2	9,922	14.4	881.1	3.3	48.6	369.0
Area 15 - Carpenter Avenue	29.5	36.1	10.7	52,209	5.7	75.0	4.3	19,501	0.6	1,540.8	2.5	101.8	0.0
Area 16 - Sea Cliff Streets	51.9	37.6	19.5	95,124	10.6	75.0	8.0	36,266	52.8	3,221.1	11.7	177.3	1,347.3
WATERSHED TOTAL ANNUAL POLLUTANT LOAD REMOVAL									**221.8**	**29,140.8**	**52.1**	**1,632.5**	**5,333.8**

issues. The following is a recommended framework for implementing the improvements included in this Plan.

- The existing sampling and monitoring program should be continued. Baseline samples at the additional sampling locations in Drainage Area 8 and Drainage Area 9, as shown on Map 7A and as discussed in Section 3.3.1, should be taken prior to implementation of improvements and periodically as the improvements are implemented to assess water quality improvements over time. The sampling and monitoring program and the monitoring of operations over the plan implementation period will allow for evaluation of the component performances and the water quality improvements achieved in the subwatershed.

- The focus of the initial neighborhood stewardship source control efforts should be on the removal of bacteria from runoff through educational efforts and/or increased enforcement for pet waste clean up, filter strip planting along the creek (Drainage Area 8), and septic system maintenance. Hotpsots source control should begin with an assessment of the individual hotspot locations to determine if the sites have the potential to contribute runoff to the subwatershed and then providing information to identified hotspots on methods to reduce impacts. Initial municipal good housekeeping operations for source control should include increased subwatershed street sweeping particularly focused on periods following winter storm events and prior to heavy spring rains. Additional educational and good housekeeping efforts identified in this plan should be implemented annually and can be coordinated with the requirements of the SPDES MS4 educational program and municipal program requirements.

  As these initial measures are implemented, the success will need to be evaluated and additional measures undertaken as necessary to continue the pollutant reduction. Additional measures may include enacting new ordinances including a possible watershed protection overlay district, increasing enforcement and

requiring site upgrades. These additional measures will likely be required on a broader scale than the GR/PD subwatershed and will require greater inter-municipal coordination and cooperation.

- Grant funding applications for high priority target structural projects should be prepared as program funds become available.

- Implementation of the highest priority target structural abatement actions should begin in upland locations where efforts will have the least disruption on busy roads and require the least permitting effort such as the installation of infiltration structures in Drainage Areas 7, 10, 11 and 13 shown on Table 3-5.

- Reconstruction of the swale and installation of a HS for Drainage Area 15 runoff are included as the highest priority and should be timed to coincide with improvements that the golf course may be undertaking.

- Installation of HSs in upgradient Areas 4, 5 and 6 and in Areas 2 and 3 on Shore Road are target abatement actions ranked with the second highest priority and should follow the completion of the high priority target projects discussed above and when funding is obtained.

- The installation of a HS and the piping system reconstruction in Drainage Area 1 and installation of a HS and a MF in Drainage Area 9, each ranked as priority 3, would likely be implemented following the above target projects due to the significant coordination and jurisdictional issues that will need to be resolved.

- The actions with the priority ranks of 4 include smaller projects that will have less of an impact on pollutant abatement including bioretention swales and HS in Drainage Area 2, buffer planting, illicit discharge investigation and elimination,

and OT 4 and OT 5 repiping and removal in Drainage Area 8, and recharge basin overflow investigation and possible improvement in Drainage Area 12.

- Following implementation of target projects and results of the sampling and monitoring program, the need for the additional and/or alternative abatement actions included on Table 3-5, such as providing additional infiltration capacity or the installation of a UV system at the outfall, should be assessed.

3.6 SOURCES OF FUNDING

This section identifies sources of funding that can provide means to finance the development of programs and implementation of improvements for the GR/PD subwatershed.

3.5.1 FEDERAL

National Oceanic and Atmospheric Administration (NOAA)

NOAA is responsible for providing technical assistance through the Resource Conservation and Assessment/Coastal Resources Coordinator (CRC) program. The CRC program was established to restore coastal and marine environments affected by hazardous waste releases through the development of plans and projects to address the elimination of waste sources and the decontamination of affected sites. The CRC program offers technical assistance from a variety of professionals having expertise in evaluating ecological risk, the potential types and sources of pollutants, development and implementation of techniques for evaluating the magnitude and consequences of environmental degradation, assessment of the cost-effectiveness of strategies for remediation, and the design of monitoring protocol.

In addition to the CRC, NOAA's Community-based Restoration Program (CRP) applies a grass-roots approach to restoration by actively engaging communities in on-the-ground

restoration of fishery habitats around the nation. The CRP emphasizes partnerships and collaborative strategies built around restoring NOAA trust resources and improving the environmental quality of local communities. The program provides seed money and technical expertise to help communities restore degraded fishery habitats, develops strong partnerships to accomplish sound coastal restoration projects, promoting significant community support and volunteer participation, instills stewardship and an abiding conservation ethic, and leverages resources through national, regional, and local partnerships. The CRP is a source of funding to implement the projects and recommendations such as wetland habitat restoration projects, riparian buffers and stewardship opportunities.

Federal Clean Water Act (CWA), Section 319

In 1987, Congress amended the Federal CWA by adding Subsection 319, entitled the *Nonpoint Source Management Program*. The purpose of the amendment was to provide guidance and monetary support to state and local governments for the development and implementation of non-point source initiatives.

The USEPA is authorized under subsection 319 of the CWA to distribute federal grants to states for use in state stormwater control programs and projects that have been subject to USEPA review and approval. Grants are available for a number of non-point source ventures including financing, procurement of technical expertise, educational instruction, technology transfer, implementation of pilot projects, and the monitoring of particular non-point source projects. NYSDEC implements many of the environmental programs developed at the federal level and is responsible for distributing some federal funds to local communities. The funds can be used for both the implementation and the monitoring of the drainage improvements projects.

3.5.2 NEW YORK STATE

Clean Water Act (CWA) State Revolving Loan Fund (SRLF)

The primary purpose of the CWA SRLF is to promote water quality by funding proactive, reactive, and restoration projects and programs to protect water resources. Low-interest loans for water quality control improvements are offered to communities under the federal government's CWA SRLF. The SRLF was initially seeded by funds provided by federal grants and the matching funds of states to finance non-point pollution sources projects that are developed in accordance with the New York State *Nonpoint Source Management Plan*. Projects considered eligible for funding include acquisition of environmentally sensitive land, water body and wetland restoration projects, and erosion and sedimentation control projects. As SRLFs are amortized, the loan fund is replenished, and funds become available for dispersal to other entities for their projects. The self-sustaining nature of revolving loan programs is essential in ensuring the availability of future funding resources and the perpetuation of adequate stormwater treatment control. The SRLF grants can be used to implement the projects and recommendations included in this Plan such as land acquisition, habitat restoration, and storm drainage improvements such as the golf course swale

New York State Environmental Protection Fund (EPF)

The Environmental Protection Fund was created in 1993 to provide funding for environmental protection initiatives. NYSDOS DCR awards EPF Local Waterfront Revitalization Program (LWRP) grants; the NYSDEC provides grants for Water Quality Improvement grants for projects including those for storm water mitigation, and the NYS Office of Parks, Recreation and Historic Preservation for grants for the acquisition and preservation of land to be included as public parklands. The EPF grants can be used to implement the projects and recommendations included in this plan such as land acquisition, stormwater mitigation, habitat restoration projects, sediment removal, and educational efforts.

New York State EPF Local Waterfront Revitalization Program (EPF LWRP)

The Department of State administers the Environmental Protection Fund Local Waterfront Revitalization Program (Title 11). EPF LWRP funds are available to cities, towns, villages and counties for projects that fall under the following categories:

- Visioning and development of local or regional revitalization strategies
- Completing or implementing a Local or Regional Waterfront Revitalization Program
- Adapting to climate change
- Downtown and hamlet revitalization
- Preparing or implementing a local or regional watershed management plan
- Urban waterfront redevelopment
- Creating a blueway trail
- Interpreting waterfront resources - New York State Coastal Resources Interpretive Program

Transportation Equity Act for the 21st Century (TEA-21)

The Nassau Suffolk Transportation Coordinating Committee (NSTCC) is authorized to administer the initiatives of TEA-21. TEA-21 provides funding for a number of transportation-related projects including stormwater control projects that are proposed for improving environmental quality. The TEA-21 funds can be used to implement drainage improvement projects.

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United States Fish and Wildlife Service. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. December.

Glenwood Road/Powerhouse Drain Pollution Abatement Plan

APPENDIX A
CWP Source Control Profile Sheets

H-1

Hotspot Source Area: Vehicles

VEHICLE MAINTENANCE AND REPAIR

Description

Vehicle maintenance and repair operations can exert a significant impact on water quality by generating toxins such as solvents, waste oil, antifreeze, and other fluids. Often, vehicles that are wrecked or awaiting repair can be a storm water hotspot if leaking fluids are exposed to storm water runoff (Figure 1). Vehicle maintenance and repair can generate oil and grease, trace metals, hydrocarbons, and other toxic organic compounds. Table 1 summarizes a series of simple pollution prevention techniques for vehicle maintenance and repair operations that can prevent storm water contamination. You are encouraged to consult the Resources section of this sheet to get a more comprehensive review of pollution prevention practices for vehicle maintenance and repair operations.

Figure 1: Junkyard and Potential Source of Storm Water Pollution

Application

Pollution prevention practices should be applied in any facility that maintains or repairs vehicles in a subwatershed. Examples include car dealerships, body shops, service stations, quick lubes, school bus depots, trucking companies, and fleet maintenance operations at larger industrial, institutional, municipal or transport-related operations. Repair facilities are often clustered together, and are a major priority for subwatershed pollution prevention.

Table 1: Pollution Prevention Practices for Vehicle Maintenance and Repair Activities

- Avoid hosing down work or fueling areas
- Clean all spills immediately using dry cleaning techniques
- Collect used antifreeze, oil, grease, oil filters, cleaning solutions, solvents, batteries, hydraulic and transmission fluids and recycle with appropriate agencies
- Conduct all vehicle and equipment repairs indoors or under a cover (if done outdoors)
- Connect outdoor vehicle storage areas to a separate storm water collection system with an oil/grit separator that discharges to a dead holding tank, the sanitary sewer or a storm water treatment practice
- Designate a specific location for outdoor maintenance activities that is designed to prevent storm water pollution (paved, away from storm drains, and with storm water containment measures)
- Inspect the condition of all vehicles and equipment stored outdoors frequently
- Use a tarp, ground cloth, or drip pans beneath vehicles or equipment being repaired outdoors to capture all spills and drips
- Seal service bay concrete floors with an impervious material so cleanup can be done without using solvents. Do not wash service bays to outdoor storm drains
- Store cracked batteries in a covered secondary containment area until they can be disposed of properly
- Wash parts in a self-contained solvent sink rather than outdoors

Primary Training Targets

Owners, fleet operation managers, service managers, maintenance supervisors, mechanics and other employees are key targets for training.

Feasibility

Pollution prevention techniques for vehicle repair facilities broadly apply to all regions and climates. These techniques generally rely on changes to basic operating procedures, after an initial inspection of facility operations. The inspection relies on a standard operations checklist that can be completed in a few hours.

Implementation Considerations

Employee training is essential to successfully implement vehicle repair pollution prevention practices. The connection between the storm drain system and local streams should be emphasized so that employees understand why any fluids need to be properly disposed of. It is also important to understand the demographics of the work force; in some communities, it may require a multilingual education program.

Cost - Employee training is generally inexpensive, since training can be done using posters, pamphlets, or videos. Structural practices can vary based on what equipment is required. For instance, solvent sinks to clean parts can cost from $1,500 to $15,000, while spray cabinets may cost more than $50,000. In addition, proper recycling/disposal of used or spilled fluids usually requires outside contractors that may increase costs.

Resources

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs.
http://www.ecy.wa.gov/biblio/9914.html

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Coordinating Committee For Automotive Repair (CCAR) Source: US EPA CCAR-GreenLink®, the National Automotive Environmental Compliance Assistance Center CCAR-GreenLink® Virtual Shop http://www.ccar-greenlink.org/

Auto Body Shops Pollution Prevention Guide. Peaks to Prairies Pollution Prevention Information Center.
http://peakstoprairies.org/p2bande/autobody/abg uide/index.cfm

Massachusetts Office of Technical Assistance for Toxics Use Reduction (OTA). Crash Course for Compliance and Pollution Prevention Toolbox
http://www.state.ma.us/ota/pubs/toolfull.pdf

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities.
http://www.swrcb.ca.gov/stormwtr/murp.html

US EPA. Virtual Facility Regulatory Tour: Vehicle Maintenance. FedSite Federal Facilities Compliance Assistance Center.
http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/fedsite/virtual.html

City of Santa Cruz. Best Management Practices for Vehicle Service Facilities (in English and Spanish).
http://www.ci.santa-cruz.ca.us/pw/pdf/vehiclebmp.pdf

City of Los Angeles Bilingual Poster of BMPs for Auto Repair Industry
http://www.lastormwater.org/downloads/PDFs/autopstr.pdf

H-2

Hotspot Source Area: Vehicles

VEHICLE FUELING

Description

Spills at vehicle fueling operations have the potential to directly contribute oil, grease, and gasoline to storm water, and can be a significant source of lead, copper and zinc, and petroleum hydrocarbons. Delivery of pollutants to the storm drain can be sharply reduced by well-designed fueling areas and improved operational procedures. The risk of spills depends on whether the fueling area is covered and has secondary containment. The type, condition, and exposure of the fueling surface can also be important. Table 1 describes common pollution prevention practices for fueling operations.

Application

These practices can be applied to any facility that dispenses fuel. Examples include retail gas stations, bus depots, marinas, and fleet maintenance operations (Figure 1). In addition, these practices also apply to temporary above-ground fueling areas for construction and earthmoving equipment. Many fueling areas are usually present in urban subwatersheds, and they tend to be clustered along commercial and highway corridors. These hotspots are often a priority for subwatershed source control.

Figure 1: Covered Retail Gas Operation Without Containment for Potential Spills

Table 1: Pollution Prevention Practices For Fueling Operation Areas

- Maintain an updated spill prevention and response plan on premises of all fueling facilities (see Profile Sheet H-7)
- Cover fueling stations with a canopy or roof to prevent direct contact with rainfall
- Design fueling pads for large mobile equipment to prevent the run-on of storm water and collect any runoff in a dead-end sump
- Retrofit underground storage tanks with spill containment and overfill prevention systems
- Keep suitable cleanup materials on the premises to promptly clean up spills
- Install slotted inlets along the perimeter of the "downhill" side of fueling stations to collect fluids and connect the drain to a waste tank or storm water treatment practice. The collection system should have a shutoff valve to contain a large fuel spill event
- Locate storm drain inlets away from the immediate vicinity of the fueling area
- Clean fuel-dispensing areas with dry cleanup methods. Never wash down areas before dry clean up has been done. Ensure that wash water is collected and disposed of in the sanitary sewer system or approved storm water treatment practice
- Pave fueling stations with concrete rather than asphalt
- Protect above ground fuel tanks using a containment berm with an impervious floor of Portland cement. The containment berm should have enough capacity to contain 110% of the total tank volume
- Use fuel-dispensing nozzles with automatic shutoffs, if allowed
- Consider installing a perimeter sand filter to capture and treat any runoff produced by the station

Primary Training Targets

Training efforts should be targeted to owners, operators, attendants, and petroleum wholesalers.

Feasibility

Vehicle fueling pollution prevention practices apply to all geographic and climatic regions. The practices are relatively low-cost, except for structural measures that are installed during new construction or station remodeling.

Implementation Considerations

Fueling Area Covers - Fueling areas can be covered by installing an overhanging roof or canopy. Covers prevent exposure to rainfall and are a desirable amenity for retail fueling station customers. The area of the fueling cover should exceed the area where fuel is dispensed. All downspouts draining the cover or roof should be routed to prevent discharge across the fueling area. If large equipment makes it difficult to install covers or roofs, fueling islands should be designed to prevent storm water run-on through grading, and any runoff from the fueling area should be directed to a dead-end sump.

Surfaces - Fuel dispensing areas should be paved with concrete; the use of asphalt should be avoided, unless the surface is sealed with an impervious sealant. Concrete pads used in fuel dispensing areas should extend to the full length that the hose and nozzle assembly can be pulled, plus an additional foot.

Grading - Fuel dispensing areas should be graded with a slope that prevents ponding, and separated from the rest of the site by berms, dikes or other grade breaks that prevent run-on of urban runoff. The recommended grade for fuel dispensing areas is 2 - 4% (CSWQTF, 1997).

Cost - Costs to implement pollution prevention practices at fueling stations will vary, with many of the costs coming upfront during the design of a new fueling facility. Once a facility has implemented the recommended source control measures, ongoing maintenance costs should be low.

Resources

Best Management Practice Guide – Retail Gasoline Outlets. Prepared by Retail Gasoline Outlet Work Group.
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGO BMP Guide_03-97_.pdf

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs.
http://www.ecy.wa.gov/biblio/9914.html

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: New Development and Redevelopment.
http://www.cabmphandbooks.com/

City of Los Angeles, CA Best Management Practices for Gas Stations
http://www.lacity.org/SAN/wpd/downloads/PDFs/gasstation.pdf

City of Dana Point Stormwater Best Management Practices (BMPs) For Automotive Maintenance And Car Care
http://www.danapoint.org/water/WC-AUTOMOTIVE.pdf

Alachua County, FL Best Management Practices for Controlling Runoff from Gas Stations
http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Gas%20Stations.pdf

California Stormwater Regional Control Board Retail Gasoline Outlets: New Development Design Standards For Mitigation Of Storm Water Impacts
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGOpaper.pdf
http://www.swrcb.ca.gov/rwqcb4/html/programs/stormwater/la_ms4_tentative/RGOPaperSupplement_12-01_.pdf

Canadian Petroleum Products Institute Best Management Practices Stormwater Runoff from Petroleum Facilities
http://www.cppi.ca/tech/BMPstormwater.pdf

City of Monterey (CA) Posters of Gas Station BMPs.
http://www.monterey.org/publicworks/stormeduc.html

Pinole County, CA Typical Stormwater Violations Observed in Auto Facilities and Recommended Best Management Practices (BMPs)
http://www.ci.pinole.ca.us/publicworks/downloads/AutoStormwater.pdf

H-3

Hotspot Source Area: Vehicles

VEHICLE WASHING

Description

Vehicle washing pollution prevention practices apply to many commercial, industrial, institutional, municipal and transport-related operations. Vehicle wash water may contain sediments, phosphorus, metals, oil and grease, and other pollutants that can degrade water quality. When vehicles are washed on impervious surfaces such as parking lots or industrial areas, dirty wash water can contaminate storm water that ends up in streams.

Application

Improved washing practices can be used at any facility that routinely washes vehicles. Examples include commercial car washes, bus depots, car dealerships, rental car companies, trucking companies, and fleet operations. In addition, washing dump trucks and other construction equipment can be a problem. Washing operations tend to be unevenly distributed within urban subwatersheds. Vehicle washing also occurs in neighborhoods, and techniques to keep wash water out of the storm drain system are discussed in the car washing profile sheet (N-11). Table 1 reviews some of the pollution prevention techniques available for hotspot vehicle washing operations.

Primary Training Targets

Owners, fleet managers, and employees of operations that include car washes are the primary training target.

Feasibility

Vehicle washing practices can be applied to all regions and climates. Vehicle washing tends to occur more frequently in summer months and in drier regions of the country. Sound vehicle washing practices are not always used at many sites because operators are reluctant to change traditional cleaning methods. In addition, the cost of specialized equipment to manage high volumes of wash water can be too expensive for small businesses.

Improved vehicle washing practices are relatively simple to implement and are very effective at preventing storm water contamination. Training is essential to get owners and employees to adopt these practices, and should be designed to overcome cultural and social barriers to improved washing practices.

Table 1: Pollution Prevention Practices for Vehicle Washing

- Wash vehicles at indoor car washes that recycle, treat or convey wash water to the sanitary sewer system
- Use biodegradable, phosphate-free, water-based soaps
- Use flow-restricted hose nozzles that automatically turn off when left unattended
- Wash vehicles on a permeable surface or a washpad that has a containment system
- Prohibit discharge of wash water into the storm drain system or ground by using temporary berms, storm drain covers, drain plugs or other containment system
- Label storm drains with "No Dumping" signs to deter disposal of wash water in the storm drain system
- Pressure and steam clean off-site to avoid runoff with high pollutant concentrations
- Obtain permission from sewage treatment facilities to discharge to the sanitary sewer

Implementation Considerations

The ideal practice is to wash all vehicles at commercial car washes or indoor facilities that are specially designed for washing operations. Table 2 offers some tips for indoor car wash sites. When washing operations are conducted outside, a designated wash area should having the following characteristics:

- Paved with an impervious surface, such as Portland cement concrete
- Bermed to contain wash water
- Sloped so that wash water is collected and discharged to the sanitary sewer system, holding tank or dead-end sump
- Operated by trained workers to confine washing operations to the designated wash area

Outdoor vehicle washing facilities should use pressurized hoses without detergents to remove most dirt and grime. If detergents are used, they should be phosphate-free to reduce nutrient loading. If acids, bases, metal brighteners, or degreasing agents are used, wash water should be discharged to a treatment facility, sanitary sewer, or a sump. In addition, waters from the pressure washing of engines and vehicle undercarriages must be disposed of using the same options.

Table 2: Tips for Indoor Car Wash Sites
(Adapted from U.S. EPA, 2003)

- Facilities should have designated areas for indoor vehicle washing where no other activities are performed (e.g. fluid changes or repair services)
- Indoor vehicle wash areas should have floor drains that receive only vehicle washing wastewater (not floor washdown or spill removal wash waters) and be connected to a holding tank with a gravity discharge pipe, to a sump that pumps to a holding tank, or to an oil/grit separator that discharges to a municipal sanitary sewer
- The floor of indoor vehicle wash bays should be completely bermed to collect wash water
- Aromatic and chlorinated hydrocarbon solvents should be eliminated from vehicle-washing operations
- Vehicle-washing operations should use vehicle rinsewater to create new wash water through the use of recycling systems that filter and remove grit.

Discharge to pervious areas may be an option for washing operations that generate small amounts of relatively clean wash water (water only - no soaps, no steam cleaning). The clean wash water should be directed as sheet flow across a vegetated area to infiltrate or evaporate before it enters the storm drain system. This option should be exercised with caution, especially in environmentally sensitive areas or protected groundwater recharge areas.

The best way to avoid stormwater contamination during washing operations is to drain the wash water to the sanitary sewer system. Operations that produce high volumes of wash water should consider installing systems that connect to the sewer. Other options for large and small operations include containment units to capture the wash water prior to transport away for proper disposal (Figure 1). If vehicles must be washed on an impervious surface, a storm drain filter should be used to capture solid contaminants.

Cost - The cost of using vehicle-washing practices can vary greatly and depends on the size of the operation (Table 3). The cost of constructing a commercial grade system connected to the sanitary sewer can exceed $100,000. Disposal fees and frequency of washing can also influence the cost. Training costs can be minimized by using educational

Figure 1: Containment System Preventing Wash Water from Entering the Storm Drain

materials available from local governments, professional associations or EPA's National Compliance Assistance Centers (http://www.assistancecenters.net/). Temporary, portable containment systems can be shared by several companies that cannot afford specialized equipment independently.

Table 3: Sample Equipment Costs for Vehicle Washing Practices

Item	Cost
Bubble Buster	$2,000 –2,500*
Catch basin insert	$65*
Containment mat	$480-5,840**
Storm drain cover (24" drain)	$120.00 **
Water dike/ berm (20 ft)	$100.00 **
Pump	$75-3,000**
Wastewater storage container	$50-1,000+**

*Source: *U.S. EPA, 1992 **Robinson, 2003*

Resources

EPA FedSite Virtual Facility Regulatory Tour, Vehicle Maintenance Facility Tour. Vehicle Washing - P2 Opportunities http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/fedsite/virtual.html

Alachua County Pollution Prevention Fact Sheet: Best Management Practices for Controlling Runoff from Commercial Outdoor Car Washing. http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Commercial Outdoor Car Wash.pdf.

Kitsap County Sound Car Wash Program. http://www.kitsapgov.com/sswm/carwash.htm.

Washington Department of Ecology. 1995. Vehicle and Equipment Wash Water Discharges. Best Management Practices Manual. Olympia, Washington. http://www.ecy.wa.gov/pubs/95056.pdf

U.S. Environmental Protection Agency. Pollution Prevention/Good Housekeeping for Municipal Operations. http://cfpub2.epa.gov/npdes/stormwater/mcnuofbmps/poll_18.cfm

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial. http://www.cabmphandbooks.com/

H-4

Hotspot Source Area: Vehicles

VEHICLE STORAGE

Description

Parking lots and vehicle storage areas can introduce sediment, metals, oil and grease, and trash into storm water runoff. Simple pavement sweeping, litter control, and storm water treatment practices can minimize pollutant export from these hotspots. Table 1 provides a list of simple pollution prevention practices intended to prevent or reduce the discharge of pollutants from parking and vehicle storage areas.

Application

Pollution prevention practices can be used at larger parking lots located within a subwatershed. Examples include regional malls, stadium lots, big box retail, airport parking, car dealerships, rental car companies, trucking companies, and fleet operations (Figure 1). The largest, most heavily used parking lots with vehicles in the poorest condition (e.g., older cars or wrecked vehicles) should be targeted first. This practice is also closely related to parking lot maintenance source controls, which are discussed in greater detail in profile sheet H-11.

Primary Training Targets

Owners, fleet operation managers, and property managers that maintain parking lots are key training targets.

Figure 1: Retail Parking Lot

Table 1: Pollution Prevention Practices for Parking Lot and Vehicle Storage Areas

Parking Lots

- Post signs to control litter and prevent patrons from changing automobile fluids in the parking lot (e.g., changing oil, adding transmission fluid, etc.)
- Pick up litter daily and provide trash receptacles to discourage littering
- Stencil or mark storm drain inlets with "No Dumping, Drains to _____" message
- Direct runoff to bioretention areas, vegetated swales, or sand filters
- Design landscape islands in parking areas to function as bioretention areas
- Disconnect rooftop drains that discharge to paved surfaces
- Use permeable pavement options for spillover parking (Profile sheet OS-11 in Manual 3)
- Inspect catch basins twice a year and remove accumulated sediments, as needed
- Vacuum or sweep large parking lots on a monthly basis, or more frequently
- Install parking lot retrofits such as bioretention, swales, infiltration trenches, and storm water filters (Profile sheets OS-7 through OS-10 in Manual 3)

Vehicle Storage Areas

- Do not store wrecked vehicles on lots unless runoff containment and treatment are provided
- Use drip pans or other spill containment measures for vehicles that will be parked for extended periods of time
- Use absorbent material to clean up automotive fluids from parking lots

Feasibility

Sweeping can be employed for parking lots that empty out on a regular basis. Mechanical sweepers can be used to remove small quantities of solids. Vacuum sweepers should be used on larger parking lot storage areas, since they are superior in picking up deposited pollutants (See Manual 9). Constraints for sweeping large parking lots include high annual costs, difficulty in controlling parking, and the inability of current sweeper technology to remove oil and grease. Proper disposal of swept materials might also represent a limitation.

Implementation Considerations

The design of parking lots and vehicle storage areas can greatly influence the ability to treat storm water runoff. Many parking areas are landscaped with small vegetative areas between parking rows for aesthetic reasons or to create a visual pattern for traffic flow. These landscaped areas can be modified to provide storm water treatment in the form of bioretention (Figure 2).

Figure 2: Parking Lot Island Turned Bioretention Area

Catch basin cleanouts are also an important practice in parking areas. Catch basins within the parking lot should be inspected at least twice a year and cleaned as necessary. Cleanouts can be done manually or by vacuum truck. The cleanout method selected depends on the number and size of the inlets present (see Manual 9).

