# Oldmans Creek Watershed Restoration and Protection Plan

**Photo Credit: Mike Hogan**


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# 1. Introduction

The purpose of creating a watershed restoration and protection plan for the Oldmans Creek Watershed is to ensure that the valuable uses that this freshwater system (and tidal segments) has provided the area in the past continues into the future. These uses include recreational activities and fishing, along with the ability of the river to provide a healthy ecosystem for aquatic species and the surrounding wildlife.

The main stem of the Oldmans Creek runs approximately 20 stream miles flowing from the southeast to the northwest and drains 44 square miles of land before it empties into the Delaware River. It is a source for two major lakes, and the main stem courses between Salem and Gloucester Counties. The drainage area for the creek takes in seven municipalities. Those on the Gloucester County side from southeast to northwest are Elk, South Harrison, Woolwich, and Logan Townships. In Salem County the creek flows from Upper Pittsgrove Township through Pilesgrove Township to empty into the Delaware River on the north side of Oldmans Township.

The Oldmans Creek Watershed is largely composed of agricultural lands. The proper placement of best management practices (BMPs) on these farms can help to improve the water quality and water quantity issues experienced in this watershed. However, as development changes the landscape of this watershed, low impact development practices will be necessary to avoid any increases in water quality impairments and flooding problems.

The Rutgers Cooperative Extension (RCE) Water Resources Program has undertaken the task of performing GIS analyses and the analysis of stream visual assessments performed by the South Jersey Land and Water Trust to provide stakeholders within the Oldmans Creek Watershed with a watershed restoration and protection plan to ensure the quality of the watershed for the future.

# 2. Watershed Characterization

## *2.1 Delineation of the Oldmans Creek Watershed*

Oldmans Creek Watershed is comprised of seven NJDEP 14 Digit Hydrologic Unit Code (HUC14) delineations as represented in the vector digital data originated by the New Jersey Department of Environmental Protection (NJDEP) and the New Jersey Geological Survey (NJGS). The area covered by these seven subwatersheds can be seen in Figure 1 and in Map 1 of Appendix A.

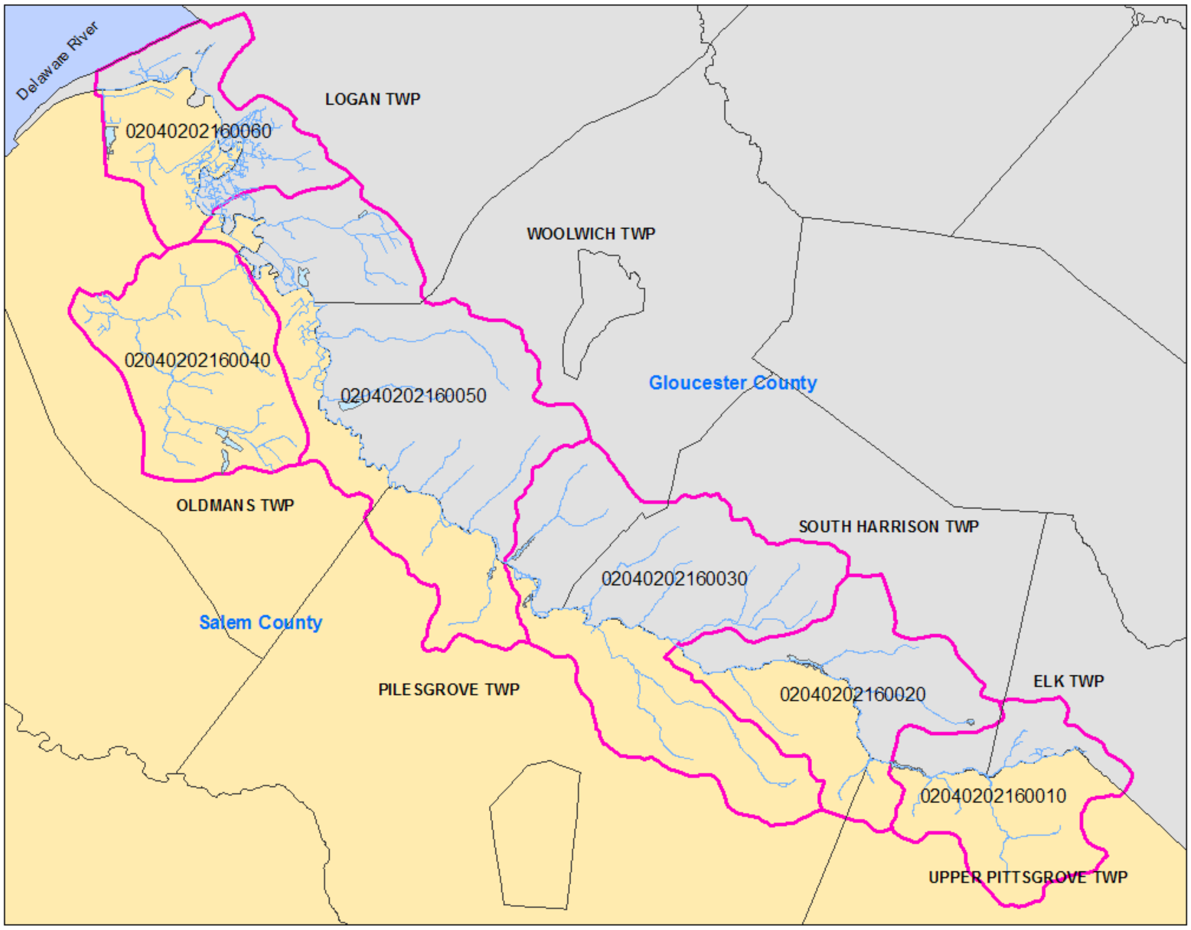


**Figure 1: HUC14's of the Oldmans Creek Watershed**

The seven HUC14's of the Oldmans Creek Watershed share the initial 12 digits of the code (020402021600) and differ only in the last two digits. These last two digits are -10, -20, -30, -40, -50, -60 and -70, starting at the headwaters and proceeding to the outlet of the watershed.

The drainage area that comprises the headwaters of the Oldmans Creek Watershed begins at an elevation of approximately 150 feet above sea level in Upper Pittsgrove Township and drops to sea level as the stream discharges to the Delaware River. The Oldmans Creek Watershed is the southern most drainage area within Watershed Management Area 18 (NJDEP, 2009).

## *2.2 Location, Area and Stream Length*

The Oldmans Creek Watershed contains 114 miles of stream, including all tributaries. The main stem comprises approximately 20 miles of these waterways. The main stem of the stream provides the boundary between the northern border of Salem County and the southern border of Gloucester County (Figure 1, Map 1 of Appendix A). Major tributaries include Tides Branch, Ebenezers Branch, Rainey Run, Porches Creek and Kettle Run (Map 1, Appendix A). The headwaters begin in Elk Township, Gloucester County and Upper Pittsgrove Township in

Salem County. Gloucester County also contains drainage area in the Townships of South Harrison, Woolwich and Logan, where Salem County provides drainage area in Pilesgrove Township and Oldmans Township. The total drainage area of the seven HUC14s that comprise the Oldmans Creek Watershed is 44 square miles.

Two impoundments are located in the upper portions of the watershed. Algonkin Lake (12 acres) is found in the upper most HUC14 (02040202160010) between Upper Pittsgrove in Salem County and South Harrison in Gloucester County. Harrisonville Lake (18 acres) is found in the central portion of the next downstream HUC14 (02040202160020) between South Harrison in Gloucester and Pilesgrove Township in Salem County. Many other small impoundments are found along the tributaries and the main stem of the Oldmans Creek. The main stem of the creek experiences tidal fluctuations to a point just upstream of where the New Jersey Turnpike crosses over the Creek, in the area of Rainey Run in Woolwich Township. The lower watershed contains a large area of wetland/freshwater tidal marsh known locally as the Pedricktown Marsh. This marsh has been noted for being an important stopover site for migratory waterfowl.

## *2.3 Stream Classification*

The Oldmans Creek is designated as FW2; "FW2" means the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters. The Oldmans Creek is further subcategorized into a FW2-NT (non-trout), FW2-NT/SE1 (non-trout, fresh/saline) and FW2-NTC1 (non-trout, Category One).

The Category One (C1) anti-degradation level of protection includes the tributary feeding the upstream inlet of Harrisonville Lake (midway through HUC02040202160020) and covers the main steam and all tributaries through the end of the third HUC14, 02040202160030, where it ends after the confluence with Porches Creek in Woolwich Township at Kings Highway. (See Figure 2 and Map 1 in Appendix A) This C1 portion of Oldmans Creek supports the Federally Threatened and State Endangered Bog Turtle. The section is also home to the State Threatened Triangle Floater (39 N.J.R. 1845(a)).

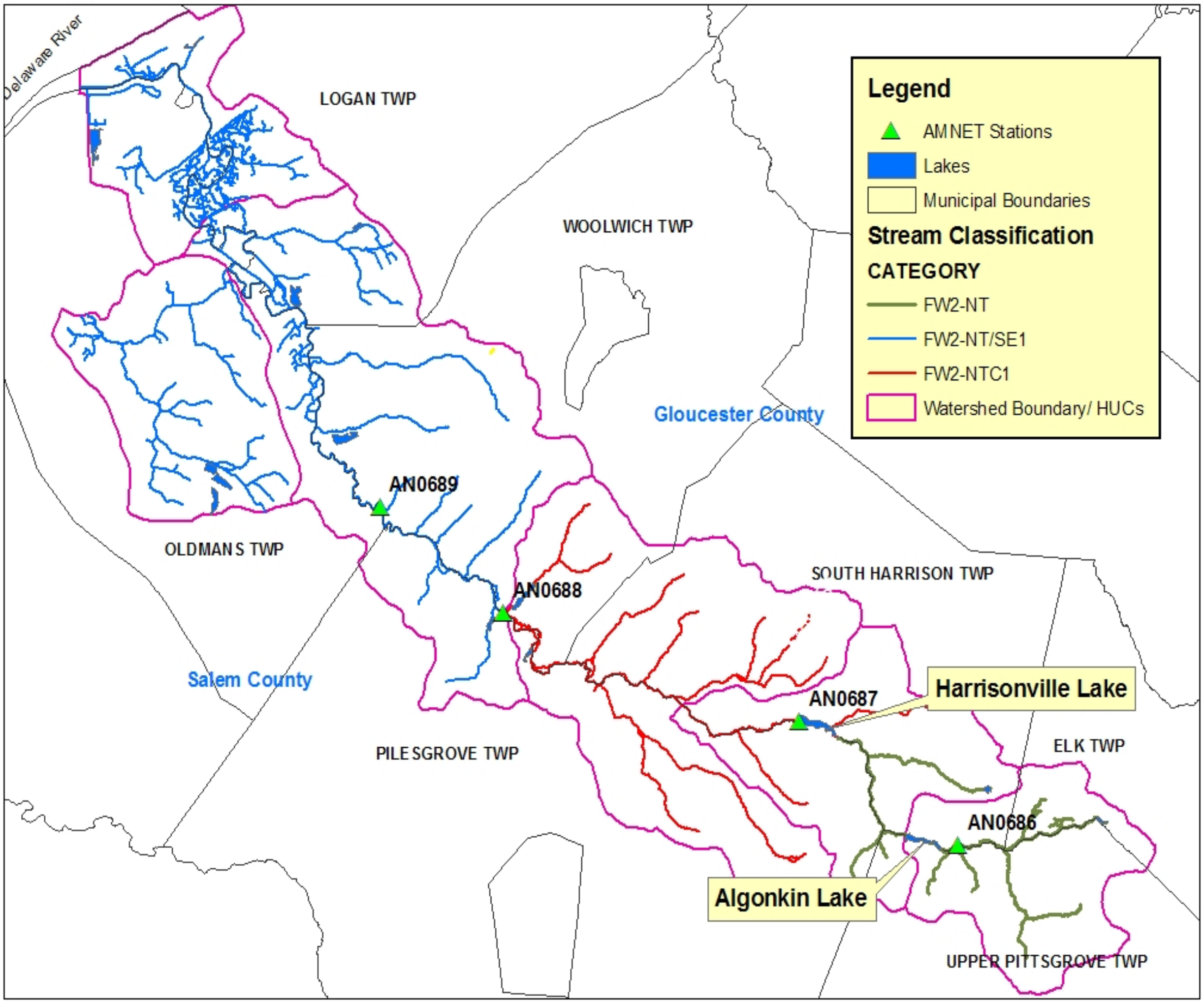


**Figure 2: Oldmans Creek Stream Classification**

## *2.4 Land Use*

Land use and land cover for the Oldmans Creek watershed was evaluated using ESRI Arc GIS 9.0 and the 2002 Land Use/Land Cover geospatial database from the New Jersey Department of Environmental Protection (Map 2, Appendix A). Figure 3 represents the break down of land cover/land use types throughout the entire Oldmans Creek Watershed.

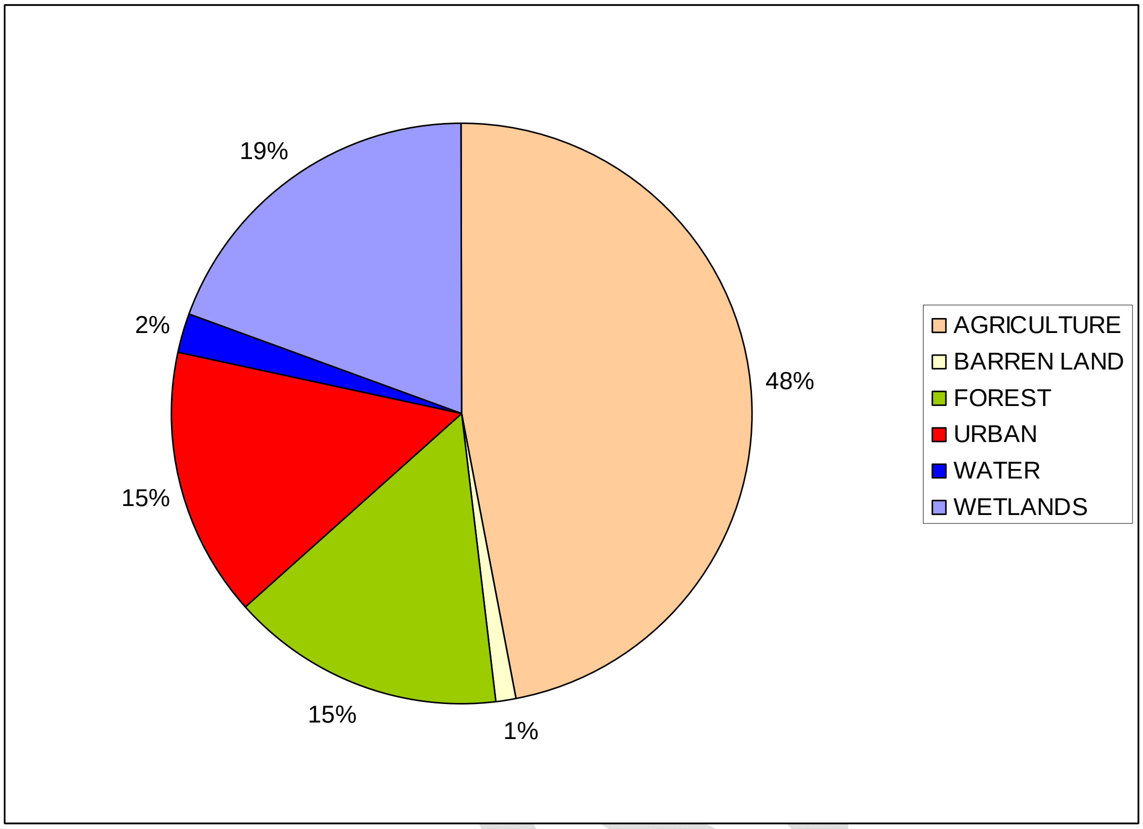


**Figure 3: 2002 Land Use/Land Cover of Oldmans Creek Watershed**

As of 2002, nearly 50% of the land use was designated as agricultural use. A large portion (34.5%) of the undeveloped lands of the Oldmans Creek Watershed is comprised of freshwater wetlands, saltwater wetlands or forest. A summary of the land use and land cover analysis is presented in Table 1.

Urban land uses are more prevalent within the two HUC14s most immediately adjacent to the Delaware River. In these two cases, there is about half as much urban land as agricultural land. Within each of the other three HUC14s, there is approximately 20-25% as much urban land as agricultural land. It is important to note, however, that the Oldmans Creek continues to be an urbanizing watershed in which agricultural lands are being developed for residential subdivisions this may not have been reflected in the 2002 Land Use/Land Cover geospatial database. In addition, major industrial/commercial parks are located within the watershed, as are industrial sites along the Delaware River.

**Table 1: Oldmans Creek 2002 Land Use/Land Cover**

| HUC14 Subwatershed | (Units) | *Agriculture* | Urban | Forest | Barren Land | Water | Wetlands | TOTAL |
|---|---|---|---|---|---|---|---|---|
| **02040202160010 (Upper Basin)** | (Acres)* | 1536 | 326 | 603 | 4 | 31 | 550 | 3049 |
| | (Sq. Mi.) | 2.40 | 0.51 | 0.94 | 0.01 | 0.05 | 0.86 | 4.76 |
| | (%) | 50.4% | 10.7% | 19.8% | 0.1% | 1.0% | 18.0% | 100.0% |
| | (% of Oldmans Creek Watershed) | 5.5% | 1.2% | 2.1% | 0.0% | 0.1% | 2.0% | 10.8% |
| **02040202160020** | (Acres)* | 1,903 | 467 | 824 | 22 | 31 | 485 | 3,732 |
| | (Sq. Mi.) | 2.97 | 0.73 | 1.29 | 0.03 | 0.05 | 0.76 | 5.83 |
| | (%) | 51.0% | 12.5% | 22.1% | 0.6% | 0.8% | 13.0% | 100.0% |
| | (% of Oldmans Creek Watershed) | 6.8% | 1.7% | 2.9% | 0.1% | 0.1% | 1.7% | 13.3% |
| **02040202160030** | (Acres)* | 3,988 | 971 | 973 | 81 | 36 | 612 | 6,662 |
| | (Sq. Mi.) | 6.23 | 1.52 | 1.52 | 0.13 | 0.06 | 0.96 | 10.41 |
| | (%) | 59.9% | 14.6% | 14.6% | 1.2% | 0.5% | 9.2% | 100.0% |
| | (% of Oldmans Creek Watershed) | 14.2% | 3.4% | 3.5% | 0.3% | 0.1% | 2.2% | 23.7% |
| **02040202160040** | (Acres)* | 1,997 | 362 | 289 | 28 | 127 | 779 | 3,581 |
| | (Sq. Mi.) | 3.12 | 0.57 | 0.45 | 0.04 | 0.20 | 1.22 | 5.60 |
| | (%) | 55.8% | 10.1% | 8.1% | 0.8% | 3.6% | 21.8% | 100.0% |
| | (% of Oldmans Creek Watershed) | 7.1% | 1.3% | 1.0% | 0.1% | 0.5% | 2.8% | 12.7% |
| **02040202160050** | (Acres)* | 3,450 | 1,710 | 1412 | 69 | 245 | 1,235 | 8,121 |
| | (Sq. Mi.) | 5.39 | 2.67 | 2.21 | 0.11 | 0.38 | 1.93 | 12.69 |
| | (%) | 42.5% | 21.1% | 17.4% | 0.9% | 3.0% | 15.2% | 100.0% |
| | (% of Oldmans Creek Watershed) | 12.3% | 6.1% | 5.0% | 0.2% | 0.9% | 4.4% | 28.8% |
| **02040202160060 (Outlet to Delaware River)** | (Acres)* | 960 | 410 | 180 | 79 | 281 | 1,101 | 3,011 |
| | (Sq. Mi.) | 1.50 | 0.64 | 0.28 | 0.12 | 0.44 | 1.72 | 4.71 |
| | (%) | 31.9% | 13.6% | 6.0% | 2.6% | 9.3% | 36.6% | 100.0% |
| | (% of Oldmans Creek Watershed) | 3.4% | 1.5% | 0.6% | 0.3% | 1.0% | 3.9% | 10.7% |
| **TOTAL** | **(Acres)*** | **1,3834** | **4,246** | **4,281** | **283** | **751** | **4,762** | **28,157** |
| | **(Sq. Mi.)** | **21.62** | **6.63** | **6.69** | **0.44** | **1.17** | **7.44** | **43.99** |
| | (% of Oldmans Creek Watershed) | **49.1%** | **15.1%** | **15.2%** | **1.0%** | **2.7%** | **16.9%** | **100.0%** |

***Acres rounded to the nearest whole number**

# 3. Assessment of Existing Data

## *3.1 Total Maximum Daily Loads (TMDLs)*

### 3.1.1 General TMDL Background

Section 303 of the Federal Clean Water Act (CWA) requires New Jersey to prepare and submit to the United States Environmental Protection Agency (USEPA) a report that identifies waters that do not meet or are not expected to meet state surface water quality standards and criteria. This report is commonly referred to as the 303(d) list. Included on the 303(d) list are waterbodies which require a total maximum daily load (TMDL) based on water quality standards not being attained. A TMDL must be developed for each individual pollutant in these water bodies based on an agreed upon schedule between the state and USEPA.

A TMDL is a calculation of the maximum amount of a single pollutant that a waterbody can receive and still meet state water quality standards. It quantitatively assesses water quality problems, contributing sources, and load reductions or control actions needed to restore and protect individual water bodies. The ultimate goal of the TMDL process is to meet the water quality standards and ultimately improve the water resources within a watershed.

A TMDL establishes Waste Load Allocations and Load Allocations for point and nonpoint sources (NPS), respectively. These allocations together, with a margin of safety, are used to calculate the TMDL value. Point source pollution can come from the wastewater of various industries, federal, state, county, and municipal facilities, private companies, private residential developments, hospitals, and schools. These point sources are all regulated. NPS pollution, on the other hand, comes from many diffuse sources that enter waterways from stormwater runoff. Some sources of NPS pollution are excess fertilizers, sediment from streets or land that is not stable, and bacteria from pet wastes or faulty septic systems. The Municipal Separate Storm Sewer Systems (MS4) is a New Jersey Pollutant Discharge Elimination System (NJPDES) permitted point source that the individual municipalities must maintain according to N.J.A.C. 7:14A. These storm sewers discharge stormwater to local streams carrying diffuse source pollution, including the types of pollution previously noted as nonpoint source pollution.

Within the Integrated List of Waterbodies (NJDEP, 2006) for New Jersey (a.k.a. the 303(d) list) are lists that indicate the presence and level of impairment for each waterbody monitored. The lists are defined as follows:

- **Sublist 1** suggests that the waterbody is meeting water quality standards.
- **Sublist 2** states that a waterbody is attaining some of the designated uses, and no use is threatened. Furthermore, Sublist 2 suggests that data are insufficient to declare if other uses are being met.
- **Sublist 3** maintains a list of waterbodies where no data or information are available to support an attainment determination.

- **Sublist 4** lists waterbodies where use attainment is threatened and/or a waterbody is impaired; however, a TMDL will not be required to restore the waterbody to meet its use designation.
    - ➢**Sublist 4a** includes waterbodies that have a TMDL developed and approved by the USEPA, that when implemented, will result in the waterbody reaching its designated use.
    - ➢**Sublist 4b** establishes that the impaired reach will require pollutant control measurements taken by local, state, or federal authorities that will result in full attainment of designated use.
    - ➢**Sublist 4c** states that the impairment is not caused by a pollutant, but is due to factors such as instream channel condition and so forth. It is recommended by the USEPA that this list be a guideline for water quality management actions that will address the cause of impairment.
- **Sublist 5** clearly states that the water quality standard is not being attained and requires a TMDL.

### 3.1.2 Oldmans Creek and the TMDL Process

The Oldmans Creek is listed on the Integrated List of Waterbodies for 2004 (based on water quality parameters) and 2006 (based on use attainment). The listings are summarized as follows and in Table 2.
(See also Maps 3, 4 and 5 in Appendix A).

- The non-tidal segment of Oldmans Creek's main-stem (and all tributaries upstream from the main-stem's head of tide) is under a TMDL implementation priority for fecal coliform. The TMDL document was approved in September of 2003 and calls for a 95% reduction[1] in the wasteload allocation of fecal coliform.
- The segment of Oldmans Creek (and all of its tributaries) from Kings Highway to Route 45 is under a TMDL implementation priority for total phosphorus. The TMDL document was approved in September of 2005 and calls for a 67.3% reduction[2] in the loading from all land use to achieve water quality standards for total phosphorus.
- Harrisonville Lake and its tributaries are in a TMDL for phosphorus. The TMDL document was approved in September 2003 and calls for a 85% reduction[3] in the loading from all land uses to achieve water quality standards. The Harrisonville lakeshed comprises 8.75 square miles of the larger Oldmans Creek watershed and 2.5 river miles of the main stem Oldmans Creek.
- Oldmans Creek, a tributary of the Delaware River (estuary zone 5), is included in a larger TMDL (for the Delaware River) for two volatile organic compounds, 1,2-dichloroethane and tetrachloroethene. A TMDL is also in place for polychlorinated biphenyls for estuary zone 5 of the Delaware River.

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[1] Includes a 43% margin of safety as determined in the NJDEP authored TMDL report adopted September 2003.
[2] Includes a 30.4% margin of safety as determined in the NJDEP authored TMDL report adopted September 2005.
[3] Includes a 34% margin of safety as determined in the NJDEP authored TMDL report adopted September 2003.

**Table 2: 2006 NJDEP Integrated List (HUC14s of the Oldmans Creek Watershed)**

| | 2040202160010 | 2040202160020 | 2040202160030 | 2040202160040 | 2040202160050 | 2040202160060 |
|---|---|---|---|---|---|---|
| Aquatic Life General | Sublist 5 | Sublist 5 | Sublist 4A | Sublist 3 | Sublist 5 | Sublist 3 |
| Primary Contact Recreation | Sublist 4A | Sublist 4A | Sublist 4A | Sublist 3 | Sublist 4A | Sublist 3 |
| Secondary Contact Recreation | Sublist 4A | Sublist 4A | Sublist 3 | Sublist 3 | Sublist 3 | Sublist 3 |
| Drinking | Sublist 2 | Sublist 2 | Sublist 2 | Sublist 3 | Sublist 2 | Sublist 3 |
| Agriculture | Sublist 2 | Sublist 2 | Sublist 2 | Sublist 3 | Sublist 2 | Sublist 3 |
| Industrial | Sublist 2 | Sublist 2 | Sublist 2 | Sublist 3 | Sublist 2 | Sublist 3 |
| Fish Consumption | Sublist 3 | Sublist 3 | Sublist 3 | Sublist 5 | Sublist 5 | Sublist 5 |
| pH | Non-attainment | Non-attainment | | | | |
| TP | | | Sublist 4A | | Non-attainment | |
| TSS | | | | | Non-attainment | |
| Pathogens | Sublist 4A | Sublist 4A | Sublist 4A | | Sublist 4A | |
| PCBs | | | | Non-attainment | Non-attainment | Non-attainment |
| Dioxins | | | | Non-attainment | Non-attainment | Non-attainment |

## *3.2 Stream Visual Assessments*

### General SVAP Background

Stream Visual Assessment (SVAP) was originally developed for use by the landowner (USDA, 1998), but it has proved to also be useful by those familiar with the river system and flooding occurrences. The protocol provides an outline on how to quantitatively score in-stream and riparian qualities that includes water appearance, channel condition, and riparian health (Bjorkland et al., 2001). There are ten (10) primary SVAP elements:

- channel condition,
- hydrologic alternation,
- riparian zone,
- bank stability,
- water appearance,
- nutrient enrichment,
- barriers to fish movement,
- instream fish cover,

- presence of pools and/or manure, and
- invertebrate habitat.

In addition, there are elements that should only be scored if applicable. These are canopy cover, manure presence, salinity, riffle embeddedness, and observed macroinvertebrates. Elements are scored 1 to 10 (poor to excellent) with the exception of observed macroinvertebrates, which uses a scale ranging from 1 to 15.

Following visual and physical assessment through SVAP, other means to characterize stream and watershed health exist; these may include ecological assessments, benthic community monitoring, and chemical monitoring. The physical data collected using SVAP can assist in targeting monitoring locations and prioritizing restoration projects a major goal for watershed stakeholders.

## SVAP Analysis of Oldmans Creek Watershed

Stream reaches of the Oldmans Creek and its tributaries were assessed using SVAP between September 2006 and September 2008. SVAP was performed by volunteers and staff from the South Jersey Land and Water Trust (SJLWT) with guidance by the Rutgers Cooperative Extension (RCE) Water Resource Program (WRP). Scores, GPS coordinates and notes for each stream reach were recorded on a field datasheet (Appendix D) and then entered into an online web form linked to a database. The database was used by RCE WRP staff to create a geospatial database and ARC GIS 9 project. Maps 6 through 11 in Appendix A illustrate the assessed stream reaches with corresponding average SVAP scores. Figure 4 shows the frequency of each SVAP according to the category.

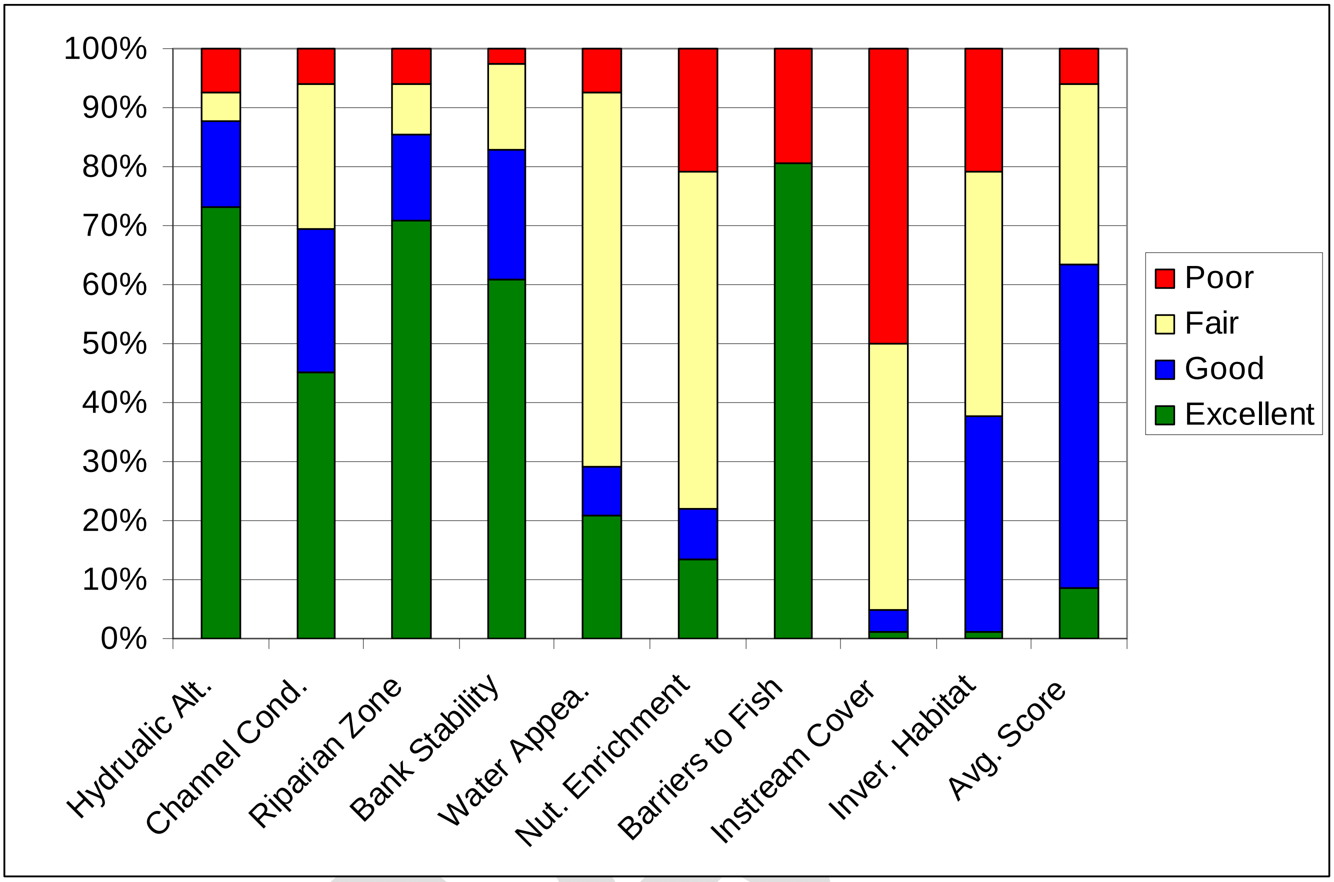



**Figure 4: SVAP Score Percent Frequency**

Table 3 further breaks down score frequencies according to HUC14 sub-watersheds.

**Table 3: Frequency of SVAP Scores by Category**

| HUC14 | Poor | Fair | Good | Excellent | HUC14 | Poor | Fair | Good | Excellent |
|---|---|---|---|---|---|---|---|---|---|
| 02040202160010 | | | | | 02040202160020 | | | | |
| Hydraulic Alt. | 1 | 0 | 2 | 6 | Hydraulic Alt. | 0 | 0 | 2 | 10 |
| Channel Cond. | 2 | 0 | 3 | 4 | Channel Cond. | 0 | 2 | 3 | 7 |
| Riparian Zone | 1 | 2 | 0 | 6 | Riparian Zone | 1 | 0 | 1 | 10 |
| Bank Stability | 0 | 1 | 2 | 6 | Bank Stability | 0 | 1 | 0 | 11 |
| Water Appear. | 0 | 4 | 1 | 4 | Water Appear. | 0 | 2 | 5 | 5 |
| Nut. Enrichment | 1 | 4 | 2 | 2 | Nut. Enrichment | 1 | 5 | 5 | 1 |
| Barriers to Fish | 2 | 0 | 0 | 7 | Barriers to Fish | 3 | 0 | 0 | 9 |
| In-stream Cover | 3 | 6 | 0 | 0 | In-stream Cover | 5 | 6 | 1 | 0 |
| Invert. Habitat | 1 | 5 | 3 | 0 | Invert. Habitat | 1 | 5 | 6 | 0 |
| Avg. Score | 1 | 2 | 5 | 1 | Avg. Score | 0 | 3 | 7 | 2 |
| 02040202160030 | | | | | 02040202160040 | | | | |
| Hydraulic Alt. | 0 | 1 | 0 | 16 | Hydraulic Alt. | 4 | 0 | 6 | 7 |
| Channel Cond. | 0 | 13 | 2 | 2 | Channel Cond. | 3 | 0 | 6 | 8 |
| Riparian Zone | 0 | 3 | 4 | 10 | Riparian Zone | 3 | 1 | 2 | 11 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bank Stability | 0 | 9 | 5 | 3 | Bank Stability | 2 | 0 | 1 | 14 |
| Water Appear. | 1 | 16 | 0 | 0 | Water Appear. | 0 | 10 | 0 | 7 |
| Nut. Enrichment | 3 | 14 | 0 | 0 | Nut. Enrichment | 7 | 3 | 0 | 7 |
| Barriers to Fish | 5 | 0 | 0 | 12 | Barriers to Fish | 1 | 0 | 0 | 16 |
| In-stream Cover | 15 | 2 | 0 | 0 | In-stream Cover | 7 | 10 | 0 | 0 |
| Invert. Habitat | 3 | 12 | 2 | 0 | Invert. Habitat | 5 | 5 | 7 | 0 |
| Avg. Score | 2 | 12 | 2 | 1 | Avg. Score | 2 | 1 | 14 | 0 |
| 02040202160050 | | | | | 02040202160060 | | | | |
| Hydraulic Alt. | 1 | 3 | 2 | 15 | Hydraulic Alt. | 0 | 0 | 0 | 6 |
| Channel Cond. | 0 | 5 | 4 | 12 | Channel Cond. | 0 | 0 | 2 | 4 |
| Riparian Zone | 0 | 1 | 2 | 18 | Riparian Zone | 0 | 0 | 3 | 3 |
| Bank Stability | 0 | 1 | 8 | 12 | Bank Stability | 0 | 0 | 2 | 4 |
| Water Appear. | 3 | 16 | 1 | 1 | Water Appear. | 2 | 4 | 0 | 0 |
| Nut. Enrichment | 3 | 17 | 0 | 1 | Nut. Enrichment | 2 | 4 | 0 | 0 |
| Barriers to Fish | 4 | 0 | 0 | 17 | Barriers to Fish | 1 | 0 | 0 | 5 |
| In-stream Cover | 11 | 7 | 2 | 1 | In-stream Cover | 0 | 6 | 0 | 0 |
| Invert. Habitat | 7 | 6 | 7 | 1 | Invert. Habitat | 0 | 1 | 5 | 0 |
| Avg. Score | 0 | 7 | 11 | 3 | Avg. Score | 0 | 0 | 6 | 0 |



## *3.3 Biological Assessments*

### 3.3.1 General Biological Assessment Background

The NJDEP has been monitoring the biological communities of the State's waterways since the early 1970's, specifically the benthic macroinvertebrate communities. Benthic macroinvertebrates are primarily bottom-dwelling (benthic) organisms that are macroscopic and generally ubiquitous in freshwater. Due to their important role in the food web, macroinvertebrate communities reflect current perturbations in the environment. There are several advantages to using macroinvertebrates to gauge the health of a stream. First, macroinvertebrates have limited mobility, and thus, are good indicators of site-specific water conditions. Also, macroinvertebrates are sensitive to pollution, both point and nonpoint sources; macroinvertebrates can be impacted by short-term environmental impacts such as intermittent discharges and contaminated spills. In addition to indicating chemical impacts to stream quality, macroinvertebrates can gauge non-chemical issues of a stream such as turbidity and siltation, eutrophication, and thermal stresses. Finally, macroinvertebrate communities are a holistic overall indicator of water quality health, which is consistent with the goals of the Clean Water Act. These organisms are normally abundant in New Jersey freshwaters and are relatively inexpensive to sample.

The NJDEP Bureau of Freshwater and Biological Monitoring currently administers the Ambient Biomonitoring Network (AMNET) Program. The AMNET Program began in 1992 and is currently comprised of more than 800 stream sites with approximately 200 monitoring locations in each of the five major drainage basins of New Jersey (i.e., upper and lower Delaware, Northeast, Raritan, and Atlantic). These sites are sampled once every five years using a modified version of the USEPA Rapid Bioassessment Protocol (RBP) II. To evaluate the biological condition of the sampling locations, several community measures are calculated by the NJDEP from the data collected and include the following:

1. Taxa Richness: Taxa richness is a measure of the total number of benthic macroinvertebrate families identified. A reduction in taxa richness typically indicates the presence of organic enrichment, toxics, sedimentation, or other factors.

2. EPT (Ephemeroptera, Plecoptera, Trichoptera) Index: The EPT Index is a measure of the total number of Ephemeroptera, Plecoptera, and Trichoptera families (i.e., mayflies, stoneflies, and caddisflies). These organisms typically require clear moving water habitats.

3. %EPT: Percent EPT measures the numeric abundance of the mayflies, stoneflies, and caddisflies within a sample. A high percentage of EPT taxa are associated with good water quality.

4. % CDF (percent contribution of the dominant family): Percent CDF measures the relative balance within the benthic macroinvertebrate community. A healthy community is characterized by a diverse number of taxa that have abundances somewhat proportional to each other.

5. Family Biotic Index: The Family Biotic Index measures the relative tolerances of benthic macroinvertebrates to organic enrichment based on tolerance scores assigned to families ranging from 0 (intolerant) to 10 (tolerant).

This analysis integrates several community parameters into one easily comprehended evaluation of biological integrity referred to as the New Jersey Impairment Score (NJIS). The NJIS has been established for three categories of water quality bioassessment for New Jersey streams: non-impaired, moderately impaired, and severely impaired. A non-impaired site has a benthic community comparable to other high quality "reference" streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and a good representation of intolerant individuals. A moderately impaired site is characterized by reduced macroinvertebrate taxa richness, in particular the EPT taxa. Changes in taxa composition result in reduced community balance and intolerant taxa become absent. A severely impaired site is one in which the benthic community is significantly different from that of the reference streams. The macroinvertebrates are dominated by a few taxa which are often very abundant. Tolerant taxa are typically the only taxa present.

The scoring criteria currently used by the NJDEP is as follows:

- Non-impaired sites have total scores ranging from 24-30,
- Moderately impaired sites have total scores ranging from 9 to 21, and
- Severely impaired sites have total scores ranging from 0 to 6.

It is important to note that the entire scoring system is based on comparisons with reference streams and a historical database consisting of 200 benthic macroinvertebrate samples collected from New Jersey streams. While a low score indicates "impairment," the score may actually be a consequence of habitat or other natural differences between the subject stream and the reference stream.

Starting with the second round of sampling under the AMNET program, habitat assessments were conducted in conjunction with the biological assessments. The habitat assessment, which was designed to provide a measure of habitat quality, involves a visual based technique for assessing stream habitat structure. The findings from the habitat assessment are used to interpret survey results and identify obvious constraints on the attainable biological potential within the study area. The habitat assessment is designed to provide an estimate of habitat quality based upon qualitative estimates of selected habitat attributes. The assessment involves the numerical scoring of ten habitat parameters to evaluate instream substrate, channel morphology, bank structural features, and riparian vegetation. Each parameter is scored and summed to produce a total score which is assigned a habitat quality category of optimal, sub-optimal, marginal, or poor. Sites with optimal/excellent habitat conditions have total scores ranging from 160 to 200; sites with suboptimal/good habitat conditions have total scores ranging from 110 to 159; sites with marginal/fair habitat conditions have total scores ranging from 60 to 109, and sites with poor habitat conditions have total scores less than 60.

### 3.3.2 Biological Assessments in the Oldmans Creek Watershed

In the Oldmans Creek Watershed, four biomonitoring stations exist (See Figure 5). These stations are among the approximately 800 stations monitored by the NJDEP's Bureau of Freshwater & Biological Monitoring as part of the Ambient Biomonitoring Network (AMNET) (NJDEP, 2003). Data collected from these monitoring locations are used to evaluate streams for biological impairment as indicated by the New Jersey Impairment Score (NJIS).

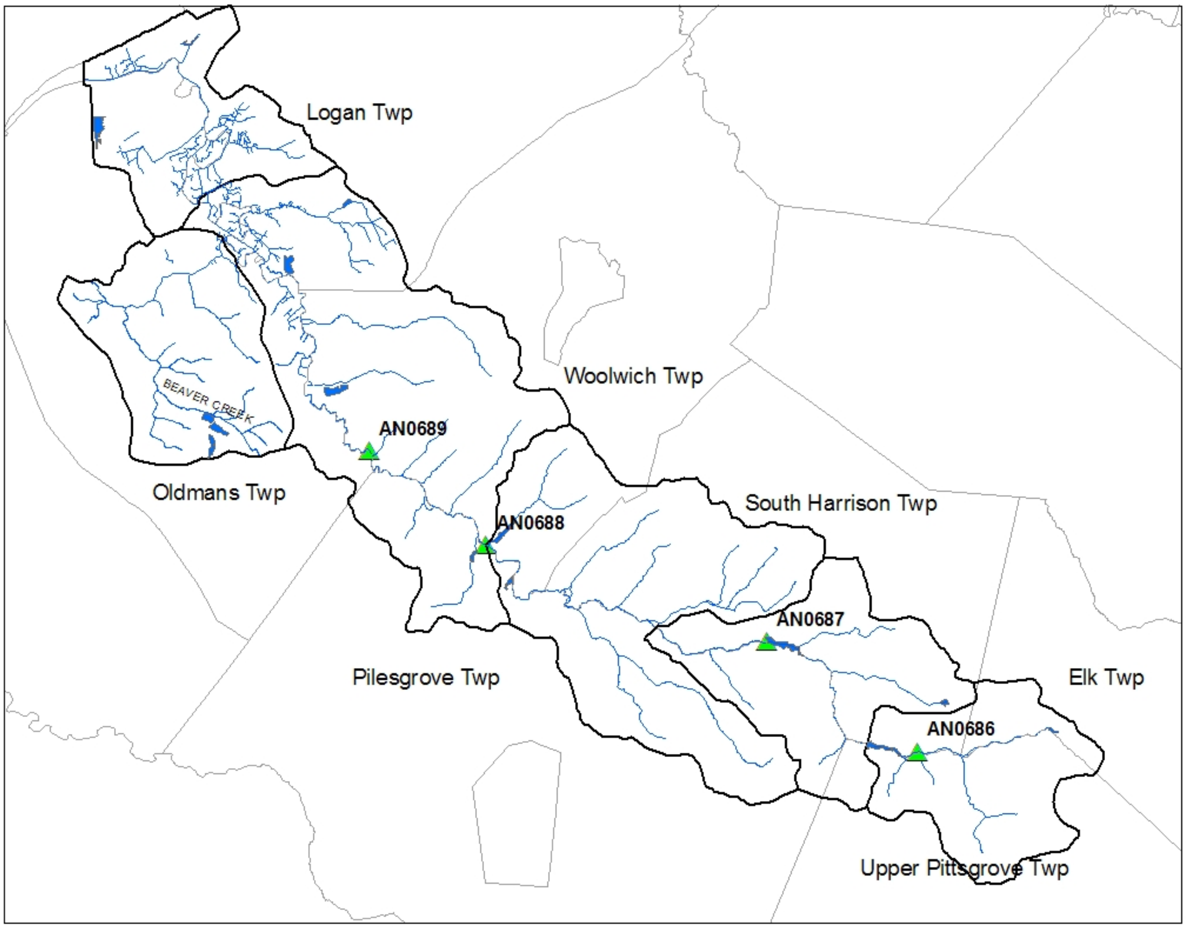



**Figure 5: AMNET Stations in the Oldmans Creek Watershed**

Table 4 lists these AMNET locations within the Oldmans Creek Watershed and the assessment results. Assessment results can be defined as non-impaired, moderately impaired, and severely impaired.

> **Non-impaired** is defined by a benthic community comparable to other undisturbed streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals.
>
> **Moderately impaired** describes a macroinvertebrate community whose richness has been reduced, in particular pollutant-intolerant species. There may also be a reduced community balance and numbers of pollutant-intolerant taxa.
>
> **Severely impaired** refers to a benthic community dramatically different from those in less impaired situations; macroinvertebrates are dominated by a few taxa with many individuals and only pollutant-tolerant individuals are present. (NJDEP, 2003)

**Table 4: Oldmans Creek AMNET Station Status**

| | | Round 1 | Round 2 | Round 3 |
|---|---|---|---|---|
| AN0686 | Swedesboro Road in South Harrison Township | Moderate | Moderate | Non-Impaired |
| AN0687 | Harrisonville Lake Road in South Harrison Township | Moderate | Moderate | Non-Impaired |
| AN0688 | Kings Highway in Woolwich Township | Moderate | Moderate | Moderate |
| AN0689 | Pointers-Auburn Road (Rt. 551) in Woolwich Township | Moderate | Severe | N/A* |

***Location not included in Round 3**

## *3.4 Aerial Loading Analysis*

Nonpoint source pollutant loading varies with land use. Loading coefficients have been developed through the study of stormwater runoff from the various types of land uses. These coefficients can be used to estimate the impact of the individual sub-watersheds that contribute drainage area, and therefore potential nonpoint source pollution to the waterway. The pollutant loading coefficients ($L_c$) that were used for this report were compiled from the New Jersey Best Management Practices Manual and from current literature sources, (NJDEP, 2004) and can be found in Appendix E of this document.

Annual NPS loads for each subwatershed were calculated using the loading equation:

$$Load = UL_c \times Area$$

*Load* is in units of pounds of pollutant per year (lbs/yr); $UL_c$ is in units of pounds per acre per year (lbs/acre/yr) for each specific land use, and *Area* is in acres for each specific land use. The loading equation provides an approximation for annual NPS loads on a subwatershed basis. This allows for the comparison of pollutant loading between subwatersheds and provides a method by which to prioritize subwatersheds for restoration and/or preservation.

The following two tables provide estimates of nonpoint source pollution related to land use using the land use coefficient ($L_c$) in the Oldmans Creek Watershed. Table 5 provides the overall, total nonpoint source loading per subwatershed.

**Table 5: Oldmans Creek Aerial Loading Analysis**

| HUC14 Subwatershed | TP (kg/yr) | TN (kg/yr) | NO2+NO3 (kg/yr) | NH3-N (kg/yr) | TSS (kg/yr) |
|---|---|---|---|---|---|
| 02040202160010 | 1,074 | 21,206 | 584 | 104 | 544,720 |
| 02040202160020 | 1,333 | 25,897 | 547 | 62 | 676,496 |
| 02040202160030 | 2,760 | 51,336 | 1,158 | 311 | 1,371,193 |
| 02040202160040 | 1,378 | 26,495 | 852 | 238 | 691,799 |
| 02040202160050 | 2,908 | 58,981 | 3,370 | 1,128 | 1,366,382 |
| 02040202160060 | 901 | 19,978 | 1,423 | 429 | 419,644 |
| **TOTAL** | **10,354** | **203,892** | **7,935** | **2,271** | **5,070,234** |

Every subwatershed has a different distribution of land uses. It is useful to analyze the pollutant loading per acre of the subwatershed. To correct for the size of the subwatersheds, the total loading was normalized to the area of the subwatershed in Table 6.

**Table 6: Oldmans Creek Aerial Loading Normalized to Area**

| HUC14 Subwatershed | TP (kg/yr/acre) | TN (kg/yr/acre) | NO2+NO3 (kg/yr/acre) | NH3-N (kg/yr/acre) | TSS (kg/yr/acre) |
|---|---|---|---|---|---|
| 02040202160010 | 0.35 | 6.96 | 0.19 | 0.03 | 178.67 |
| 02040202160020 | 0.36 | 6.94 | 0.15 | 0.02 | 181.26 |
| 02040202160030 | 0.41 | 7.71 | 0.17 | 0.05 | 205.96 |
| 02040202160040 | 0.38 | 7.40 | 0.24 | 0.07 | 193.17 |
| 02040202160050 | 0.36 | 7.23 | 0.41 | 0.14 | 167.60 |
| 02040202160060 | 0.30 | 6.63 | 0.47 | 0.14 | 139.35 |

The larger HUC14s (02040202160030 and -50) do contribute a larger portion of the pollutants attributed to aerial loading, but do not contribute more on a per acre basis. An effort should be made to implement BMPs in a well distributed manner throughout the watershed.

The Oldmans Creek Watershed is experiencing land use changes from agriculture to high/medium residential development. It is these changes that will redistribute how and what the land provides to the overland contribution of pollutant loading to the streams. Although the modeled overland contribution of nutrients remains approximately the same, the concern changes from total suspended solids in agricultural lands to trace metal pollutants in residential areas. However, the implementation of BMPs on agricultural lands can reduce the contribution of total suspended solids as well as increase infiltration to recharge groundwater supplies. Low impact development will aid in reducing diffuse source pollution with residential land use.

# 4. Conditions and Recommendations

The Oldmans Creek Watershed is experiencing some crucial water quality and water quantity management issues. Given the TMDLs, agricultural water uses and land use changes being experienced in this watershed, the implementation of stormwater management measures will become essential in mitigating more deleterious effects on this watershed. The following summary of watershed conditions and recommendations are intended to aid in planning efforts.

## *4.1 Introduction to management measures*

Water resources management measures are intended to protect the water quality and water quantity and to sustain their uses for the needs of the watershed. The focus on stormwater BMPs achieve this intention by creating greater recharge of the groundwater used for drinking, irrigation or baseflow for stream life. By recharging a greater volume of stormwater runoff, streams do not receive a sudden surge in flow during storms and will not receive the associated stormwater runoff pollutants. Also, the vegetation connected with BMPs filter the water while producing wildlife habitat and sequestering carbon dioxide.

These management measures come in two different scales. The first scale is on a watershed-wide basis. These are commonly educational programs or projects that cover issues that the entire watershed is experiencing. In the case of Oldmans Creek Watershed, some of these watershed-wide projects are recommendations to collect more information to quantify the extent of concerns. The second scale is at the individual project scale. Management practices are recommended for specific problems areas in HUC14 and municipality.

Recommendations at both scales are intended to be incorporated into each municipalities "Municipal Stormwater Management Plan." Each municipality is required to have a Stormwater Management Plan by the New Jersey Pollutant Discharge Elimination System (NJPDES) State Permit. These recommendations are intended to aid the town in identifying problem areas to address and can be used as a mitigation strategy or bank in their land use management.