Most communities have contractors that can be hired to clean out catch basins and vacuum sweep lots. Mechanical sweeping services are available, although the cost to purchase a new sweeper can exceed $200,000. Employee training regarding spill prevention for parking areas is generally low-cost and requires limited staff time.

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology
http://www.ecy.wa.gov/biblio/9014.html

H-5

Hotspot Source Area: Outdoor Materials

LOADING AND UNLOADING

Description

Outdoor loading and unloading normally takes place on docks or terminals at many commercial, industrial, institutional, and municipal operations. Materials spilled or leaked during this process can either be carried away in storm water runoff or washed off when the area is cleaned. As a result, many different pollutants can be introduced into the storm drain system, including sediment, nutrients, trash, organic material, trace metals, and an assortment of other pollutants. A number of simple and effective pollution prevention practices can be used at loading/unloading areas to prevent runoff contamination, as shown in Table 1.

Application

While nearly every commercial, industrial, institutional, municipal and transport-related site has a location where materials or products are shipped or received, the risk of storm water pollution is greatest for operations that transfer high volumes of material or liquids, or unload potentially hazardous materials. Some notable examples to look for in a subwatershed include distribution centers, grocery stores, building supply outlets, lawn and garden centers, petroleum wholesalers, warehouses, landfills, ports, solid waste facilities, and maintenance depots (Figure 1). Attention should also be paid to industrial operations that process bulk materials, and any operations regulated under industrial storm water NPDES permits.

Primary Training Targets

Owners, site managers, facility engineers, supervisors, and employees of operations with loading/unloading facilities are the primary training target.

Feasibility

Loading/unloading pollution prevention practices can be applied in all geographic and climatic regions, and work most effectively at preventing sediment, nutrients, toxic materials, and oil from coming into contact with storm water runoff or runon. Few impediments exist to using this practice, except for the cost to retrofit existing loading and unloading areas with covers or secondary containment.

Figure 1: Loading/Unloading Area of Warehouse

Table 1: Pollution Prevention Practices for Loading and Unloading Areas
• Avoid loading/unloading materials in the rain
• Close adjacent storm drains during loading/unloading operations
• Surround the loading/unloading area with berms or grading to prevent run-on or pooling of storm water. If possible, cover the area with a canopy or roof
• Ensure that a trained employee is always present to handle and cleanup spills
• Inspect the integrity of all containers before loading/unloading
• Inspect equipment such as valves, pumps, flanges, and connections regularly for leaks, and repair as needed
• Install an automatic shutoff valve to interrupt flow in the event of a catastrophic liquid spill
• Install a high-level alarm on storage tanks to prevent overfilling
• Pave the loading/unloading area with concrete rather than asphalt
• Place drip pans or other temporary containment devices at locations where leaks or spills may occur, and always use pans when making and breaking connections
• Position roof downspouts to direct storm water away from loading/unloading areas and into bioretention areas
• Prepare and implement an Emergency Spill Cleanup Plan for the facility (see Profile Sheet H-7)
• Sweep loading/unloading area surfaces frequently to remove material that could otherwise be washed off by storm water
• Train all employees, especially fork lift operators, on basic pollution prevention practices and post signs
• Use seals, overhangs, or door skirts on docks and terminals to prevent contact with rainwater

Implementation Considerations

Loading/unloading pollution prevention practices should be integrated into the overall storm water pollution prevention plan for a facility. Employee training should focus on proper techniques to transfer materials, using informational signs at loading docks and material handling sites and during routine safety meetings.

Cost - Costs to implement loading/unloading pollution prevention practices consist of one-time construction costs to retrofit new or existing loading areas, but annual maintenance costs are relatively low thereafter. Exceptions include industries that elect to use expensive air pressure or vacuum systems for loading/unloading facilities, which can also be expensive to maintain (U.S. EPA, 1992). Ongoing costs include employee training and periodic monitoring of loading/unloading activities.

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology 99-14
http://www.ecy.wa.gov/biblio/9914.html

Ventura County Flood Control District Clean Business Program Fact Sheet
http://www.vcstormwater.org/sheet-materials.htm

Business Best Management Practices Stormwater Bmp #3 - Shipping/Receiving/Loading Docks
http://www.cleancharles.org/stormwater_bmp3.shtml

City of Los Angeles, CA Reference Guide For Stormwater Best Management Practices
http://www.lastormwater.org/downloads/PDFs/bmp_refguide.pdf

H-6

Hotspot Source Area: Outdoor Materials

OUTDOOR STORAGE

Description

Protecting outdoor storage areas is a simple and effective pollution prevention practice for many commercial, industrial, institutional, municipal, and transport-related operations. The underlying concept is to prevent runoff contamination by avoiding contact between outdoor materials and rainfall (or runoff). Unprotected outdoor storage areas can generate a wide range of storm water pollutants, such as sediment, nutrients, toxic materials, and oil and grease (Figure 1).

Materials can be protected by installing covers, secondary containment, and other structures to prevent accidental release. Outdoor storage areas can be protected on a temporary basis (tarps or plastic sheeting) or permanently through structural containment measures (such as roofs, buildings, or concrete berms). Table 1 summarizes pollution prevention practices available for outdoor storage areas.

Figure 1: Mulch Stored Outdoors at a Garden Center

Application

Many businesses store materials or products outdoors. The risk of storm water pollution is greatest for operations that store large quantities of liquids or bulk materials at sites that are connected to the storm drain system. Several notable operations include nurseries and garden centers, boat building/repair, auto recyclers/body shops, building supply outlets, landfills, ports, recycling centers, solid waste and composting facilities, highway maintenance depots, and power plants. Attention should also be paid to industrial operations that process bulk materials, which are often regulated under industrial storm water NPDES permits.

Primary Training Targets

Owners, site managers, facility engineers, supervisors, and employees of operations with loading/unloading facilities are the primary training target.

Feasibility

Outdoor storage protection can be widely applied in all regions and climate zones, and requires routine monitoring by employees. Most operations have used covering as the major practice to handle outdoor storage protection (U.S. EPA, 1999). The strategy is to design and maintain outdoor material storage areas so that they:

- Reduce exposure to storm water and prevent runon
- Use secondary containment to capture spills
- Can be regularly inspected
- Have an adequate spill response plan and cleanup equipment

Table 1: Pollution Prevention Practices for Protecting Outdoor Storage Areas

- Emphasize employee education regarding storage area maintenance
- Keep an up-to-date inventory of materials stored outdoors, and try to minimize them
- Store liquids in designated areas on an impervious surface with secondary containment
- Inspect outdoor storage containers regularly to ensure that they are in good condition
- Minimize storm water run-on by enclosing storage areas or building a berm around them
- Slope containment areas to a drain with a positive control (lock, valve, or plug) that leads to the sanitary sewer (if permitted) or to a holding tank
- Schedule regular pumping of holding tanks containing storm water collected from secondary containment areas

Implementation Considerations

Covers - The use of impermeable covers is an effective pollution prevention practice for non-hazardous materials. Covers can be as simple as plastic sheeting or tarps, or more elaborate roofs and canopies. Site layout, available space, affordability, and compatibility with the covered material all dictate the type of cover needed for a site. In addition, the cover should be compatible with local fire and building codes and OSHA workplace safety standards. Care should be taken to ensure that the cover fully protects the storage site and is firmly anchored into place.

Secondary Containment - Secondary containment is designed to contain possible spills of liquids and prevent storm water run-on from entering outdoor storage areas. Secondary containment structures vary in design, ranging from berms and drum holding areas to specially-designed solvent storage rooms (Figure 2).

Figure 2: Secondary Containment of Storage Drums Behind a Car Repair Shop

Secondary containment can be constructed from a variety of materials, such as concrete curbs, earthen berms, plastic tubs, or fiberglass or metal containers. The type of material used depends on the substance contained and its resistance to weathering. In general, secondary containment areas should be sized to hold 110% of the volume of the storage tank or container unless other containment sizing regulations apply (e.g., fire codes).

If secondary containment areas are uncovered, any water that accumulates must be collected in a sanitary sewer, a storm water treatment system, or a licensed disposal facility. Water quality monitoring may be needed to determine whether the water is contaminated and dictate the method of disposal. If the storm water is clean, or an on-site storm water treatment practice is used, a valve should be installed in the containment dike so that excess storm water can be drained out of the storage area and directed either to the storm drain (if clean) or into the storm water treatment system (if contaminated). The valve should always be kept closed except when storm water is drained, so that any spills that occur can be effectively contained. Local sewer authorities may not allow discharges from a large containment area into the sewer system, and permission must be obtained prior to discharge. If discharges to the sanitary sewer system are prohibited, containment should be provided, such as a holding tank that is regularly pumped out.

Employee training on outdoor storage pollution prevention should focus on the activities and site areas with the potential to pollute storm water and the proper techniques to manage material storage areas to prevent runoff contamination.

Training can be conducted through safety meetings and the posting of on-site informational signs. Employees should also know the on-site person who is trained in spill response.

Cost - Many storage protection practices are relatively inexpensive to install (Table 2). Actual costs depend on the size of the storage area and the nature of the pollution prevention practices. Other factors are whether practices are temporary or permanent and the type of materials used for covers and containment. Employee training can be done in connection with other safety training to reduce program costs. Training costs can also be reduced by using existing educational materials from local governments, professional associations or from EPA's National Compliance Assistance Centers (http://www.assistancecenters.net).

Table 2: Sample Equipment Costs for Outdoor Storage Protection

Storage Protection Device	Cost
Concrete Slab (8")	$3.50 to $5.00 per ft^2
Containment Pallets	$50 to $350 based on size and # of barrels to be stored
Storage buildings	$6 to $11 per ft^2
Tarps & Canopies	$25 to $500 depending on size of area to cover

Sources: Costs were derived from a review of Ferguson et al., 1997 and numerous websites that handle proprietary spill control or hazardous material control products

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook; Industrial and Commercial. http://www.cabmphandbooks.com/

Rouge River National Wet Weather Demonstration Project. Wayne County, MI. http://www.rougeriver.com/geninfo/rougeproj.html

Storm Water Management Fact Sheet: Coverings. USEPA. Office of Water. http://www.epa.gov/owm/mtb/covs.pdf.

EPA Office of Wastewater Management Storm Water Management Fact Sheet: Coverings http://www.epa.gov/owm/mtb/covs.pdf

California Stormwater Quality Association Factsheet: Outdoor Storage of Raw Materials http://www.cabmphandbooks.com/Documents/Municipal/SC-33.pdf

Alameda Countywide Clean Water Program Outdoor Storage of Liquid Materials http://www.cleanwaterprogram.com/outdoor_stor_liquid_fact_sht.pdf

Washtenaw County, MI Community Partners for Clean Streams Fact Sheet Series #1: Housekeeping Practices http://www.ewashtenaw.org/content/dc_drnbmp1.pdf

H-7

Hotspot Source Area: Spills and Accidents

SPILL PREVENTION AND RESPONSE

ATTENTION
Spill Clean-up Kit
Located Here

Description

Spill prevention and response plans describe operational procedures to reduce spill risks and ensure that proper controls are in place when they do occur. Spill prevention plans standardize everyday procedures and rely heavily on employee training and education. The investment is a good one for most operations, since spill prevention plans reduce potential liability, fines and costs associated with spill cleanup. Table 1 provides some simple tips to prevent and respond to spills.

Application

A spill prevention and response plan is useful at any storm water hotspot operation, and is mandatory for any operation that uses, generates, produces, or transports hazardous materials, petroleum products or fertilizers. These operations are known as SARA 312 sites and are regulated by state environmental agencies. A list of SARA 312 sites within a subwatershed helps locate these potential storm water hotspots. In addition, all industrial sites regulated by individual or group NPDES storm water permits must have an updated spill prevention and response plan on-site. Lastly, spill containment and response plans should be prepared for major highways that cross the subwatershed, since truck and tanker accidents often represent the greatest potential spill risk in many communities (Figure 1).

Figure 1: Overturned, Leaking Tractor Trailer

Table 1: Pollution Prevention Practices for Spill Prevention and Response

- Develop a Spill Prevention Plan and ensure that employees are familiar with it and proper spill cleanup procedures
- Store and contain liquid materials to prevent the contents from entering the storm drain system, surface waters, or groundwater (see Profile Sheet H-7 on outdoor material storage)
- Store and maintain appropriate spill cleanup materials in a readily accessible location and strategically deploy them based on the type and quantities of chemicals present
- Schedule regular inspections for leaks and spills and replace storage containers as needed
- Label all containers according to their contents and potential hazards (e.g., solvent, gasoline)
- Clean up spills promptly and with as little water as possible; dispose of used cleanup materials properly
- Always treat cleanup materials used for hazardous substances as a hazardous waste
- Use absorbents, gels, and foams to cleanup chemical materials
- Report spills that pose an immediate threat to human health or the environment to the appropriate local agencies, such as the fire department

Primary Training Targets

The owner or operator, facility engineer, safety supervisor, and employees should receive annual training on spill prevention and response.

Feasibility

Spill prevention and response plans are recommended for storm water hotspots in every region and climate zone.

Implementation Considerations

Cleanup costs for a single 55-gallon drum that spills and reaches the storm drain have been estimated at 10 to 100 times its raw material value. A spill reponse and prevention plan is used to assess how pollutants are handled at the site and the pattern of storm water movement. The plan seeks to minimize the chance of accidental spills and ensure that proper safety and response measures are understood and applied (U.S. EPA, 1992). A good spill prevention and response plan includes five major components:

1. A Site Map and Evaluation of Past Spills and Leaks

A site map should provide the following information:

- A general description of the facility
- Owner's name and address
- Nature of the activities at the facility
- Types of chemicals used
- Location of chemical storage areas
- Location of the storm drains and water bodies
- Direction of the drainage away from the site
- Location of any structures or devices used to prevent spills leaving the site

2. An Inventory of Materials at the Site

A material inventory list should be created including the type of material, the location where it is stored, the type of container, its estimated volume, and whether a material safety data sheet is required. The inventory should also indicate what safeguards are currently in place to reduce the exposure of chemicals to storm water, provide insight as to spill risks, and help local authorities in the event of an emergency response (such as a fire).

3. Locations of Possible Spill Areas

It is important to identify potential spill areas, project potential spill volume, and determine the drainage paths in order to choose the most appropriate prevention, containment, and spill response practices. Areas at the site that can be most vulnerable to spills include the following:

- Areas for outdoor processing (H-4)
- Loading and unloading sites (H-5)
- Outdoor storage locations (H-6)
- Waste storage disposal (H-8)

Also, the spill potential should be assessed for stationary facilities, including manufacturing operations, warehouses, and service stations.

4. A List of Required Spill Response Equipment

The plan should document what kind of spill response equipment will be stored at the site, and contain clear and concise step-by-step instructions for their use.

5. Employee Training Needs

Effective and repeated employee training is essential to effectively implement this practice. Lack of employee motivation or training is considered the biggest weakness of most spill prevention plans. Employee training programs should be held annually to educate all personnel on the spill prevention plan. Spill prevention messages can be reinforced through signage and periodic inspections. The spill response training program should include detailed information on the following:

- The specific individuals responsible for implementing the plan
- Safety procedures for handling each kind of waste

- Current emergency contact numbers to notify appropriate authorities
- Step-by-step procedures to contain, divert, isolate, and clean up a spill
- Training in the use of spill response equipment, including safety procedures

Cost - Spill prevention and response plans are a good investment since they reduce the liability, cleanup costs and penalties. The costs to implement plans depend on the amount of employee training and cleanup equipment needed (which vary depending on the size of the facility); the containment needed; and the types of materials handled at the facility. The costs to inspect the site and write a plan range from $5,000 to as high as $20,000 for petroleum industries (IPAA, 2001). Costs to prepare plans at most other hotspots are much lower – about $4,000 to $7,000 (SWRCB, 1999). Annual costs to implement the plan are estimated to be less than $2,500, mostly for on-going training and spill response equipment. Table 2 shows some of the equipment costs related to spill response.

Table 2: Sample Equipment Costs for Spill Prevention and Response

Storage Protection Device	Cost
Absorbents	$2 to $35 for 25 lb. bag
Containment Pallets	$50 to $350, based on size and number of barrels to be stored
Industrial Spill Kits	$280 to $450, based on # of pads, booms, goggles, gloves, etc.

Sources: Costs were derived from a review of numerous websites that handle proprietary spill control or hazardous material control products

Resources

California Stormwater Quality Association. 2003 California Stormwater BMP Handbook: Industrial and Commercial.
www.cabmphandbooks.com

Setting Administrative Civil Liability. State Of California Regional Water Quality Control Board, San Francisco Bay Region.
www.swrcb.ca.gov/rwqcb2/OrderNum/99-038.doc

Pollution Prevention Fact Sheet Sector: Printers/Lithographer: Spill Prevention.
http://dep.state.ct.us/wst/p2/p2printer/spillprc.htm

EPA Office of Wastewater Management Storm Water Management Fact Sheet: Spill Prevention Planning
http://www.epa.gov/owm/mtb/spillprv.pdf

Developing A Spill Prevention Response Plan
http://www.dep.state.pa.us/dep/subject/pubs/water/wc/FS1471.doc

City of Rancho Santa Margarita Spill Prevention and Cleanup
http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1697

Land of Sky Regional Council Municipal Pollution Prevention Planning
http://h2o.enr.state.nc.us/su/PDF_Files/Land_of_Sky_factsheets/FactSheet_5.pdf

Environmentally Responsible Best Management Practices Emergency Response and Spill Cleanup Plans
http://www.cleanrivers-pdx.org/pdf/bmp04.pdf

City of Mitcham, Australia Emergency Spill Response Factsheet
http://www.mitchamcouncil.sa.gov.au/webdata/resources/files/Emergency_Spill_Response_Plan1.pdf

H-8

Hotspot Source Area: Waste Management

DUMPSTER MANAGEMENT

Description

Dumpsters provide temporary storage of solid wastes at many businesses. Most dumpsters are unregulated hotspots that can be a significant pollution source in many subwatersheds. Many dumpsters are open, which allows rainfall to mix with the wastes, creating a potent brew affectionately known as "dumpster juice." When combined with the inevitable spillage, dumpsters can be a source of trash, oil and grease, metals, bacteria, organic material, nutrients, and sediments. Poor dumpster management can make a site unsightly, create unpleasant odors, and attract rodents (Figure 1). Table 1 lists some common pollution prevention practices for dumpsters.

Application

Every business generates waste as a part of its daily operations and temporarily stores it pending disposal by an independent contractor. Nearly every hotspot site has a ubiquitous dumpster located somewhere behind the building. Several factors should be evaluated to determine whether an individual dumpster could be a pollution source. The first is whether the dumpster pad is directly connected to the storm drain system. The second factor is how frequently the dumpster is emptied. Frequently emptied dumpsters usually have more spillage and are open more often and exposed to rainfall. The last factor is the type and moisture content of wastes thrown in the dumpster, which can include trash, yard waste, building rubble, food, or other waste products.

Figure 1: Dumpster Site with Typical Signs of Poor Management (trash accumulation, dumpster without lid, dumpster near storm drain)

Good dumpster management is particularly important to reduce trash loadings to a stream. Several kinds of hotspots deserve scrutiny if they exist in a subwatershed, including dumpsters serving convenience stores, fast food restaurants, shopping centers, recycling centers, solid waste collection areas and hospitals. It may useful to target waste haulers as well, since the placement of temporary open dumpsters for demolition, remodeling and other construction purposes can be a problem in some subwatersheds.

Primary Training Targets

Key education targets are the managers and employees that use the dumpster.

Feasibility

Dumpster pollution prevention practices can be applied in all regions and climate zones.

Table 1: Pollution Prevention Practices for Dumpsters

- Locate dumpsters on a flat concrete surface that does not slope or drain to the storm drain system
- Install a secondary containment system such as a berm or curb around the dumpster if it is connected to the storm drain
- Install protective covers or lids to keep rainfall from accumulating in the dumpster or secondary containment area
- Close lids at dumpsters located at vehicle service areas, fast food restaurants, and convenience stores
- Install an oil and grease separator or sump pit for dumpsters that receive waste with a high moisture content
- Place clear and visible signs on dumpsters indicating what kind of waste can be accepted
- Never throw oil and grease or other liquids into a dumpster - provide alternative disposal locations for impermissible substances
- Close and secure lids properly when the dumpster is not being loaded or unloaded
- Empty dumpsters on a frequent basis to prevent overfilling or storage outside the dumpster
- Repair leaking or damaged dumpsters immediately
- Never use bleach and soap to clean the container unless the wash water is sent to the sanitary sewer system
- Pick up and sweep trash and litter from around the dumpster regularly

Implementation Considerations

Dumpster pollution prevention practices can be hard to implement. Perhaps the greatest challenge is changing the mindset of employees about proper disposal techniques. Since dumpster practices require additional effort, owners need to train staff and inspect dumpsters more frequently. Lastly, dumpster practices that require liquids/oil and grease separation or secondary containment may be costly for many small businesses.

Target Areas for Education and Enforcement- Education and enforcement should be targeted to specific types of dumpsters that are known hotspots and/or have high potential for environmental contamination. These include:

- Foodservice dumpsters that produce waste with high moisture content and oil and grease that can be easily carried by storm water runoff (Figure 2)
- Automobile service dumpsters that can potentially produce a high volume of wastes, such as oil and grease, cleaning fluids, used parts, filters, and rags
- Industrial dumpsters that produce a high volume and variety of wastes
- Dumpsters with multiple contributors, such as multi-family units, and institutional facilities
- Temporary dumpster locations at small construction sites, demolition projects, and redevelopment projects

Figure 2: Restaurant Waste Barrels Without Secondary Containment

Routine Inspection - Dumpsters should be routinely inspected for the following problems:

- Cracks or dents in the dumpster that may permit storm water run-on
- Poorly functioning lids that cannot be closed or secured
- Hydraulic hoses with cracks or leaks (if applicable)
- Presence of impermissible substances in the container
- Liquid leaking from the container and/or signs of previous leakage, which are often indicated by stains or deposits on ground or storm drain inlets

Working with Solid Waste Disposal Contractor - Choosing a reliable and environmentally-conscious waste disposal contractor is important to prevent storm water contamination. Routine maintenance and emptying of the dumpster by the solid waste disposal contractor should be performed on a regular basis. If concerns about the condition of the dumpster or collection process arise (e.g. dumpster put in wrong location, dented corners, infrequent dumping, etc.), the service should be contacted immediately.

Cost - Proper dumpster management is a relatively inexpensive storm water pollution prevention practice and avoids the liability for spills and/or containment. Operational costs depend on the volume and type of waste, frequency of maintenance (e.g., replacing damaged containers), and whether additional protective measures need to be installed, such as secondary containment systems, canopies, and signs.

Operational costs are primarily related to training workers on proper dumpster management. Frequent training is needed to maintain compliance by workers, particularly in high turnover businesses.

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Storm Water BMP 64. Solid Waste Containers (Dumpsters/Compactors)
http://www.cleancharles.org/stormwater_bmp4.shtml

North Central Texas Council of Governments (NCTCOG) Building Maintenance BMP Fact Sheet
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

San Mateo Countywide Storm Water Pollution Prevention Program: Storm Water Best Management Practices for Supermarkets and Grocery Stores
http://www.flowstobay.org/pdfs/bmp/Food/grocery.pdf

Harvard University Stormwater Bmp, Solid Waste Container
http://www.uos.harvard.edu/ehs/env_5bmp4.shtml

California Stormwater Quality Association Factsheet: Waste Handling and Disposal
http://www.cabmphandbooks.com/Documents/Municipal/SC-75.pdf

City of Rancho Santa Margarita Waste Handling and Disposal
http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1772

Stanford University SLAC Stormwater BMP Factsheet: Waste Handling and Disposal
http://www.slac.stanford.edu/esh/epr/Stormwater/BMP9.html

H-10

Hotspot Source Area: Physical Plant

BUILDING MAINTENANCE

Description

Many routine practices used to maintain the walls and rooftops of buildings can cause storm water pollution such as washing, power washing, sanding, sandblasting, painting, graffiti removal, and roof maintenance (Figure 1). Some building maintenance practices produce polluted wash water that can directly enter the storm drain system during dry weather, whereas others deposit fine particles or liquids that can wash off during wet weather (e.g., cleaners, paint, solvents or sealers). In either case, maintenance practices can cause sediment, metals, hydrocarbons, or other potentially toxic pollutants to enter the storm drain system. Table 1 summarizes simple pollution prevention practices that can be used by maintenance contractors to minimize the risk of storm water pollution during routine building maintenance.

Figure 1: Roof Maintenance

Application

Routine maintenance occurs at most buildings, but is performed most frequently at high-visibility retail, institutional, and industrial sites. Since maintenance is often conducted by small contractors that use specialized mobile equipment, the best approach is to directly educate and train contractors rather than individual property owners.

Primary Training Targets

The training targets for this practice are facility operators; maintenance crews; and washing, power-washing, sandblasting, and painting contractors.

Feasibility

Since most maintenance contractors are small businesses, it can be hard to assemble them for pollution prevention training.

Implementation Considerations

While these pollution prevention practices primarily rely on simple good housekeeping, they can be hard to implement if either the property manager or contractor lacks awareness about the environmental consequences of building maintenance operations. Municipalities and industries can help promote broader use by specifying precise pollution prevention practices when they negotiate maintenance contracts or work orders.

Cost - Presumed to be minimal, with the exception of storm drain covers or containment devices.

Table 1: Pollution Prevention Practices for Building Maintenance

- Enclose painting and sanding operations, where possible or required by air quality regulations
- Lay tarps below outside work areas to collect fine particles and splatters
- Sweep up paved surfaces immediately after scraping, stripping, sanding or sandblasting operations are completed. Do not use blowers or hoses
- Block adjacent storm drains when stripping or cleaning buildings with high-pressure water (Figure 2), and contain and collect wash water for disposal in the sanitary sewer or other appropriate disposal method. Filtering wash water at the storm drain inlet may be acceptable if no soaps are used
- Direct runoff from pressure washing operations over grassy areas or to a bermed area where it can be collected for disposal in the sanitary sewer
- Never clean paintbrushes, sprayers or containers in a manner where rinse water can reach a curb, gutter, storm drain or stream
- When cleaning up after using water-based paints, first paint out the brushes as much as possible, then rinse in a sink. Empty cans, brushes and rags should be disposed in the trash
- When cleaning up after using oil-based paints, paint out the brushes as much as possible, then filter and reuse thinners and solvents. Treat excess liquids as a hazardous waste and dispose of accordingly
- Purchase paints, sealants and finishes that have low environmental risk
- Prevent discharge of wash water to the storm drain system or ground
- Label storm drains with "No Dumping" signs to deter disposal of waste and washwater

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com

North Central Texas Council of Governments Building Maintenance Pollution Prevention BMPs
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

Ventura Countywide Stormwater Quality Management Program. Clean Business Program Fact Sheet: Building Maintenance and Grounds Maintenance
http://www.vcstormwater.org/

Washtenaw County, MI Community Partners for Clean Streams Fact Sheet SERIES #4: Maintaining Buildings and Pavement
http://www.ewashtenaw.org

Figure 2: Storm Drain Cover Used when Washing with Soaps

Pierce County, WA Cleaning And Washing Activities
http://www.co.pierce.wa.us/pc/services/home/environ/water/swm/sppman/a1.htm#a15

City of Rancho Santa Margarita Building Maintenance
http://www.cityofrsm.org/civica/filebank/blobdload.asp?BlobID=1684

H-11

Hotspot Source Area: Physical Plant

PARKING LOT MAINTENANCE

Description

Parking lots are associated with nearly every commercial, industrial, institutional, municipal and transport-related operation in a subwatershed. Each lot requires annual maintenance, including litter pickup, sweeping, pothole repair, power-washing, steam cleaning, de-greasing, re-striping, and re-surfacing. Several maintenance operations have the potential to pollute storm water runoff if sensible pollution prevention practices are not employed. This is particularly true for power washing, which can deliver sediment, nutrients, hydrocarbons, and other pollutants to the storm drain system. Less is known about the storm water impacts of parking lot re-sealing and re-surfacing operations, but anecdotal data suggests that they could be a significant source of polycyclic aromatic hydrocarbons under certain conditions.