The identification of these recommendations will also aid in helping counties, municipalities and other stakeholders to obtain funding for implementation. Towns can work on their own, or coordinate as a regional implementation project to install BMPs or promote educational function for the ultimate benefit of sustaining the water resources in the watershed.

## *4.2 Watershed Wide Recommendations*

### Survey of Detention Basins, Retention Basins, and Other Impoundments

Two types of stormwater management basins are typically used in New Jersey: 1) detention basins and 2) retention basins or wet ponds. The detention basin typically is fitted with a concrete low flow channel and is meant to go dry between storms. The retention basin or wet pond is meant to always have a standing pool of water and provides stormwater storage on the surface of this standing pool of water. Retention basins have been found to be more effective at removing pollutants but they tend attract geese which can add to the pollutant load being discharged from the basin.

The Oldmans Creek Watershed contains many detention and retention basins. Many of these basins were designed for flood control, not water quality. These basins discharge to the freshwater system within the watershed. These basins can play an important role in addressing the overall water quality and water quantity issues in the watershed. For example, these basins can be designed to capture stormwater and release it slowly while the impounded water infiltrates, evaporates, or transpires through the leaves of vegetation in the basin. The impounded water volume also allows for sediment and pollutants that attach to sediment to settle in the basin.

These basins also can have a negative impact on water quality and quantity. Many of these basins that have been constructed over the years have been planted with turf grass and are mowed on a regular basis. These types of basins tend to attract geese that like the well-manicured turf grass habitat. The feces from these geese can make these basins a source of pollutants. Furthermore, many of these basins have concrete low flow channels that hurry the stormwater runoff from small storms through the basins, increasing the flashy hydrology of local streams during the smaller storm events.

Many of these detention basins and retention basins can be retrofitted to enhance their ability to remove pollutants and minimize localized flooding during the smaller storm events. Well-manicured, mowed detention basins can be naturalized and converted to wetlands or bioretention systems that are more effective at removing pollutants from stormwater and infiltrating runoff volumes from the small storms. The retention basins or wet ponds can be retrofitted to include a vegetative buffer along the edge of the water. This will deter geese from using this wet pond, thereby reducing the pathogen and nutrient loading from geese.

The Oldmans Creek Watershed also contains many impoundments including online impoundments and offline impoundments. Many of these impoundments were created as irrigation ponds for farmers while some were created to provide recreational opportunities for residents in the surrounding towns. The online impoundments are found behind dams placed in the flow of the stream. The offline impoundments often are found on farms and collect stormwater runoff that can be used for irrigation. Both the online and offline impoundments can provide water quality treatment by removing nutrients, sediment and pathogens. These pollutants are captured in these impoundments and prevented from being transported downstream. Once captured in the impoundment, these pollutants can result in eutrophic conditions forming in the pond (i.e., excessive algal blooms and low dissolved oxygen). If the water discharging from these impoundments has low dissolved oxygen, it can be harmful to downstream aquatic life. Additionally, the water in these impoundments heats up over the summer. The discharge of this warm water can also have a detrimental impact on the downstream aquatic life. Finally, these ponds tend to collect sediment and require dredging if they are expected to continue to function as pollutant sinks and healthy aquatic ecosystems. Many of these impoundments are also plagued by Canada geese that elevate the pollutant load in these systems.

A survey of the detention basins, retention basins and other impoundments throughout the watershed will serve to identify retrofitting opportunities that can improve water quality and reduce flooding. The survey should include basin size, drainage area, usage, age, sedimentation accumulation, scouring, surrounding vegetation, as well as the number and size of inlets and outlets to the basin. During the survey, potential for retrofitting would be identified. The survey would result in a database that could be used to prioritize basins for retrofitting.

## Survey of Pathogen Sources

All non-tidal portions of the Oldmans Creek Watershed are under a New Jersey Department of Environmental Protection TMDL implementation plan that requires a 95% reduction in fecal coliform loading from nonpoint sources. Sources to the stream can include wildlife (nuisance and native), improperly functioning onsite wastewater treatment systems (OWTS, a.k.a. septic systems), farm animal waste management, pet waste, and garbage dumpster leachate. The identification and quantification of bacterial sources are critical to attaining non-impairment status.

The collection of water quality data, including fecal coliform and *E. coli*, along the main stem and the significant tributaries within the Oldmans Creek Watershed would advance the evaluation process of determining where the bacteria are entering the system.

The survey will identify the location of homes with OWTSs. Education efforts need to be targeted at these homeowners to ensure that their OWTSs are being maintained. Additionally, an analysis should be conducted to determine the risk to nearby waters that is associated with these systems. The soil suitability, depth to groundwater, and the proximity to nearby waterways needs to be considered in this analysis. If the risk for environmental impact from these systems is great, a more advanced management level should be considered.

Together with the collection of water quality data, site evaluations of farm waste management systems, identification of areas of nuisance wildlife congregation (i.e., geese in detention basins, raccoons in storm sewers), location and functioning capacity of sanitary sewers and septic systems, as well as an assessment of pet waste ordinances and garbage dumpster management should provide ample information to address sources. The addition of microbial source tracking such as optical brightener identification, DNA testing or antibiotic resistant testing could provide additional information on the entrance of human bacteria to the system.

## Stormwater Conveyance System Improvements Program

Although the new development in the Oldmans Creek Watershed have adequate stormwater conveyance systems, many of the older developments and many of the roadways have inadequate stormwater conveyance systems. Stormwater is collected in much of the watershed by a series of drainage ditches and old storm sewers that discharge directly to the stream. Discharges from these ditches and storm sewers deliver large volumes of runoff that contain a wide range of pollutants and a wide variety of floatables. SVAPs performed for this study found a multitude of sites that were littered with trash and debris that had been deposited from these stormwater conveyance systems. These systems can be retrofitted to reduce pollutant loads and promote infiltration of stormwater runoff.

Stormwater conveyance is also an issue on the large agricultural lands in the watershed. These farm ditches are essential to proper farm drainage. Many of these ditches provide opportunities for improvements that would result in optimizing infiltration while reducing sediment, nutrient and pathogen pollutant loads to the Oldmans Creek.

This program would work with municipalities, homeowners, and farmers to improve their stormwater conveyance systems. Converting ditches into vegetative swales or bioretention systems could be one solution. Some of these ditches many need hard structure like rip rap to reduce the energy of the water, which will decrease erosion. Some of the outfalls from the older storm sewer systems may need to be retrofitted with scour holes to reduce erosion, pocket wetlands or bioretention systems to provide treatment of the stormwater being discharged.

## Watershed Based Education and Outreach

The programs listed below are a sample of educational programs that are available in New Jersey. The educational programs that will create true change in the actions of people must provide stakeholders with hands on activities and contain a strong outreach component. It is for this reason that RCE plays an important role and offers programs that can be delivered at the municipality and work with the local stakeholders to educate them on specific concerns in their area.

The United States Environmental Protection Agency (USEPA) and the NJDEP offer newsletters, brochures and other outreach materials and these can be used by the watershed groups to educate stakeholders. However, priority should be given to hands on instruction.

**Rutgers Cooperative Extension Water Resources Program *Stormwater Management in Your Backyard Program***

This program provides a detailed overview of stormwater management. It introduces the factors that affect stormwater runoff, point and nonpoint source pollution, the impact of development (particularly impervious cover) on stormwater runoff, and the pollutants found in stormwater runoff. An overview of New Jersey's stormwater regulations is presented including who must comply and what they are required to do. Additionally, the concept of TMDLs is introduced along with various other requirements of the Federal Clean Water Act that have serious implications in New Jersey. A thorough discussion of different types of BMPs that can be implemented to control stormwater runoff is presented and how these BMPs can be used to achieve the quality, quantity and groundwater recharge requirements of New Jersey regulations. The BMPs discussed include bioretention systems (i.e., rain gardens), sand filters, stormwater wetlands, extended detention basins, infiltration basins, manufactured treatment devices, vegetated filters, and wet ponds. The program also discusses the various management practices that the homeowner can install including dry wells, rain gardens, rain barrels, and alternative landscaping. The protocol for designing these systems is reviewed in detail with real world examples provided. A step by step guide is worked through for designing a rain garden so that homeowners can actually construct one on their property. The students have an opportunity to bring in sketches of their property for the class to review and discuss various BMP options for each site. The course also provides a discussion of BMP maintenance focusing on the homeowner BMPs. The course concludes with a discussion of larger watershed restoration projects and how the students can lead these restoration efforts in their community. The course is very interactive, and ample time is set aside for question and answer sessions.

For more information, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

**Rutgers Cooperative Extension's Environmental Steward Program**

RCE has formed a partnership with Duke Farms to create a statewide Environmental Steward certification program. Participants learn land and water stewardship, BMPs, environmental public advocacy, and leadership. Each group meets twenty times for classroom and field study. They are taught by experts from Rutgers and its consortium partners. Students are certified as Rutgers Environmental Stewards when they have completed sixty hours of classroom instruction *and* sixty hours of volunteer internship. Classes are held throughout New Jersey including the Essex County Environmental Center in Roseland, Duke Farms in Hillsborough, Somerset County and the Rutgers EcoComplex in Bordentown, Burlington County. Consortium partners can ask students to provide volunteer assistance to complete their internship requirements.

Graduates of this program become knowledgeable about the basic processes of earth, air, water, and biological systems. They increase their awareness of techniques and tools used to monitor and assess the health of the environment. They gain an understanding of the research and regulatory infrastructure of state and federal agencies operating in New Jersey that relate to environmental issues. Unlike some programs, they are also given an introduction to group dynamics and community leadership. Participants are taught to recognize the elements of sound science and public policy based in science while acquiring a sense of the limits of the current understanding of the environment. The goal of the Rutgers Environmental Stewards program is to give graduates knowledge to expand public awareness of scientifically based information related to environmental issues and facilitate positive change in their community.

For more information please log on to: http://envirostewards.rutgers.edu/.

**Equine Operations Technical Assistance Program**

The watershed is home to a variety of equine operations. These facilities can be potential sources of bacteria contamination. Technical assistance is necessary for the equine operators to provide them information on how to better manage their facility to minimize their impact on the surrounding waterways. Additionally, this program should work with these farmers to take advantage for Farm Bill funding that is available from Natural Resources Conservation Service (NRCS) to implement environmental controls and conservation practices. RCE has the potential to develop and implement this program. Traditionally, RCE has provided twilight training sessions at local farms to address county-wide agricultural and environmental issues. Also, RCE County Agents have been working one-on-one with farmers across the state to help them adopt agricultural management practices for their farms.

The Technical Assistance Program will build upon North Jersey Resource Conservation and Development Council's (North Jersey RC&D) Farmer Friendly Program and the Rutgers Equine Science Center Sustainable Agriculture Research and Education's program on equine pasture management. Additionally, the RCE of Salem County's Agricultural Agent, Dave Lee, developed a program where RCE County Staff would visit local farms and help them identify farm issues that could adversely impact the nearby waterways and solutions for these issues. The information collected and lessons learned from these other efforts will be incorporated into this Technical Assistance Program.

For more information, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

**Rutgers Cooperative Extension Water Resources Program Restore-A-Waterway Program**

Restore-a-Waterway is a technical service provider program offered by the RCE Water Resources Program. The Program is funded jointly by the United States Department of Agriculture Cooperative State Research, Education, and Extension Service (USDA CSREES), New Jersey Sea Grant, and the New Jersey Agricultural Experiment Station (NJAES). The goal of the program is to provide technical assistance to citizen groups that want to take action in restoring the condition of a waterway. RCE provides expertise to these groups to assist them in their efforts. Forms of technical assistance include helping these groups to:

- perform physical waterway characterizations,
- develop and implement chemical and biological quality assurance project plans (i.e., QAPPs),
- interpret and analyze of data,
- identify problems and sources of those problems within a watershed,
- design solutions to mitigate the identified problems,
- secure funds to implement the designed solutions,
- implement the solutions.

In addition to offering workshops to help educate citizen groups on these technical issues, Restore-a-Waterway can be adapted for municipal officials to address their specific needs. The implementation of solutions after monitoring and analysis is an important focus of this program.

Target communities would be those that are mentioned and prioritized in this document. Selection, design and implementation of BMPs recommended within this document can be optimized through the use of this program.

If you are interested in participating in Restore-a-Waterway, please contact: Amy Boyajian at (732) 932-9800 x 6164 or Boyajian@envsci.rutgers.edu.

**Community-Project-Based Learning Educational Program**

The RCE Water Resources Program has joined forces with Research in Education Applied to Learning (R.E.A.L.) Science to create a new method of science instruction called "Community-Project-Based Learning." R.E.A.L. Science is a nonprofit organization that provides a support system for innovative standards-based authentic science projects along with effective teacher in-service training programs in science education. Community-Project-Based Learning incorporates the authentic practice of real scientists into the regular classroom setting. Community-Project-Based Learning identifies a real environmental problem in the community and works with the students to address these driving questions: Is there a real problem with our watershed? What is our contribution to the problem? If there is pollution in our watershed, how can we fix it? The project objectives include the students investigating various aspects of the natural environment on and around the school grounds, students documenting findings, and students communicating these findings to fellow classmates and the community. Working in teams, the students design a solution to a problem and present these solutions to their classmates. The best solutions are selected and built on the school grounds.

These projects expose students to the actual practice of scientists in the fields of ecology and environmental science and cover issues in geology, biology, chemistry, and applied mathematics. Lessons and activities are designed with classroom teachers to instruct students within the state standards-based curriculum. The students work together to address relevant environmental problems in their community.

Students participate as legitimate members of a scientific community. They work with their teachers, parents, local scientists, and other knowledgeable members of the community to create a solution to a relevant environmental problem in their community. As scientists, the students assemble existing data, collect new data, and work with professionals from the community to fully understand the problem, while honing their skills and learning within the guidelines of the New Jersey State Core Curriculum Content Standards.

For more information, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

**Lake and Pond Management Program**

Many of the ponds and small lakes in New Jersey are suffering from signs of eutrophication, resulting from uncontrolled nutrient inputs. The RCE Water Resources Program offers technical assistance to these pond and lake owners. The RCE Water Resources Program will prepare lake/pond management plans for these systems. These studies can be a simple dredging feasibility study that quantifies the sediment in the pond and characterizes its chemical composition and physical properties. This information is crucial when considering the option of dredging. These feasibility studies also identify the permits needed to dredge the pond or lake. More detailed studies can also be provided, which examine the source of the sediment being discharged to the pond. These studies make detailed recommendations on how to reduce or eliminate these pollutant sources.

It is important to note that there are many very good lake and pond management consultants in New Jersey that can also do this type of work. For a list of lake and pond consultants or more information on how RCE can help address lake and pond issues, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

**Best Management Practices in Landscaping (under development)**

Landscapers contribute to the application of fertilizer, the removal of yard waste, the construction of gardens and the maintenance of the grounds surrounding the streams and lakes within a watershed. For these reasons, a program that will be aimed at teaching the BMPs of landscaping could be required as a part of the licensing processes of landscapers.

As yet undeveloped, this program has the potential to be administered through the Environmental Steward or the Restore–A-Waterway programs. After initial development of the program, it is possible for the municipality to offer it or have it offered through the box stores that carry lawn maintenance equipment and fertilizers. Key aspects of this educational program will be soil testing and the subsequent application of necessary nutrients; the design, implementation and maintenance of rain gardens; buffer establishment and maintenance, and the BMPs of waste disposal.

Addressing the large number of landscaping professionals can have a strong impact on stormwater management and will best be served by a general registration of landscapers. Registration is one recommendation that could be undertaken by the individual municipalities. Requirements for using the BMPs can then be more efficiently delivered to the interested parties.

**South Jersey Land and Water Trust Educational Programs**

The South Jersey Land and Water Trust offers free classroom presentations for grades 2-12 throughout the watershed. Students learn the definition of a watershed and the ways in which the fresh waters become polluted. They also learn what they can do to make a difference. More information can be found at: http://www.sjlandwater.org/programs-education.html.

## 4.3 Conditions and Recommendations by HUC

The following sections contain a brief overview of the characteristics of the watershed as broken into the six HUC14 watersheds that compose the Oldmans Creek Watershed together with site specific recommendations for the optimal placement of BMPs. Several recommendations are repeated often for different locations throughout the watershed. These often repeated recommendations include the installation of vegetative buffers, the disconnection and infiltration of runoff from impervious surfaces and the monitoring of ponds.

**Vegetative buffers**

Multiple areas of stream and impoundment waters were found to be devoid of vegetation. This loss of streambank vegetation affects the waters in many ways. If the waters edge is mowed or has no vegetation, the soil is not stable and can erode into the water, causing an increase in total suspended solids and the nutrients that are attached to the eroded sediment. A vegetated stream bank also serves to filter overland flow and to deter the habitation of geese that feed on turf grass. The presence of a buffer can also be used to receive drainage runoff, thereby decreasing the direct connection of farm fields to stream.

Implementing the installation of vegetative buffers throughout the watershed will be a significant contributor in addressing the two large issues that face the Oldmans Creek Watershed- the phosphorus TMDL and the bacteria TMDL. Although US Farm Bill funding is available from the National Resource Conservation Service (NRCS) to help farmers install vegetative buffers, these funding programs require the farm to supply a cash match, which the farmer often cannot provide.

**Disconnection and Infiltration of Runoff from Impervious Surfaces**

The development of land increases the impervious footprint. Rainwater from these impervious surfaces such as rooftops, driveways, roads or compacted dirt parking areas often require a conveyance system to move the excess water away from the developed area. This routing of excess rainwater removes an essential resource from recharging into the groundwater aquifers. This conveyance may also create a flashy hydrology in the streams and tends to carry the pollutants from these impervious surfaces directly to the stream. These impervious surfaces that are "directly connected" to the stream tend to short circuit groundwater recharge and pollutant attenuation and can be remedied by "disconnecting" these impervious surfaces and infiltrating this excess rainwater.

The disconnection of impervious area and the infiltration of the excess stormwater can take place in various scenarios, from the routing of sheet flow off an industrial parking lot to a vegetated swale, to the capture of roof runoff in a small bioretention system known as a rain garden.

Municipalities can incorporate recommendations that provide development or re-development with guidance on how to achieve maximum infiltration from their impervious footprint. Education efforts aimed at residents can incorporate this agenda. The RCE Water Resources Program offers a "RU Disconnected?" manual that supports this endeavor for use with residential programs and commercial applications, as well. In addition, the municipalities may find an ideal opportunity to work with the South Jersey Land and Water Trust and other agencies on developing new ordinances to promote disconnection and infiltration.

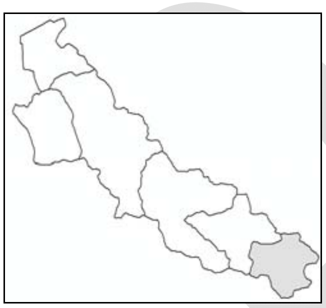
**Pond Management**

Although a watershed wide survey of ponds has previously been recommended, site specific recommendations have been identified so that these ponds can have immediate implementation of proper pond management plans. Many of the ponds in the watershed serve as retention systems, removing pollutants through settling. This has resulted in many of these ponds being filled with nutrient enriched sediments. Often these nutrients are released from these sediments causing algal blooms. Eliminating or minimizing the source of nutrients to the ponds can help reduce the algal blooms but once these algal blooms begin to occur on an annual basis, it is difficult to interrupt the process without dredging the pond. Characterization studies may need to be conducted for many of these ponds to determine if they are becoming eutrophic. These studies would also determine depth of sediment in the ponds and whether there is a need for dredging. The shoreline buffers should also be evaluated to determine if they need to be enhanced to further remove pollutants and deter geese from inhabiting these ponds and the surrounding area.

Three fact sheets produced by the Rutgers Cooperative Extension Water Resources Program have been added to this report (See Appendix C). The first fact sheet (FS1076) provides information on how to prevent and manage algal blooms. The second fact sheet (FS1077) discusses the issues related to preventing shoreline erosion and the removal of sediments from ponds. The third fact sheet (FS1078) has recommendations on the control of geese and other pests. The RCE Water Resources Program also offers technical assistance to pond and lake owners to help them address their water quality problems.



## HUC02040202160010 (Headwaters)



Total area of HUC 02040202160010 is 4.76 square miles,
    10.3% of total area of the Oldmans Creek Watershed
Gloucester County
    Elk Township: 0.93 square miles
    South Harrison: 0.62 square miles
Salem County
    Upper Pittsgrove: 3.21 square miles

HUC Highlights

- Primary Land Cover: 50% Agriculture, 38% Forest and Wetlands, 11% Urban
- Stream Classification: FW2-NT
- Targeted Pollutant Reduction: Pathogens (NJDEP TMDL (2003), 95% reduction); Stressors on Aquatic Life
- Contains Algonkin Lake

## Gloucester County

### Elk Township

Elk Township contributes drainage area to AMNET Station AN0686 (moderate impairment) and also to Algonkin Lake. Since this HUC is listed on Sublist 5 of the 2006 Integrated List for Aquatic Life, stressors from surrounding land use should be addressed. This HUC is also under a TMDL for bacteria. This is the primary driver for prioritizing buffers around waters that receive drainage from farms that house animals.

Elk Township borders the headwaters of the Oldmans Creek for approximately 1.3 miles. GIS analysis shows that vegetated buffer appears adequate (50 feet wide) or more than adequate (more than 50 feet wide) along most of this border. However, one area of agriculture located east of Bridgeton Pike (NJ77) appears to offer little to no vegetated buffer for a length of approximately 1,000 linear feet of stream. Several online impoundments that drain agricultural lands should be characterized to determine if they are in danger of becoming eutrophic, and the shoreline buffers along these impoundments should be enhanced. Offline impoundments that are experiencing regular algal blooms should also be characterized to determine if they are in danger of becoming eutrophic. Depth of, sediment should be measured at these impoundments to determine if dredging is needed.

(Refer to Table 7 and Map 12 in Appendix A for specific recommended projects)

### South Harrison

The portion of the upper HUC that is within the South Harrison boundary is made up in large part by land that has had little to no development and land cover appears to be primarily forest. These conditions are ideal for the optimal drainage conditions to support a significant resource in this HUC- Algonkin Lake. The low impact land use in this portion of South Harrison should be supported through zoning and preservation.

Invasive species such as Japanese stiltgrass have been noted as being present during the SVAP evaluation at Algonkin Lake. Invasive species have the potential to destroy healthy ecosystems and create a mono-culture that eliminates biodiversity. Notoriously difficult to combat, parks departments or volunteer organizations can create long term plans to address this issue.

(Refer to Table 7 and Map 12 in Appendix A for specific recommended projects)

**Figure 6: Algonkin Lake**
Photo Credit: Mike Hogan

**Salem County**

Upper Pittsgrove Township

Upper Pittsgrove Township provides the majority of the drainage area in this HUC14 watershed. Since reducing pathogen loads to the Oldmans Creek is a priority in this HUC, farm lands containing animals should be given the highest priority for riparian buffer installation. A farm survey would help to further prioritize buffer projects.

The large extent of agricultural land in this watershed dictates the need for preservation and farmer cooperation in optimal land management. Watershed wide recommendations such as educational programs promoting the vegetation of drainage swales and the buffering of ponds should be considered.

Aquatic life impairments are a concern in this HUC 14. At times, stream flow has been shown to contribute to aquatic life impairments. Often low baseflow due to excessive water withdrawals for irrigation or drastic increase in impervious areas in the watershed that limit groundwater recharge can reduce baseflow and negatively impact the aquatic life. Stream baseflow should be monitored in this HUC 14 to determine if baseflow is being impacted during high irrigation periods.

Invasive species such as Phragmites have been noted as being present during the SVAP evaluation along Route 77. Invasive species have the potential to destroy healthy ecosystems and create a mono-culture that eliminates biodiversity. Notoriously difficult to combat, parks departments or volunteer organizations can create long term plans to address this issue.

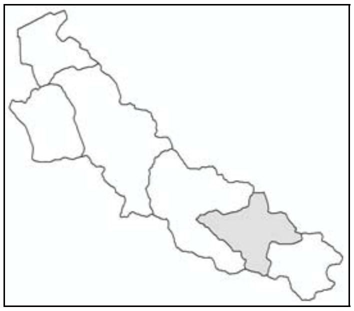
(Refer to Table 7 and Map 12 in Appendix A for specific recommended projects)

**Table 7: HUC 02040202160010 Projects**

| Ranking | Identifier | Municipality | Issue | Recommended Management Measure | Type of BMP |
|---|---|---|---|---|---|
| 3 | 010ELK01 | Elk | Online agricultural (ag) pond that drains approx. 62 acres, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 500 linear feet of shoreline buffer |
| 10 | 010ELK02 | Elk | Offline ag pond that drains approx. 45 acres, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 2,000 linear feet of shoreline buffer |
| 15 | 010ELK03 | Elk | Offline ag pond that drains approx. 15 acres | Conduct a characterization study | |
| 1 | 010ELK04 | Elk | Online ag pond, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 1,500 linear feet of shoreline buffer |
| 9 | 010ELK05 | Elk | No riparian buffer along stream | Install riparian buffer | 600 linear feet of riparian buffer |
| 8 | 010ELK06 | Elk | No riparian buffer along stream | Install riparian buffer | 1,700 linear feet of riparian buffer |
| 11 | 010ELK07 | Elk | Offline pond, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 500 linear feet of shoreline buffer |
| 7 | 010ELK08 | Elk | Online ag pond (headwaters), little to no shoreline buffer | Enhance shoreline buffer | 250 linear feet of riparian buffer |
| 13 | 010ELK09 | Elk | Unvegetated ag drainage swale (headwaters) | Revegetate swale | 2,000 linear feet of vegetation |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | enhancement |
| 12 | 010SHR01 | South Harrison | Invasive species (i.e. Japanese stiltgrass) at Algonkin Lake | Develop Lake Management Plan and remediate invasive species | |
| | 010PIT01 | Upper Pittsgrove | Minimal buffer width | Enhance buffer | 25 linear feet of riparian buffer |
| 2 | 010PIT02 | Upper Pittsgrove | Large, online ag pond, no buffer | Enhance shoreline buffer | 1,300 linear feet of shoreline buffer |
| 6 | 010PIT03 | Upper Pittsgrove | Online pond, heavy algae | Conduct a characterization study | |
| 4 | 010PIT04 | Upper Pittsgrove | Online pond, no to little shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 150 linear feet of shoreline buffer |
| 17 | 010PIT05 | Upper Pittsgrove | Offline detention basin | Naturalize with native vegetation | 4,500 sq feet of planting |
| 16 | 010PIT06 | Upper Pittsgrove | Narrow riparian buffer width | Enhance riparian buffer | 500 linear feet of riparian buffer |
| 5 | 010PIT07 | Upper Pittsgrove | Residence without riparian buffer | Install riparian buffer | 115 linear feet of shoreline or riparian buffer |
| 14 | 010PIT08 | Upper Pittsgrove | Unvegetated ag drainage swale | Revegetate swale | 800 linear feet of vegetation enhancement |
| 15 | 010PIT09 | Upper Pittsgrove | Invasive Species (Phragmites) | Remediate invasive species | |

## HUC02040202160020



Total area of HUC 02040202160020 is 7.83 square miles,
17% of total area of the Oldmans Creek Watershed
Gloucester County
South Harrison: 3.37 square miles
Salem County
Upper Pittsgrove: 0.4 square miles
Pilesgrove: 4.06 square miles

HUC Highlights

Primary Land Cover: 51% Agriculture, 35% Forest and Wetlands, 12.5% Urban

Stream Classification: FW2-NT upstream of Harrisonville Lake, FW2-NT C1 downstream of the lake.

Targeted Pollutant Reduction: Pathogens (NJDEP (2003) TMDL; 95% reduction); Stressors on Aquatic Life (Sublist 5)

Harrisonville Lake is under an NJDEP TMDL for phosphorus reductions (85% reduction in nonpoint source phosphorus loading to the lake)

*HUC020402021600**20** contains five miles of Category One (C1) classified streams at and below Harrisonville Lake. The NJDEP upgraded this portion of the Oldmans Creek to C1 based on freshwater benthic macroinvertebrates or freshwater E&T species (39 N.J.R. 1845). This area contains one of Southern New Jersey's most researched and managed Federal Threatened and State Endangered Bog Turtle site. The State Threatened Triangle Floater is also represented here. The C1 designation runs for 2.3 miles on the main stem between South Harrison and Pilesgrove. There is an additional 1.4 miles of tributary streams designated C1 running through South Harrison and 1.25 miles of tributary running through Pilesgrove.*

*C1 Waters are provided the highest form of protection against deterioration that is available. To protect Category One waters, a 300-foot Special Water Resource Protection Areas of existing vegetation is required to be maintained with no stormwater piping or structures be constructed within it (N.J.A.C 7:8). Tributaries upstream of a designated stream that fall within the same HUC14 are subject to all C1 regulations. (Refer to Map 1, Appendix A and Figure 2).*

**Gloucester County**

<u>South Harrison</u>

The tributary Lincoln Stream (above Harrisonville Lake, designated FW2-NT) begins west of Linwood running parallel to Lincoln Road and joining the main stem just after crossing under Lincoln Mill Road. Two SVAP surveys on this stream found high marks with both averaging 8.6 (out of 10) overall. This tributary appears well buffered as it passes mainly through forested land use. In the lower reaches, it does intercept two agriculture fields but still appears buffered. It is undetermined at this time if farm drainage has been routed directly to stream.

The next tributary in South Harrison HUC02, named Oldmans, is located northwest of Lincoln Stream and joins the mainstem just above Harrisonville Lake. This tributary is the earliest classification of C1 stream. The drainage area consists primarily of agricultural lands, with significant buffers (300 feet or greater) in the upper reach, somewhat adequate (150 to 200 feet) buffers in the lower reach and areas of minimal buffer (less than 50 feet) in the center between Monroeville and Lincoln Mill Roads and west of Monroeville. This C1 classified tributary achieved an overall SVAP score of 8.4, but displayed aging stormwater infrastructure (Figure 7).

**Figure 7: Erosion under outfall**

The main stem of this Category 1 stream passes through a State owned open space containing Harrisonville Lake. Harrisonville Lake often exhibits algal growth thereby increasing concerns for the eutrophication of a resource to this community. Land use in the Harrisonville Lake Road area appears to contain minimal buffers that may be being short circuited by pipes directly draining to the lake. The dam has recently been restored, but residents have reported that these repairs appear inadequate and that the dam continues to show signs of leakage. The downstream side of the dam is a hard structure, which may have been deemed necessary for stability but provides no pollutant filtering capacity for overland flow to the stream.

A lake management plan is recommended that will consider all drainage connections to lake (020SHR04). Residential land that borders Harrisonville Lake on Harrisonville Lake Road may be maintaining lakeside property that is within the State owned open space land and mowing to the edge of the lake. This soil should be properly secured with a buffer, estimated to be 120 linear feet along the shoreline. Another three residences on the shoreline of the Harrisonville Lake may also share the shoreline with the state owned open space, and should be encouraged to stabilize shoreline soil and enhance a vegetative buffer. Approximately 250 linear feet (020SHR07 and 020SHR08) of enhanced buffer system would improve the quality of runoff from these areas.

**Figure 8: Harrisonville Lake**
Photo Credits: Mike Hogan and Greg Rusciano

Land off of Ferrell Road that is adjacent to Harrisonville Lake appears to contain a parking area for trucks. There is a concern that runoff from this site is reaching the lake. Within 250 feet of the lake, the soil appears unstable with soil rills apparent through aerial photography. Effort should be taken to ensure that the impervious areas on this site are disconnected and that the collection of stormwater is treated prior to discharge to the groundwater and surface water.
(ID #020SHR05)

**Salem County**

Upper Pittsgrove Township

Only a very small portion of this HUC is in Upper Pittsgrove, in the area of Commissioners Road, in the southwestern portion of this HUC. Agricultural land use dominates and several offline ponds receive field drainage. The 1,300 feet of tributary that runs through this municipality in the HUC appears well buffered. It is unclear if there is direct drainage from these fields to the stream.

Pilesgrove Township

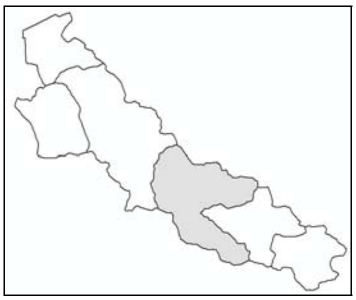
Pilesgrove contributes the largest land area to this HUC 14 watershed, with agricultural land use dominating and areas of forest and light residential use dispersed around the watershed. Offline impoundments or irrigation ponds appear to dominate the drainage infrastructure and therefore are prioritized for characterization and maintenance. These pond characterizations studies should determine if these ponds are in jeopardy of becoming eutrophic. They should also include an analysis of the nutrient sources, sediment depth and shoreline buffering capacity. Additionally, farms should be encouraged to develop and implement comprehensive nutrient management plans to limit nutrients discharging to the stream. United States Farm Bill money is often available for developing and implementing these plans. The Natural Resources Conservation Service (NRCS) can provide technical assistance in preparing these plans.

**Table 8: HUC 02040202160020 Projects**

| Ranking | Identifier | Location | Issue | Recommended management measure | Type of BMP |
|---|---|---|---|---|---|
| | 020SHR04 | South Harrison and Pilesgrove | Invasive species and nutrient enrichment at Algonkin Lake | Develop Lake Management Plan and remediate invasive species | |
| | 020SHR02 | South Harrison | Offline ag pond, little to no buffer | Enhance shoreline buffer | 1,500 linear feet of shoreline buffer |
| | 020SHR01 | South Harrison | little to no riparian buffer along C1 stream | Install and enhance riparian buffer | 780 linear feet of riparian buffer |
| | 020SHR03 | South Harrison | Large ag field with 150 ft width buffer | Increase riparian buffer; determine if direct drainage to C1 stream | Increase buffer width along 350 linear feet |
| | 020SHR05 | South Harrison | Loss of buffer on Algonkin Lake (residential or open space lands?) | Enhance shoreline buffer | 100 feet linear feet |
| | 020DHR06 | South Harrison | Direct drainage from truck parking area | Install vegetated swale or vegetative filter strip | 300 linerar feet |
| | 020SHR07 | South Harrison | Loss of buffer on Algonkin Lake (residential or open space lands?) | Enhance shoreline buffer | 100 linear feet |
| | 020SHR08 | South Harrison | Loss of buffer on Algonkin Lake (residential or open space lands?) | Enhance shoreline buffer | 150 linear feet |
| | 020PIL01 | Pilesgrove | Non-vegetative swale drains ag field | Revegetate swale | 860 linear feet of vegetation |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | enhancement |
| | 020SHR09 | Pilesgrove | Large offline ag pond with algae | Conduct a characterization study | |
| | 020PIL02 | Pilesgrove | Little to no buffer along C1 stream | Install and enhance riparian buffer | 900 linear feet of riparian buffer |

## HUC02040202160030



Total area of HUC 02040202160030 is 10.4 square miles,
22.6% of total area of the Oldmans Creek Watershed
Gloucester County
South Harrison: 4.19 square miles
Woolwich: 2.15 square miles
Salem County
Pilesgrove: 4.06 square miles

HUC Highlights

Primary Land Cover: 60% Agriculture, 24% Forest and Wetlands, 14.6% Urban
Stream Classification: FW2-NT C1
Targeted Pollutant Reduction: NJDEP TMDLs for Pathogens (95% reduction, NJDEP, 2003) and Total Phosphorus (67.3% reduction, NJDEP, 2005).

The AMNET station at the outlet of this HUC 14 watershed (AN0688, Kings Hwy in Woolwich, Gloucester), was ranked as moderately impaired for both Round 1 and Round 2.

*All 19.5 miles of streams in HUC020402021600**30** are designated Category One (C1) and are protected at the highest level.*

**Gloucester County**
In Gloucester County there are four main tributaries to main stem Oldmans including Marl Run through South Harrison and Porches Creek, including Porches Mill Pond, in Woolwich Township.

<u>South Harrison</u>
Based upon a review of aerial photography, an online pond at the headwaters of Marl Run may be receiving runoff from an animal facility in the area. This location should be ground verified and best management practices identified if direct runoff is the case.

Several stormwater infrastructure facilities have been identified as having the need for an appropriate upgrade. (Figure 9). Stormwater runoff from some roads is routed through large pipes directly to the stream. The lack of proper catch basins allows large floatables direct access to the stream.

**Figure 9: Stormwater conduit on Marl Run**

**Salem County**

The Salem County portion of this HUC has two tributaries that converge into one after Route 45 before emptying into the main stem in the area of Lincoln Road. These tributaries consist of 5.3 miles of stream that provide drainage for area composed primarily of agriculture. This section of stream contains little to no riparian or shoreline buffers. Slightly less than half this length (2.25 miles of stream) requires additional riparian buffers on both sides of the stream. Four offline and three online ponding areas have been identified from aerial photographs on this tributary.

Pilesgrove

The issues identified in Pilesgrove Township are dominated by agricultural detention (030PIL01 through 030PIL11). Many areas of detention, whether online or offline, have been found to be deficient in buffer width. Many of these ponding areas have been noted as containing algal blooms. A survey that captures the characteristics of each of these areas should aid in prioritizing remediation efforts.

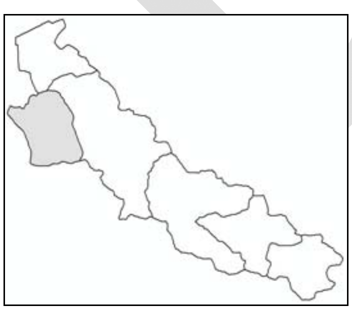
**Table 9: HUC 02040202160030 Projects**

| **Ranking** | **Identifier** | **Location** | **Issue** | **Recommended Management Measure** | **Type of BMP** |
|---|---|---|---|---|---|
| | 030SHR01 | South Harrison | Poor stormwater infrastructure | Revegetate swales, enhance catch basin, stabilize outlets | |
| | 030PIL01 | Pilesgrove | Offline ag pond, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization | 1,900 linear feet of shoreline buffer |

| | | | | | |
|---|---|---|---|---|---|
| | | | | study | |
| | 030PIL02 | Pilesgrove | Offline ag pond, little to no shoreline buffer | Enhance shoreline buffer and conduct a characterization study | 2,600 linear feet of shoreline buffer |
| | 030PIL03 | Pilesgrove | Potential cow access to stream | Fencing around stream | |
| | 030PIL04 | Pilesgrove | Online pond, little to no shoreline buffer, possible cow farm | Enhance shoreline buffer and conduct a characterization study | 230 linear feet of shoreline buffer |
| | 030PIL05 | Pilesgrove | Large online pond, little to no buffer | Enhance shoreline buffer | 600 linear feet of shoreline buffer |
| | 030PIL06 | Pilesgrove | Online pond, algae, animal farm to south (drainage may bypass existing 100 ft width buffer) | Enhance shoreline buffer and conduct a characterization study | 500 linear feet (increase width vs. ensure drainage not bypassing existing buffer) |
| | 030PIL08 | Pilesgrove | Offline pond with algae | Conduct a characterization study | |
| | 030PIL07 | Pilesgrove | Eroded streambank with no riparian buffer | Stabilize stream bank and install riparian buffer | 150 linear feet of riparian buffer |
| | 030PIL09 | Pilesgrove | Online pond; buffer appears adequate | Conduct a characterization study | |
| | 030PIL11 | Pilesgrove | Offline pond with algae; drains to marsh area. Buffer appears adequate | Conduct a characterization study | |
| | 030PIL12 | Pilesgrove | Direct drainage from truck parking area, 166 acres of | Install vegetated swale or vegetative filter strip or | BMPs to disconnect impervious surfaces and |

| | | | | | |
|---|---|---|---|---|---|
| | | | impervious surfaces | infiltration BMP | infiltrate runoff |
| | 030WOL01 | Woolwich | Impervious surfaces in low density residential area | BMPs to disconnect runoff and lawn care education | BMPs to disconnect impervious surfaces and infiltrate runoff |
| | 030SHR06 | South Harrison | Headwater stream, little to no riparian buffer | Install riparian buffer | 2,400 linear feet of riparian buffer |
| | 030SHR02 | South Harrison | Online pond, Marl Run west branch, on animal farm | Conduct a characterization study | |
| | 030SHR03 | South Harrison | Online pond | Conduct a characterization study | |
| | 030SHR04 | South Harrison | Farm debris within 25 feet of the stream | Increase riparian buffer width and remove debris | 250 linear feet of riparian buffer |
| | 030SHR05 | South Harrison | Online ag pond | Conduct a characterization study | |
| | 030SHR06 | South Harrison | Stream, little to no riparian buffer | Install riparian buffer | 500 linear feet of riparian buffer |

**HUC02040202160040**



Total area of HUC 02040202160040 is 5.6 square miles
12% of total area of the Oldmans Creek Watershed

Salem County
Oldmans: 5.6 square miles

HUC Highlights
Primary Land Cover: 56% Agriculture, 30% Forest and Wetlands, 10% Urban
Stream Classification: FW2-NT/SE1

Targeted Pollutant Reduction: No nonpoint related pollutants noted for this HUC
Stream in this HUC is known as "Beaver Creek"

In the southeast corner of this HUC14 watershed, south of Tighe Road, three headwater tributaries flow through mostly unbuffered agricultural lands. The water received only moderate ratings in SVAP scores for nutrient enrichment and water appearance. The water quality from waters draining this area would greatly benefit by enhancing or installing stream buffers; approximately 6,000 linear feet of riparian buffer is needed (040OLD01, 02 and 03).

As the stream flows between Tighe and Straughens Mill Road, it is receiving drainage from land primarily composed of agricultural and forest land. This land appears mostly well buffered. Three impoundments in this area appear to be offline and could be an effective means at decreasing pollutant loading from stormwater runoff to the stream. However, monitoring and evaluation of outlet structures should be performed (040OLD04, 05 and 06).

Above Route 643, SVAP survey scores were generally good with ecosystem and native species noted. However, moderate algae in the water could indicate nutrient enrichment of waters upstream. Japanese knotweed was noted at Route 643. This should be monitored for the plants affect on stream bank stability in the future.

Below Route 643, the stream flows through large agricultural fields without riparian buffers (Figure 10). The stream appears to have been straightened and is deeply incised. Aquatic life appears to be impaired and moderate algae was seen on stream substrates.

**Figure 10: Unbuffered stream**
Photo Credit: Mike Hogan

This area to the west of Straughens Mill Road (643) would greatly benefit by installing riparian buffers along the streams that flow through the farm fields. Stream buffer installation projects have been identified in recommendations 040OLD08 through 040OLD13. Two online impoundments also receive unbuffered drainage from agricultural lands. The water quality of these impoundments, as well as water draining from these impoundments, should benefit from the installation of vegetated buffers. Monitoring of these impoundments would be necessary to ensure that the pond is serving as a sediment sink. (040OLD14 and 15)

Headwaters west of Pennsville-Pedricktown Road flow east under the road and converge with the main stem of Beaver Creek. Many tributaries flow through agricultural lands here and most of the streams have little or no riparian buffers. Over 5,000 linear feet of stream need enhanced riparian buffers in this area. (040OLD16, 17 and 18)

The mainstem Beaver Creek becomes tidal upstream of Straughens Mill Road, and the stream widens here. Agricultural fields and now, neighborhoods (i.e., Donna Drive) are close to the stream. Riparian buffers (040OLD19 to 22) and the installation of BMPs (040OLD23) in the residential area are recommended. These residential BMPs should focus on the disconnection and infiltration of the runoff from impervious areas by using bioretention (rain gardens), vegetated swales along roads and by minimizing curbs and catch basins.



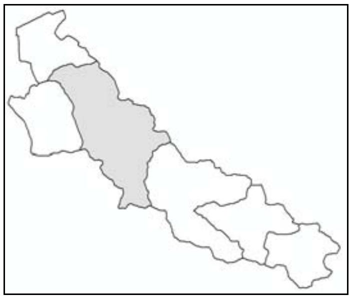
**Table 10: HUC 02040202160040 Projects**

| Ranking | Identifier | Location | Issue | Recommended Management Measures | Type of BMP |
|---|---|---|---|---|---|
| | 040OLD01 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 1,500 linear feet of riparian buffer |
| | 040OLD02 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 800 linear feet of riparian buffer |
| | 040OLD03 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 4,000 linear feet of riparian buffer |
| | 040OLD04 | Oldmans | Offline pond | Enhance shoreline buffer and conduct a characterization study | |
| | 040OLD05 | Oldmans | Offline pond, appears to have good shoreline buffer | Conduct a characterization study | |
| | 040OLD06 | Oldmans | Offline pond, appears to have good shoreline buffer | Conduct a characterization study | |
| | 040OLD08 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 1,600 linear feet of riparian buffer |

| | | | | | |
|---|---|---|---|---|---|
| | 040OLD09 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 900 linear feet of riparian buffer |
| | 040OLD10 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 1,800 linear feet of riparian buffer |
| | 040OLD11 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 700 linear feet of riparian buffer |
| | 040OLD12 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 1,000 linear feet of riparian buffer |
| | 040OLD13 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 900 linear feet of riparian buffer |
| | 040OLD14 | Oldmans | Online impoundment | Enhance shoreline buffer and conduct a characterization study | 1,500 linear feet of shoreline buffer |
| | 040OLD15 | Oldmans | Online impoundment | Enhance shoreline buffer and conduct a characterization study | 1,500 linear feet of shoreline buffer |
| | 040OLD16 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 3,000 linear feet of riparian buffer |
| | 040OLD17 | Oldmans | Stream, little to no riparian | Enhance riparian buffer | 900 linear feet of riparian buffer |
| | 040OLD18 | Oldmans | Stream, little to no riparian buffer | Enhance riparian buffer | 3,000 linear feet of riparian buffer |
| | 040OLD19 | Oldmans | Stream, minimal buffer | Enhance riparian buffer | 4,000 linear feet of riparian buffer |
| | 040OLD20 | Oldmans | Stream, minimal buffer | Enhance riparian buffer | 3,500 linear feet of riparian buffer |
| | 040OLD21 | Oldmans | Stream, minimal buffer | Enhance riparian buffer | 3,500 linear feet of riparian buffer |
| | 040OLD22 | Oldmans | Stream, minimal buffer | Enhance riparian buffer | 2,000 linear feet of riparian buffer |

| | | | | | |
|---|---|---|---|---|---|
| | 040OLD23 | Oldmans | Uncontrolled Residential area | BMPs to disconnect runoff and lawn care education | BMPs to disconnect impervious surfaces and infiltrate runoff |

### HUC02040202160050



Total area of HUC 02040202160050 is 12.7 square miles
% of total area of the Oldmans Creek Watershed
Gloucester County
Woolwich: 6.32 square miles
Logan: 2.6 square miles
Salem County
Pilesgrove: 2.1 square miles
Oldmans: 1.7 square miles

HUC Highlights

Primary Land Cover: 42% Agriculture, 33 Forest and Wetlands, 21% Urban
Stream Classification: FW2-NT/SE1
Targeted Pollutant Reduction: NJDEP TMDL for Pathogens (95% reduction NJDEP, 2003); Total Phosphorus and Total Suspended Solids (Non attainment)

Larger tributaries present in Gloucester County include Rainey Run and Ebenezers Branch in Woolwich and Tide Branch in Logan. Head of tide on main stem Oldmans Creek reaches above the New Jersey Turnpike, between the turnpike and Kings Hwy, in the area where Rainey Run enters the main stem. The tidal zone extends up the tributaries of Tide Branch and Ebenezers Branch.

AMNET Station AN0689 is located at Auburn Road (Rt. 551), midway through HUC02040202160050. Round 1 of the biological assessments was moderately impaired, whereas round 2 was severely impaired.

Upon entering this HUC, the stream has been divided (downstream of Kings Highway, behind Monrovian Church Road, Woolwich) for approximately 1,000 feet (Figure 11).


**Figure 11: Stream division at Monrovian Church Road**

## Gloucester County

### Woolwich

*Beckett Country Club Golf Course*
The most upstream tributary in this HUC is Rainey Run which flows through the Beckett Country Club Golf Course for approximately 4000 feet. Vegetated buffers appear in portions of the golf course, but in some portions, there are no buffers. Three online ponds within the golf course are seen in the aerial photographs. The sustainability of this golf course should be considered with respect to irrigation, water reuse, goose populations and stream buffers (050WOL01).

*Residential Development*
Rainey Run then flows through a residential area with buffers that appear adequate. During the SVAP surveys, it was determined that the base flow was low and the stream was discolored orange, potentially from soil iron content. BMPs that disconnect and infiltrate runoff from impervious residential surfaces, including road runoff, should be considered in this area. These would serve to increase baseflow. Such BMPs would include bioretention (rain gardens) and vegetated swales along roads (050WOL02 through 06 and 12 through 13).

Ebenezer Branch in Woolwich Township has several large online irrigation/drainage ponds. A large farm off of Oldmans Creek Road has a stretch of tributary that passes through a grassy field and has no riparian buffers, and farm animals have access to the stream. This area should be evaluated for the implementation of a fence and stream buffer that would protect stream water quality (050WOL09).

The main stem meanders with lightly buffered agricultural lands on the Gloucester County side and wetlands (Pedricktown Marsh) on the Salem County side.

Pedricktown Marsh serves as a water quality filter and provides protection from storm surges. This area also provides vital habitat for migrating birds and many aquatic species. The protection of this vital resource is in the best interest of the municipalities that have land here, but also for the benefit of the receiving waters, the Delaware River.

Logan

The tributary that receives drainage from the Logan Township portion of this HUC14 watershed is called the Tide Branch. The headwaters of Tide Branch that lie southeast of I-295 are becoming densely developed. This land has several new densely developed residential neighborhoods close to the stream, with Auburn Chase and Creek Run among them. These neighborhoods typically have retention/detention ponds included in their stormwater infrastructure. The curbing is often Belgium Block which initially routes stormwater directly to catch basins. There is some riparian buffer with widths ranging between 50 and 100 feet. These residential areas should be evaluated for the potential to disconnect and infiltrate the runoff from impervious areas. Best management practices such as vegetated swales or curb cuts with bioretention areas should be considered to infiltrate the rain closest to the point of runoff.

The presence of industrial parks in close proximity to the stream also raises the potential for disconnection and infiltration projects. Businesses between Center Square Road and 295 and around Heron Drive (i.e., Pureland) can be evaluated for disconnection opportunities on this site and also for the presence of geese populations on expansive lawns that may contribute to the pathogen contamination of the waters. Businesses along Technology Drive also have opportunities to increase the riparian buffers off the back of their parking lots. (See projects 050LOG03, 04 and 05)

**Figure 12: Commercial Sites for BMP installation**
(Photo Credits: Greg Rusciano)

There is a large green retention pond in back of industrial buildings around Technology Drive. This area may consider a pond management plan to make sure this is a sink and not a source and to make sure the buffer is being used and not having the overflow go directly to stream (050LOG06).

**Salem County**

The Salem County side of this HUC14 watershed does not contain as much drainage area as the Gloucester County side, with a good portion of the land in Salem County draining to HUC02040202160040 to the southwest. The most upstream portions of this watershed area in Salem County are found in Pilesgrove Township, with the downstream area in Oldmans Township.

<u>Pilesgrove</u>

Two small tributaries exist in the upstream portion of this HUC, opposite the area of Rainey Run in Gloucester County. The first tributary begins after several large agriculture fields, then flows through a forested buffer that appears to have light residential development, with an increase in newer development as this tributary gets closer to the main stem. One area of concern on this tributary is unstabilzed soil from a property off of Kings Highway. The stream behind this property is impounded and should be monitored for nutrients and temperature (050PIL01). This pond is 750 feet upstream of the main stem.

<u>Oldmans</u>

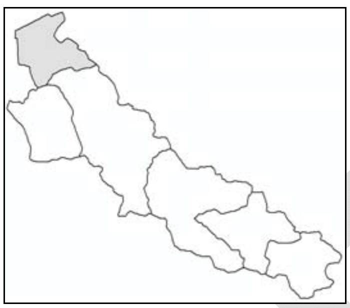
Downstream on the Salem County side of this HUC14, large swaths of agricultural land use abut to the stream and marsh. This land is inter-dispersed low density residential development.