Application

In general, power washing and steam cleaning are conducted more frequently at commercial and retail parking lots in high visibility locations, airport runways and some industrial parking lots. When evaluating these operations, it is helpful to interview mobile vendors about the kinds of parking lots they maintain most often. Several factors help determine whether this pollution prevention practice should be applied to a parking lot, including the size and usage of the lot, the pavement condition, and whether it is directly connected to the storm drain system.

Primary Training Targets

Training targets include property managers; facility engineers; and sweeping, steam cleaning, power-washing, asphalt re-surfacing, and sealing contractors.

Table 1: Pollution Prevention Practices for Parking Lot Maintenance

- Use dry methods such as absorbents, brooms, or wire brushes to clean pavement surfaces where possible
- Mechanically remove loose debris before washing or power washing the lot
- Pressure wash pavement only when needed, and avoid using acids, soaps, solvents and other cleaning agents. Also, block adjacent storm drains, contain and collect wash water for disposal in the sanitary sewer or other appropriate disposal method
- Filtering of wash water at the storm drain inlet may be acceptable if no soaps are used. Direct runoff from pressure washing operations over a grassy area or to a bermed area where it can be collected for disposal in the sanitary sewer system
- Cover and seal nearby storm drain inlets and manholes before applying sealant to parking lot surfaces, and only apply sealants when no precipitation is forecast
- Conduct surface repair work during dry weather, where possible
- Post signs in parking areas to control litter and prohibit automobile maintenance or washing in the parking lot
- Inspect and cleanout catch basins and storm water treatment practices routinely to remove sediment and pollutants (see Manual 9)

Feasibility

Parking lot maintenance practices can be applied in all regions of the country, and sweeping and power washing are commonly used for aesthetic reasons in many large parking areas. Many facilities contract out their parking lot maintenance work to small businesses, such as mobile washers and sweeping companies. These contractors should be the primary target of training and education on parking lot pollution prevention practices.

Changing the mindset of contractual maintenance employees and facility managers can be a challenge to implementing this practice, so some communities have included specific language in their storm water ordinances regulating pavement cleaning to prevent discharges to the storm drain.

Implementation Considerations

Parking lot pollution prevention focuses mainly on two maintenance practices: power washing and sweeping. Dry cleanup of parking lots is preferred to any wash down activity, since washing can introduce oils and heavy metals into the storm drain system (Figure 1). For small and medium-sized lots, dry cleanup can be done using a broom, or a mop and a bucket of warm water (which is disposed of in the sanitary sewer). Larger lots can be cleaned using sweeper technologies (see Manual 9). The frequency of parking lot sweeping should be based on usage and field observations of waste accumulation.

Cost - Parking lot pollution prevention is generally a low-cost practice, focused on simple operational changes to reduce discharges to the storm drain system. The main cost associated with this practice is employee training.

Figure 1: Parking Lot Power Washing

Resources

Alameda Countywide, CA Clean Water Program: Parking Lots
http://www.cleanwaterprogram.com/parking_lots_fact_sht.pdf

Fort Worth, TX Mobile Commercial Cosmetic Cleaning Fact Sheet for Power Washers
http://www.fortworthgov.org/DEM/factsheet.htm

City of Carlsbad, CA Best Management Practices for Power Washing
http://www.ci.carlsbad.ca.us/stormwater/comstopmpdf/mobilewashing.pdf

North Central Texas Council of Governments Building Maintenance BMP Fact Sheet
http://www.dfwstormwater.com/P2/PDF/p2bldg_bmps.pdf

H-12

Hotspot Source Area: Turf and Landscaping

TURF MANAGEMENT

Description

Many non-residential areas in a subwatershed have significant areas of intensively managed turf. Examples include road and utility rights-of-way, schools, ball fields, parks, corporate office parks and the grounds of large institutions, each of which has a different turf management regime (Figure 1). Turf management involves mowing, fertilization, pesticide application, and supplemental irrigation, where needed. These services are generally performed by a lawn care/landscaping contractor or an in-house maintenance crew. Poor turf management practices have the potential to create storm water pollution, particularly in urban areas where soils are compacted. Potential pollutants generated by poor turf management include nutrients, herbicides, organic carbon and sediment. In addition, poor irrigation practices can produce nuisance water in some subwatersheds.

Table 1 summarizes a series of simple pollution prevention practices for turf management to reduce this potential pollution source. Turf management practices are implemented by educating, training and certifying workers in the lawn care industry.

Figure 1: Extensive Turf Areas Commonly Found in Schoolyards

Application

The typical distribution of turf cover in three Mid-Atlantic states is shown in Table 2. As can be seen, home lawns constitute 67% of the total turf cover. Pollution prevention practices for residential lawns are described in profile sheets N-1 through N-8. Non-residential turf comprises about a third of the total turf cover (although the exact percentage will vary from subwatershed to subwatershed).

Municipal turf accounts for about two-thirds of non-residential turf, and includes roadside rights-of-way, public open space, parks and schools. Institutional turf, commercial turf and golf courses each represent about 10% of non-residential turf. With the exception of airports and sod farms, turf cover is generally rare at most industrial sites.

In terms of the intensity of turf management, golf courses, institutions, and corporate office parks usually receive the highest inputs of water, fertilizer, and pesticides. Turf management on municipal lands tends to be fairly modest, with the exception of athletic fields at schools and some park settings. Highway and power line rights-of-way are seldom fertilized or irrigated, although they are increasingly sprayed with herbicides to limit vegetative growth in places that cannot be safely or conveniently mowed. Recent research has linked roadway and utility herbicide use to the presence of atrazine and simazine in urban streams. These herbicides were detected in streams where they were used to control vegetation in rights-of-way, but were not available to residential homeowners for retail sale (USGS, 1999).

Table 1: Pollution Prevention for Turf Management
• Evaluate whether some or all of the turf area can be managed as meadow or forest. If so, consider watershed reforestation techniques (see Manual 7)
• Sweep any grass clippings away from paved surfaces after mowing
• Use mulching type mowers to return grass clippings to the lawn
• Never apply fertilizers or pesticides within five feet of pavement, 25 feet of a storm drain inlet, or 50 feet of a stream or water body
• Consider a low or no fertilizer approach to maintain turf
• Select a reputable lawn care or landscape service that uses organic fertilizers and natural pest management techniques
• Perform a soil test to determine actual fertilization need and set application rates
• Calibrate fertilizer spreaders to avoid excessive application. Do not apply fertilizer just prior to predicted rainfall events or on wet turf
• Do not prepare herbicides or pesticides for application near storm drains
• Minimize off-target application of fertilizers, and leave a no-application zone for fertilizer and pesticides around streams and lakes
• Work fertilizers into the soil rather than just applying onto the surface
• Reduce water needs during the hot summer months by adjusting grass to an increased height
• Consider turf alternatives, such as native or low-water, cool-season turf grasses
• Select grass species that will best meet the requirements and purposes of the lawn area
• Use synthetic turf for small, lightly used and inaccessible areas that require no watering, chemicals, or mowing

Primary Training Targets

The training targets for this practice include property managers; landscaping contractors; golf course managers; and road, park, and utility maintenance crews and supervisors.

Table 2: Distribution of Turf Cover by Sector in Three Mid-Atlantic States	
Sector	% of Total Turf Cover
Home Lawns	67
Roadside Rights-of-Way	10
Municipal Open Space	7
Parks	3.5
Schools	3
Commercial/Corporate	3
Institutions	3
Golf Courses	2.5
Airports/Sod Farms	1
Source: Schueler, 2003	

Feasibility

Turf grass management practices vary regionally, in response to different growing seasons, rainfall amounts and soil types. As Swann (1999) notes, arid and semi-arid areas rely heavily on supplemental irrigation, whereas the practice is less common in humid regions. Herbicide use tends to be greater in northern regions, while outdoor insecticide use is greatest in southern regions. To reduce the quantity of products used to manage turf, consult the local cooperative extension service for advice on the most appropriate grass species depending on its intended use.

A second key feasibility factor is the nature of the local lawn care industry. In many regions, it tends to be a low-wage, seasonal industry that employs young workers. These workers often have limited education, may not speak English, and have high turnover rates. As a result, education programs targeted toward the industry need to be simple, multi-lingual, and frequently repeated.

Implementation Considerations

In general, healthy and attractive turf is produced by good pollution prevention practices. A number of factors influence turf health, which can be stressed by mowing activity. Mowing grass too short causes turf to become less tolerant of environmental stresses, more disease-prone and more reliant on pesticides, fertilizers and irrigation. Mowing only a third of the grass blade height during cooler times of the day can minimize turf stress. Areas where soil is compacted may require aeration or soil amendments in order to increase permeability.

Equipment modifications may also be necessary to reduce environmental impacts. Fertilizer application equipment should be calibrated frequently (see the Resources section for more tips). Granular spreaders need to be calibrated for each product, since each fertilizer requires a different spreader setting to provide the desired rate of fertilizer. Liquid fertilizers should be applied using coarse droplet nozzles with a close/tight spray pattern at the lowest pumping pressure to avoid drift onto non-turf areas.

Professional training is extremely important to successfully implement turf management practices. Lawn care company employees can be trained on the proper calibration, use, and application techniques for the equipment they will use. Local governments have found that certification classes and promotional tie-ins can promote changes in the practice of professional landscape and lawn care companies. Examples include training, certification, and recognition programs for environmentally sensitive golf course management (See Profile Sheet II-15 for resources designed specifically for golf course managers).

Educating lawn care professionals on turf pollution prevention practices is an excellent way to improve local water quality. Messages to highlight in any education program include:

- Local information on proper timing and application rates for fertilizers and pesticides
- Registration and permit requirements for professional landscaping and lawn care service companies
- Recommended management practices and guidelines for reducing maintained turf area

Cost - Costs consist largely of program efforts for training and education, with only small operational costs to implement turf management practices. It is often reasonable to assume that operational savings from reduced fertilizer and herbicide inputs will offset any increased costs for more intensive practices, such as manual weed removal. Replacement of turf areas should also reduce mowing costs. A study in North Marin County, CA compared traditionally landscaped projects to projects that met specific design criteria for water conservation. The study found that when costs for water, labor, fertilizer, fuel, and herbicide were considered, annual savings of $75 per dwelling unit were realized for the water-conserving projects (Iwata, 1994). Water-conserving landscapes averaged 55% less turf area; used 54% less water; and saved 25% in labor costs, 61% in fertilizer, 44% in fuel, and 22% in herbicides, with a overall total of 10% less landscaped area.

Resources

California Stormwater BMP Handbook: Industrial and Commercial.
http://www.cabmphandbooks.com/

Xeriscape: Winning the Turf War Over Water
http://hem.dis.anl.gov/eehem/94/940711.html

University of Florida Cooperative Extension How to Calibrate a Fertilizer Spreader
http://turf.ufl.edu/residential/fertspreader.htm

Turf and Landscape Irrigation Best Management Practices. Prepared by the Water Management Committee of The Irrigation Association
http://www.irrigation.org/gov/default.aspx?r=1&pg=bmps.htm

Health Dangers of Urban Use of Pesticides Working Group. Sustainable Municipal Turf Management. Region of Ottawa-Carleton, Ontario Canada
http://www.sonkey.ws/ipm.html

US EPA. Integrated Pest Management (IPM) in Schools
http://www.epa.gov/pesticides/ipm/

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities.
http://www.swrcb.ca.gov/stormwtr/murp.html

Stormwater Management Manual for Western Washington: Volume IV - Source Control BMPs. WA Dept. of Ecology, Olympia, WA.
http://www.ecy.wa.gov/biblio/9914.html

Landscaping for Stormwater Management
http://www.dep.state.fl.us/law/Documents/Grants/CMP/pdf/stormwaterrnems.pdf

St. Johns River Water Management District Florida Landscaping to Promote Water Conservation Using the Principles of Xeriscape
http://sjr.state.fl.us/programs/outreach/conservation/landscape/loc.html

H-13

Hotspot Source Area: Turf and Landscaping

LANDSCAPING/GROUNDS CARE

Description

Landscaping is a common feature in commercial, industrial and municipal settings, and typically involves maintaining beds of trees, shrubs, ground covers and/or flowers that are intended to meet unique landscaping objectives for a site (Figure 1). Once installed, landscaping beds are maintained seasonally to renovate, mulch, weed, and prune; pick up leaves and trash; inspect and repair irrigation systems; and apply fertilizers and pesticides, as needed. A well-designed and maintained landscaping bed absorbs rainfall, produces little runoff and discharges few pollutants. In some cases, landscaping can serve as an attractive on-site storm water retrofit.

However, landscaping can be a source of storm water pollutants at many sites, particularly if it drains to adjacent impervious areas. Poor landscaping practices can generate organic wastes; excess irrigation water, nutrients, and pesticides; organic carbon; and sediment loads to the storm drain system.

Figure 1: Landscaped Area at a Commercial Development

A series of simple pollution prevention practices, profiled in Table 1, can greatly reduce the potential for storm water pollution during routine landscape maintenance operations. Most landscaping maintenance is performed by contractors or in-house maintenance crews. Improved practices are generally adopted by educating, training, and certifying workers and supervisors within the landscaping and lawn care industry.

Application

Landscaping is a significant component of commercial land use, particularly in communities that have ordinances requiring landscaping on as much as 5-10% of commercial sites. Institutional lands such as colleges, private schools, and churches may also have a high percentage of landscaping. The best pollution prevention opportunities will be found at larger commercial and institutional sites in most subwatersheds.

Primary Training Targets

Property managers, lawn care and landscaping contractors, and municipal landscaping crews are the major training targets for this practice. These groups can be targeted for business recognition, certification or training programs. Since they are often responsible for turf management (H-12), outreach efforts should be integrated.

Table 1: Pollution Prevention for Landscaping and Grounds Care

Landscape Management

- Collect landscape waste and dispose at a local municipal yard waste recycling/composting facility
- Cover exposed beds and soils with mulch to minimize erosion and runoff
- Use manual and/or mechanical methods to remove weeds rather than herbicides
- Select a reputable landscaping company that uses native plants, organic fertilizers and natural pest management techniques
- Never apply fertilizers or pesticides within five feet of pavement, 25 feet of a storm drain inlet or 50 feet of a stream or water body
- Do not use leaf blowers to blow waste into streets, storm drains, or ditches
- Sweep up any organic matter from paved surfaces after landscaping operations
- Evaluate whether storm water can be directed into the landscaping bed to obtain further treatment. If installing a new landscaping bed, consider designing as a bioretention area or rain garden (see Manual 3)

Pesticides

- Develop and implement an integrated pest management plan that uses pesticides only as a last resort
- Apply pesticides when rain is **not** expected and when wind speeds are low
- Use the minimum amount needed for the job, employ techniques to curtail spray drift of pesticides and never mix or prepare pesticides within 25 feet of storm drains
- Consider a low or no pesticide approach to maintain landscaping areas

Irrigation

- Employ shutoff devices to prevent irrigation after precipitation or if a pressure drop occurs due to broken sprinkler heads or lines
- Design irrigation systems specific to each landscaped area's water requirements and make irrigation plans consistent with local water conservation resolutions
- Select native plant species whenever possible and group together plants with similar water requirements in order to reduce excess irrigation

Feasibility

Landscaping practices vary regionally, in response to different growing seasons, winter temperatures, rainfall depths and soil types. This, in turn, influences the type and availability of native plant species that can be used. The local cooperative extension service should be consulted on effective local practices for your region.

A second key feasibility factor is the nature of the local landscaping industry, which tends to employ younger, low-wage, seasonal workers. Landscaping workers often have limited education, may not speak English and change jobs frequently. As a result, education programs targeted toward landscaping contractors need to be simple, multilingual, and repeated every year.

Implementation Considerations

Landscape Management - Landscape management starts with the right soil conditions for planting. An adequate topsoil layer contains at least 8 - 10% organic matter to provide a growing medium. Soil amendments may be needed to reduce soil compaction and improve permeability. Plant material that is adapted to the local climate and soil type should be selected, and native plants should be the first choice.

Integrated Pest Management (IPM) - This approach uses environmentally-friendly measures to control pests at an acceptable level. IPM plans follow five basic steps to identify pest controls with minimal environmental impacts that maintain healthy landscaping.

The basic steps are to:

1. Identify problem pests and their life cycles. Any pest control used should be conducted at the life stage when the pest is most vulnerable
2. Establish tolerance thresholds for pests
3. Monitor pest problems and modify current landscaping practices to discourage pests
4. Use non-chemical (cultural, physical, mechanical, or biological) controls first; if pests exceed the tolerance thresholds, select the least toxic chemical pesticides available
5. Evaluate and record the effectiveness of pest controls and modify as needed to prevent recurrence

Irrigation – Over-watering can produce runoff that contains a variety of pollutants. An efficiently watered landscape avoids unwanted runoff, conserves water and saves money. The amount of irrigation needed depends on the rooting depth of the plant species, the available water-holding capacity of the soil, and the efficiency of the irrigation system. One method to reduce over-watering is to conduct a water audit to monitor water usage in landscaping, and design the most efficient use of irrigation water. A water audit evaluates three types of site data:

- Water-use history
- Information on the landscaped area (size, plant species, etc.)
- Evapotranspiration data from a local weather station to get a reasonable estimate of the amount of water a site *should* be using

Next, the existing irrigation system is inspected to check valve performance, pressure, flow rates, and coverage patterns. This information helps design a more efficient irrigation system and watering schedule for the landscaping area.

Automated irrigation technology can also improve irrigation efficiency and conserve water. For example, automated irrigation controllers are available, which communicate directly with weather stations to get local weather data to optimize irrigation scheduling. A study in California found that using an automated controller saved 37 gallons of water per day per 1,200 ft^2 of landscaped area (Meeks, 2002).

Delivery Mechanism(s) to Make Projects Happen

A wide range of educational materials is available to promote better pollution prevention practices in the landscaping industry. Materials can include brochures, posters, training courses, and online homestudy courses. In addition, several communities have designed programs to train and certify landscape maintenance contractors. In order to be certified, landscape contractors typically attend training classes on efficient landscaping practices, including non-point source pollution reduction, water efficiency, integrated pest management, and green waste reduction. Commercial contractors use the certification as a marketing tool to attract customers that want an environmental approach to landscape maintenance.

Cost – The costs to implement landscaping pollution prevention practices primarily involve training and education. Operational costs for changing current landscaping practices are generally quite low.

Resources

California Stormwater BMP Handbook: Industrial and Commercial
http://www.cabmphandbooks.com/

Turf and Landscape Irrigation Best Management Practices, Prepared by the Water Management Committee of The Irrigation Association
http://www.irrigation.org/gov/default.aspx?r_1&pg=bmps.htm

Integrated Pest Management (IPM) in Schools
http://www.epa.gov/pesticides/ipm/

Florida Yards and Neighborhoods Program
http://hort.ifas.ufl.edu/fyn

Washington State Department of Ecology Water Quality Program. Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology
http://www.ecy.wa.gov/biblio/9914.html

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities
http://www.swrcb.ca.gov/stormwtr/murp.html

H-14

Hotspot Source Area: Miscellaneous Sources

SWIMMING POOL DISCHARGES

Description

Routine swimming pool maintenance can cause chlorinated water or filter backflush water to be discharged to the storm drain or stream, which can be toxic to aquatic life. Municipal and commercially-owned pools can be a major source of chlorinated water, as they hold as much as 100,000 gallons of water with an initial chlorine concentration of two to four parts per million (Figure 1). When exposed to sunlight, chlorine levels break down over several days. Consequently, holding water in the pool for several days prior to proper discharge is the core of this pollution prevention practice. Most states and localities require that larger pools discharge to the sanitary sewer system, and have appropriate pre-treatment and NPDES permits. Table 1 describes other pollution prevention practices for swimming pool discharges.

Application

The density of swimming pools can be ascertained by inspecting low-altitude aerial photographs or consulting local health department databases. If pool density appears to be high in the subwatershed, then it may be worth checking out local plumbing codes and practices that relate to public and private swimming pool discharges.

Primary Training Target

The primary training targets are pool managers that operate municipal and commercially-owned pools and local pool inspectors.

Figure 1: Large Municipal Pool

Table 1: Pollution Prevention Practices for Swimming Pool Discharges

The best option for discharging chlorinated water drained from pools is the sanitary sewer (i.e., sewage treatment plant). If discharge to a sanitary sewer is not possible, chlorinated water from pools and hot tubs may be discharged over lawns or pervious areas when the following provisions are met:

- Shut off the chlorination system or stop adding chlorine one week before disposing of pool water
- Make sure the pH of pool discharge is between 6.5 and 8.5
- Chlorine levels should not exceed 0.01 ppm for pool water discharges
- Discharge or spread pool water where it will not flow into a stream, storm sewer, or someone else's property
- Pool discharges should be handled in a manner that will prevent nuisance conditions (e.g., odors and mosquito-breeding conditions). Avoid ponding water for prolonged periods

Extra care must be taken when disposing of water resulting from backflushing of pool filters. It should be discharged to the sanitary sewer, septic tank system, or a seepage pit.

Feasibility

This practice applies to all pool owners and operators. Outdoor pool density tends to be greater in warmer regions, although the discharge problem may be more severe in cooler climates where swimming pools are drained at the end of the season to prevent damage from freezing. While this pollution prevention practice is easily implemented at municipally-owned pools, proper discharge of chlorinated pool water may be harder to control at privately-owned pools.

Implementation Considerations

This pollution prevention practice is implemented through a combination of education, enforcement, and inspection. Education can be achieved through pamphlets and posters targeted to pool managers that operate municipal, neighborhood and commercially-owned pools. End-of-season inspections are also helpful, and may be done in conjunction with routine safety and health inspections required by local authorities. The educational message to pool owners and commercial pool cleaners should clearly emphasize the impact of chlorinated pool water on aquatic life.

Cost – Swimming pool discharge pollution prevention practices are generally low cost and primarily involve staff time for inspections and education of pool managers and employees.

Resources

2003 California Stormwater BMP Handbook: Municipal
http://www.cabmphandbooks.com

Water Quality Permit Program: Guidance for Swimming Pool and Hot Tub Discharges
http://www.deq.state.or.us/wq/wqpermit/swimpools.pdf

National Menu of Best Management Practices for Storm Water Phase II: Alternative Discharge Options for Chlorinated Water
http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

Stormwater Management Manual for Western Washington: Volume IV -- Source Control BMPs. WA Dept. of Ecology, Olympia, WA.
http://www.ecy.wa.gov/biblio/99014.html

H-15

Hotspot Source Area: Miscellaneous Sources

UNIQUE HOTSPOT OPERATIONS

Certain unique hotspot operations require customized pollution prevention practices. Examples of unique hotspot operations include construction sites, marinas, hobby farms, golf courses, fairgrounds, racetracks, and restaurants. Each type of hotspot has its own mix of pollution prevention practices, which are described in the Resources sections of this sheet.

CONSTRUCTION

Construction sites have long been recognized as pollution hotspots, and pollution prevention and erosion control practices are required for sites that disturb more than one acre. While erosion and sedimentation are the greatest concerns at construction sites, practices used to store and handle construction materials and maintain heavy equipment can be a source of many pollutants including nutrients, soil additives, pesticides, trash, heavy metals, and oil and grease. The magnitude of storm water pollutants depends on the size of the construction site and climatic conditions.

Resources

How to Inspect Construction Sites for Compliance With NPDES Permit
www.epa.gov/region6/water/npdes/sw/ms4/c3/coninsp.ppt

Best Management Practices Manual For Construction Sites In Honolulu
http://www.cleanwaterhonolulu.com/reports/BMP_manual.pdf

City of Dana Point Stormwater Best Management Practices (BMPs) For General Construction and Site Supervision
http://www.danapoint.org/water/WC-CONSTRUCTION.pdf

EPA NPDES Storm Water Pollution Prevention Plans for Construction Activities
http://cfpub1.epa.gov/npdes/stormwater/swppp.cfm

EPA NPDES Construction Site Storm Water Runoff Controls
http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

California Dept. of Transportation Construction Site Best Management Practices (BMPs) Manual
http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf

N-1

Neighborhood Source Area: Yard

REDUCED FERTILIZER USE

Description

The ideal behavior is to not apply fertilizer to lawns. The next best thing for homeowners who feel they must fertilize is to practice natural lawn care: using low inputs of organic or slow release fertilizers that are based on actual needs as determined by a soil test. The obvious negative watershed behavior is improper fertilization, whether in terms of the timing, frequency or rate of fertilizer applications, or a combination of all three. The other important variable to define is who is applying fertilizer in the neighborhood. Nationally, about 75% of lawn fertilization is done by homeowners, with the remaining 25% applied by lawn care companies (Figure 1). This split, however, tends to be highly variable within individual neighborhoods, depending on its income and demographics.

How Fertilizer Influences Water Quality

Recent research has demonstrated that lawn over-fertilization produces nutrient runoff with the potential to cause downstream eutrophication in streams, lakes, and estuaries (Barth, 1995a and 1995b). Scientists have also discovered that nitrogen and phosphorus levels in lawn runoff are about two to 10 times higher than any other part of the urban landscape such as streets, rooftops, driveways or parking lots (Bannerman *et al.*, 1993; Steuer *et al.*, 1997; Waschbusch *et al.*, 2000; Garn, 2002).

Figure 1: Lawn Care Company Truck

Percentage of People Engaging in Fertilizer Use

Lawn fertilization is among the most widespread watershed behaviors in which residents engage. A survey of lawn care practices in the Chesapeake Bay indicated that 89% of citizens owned a yard, and of these, 50% applied fertilizer every year (Swann, 1999). The average rate of fertilization in 10 other regional lawn care surveys was even higher (78%), although this may reflect the fact that these surveys were biased towards predominantly suburban neighborhoods and excluded non-lawn owners. Several studies have measured the frequency of lawn fertilization, and have found that lawns are fertilized about twice a year, with spring and fall being the most common season for applications (Swann, 1999).

A significant fraction of homeowners can be classified as "over-fertilizers" who apply fertilizers above recommended rates. Surveys indicate the number of over-fertilizers at 50% to 70% of all fertilizers (Morris and Traxler, 1996; Swann, 1999; Knox *et al.*, 1995). Clearly, many homeowners, in a quest for quick results or a bright green lawn, are applying more nutrients to their lawns than they actually need.

Variation in Fertilization Behavior

Many regional and neighborhood factors influence local fertilization behavior. From a regional standpoint, climate is a very important factor, as it determines the length of the growing season, type of grass, and the irrigation needed to maintain a lawn. A detailed discussion of the role these factors play in fertilization can be

found in Barth (1995a). A host of factors also comes into play at the individual neighborhood scale. Some of the more important variables include average income, market value of houses, soil quality, and the age of the development (Law *et al.*, 2004). Higher rates of fertilization appear to be very common in new suburban neighborhoods where residents seek to establish lawns and landscaping. Also, lawn irrigation systems and fertilization are strongly associated.

Difficulty in Changing Behavior

Changing fertilization behaviors can be hard since the desire for green lawns is deeply rooted in our culture (Jenkins, 1994; Teyssot, 1999). For example, the primary fertilizer is a man in the 45 to 54 year age group (BHI, 1997) who feels that "a green attractive lawn is an important asset in a neighborhood" (De Young, 1997). According to surveys, less than 10% of lawn owners take the trouble to take soil tests to determine whether fertilization is even needed (Swann, 1999; Law *et al.*, 2004). Most lawn owners are ignorant of the phosphorus or nitrogen content of the fertilizer they apply (Morris and Traxler, 1996), and are unaware that grass-cycling can sharply reduce fertilizer needs.