**Table 11: HUC 02040202160020 Projects**

| Ranking | Identifier | Location | Issue | Type of BMP | Extent |
|---|---|---|---|---|---|
| | 050WOL02, 050WOL03, 050WOL04, 050WOL05, 050WOL06, 050WOL13, 050WOL12 | Woolwich | Residential Development | BMPs for disconnection and infiltration of impervious surfaces | |
| | 050LOG01, 050LOG02, | Logan | Residential Development | BMPs for disconnection and infiltration of impervious surfaces | |
| | 050WOL07, 050WOL1` | Woolwich | Offline pond | Conduct a characterization study | |
| | 050WOL08, 050WOL10, 050WOL14 | Woolwich | Online pond | Conduct a characterization study | |
| | 050WOL09 | Woolwich | Animal access, | Install fence | 600 linear |

| | | | | | |
|---|---|---|---|---|---|
| | | | no riparian buffer | and riparian buffer | feet of riparian buffer |
| | 050LOG03, 050LOG04, 050LOG05 | Logan | Industrial Complex | Disconnect and infiltrate runoff from impervious area and evaluate for goose habitat | |
| | 050LOG06 | Logan | Offline pond | Conduct a characterization study | |
| | 050PIL01 | Pilesgrove (off Kings Highway) | Unstabilized soil | Stabilize site with vegetation | |

## HUC02040202160060 (Outlet to Delaware River)



Total area of HUC 02040202160060 is 4.71square miles
10.2% of total area of the Oldmans Creek Watershed
Gloucester County
Logan: 2.5 square miles
Salem County
Oldmans: 2.21 square miles

HUC Highlights
Primary Land Cover: 32% Agriculture, 51% Forest and Wetlands, 14% Urban
Stream Classification: FW2-NT/SE1
Targeted Pollutant Reduction: No nonpoint related pollutants noted for this HUC

**Gloucester**

<u>Logan</u>

As the Oldmans Creek Watershed takes it final course through this HUC14 watershed to the Delaware River, the elevation change is slower and creates the ecologically significant Pedricktown Marsh. Most of the land in this HUC covered by the Pedricktown Marsh is in Logan, Salem County. The marsh appears close to its natural state upstream of the train tracks and has been punctuated by agriculture downstream of the train tracks.

In the upper most tributaries in Logan, before the stream meanders into the marsh, industrial complexes present large swaths of impervious area that could be evaluated for BMPs to disconnect and infiltrate stormwater runoff. These complexes also have lawn areas that may invite resident goose populations that would contribute to bacteria sources. (060LOG01, 02, 03, and 04)

**Salem**

Oldmans

After the train tracks, the marsh is replaced by agriculture with minimal buffers around the stream. The SVAP surveys in this area found several non-native vegetative species, including *Phragmites*, Japanese knotweed and purple loosestrife. This area should be evaluated for streambank stability and addressed as needed. (060OLD01)

**Table 12: HUC 02040202160060 Projects**

| Ranking | Identifier | Location | Issue | Recommended Management Measures | Type of BMP |
|---|---|---|---|---|---|
| | 060LOG01, 060LOG02, 060LOG03, 060LOG04 | Logan | Industrial Complex | Disconnect and infiltrate runoff from impervious area and evaluate for goose habitat | |
| | 060OLD01 | Oldmans | Minimal buffer and presence of invasive species | Evaluate for bank stability | |

## *4.4 Water Quality Parameters Not Addressed*

pH

The pH level of all waters should be within a range of 6.5 to 8.5 Standard Units (S.U.). Values less than 7 are considered “acidic” and values over 7 are considered “basic.” A value of 7 would be considered neutral. The pH of the water determines the chemical make up of the water, changing the solubility and biological availability of the components within the water. Natural variation of the pH can be due to cycles of photosynthesis and the geochemical composition of the soil that the water has flowed through and over.

Nonpoint source pollution from stormwater runoff is not considered a major contributor to the negative impact on the pH of natural waters. Industrial or municipal effluent in point source pollution is generally a greater concern, but this discharge is regulated and usually easily remedied.

The atmospheric deposition of acidic components that could be added to natural water systems is a suspect in a pH impairment, but is often buffered by the geological components of the land. The natural geology can also lead to a more acidic environment, which has been the case of several Pinelands streams subsequently removed from the integrated list.

The two upper most HUC14 watersheds (020402021600-01 and 02) in the Oldmans Creek Watershed have been designated as impaired for pH. Further investigation would be needed to determine the root cause of this impairment.

PCBs and Dioxin (HUCs 4, 5 and 6)
The most downstream three HUC14 watersheds (020402021600-60 -50 and -40) in the Oldmans Creek Watershed have been designated as impaired for PCBs and dioxin. Traditionally these pollutants have been traced to historical industrial discharges. These chemicals are currently regulated in point source discharges. Although PCBs and dioxin are not often found in stormwater runoff, these chemicals can be moved by stormwater runoff from industrial sites and transported to the stream, ultimately being deposited in stream and lake sediments, where they continue to be available to the water column. The Delaware River Basin Commission has been working on identifying these sources of contaminates and should continue these efforts.

Aquatic Life Stressors
The biomonitoring within this watershed has identified these waters as moderately to severely impaired based upon the analysis of the macroinvertebrate community. Many stressors are present and the magnitude of effect that each stressor has on the aquatic life has not been determined here. Although the recommended management measures in this plan will reduce pollutants to the Oldmans Creek and its tributaries and lakes, these efforts many not be sufficient to improve the health of the macroinvertebrate community. Continued biomonitoring is recommended as these management measures are implemented to determine if these practices improve the health of the macroinvertebrate community. Additionally, a stressor identification analysis for the entire watershed could provide more information for identifying the root cause of these impairments to the macroinvertebrate community.

Mercury
Oldmans Creek was excluded from the NJDEP Statewide TMDL for mercury in fish tissue that was proposed on June 15, 2009 because of the tidal nature of the area.

# 5. Implementation Projects

Three implementation projects were completed during the compilation of this watershed restoration and protection plan. All three are located within the drainage area of the Oldmans Creek Watershed, and all address water recharge, water quality and wildlife habitat. Summations of each of the three projects have been described in Implementation Fact Sheets contained in Appendix B of this report. Brief descriptions of the projects are presented here.

South Harrison Elementary School

The first project retrofitted a stormwater swale placed in the center of the South Harrison Elementary School. Initial evaluations showed a swale with poor infiltration that often had standing water, creating a mosquito habitat. The mowed cool season grasses also did a poor job at preventing soil erosion. The area was densely planted with native species, including *Iris versicolor*, soft rush, *Monarda* and black -eyed Susans.

With the deep native plant root system loosening the compacted soils, the basin is expected to infiltrate an increased volume of runoff. The native vegetation will also provide habitat for small vertebrates, butterflies and birds.

An educational component accompanied the first phase of this project which took place in the autumn of 2008. The South Jersey Land and Water Trust worked with the Rutgers Cooperative Extension Water Resources Program to provide environmental education to the fourth grades student. This educational component included a classroom presentation of watershed facts and then a hands-on task of helping implement this stormwater retrofit.

Gloucester County Solid Waste Complex Stormwater Basin Retrofit

Stormwater management on the lands of the Gloucester County Improvement Authority's landfill includes the use of large basins that receive stormwater runoff from covered landfill piles. Of the 540 acres, only twenty percent of the landfill being used for the placement of waste, the remaining area is needed for stormwater management and wildlife management and visual buffer. However, the large stormwater basins have previously been maintained by regular mowing and therefore have become severely compacted, decreasing the potential infiltration capacity of the basin. This mowed area also presented a discontinuous area not optimal for wildlife habitat.

The restoration of a 36-acre stormwater basin took place in three phases. The first phase included planting wetland vegetation around the areas regularly inundated with water. Native herbaceous plants and shrubbery adapted to these conditions were chosen. The second phase consisted of increasing the buffer width around the ponding area of the basin with species adapted to upland conditions. Finally, the entire basin was seeded with a specially designed seed mix for the retrofitting of stormwater detention basins. Maintenance of the basin has been reduced to one annual mowing cycle, saving the time, money and fuel for the County.

The Gloucester County Solid Waste Complex Basin Outlet Stabilization and Naturalization Project

With the extensive stormwater infrastructure contained on the Gloucester County Landfill, another area of remediation became evident. An outlet of a large stormwater basin was eroding and spilling large amounts of sediment onto a nearby agricultural field. The stabilization of the soil was achieved by densely installing native shrubbery including Inkberry Holly, red-osier dogwood, sweet pepperbush and Virginia sweetspire. Herbaceous vegetation was also planted densely and closer to the outlet. Since this area was more remotely located, complete deer fencing was installed around the perimeter of the newly vegetated area.

# 6. Funding Opportunities

U.S. Farm Bill

The U.S. Department of Agriculture (USDA) provides farmers with assistance to implement agricultural conservation practices such as those identified in this plan. This funding can help support nutrient management, vegetative buffers and other agricultural BMPs designed to reduce pollution that could enter the waterways of the Oldmans Creek, and ultimately, the Delaware River. The local Natural Resources Conservation Service (NRCS) office can provide farmers assistance with applying for these funds. (http://www.nj.nrcs.usda.gov/programs/index.html)

The NJ-CREP is a cooperative effort between NJDEP and the NJ Department of Agriculture and is designed to assist farmers in reducing nonpoint source pollution caused by agricultural runoff. Under this program, farmers receive financial incentives to voluntarily remove marginal pastureland or cropland and convert the land to native grasses, trees and other vegetation.

(http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp)

Other

The New Jersey Department of Environmental Protection administers funding from the U.S. Environmental Protection Agency directed at reducing water quality impairments through the implementation of nonpoint source pollution controls. This could be allotted for urban, residential or agricultural land use. (http://www.state.nj.us/dep/watershedmgt/319grant.htm)

County and municipal government

County and municipal entities may choose to allocate funding to projects that will address the problems that have the potential of creating the need for additional regulations, such as TMDLs, or if projects help meet the permit requirements under their MS4 permit. These projects can also be funded through a mitigation bank created by the government entity.

# 7. Milestones and Monitoring

## *7.1 Schedule for implementation of management measures*

Implementation of the projects listed herein will require some level of funding. Stakeholders including county and municipal governments as well as the South Jersey Land and Water Trust and other environmental commissions need to work together to begin the implementation of this plan. The following is a schedule for implementation provided funding is available.

The following initiative should begin in Year 1 and continue through Year 3:

1. Water Quality Sampling to include bacteria: In Year 1, develop a sampling plan and implement the sampling plan. Continue to monitor and identify sources in Years 2 and 3. Use data to further prioritize sources.

2. Farmer Technical Assistance Program: In Year 1 develop program tools to conduct on-farm surveys with RCE and the Salem County Cooperative Extension. Conduct a pilot program to test these survey tools. Implement demonstration BMPs on several farms that can be used in future sessions as educational tools. Continue efforts in Years 2 and 3.
3. Pond and Lake Management Survey: A full watershed review of all impoundments and the characteristics that contribute to the impairment of the waterways should begin early in year one. This survey may help to identify sampling locations for water quality monitoring.
4. Stormwater Management in Your Backyard Program: In Year 1 expand the South Jersey Land and Water Trust and Rutgers Gloucester County Cooperative Extension rain garden efforts through this program. Continue to work with stakeholders to construct more rain gardens in the watershed.
5. Goose Management Program: In Year 1 develop a goose management program for small ponds in the watershed and for publicly owned lands. In Years 2 and 3 implement the management program.
6. The Disconnection of Stormwater Runoff from Impervious Surfaces: In Years 1 and 2 work with municipalities to modify municipal ordinances to contain impervious cover disconnection requirements. In Years 2 and 3 implement several demonstration projects that disconnect impervious surfaces from small commercial sites.
7. Septic Management Program: Although not identified during the compilation of this plan, septic systems within the watershed may be considered a potential source of bacteria. Begin in Year 1 by conducting a detailed survey of locations of septic systems and begin educational programs in these areas. In Years 2 and 3 continue educational programs and work with municipalities to implement septic system tracking programs where needed.
8. Specific projects in the six HUC14s: In Year 1 begin implementing these specific projects as part of 1-7 discussed above. Prioritize the projects in these six subwatersheds based upon water quality data.

## 7.2 Description of interim measurable milestones

Five years after the commencement of the implementation of management measures, a detailed evaluation will be conducted to quantify the water quality improvements attained in the watershed. Based upon this evaluation, practices can be modified to further refine the recommendations for management measures, which are needed to ultimately attain the goal of the plan.

## *7.3 Monitoring Component*

The implementation of the management measures will result in water quality improvements while minimizing flooding and promoting groundwater recharge or reuse. Both modeling and monitoring can be conducted to quantify these improvements.

Monitoring can be conducted to also quantify the improvements to the Oldmans Creek and its watershed that result from the implementation of the Plan. NJDEP does maintain four ambient biomonitoring sites on the Oldmans Creek. These sites can provide information on improvement in the effects of water quality on aquatic biota. Moreover, water quality samples can be collected throughout the system and analyzed for various pollutants that are a concern within the watershed such as nutrients and bacteria.

# References


16 N.J.R. 1147(a), 16 N.J.R. 2102(b), N.J.A.C. 7:14, Water Pollution Control Act, http://www.state.nj.us/dep/dwq/714.htm, posted 9/26/07.

39 N.J.R. 1845 (a), Rule Proposals, Environmental Protection Land Use Management Water Monitoring and Standards, Proposed Amendments: N.J.A.C. 7:9B-1.4 and 1.15, New Jersey Register Copyright 2007 by the New Jersey Office of Administrative Law, Trenton, NJ, May 21, 2007.

36 N.J.R. 812, New Jersey Administrative Code (N.J.A.C. 7:8), Environmental Management, Stormwater Management, New Jersey Register Copyright 2004 by the New Jersey Office of Administrative Law, Trenton, NJ, February 2, 2004.

Bjorkland, R., Pringle C.M., Newton, B.; A stream visual assessment protocol (SVAP) for riparian landowners. *Environmental Monitoring Assessment*, 68: 99-125 (2001).

New Jersey Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS), NJDEP 14 Digit Hydrologic Unit Code delineations for New Jersey (DEPHUC14), Edition 2, vector digital data, Trenton, NJ, (2006).

New Jersey Department of Environmental Protection (NJDEP), NJDEP Watershed Management Areas in New Jersey (Version 200901), vector digital data, Trenton, NJ, (2009).

New Jersey Department of Environmental Protection (NJDEP), New Jersey Integrated Water Quality Monitoring and Assessment Report (Draft), Trenton, NJ, August 2008.

New Jersey Department of Environmental Protection (NJDEP) Total Maximum Daily Loads for Fecal Coliform to Address 27 Streams in the Lower Delaware Water Region, Approved (by EPA Region 2): September 29, 2003.

New Jersey Department of Environmental Protection, Total Maximum Daily Loads for Phosphorus To Address 13 Eutrophic Lakes in the Lower Delaware Region, Trenton, NJ, Approved (by EPA Region 2): September 30, 2003.

New Jersey Department of Environmental Protection, Total Maximum Daily Loads for Phosphorus to Address 5 Stream Segments in the Lower Delaware Water Region, Trenton, NJ, Approved: September 30, 2005.

New Jersey Department of Environmental Protection, Total Maximum Daily Loads for Mercury Impairments Based on Concentration in Fish Tissue Caused Mainly by Air Deposition to Address 122 HUC 14s Statewide, Trenton, NJ, Proposed: June 15, 2009

New Jersey Department of Environmental Protection, Ambient Biomonitoring Network, Watershed Management Areas 17, 18, 19, and 20, Lower Delaware Region, 2000-2001 Benthic Macroinvertebrate Data, Trenton, NJ, November 2003.

New Jersey Department of Environmental Protection, New Jersey Stormwater Best Management Practices Manual, Trenton, NJ, April 2004.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Technical Note 99-1, Stream Visual Assessment Protocol, December 1998.

United States Environmental Protection Agency (US EPA), Regions II and III, Total Maximum Daily Loads for Polychlorinated Biphenyls (PCBs) For Zones 205 of the Tidal Delaware River, Prepared by the Delaware Basin Commission, Trenton, NJ, 12/15/03.

## Appendix A:Maps

Map 1: Watershed Map
Map 2: Land Use Map
Map 3: 2006 Impaired Waterways
Map 4: 2006 Impaired Waterways (Continued)
Map 6: SVAP Left Riparian
Map 11: SVAP Right Riparian
Map 7: SVAP Channel Condition
Map 8: SVAP Nutrient Enrichment
Map 9: SVAP Right Bank Stability
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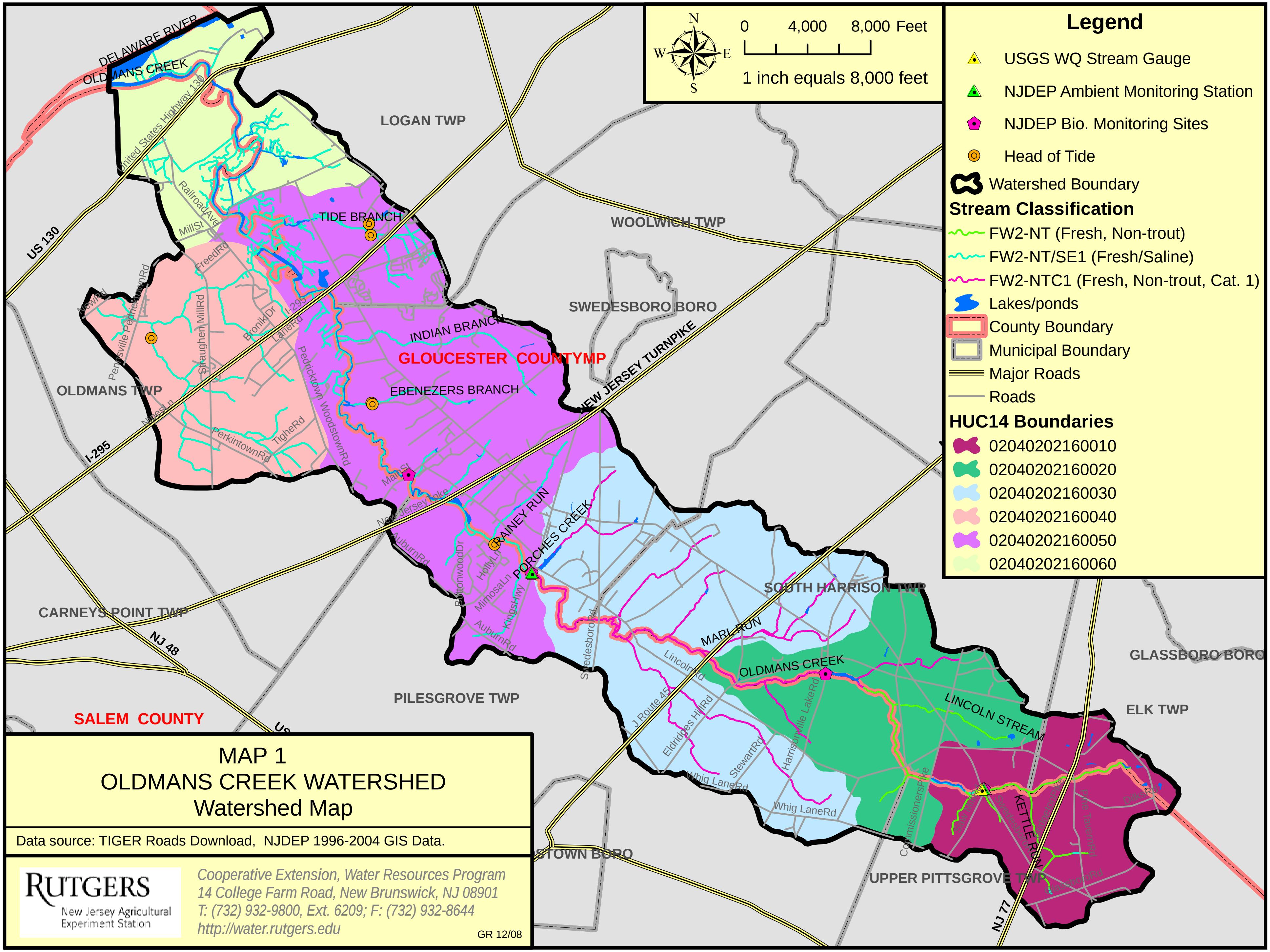
Map 12: HUC 02040202160010 Identified Projects
Map 13: HUC 02040202160020 Identified Projects
Map 14: HUC 02040202160030 Identified Projects
Map 15: HUC 02040202160040 Identified Projects
Map 16: HUC 02040202160050 Identified Projects
Map 17: HUC 02040202160060 Identified Projects




# MAP 1
# OLDMANS CREEK WATERSHED
## Watershed Map

Data source: TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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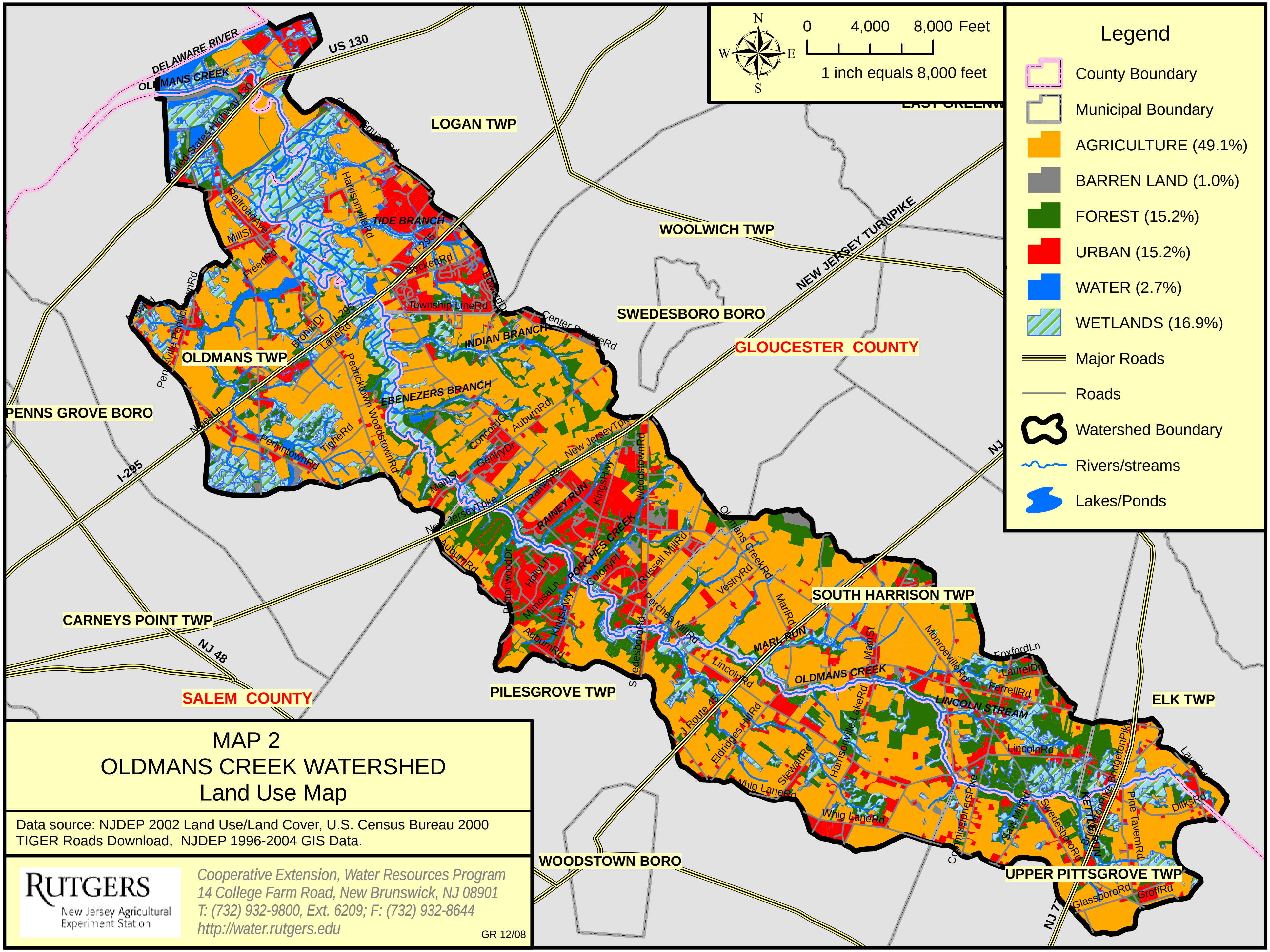

MAP 2
OLDMANS CREEK WATERSHED
Land Use Map
Data source: NJDEP 2002 Land Use/Land Cover, U.S. Census Bureau 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.
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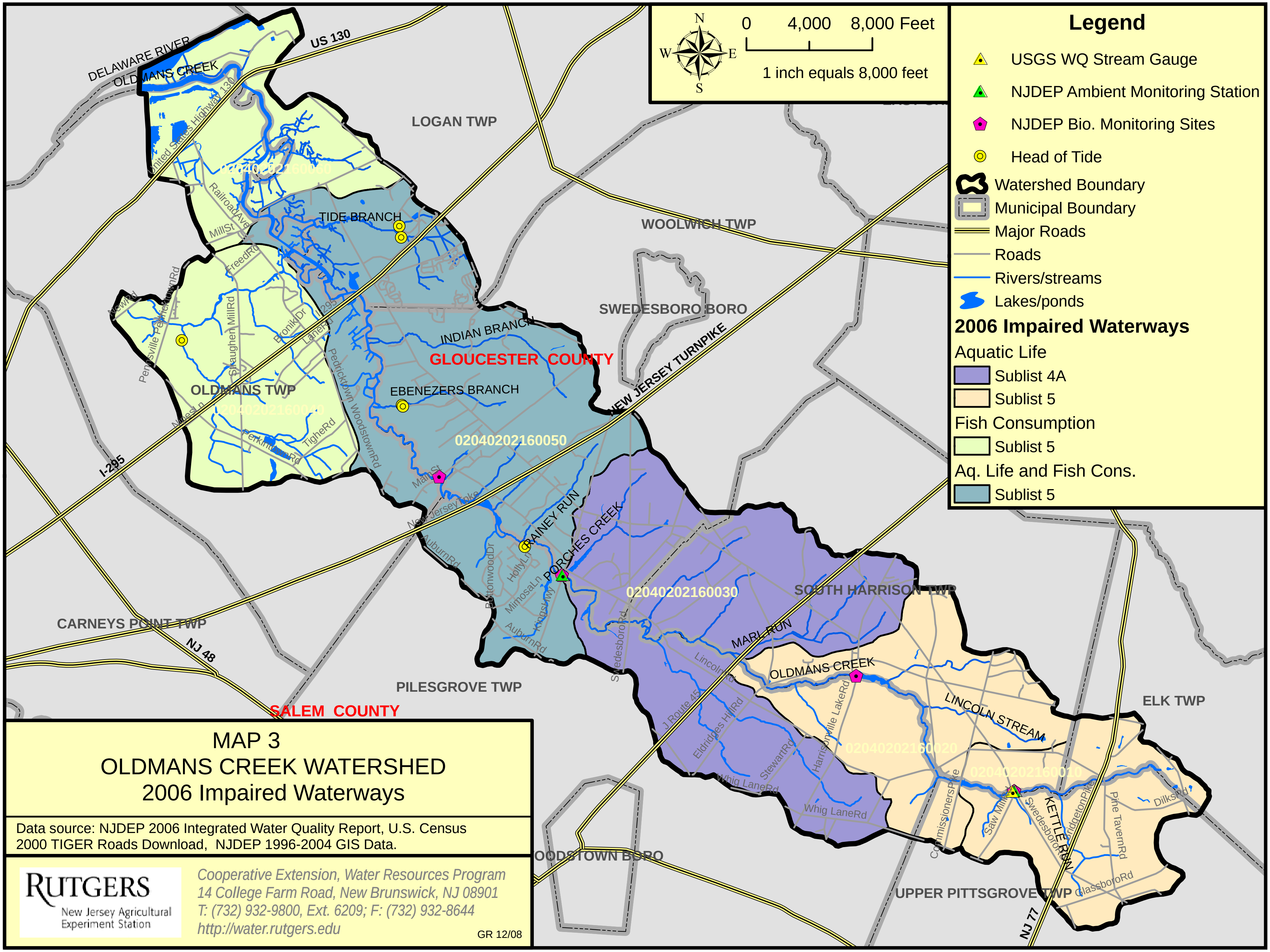
Legend
County Boundary
Municipal Boundary
AGRICULTURE (49.1%)
BARREN LAND (1.0%)
FOREST (15.2%)
URBAN (15.2%)
WATER (2.7%)
WETLANDS (16.9%)
Major Roads
Roads
Watershed Boundary
Rivers/streams
Lakes/Ponds
N
S
E
W
0
4,000
8,000 Feet
1 inch equals 8,000 feet
DELAWARE RIVER
OLDMANS CREEK
US 130
LOGAN TWP
WOOLWICH TWP
SWEDESBORO BORO
GLOUCESTER COUNTY
NEW JERSEY TURNPIKE
OLDMANS TWP
PENNS GROVE BORO
CARNEYS POINT TWP
SALEM COUNTY
PILESGROVE TWP
WOODSTOWN BORO
SOUTH HARRISON TWP
ELK TWP
UPPER PITTSGROVE TWP
I-295
NJ 48
NJ 77
TIDE BRANCH
INDIAN BRANCH
EBENEZERS BRANCH
RAINEY RUN
PORCHES CREEK
MARL RUN
OLDMANS CREEK
LINCOLN STREAM


Legend
USGS WQ Stream Gauge
NJDEP Ambient Monitoring Station
NJDEP Bio. Monitoring Sites
Head of Tide
Watershed Boundary
Municipal Boundary
Major Roads
Roads
Rivers/streams
Lakes/ponds
2006 Impaired Waterways
Aquatic Life
Sublist 4A
Sublist 5
Fish Consumption
Sublist 5
Aq. Life and Fish Cons.
Sublist 5
N
S
E
W
0 4,000 8,000 Feet
1 inch equals 8,000 feet
DELAWARE RIVER
OLDMANS CREEK
US 130
LOGAN TWP
WOOLWICH TWP
SWEDESBORO BORO
TIDE BRANCH
INDIAN BRANCH
GLOUCESTER COUNTY
EBENEZERS BRANCH
OLDMANS TWP
NEW JERSEY TURNPIKE
0204020216050
I-295
RAINEY RUN
PORCHES CREEK
0204020216030
SOUTH HARRISON TWP
CARNEYS POINT TWP
NJ 48
MARL RUN
OLDMANS CREEK
PILESGROVE TWP
SALEM COUNTY
LINCOLN STREAM
ELK TWP
0204020216020
0204020216010
KETTLE RUN
WOODSTOWN BORO
UPPER PITTSGROVE TWP
NJ 77
MAP 3
OLDMANS CREEK WATERSHED
2006 Impaired Waterways
Data source: NJDEP 2006 Integrated Water Quality Report, U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.
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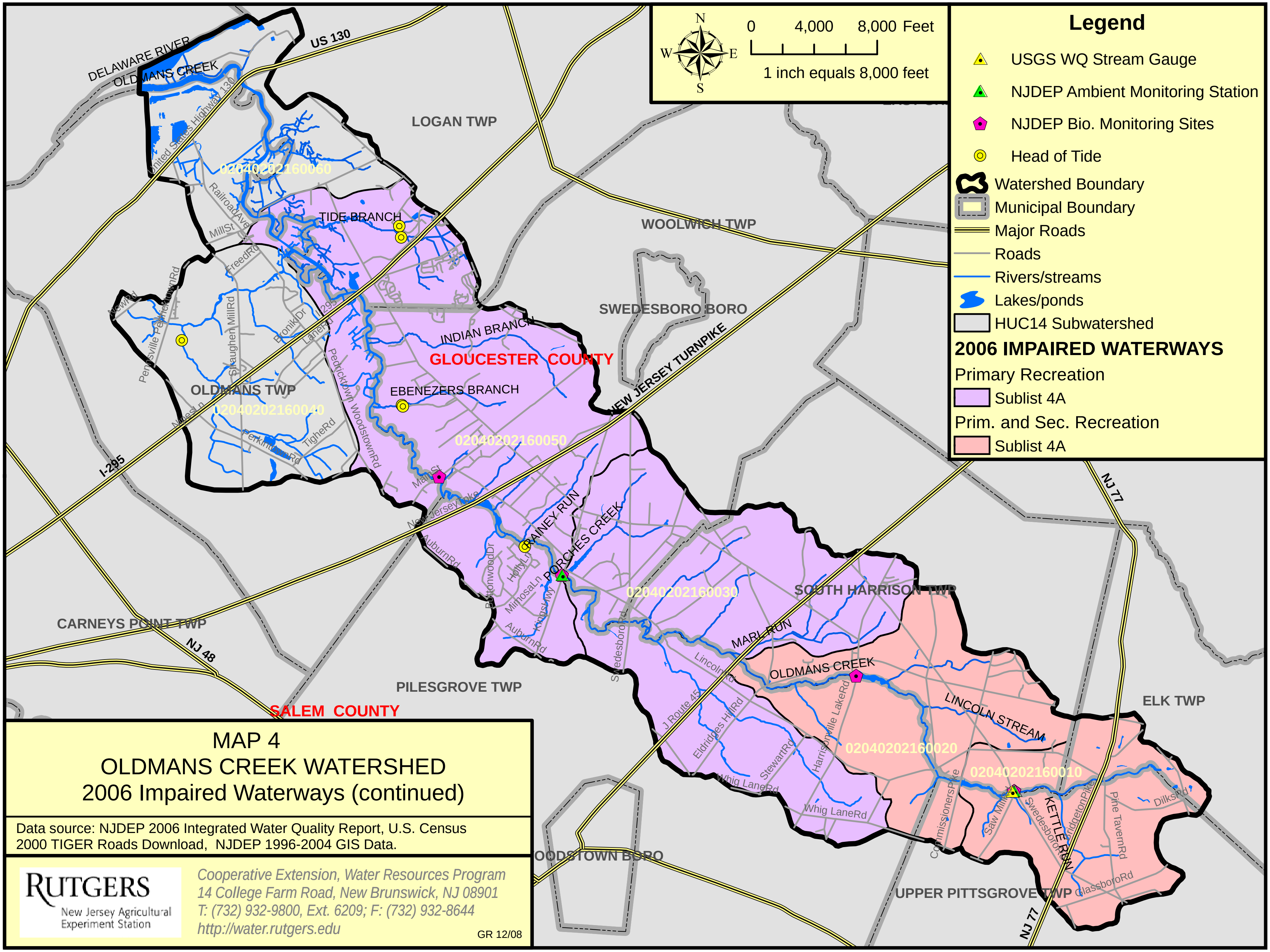


# MAP 4
## OLDMANS CREEK WATERSHED
## 2006 Impaired Waterways (continued)

Data source: NJDEP 2006 Integrated Water Quality Report, U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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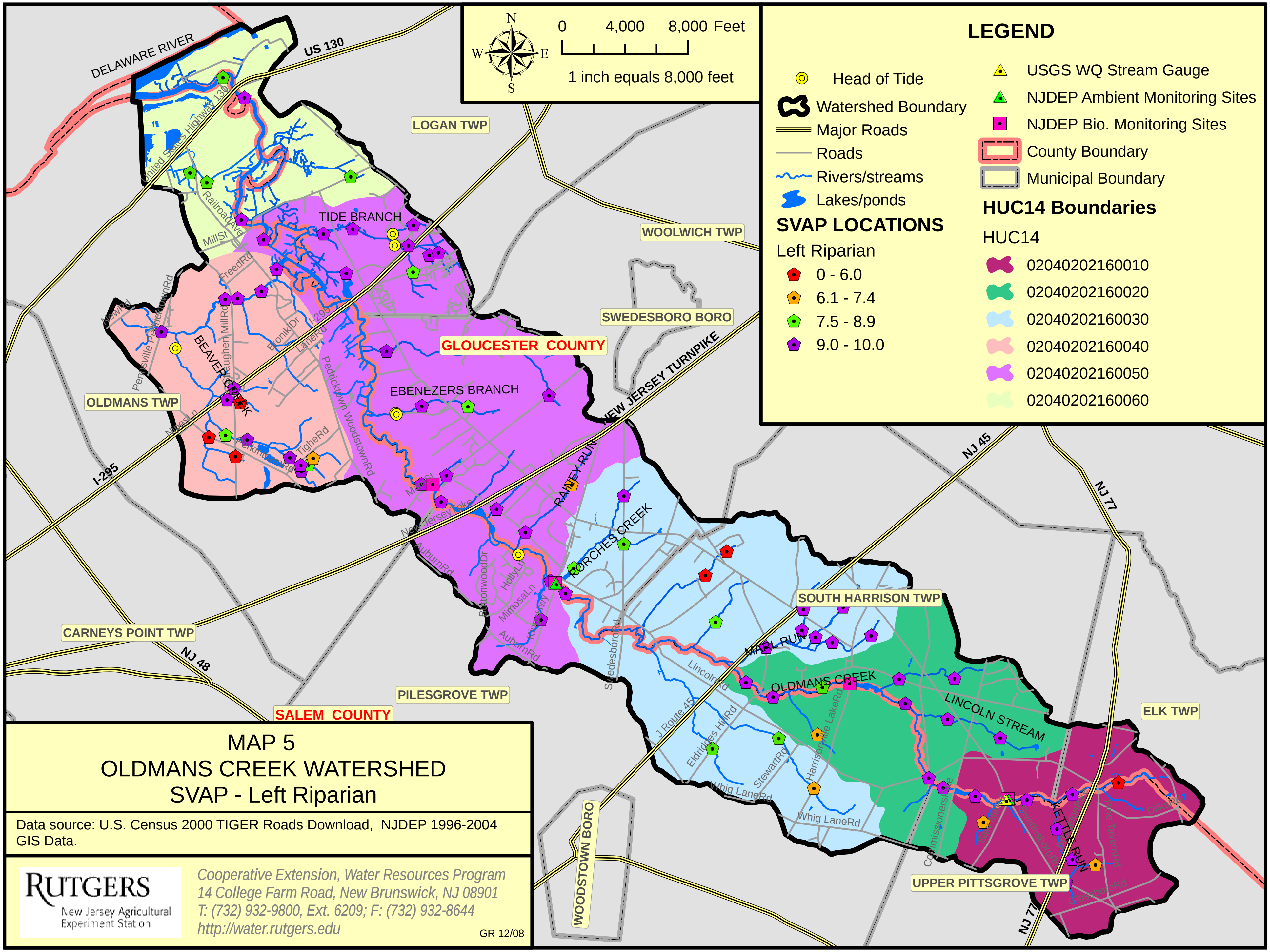


MAP 5
OLDMANS CREEK WATERSHED
SVAP - Left Riparian

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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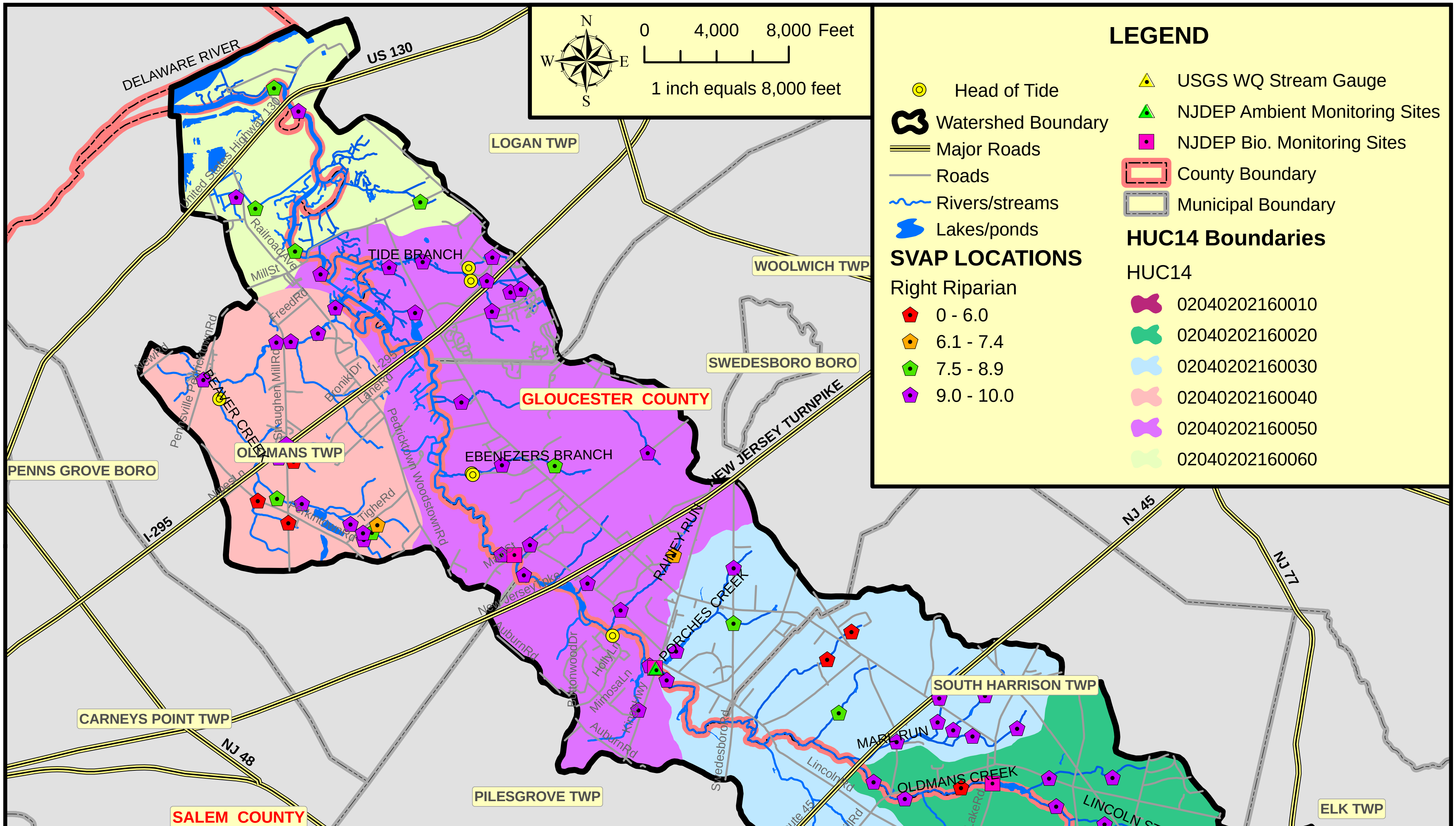


# MAP 6
# OLDMANS CREEK WATERSHED
# SVAP - Right Riparian

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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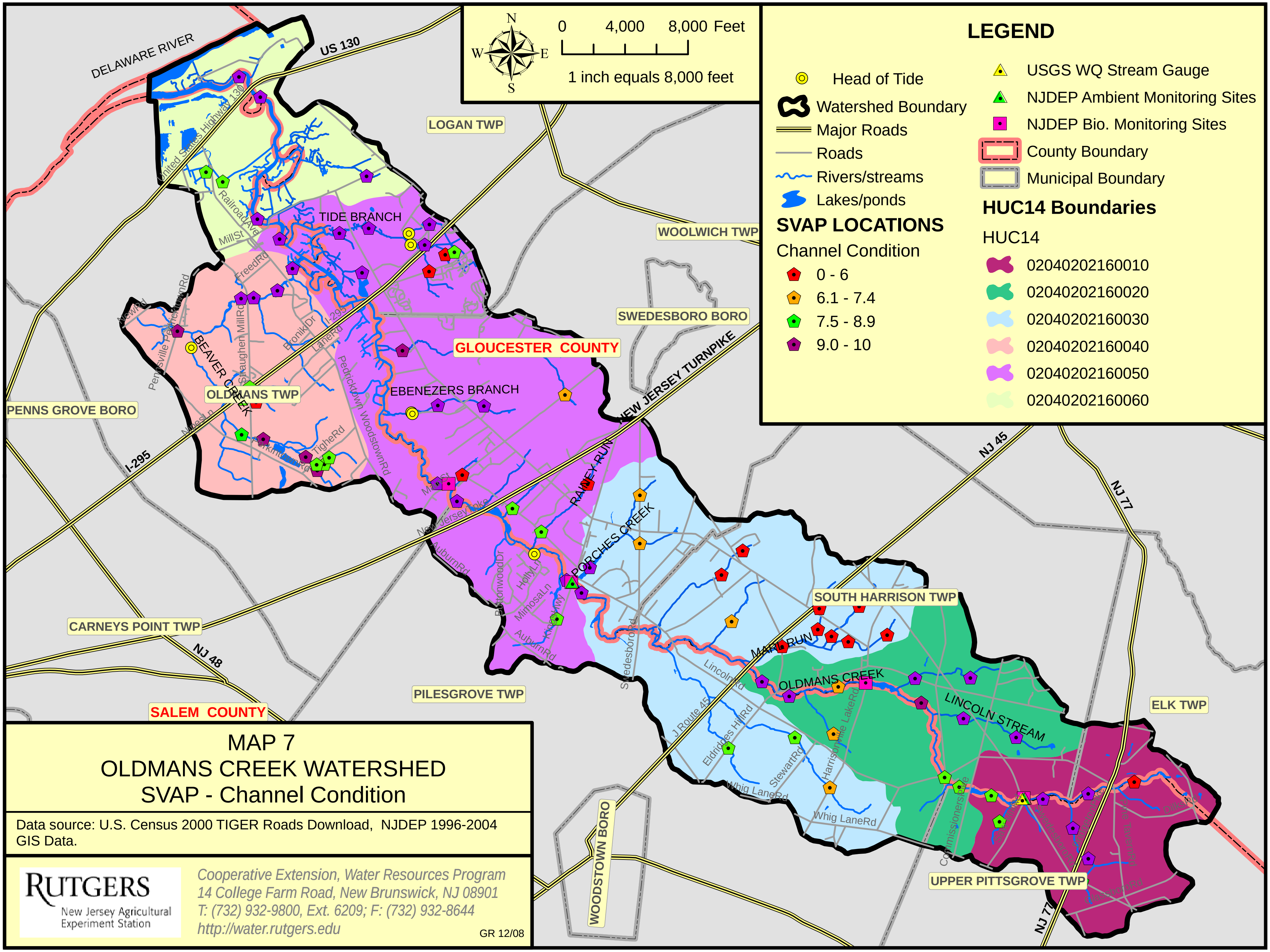


MAP 7
OLDMANS CREEK WATERSHED
SVAP - Channel Condition

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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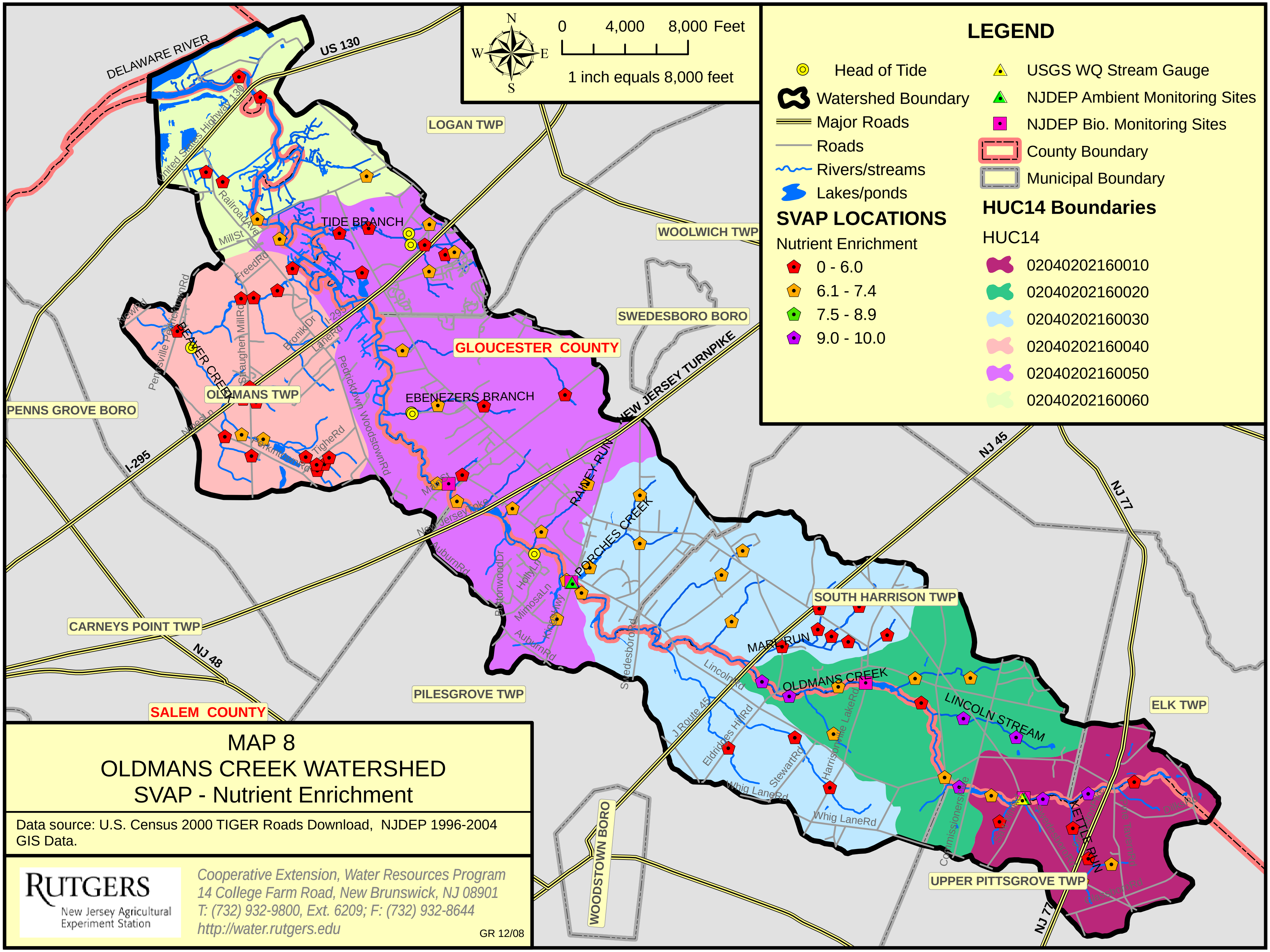


# MAP 8
# OLDMANS CREEK WATERSHED
# SVAP - Nutrient Enrichment

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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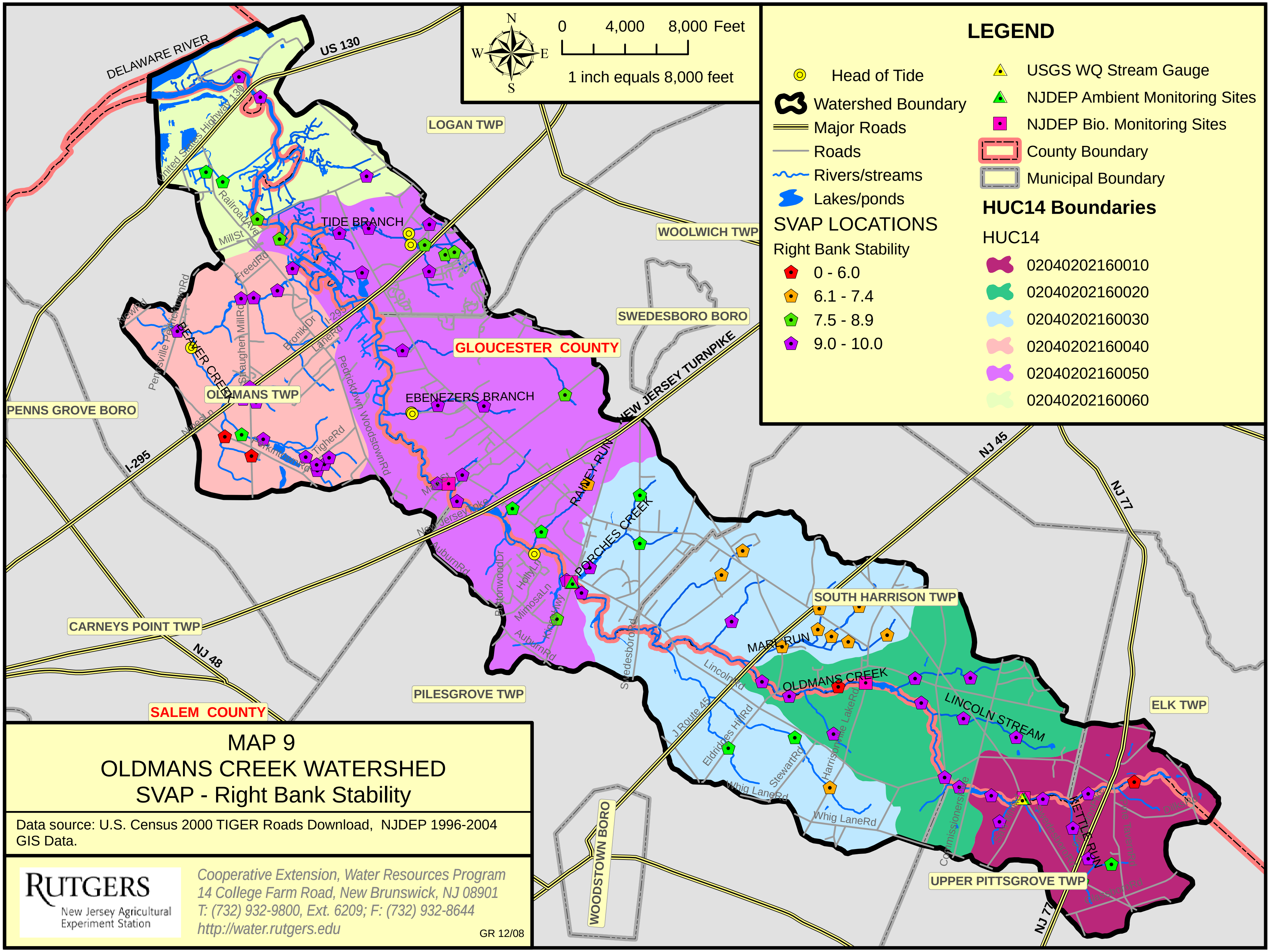