Most residents rely on commercial sources of information when making their fertilization decisions. The average consumer relies on product labels, store attendants, and lawn care companies as their primary, and often exclusive, sources of lawn care information. Consumers are also influenced by direct mail and word of mouth when they choose a lawn care company (Swann, 1999 and AMR, 1997).

Two approaches have shown promise in changing fertilization behaviors within a neighborhood, and both involve direct contact with individual homeowners. The first relies on using neighbors to spread the message to other residents, through master gardening programs. Individuals tend to be very receptive to advice from their peers, particularly if it relates to a common interest in healthy lawns. The second approach is similar in that it involves direct assistance to individuals at their homes (e.g., soil tests and lawn advice) or at the point of sale.

Techniques to Change Behavior

Most communities have primarily relied on carrots to change fertilization behaviors, although sticks are occasionally used in phosphorus-sensitive areas. The following are some of the most common techniques for changing fertilization behaviors:

- Seasonal media awareness campaigns
- Distribution of lawn care outreach materials (brochures, newsletters, posters, etc.; Figure 2)
- Direct homeowner assistance and training
- Master gardener program
- Exhibits and demonstration at point-of-sale retail outlets
- Free or reduced cost for soil testing
- Training and/or certification of lawn care professionals
- Lawn and garden shows on radio
- Local restrictions on phosphorus content in fertilizer

Good Examples

King County, Washington- Northwest Natural Yard Days This month-long program offers discounts on natural yard care products and educational information about natural yard care in local stores throughout King County and Tacoma. Education specialists came to Saturday and Sunday events at some stores and spent time with buyers to help them make good choices and learn about natural yard care, including the use of organic fertilizers that don't wash off into streams and lakes as easily as "quick release" chemical fertilizers. For more details, consult: http://dnr.metrokc.gov/swd/ResRecy/events/naturalyard.shtml

North Carolina Department of Agriculture Free Residential Lawn Soil Testing. Residents can get a free soil test to determine the exact fertilizer and lime needs for their lawn, as well as for the garden, landscape plants and fruit trees. Information sheets and soil boxes are available from various government agencies, or local garden shops and other businesses. For more information, consult: http://www.ncagr.com/agronomi/stfaqs.htm

Minnesota Department of Agriculture Phosphorus Lawn Fertilizer Use Restrictions. Starting in 2004, these restrictions limit the concentration of phosphorus in lawn care products and restrict its application at higher rates to specific situations based on need. http://www.mda.state.mn.us/appd/ace/lawnewaterq.htm

Top Resources

Cornell Cooperative Extension. The Homeowner's Lawn Care Water Quality Almanac. http://www.gardening.cornell.edu/lawn/almanac/index.html

University of Rhode Island Cooperative Extension Home*A*Syst Healthy Landscapes Program http://www.healthylandscapes.org/

University of Maryland Cooperative Extension - Home and Garden Information Center. http://www.agnr.umd.edu/users/hgic/

Turf and Landscape Best Management Practices. South Florida Water Management District and the Broward County Extension Education Division http://www.sfwmd.gov/org/exa/broward/e11bmp/fertmgt.html

Florida Yards and Neighborhoods Handbook: A Guide to Environmentally Friendly Landscaping http://hort.ufl.edu/fyn/hand.htm

University of Minnesota Extension Service Low-Input Lawn Care (LILaC) http://www.extension.umn.edu/distribution/horticulture/DG7552.html

Austin TX, Stillhouse Spring Cleaning http://www.ci.austin.tx.us/growgreen/stillhouse.htm

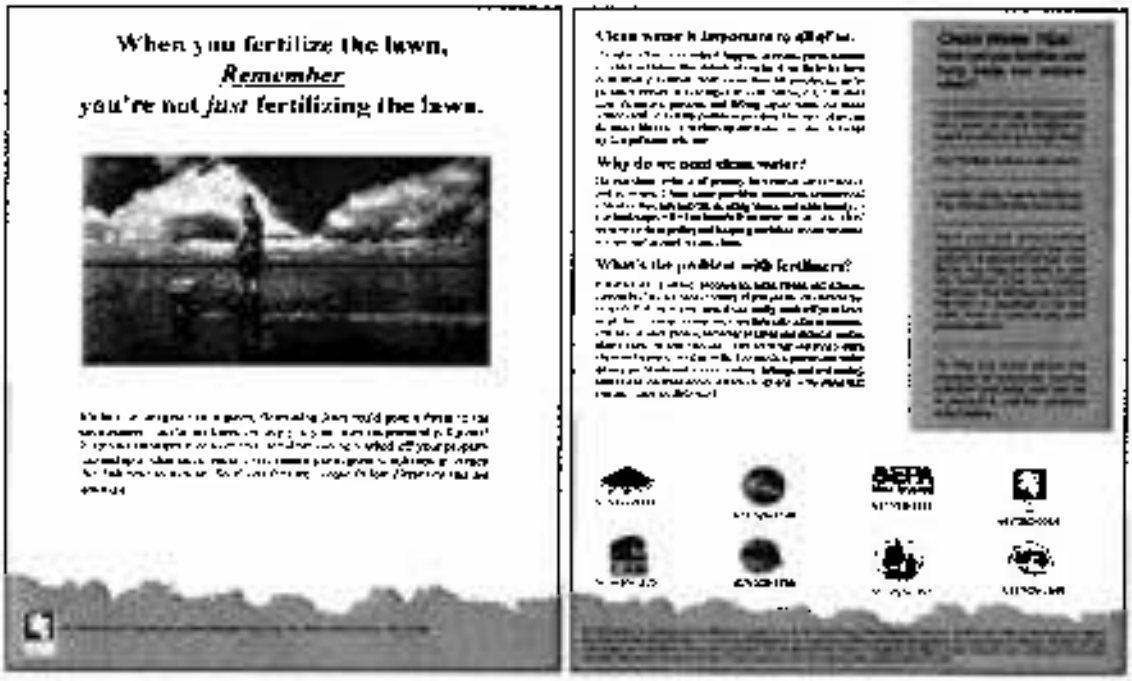


Figure 2: Educational Brochure on Fertilizer
Source: http://www.state.ne.us/dep/brp/wat/files/fertiliz.pdf

N-2

Neighborhood Source Area: Yard

REDUCED PESTICIDE USE

Description

The ideal watershed behavior is to not apply any insecticides or herbicides to the lawn or garden. Many residents, however, still want to control pests and weeds, so the next best behavior is a natural approach that emphasizes limited use of safer chemicals, proper timing and targeted application methods. The negative residential behavior is over-use or improper application of insecticides and herbicides that are known to have an adverse impact on aquatic life.

How Pesticide Use Influences Subwatershed Quality

The leading source of pesticides to urban streams is homeowner applications in the lawn and garden to kill insects and weeds. The pesticides of greatest concern are insecticides, such as diazinon and chlorpyrifos, and a large group of herbicides (CWP, 2003; USGS, 2001; Schueler, 1995; Figure 1). Very low levels of these pesticides can be harmful to aquatic life. According to a national monitoring study, one or more pesticides were detected in 99% of urban streams sampled (USGS, 2001). Pesticide levels in urban streams exceeded national water quality standards to protect aquatic life in one out of every five samples. Even more troubling was the finding that 100% of fish in urban streams had detectable levels of pesticide in their tissues, with 20% exceeding recommended guidelines for fish-eating wildlife (such as racoons, kingfishers, ospreys and eagles).

Figure 1: Bag of Pesticide Granules

Percentage of People Engaging in Pesticide Use

About half of Chesapeake Bay residents reported that they had applied pesticides to their lawn or garden (Swann, 1999). Surveys on residential pesticide use for other regions of the country indicate that home pesticide use varies greatly, ranging from a low of 17% to a high of 87% of households (Swann, 1999). According to EPA, the average acre of maintained suburban lawn receives five to seven pounds of pesticides each year.

Variation in Pesticide Use

Many regional and neighborhood factors influence the degree of local pesticide use. From a regional standpoint, climate is an extremely important factor. For example, insecticides are applied more widely in warmer climates where insect control is a year round problem (e.g., 50 to 90% of warm-weather residents report using them). This can be compared to 20 to 50% of insecticide use reported for colder regions where hard winters help keep insects in check (Schueler, 2000b). By contrast, herbicide application rates tend to be higher in colder climates in order to kill weeds that arrive with the onset of spring (e.g., 60 to 75% of cold weather residents report use).

Many neighborhood factors can play a strong role in the degree of pesticide use. These include lot or lawn size, presence of gardens, condition of turf, presence or absence of irrigation and neighborhood age. The average income and demographics within a neighborhood are also thought to play a strong role, particularly if residents rely on lawn care and landscaping companies to maintain their lawns.

Difficulty in Changing the Behavior

Pesticide use is a difficult behavior to change for several reasons. First, many residents want a quick and effective solution to their pest problems. Second, many residents lack awareness about the link between their pesticide use and stream quality. Lastly, many residents rely on commercial sources of information when choosing pesticides, and lack understanding of safer alternatives and practices. As with fertilizers, product labels are the primary source of information about pesticides. Nearly 90% of homeowners rely on them to guide their pesticide use (Swann, 1999). In addition, many residents are unaware of the pesticide application practices that their lawn care company applies to their yard and prefer to rely on professional know-how (Knox *et al.*, 1995).

Confusion also stems from the recent growth of "weed and feed" lawn care products that combine weed control and fertilizer in a single bag. In one Minnesota study, 63% of residents reported that they used weed and feed lawn products, but only 24% understood that they were applying herbicides to their lawn (Morris and Traxler, 1996).

Techniques to Change the Behavior

Most communities rely on the same basic combination of carrots to change pesticide use as they do for fertilizer use, since they are so interrelated. The following are some of the most common techniques to change pesticide use:

- Seasonal media awareness campaigns
- Distribution of lawn care outreach materials (brochures, newsletters, posters, etc.)
- Direct homeowner assistance and training
- Master gardener program
- Exhibits and demonstration at point of sale at retail outlets
- Pest advice hotlines
- Training, certification and/or licensing of lawn care professionals and pesticide applicators
- Radio lawn and garden advice shows

Figure 2: Educational Pesticide Brochure
Source: http://www.lacity.org/SAN/wpd/index.htm

Good Examples

Perdue Pesticide Program - Web-based program to help comply with the State of Indiana regulations that help homeowners use pesticides effectively and safely. According to Indiana law and recently enacted regulations, all retail establishments in the state that sell gardening and pest control products and offer recommendations on their use must be licensed as consultants, while their sales associates must be trained to knowledgeably disseminate product information.
http://www.btny.purdue.edu/PPP/

Green Communities Association's Pesticide Free Naturally: A Campaign to Reduce the Cosmetic Use of Pesticides - The campaign includes an Action Kit that includes pesticide-free lawn signs, fact sheets on health impacts, tips on how to engage neighbors in discussions about pesticide use, a children's activity pack, and information on effective alternatives to pesticides, including home recipes.
http://www.gca.ca/indexcms/index.php?pfn

Top Resources

Tips for Homeowners on Hiring a Pesticide Applicator
http://www.epa.gov/oppfead1/Publications/CitGuide/citguide.pdf

Try Pesticide Alternatives
http://www.mda.state.md.us/pdf/Tip1.pdf

Washington State University - Pesticide Safety Programs
http://pep.wsu.edu/pspi/

National Pesticide Information Center Site - Provides objective, science-based information about a variety of pesticide-related subjects, including pesticide products, toxicology, and environmental chemistry.
http://npic.orst.edu/

IPM Practitioners Association IPM ACCESS Webpage
http://www.ehn.org/~ipmpa/

Our Water, Our World
http://sfwater.org/detail.cfm/MC_ID/4/MSC_ID/78/MTO_ID/NULL/C_ID/1402

Grow Green, Landscaping for Clean Water
http://www.ci.austin.tx.us/growgreen/default.htm

N-3	Neighborhood Source Area: Yard **XERISCAPING**	

Description

The ideal watershed behavior is to maintain a lawn with native species that does not require watering or irrigation at all (Figure 1). The next best thing is to water the lawn sparingly so water does not run off to impervious areas or local waterways. The negative behavior is over-watering to the extent that water and its associated pollutants reach the storm drain conveyance system and enter the stream.

How Lawn Watering Influences Watershed and Subwatershed Quality

Lawn watering exerts different impacts at the watershed and subwatershed scale. At the watershed scale, over-watering cumulatively leads to sharp increases in river withdraws or groundwater pumping that can affect regional water supplies, as well as aquatic resources. Normal daily household water demands can double or even triple during really hot and dry summer days, which can put a great deal of stress on rivers, reservoirs and groundwater at a time when they are frequently at their lowest levels. According to Steiner *et al.* (2000), the average home in the Washington D.C. metropolitan area consumes about 22,700 gallons of water for outdoor use each year, mostly for lawn watering. Outdoor water use rates are often twice as high in arid and semi-arid regions of the country (Solley *et al.*, 1998).

Figure 1: Xeriscape Garden

Lawn watering has a different impact at the subwatershed level. Generally, most of the water supply delivered to a household originates from outside the watershed. When homeowners water their lawns, some fraction of this "imported" water may reach the street and eventually return to the stream itself. Thus, in arid and semi-arid subwatersheds, overwatering can actually increase dry weather flows in streams. The compacted nature of lawns can increase the runoff potential (Legg *et al.*, 1996).This may not necessarily be a negative impact, although it is likely that this nuisance water may carry nutrients and pesticides to the stream.

Percentage of Homeowners Engaging in Lawn Watering

Outdoor water use is nearly universal, but there are sharp differences from household to household in actual water use. Nationally, the average person uses 154 gallons of water per day, with 42% used indoors and 58% used outdoors (AWWARF, 1999). Curtailing outdoor water use is an important theme of urban water conservation (Figure 2).

Factors that Contribute to Variation in Lawn Watering

As might be expected, lawn watering and outdoor water use are greatest in arid and semi-arid regions, although high use is noted in nearly all urban areas during dry weather, and particularly during times of drought. Several neighborhood factors explain the variability in outdoor watering, the most notable of which is the proportion of homes that have permanent

irrigation systems installed (AWWARF, 1999). Other key factors include lawn size, income, the price of water, and the age of the lawn (younger lawns require more watering).

Difficulty in Changing Lawn Watering Behavior

Lawn watering is one behavior that residents show some willingness to change. Perhaps the best example is the widespread response to outdoor watering restrictions in times of drought or water emergency. Sharp reductions in lawn watering can be achieved even without a crisis.

Techniques to Change the Behavior

A range of both carrots and sticks can be used to influence watering behavior, including:

- Seasonal watershed conservation campaigns (e.g., radio, TV, newspaper and billboards)
- Distribution of xeriscaping and water conservation education materials (e.g. bill inserts, brochures, newsletters, posters, etc.)
- Demonstration gardens
- Discounts/rebates for efficient sprinklers and irrigation system
- Differential water rates to discourage excessive use during peak periods (pricing)
- Water bill credits for installing xeriscapes
- Voluntary or mandatory outdoor water restrictions


splash

quick facts on...

Xeriscape:
How to Save Water Through Water-smart Landscaping

Figure 2: Educational Xeriscaping Brochure
Source: http://www.sfwmd.gov/images/pdfs/splash/splxeris.pdf

Good Examples

Corpus Christi Texas. Xeriscape Learning Center and Design Garden. A demonstration garden at the entrance to the Corpus Christi Museum of Science and History demonstrates xeriscape principles to about 150,000 residents and tourists annually.
http://www.cctexas.com/?fuseaction=main.view&page=1182

Metropolitan Water District of Southern California- On-line Watering Calculator and Watering Index
This tool developed by the City of San Diego estimates the right amount of water for your landscape or garden every week and demonstrates how to adjust your watering schedule.
http://www.mwdh2o.com/mwdh2o/pages/conserv/conserv01.html

Las Vegas Valley Groundwater Management Program -Conservation Incentive Program. Southern Nevada Water Authority (SNWA) offers a Water Smart Landscapes Rebate Program that gives residential property owners a rebate of 40 cents per square foot when they upgrade some or all of their water-thirsty grass to xeriscape, a lush yet water-efficient landscape.
http://www.lasvegasgmp.com/html/gwupdate_summer2002.html

Top Resources

Colorado Springs Utilities Xeriscape Page
http://www.csu.org/xeri/

Xeriscape Gardening
This web page contains information about xeriscape planning and design, practical turf areas, appropriate plant selection, soil improvement, use of mulches, efficient irrigation, and appropriate maintenance.
http://www.xeriscape.org/

California Urban Water Conservation Council - H2ouse Water Saver Website
This website includes specific actions residents can take to conserve water indoors and outdoors.
www.h2ouse.org

American Water Work Association (AWWA) - WaterWiser Website
WaterWiser is an interactive web site that strives to meet the information needs of the water conservation community and the drinking water industry. The site provides news, information, research results, discussion forums, references, a calendar of events, searchable information databases, and other resources primarily targeted to water conservation professionals, but freely accessible to others in the water industry and the general public.
http://www.awwa.org/waterwiser

EPA's Water Efficiency Program
http://www.epa.gov/owm/water-efficiency/

N-4

Neighborhood Source Area: Yard

NATURAL LANDSCAPING

Description

The ideal watershed behavior is to replace existing turf cover with native species of annuals, perennials, shrub and forest cover in mulched beds that produce less runoff and create backyard habitat. The negative watershed behavior is exclusive reliance on turf cover in the yard and/or use of non-native invasive species that can spread from the yard into adjacent stream corridors or natural area remnants.

How Natural Landscaping Influences Subwatershed Quality

The cumulative effect of natural landscaping practices on subwatershed quality are hard to quantify, but can provide some clear benefits. First, reduced turf area produces more natural hydrologic conditions in the yard, since mulched beds intercept and adsorb rainfall and can produce less runoff (Figure 1). Natural landscaping also creates native habitats, increases forest cover, and creates a natural seed bank of native plant species in subwatersheds. Natural landscaping can also prevent the spread of invasive non-native plant species into the stream corridor, which is an increasing problem in many urban subwatersheds. English ivy, bamboo, and other fast-spreading non-native species can quickly dominate the plant community of the urban stream corridor.

Percentage of Homeowners Engaging in Natural Landscaping

The proportion of homeowners that engage in natural landscaping is poorly understood at both the national and neighborhood level. About half of Americans report that home gardening and landscaping is one of their major hobbies (Figure 1), but the proportion using native plants or landscape for wildlife or watershed appears to constitute a much smaller niche market.

Variation in Landscaping Behavior

Native plant species are adapted to local differences in soil, rainfall and temperature conditions. Neighborhood factors such as neighborhood age, lot size, income level and watershed awareness appear to influence the promotion of natural landscaping.

Figure 1: Before (a) and After (b) Natural Landscaping

Difficulty In Changing Landscaping Behavior

While natural landscaping practices have been growing in recent years, there are a number of barriers to more widespread implementation. The first barrier is that many homeowners are not aware of which plant species are native or non-native, and they do not know the benefits of natural landscaping. Second, native plant materials are not always widely available at garden centers and nurseries. Third, some communities still have weed and vegetation control ordinances that discourage natural landscaping.

Techniques to Promote Natural Landscaping

A range of carrots and sticks can help promote more widespread use of natural landscaping in a subwatershed, including:

- Conventional outreach on natural landscaping (brochures, newsletters, plant guides)
- Backyard habitat programs
- Free or reduced mulch
- Distribution of free or discounted native plant material
- Repeal of local weed ordinances with natural landscaping criteria
- Support of garden clubs and native plant societies
- Demonstration gardens (e.g. Bayscapes)
- Invasive species alerts
- Promotion of native plant nurseries
- Homeowner award/recognition programs
- Xeriscaping rebates

Good Examples

City of Austin, TX - WaterWise Program. Owners of new and existing homes may qualify for rebates up to $500 for Water Wise plantings of trees and shrubs. The goal of this program is to install a quality, low water use, low maintenance native landscape. http://www.ci.austin.tx.us/watercon/wwlandscape.htm

Village of Long Grove, IL - Village Code. Natural landscaping is encouraged in the city code, which states "impervious surfaces shall not exceed forty percent (40%) of the total lot area. The remaining minimum sixty percent (60%) of the lot area shall be maintained as a 'green area' and shall consist of native wild areas, grass, trees, ponds or other natural vegetation." The code also does not limit residential vegetation height, which in other communities can limit use of natural plant species. http://www.longgrove.net/

Top Resources

National Wildlife Federation - Natural Back Yard Habitat Program. The Backyard Wildlife Habitat program educates people about the benefits and techniques of creating and restoring natural landscapes. Through a backyard wildlife "certification" process, guided efforts of homeowners and other community members to improve wildlife habitat where they live and work are formally acknowledged. http://www.nwf.org/backyardwildlifehabitat/

Alliance for the Chesapeake Bay - Bayscapes. This website provides practical guidance on how to design a "Bayscape," which is a watershed friendly form of natural landscaping. http://alliancechesbay.org/bayscapes.cfm

Wild-Ones- Native Plants, Natural Landscaping Publications and Model Ordinances. Website contains a wealth of information on natural landscaping, including the *Wild Ones Handbook* - a compendium of useful information for the native plant landscaper and wildflower gardener, appropriate for all bioregions. The site also provides vegetation and weed control model municipal ordinances that encourage the use of native plant communities as an alternative in urban landscape design. http://www.for-wild.org/

N-5

Neighborhood Source Area: Yard

TREE PLANTING

Description

The ideal watershed behavior is to ultimately achieve a mature tree canopy that covers more than 50% of residential lots within a neighborhood through tree planting and care (Figure 1a). The negative watershed behavior is tree clearing that reduces existing tree canopy on a residential lot and in neighborhoods (Figure 1b).

How Tree Planting Influences Subwatershed Quality

Forested neighborhoods have a distinctly different hydrological profile than non-forested neighborhoods. For operational purposes, American Forests defines forested neighborhoods as having at least 50% forest canopy covering the residential lot. The branches and leaves of the forest canopy help intercept and slowdown rainfall. For example, a large oak tree can intercept and retain more than 500 to 1,000 gallons of rainfall in a given year, which is roughly equivalent to a rain barrel in terms of runoff reduction (Cappiella, 2004). According to American Forests (1999), a healthy forest canopy can reduce storm water runoff by as much as 7% in a neighborhood.

Figure 1: **Lots with Extensive Tree Cover (a) and Less Tree Cover (b)**

A healthy residential forest canopy provides many additional environmental and economic benefits within a neighborhood. These include savings on home heating and cooling costs, higher property values, shading, removal of air pollutants, and noise reduction (Cappiella, 2004).

Percentage of Homeowners Engaging in Tree Planting

Regional GIS analyses of urban areas conducted by American Forests (2001) reveal that about 60% of neighborhoods have less than 50% forest canopy cover. The actual rate of tree planting is a poorly understood residential behavior. The actual rate of tree planting is a poorly understood residential behavior. A survey in the Chesapeake Bay watershed indicated that 71% of residents had planted a tree within the last five years (CBP, 2002). Tree planting rates by homeowners of around 50% were reported in urban metropolitan areas such as Baltimore, MD and Washington, D.C.; however, more research is needed to determine the frequency and impact of tree planting in urban subwatersheds.

Variation in Tree Planting Behavior

Trees may not be part of the native plant community in some regions of the country, and specific tree or prairie species will be determined by local climate and soils. Also, concerns about fire safety may make the 50% forest canopy goal impractical in regions that experience wildfires. At the neighborhood level, several factors influence the extent of forest canopy that can be attained. Probably the most important factor is the neighborhood age, as recently constructed neighborhoods generally lack established forest cover (Figure 2). Other factors include the existing forest canopy, lot subsidies or rebates for energy conservation plantings, size and soil depth.

Difficulty in Increasing Tree Planting Behavior

Generally, tree planting is a relatively easy behavior to encourage, although it may take decades to grow a mature canopy on a residential lot. Perhaps the biggest barrier to overcome is to find the best locations in the yard to plant trees that can grow to maturity (e.g., away from overhead powerlines, underground utilities, septic systems, etc.). The second concern is proper planting and care techniques to ensure that trees can survive and flourish in the critical first few years after they are planted. Third, some localities may discourage tree planting in the right-of-way due to maintenance concerns and pavement cracking.

Techniques for Increasing Residential Forest Canopy Cover

A series of techniques can promote tree planting and discourage tree clearing:

- Distribution of outreach materials on tree planting (brochures, newsletters, plant guides)
- Tree clearing ordinances and permits
- Direct forestry assistance
- Free seedlings or other native tree stocks
- Native tree planting guidebooks

Figure 2: Newly Planted Trees in a New Neighborhood

Good Examples

Slinger, WI -Residential Tree Power Incentive Program. The electric utility in this community offers cash incentives for planting deciduous trees that conserve energy by providing significant shading of an air conditioning unit or the south or west exposure of a home upon tree maturity.
http://www.slinger-wi-usa.org/utilityprograms.htm

Tucson Electric Power (TEP) Tree Planting Incentives for Residents. TEP, working with the Trees for Tucson program, offers residents up to two five-gallon size trees at $3.00 per tree for planting on the west, east or south side of their homes. The program has distributed more than 22,000 trees since its inception, and also provides information to homeowners, neighborhood groups, and schools on low-water species appropriate to the local environment, and optimum placement of trees for energy and water conservation.
http://swenergy.org/programs/arizona/utility.htm

Banks and Buffers: A Guide to Selecting Native Plants for Streambanks and Shorelines. Produced by the Tennessee Valley Authority, this guide includes a software application to assist in plant selection. It also contains selected characteristics and environmental tolerances of 117 native plants and over 400 color photographs illustrating habitat and growth form. http://www.tva.gov/river/landandshore/stabilization/index.htm

National Arbor Day Foundation Awards This award recognition program honors the achievements of citizens, communities, the media, and schools whose work in the cause of tree planting, care, and conservation have set an example of excellence. Applications are submitted through the Department of Natural Resources to the National Arbor Day Foundation. Contact: DNR - Forest Service regional office or The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. http://www.arborday.org/

Top Resources

American Forests - CityGreen GIS software
http://www.americanforests.org/

Center for Urban Forest Research
http://wcufrc.ucdavis.edu/

Guidelines for Developing and Evaluating Tree Ordinances
http://www.isa-arbor.com/publications/ordinance.aspx

Treelink
http://www.treelink.org/

National Tree Trust
http://www.nationaltreetrust.org/

Treepeople
http://www.treepeople.org/

Society of Municipal Arborists
http://www.urban-forestry.com/

Urban Forest Ecosystems Institute
http://www.ufei.calpoly.edu/

USDA Forest Service, Northeastern Research Station
http://www.fs.fed.us/ne/

USDA Forest Service, Southern Region
http://www.urbanforestrysouth.org/

USDA Forest Service, Pacific Northwest Research Station
http://www.fs.fed.us/pnw/

USDA Forest Service, Pacific Southwest Research Station
http://www.fs.fed.us/psw/

N-6

Neighborhood Source Area: Yard

YARD WASTE COMPOSTING

Description

The ideal watershed behavior is to recycle or compost yard waste entirely within the yard, so that it stays out of the solid waste stream and the storm drain system. The next best behavior is curbside yard waste collection that keeps organic matter from the storm drain system (Figure 1). The negative behavior is to blow or rake yard waste into the gutter and storm drain system or dump it into the stream corridor or natural areas.

How Yard Waste Influences Watershed and Subwatershed Quality

The major benefit of managing yard waste is realized at the regional or watershed level, where it can preserve local landfill capacity by keeping organic waste out of the trash stream. Yard waste normally comprises about 10% of the annual waste stream during the year, but this rises to almost 70% during the fall. The impact of yard waste at the subwatershed level is poorly defined, but can be significant, at least on a seasonal basis. The major concern is the potential for nutrient and organic matter to wash off to the storm drain system, whether it consists of grass clippings, fallen leaves or organic debris accumulating on impervious surfaces and street gutters. The second concern is dumping yard wastes in the stream corridor itself.

Figure 1: Curbside Yard Waste Pick-up

Percentage of Residents Engaging in Yard Waste Composting

Based on municipal surveys, the average rate of backyard composting of yard waste ranges from one to 5% of households, although participation rates as high as 10% have been observed after intensive municipal education and subsidy programs. Much higher rates have been reported for recycling of grass clippings, whether by composting or use of grass-cycling mowers. Surveys indicate about 40 to 70% of households currently recycle grass clippings, with higher rates reported in communities that prohibit grass-clippings in regular trash pickup (Smith, 1996; DeYoung, 1997; Morris and Traxler, 1996; and Knox *et al.*, 1995). The highest homeowner participation rates are noted for curbside leaf and yard waste collection (50 to 70%), which is not surprising given the convenient nature of this municipal service. It is worth noting that communities need to educate homeowners to keep leaves out of streets and gutters during seasonal curbside pick-up where they can easily reach the storm drain system.

Variation in Yard Waste Behavior

Regional factors influencing the generation and disposal of yard waste include the length of growing season, the presence of deciduous trees, and annual rainfall. Neighborhood factors contributing to the generation of yard waste are large lot size or turf area, high forest canopy, low usage of lawn care or landscaping companies, and older neighborhoods. The actual rate of participation in various yard waste

programs depends largely on their ease and convenience, as well as the degree of outreach, notification and education employed by the municipality.

Techniques to Change the Behavior

To promote better management of yard wastes, communities can facilitate backyard composting and "grass-cycling" lawnmowers, arrange seasonal curbside yard waste collection, and/or prohibit yard waste from regularly scheduled trash pickup. Other techniques include:

- Conventional outreach methods (bill inserts, brochures, newsletters, neighborhood meetings)
- Regular yard waste collection
- Fall leaf collection
- Seasonal collection (e.g., Christmas trees)
- Distribution of free or discounted compost bins
- Ban on lawn clipping pickup
- Promotion of grass-cycling
- Notification about keeping leaves out of gutters during fall leaf pick-up

Good Examples

Fort Worth, TX, Division of Environmental Management - "Don't Bag It" Program
The City of Fort Worth requires that, if grass clippings are put out for pick-up, they be contained in paper yard bags to be sent to a composting facility instead of the landfill. Under the "Don't Bag It" program homeowners are encouraged to leave lawn clippings on the grass to allow them to work themselves back into the soil. Residents that have followed this lawn care plan report that they mow their lawns in 38% less time than when they bagged their grass clippings. They also found that their lawns are 30% better than they were before the "Don't Bag It" campaign.
http://www.fortworthgov.org/dem/dontbag.htm

The Village of Niles, IL - Yard Waste Collection
The Village of Niles offers an optional yard waste collection service to help residents comply with an Illinois law that requires the separation of yard waste from regular garbage. To participate in the curbside yard waste collection homeowners need to purchase stickers for a nominal fee to place on yard waste bags. Mulching is recommended as an alternative no-cost disposal method. Free leaf pick up is provided in the fall.
http://www.vniles.com/Pages/yard%20waste%20collection.asp

City of Gresham, OR Yard Debris Exemption Program – Residents can receive a $3.65 reduction on their garbage bill when they agree to compost yard waste instead of having it picked up by the curbside yard-debris collection program. The approval process requires an application and a site inspection by a Master Gardener and composting expert who inspects the homeowner composting system before granting the exemption.
http://www.ci.gresham.or.us/departments/cao/gresham_municipal_code/chapter_7/25/450.html

Top Resources

USEPA- Composting Materials - *Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities; Composting, Yard Trimmings, and Municipal Solid Waste; and Innovative Uses of Compost: Erosion Control, Turf Remediation, and Landscaping*
http://www.epa.gov/compost/

Master Composter
http://www.mastercomposter.com/

Compost Guide Web Page
http://www.compostguide.com/

Recycle Your Grass Clippings
http://ucce.ucdavis.edu/files/filelibrary/1808/3868.doc

"Don't Bag It" Lawn Care
http://muextension.missouri.edu/xplor/agguides/hort/g06959.htm

Washington County, Minnesota, Recycling & Yard Waste
http://www.co.washington.mn.us/info_for_residents/environment/yard_waste/

N-7

Neighborhood Source Area: Yard

SOIL RECLAMATION

Description

The ideal watershed behavior is to reduce soil compaction and restore hydrologic properties on residential lawns through soil amendments and conditioning. Many urban lawns have been highly compacted as a result of past construction, soil disturbance and ongoing human traffic (Figure 1). This behavior seeks to recover the porosity and bulk density of soils by incorporating soil amendments or conditioners into the lawn, such as compost (McDonald, 1999). Soil reclamation improves the hydrological properties of the lawn by promoting more storage and infiltration, and producing less runoff.

How Soil Reclamation Influences Subwatershed Quality

Lawns are not the sponge many people think. Most lawn soils are extremely compacted, and recent research indicates that about half of all rain storms produce at least some runoff from lawns (Schueler, 2000a). Therefore, widespread application of lawn reclamation practices may show promise to improve hydrological conditions in residential subwatersheds. In addition, reduced runoff from reclaimed lawn soils may also reduce nutrient and sediment loading to surface waters. It is worth noting that lawn reclamation is still experimental, and that no subwatershed has received widespread yard reclamation yet.

Figure 1: Soil Compaction During Remodeling

Percentage of Homeowners Engaging in Soil Reclamation

Since this is a new and costly behavior to practice, it is doubtful whether more than a small percentage of homeowners currently engage in lawn reclamation.

Variation in Lawn Reclamation

Given that lawn reclamation is so new, little is known about regional or neighborhood factors that might lead to greater application. Two factors, however, are likely to be important. The first is the degree of existing compaction through the soil profile and its effect on runoff generation. Much of the pioneering work on soil amendments has been done on glacial till soils that are close to the surface. Therefore, the porosity and hydrologic soil group of parent soils are worth investigating.

The second key factor involved in soil reclamation is its relatively high cost, which can run from $2,000 to $10,000 per acre, depending on the availability of discounted compost and homeowner labor (Chollak and Rosenfeld, 1998). Given that soil reclamation is expensive, time consuming, and essentially requires complete lawn replacement, this behavior will undoubtedly require significant subsidies, discounts or other incentives to achieve greater subwatershed implementation.

Techniques to Promote Lawn Reclamation

Several potential techniques can be used to promote lawn reclamation:

- Conventional outreach materials (brochures, guides, etc.)
- Free soil testing
- Subsidies
- Free or discounted compost
- Direct technical assistance (e.g., municipality or local cooperative extension office)
- Credits or rebates on storm water utility fees

Good Examples

City of Seattle. The City has prepared an excellent guide on lawn compost amendments. Entitled *How Soil Amendments and Compost can Aid in Salmon Recovery*, this detailed guide is available from http://depts.washington.edu/cuwrm/publicm/s4s.pdf

Top Resources

Low Impact Development Center: Soil Amendments
http://www.lid-stormwater.net/soilamend/soilamend_home.htm

USDA Natural Resources Conservation Service
http://www.il.nrcs.usda.gov/technical/engineer/urban/tech_notes/techmote2.html

Improve the Health of Your Soil
http://www.ci.eugene.or.us/PW/storm/Publications/healthy_soil.pdf

N-8

Neighborhood Source Area: Yard

EROSION REPAIR

Description

While most yards have extensive vegetative cover, soil erosion can occur on steep slopes, in bare patches, and around driveways. The ideal watershed behavior is to survey the yard for any patches of exposed soils and establish a fast-growing grass or ground cover (Figure 1). The negative watershed behavior is to allow erosion to continue unchecked. In most cases, existing residential yards are exempt from local erosion and sediment control laws, which means that a voluntary approach to erosion control is needed.

Figure 1: Reseeded Areas on a Lawn

How Lawn Erosion Influences Subwatershed Quality

Source area monitoring has revealed that some of the highest sediment concentrations in residential neighborhoods are generated from the yard (CWP, 2003). In many cases, erosion occurs in areas of the yard that are close to driveways, sidewalks and roads, or are directly in the flow path of storm water runoff. Bare patches of exposed soils can be caused by vehicles, snowplows, plant dieback, foot traffic and many other disturbances.

Percentage of Homeowners Engaging Erosion Repair

Reliable percentages could not be developed to profile the proportion of homeowners that repair soil erosion.

Factors that Contribute to Variation in Lawn Erosion

Climate appears to play a major role in residential soil erosion problems. For example, it is extremely difficult to maintain a vigorous ground cover on yards in arid and semi-arid climates without supplemental irrigation. Consequently, yards in these regions tend to have higher sediment erosion rates. Also, yards in regions with heavy snowfall or hard winters often require spot re-seeding in the spring. Neighborhood factors also play a strong role. For example, exposed soils are considered a social anathema in neighborhoods where turf care is widely practiced. Other factors that contribute to the potential for yard erosion are small lot size, heavy foot or vehicular traffic, inadequate parking capacity, older neighborhoods, and the absence of a strong neighborhood or civic association.

Techniques to Address Soil Erosion

- Conventional outreach methods (bill inserts, brochures, newsletters, neighborhood meetings)
- Distribution of free or discounted mulch
- Distribution of free or discounted grass patch repair kits
- Technical assistance on solving severe erosion problems on steep slopes
- Non-regulatory erosion and sediment control (ESC) consultations
- Enforcement actions under existing ESC, water quality, or nuisance ordinances

Good Examples

Riparian Homeowner's Stewardship Project (Ingham County, MI). County staff developed and distributed the *Red Cedar River Riparian Homeowner's Handbook* to more than 300 individual homeowners, local government officials, and other interested groups, and conducted individual, on-site consultations with interested homeowners on buffer strip design and erosion control.
http://www.glc.org/basin/project?id=74

Top Resources

Erosion in Your Own Backyard (Virginia Cooperative Extension). This fact sheet emphasizes how a properly planted landscape is the best protection against erosion.
http://www.ext.vt.edu/departments/envirohort/articles/lawns_and_landscaping/erosion.html

*University of Rhode Island Cooperative Extension Home*A*Syst*
http://www.uri.edu/ce/wq/has/html/has.html

Reducing Erosion and Runoff Information Webpage (Master Gardeners). This website covers signs of erosion and runoff, reasons to control runoff and erosion, using plants to reduce erosion, handling steep slopes, ground cover selection, and building and protecting soil.
http://www.mastergardenproducts.com/sustainablelandscape/erosion.htm

N-9

Neighborhood Source Area: Yard

SEPTIC SYSTEM MAINTENANCE

Description

While most urban subwatersheds are served by sewers, some still rely on septic systems for sewage disposal, particularly in less developed subwatersheds that may lie outside of the sewer service envelope. The ideal watershed behavior is to regularly inspect and maintain septic systems, make repairs as needed, and prevent disposal of household chemicals through the leach field. The accepted practice is to inspect the tank and leach field once every two years to make sure it is working properly, and to pump out the tank (Olbrot, 1995; Figure 1). The negative watershed behavior is to ignore regular inspections and pumpouts to the point that the septic system becomes a subwatershed pollution source.

How Septic Systems Influence Subwatershed Quality

Failing septic systems can be a major source of bacteria, nitrogen, and phosphorus, depending on the overall density of systems present in a subwatershed (Swann, 2001). Failure results in surface or subsurface movement of nutrients and bacteria into the stream. According to the U.S. EPA (2002), more than half of all existing septic systems are more than 30 years old, which is well past their design life. The same study estimates that about 10% of all septic systems are not functioning properly at any given time, with even higher failure rates in some regions and soil conditions. It is extremely important to understand resident behavior in regard to inspection, pump out and repair, particularly if septic system density in a subwatershed is high.

Figure 1: Septic System Inspection/Cleaning Truck

Percentage of Homeowners Engaging in Septic System Maintenance

Until recently, homeowner awareness about septic system maintenance was poorly understood. Swann (1999) conducted one of the first surveys to examine how frequently homeowners maintain their septic systems. Roughly half of the owners were classified as "septic slackers," since they indicated that they had not inspected or cleaned out their systems in the past three years. A small, but significant, fraction (12%) of septic system owners had no idea where their septic system was located on their property. In addition, only 42% of septic system owners had ever requested advice on how to maintain their septic system, and they relied primarily on the private sector for advice (e.g., pumping service, contractors, and plumbers).

Variation in Septic System Maintenance

Septic system failure rates appear to vary regionally, ranging from five to 40% (Swann, 2001). In most regions, failure rates are tied to current or past design, construction and maintenance regulations, which are set by local or state public health authorities. Failing systems are often clustered together. At the neighborhood level, many factors can influence septic system problems. Key factors linked to failure include small lot size, aging systems, poor soil or water table conditions, and close proximity to streams, lake fronts or ditches. In other cases, failure rates are tied to experimental septic system technologies, and seasonal use of properties.

Difficulty in Improving Septic System Maintenance

Septic systems are a classic case of "out of sight, out of mind." Many owners take their septic systems for granted, until they back up or break out on the surface of their lawn. Subsurface failures, which are the most common, go unnoticed. In addition, inspections, pump outs, and repair can be costly, so many homeowners tend to put off these expenditures until there is a real problem. Lastly, many septic system owners lack basic awareness about the link between septic systems and water quality at the subwatershed level.

Techniques to Increase Septic System Maintenance

Many carrots and sticks have been developed in recent years to improve resident behaviors in regard to septic system maintenance, including:

- Media campaigns to increase awareness about septic system and water quality (e.g., billboards, radio, newspaper)
- Conventional outreach materials on maintenance (e.g., brochures, bill inserts, newsletters)
- Free or mandatory inspections
- Discount coupons for septic system maintenance
- Low interest loans for septic system repairs
- Performance certification upon property transfer
- Creation of septic management districts
- Certification and training of operation/maintenance professionals
- Termination of public services for failing systems

Good Examples

Swann (2001) describes a series of case studies of effective local programs to improve septic system maintenance. Some additional examples are provided below:

Washtenaw County, Michigan Time-Of-Sale Program. The County's septic system regulation requires the inspection of all residential septic systems by private evaluators at the time of sale of a property. Evaluations must be done by a certified inspector who has received a license after training and an exam. http://www.rougeriver.com/pdfs/illicit/OSS-02.pdf

Yarmouth, Maine Free Pumpouts (Septic Tank Pumping Ordinance) - The town offers free septic system pump-outs to residents once every three years. http://www.yarmouth.me.us/vertical/Sites/%7B13958773-A779-4444-B6CF-0925DFE46122%7D/uploads/%7B363C4270-0879-43BC-8639-55BFA419AC12%7D.PDF

Cannon Township, MI Septic Inspections and Testing - The township used school children to conduct dye tests to identify failing septic systems. This program doubled as an education campaign to increase awareness of septic system owners. http://peer.tamu.edu/curriculum_modules/Water_Quality/module_1/Kids%20Dye%20Project.htm

Top Resources

Many excellent resources are available to educate homeowners about septic systems and water quality. Some of the better reference websites are provided below, and many contain additional educational links.

On-site Wastewater Treatment Systems Manual
http://www.epa.gov/ord/NRMRL/Pubs/625R00008/html/625R00008.htm

A Homeowner's Guide to Septic Systems
http://www.epa.gov/npdes/pubs/homeowner_guide_long.pdf

National Small Flows Clearinghouse
http://www.nesc.wvu.edu/nsfc/nsfc_septicnews.htm

On-site Septic Systems: Educating the Homeowner
http://www.nesc.wvu.edu/nsfc/Articles/SFQ/SFQw02_web/SFQw02_Onsite_Education.html

University of Minnesota Onsite Sewage Treatment Program
http://septic.coafes.umn.edu/

*North Carolina Coast*A*Syst*
http://www.smil.ncsu.edu/assist/cas/septic/index.htm

N-10

Neighborhood Source Area: Yard

SAFE POOL DISCHARGES

Description

Routine and end-of-season pool maintenance can cause chlorinated water or filter back flush water to be discharged into the storm drain system or the stream. The ideal watershed behavior is to discharge chlorinated pool water to the sanitary sewer system, or hold it for a week or more before spreading over a suitable pervious surface. The negative watershed behavior is to drain pool water directly into the storm drain system or stream where it may be toxic to aquatic life (Figure 1). Public and community pools can also be a subwatershed hotspot; details on controlling these pollution sources can be found in Profile Sheet II-14.

How Swimming Pool Maintenance Influences Subwatershed Water Quality

Pool water typically contains two to four parts per million of chlorine, as well as other chemicals to reduce bacteria and algae, and control pH. Consequently, the direct discharge of pool water can be toxic to aquatic life in small streams. Not much research has been done to characterize the precise impact of pool discharges on aquatic systems, but there is anecdotal evidence of fish kills and other problems. Part of the problem is the size of pool discharges: the average in-ground pool is estimated to have a capacity of nearly 20,000 gallons.

Percentage of Homeowners Engaging In Pool Maintenance

The density of swimming pools in a subwatershed is extremely variable, but can be determined through inspection of low-altitude aerial photographs or the USSR survey (Figure 2). The number of in-ground or above-ground swimming pools in the United States is estimated at 7.5 million (Pool and Spa Marketing, 2003), or about 7% of all households. The actual operational and discharge behaviors of pool owners remains poorly understood, so it is difficult to characterize the magnitude of the pool discharge problem.

Figure 1: Swimming Pool Discharging to Street and Into Storm Drain

Figure 2: Aerial Photo Showing High Density of Swimming Pools (~30%) In a Neighborhood

Variation in Pool Discharge

While the greatest pool density is found in warmer regions, the actual discharge problem may be more acute in northern regions where pools must be drained before the onset of winter. Key neighborhood factors include local plumbing codes that govern how discharge water is handled, the overall density of pools in the subwatershed, and their age.

Techniques to Change the Behavior

Most pool owners understand that regular maintenance is essential to keep a pool safe and clean, and they probably conduct more water quality monitoring as a group than any other segment of society. Therefore, they may be more receptive to changing discharge behaviors with proper education. Some techniques include:

- Conventional outreach techniques on proper discharge (pamphlets, water bill inserts, posters)
- Educational kiosks at the retail outlets where they purchase pool chemicals
- Changes in local plumbing codes to require discharge to sanitary sewer systems
- Adoption of water quality ordinances that allow for fines/enforcement for unsafe pool discharges
- Inspections (done in conjunction with regular local health and safety inspections)

Good Examples

State of Maryland Pool Permit. The State has developed a general permit to govern pool discharges. The general discharge permit, developed by the Maryland Department of the Environment, addresses discharges from both swimming pools and spas. It can be found at: http://www.mde.state.md.us/assets/document/permit/MDE-WMA-PER070-SI.pdf

Top Resources

Guidelines for Swimming Pool and Spa Owners and Operators
http://www.montgomerycountymd.gov/mc/services/dep/Enforcement/pools.htm

Oregon Department of Environmental Quality (ODEQ). 1997. Water Quality Permit Program; Guidance for Swimming Pool and Hot Tub Discharges.
http://www.deq.state.or.us/wq/wqpermit/swimpools.pdf

US EPA National Menu of Best Management Practices for Storm Water Phase II: Alternative Discharge Options for Chlorinated Water, Office of Wastewater Management
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/poll_1.cfm

N-11

Neighborhood Source Area: Driveway

SAFE CAR WASHING

Description

The ideal watershed behavior is to wash cars less often, wash them on grassy areas, and use phosphorus-free detergents and non-toxic cleaning products. Alternatively, residents can use commercial car washes that treat or recycle wash water. The negative behavior is to wash cars in a manner where dirty wash water frequently flows into the street, storm drain system, or the stream. This behavior applies not only to individuals, but to community groups that organize outdoor car washes for charitable purposes (Figure 1).

How Car Washing Influences Subwatershed Quality

Outdoor car washing has the potential to generate high nutrient, sediment, metal, and hydrocarbon loads in many subwatersheds. Detergent-rich water used to wash the grime off cars can flow down the driveway and into the storm drain, where it can be an episodic pollution source during dry weather. Not much is currently known about the quality of car wash water, but local water quality sampling can easily characterize it. Car wash water can also be a significant flow source to streams during dry weather. As an example, a typical hose flowing at normal pressure produces between 630 and 1,020 gallons of water per hour, depending on its diameter. These flows can be sharply reduced if the hose is equipped with a shut-off nozzle.

Figure 1: Poor Practices at a Charity Car Wash Event at a Local Gas Station

Percentage of Residents Engaging in Car Washing

Car washing is one of the most common watershed behaviors in which residents engage. According to surveys, about 55 to 70% of homeowners wash their own cars, with the remainder utilizing commercial car washes (Schueler, 2000b). Of these, 60% of homeowners can be classified as "chronic car-washers," in that they wash their car at least once a month (Smith, 1996; PRG, 1998; and Hardwick, 1997). Between 70 and 90% of residents reported that their car wash-water drained directly to the street, and presumably, to the nearest stream.

Variation in Car Washing

Regional and climatic factors play a strong role in determining the frequency of residential car washing. In colder climates, many residents utilize commercial car washes during the winter months, and then wash their cars themselves during the summer. In warmer climates, residential car washing is often a year-round phenomenon. Neighborhood factors that influence car washing include the number of vehicles per household, lot size, driveway surfaces, income and demographics. Another key factor is the nature of the storm water conveyance system. If a neighborhood has open section roads with grass swales, the impact of car wash water will be less.

Difficulty in Changing Car Washing Behaviors

Residential car washing is a hard watershed behavior to change, since the alternative of using commercial car washes costs more money. In addition, many residents are not aware of the water quality consequences of car washing, nor do they understand the chemical content of the soaps and detergents they use. Lastly, many residents do not understand that their driveway is often directly connected to the storm drain system and the urban stream. Consequently, many communities will need to educate homeowners about the water quality implications of car washing.

Techniques to Change Car Washing Behavior

Several communities have developed effective techniques to promote safer car washing, including:

- Media campaigns to increase awareness about water quality impacts of car washing (billboards, posters, etc.)
- Conventional outreach materials (brochures, posters, water bill inserts)
- Promote use of nozzles with shut-off valves
- Provide information on environmentally safe car washing products at point of sale
- Provide storm drain plugs and wet vacs for charity carwash events
- Provide discounted tickets for use at commercial car washes
- Modify sewer bylaws or plumbing codes to prevent storm drain discharges
- Storm drain marking (see N-21)

Good Examples

Puget Sound Car Wash Association - This charity car wash program allows qualifying nonprofit organizations to raise money for their group by selling tickets that can be redeemed at participating commercial car wash facilities. http://www.charitycarwash.com/

Drain Plugs and Bubble Busters (Kitsap County) – This program provides drain plugs to contain car wash water from charitable car wash events, as well as "bubble busters" to pump out and safely dispose of wash water. http://www.kitsapgov.com/sswm/carwash.htm

Top Resources

RiverSafe Carwash Campaign
http://www.riversides.org/riversafe/

The Dirty Secret of Washing Your Car at Home
http://www.forester.net/sw_0106_trenches.html

Best Management Practices for Controlling Runoff from Commercial Outdoor Car Washing
http://environment.alachua-county.org/Natural_Resources/Water_Quality/Documents/Commercial Outdoor Car Wash.pdf

How to Run a Successful Carwash fundraiser
http://www.carwashguys.com/fundraisers/LAschools.html

Make Your Next Car Wash "Environmentally Smart"
http://www.ci.eugene.or.us/PW/storm/Publications/Carwash fundraiser.pdf

N-12

Neighborhood Source Area: Driveway

DRIVEWAY SWEEPING

Description

The ideal watershed behavior is to regularly sweep driveways and sidewalks and dispose of sweepings in the trash. The negative behavior is to use hoses or leaf blowers to clean off driveways and sidewalks that direct dirt and organic matter into the street or storm drain system.

How Driveway Cleaning Influences Water Quality

Source area research has indicated that driveways are a significant source of sediment, nutrients and metals in urban neighborhoods (CWP, 2003). Broom sweeping and disposal can reduce wash-off of accumulated pollutants during subsequent storms. On the other hand, hosing and blowing tend to move pollutants to the street and gutters, where they have a greater chance of reaching the stream (Figure 1).

Figure 1: Power Washing of a Driveway

Percentage of Homeowners Engaging in Driveway Cleaning

Residential driveway and sidewalk cleaning behaviors are poorly understood. Rough estimates that show 15% of residents using hoses and an additional 10% using leaf blowers to clean driveways and sidewalks appear to be conservative. The recent growth in the use of motorized leaf blowers has been quite rapid. The Outdoor Power Equipment Institute (2003) reports annual sales of more than 1.5 million units and indicates that leaf blowers are the fastest growing segment of the industry. To date, most environmental concerns about leaf blowers have focused on noise and air quality emissions; their role in re-suspending pollutants is poorly understood.

Variation in Driveway Cleaning

Regional and climatic factors play a strong role in determining the frequency of driveway cleaning. Since storms occur more rarely in regions with arid and semi-arid climates, particles and organic matter accumulate longer on driveway and sidewalk surfaces, which often prompts more frequent cleaning. By contrast, frequent storms in more humid regions often clean off driveway and sidewalk surfaces themselves. A number of neighborhood factors also influence driveway cleaning behaviors, including driveway dimensions, the nature of driveway surfaces, forest canopy coverage, and the nature of the storm water conveyance system. If a neighborhood has open section roads with grass swales, the impact of driveway cleaning may be less.

Difficulty in Changing Driveway Cleaning Behavior

Driveway cleaning is also a hard behavior to change, since hosing and leaf blowing are often faster and more convenient ways to get the job done. Few residents understand that their driveway is often directly connected to street gutters, and eventually, the urban stream. Lastly, few communities have emphasized the importance of educating residents and landscape contractors about the water quality impacts of driveway cleaning behaviors. Consequently, greater effort is needed to increase residential awareness about the water quality consequence of hosing and leafblowing.

Techniques to Change Car Washing Behavior

Not many communities have targeted driveway cleaning as an important residential watershed behavior. As a result, only a few innovative techniques have been developed for driveway cleaning behavior so far, including:

- Media campaigns to increase awareness about water quality impacts of driveway cleaning (billboards, posters, etc.)
- Conventional outreach materials (brochures, posters, water bill inserts)
- Landscaping contractor training or certification programs that emphasize proper leaf blower use

Top Resources

Tips on Cleaning Driveways, Decks, Sidewalks and Patios
http://www.thinkbluesd.org/brochures/Impervious_Surfaces.pdf

Stormwater Management for Homeowners
http://www.soil.ncsu.edu/assist/homeassist/stormwater/

N-13

Neighborhood Source Area: Sidewalk/Driveway

SAFE DE-ICER USE

Description

The ideal watershed behavior is to avoid using de-icing products on driveways and sidewalks by manually clearing and shoveling snow and ice. The next best behavior is to purchase environmentally friendly de-icing products, and apply them early but sparingly during snowfall events. The negative watershed behavior is the indiscriminate application of de-icing compounds.

How Use of Home De-icing Products Influences Water Quality

De-icing compounds, such as rock salt and urea fertilizers, can increase chloride and nutrient levels in a neighborhood. While the vast majority of de-icing chemicals applied in a subwatershed come from municipal road salting operations, homeowners often apply them at a much higher unit-area rate. During snowmelt events, chloride levels in street runoff can rise to as high as 2,000 to 4,000 parts per million, which can adversely affect aquatic life, turf, landscaping, wildlife and pets (Environment Canada, 2001). In addition, rock salt contains impurities such as phosphorus, nitrogen, copper and even cyanide. Homeowners can also make informed choices in the de-icing chemicals they use, and put their sidewalk and driveway on a low salt diet. In general, calcium chloride is preferred to sodium chloride (rock salt), and both are superior to urea, kitty litter and ashes.

Percentage of Homeowners Applying De-icing Compounds

No reliable data is available to characterize homeowner use of de-icing compounds.

Factors that Contribute to Variation in Behavior

The use of de-icing compounds is directly related to climatic factors, and actual use depends on the severity of winter conditions. Several neighborhood factors also influence the use of de-icing compounds, including lot size, driveway dimensions, the nature of driveway surfaces, and the storm water conveyance system.