MAP 9
OLDMANS CREEK WATERSHED
SVAP - Right Bank Stability

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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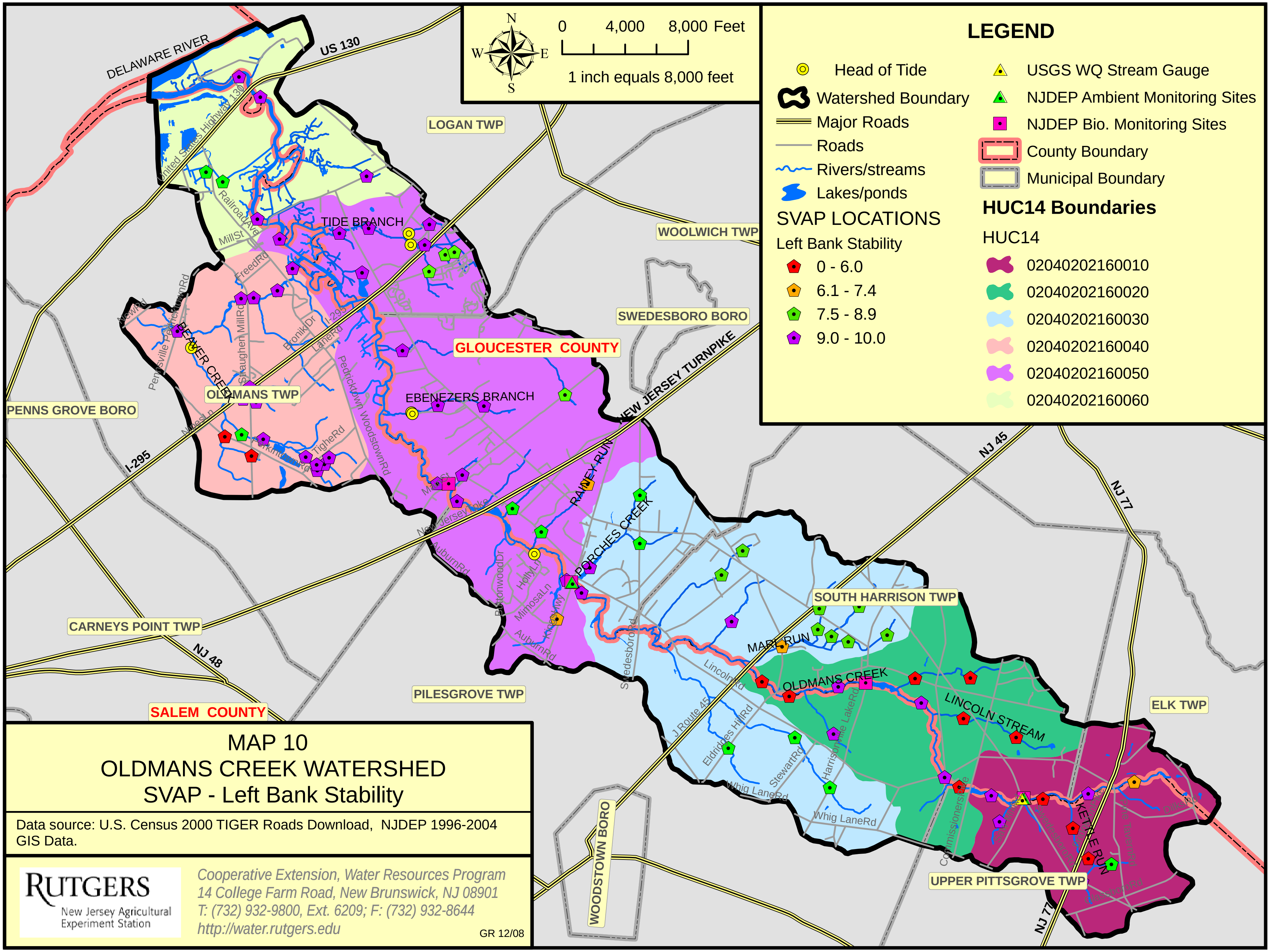


# MAP 10
# OLDMANS CREEK WATERSHED
# SVAP - Left Bank Stability

Data source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data.

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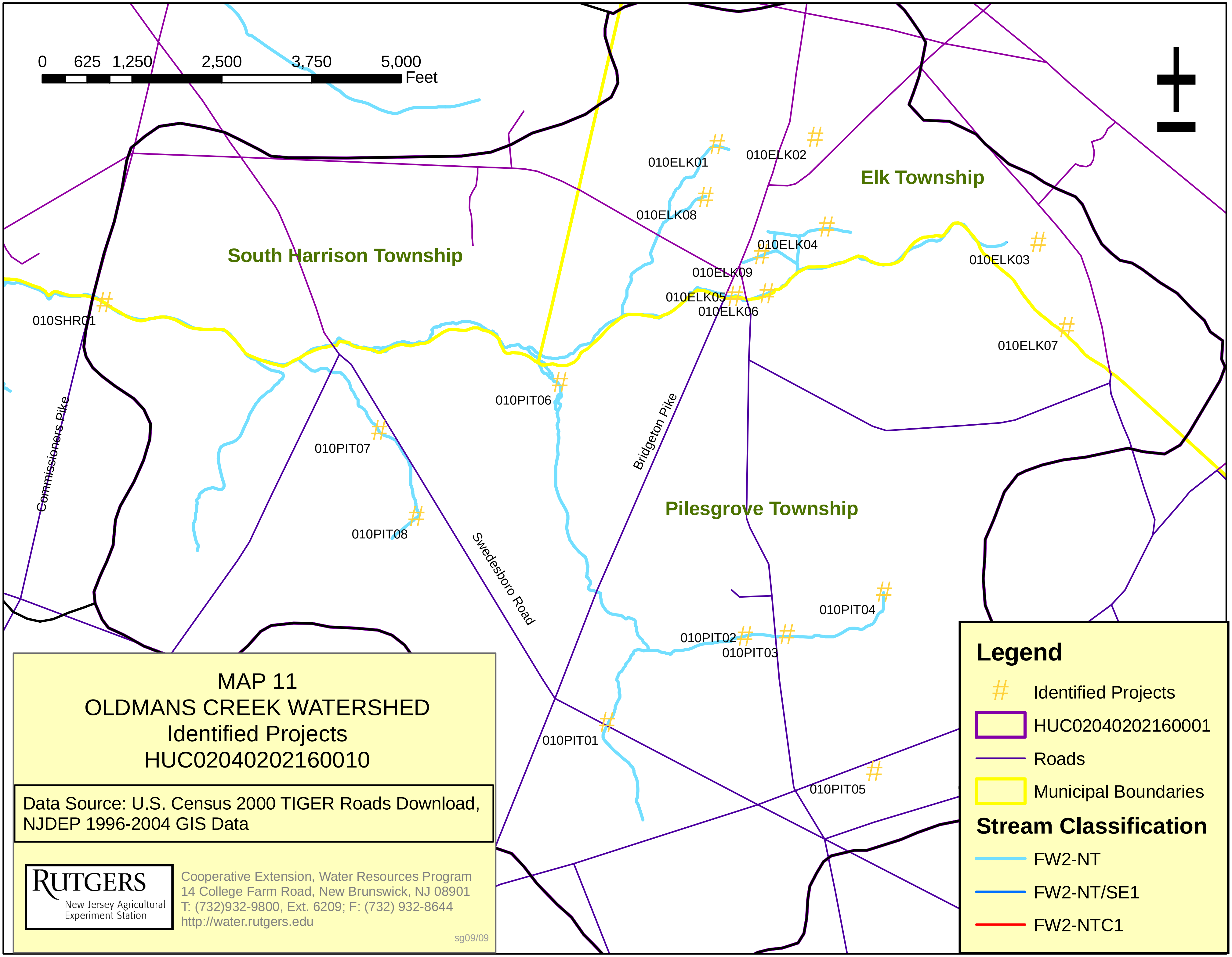
GR 12/08




MAP 11
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160010

Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data

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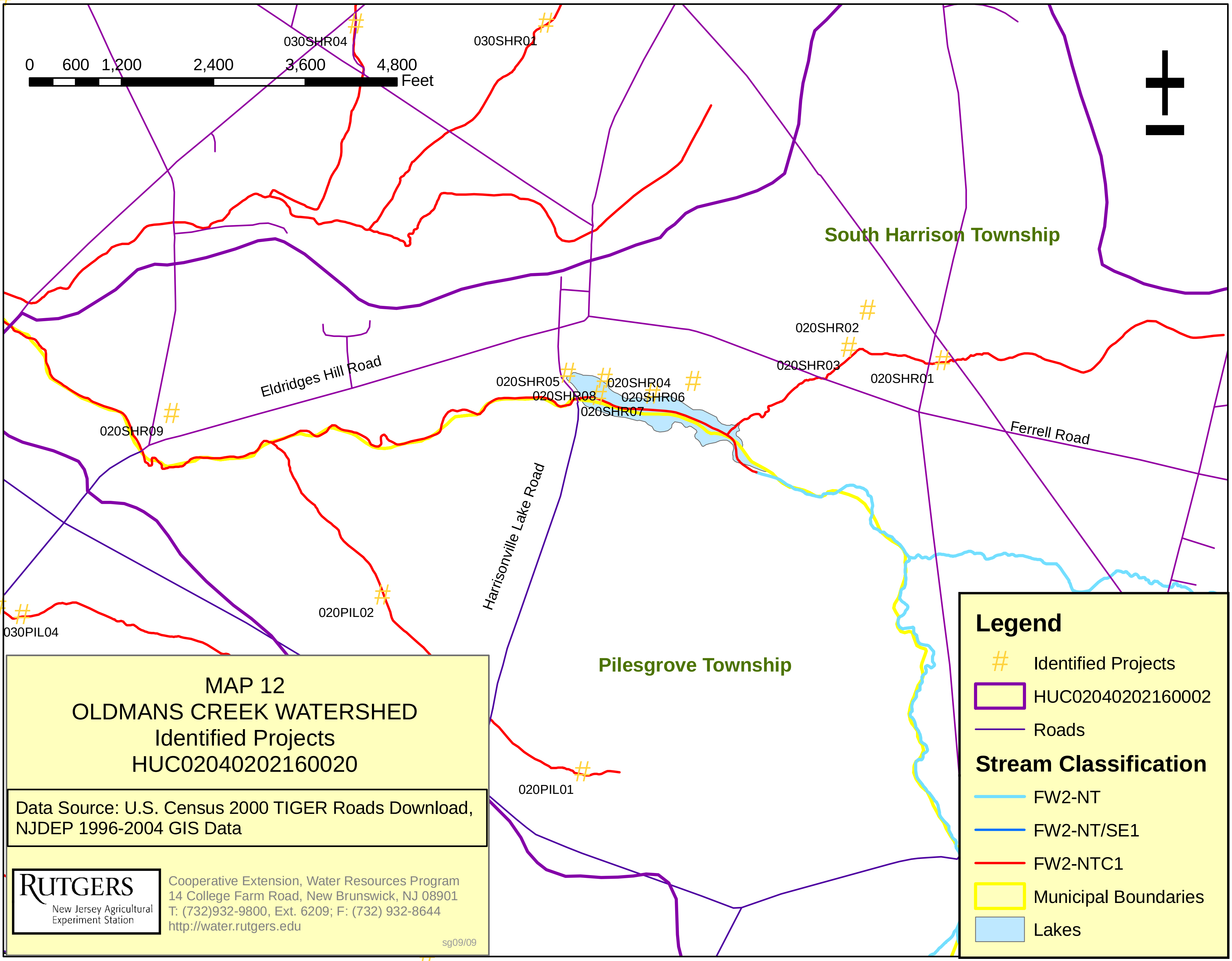


MAP 12
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160020

Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data

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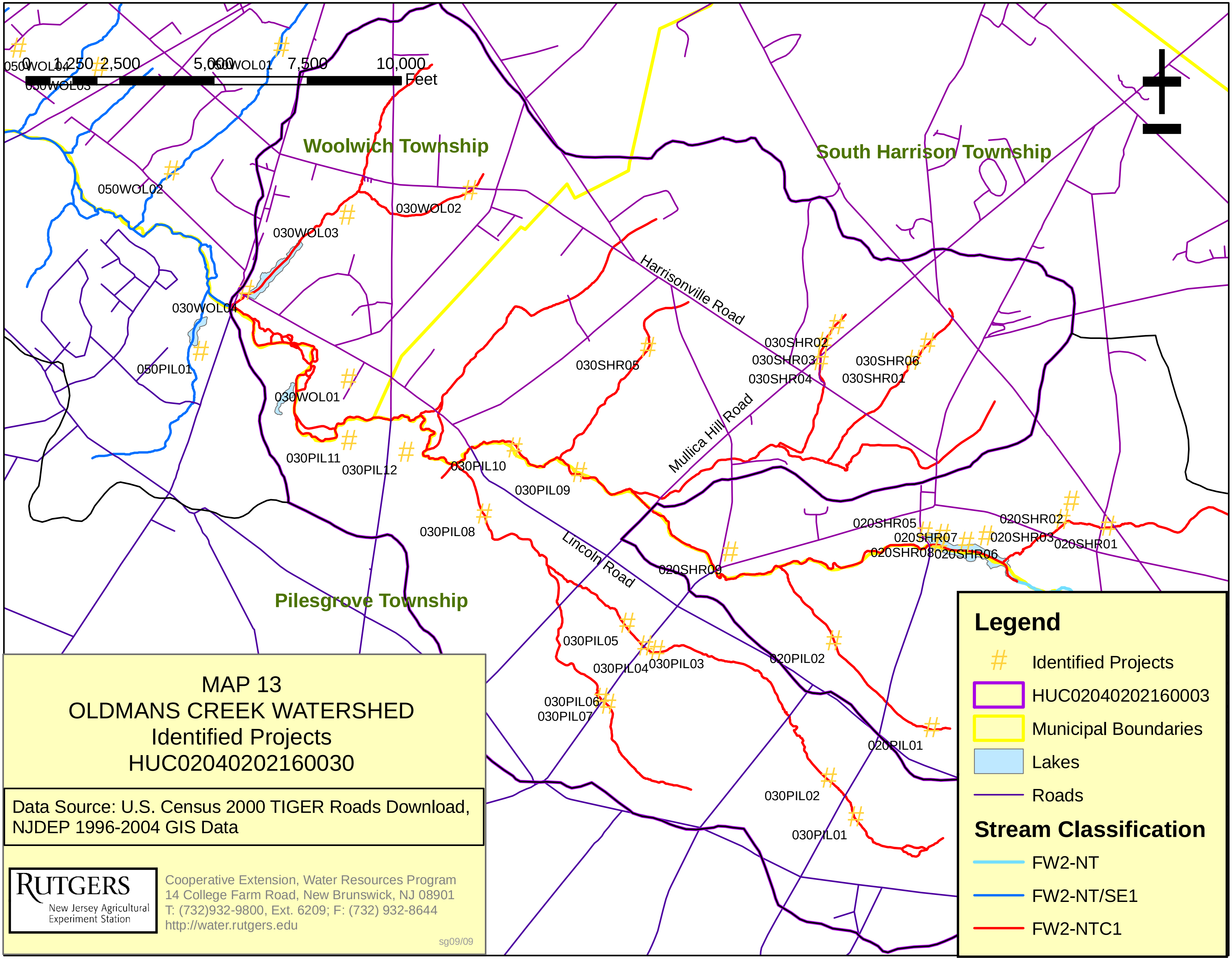
MAP 13
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160030
Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data
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sg09/09
0 1,250 2,500 5,000 7,500 10,000
Feet
Woolwich Township
South Harrison Township
Pilesgrove Township
Harrisonville Road
Mullica Hill Road
Lincoln Road
050WOL04
050WOL03
050WOL01
050WOL02
050PIL01
030WOL01
030WOL02
030WOL03
030WOL04
030SHR01
030SHR02
030SHR03
030SHR04
030SHR05
030SHR06
030PIL01
030PIL02
030PIL03
030PIL04
030PIL05
030PIL06
030PIL07
030PIL08
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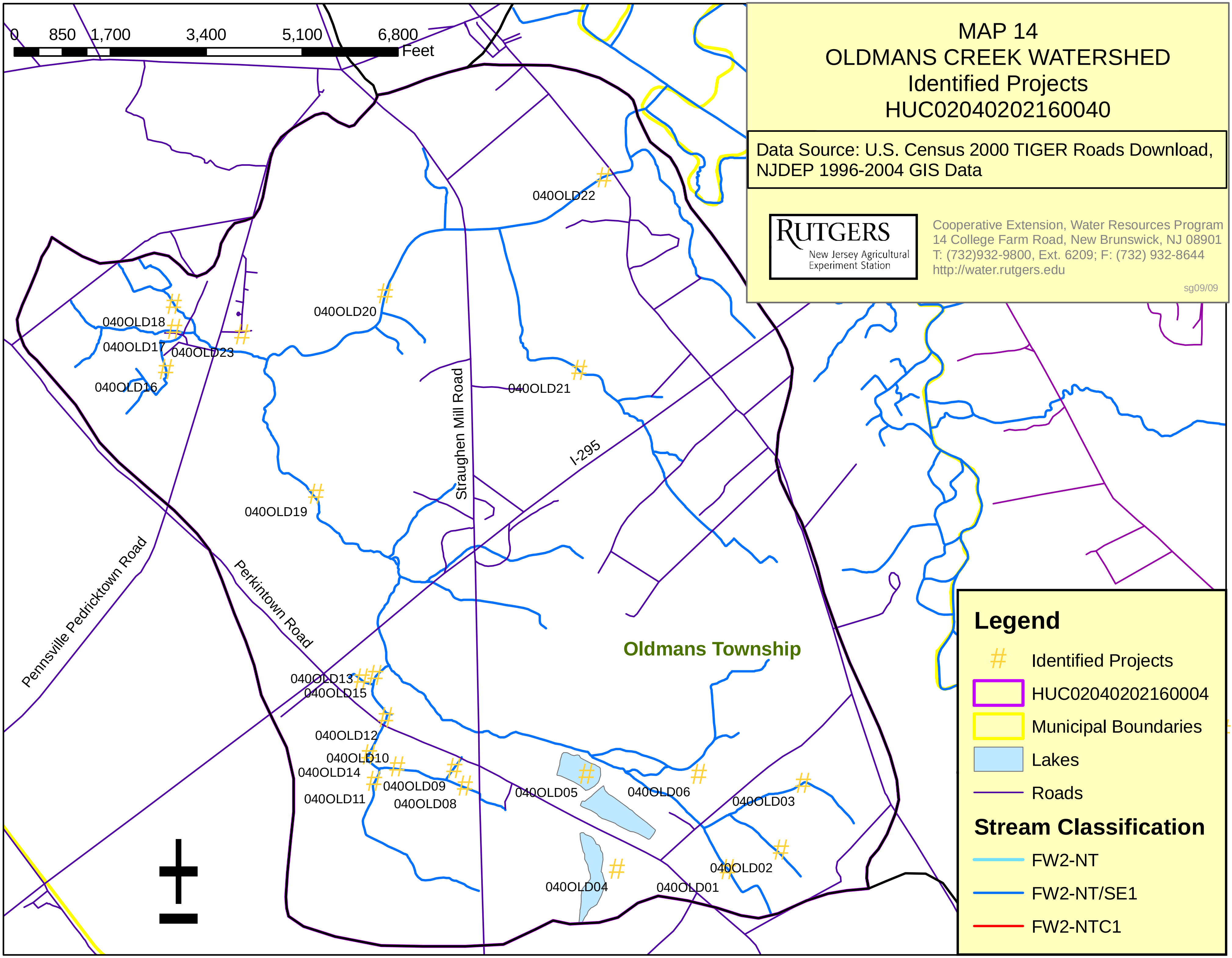
020SHR01
020SHR02
020SHR03
020SHR05
020SHR06
020SHR07
020SHR08
020SHR09
020PIL01
020PIL02
Legend
Identified Projects
HUC02040202160003
Municipal Boundaries
Lakes
Roads
Stream Classification
FW2-NT
FW2-NT/SE1
FW2-NTC1


MAP 14
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160040
Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data
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sg09/09
0 850 1,700 3,400 5,100 6,800
Feet
040OLD22
040OLD20
040OLD18
040OLD17
040OLD23
040OLD16
040OLD21
040OLD19
Straughen Mill Road
I-295
Pennsville Pedricktown Road
Perkintown Road
Oldmans Township
040OLD13
040OLD15
040OLD12
040OLD10
040OLD14
040OLD09
040OLD11
040OLD08
040OLD05
040OLD06
040OLD03
040OLD02
040OLD04
040OLD01
Legend
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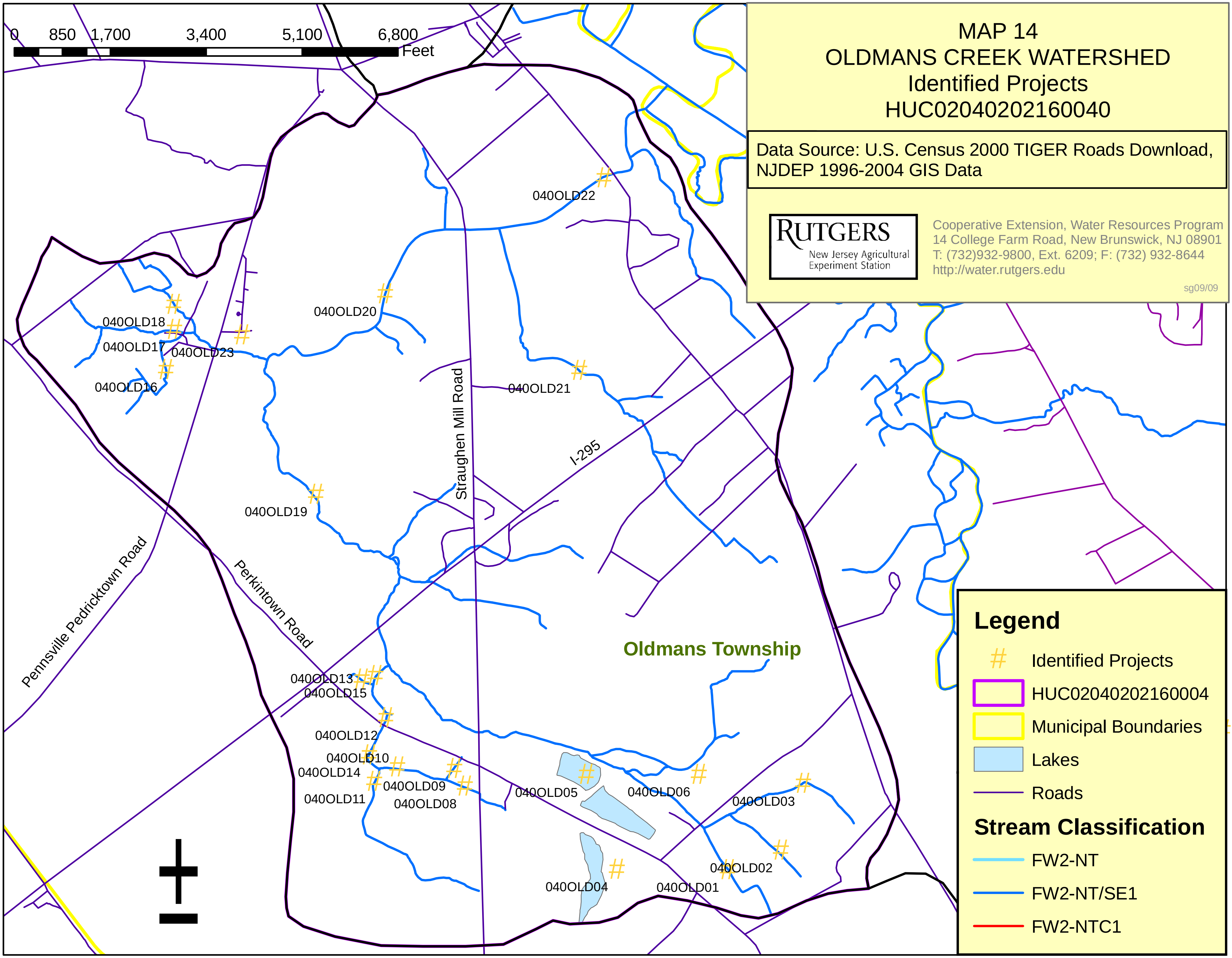
Municipal Boundaries
Lakes
Roads
Stream Classification
FW2-NT
FW2-NT/SE1
FW2-NTC1