Difficulty in Modifying De-icing Behaviors

Keeping ice and snow off driveways and sidewalks is important for safety. The biggest challenge is to make consumers aware of how to choose the best de-icing product for the home and the environment. The most important behavior is to read labels to compare the pros and cons of the main ingredients contained in common de-icing products. Table 1 provides some comparative data on the cost and environmental risk of de-icing compounds.

When it comes to snow removal, there is no substitute for muscle and elbow grease. De-icers work best when there is only a thin layer of snow or ice that must be melted, and they are applied at the recommended rate.

Table 1: Comparison of De-icing Compounds			
Check the Label for	**Works Down to**	**Cost**	**Environmental Risks**
NaCl, Sodium Chloride (also known as rock salt)	15° F	About $5 for a 50 pound bag	Contain cyanide Chloride impacts
Calcium Magnesium Acetate (CMA)	22° to 25° F	20 times more than rock salt	Less toxic
CaCl, Calcium Chloride	-25° F	3 times more than rock salt	Uses lower doses No Cyanide Chloride impact
Urea	20° to 25° F	5 times more than rock salt	Needless nutrients Less Corrosion
Sand	No melting effect	About $3 for a 50 lb. bag	Accumulates in streets and streams

Techniques to Change De-icing Behavior

- Conventional outreach materials (seasonal newsletters, brochures, water bill inserts)
- Broadcast advice from local TV meteorologists during storms
- Brochures or advice at point of sale

Good Example

Montgomery County Maryland De-icer Use Press Release
http://www.montgomerycountymd.gov/apps/news/press/DisplayInfo.cfm?ItemID=157

Top Resources

Using De-icers Correctly
http://www.saltinstitute.org/kirchner-1.html

Melting Ice Safely
http://www.agnr.umd.edu/MCE/Publications/PDFs/FS707.pdf

Slip-Sliding Away! A review of the available options, and their environmental, safety, and efficiency implications.
http://www.consciouschoice.com/environs/slip5lidingaway1201.html

Ice Control for Roads and Walkways
http://www.symsh.org/EPPG/9_3.asp

Protect Concrete and Vegetation with Proper Use of De-icers
http://snow.grounds-mag.com/ar/grounds_maintenance_january_3/

Winter De-icing Agents for the Homeowner
http://www.ianr.unl.edu/pubs/horticulture/g1121.htm

National Snow and Ice Data Center
http:// www.nside.org/

Salt Institute
http://www.saltinstitute.org/

Neighborhood Source Area: Garage

N-14 HOUSEHOLD HAZARDOUS WASTE COLLECTION

Description

The average garage contains many products that are classified as hazardous waste, including paints, stains, solvents, used motor oil, excess pesticides, and cleaning products. The ideal watershed behavior is to regularly participate in household hazardous waste (HHW) collection days, and to be careful when rinsing paintbrushes, cleaning pesticide applicators and fertilizer spreaders, and fueling outdoor power equipment (Figure 1). The negative watershed behavior is continued storage, improper disposal or illegal dumping of household hazardous wastes, and poor cleaning, refueling and rinsing practices.

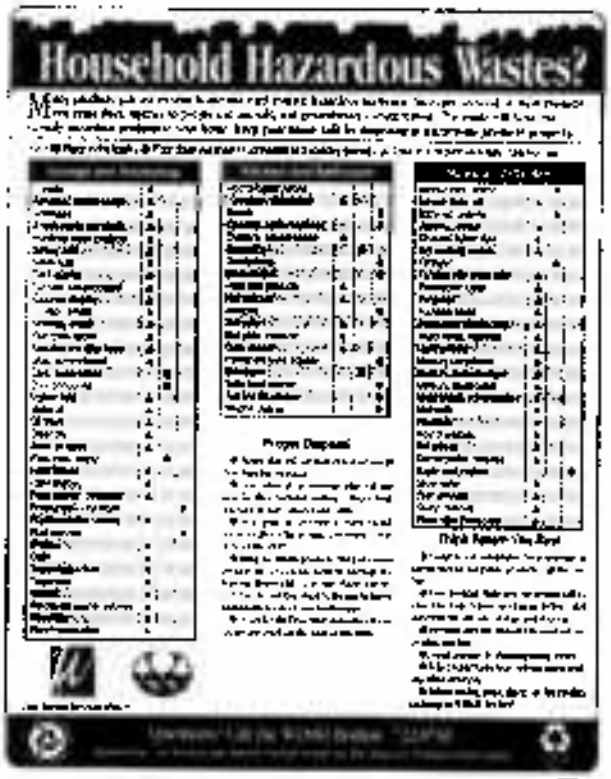


Figure 1: Household Hazardous Waste Disposal Guidelines

Source: http://www.dukelifestreams.org/understanding/impact_oil.html

How It Influences Water Quality

According to EPA, the average home/garage accumulates as much as 100 pounds of household hazardous waste per year. Nationally, households are collectively estimated to generate more than 1.6 million tons of household hazardous wastes annually. The proportion of HHW that reaches the storm drain system is not well known. Most HHW appears to be stored indefinitely, thrown out with the trash, or flushed down the sink/toilet, which is not environmentally acceptable. The key unknown is what fraction of HHW is illegally dumped into the storm drain. It is probable that most HHW enters the storm drain system during outdoor rinsing of pesticide applicators and outdoor painting cleanup. HHW that reaches the storm drain system can potentially be toxic to downstream aquatic life.

Percentage of Residents Engaging in HHW Collection

Homeowner participation in HHW collection programs is usually quite low, with several studies indicating participation rates of one to 5% (HGAC, 2004).

Variation in Participation

Convenience and awareness appear to be critical factors influencing participation in household hazardous waste collection programs. Participation is inversely related to the distance homeowners must travel to recycle waste, restrictions on what can be accepted and the number of days each year that collection events are held.

Techniques to Increase Participation

Communities continue to experiment with improved techniques to make HHW collection more convenient for residents, including:

- Mass media campaigns to educate residents on proper outdoor cleaning/rinsing
- Conventional outreach to notify residents about HHW collection days
- More frequent HHW collection days
- Providing curbside disposal options for certain HHW
- Establishing permanent collection facilities at solid waste facilities
- Providing mobile HHW pickup
- Waiving disposal fees at landfills
- Storm drain marking (see N-21)

Good Examples

The City of Denver Pilot Door-to-Door HHW Collection Program. This unique program assists residents in proper disposal and recycling of household hazardous wastes. Residents are permitted one HHW collection annually and receive a collection date and an HHW Kit that can hold up to 75 pounds. The program not only provides a curbside pick-up program for household hazardous waste, but also educates citizens on how to prevent the accumulation of chemicals in the garage.
http://www.denvergov.org/admin/template3/forms/INSERT1.pdf

King County Wastemobile. The Wastemobile is a traveling collection program that goes to two sites in the county per month to accept HHW and provide information about alternatives to hazardous products. The Wastemobile is funded through a surcharge on solid waste disposal and wastewater discharge, and residents utilizing the Wastemobile are not charged a fee on site.
http://www.govlink.org/hazwaste/house/disposal/wastemobile/

Top Resources

EPA Household Hazardous Waste Website
http://www.epa.gov/epaoswer/non-hw/muncpl/hhw.htm

Guide to Household Hazardous Wastes
http://www.epa.gov/ertlakes/seahome/housewaste/house/products.htm

Household Hazardous Waste - Steps to Safe Management
A guide for residential homeowners that describes household hazardous waste and the dangers of improper disposal.
http://www.epa.gov/epaoswer/non-hw/household/hhw.htm

Household Hazardous Waste (HHW) Management: A Manual for One Day Community Collection Programs
A manual that helps communities plan for one-day, drop-off HHW collection programs. Provides community leaders with guidance on all aspects of planning, organizing, and publicizing a HHW collection program.
http://www.epa.gov/epaoswer/non-hw/household/hhw/cov_toc.pdf

Department of Defense - Household Hazardous Waste Topic Hub
http://www.p2pays.org/p2px/toc.cfm?hub=16&subsec=7&nav=7&CFID=23448&CFTOKEN=55325833

Household/Small Business Hazardous Waste: A Manual for Sponsoring a Collection Event
http://www.dep.state.pa.us/dep/deputate/airwaste/wm/HHW/Documents/TechMan.pdf

N-15

Neighborhood Source Area: Driveway

CAR FLUID RECYCLING

Description

The ideal watershed behavior is to have automotive fluids changed at a commercial operation where stringent pollution source controls and fluid recycling practices are in place. The next best alternative is to perform car maintenance under cover within the garage, and carefully dispose of all oil, antifreeze and other fluids at approved recycling facilities. The negative behavior is to improperly store, dump or otherwise dispose of car fluids into the storm drain system.

How Fluid Changing Influences Water Quality

Dumping automotive fluids down storm drains can be a major water quality problem, since only a few quarts of oil or a few gallons of antifreeze can have a major impact on small streams. Dumping can be a major source of hydrocarbons, oil/grease, metals, xylene and other pollutants to a stream, and are potentially toxic if dumped during dry-weather conditions when existing flow cannot dilute these discharges. The major culprit has been the backyard mechanic who changes his or her own automotive fluids (Figure 1). It has been estimated that do-it-yourself mechanics

Figure 1: Fluid Changing on Driveway

improperly dispose of 192 million gallons of used oil into the environment each year (University of Missouri, 1994). It remains unclear what fraction of the improper disposal of motor oil occurs within the storm drain system.

Percentage of People Engaging In Improper Disposal

The number of backyard mechanics who change their own oil and antifreeze has been dropping steadily in recent decades. With the advent of the $20 oil change, only about 30% of car owners still change their own oil or antifreeze (Swann, 2001). Backyard mechanics have traditionally been the target of community oil recycling and storm drain marking programs. These programs appear to have been quite effective, since more than 80% of backyard mechanics claim to dispose of or recycle these fluids properly (Smith, 1996; PRC, 1998; Assing, 1994). Most backyard mechanics were more prone to recycle oil than antifreeze. Backyard mechanics that indicated they had improperly disposed of automotive fluids reported that they dumped it into trashcans rather than the storm drain system. Oil and antifreeze dumping is considered socially unacceptable in many communities, and, according to Swann (2001), less than 5% of backyard mechanics report that they illegally dump oil.

Variation in Car Fluid Disposal

Neighborhood demographic and income levels appear to be important factors governing the number of "do-it-yourselfers" in a given subwatershed. As with other residential behaviors, proper disposal of oil and anti-freeze is primarily influenced by the ease, convenience and costs for accepting these fluids at local service stations or municipal collection stations.

Techniques to Change Car Fluid Disposal

While used oil collection has been a common municipal service for many years, some communities are continuously refining their programs to increase participation (Figure 2). These techniques include:

- Conventional outreach materials provided at point of sale (e.g., auto parts stores, service stations)
- Multilingual outreach materials
- Community oil recycling
- Directories of used oil collection stations
- Free or discounted oil disposal containers
- Storm drain marking

Figure 2: Frisbee Advertising Oil Recycling

Good Examples

King County Kiosks (Washington). Thirty interactive kiosks on oil recycling were placed in King County licensing offices, county buildings and other locations. In addition, a direct mail campaign to 6,000 households and three newspaper ads were used to distribute coupons good for product or service discounts that could be used when dropping off oil at participating sites.

California's Used Oil Recycling Program Incentive Program. Residents can receive incentives from certified centers that recycle used oil. Certified centers must accept used oil from the public at no charge during business hours and offer a $0.16 per gallon recycling incentive. In turn, only certified used oil collection centers can file a claim for recovery of the $0.16 per gallon it pays out. Certified centers can also claim the recycling incentive for all used oil generated on site from their business as an inducement to take oil from the public. http://www.ciwmb.ca.gov/BoardInfo/ProgramResp/SpecialWaste/HHW.htm - Public%20Info

Top Resources

Car Care for Do-It-Yourselfers
http://www.monterey.org/publicworks/carcare.html

Car Care for Cleaner Water
http://clean-water.uwex.edu/pubs/stormie/carcare.pdf

Motor Vehicle Maintenance
http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/HH-15.pdf

How To Set Up a Local Program to Recycle Used Oil - Explains the organization, design, implementation, and promotion of a used oil program, as well as administrative issues. Includes sample brochures and letters. http://www.epa.gov/epaoswer/non-hw/recycle/89039a.pdf

N-16

Neighborhood Source Area: Rooftop

DOWNSPOUT DISCONNECTION

Description

Downspout disconnection spreads rooftop runoff from individual downspouts across the lawn or yard where it filters or infiltrates into the ground. While some disconnections are simple, most require the installation of an on-site storm water retrofit practice. These simple practices capture, store and infiltrate storm water runoff from residential lots, and include rain barrels, rain gardens, French drains or dry wells. *Rain barrels* capture runoff from rooftops and are typically installed on individual roof leaders. Runoff captured in the barrel is stored for later use as supplemental irrigation. *Rain gardens* are shallow, landscaped depressions in the yard used to store and infiltrate runoff from rooftops and other impervious surfaces on the lot. *French drains and dry wells* are shallow small stone trenches used to infiltrate rooftop runoff into the ground, where soils are permeable. More details about on-site retrofit practices can be found in Profile Sheets 0S-15 through 0S-17 in Manual 3.

The ideal watershed behavior is to disconnect all downspouts so individual rooftops deliver no runoff to the storm drain system or stream. The negative watershed behavior is to pipe downspouts across the yard and into the curb or street in order to promote positive drainage (Figure 1).

How Downspout Disconnection Influences Subwatershed Quality

Downspout disconnection reduces the amount of impervious cover on a developed lot that can generate stormwater runoff. In addition to reducing the volume of runoff, downspout disconnection promotes groundwater recharge, reduces storm water runoff volumes, and filters out pollutants through the lawn soil. Since each individual retrofit for downspout disconnection treats only a few hundred or thousand square feet of impervious cover, dozens or hundreds are needed to make a measurable difference at the subwatershed level. Consequently, an intensive campaign to target education, technical assistance, and financial resources within a neighborhood or subwatershed to encourage widespread adoption of disconnection is needed.

Percentage of Residents Engaging in Downspout Disconnection

Data is not currently available to estimate the rate at which homeowners voluntarily disconnect downspouts. The frequency of this behavior is thought to be extremely low in most neighborhoods unless a community aggressively promotes and subsidizes disconnections. If this occurs, homeowner participation rates of 20 to 30% have been reported in pilot projects (Environment Canada, 2001).

Figure 1: Downspout Intentionally Bypassing Landscaped Area and Draining onto Driveway

Variation in Downspout Disconnection

The potential to disconnect downspouts is normally evaluated as part of the Neighborhood Source Assessment component of the USSR survey (see Manual 11). The most important neighborhood factor is the proportion of existing homes directly connected to the storm drain system. Negative neighborhood factors include the presence of basements, compacted soils, and poor neighborhood awareness or involvement. Positive factors are large rooftop areas that are directly connected to the storm drain system, lots with extensive tree canopy, and good neighborhood housekeeping. In general, large residential lots are most suitable for most disconnection retrofits (1/4 acre lots and larger), although rain barrels can be used on lots as small as 4,000 square feet (Figure 2).

To date, the impetus for most disconnection retrofit programs has been to separate residential storm water from sewer flows in older neighborhoods in order to minimize basement sewer backups or combined sewer overflows.

Figure 2: Rain Barrel Used on a Back, Second Floor Balcony

Techniques to Promote Downspout Disconnection

Communities are experimenting with many different carrots to promote disconnection retrofits, including:

- Conventional outreach materials (flyers, brochures, posters)
- Free or discounted rain barrel distribution
- Municipal or schoolyard demonstration projects
- Credits or subsidies for disconnection retrofits
- Direct technical assistance
- Provision of discounted mulch, piping or plant materials
- Modification of sewer and storm water ordinances to promote disconnection
- Mandatory disconnection for targeted subwatersheds

Good Examples

Downspout Disconnection Program (Portland, OR). The City offers residents a credit of $53 per disconnection in the form of a check or a one-time lump sum credit toward their sewer bill after inspection and approval of the work. In addition, neighborhood associations and other civic groups (churches, schools, etc.) can earn $13 for every downspout they disconnect. http://www.portlandonline.com/bes/index.cfm?c=32144

Rain Blocker Program (City of Chicago). The Rain Blocker pilot program is specifically designed to eliminate or greatly reduce the amount of basement flooding caused by sewer surcharge. The program works by restricting the rate of storm water flow into the city sewer system, via installing vortex restrictors within the catch basins of city streets and through downspout disconnection from buildings. http://www.cityofchicago.org/WaterManagement/Blocker.html

Neighborhood Rain Gardens (Minneapolis, MN). This program works with neighborhood associations to encourage landscaping for rainwater management. The Fulton Neighborhood Association has worked with eight homeowners to install rain gardens, rain barrels, gutter downspout redirection, and infiltration systems that reduce runoff delivered from individual properties to streets, alleys and sidewalks.
http://www.fultonneighborhood.org/lfrwm.htm

Top Resources

How to Disconnect Your Downspouts (Portland Oregon)
http://www.portlandonline.com/bes/index.cfm?c=32144

Milwaukee Downspout Disconnection Program
http://www.mmsd.com/projects/downspout.cfm

Boston Water and Sewer Commission's Downspout Disconnection Program
http://www.bwsc.org/Customer_Service/Programs/downspout.htm

RainGardens.org
http://www.raingardens.org/

Rain Gardens: A how-to manual for homeowners
http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/rgmanual.pdf

Rain Garden Applications and Simple Calculations
http://www.cwp.org/Community_Watersheds/Rain_Garden.htm

How to Build and Install a Rain Barrel
http://www.cwp.org/Community_Watersheds/brochure.pdf

Skills for Protecting Your Stream: Retrofitting Your Own Backyard
http://www.cwp.org/Community_Watersheds/Retrofitting_Backyard.pdf

N-17

Neighborhood Source Area: Rooftop

SINGLE LOT CONTROLS

Description

The ideal watershed behavior is to gradually reduce impervious cover on residential lots by converting impervious cover to pervious cover. Examples include converting an impervious driveway to a more pervious design, or eliminating an old walkway, deck or outbuilding. In practice, however, most homeowners gradually add more impervious cover to their residential lots over time, in the form of decks, patios, walkways and home additions. Thus, the practical watershed behavior is to treat storm water runoff produced by new impervious cover, using downspout disconnection and other on-site retrofits to minimize storm water runoff (see Profile sheets N-16 and OS-15 to 17 in Manual 3).

How Impervious Cover Influences Subwatershed Quality

Impervious cover plays a strong role in defining both subwatershed quality and stream health (CWP, 2003). The amount of impervious cover in a neighborhood or a subwatershed does not remain constant over time, but rather increases incrementally as individual residents remodel, redevelop or otherwise improve their lots. Collectively, the gradual "creep" in impervious cover may make it more difficult to achieve subwatershed restoration goals.

Percentage of Residents Adding Impervious Cover

More than 18 million households (20% of all households in the U.S.) completed projects over the last decade that added impervious cover to their residential lots (U.S. Census, 2001). This included three million home additions (e.g., expansions, decks, carports, attached garages, porches, and other remodeling), as well as 15 million detached structures (e.g., driveways, walkways, patios, terraces, swimming pools, tennis courts, detached decks, garages, sheds, and other outbuildings).

Factors that Contribute to Variation In Adding Impervious Cover

The precise reasons why impervious cover is added or reduced within a neighborhood are often unique, and reflect its age, housing stock, demographics, income levels, and average lot size. In many cases, the degree of redevelopment/remodeling activity can be ascertained during the neighborhood source assessment of the USSR survey (see Manual 11). If redevelopment activity level is high, serious consideration should be given to residential storm water management requirements such as those described in BASMAA (1997) and Winer (2003). In some communities, erosion control or storm water treatment requirements are triggered when areas as small as 100, 250, or 500 square feet are disturbed.

Techniques to Change the Behavior

Most communities have been reluctant to regulate small remodeling and redevelopment projects on individual residential lots, but a few have developed simplified techniques to address the storm water impacts single lots (Figure 1).

Other techniques include:

- Conventional outreach materials (brochures, water bill inserts)
- Contractor training and certification (see Hotspot Profile Sheet H-9)
- Setting storm water utility rates based on actual impervious cover
- Simplified residential storm water management plans

Good Examples

Simplified Residential Storm Water Management Plan (Maryland Critical Area) - The regulatory threshold to treat storm water runoff is triggered at only 250 square feet, which means that many decks, additions, and other residential projects must comply. To simplify compliance for individual residential lots, the Critical Area Commission allows non-engineered storm water plans such as compensatory tree planting, rooftop disconnection, and pervious driveways and walkways.
http://www.dnr.state.md.us/criticalarea/10percent_rule.html

City of Charlotte and Mecklenberg County, NC Stormwater Credits - These communities created a credit system for storm water fees when property owners are able to show an effective reduction of the impact their property has on the drainage system. The fee credit applies to all properties, including single-family residential properties with practices that reduce storm water runoff from their site.
http://www.charmeck.org/Living/Environment/Home.htm

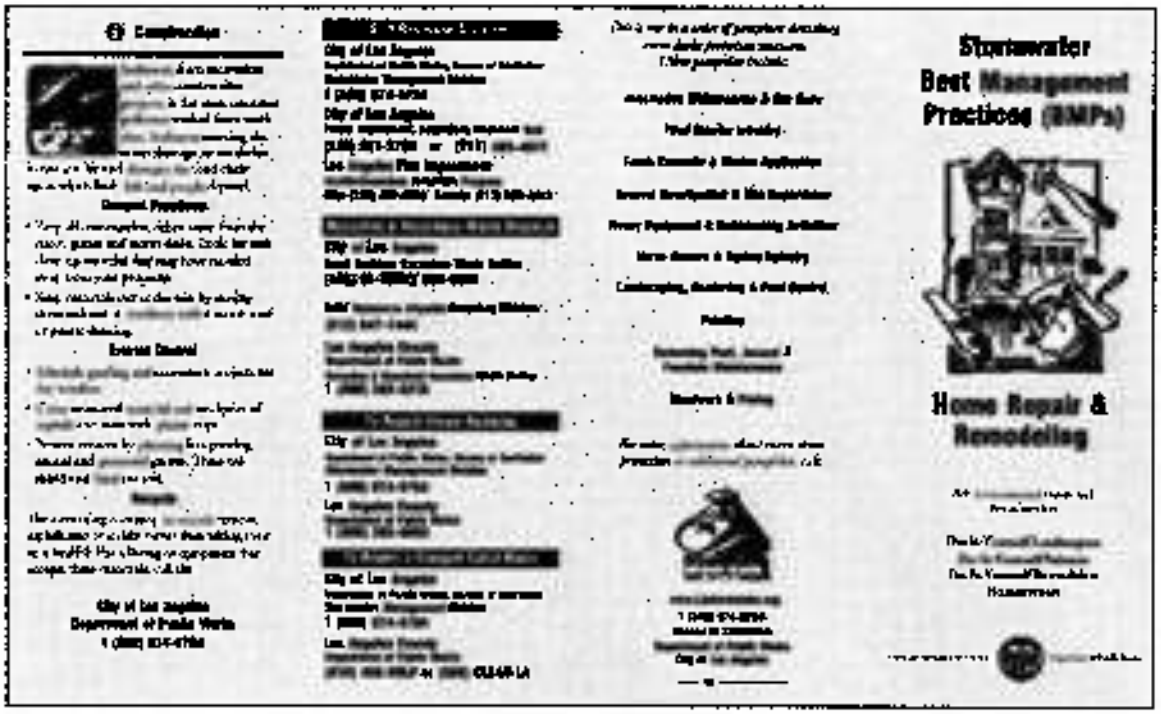


Figure 1: Repair and Remodeling Brochure
Source: http://www.lacity.org/SAN/wpd/index.htm

N-18

Neighborhood Source Area: Common Areas

PET WASTE PICKUP

Description

The ideal watershed behavior is to pick up and properly dispose of pet waste (Figure 1). The negative watershed behavior is to leave pet waste in common areas and the yard, where it can be washed off in storm water runoff.

How Pet Waste Influences Subwatershed Quality

Pet waste has been found to be a major source of fecal coliform bacteria and pathogens in many urban subwatersheds (Schueler, 1999). A typical dog poop contains more than three billion fecal coliform bacteria and as many as 10% of dogs are also infected with either *giardia* or salmonella, which is not surprising considering they drink urban creek water. Fecal coliform bacteria are frequently detected in urban streams and rivers after storms, with levels as high 5,000 fecal coliform per tablespoon. Thus, it is not uncommon for urban and suburban creeks to frequently violate bacteria standards for swimming and water contact recreation after larger rainstorms.

Percentage of Residents that Pick Up After Pets

Surveys indicate that about 40% of all households own one or more dogs (Swann, 1999). Not all dog owners, however, are dog walkers. Only about half of dogs are walked regularly. About 60% of dog walkers claim to pick up after their dog some or all of the time (Swann, 1999; HGIC, 1998; and Hardwick, 1997). The primary disposal method reported by residents for pet waste is the trash can, with toilets coming in distant second. Dog walkers that do not pick up after their dogs are highly resistant to change; nearly half would not pick up even if confronted with fines or complaints from neighbors (Swann, 1999). Men are also prone to pick up after their dogs less often than women (Swann, 1999).

Figure 1: Pet Waste Pickup Station

Techniques to Promote Pet Waste Pickup

The key technique is to educate residents on sanitary and convenient options for retrieving and disposing of pet waste. Several communities have used both carrots and sticks to get more owners to pick up after their pets, including:

- Mass media campaigns of the water quality impacts of pet waste
- Conventional outreach materials (brochures, flyers, posters)
- Pooper bag stations in parks, greenways and common areas
- Educational signs in same areas
- "Pooper scooper" ordinances and enforcement
- Banning dogs from beaches and waterfront areas
- Providing designated "dog parks"

Good Examples

Water Quality Consortium Nonpoint Source Education Materials
The Water Quality Consortium implemented an ad campaign focused on four themes: a man pushing a fertilizer spreader, a car driving on water leaking oil, a man washing his car, and man walking his dog. Each ad explains how the behavior leads to water pollution and provides specific tips outlining what residents can do to protect water quality.
http://www.psat.wa.gov/Programs/Pie_Ed/Water_Ed_Materials.htm

Pick It Up - It's Your Doodie Campaign (Gwinnett County Parks & Recreation Department) - The county park agency provides plastic grocery bags for pet owners to use to clean up after their pets as part of a pilot program. The baggies are attached to a wooden post at a local park. Underneath a sign explains their purpose. Pet owners are also encouraged to bring replacement bags when they visit the park.
http://www.gwinnettcitizen.com/0203/doodie.html

Top Resources

Public Open Space and Dogs: A Design and Management Guide for Open Space Professionals and Government
http://www.petnet.com.au/openspace/frontis.html

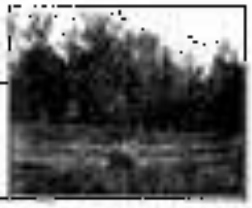
Considerations for the Selection and Use of Pet Waste Collection Systems in Public Areas
http://www.ecy.wa.gov/programs/wq/nonpoint/pet_waste/petwaste_station.pdf

Properly Disposing of Pet Waste
http://www.cleanwatercampaign.com/what_can_i_do/pet_waste_home.html

Managing Pet and Wildlife Waste to Prevent Contamination of Drinking Water
U.S. EPA Source Water Protection Practices Bulletin.
http://www.epa.gov/safewater/protect/pdfs/petwaste.pdf

Neighborhood Source Area: Common Areas

N-19 STORM WATER PRACTICE MAINTENANCE



Description

The ideal watershed behavior is to regularly maintain storm water treatment practices, which are normally located in common space managed by a homeowner's association. The negative behavior is to ignore routine and non-routine maintenance tasks to the extent that the ability of the practice to remove pollutants and protect streams is impaired. Storm water maintenance consists of routine and non-routine tasks. Routine tasks include on-going inspections, mowing, vegetation management, trash and debris pickup, and removal of any obstructions within pipes and riser structures. Non-routine tasks include sediment clean-outs, structural repairs, tree removal, fence repair, and other major tasks performed every five to 10 years.

How Storm Water Maintenance Influences Subwatershed Quality

Storm water detention or treatment practices have been constructed in many subwatersheds over the last few decades. The vast majority of these practices have been dry or wet storm water ponds. These ponds were designed to detain flood waters and, in some cases, remove pollutants as well. Ongoing pond maintenance is needed to maintain pollutant removal rates, keep the pond safe, and to enhance its habitat, wetland or landscaping value (Figure 1).

Percentage of People Engaging in Storm Water Practice Maintenance

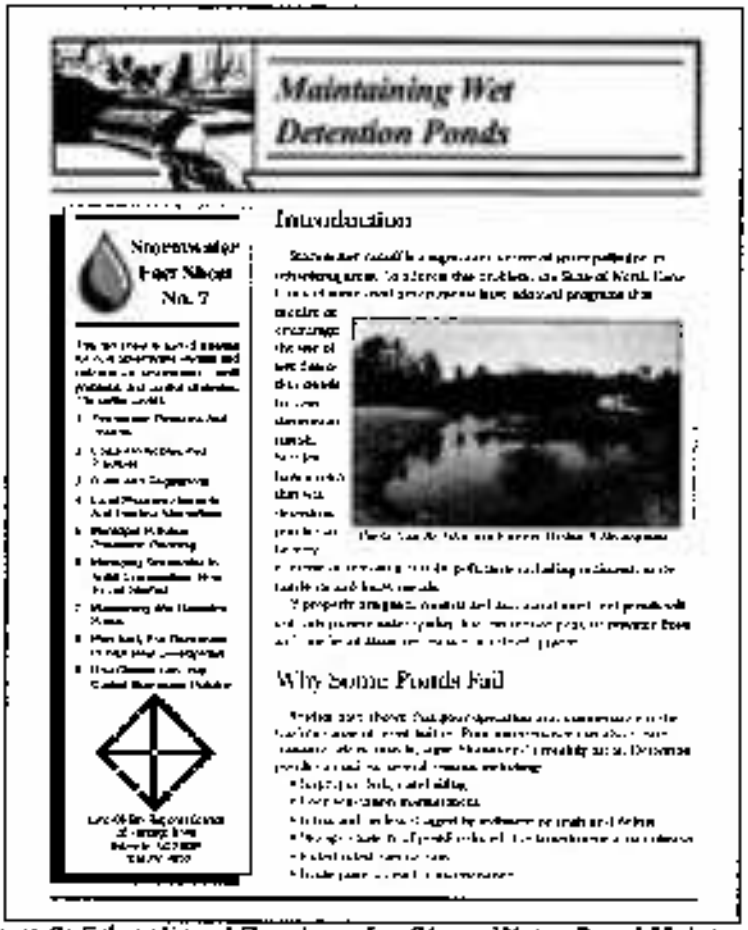
Little data is available to characterize this watershed behavior, although anecdotal evidence indicates that maintenance is the exception rather than the rule at many ponds.

Figure 1: Wet Storm Water Pond

Variation in Storm Water Practice Maintenance

Each state or locality has its own storm water history, which begins when storm water detention or treatment practices were first required on new development projects. Thus, some communities may have hundreds or even thousands of storm water practices built over decades, while others may have few practices and no real history of managing storm water.

If a community has a history of managing storm water, several neighborhood factors play a role in defining maintenance behaviors. The most critical factor is the age of the neighborhood, since most storm water practices have only been built in the last 10 to 15 years. The second key neighborhood factor is the design objective of the past storm water management practices (e.g., provide flood control, peak shaving, water quality or recharge). The last important factor is the size, sophistication and financial health of the homeowners association that has maintenance responsibility for the pond.


Maintaining Wet Detention Ponds

Introduction

Why Some Ponds Fail

Figure 2: Educational Brochure for Storm Water Pond Maintenance
Source: http://h2o.enr.state.nc.us/su/PDF_Files/Land_of_Sky_factsheets/FactSheet_7.pdf

Difficulty in Improving Maintenance of Storm Water Practices

Improving routine and non-routine maintenance can be difficult, since many homeowner or civic associations lack adequate maintenance budgets. They may also be ignorant of the purpose and functions of storm water practices, and not understand basic maintenance operations. Consequently, targeted education and direct technical assistance to homeowner associations is important to improve maintenance behaviors.

Techniques to Improve Maintenance Behavior

Some communities have adopted innovative techniques to improve the frequency of maintenance of storm water practices, including the following:

- Conventional outreach materials (maintenance guidebooks)
- Liaison w/homeowner and civic associations
- Free inspections and contractor referral
- Pondscaping assistance (e.g., technical assistance, free plant material)
- Adopt-a-pond programs
- Storm water maintenance classes and work parties
- Pond beautification awards
- Annual maintenance reminder letters

Good Examples

Adopt- a-Pond Program (Baltimore County, MD) The County developed a pilot pond adoption program that features four different levels of participation. The basic level includes inspections and trash pickup, while the most advanced involves pondscaping, wildlife enhancements, and simple retrofits. Another interesting feature of this pond adoption program is the fact that the training and administration of the program are subcontracted to a local watershed organization. Contact the Center for Watershed protection for information on how to access.

Adopt-a-Pond Program (Hillsborough County, FL). This Florida county has the largest and longest running "adopt a pond" program in the nation. Nearly 200 ponds have been adopted by neighborhood groups and service clubs. The program features signs, volunteer recognition, newsletters and work parties to actively engage, train and retain volunteers. For more details: http://www.swfwmd.state.fl.us/documents/publications/files/adopt.htm

Pond Maintenance Training and Work Parties (Lacey, WA). This version of an adopt-a-pond program uses a series of night-time training classes on the basics of storm water maintenance, followed by weekend work parties to spruce up and landscape storm water ponds.

Top Resources

Thurston County, Washington, "How to Care for Your Stormwater Pond." This web document is an excerpt from the publication *Maintaining Your Stormwater Pond: A Step-by-Step Guide to Keeping Your Stormwater Pond Happy and Healthy.* Geared toward private landowners and homeowner associations, this document answers basic questions on storm water pond maintenance.
http://www.co.thurston.wa.us/swm/stormwaterpages/maintainpond.pdf

Northern Virginia Planning District Commission, Maintaining Your BMP – A Guidebook for Private Owners and Operators in Northern Virginia. This document is designed for individual property owners, homeowner association leaders, and residential/commercial property managers. The guidebook outlines the basic maintenance and planning tasks to help keep practices functioning properly, and includes information on general maintenance needs, who should carry out maintenance, inspections, and basic planning. The document also includes a simple inspection checklist and a maintenance cost planning sheet.
http://www.novaregion.org/pdf/Maintaining_BMPs.pdf

Montgomery County, MD "Maintaining Urban Storm water Facilities: A Guidebook for Common Ownership Communities." This guidebook describes the four primary types of storm water practices found in the County and outline some basic maintenance tasks to keep them functioning properly.
http://www.montgomerycountymd.gov/mcgtmpl.asp?url=/content/dep/stormwater/maintain.asp

City of Eugene, Oregon - Storm Water Drain Maintenance on Private Property. This short guide discusses the maintenance of storm water drains, street gutters, underground pipes, roadside ditches, and open drainage channels. Proper storm water drain maintenance is crucial for flood control and water quality protection. This guide explains the private property owner's responsibility to maintain storm water drains on his or her property and some simple maintenance procedures to meet this responsibility.
http://www.stormwatercenter.net/

South Carolina Department of Health and Environmental Control, Ocean and Coastal Resource Management's A Citizen's Guide to Storm Water Pond Maintenance. This booklet is a guide for individuals and homeowner associations on the proper function and maintenance of storm water ponds. Instructions are provided on inspections, dredging, weed control, herbicides, pollutants and pesticides. Photos and descriptions of nuisance aquatic plant species are provided to aid in the identification and removal of these species from storm water ponds.
http://www.scdhec.net/ocrm/pubs/ponds.pdf

Howard County, MD – Maintaining Your Stormwater Management Structure. This manual is directed at commercial property managers who own storm water management structures. The purpose of this manual is to describe the four types of stormwater management structures and their maintenance requirements.
http://www.co.ho.md.us/DPW/DOCS/stormwatermanual.pdf

Stormwater Manager's Resource Center. This website offers information on maintenance arrangements, agreements, costs, frequencies, and educational materials.
http://www.stormwatercenter.net
(Click on "Program Resources" then "STP Maintenance")

N-20

Neighborhood Source Area: Common Areas

BUFFERSCAPING

Description

Many neighborhoods built in the last few decades still have a decent stream corridor protected by buffers, flood plain setbacks or wetland protection requirements. The stream corridor that remains is often in common or private ownership. The ideal watershed behavior is to respect the boundaries of the stream corridor and expand it where possible through "bufferscaping" and backyard planting of native plants and trees. The negative watershed behavior is stream corridor encroachment, through clearing, dumping, allowing invasive plant species to spread from private yards, and erecting structures (Figure 1).

How Bufferscaping Influences Subwatershed Quality

A forested stream corridor is an essential ingredient of a healthy stream, except in certain arid and semi-arid regions. Bufferscaping can add to the total area of the stream corridor, provide wildlife habitat and enhance the structure and function of the buffer. By contrast, encroachment activities diminish the quality, function and attractiveness of the stream buffer.

Percentage of People Encroaching on/Expanding the Stream Corridor

Data is not currently available to estimate the rate at which homeowners add to the stream corridor, but several troubling studies have examined the degree of residential buffer encroachment. Many residents perceive buffers as an extension of their backyard, and think little of removing trees, dumping yard wastes or erecting structures on their land. A major reason is that nearly 60% of residents are ignorant of the boundaries and intended purpose of stream buffers (Horaty, 1993). Studies of wetland buffer encroachment in Washington residential areas found that 95% of buffers were visibly altered, 40% to such a degree that their functional value was eliminated (Cooke, 1991). Other studies of Maryland buffers indicate encroachment rates of as much as 1% of area buffer per year. Clearly, residential awareness and behaviors in regard to the stream corridor need to be improved in many subwatersheds.

Neighborhood Factors that Contribute to Buffer Stewardship

Several factors play a role in how buffers are managed within a neighborhood: the age of the development, lot size, activism of homeowner association, boundary signs, and the prior existence of stream buffer or flood plain regulations.

Figure 1: A New Subdivision Encroaching on the Stream Buffer

Techniques to Encourage Buffer Stewardship

Protecting or expanding stream buffers requires direct education and interaction with individual property owners that back up to the buffer. Some useful techniques include:

- Bufferscaping assistance and guides
- Community buffer walks
- Buffer boundary inspections
- Boundary signs (Figure 2)
- Defining unallowed uses in local stream buffer ordinances
- Presentations to community associations
- Adopt-a-stream program
- Financial incentives for bufferscaping

Figure 2: Sign Identifying a Buffer Boundary

Good Examples

Burnett County, WI Natural Shoreline Incentives. The county pays homeowners to enroll in a program to maintain shorelines in their natural state. The program asks for a voluntary commitment by placing a covenant on a homeowner's property stating that the shoreline will remain natural. Program members receive a payment of $250 after an initial inspection that certifies the property meets program standards, and the shoreline covenant is recorded. Participants also receive an annual deduction from their tax statement as a thank you.
http://www.burnettcounty.com/burnett/lwcd/preserve.html

Tennessee Valley Authority Banks and Buffers Software: A Guide to Selecting Native Plants for Streambanks and Shorelines includes software application to help homeowners select plants for bufferscaping. It also contains selected characteristics and environmental tolerances of 117 plants and more than 400 color photographs illustrating habitat and growth form.
http://www.tva.gov/river/landandshore/stabilization/websites.htm

Top Resources

The Architecture of Urban Stream Buffers
http://www.stormwatercenter.net/Library/Practice/39.pdf

Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers
http://www.chesapeakebay.net/pubs/subcommittee/nsc/forest/riphbk.pdf

Riparian Forest Buffer Design, Establishment and Maintenance
http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=13

Riparian Area Management: A Citizen's Guide
http://www.co.lake.il.us/elibrary/publications/smc/riparian.pdf

Backyard Buffers for the South Carolina Lowcountry
http://www.scdhec.net/ocrm/pubs/backyard.pdf

Alliance for the Chesapeake Bay Backyard Buffers
http://www.acb-online.org/pubs/projects/deliverables-158-1-2003.pdf

Cayuga County, NY – Green Thumbs for Blue Water Workshops
http://www.co.cayuga.ny.us/wqma/greenthumbs

Tree-mendous Maryland
http://www.dnr.state.md.us/forests/treemendous/

N-21

Neighborhood Source Area: Common Areas

STORM DRAIN MARKING

Description

The ideal watershed behavior is to get residents to fully understand the connection between storm drains and downstream waters and avoid any activity that discharges pollutants. This awareness is most often created by marking or stenciling storm drain inlets with a "Don't dump, drains to..." message (Figure 1). The negative watershed behavior is to use storm drains as a means of disposal for trash, yard waste and household products.

How Storm Drain Marking Influences Water Quality

Storm drain marking sends a clear message to keep trash and debris, leaf litter and organic matter out of the storm drain system. Stencils may also reduce residential spills and illicit discharges. Marking is also a direct and local way to increase watershed awareness and practice neighborhood stewardship. The actual water quality benefits of storm drain marking have yet to be demonstrated through field research or monitoring. Still, marking is always a sign of good neighborhood housekeeping. Santa Monica, CA also marks the hotline phone number on storm drains to report water quality problems and illegal dumping.

Percentage of Residents Engaging in Storm Drain Marking

This behavior does not require extensive resident participation; only a few trained volunteers are needed to thoroughly mark storm drains within a neighborhood. Volunteers can include scouts, service groups, high school students, neighborhood associations, and other volunteers. Normally, marking is "sanctioned" by the local public works authority or environmental agency, so it is important to coordinate closely with them (Figure 2). Table 1 provides guidance for marking storm drains.

Factors to Consider in Storm Drain Marking

The only significant impediment to storm drain marking is when a neighborhood is primarily served by open channels or grassed channels, rather than enclosed storm drains.

Figure 1: Storm Drain Marking

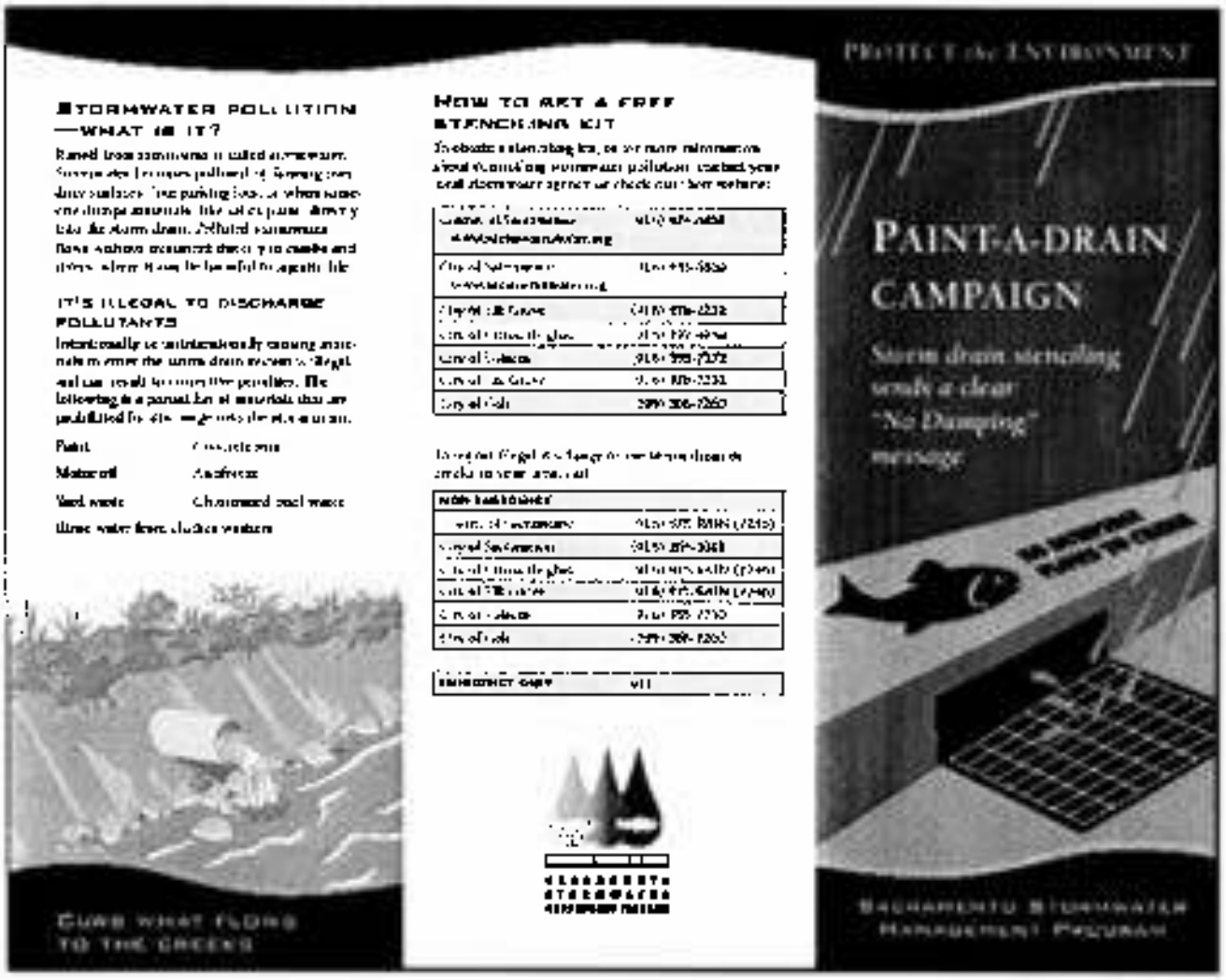


Figure 2: Educational Brochure on Storm Drain Marking/Stenciling
Source: http://www.sactostormwater.org/documents/stencil_brochure_03.pdf

Table 1: Storm Drain Marking Guidance

- Enlist one person to serve as the team leader, and make sure he/she knows all marking rules and safety procedures.
- Review all safety procedures before marking.
- Marking should be performed by at least two people, so one can be on the lookout for oncoming vehicles. Safety vests and traffic cones can be used to alert vehicles.
- Remember to wear old cloths and shoes.
- Bring paper towels or a rag to wipe up and two trash bags – one for the wet stencil (when necessary), which is not garbage, and one to pick-up garbage along the way.
- Keep track of all storm drain stencils and turn this information over to the team leader or the appropriate local government agency.
- Do not mark any storm drains with vehicles parked nearby.
- Record the locations of any storm drains that have leaves, grass clippings, oil, or other pollutants.
- Properly dispose of all trash at the end of the day, and return all empty paint cans and supplies to the team leader.

Information adapted from the following sources:
http://www.dep.state.pa.us/dep/assistance/litter/storm-drain.htm
Storm Drain Stenciling, A Manual for Communities (GI-212) *developed by the Texas Natural Resource Conservation Commission*

Top Resources

Texas Natural Resource Conservation Commission's Storm Drain Stenciling: A Guide for Communities. This extensive guide includes information on how to get volunteers involved, guidelines and materials for marking, reviews of five marking programs, and sample recognition certificates, press releases, door hangers, and public service announcements.
http://www.tnrcc.state.tx.us/exec/sbea/education.html

The Urban Dweller's Guide To Watersheds
http://www.museumca.org/creeks/umbrella.html

University of Wisconsin-Extension Water Resources Program Storm Drain Stenciling Web Page
http://clean-water.uwex.edu/wav/stormdrain/index.htm

Earthwater Stencils Home Page
http://www.earthwater-stencils.com/

Storm Drain Stenciling Project Guidelines
http://www.epa.gov/adopt/patch/html/guidelines.html

The Ocean Conservancy's Storm Drain Sentries
http://www.oceanconservancy.org/site/PageServer?pagename=op_sentries

South Carolina Department of Health and Environmental Control's Water Watch Campaign: Conducting a Storm Drain Tagging Project
http://www.scdhec.net/water/pubs/wwtag2.pdf

Multilingual Storm Drain Stenciling GreenSpace Partners worked with local watershed groups and volunteers to stencil storm drains with messages in English, Somali and Spanish.
http://www.greeninstitute.org/GSP/programs/stormwater/stencils/stencils.html

North Carolina's Storm Drain Stenciling Project This project was piloted in 1994 along coastal NC watersheds and has received support from many state and national organizations and has received the "Take Pride in North Carolina" Award.
http://www.bae.ncsu.edu/bae/programs/extension/wqg/smp-18/stormdrain/

Glenwood Road/Powerhouse Drain Pollution Abatement Plan

APPENDIX B
Structural Pollution Reduction Measures

Stormwater Ponds

Description:
Constructed stormwater retention basin that has a permanent pool (or micropool). Runoff from each rain event is detained and treated in the pool through settling and biological uptake mechanisms.

Design Options:
Micropool Extended Detention (P-1), Wet Pond (P-2), Wet Extended Detention (P-3), Multiple Pond (P-4), Pocket Pond (P-5)

KEY CONSIDERATIONS

FEASIBILITY

- Contributing drainage area greater than 10 acres for P-1, 25 acres for P-2 to P-4.
- Follow DEC Guidelines for Design of Dams.
- Provide a minimum 2' separation from the groundwater in sole source aquifers.
- Do not locate ponds in jurisdictional wetlands.
- Avoid directing hotspot runoff to design P-5.

CONVEYANCE

- Forebay at each inlet, unless the inlet contributes less than 10% of the total inflow, 4' to 6' deep.
- Stabilize the channel below the pond to prevent erosion.
- Stilling basin at the outlet to reduce velocities.

PREATREATMENT

- Forebay volume at least 10% of the WQ_v
- Forebay shall be designed with non-erosive outlet conditions.
- Provide direct access to the forebay for maintenance equipment
- In sole source aquifers, provide 100% pretreatment for hotspot runoff.

TREATMENT

- Provide the water quality volume in a combination of permanent pool and extended detention (Table 6.1 in manual provides limitations on storage breakdown)
- Minimum length to width ratio of 1.5:1
- Minimum surface area to drainage area ratio of 1:100

LANDSCAPING

- Provide a minimum 10' and preferably 15' safety bench extending from the high water mark, with a maximum slope of 6%.
- Provide an aquatic bench extending 15 feet outward from the shoreline, and a maximum depth of 18" below normal water elevation.
- Develop a landscaping plan.
- Provide a 25'pond buffer.
- No woody vegetation within 15 feet of the toe of the embankment, or 25 feet from the principal spillway.

STORMWATER MANAGEMENT SUITABILITY

[X] **Water Quality**

[X] **Channel Protection**

[X] **Overbank Flood Protection**

[X] **Extreme Flood Protection**

Accepts Hotspot Runoff: *Yes*
(2 feet minimum separation distance required to water table)

FEASIBILITY CONSIDERATIONS

[L] **Cost**

[L] **Maintenance Burden**

Key: **L**=Low **M**=Moderate **H**=High

Residential Subdivision Use: Yes
High Density/Ultra-Urban: *No*

Soils: *Hydrologic group 'A' soils may require pond liner*

Hydrologic group 'D' soils may have compaction constraints

Other Considerations:

- *Thermal effects*
- *Outlet clogging*
- *Safety bench*

MAINTENANCE REQUIREMENTS

- Legally binding maintenance agreement
- Sediment removal from forebay every five to six years or when 50% full.
- Provide a maintenance easement and right-of-way.
- Removable trash rack on the principal spillway.
- Non-clogging low flow orifice
- Riser in the embankment.
- Pond drain required, capable of drawing down the pond in 24 hours.
- Notification required for pond drainage.
- Provide an adjustable gate valve on both the WQ_v-ED pipe, and the pond drain.
- Side Slopes less than 3:1, and terminate at a safety bench.
- Principal spillway shall not permit access by small children, and endwalls above pipes greater than 48" in diameter shall be fenced.

POLLUTANT REMOVAL

G	**Phosphorus**
G	**Nitrogen**
G	**Metals** - Cadmium, Copper, Lead, and Zinc removal
G	**Pathogens** Coliform, E.Coli, Streptococci removal

Key: **G**=Good **F**=Fair **P**=Poor

Stormwater Wetlands

Description: Stormwater wetlands (a.k.a. constructed wetlands) are structural practices that incorporate wetland plants into the design to both store and treat runoff. As stormwater runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake within the practice

Design Options:
Shallow wetland (W-1), Extended Detention Wetland (W-2), Pond/Wetland (W-3), Pocket Wetland (W-4)

KEY CONSIDERATIONS

MUST MEET ALL OF THE REQUIREMENTS OF STORMWATER PONDS.

CONVEYANCE

- Minimum flowpath of 2:1 (length to width)
- Flowpath maximized

TREATMENT

- Micropool at outlet, capturing 10% of the WQ_v
- Minimum surface area to drainage area ratio of 1:100
- ED no greater than 50% of entire WQ_v (permanent pool at least 50% of the volume) 25% of the WQ_v in deepwater zones.
- 35% of the total surface area in depths six inches or less, and 65% shallower than 18”

LANDSCAPING

- Landscaping plan that indicates methods to establish and maintain wetland coverage. Minimum elements include: delineation of pondscaping zones, selection of species, planting plan, and sequence for bed preparation.
- Wetland buffer 25 feet from maximum surface elevation, with 15 foot additional setback for structures.
- Donor plant material must not be from natural wetlands

MAINTENANCE REQUIREMENTS

- Reinforcement plantings after second season if 50% coverage not achieved

POLLUTANT REMOVAL

G	**Phosphorus**
G	**Nitrogen**
F	**Metals** - Cadmium, Copper, Lead, and Zinc removal
G	**Pathogens** - Coliform, Streptococci, E.Coli removal

Key: G=Good **F**=Fair **P**=Poor

STORMWATER MANAGEMENT SUITABILITY

- [X] **Water Quality**
- [X] **Channel Protection**
- [X] **Overbank Flood Protection**
- [X] **Extreme Flood Protection**

Accepts Hotspot Runoff: *Yes*
(2 feet minimum separation distance required to water table)

IMPLEMENTATION CONSIDERATIONS

Capital Cost [M]

Maintenance Burden:

M	Shallow Wetland
M	ED Shallow Wetland
H	Pocket Wetland
M	Pond/Wetland

Residential Subdivision Use: Yes
High-Density/Ultra-Urban: *No*

Soils: *Hydrologic group ‘A’ and ‘B’ soils may require liner*

Key **:** L=Low M=Moderate H=High

Bioretention Areas (F-5)

Description: Shallow stormwater basin or landscaped area which utilizes engineered soils and vegetation to capture and treat runoff. The practice is often located in parking lot islands, and can also be used to treat residential areas.

KEY CONSIDERATIONS

CONVEYANCE

- Provide overflow for the 10-year storm to the conveyance system.
- Conveyance to the system is typically overland flow delivered to the surface of the system, typically through curb cuts or over a concrete lip.

PRETREATMENT

- Pretreatment consists of a grass channel or grass filter strip, a gravel diaphragm, and a mulch layer, sized based on the methodologies described in Section 6.4.2.

TREATMENT

- Treatment area should have a four foot deep planting soil bed, a surface mulch layer, and a 6" ponding layer.
- Size the treatment area using equations provided in Chapter 6.

LANDSCAPING

- Detailed landscaping plan required.

MAINTENANCE

- Inspect and repair/replace treatment area components
- Stone drop (at least 6") provided at the inlet
- Remulch annually

POLLUTANT REMOVAL

G	**Phosphorus**
G	**Nitrogen**
G	**Metals** - Cadmium, Copper, Lead, and Zinc removal
F	**Pathogens** – Coliform, Streptococci, E.Coli removal

Key: **G**=Good **F**=Fair **P**=Poor

STORMWATER MANAGEMENT SUITABILITY

X	**Water Quality**
	Channel Protection
	Overbank Flood Protection
	Extreme Flood Protection

Accepts Hotspot Runoff: *Yes (requires impermeable liner)*

IMPLEMENTATION CONSIDERATIONS

M	**Capital Cost**
M	**Maintenance Burden**

Residential Subdivision Use: Yes

High Density/Ultra-Urban: *Yes*

Drainage Area: *5 acres max.*

Soils: *Planting soils must meet specified criteria; No restrictions on surrounding soils*

Other Considerations:

- *Use of native plants is recommended*

Key: L=Low **M**=Medium **H**=High

Infiltration Practices

Description: Excavated trench or basin used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the basin or trench.

Design Options:
Infiltration Trench (I-1), Shallow Infiltration Basin (I-2), Dry Well (I-3)

KEY CONSIDERATIONS

FEASIBILITY

- Minimum soil infiltration rate of 0.5 inches per hour
- Soils less than 20% clay, and 40% silt/clay, and no fill soils.
- Natural slope less than 15%
- Cannot accept hotspot runoff, except under the conditions outlined in Section 6.3.1.
- Separation from groundwater table of at least three feet (four feet in sole source aquifers).
- 25' separation from structures for I-1 and I-2; 10' for I-3.

CONVEYANCE

- Flows exiting the practice must be non-erosive (3.5 to 5.0 fps)
- Maximum dewatering time of 48 hours.
- Design off-line if stormwater is conveyed to the practice by a storm drain pipe.

PRETREATMENT

- Pretreatment of 25% of the WQv at all sites.
- 50% pretreatment if fc >2.0 inches/hour.
- 100% pretreatment in areas with fc >5.0 inches/hour.
- Exit velocities from pretreatment must be non-erosive for the 2-year storm.

TREATMENT

- Water quality volume designed to exfiltrate through the floor of the practice.
- Construction sequence to maximize practice life.
- Trench depth shall be less than four feet (I-2 and I-3).
- Follow the methodologies in Chapter 6 to size practices.

LANDSCAPING

- Upstream area shall be completely stabilized before flow is directed to the practice.

MAINTENANCE REQUIREMENTS

- Never serves as a sediment control device
- Observation well shall be installed in every trench, (6" PVC pipe, with a lockable cap)
- Provide direct maintenance access.

STORMWATER MANAGEMENT SUITABILITY

- [X] **Water Quality**
- [ ] **Channel Protection**
- [ ] **Overbank Flood Protection**
- [ ] **Extreme Flood Protection**

Accepts Hotspot Runoff: *No*

IMPLEMENTATION CONSIDERATIONS

H **Capital Cost**

H **Maintenance Burden**

Residential Subdivision Use: Yes

High Density/Ultra-Urban: *Yes*

Drainage Area: *10 acres max.*

Soils: *Pervious soils required (0.5 in/hr or greater)*

Other Considerations:

- *Must not be placed under pavement or concrete*

Key: **L**=Low **M**=Moderate **H**=High

POLLUTANT REMOVAL G **Phosphorus** G **Nitrogen** G **Metals** - Cadmium, Copper, Lead, and Zinc removal G **Pathogens** - Coliform, Streptococci, E.Coli removal **Key: G**=Good **F**=Fair **P**=Poor	

Sand/ Organic Filters

Description: Multi-chamber structure designed to treat stormwater runoff through filtration, using a sediment forebay, a primary filter media and, typically, an underdrain collection system.

Design Variations:
Surface Sand Filter (F-1), Underground Sand Filter (F-2), Perimeter Sand Filter (F-3), Organic Sand Filter (F-4)

KEY CONSIDERATIONS

CONVEYANCE

- If stormwater is delivered by stormdrain, design off-line.
- Overflow shall be provided to pass a fraction of the WQ_v to a stabilized watercourse.
- Overflow for the ten-year storm to a non-erosive point.
- Flow regulator needed to divert WQ_v to the practice, and bypass larger flows.
- Underdrain (4" perforated pipe minimum; 6" preferred)

PRETREATMENT

- Pretreatment volume of 25% of WQ_v.
- Typically a sediment basin with a 1.5:1 L:W ratio, sized with the Camp-Hazen equation (See Section 6.4.3)

TREATMENT

- System must hold 75% of the WQ_v
- Filter media shall be ASTM C-33 sand for sand filters
- Organic filters shall be a peat/sand mix, or leaf compost.
- Peat shall be reed-sedge hemic peat

LANDSCAPING

- Contributing area stabilized before runoff is directed to the facility

MAINTENANCE REQUIREMENTS:

- Legally binding maintenance agreement.
- Sediment cleaned out of sedimentation chamber when it reaches more than 6" in depth.
- Vegetation height limited to 18"
- Sediment chamber cleaned if drawdowns exceed 36 hours.
- Trash and debris removal
- Silt/sediment removed from filter bed after it reaches one inch.
- If water ponds on the filter bed for greater than 48 hours, remove material, and replace.

STORMWATER MANAGEMENT SUITABILITY

- [X] **Water Quality**
- [ ] **Channel Protection**
- [ ] **Overbank Flood Protection**
- [ ] **Extreme Flood Protection**

Accepts Hotspot Runoff: *Yes (requires impermeable liner)*

IMPLEMENTATION CONSIDERATIONS

- [H] **Capital Cost**
- [H] **Maintenance Burden**

Residential Subdivision Use: No

High Density/Ultra-Urban: *Yes*

Drainage Area: *2-10 acres max.*

Soils: *No restrictions*

Other Considerations:

Typically needs to be combined with other controls to provide water quantity control

Key: L=Low **M**=Moderate **H**=High

POLLUTANT REMOVAL	
G **Phosphorus** G **Nitrogen** G **Metals** - Cadmium, Copper, Lead, and Zinc removal F **Pathogens** - Coliform, Streptococci, E.Coli removal **Key: G**=Good **F**=Fair **P**=Poor	

Open Channels

Description: Vegetated channels that are explicitly designed and constructed to capture and treat stormwater runoff within dry or wet cells formed by check dams or other means.

Design Options:
Dry Swale (O-1), Wet Swale (O-2)

KEY CONSIDERATIONS

FEASIBILITY

- Maximum longitudinal slope of 4%

CONVEYANCE

- Non-erosive (3.5 to 5.0 fps) peak velocity for the 2-year storm
- Safe conveyance of the ten-year storm with a minimum of 6 inches of freeboard.
- Side slopes gentler than 2:1 (3:1 preferred).
- The maximum allowable temporary ponding time of 48 hours

PRETREATMENT

- 10% of the WQ_v in pretreatment, usually provided using check dams at culverts or driveway crossings.

TREATMENT

- Temporary storage the WQ_v within the facility to be released over a minimum 30 minute duration.
- Bottom width no greater than 8 feet, but no less than two feet.
- Soil media as detailed in Appendix H.

MAINTENANCE

- Removal of sediment build-up within the bottom of the channel or filter strip when 25% of the original WQ_v volume has been exceeded.
- Maintain a grass height of 4" to 6" in dry swales.

MANAGEMENT CAPABILITY

G	**Phosphorus**
F	**Nitrogen**
G	**Metals** - Cadmium, Copper, Lead, and Zinc removal
P	**Pathogens** - Coliform, Streptococci, E.Coli removal

Key: **G**=Good **F**=Fair **P**=Poor

STORMWATER MANAGEMENT SUITABILITY

- [X] **Water Quality**
- [ ] **Channel Protection**
- [ ] **Overbank Flood Protection**
- [ ] **Extreme Flood Protection**

Accepts Hotspot Runoff: *Yes (requires impermeable liner)*

IMPLEMENTATION CONSIDERATIONS

L	**Capital Cost**
L	**Maintenance Burden**

Residential Subdivision Use: Yes

High Density/Ultra-Urban: *No*

Drainage Area: *5 acres max.*

Soils: *No restrictions*

Other Considerations:

- *Permeable soil layer (dry swale)*
- *Wetland plants (wet swale)*

Key: **H**=High **M**=Medium **L**=Low

Section 9.5.6 Alternative Stormwater Management Practices Proprietary Practices

Description

Proprietary practices encompass a broad range of manufactured structural control systems available from commercial vendors designed to treat stormwater runoff and/or provide water quantity control. The focus of this profile sheet is on those proprietary practices that provide some level of water quality treatment and are accepted for redevelopment applications as a standard practice. Manufactured treatment systems are often attractive in redevelopment scenarios because they tend to take up little space, often installed underground, and can usually be retrofitted to existing infrastructure.

Common proprietary systems include:

- Hydrodynamic systems such as gravity and vortex separators –devices that move water in a circular, centrifugal manner to accelerate the separation and deposition of primarily sediment from the water. They are suitable for removal of coarse particles, small drainage areas, and are more effective in an offline configuration.

- Wet vaults –water-tight "boxes" that include a permanent pool and promote settling of particulates through detention and use of internal baffles and other proprietary modifications. Manufacturers recommendation may base the sizing of the vaults based on water quality volume or flow rate, incorporate bypass, and sediment capacity.

- Media filters –surface or subsurface practices that contain filter beds containing absorptive filtering media that promotes settling of particulates as well as adsorption and absorption of other pollutants attracted to the characteristics of the proprietary filter media. Similar to traditional filtering systems, they are flow through systems which function based on contact of polluted stormwater with the filtering media, commonly contained in prefabricated devices. Commercially available media range from fabrics, activated carbon, perlite, zeolite, and combination of multiple media mixes, with varied treatment performances.

- Underground infiltration systems- prefabricated pipes and vaults designed as alternative treatment systems to capture and infiltrate the runoff. Various proprietary products are marketed as space saving structures utilizing the infiltration capacity of the sites. The offline underground infiltration modular structures have potential to perform at an acceptable treatment level when designed according to all the technical specifications of the standard infiltration systems. Manufactured infiltration systems are considered standard practices when all the required elements, design guidance, soil testing, siting, and maintenance requirements, as defined in the Design Manual, are followed.

Evaluation of Alternative Practices

As a group, the performance of manufactured stormwater management practices (SMPs) have been verified thus far only to a limited extent, with a majority of the verification studies limited to laboratory testing. Where verification data does exist, they generally indicate that these practices do not meet both an 80% total suspended solids (TSS) and 40% total phosphorus (TP) removal efficiency target that is specified in Chapter 5 of this Manual. However, selected proprietary practices that provide some level of water quality treatment meet criteria for redevelopment applications as follows. Those practices, which have demonstrated a minimum TSS removal efficiency of 50% with an average d50 particle size < 100 microns under laboratory testing, are allowed to be used in redevelopment applications. This allowance is conditioned upon the system being operated at the specific tested design flow rate, defined based on the verified performance of each specific system. Based on the conclusions of the verification sources, it is believed that these treatment systems have the capability of achieving a TSS removal efficiency of 50% in field applications.

NYSDEC's evaluation of proprietary systems for demonstration of minimum removal efficiency for redevelopment application are based on one of the following stormwater management practice evaluation systems: The U.S. Environmental Protection Agency (EPA) Environmental Technology Verification Program, the state of Washington Technology Assessment Protocol - Ecology (TAPE), the Technology Acceptance Reciprocity Partnership Protocol (TARP), the International Stormwater Best Management Practices Database, and several other evaluation systems.

The proposed manufactured treatment systems that are verified or certified through ETV, TAPE, or TARP (primarily New Jersey Corporation for Advanced Technology*)* process and meet the criteria stated above are allowed for redevelopment applications in NY. Proposed manufactured treatment systems that are not verified yet may be considered for acceptance in NY if verified at any time through one these verification sources.

All the manufactured treatment systems must be sized appropriately to provide treatment for the water quality volume or the runoff from the entire contributing area. Due to the proprietary nature of the practices, designers are responsible to ensure that manufacturer's recommendations concerning all the design details such as structural integrity, configuration, assembly, installation, operation, and maintenance of the units are followed. Designers are also responsible to address, at minimum, all the relevant requirements set by NYS standards such as quantity controls, pretreatment, bypass, overflow, head configuration, inflow/outflow rates, maintenance, separation distance, accessibility, and safety issues concerning the selected practice.

Recommended Application of Practice

Many proprietary systems are useful on small sites and space-limited areas where there is not enough land or room for other structural control alternatives. Proprietary practices can also be reasonable alternatives where there is a need to tie in to the existing drainage infrastructure,

where site elevations limit the head for certain stormwater management practices (SMPs). Hydrodynamic separators are generally more effective on sites with potential loading of coarse particulates. While specific media filters may be suitable in most conditions, infiltration systems must be limited to sites with the A or B hydrologic soil groups.

Benefits

The benefits of using proprietary practices will vary depending on the type of practice, but may include:

- Reduced space requirements for practices located below grade.
- Reduced engineering and design due to prefabricated nature of systems and design support and tools provided by manufacturer.
- Spill containment and control capabilities

Feasibility/Limitations

Depending on the proprietary system, the following factors may be considered as a limitation:

- Limited performance data. Data that do exist suggest these practices don't perform at the same level as the suite of standard practices in the NY Design Manual, particularly with regard to nutrient load reduction.
- Application constraints such as limits to area draining to a practice, due to pre-manufactured nature of products.
- High maintenance requirements (e.g., need for specialized equipment, confined space entry training, frequency of recommended maintenance, and cost of replacement components) that often are ignored or forgotten because many practices are underground and out of sight.
- Higher costs per treated area than other structural control alternatives, but this can be offset by value of land not needed due to subsurface nature of many proprietary practices.
- Concern over mosquito breeding habitat being provided by practices that have wet sumps as design components.

Sizing and Design Guidance

Sizing and design guidance will vary based on the product being used. Since sizing criteria is integral to the verified performance of manufactured practices, designers should refer to the capacities and flow rates associated with the models (sizes) of the manufactured SMPs identified by the verification source.

The New York State design standards calls for small storm hydrology and the use of Simple Method for hydrology calculation. For practices with volume-based sizing approaches, sizing should be performed to meet the water quality volume as defined in Section 4.2 of this Manual.

For rate or flow-based sizing approaches, sizing should be performed based on the peak rate of discharge for the water quality design storm, as described in Appendix B of this Manual.

Some proprietary practices can be designed on-line or off-line. On-line practices typically have built-in bypass capabilities. Flow through systems, which do not have built-in bypass must be designed as off-line systems

It is important for designers to specify proprietary practices based on their treatment capacities (CASQA, 2003). Since hydraulic capacity can be as much as ten times that of the treatment capacity, designer must ensure that hydraulic load does not exceed the performance rate defined in the verification process. The above applies to all design elements that affect the performance rate. Some examples of such design elements are head, orifice sizing, oil storage or sediment storage capacities, baffle configuration, or screen size.

Practices with a volume-based sizing approach must be sized to capture and treat 75 % of the WQv as defined in Chapter 4 of the Manual. Flow through practices must be sized to the peak rate of runoff as defined in Chapter 4 and Appendix B of this Manual. For off-line practices, the installation must include flow diversion that protects the practice from exceeding design criteria. The list of verified technologies on DEC's website provides references to the key elements of the design for each SMP. This list includes type of the system, proper applications, design methods, treatment capacity and accepted operation rate for each SMP.

Environmental/Landscape Elements

There are few or no environmental or landscaping elements that designers can consider with most proprietary treatment practices. They are frequently absent or predetermined by the manufacturer. The use of land area above the facility needs to be selective and manufacturer design codes must be strictly followed.

Maintenance

Maintenance is a critical component to ensure proper functioning of proprietary practices. Most manufacturers provide maintenance recommendations. When these schedules are not followed, proprietary practices can be expected to fail. Maintenance is often overlooked with proprietary products because they are underground and out of view. Most proprietary practices require a quarterly inspections and cleanouts at a minimum. In addition, specialized equipment (e.g., vactor trucks and boom trucks) may be required for maintaining certain proprietary products. Similar to standard practices, a maintenance agreement between the municipality and the property owner should be executed to clearly identify required or recommended maintenance activities, schedules, reporting, and enforcement procedures.

Cost

Proprietary systems are often more costly than other SMPs on a per-area-treated basis, but this is sometimes made up for in space savings. Manufacturers should be contacted directly for unit pricing, which will vary based on size of unit specified. As a rule of thumb, installation cost of most

proprietary practices will range from 50 to 100% of the unit cost (CASQA, 2003). Other proprietary practices, may not have high initial capital or installation costs, but require frequent (i.e., at least quarterly) replacement of component parts for proper operation.

References/Further Resources

Atlanta Regional Commission. 2001. *Georgia Stormwater Management Manual*. www.gastormwater.com/.

American Society of Civil Engineers (ASCE) Web site, "ASCE/EPA Stormwater Best Management Practices Nationwide Database," http://bmpdatabase.org/

California Stormwater Quality Association (CASQA). 2003. *California Stormwater BMP Handbook*. www.cabmphandbooks.com.

Center for Watershed Protection. 2001. "Assessment of Proprietary and Nonproprietary Products for Pretreatment of Larger Discharges", www.stormwatercenter.net.

Environmental Technology Acceptance and Reciprocity Partnership (ETARP). 2000. *Six State MOU, Interstate Reciprocity Technology Acceptance, Tier I Guidance.*

ETV Verification Protocol Stormwater Source Area Treatment Technologies, Draft 4.0, March 2000.

New Jersey Corporation for Advanced Technology, Verification Process Web site. http://www.njcat.org/verification. Accessed -November 2006.

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Glenwood Road/Powerhouse Drain Pollution Abatement Plan

APPENDIX C Subwatershed Drainage Structure Identification Table

Village of Sea Cliff / Hempstead Harbor Protection Committee
Glenwood Landing / Powerhouse Drain
Stormwater Pollution Abatement Plan

Subwatershed
Structure Identification Table

Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
OT1	4854	08J0011	DOUTFALL
OT2	4852	08J0010	DOUTFALL
OT3	NONE	NONE	DOUTFALL
OT4	NONE	NONE	DOUTFALL
OT5	NONE	NONE	DOUTFALL
OT6	NONE	NONE	DOUTFALL
OT7	NONE	NONE	DOUTFALL
OT8	NONE	NONE	DOUTFALL
OT9	NONE	NONE	DOUTFALL
1	46450	NONE	CB
2	32001	273-MW1	DMANHOLE
3	46451	NONE	CB
4	46452	NONE	CB
5	32003	273-MW2	DMANHOLE
6	32002	272-CW1	DMANHOLE
7	46453	NONE	CB
8	34396	273-CW3	CB
9	30842	273-CW4	CB
10	NONE	NONE	DMANHOLE
11	35580	273-CW8	CB
12	33252	273-CW9	CB
13	35581	273-CW1B	CB
14	33251	273-CW10	CB
15	NONE	NONE	CB
16	32063	273-CW45	CB
17	32006	273-MW4	DMANHOLE
18	33286	273-MW31	DMANHOLE
19	30843	273-CW46	CB
20	36770	273-CW47	CB
21	33259	273-CW40	CB
22	NONE	NONE	DMANHOLE
23	37901	273-CW41	CB
24	37902	273-CW43	CB
24A	NONE	NONE	CB
25	NONE	NONE	DMANHOLE
26	39099	273-CW42	CB
27	NONE	NONE	CB
28	33603	273-MW33	DMANHOLE
29	NONE	NONE	CB
30	NONE	NONE	CB
31	33289	273-MW32	DMANHOLE
32	39101	273-CW44	CB
33	NONE	NONE	CB
34	NONE	NONE	LCB
35	NONE	NONE	DMANHOLE

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Subwatershed
Structure Identification Table

Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
36	33287	273-MW34	DMANHOLE
36A	NONE	NONE	DMANHOLE
37	39100	273-CW62	CB
38	30847	273-CW63	CB
39	32066	273-CW64	CB
40	33604	273-MW44	DMANHOLE
41	32070	273-CW65	CB
42	32071	273-CW66	CB
43	33606	273-MW45	DMANHOLE
44	36775	273-CW67	CB
45	36774	273-CW68	CB
46	NONE	NONE	CB
47	34406	273-CW39	CB
48	NONE	NONE	CB
49	34405	273-CW35	CB
50	33257	273-CW37	CB
51	39097	273-CW38	CB
52	33256	273-CW36	DMANHOLE
53	NONE	NONE	DMANHOLE
54	NONE	NONE	DMANHOLE
55	NONE	NONE	DMANHOLE
56	NONE	NONE	DMANHOLE
57	32065	273-CW34	CB
58	32969	273-MW28	DMANHOLE
59	35584	273-CW33	CB
60	39096	273-CW32	CB
61	NONE	NONE	DMANHOLE
62	33255	273-CW31	CB
63	30846	273-CW25	CB
64	32963	NONE	DMANHOLE
65	32064	273-CW24	CB
66	39095	273-CW23	CB
67	32325	NONE	DMANHOLE
68	37899	273-CW22	CB
69	32324	NONE	DMANHOLE
70	36772	273-CW21	CB
71	34401	273-CW20	CB
72	32011	NONE	DMANHOLE
73	34400	273-CW19	CB
74	NONE	NONE	CB
75	34402	273-CW18	CB
76	NONE	NONE	CB
77	35582	273-CW16	CB
78	33254	273-CW17	CB
79	30845	273-CW15	CB

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Subwatershed
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Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
80	32321	273-MW9	DMANHOLE
81	32009	273-MW8	DMANHOLE
82	32008	273-CW7	DMANHOLE
83	32010	273-MW6	DMANHOLE
84	34398	273-CW13	CB
85	33253	273-CW14	CB
86	34404	273-CW12	CB
87	36771	273-CW11	CB
88	NONE	NONE	DMANHOLE
89	35583	273-CW22	CB
90	34403	273-CW22	CB
91	32641	273-MW13A	DMANHOLE
92	30849	273-CW22	CB
93	NONE	NONE	DMANHOLE
94	NONE	NONE	CB
95	NONE	NONE	DMANHOLE
96	NONE	NONE	CB
97	NONE	NONE	CB
98	35585	273-CW26	CB
99	NONE	NONE	CB
100	NONE	NONE	DMANHOLE
101	NONE	NONE	CB
102	NONE	NONE	CB
103	NONE	NONE	CB
104	NONE	NONE	DMANHOLE
105	NONE	NONE	DMANHOLE
106	NONE	NONE	DMANHOLE
107	NONE	NONE	LCB
108	NONE	NONE	LCB
109	39098	273-CW30	CB
110	37900	273-CW29	CB
111	33258	273-CW28	CB
112	35586	273-CW27	CB
113	33284	273-MW22	DMANHOLE
114	35587	273-CW30	CB
115	NONE	NONE	CB
116	NONE	NONE	CB
117	36769	273-CW6	CB
118	36768	273-CW5	CB
119	32004	273-MW3	DMANHOLE
120	34397	273-CW7	CB
121	NONE	NONE	DMANHOLE
122	NONE	NONE	CB
123	46517	NONE	CB
124	46518	NONE	CB

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Structure Identification Table

Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
125	37897	273-CW49	CB
126	37898	273-CW48	CB
127	NONE	NONE	DMANHOLE
128	39094	273-CW50	CB
129	NONE	NONE	DMANHOLE
130	NONE	NONE	CB
131	34399	273-CW50	CB
132	NONE	NONE	DMANHOLE
133	NONE	NONE	DMANHOLE
134	30844	273-CW50	CB
135	NONE	NONE	DMANHOLE
136	NONE	NONE	CB
137	NONE	NONE	CB
138	33291	273-MW36	DMANHOLE
139	33292	273-MW37	DMANHOLE
140	33260	273-CW54	CB
141	33261	273-CW59	CB
142	32068	273-CW55	CB
143	33295	273-MW40	DMANHOLE
144	34407	273-CW56	CB
145	NONE	NONE	DMANHOLE
146	35589	273-CW57	CB
147	32069	273-CW58	CB
148	33602	273-MW41	DMANHOLE
149	33296	273-MW43	DMANHOLE
150	36773	273-CW60	CB
151	33590	273-CW61	CB
152	37904	273-CW69	CB
153	30848	273-CW70	CB
154	35591	273-CW71	CB
155	32072	273-CW72	CB
156	NONE	NONE	DMANHOLE
157	NONE	NONE	CB
158	NONE	NONE	DMANHOLE
159	NONE	NONE	DMANHOLE
160	NONE	NONE	DMANHOLE
161	NONE	NONE	CB
162	NONE	NONE	CB
163	NONE	NONE	CB
164	NONE	NONE	CB
165	NONE	NONE	DMANHOLE
166	NONE	NONE	DMANHOLE
167	NONE	NONE	DMANHOLE
168	NONE	NONE	CB
169	NONE	NONE	DMANHOLE

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Subwatershed
Structure Identification Table

Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
170	NONE	NONE	CB
171	NONE	NONE	DMANHOLE
172	NONE	NONE	CB
173	NONE	NONE	CB
174	NONE	NONE	CB
175	NONE	NONE	DMANHOLE
176	NONE	NONE	CB
177	NONE	NONE	DMANHOLE
178	NONE	NONE	CB
179	NONE	NONE	DMANHOLE
180	NONE	NONE	CB
181	NONE	NONE	CB
182	NONE	NONE	DMANHOLE
183	NONE	NONE	CB
184	NONE	NONE	DMANHOLE
185	NONE	NONE	CB
186	NONE	NONE	CB
187	NONE	NONE	CB
188	NONE	NONE	DMANHOLE
189	NONE	NONE	DMANHOLE
190	NONE	NONE	CB
191	NONE	NONE	CB
192	NONE	NONE	DMANHOLE
193	NONE	NONE	CB
194	NONE	NONE	CB
195	NONE	NONE	DMANHOLE
196	NONE	NONE	CB
197	NONE	NONE	CB
198	NONE	NONE	DMANHOLE
199	NONE	NONE	DMANHOLE
200	NONE	NONE	CB
201	NONE	NONE	CB
202	NONE	NONE	CB
203	NONE	NONE	CB
204	NONE	NONE	CB
205	NONE	NONE	CB
206	NONE	NONE	CB
207	NONE	NONE	DMANHOLE
208	NONE	NONE	CB
209	NONE	NONE	DMANHOLE
210	NONE	NONE	CB
211	NONE	NONE	DMANHOLE
212	NONE	NONE	CB
213	NONE	NONE	CB
214	NONE	NONE	CB

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Subwatershed
Structure Identification Table

Field Reconnaisance ID Number	Nassau County GIS ID Number	TOBAY Structure ID Number	Structure Type
215	NONE	NONE	DMANHOLE
216	NONE	NONE	CB
217	NONE	NONE	CB
218	NONE	NONE	CB
NF	32005	273-MW30	DMANHOLE
NF	32007	273-MW5	DMANHOLE
NF	32012	NONE	DMANHOLE
NF	32015	273-MW11	DMANHOLE
NF	32016	273-CW10	DMANHOLE
NF	32062	273-CW2	CB
NF	32067	273-CW52	CB
NF	32322	273-MW12	DMANHOLE
NF	32323	273-MW13	DMANHOLE
NF	32961	273-MW14	DMANHOLE
NF	32962	273-MW15	DMANHOLE
NF	32964	273-MW24	DMANHOLE
NF	32965	273-MW17	DMANHOLE
NF	32966	273-MW16	DMANHOLE
NF	32967	273-MW26	DMANHOLE
NF	32968	273-MW25	DMANHOLE
NF	32970	273-MW27	DMANHOLE
NF	32975	273-MW29	DMANHOLE
NF	32976	273-MW18	DMANHOLE
NF	33281	273-MW19	DMANHOLE
NF	33282	273-MW20	DMANHOLE
NF	33283	273-MW21	DMANHOLE
NF	33290	273-MW35	DMANHOLE
NF	33293	273-MW38	DMANHOLE
NF	33294	273-MW39	DMANHOLE
NF	35577	272-CW1A	CB
NF	35578	272-CW1	CB
NF	35579	273-CW1	CB
NF	35588	273-CW53	CB
NF	37903	273-CW51	CB