MAP 14
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160040
Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data
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sg09/09
0 850 1,700 3,400 5,100 6,800 Feet
040OLD22
040OLD20
040OLD18
040OLD17
040OLD23
040OLD16
040OLD21
040OLD19
Straughen Mill Road
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Pennsville Pedricktown Road
Perkintown Road
Oldmans Township
040OLD13
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040OLD10
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040OLD02
Legend
Identified Projects
HUC02040202160004
Municipal Boundaries
Lakes
Roads
Stream Classification
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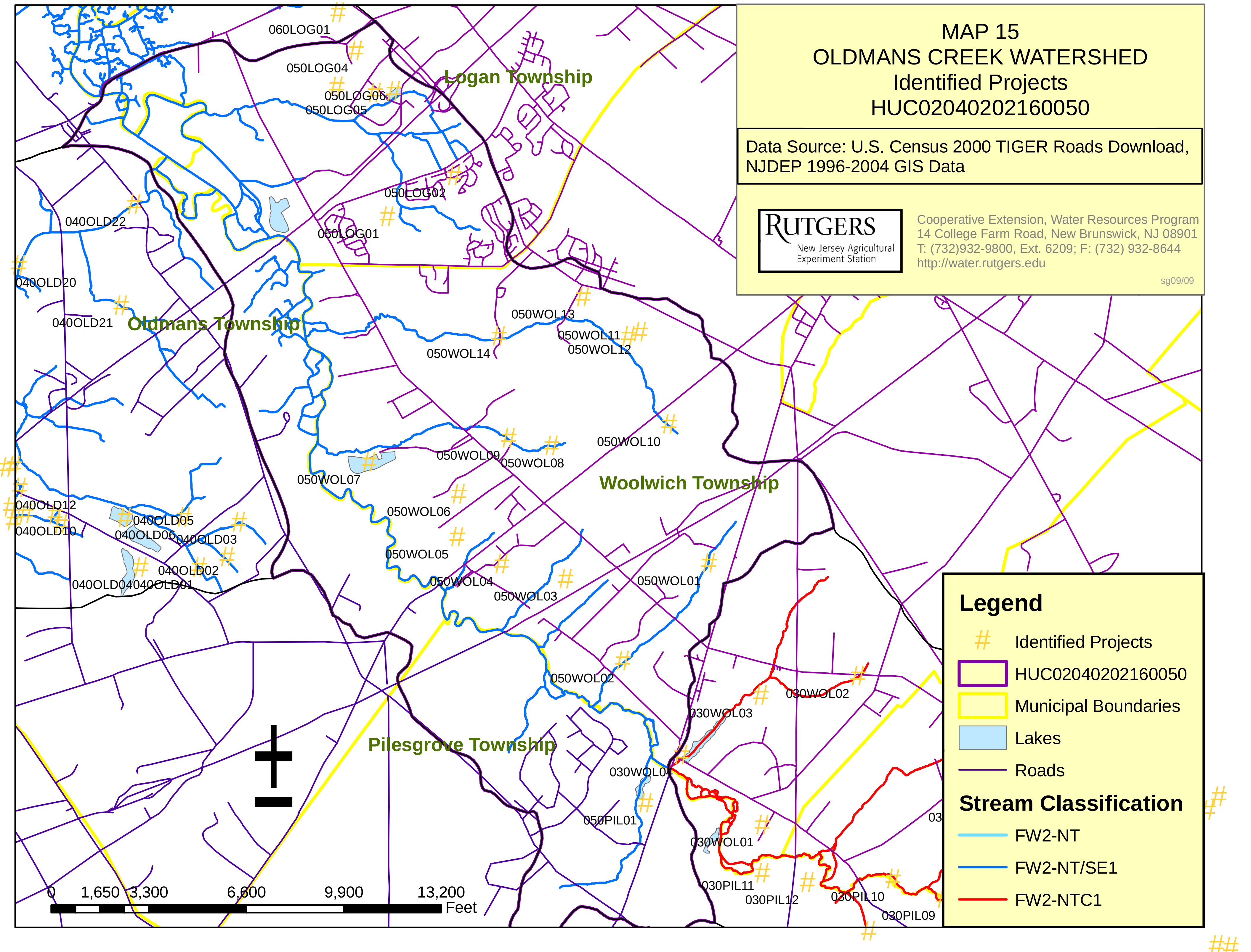
FW2-NT/SE1
FW2-NTC1


MAP 15
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160050
Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data
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http://water.rutgers.edu
sg09/09
Logan Township
Oldmans Township
Woolwich Township
Pilesgrove Township
060LOG01
050LOG04
050LOG06
050LOG05
050LOG02
050LOG01
040OLD22
040OLD20
040OLD21
040OLD12
040OLD10
040OLD05
040OLD06
040OLD03
040OLD02
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030PIL12
030PIL10
030PIL09
0
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3,300
6,600
9,900
13,200
Feet
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Municipal Boundaries
Lakes
Roads
Stream Classification
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FW2-NT/SE1
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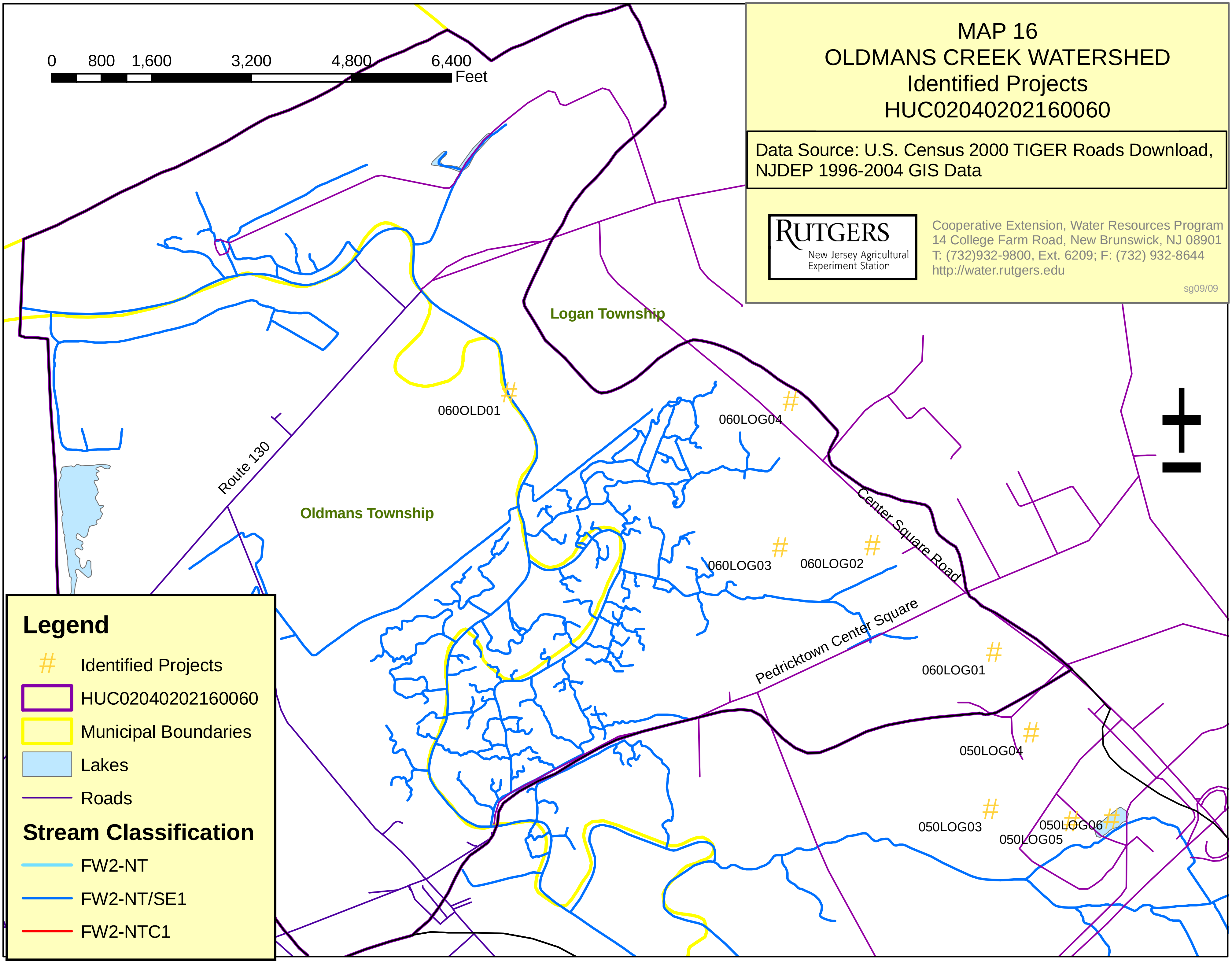
MAP 16
OLDMANS CREEK WATERSHED
Identified Projects
HUC02040202160060
Data Source: U.S. Census 2000 TIGER Roads Download, NJDEP 1996-2004 GIS Data
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http://water.rutgers.edu
sg09/09
0
800
1,600
3,200
4,800
6,400
Feet
Logan Township
Oldmans Township
Route 130
Center Square Road
Pedricktown Center Square
060OLD01
060LOG04
060LOG03
060LOG02
060LOG01
050LOG04
050LOG03
050LOG06
050LOG05
Legend
Identified Projects
HUC02040202160060
Municipal Boundaries
Lakes
Roads
Stream Classification
FW2-NT
FW2-NT/SE1
FW2-NTC1

# Appendix B: Project Implementation Fact Sheets

Implementation Fact Sheet #1: The South Harrison Elementary School Stormwater Swale Retrofit
Implementation Fact Sheet #2: The Gloucester County Solid Waste Complex Stormwater Basin Retrofit
Implementation Fact Sheet #3: The Gloucester County Solid Waste Complex Basin Outlet Stabilization and Naturalization Project

# The South Harrison Elementary School Stormwater Swale Retrofit

*(Funding Provided by the National Fish and Wildlife Foundation)*

*Implementation Fact Sheet: September 2009*

*Rutgers Cooperative Extension*
*Christopher C. Obropta, Ph.D., P.E., Sandra M. Goodrow, Ph.D., and Greg Rusciano*

**Situation:** South Harrison Elementary School is located on Mullica Hill Road in South Harrison, New Jersey. Stormwater runoff from the impervious areas of the school's property was being diverted to a long depression in the middle of the parking lot. This depression was planted with turf grass and was regularly mowed. The lower portions of this swale were devoid of vegetation and often had standing water at the base. This site also presented an ideal environmental educational component for the students in this school.

**Goal:** The goal of this project was to retrofit this piece of stormwater infrastructure by enhancing it with native vegetation that would increase the infiltration properties of the swale, as well as create wildlife habitat. The use of native vegetation would also negate the need for regular mowing, saving the time and fuel of the maintenance crew.

**Action:** The Rutgers Cooperative Extension and the South Jersey Land and Water Trust visited students and provided a discussion and demonstration regarding stormwater basics. This educational component was followed with a hands-on activity with the students actually helping to plant the native vegetation in the swale. A second round of planting helped to establish a denser distribution of healthy vegetation.

**Impact:** Along with the natural beauty of the native vegetation in this area, stabilization of the slope of the swale is enhanced and a good volume of stormwater runoff is infiltrated rather than moved on down the drainage system. Pollutant removal will be achieved through the filtration of the runoff by the vegetation and the soil. Greater infiltration of the rainwater will lead to a greater recharge of the groundwater. The native vegetation also provides microhabitat for wildlife such as butterflies and small invertebrates.

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# The Gloucester County Solid Waste Complex Stormwater Basin Retrofit

*(Funding Provided by the National Fish and Wildlife Foundation)*

*Implementation Fact Sheet: September 2009*

*Rutgers Cooperative Extension*

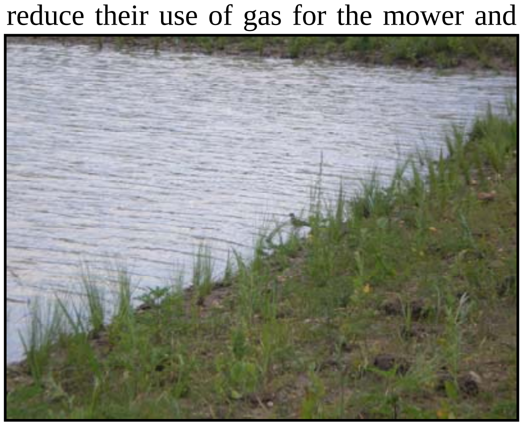
*Christopher C. Obropta, Ph.D., P.E., Sandra M. Goodrow, Ph.D., and Greg Rusciano*

**Situation:** The Gloucester County Solid Waste Complex is a sanitary landfill located on a 540-acre tract of land. Portions of this landfill site are set aside for grassland bird habitat and stormwater management. A 36-acre stormwater basin on this site was identified as an area that could be retrofitted to improve stormwater infiltration and wildlife habitat. This basin was planted with cool season grasses and mowed regularly. It also included a 1.6 acre wet pond situated before the outlet. This basin attracted nuisance wildlife, such as the Canada goose, thereby increasing the sources of bacteria in the Oldman's Creek Watershed. The soil was found to be highly compacted and therefore infiltrated stormwater runoff at a low rate.

**Goal:** The goal of this project was to create a naturalized area using native vegetation that would promote increased infiltration for the recharge of the groundwater. Additional goals included the creation of vital habitat for ground nesting birds that have lost habitat to increased development, as well as discouraging nuisance wildlife such as the Canada goose from taking up residence.

**Action:** The plan for the site included dividing the basin into three distinct sections. The 2000 square foot section surrounding the wet pond was treated as a wetland area and was densely vegetated with obligate wetland species such as fox sedge (*Carex vulpinoidea*) and soft rush (*Juncus effusus*). The buffer around the pond was extended outward with more than 4,000 square feet of additional plantings, including upland species such as lurid sedge (*Carex lurida*), little blue stem (*Schizachyrium scoparium*) and switch grass (*Panicum virgatum*). The third region of this project covered the remainder of the 36 acres. This area was seeded with a special seed mix designed for naturalization of stormwater basins. The seeds were a mix of up to twelve native varieties, including Autumn Bentgrass (*Agrostic perennans*), Partridge Pea (*Chamaecrista fasciculate*), Butterfly Milkweed (*Asclepias tuberose*) and other species that will blanket the grounds with native meadows.

**Impact:** Since the basin will need only to be mowed once a year after nesting season, the County will reduce their use of gas for the mower and will also reduce air emissions. The long native grasses will deter the settlement of nuisance wildlife, such as the Canada goose, thereby reducing bacterial sources to the waterways. Once the native grasses are established, this functioning stormwater management system will not only be a beautiful landscape and native habitat, but it will provide increased infiltration of precipitation for greater groundwater recharge. With more stormwater basins being implemented around New Jersey to counter the effects of stormwater runoff from impervious surfaces, enhancing these basins with the native species will serve to protect our ecosystems.



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National Fish and Wildlife Foundation

# The Gloucester County Solid Waste Complex
# Basin Outlet Stabilization and Naturalization Project

*(Funding Provided by the National Fish and Wildlife Foundation)*

*Implementation Fact Sheet: September 2009*

*Rutgers Cooperative Extension*
*Christopher C. Obropta, Ph.D., P.E., Sandra M. Goodrow, Ph.D., and Greg Rusciano*

**Situation:** The water passing through the outlet for a large stormwater management basin was causing soil erosion and washing loads of sediment onto nearby farm lands. The outlet area is located near an established bird sanctuary on the grounds of the Gloucester County Solid Waste Complex. The root structure and health of the warm season grasses in place did not have that capacity to stabilize the soils present. Also, solids from the stormwater outflow would wash over the allotted area and be carried into a nearby actively farmed field.

**Goal:** The goal of this project is to stabilize the soil in the area where the stormwater basin releases its overflow. The planting of native vegetation will serve to stabilize the soil and filter the overflow, as it serves as a wildlife habitat for ground nesting birds and other small wildlife. Another goal of this project is to reduce the need for regular mowing, saving on time and fuel consumption.

**Action:** The hydrologic activity on this site divided the area into two distinct sections that would support wetland species and upland species. The wetland species were located closer to the outlet and in the center whereas the upland vegetation was located as the gradient of the land slowly increased away from the center. Native shrubbery such as red osier dogwood, buttonbush and inkberry holly were densely planted at the far end of the outlet area, and herbaceous wetland grasses were planted at location where the high energy of the outflow and the longest duration of wetness would be expected.

**Impact:** The proper vegetation for the hydrology experienced by this area, as well as the soil types present in this area, are expected to achieve a level of soil stabilization that will serve to keep the soil onsite, and not wash into nearby farm fields. As this vegetation matures, a valuable filter will serve to remove solids emanating from the outfall. Given the location of this outfall area, the dense native vegetation will also serve to continue a large area of wildlife habitat.

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National Fish and Wildlife Foundation

# The Gloucester County Solid Waste Complex
# Basin Outlet Stabilization and Naturalization Project

*(Funding Provided by the National Fish and Wildlife Foundation)*

*Implementation Fact Sheet: September 2009*

*Rutgers Cooperative Extension*

*Christopher C. Obropta, Ph.D., P.E., Sandra M. Goodrow, Ph.D., and Greg Rusciano*

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# Appendix C: Lake Management Fact Sheets

Fact Sheet 1: Pond and Lake Management Part I, Dealing with Aquatic Plants & Algal Blooms
Fact Sheet 2: Pond and Lake Management Part II, Preventing Shoreline Erosion & Removing Sediments
Fact Sheet 3: Pond and Lake Management Part III, Controlling Geese & Other Pests

# Pond and Lake Management Part I: Dealing with Aquatic Plants & Algal Blooms

Fact Sheet FS1076



**Cooperative Extension**

*Christopher C. Obropta, Ph.D., P.E., Extension Specialist in Water Resources*
*and*
*Eileen Althouse, Graduate Assistant in Bioresource Engineering*

## The Need for Pond and Lake Management

Waterbodies such as lakes and ponds are valuable resources. Lakes and ponds can either be natural, or man-made, and management depends on the desired use of the waterbody. For example, not all lakes are suitable for swimming, and different management practices will be applied to areas where swimming is encouraged and areas where it is not. Human actions, as well as natural phenomena, contribute to unwanted pond and lake conditions. Excessive plant growth, algal blooms, oxygen depletion, sediment build-up, bank erosion, and pests are the most common issues faced in the management of a lake or pond. In many cases there is a "quick fix" remedy that can eliminate the symptoms of a problem at least temporarily. However, the issue will return if the root cause of the problem is not addressed. A sound pond or lake management plan addresses not only management of the symptoms, but also remediation of the causes of common pond and lake issues.

## Dealing with Aquatic Plants

Aquatic plants add aesthetic character to a pond or lake setting, and they provide valuable ecological functions. Aquatic plants stabilize banks, oxygenate the water, take up nutrients, provide shelter and spawning habitat for fish and amphibians, are a food source for waterfowl and other wildlife, and harbor zooplankton. Aquatic plants become nuisance weeds when one species grows out of control. These "weeds" can clog channels used for boating, making swimming areas unfit for swimming, or cause the pond or lake to have an unsightly overgrown appearance. Sometimes weeds may out-compete other more functional plants for space. Excessive aquatic plant growth is caused by a combination of high nutrient levels, invasion by exotic species, and/or low water levels.

Before a weed management control regiment is initiated, the plants causing the problem should be identified. Exotic or invasive species usually reappear more rapidly and require a more rigorous management approach. The most common method of controlling aquatic plants is to simply remove them. The plants are usually cut, raked, and/or pulled. In order for the weed removal to be effective, the cut or pulled weeds need to be taken out of the water and disposed of off-site, preferably by drying and composting. If the cuttings are not collected and removed, they may reattach themselves and re-grow. If left in the water, decaying plants deplete the water of oxygen and add nutrients to the water which can cause other problems such as algal blooms and/or fish kills. The equipment and manpower necessary to remove aquatic weeds depends on the size of the area to be cleared of weeds, the density of the plants, and how firmly they are rooted. Non-rooted, floating plants or floating filamentous algae can be contained and collected using weed containment booms or nets. For weakly rooted weeds, the cheapest method of weed removal is hand pulling. When the weeds are pulled, the entire biomass and root system is removed, and this method works well in most sediment types.

In waters deeper than four feet, or with more deeply rooted weeds, pulp hooks or bailing hooks can be used. Uprooting horizontal root or rhizome systems with hooks is easier than uprooting by hand. Often deeply rooted plants break when pulled by hand, pull up a lot of muck when pulled, or may be

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so deeply rooted they cannot be pulled. In this case it may be better to cut the plants. Hand held cutting tools include V-shaped drag cutters, scythes, weed whips, and machetes. The V-shaped cutter is the most versatile. It can be thrown out into the water and reeled in, or it can be dragged behind a boat, where weeds can be placed after cutting, thus reducing trips to shore. There are specialized weed barges that are designed with cutting bars and a conveyor to deposit cut plants onto the barge. Another option for weed removal is raking. Raking is most effective right after weeds have been cut. Garden rakes, lake and shore rakes, modified silage forks, and landscape rakes are all excellent choices. Sometimes the level of the pond or lake is lowered for weed removal. Lowering the water level during the winter months may also control weed growth, but in some cases it can also kill desired species. If the water level is to be lowered, a lake-lowering/draw-down permit is required from the New Jersey Department of Fish & Wildlife Bureau of Freshwater Fisheries. Algae can also be physically removed from the waterbody using nets or brooms.

### Aquascaping

Aquascaping is like landscaping, only in a waterbody instead of on land. Aquatic plants are creatively used to manage nuisance plants and create a desirable plant community. Nuisance weeds are replaced by desirable native species. Maintenance of the aquascaped area is required until the plants become established. Long-term control of undesirable plants will improve fish habitat and will stabilize near shore areas.

### Dyes

Liquid dyes can be used to inhibit plant and algal growth by prohibiting sunlight from reaching the plants. The dyes tint the water blue and work by absorbing the light waves used in photosynthesis, thereby inhibiting plant growth. Dyes are easy to apply, are nontoxic to wildlife, and do not restrict swimming. They are most effective in waterbodies that have long residence times. If there is a large influx of water into the lake from a stream, for example, the dye will quickly become diluted and will not be as effective.

### Herbicides

Herbicides can be used to kill targeted weeds. In New Jersey, only certified pesticide applicators can apply herbicides to surface waters, and every herbicide application must be permitted through the NJDEP Pesticide Control Program. An herbicide can be applied from a boat and is effective in both deep and shallow waters. Herbicides do have some drawbacks. The long-term effects of herbicide use on lake ecosystems are not fully understood. Non-targeted species may be affected when using an herbicide. Dead weeds that decompose in the waterbody deplete the dissolved oxygen supply. Using an herbicide might not be the most economical choice of plant management because regrowth may happen so fast that reapplications are necessary, especially during the summer months. The most effective way to use an herbicide is to first cut the plants and then apply; less herbicide will be necessary and the plants will be more susceptible.

## Preventing and Managing Algal Blooms

### Source Control

When algal populations in ponds and lakes grow out of control it is called an algal bloom. Since algae are often free floating, they are more difficult to target than plants. Algal control, therefore, is usually a whole lake or pond effort. The most effective way to control algal blooms is through source control. Algal populations grow to nuisance proportions when there are excess nutrients, such as phosphorus and nitrogen, in the water. The nutrients enter ponds and lakes as runoff from nonpoint sources such as fertilized lawns, farms, and recreational fields or from bottom sediments.

Algal blooms indicate a nutrient enriched or eutrophic system. If algae have nutrients and sunlight, they will grow, so the best way to manage the algae is to manage the nutrients. Since nutrients come from diffuse sources, it is sometimes difficult to identify an exact source. In residential areas, lawns are the greatest source of nutrients. Reducing fertilizer use on lawns is the most effective way to reduce nutrient inputs; however, it is more difficult to enforce. When excess fertilizer is carried to the lake in stormwater when it rains, it has the same effect on the lake as it does on a lawn; growth is increased. A management plan should establish guidelines for fertilizer use such as not applying right before a rain event or on paved surfaces such as sidewalks and driveways. Landscaping that replaces lawn area with native plants to reduce the area of applied fertilizer should also be encouraged. Homeowners should be advised to have their soil tested to see if phosphorus is even needed to fertilize their lawns at all. A buffer strip of tall grasses or other native plants should be planted between any fertilized lawn areas and the pond or lake. Leaves should be raked and removed because they also contribute nutrients, especially nitrogen, when they decompose. To prevent runoff from bringing nutrients into the pond or lake, boat landings and driveways should be left unpaved. On-site septic systems can be major contributors to a nutrient enriched waterbody. They should be properly maintained. The sediments at the bottom of the pond or lake also contain nutrients; however, algae do not have access to these nutrients unless the bottom is disturbed. Boat traffic can disturb these sediments; therefore outboard motor restrictions can be useful in controlling nutrient inputs.

## Chemicals and Aeration

If source control does not manage algal blooms, there are other options available. Chemicals such as buffered alum can be applied that form nontoxic precipitates that remove phosphorous from the water column and cover the bottom sediments so nutrients are not available to the algae. Limestone and lime have also been proven to be effective. Aeration promotes artificial circulation that brings oxygen poor water up to the surface. Surface agitators such as paddlewheel devices, bubblers, and fountain sprayers can be used to create substantial turbulence that dissolves oxygen from the air into the water. Fountains consist of a float, nozzle or sprayer head, and a pump that draws water from the pond and sprays it into the air. They are usually powered by an electric pump, or less commonly, by a windmill device. Fountains promote mixing if the water is drawn from the bottom oxygen-poor layer of the pond. Aeration and mixing are important because they:

- provide oxygen for aerobic bacteria to decompose organic matter,
- trigger processes that control blue-green algae,
- provide well-oxygenated water throughout the pond so that the pond is less likely to experience a fish-kill, and
- liberate dissolved gases, such as ammonia, carbon dioxide, hydrogen sulfide, and methane, into the air instead of allowing them to build to harmful levels in the pond.

## Barley Straw Bales

Barley bales have been on the forefront of algal control technology. As the barley straw decays when submerged in water, it releases a chemical that inhibits algal growth. The bales should be placed in the pond in early spring, kept close to the surface, and secured to allow removal prior to winter. As a rule of thumb 100 to 300 pounds of straw should be used per surface acre. Barley bales can be acquired from most plant suppliers.

## Removal of Bottom Sediments

Dredging may be necessary to prevent stored nutrients in the sediments from entering the water column and stimulating plant growth. Dredging is discussed in more detail in the Fact Sheet Pond and Lake Management Part II.

# Additional Resources:

Butler Sr., B. R. & Terlizzi, D. 1999. FS-766 Integrated Pond Management for Maryland. http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=86

Holdren, C.W. Jones & J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. And Terrene inst., in coop. with Off. Water Assess. USEPA, Madison, WI.

McComas, Steve. 1993. Lake Smarts. Terrene Institute. Washington D.C.

Ohio Pond Management Bulletin 374-99. Ohio State University Extension. http://ohioline.osu.edu/b374/b374_4.html

# Pond and Lake Management Part II: Preventing Shoreline Erosion & Removing Sediments

Fact Sheet FS1077

**Cooperative Extension**

*Christopher C. Obropta, Ph.D., P.E., Extension Specialist in Water Resources*
*and*
*Eileen Althouse, Graduate Assistant in Bioresource Engineering*

## The Need for Pond and Lake Management

Waterbodies such as lakes and ponds are valuable resources. Lakes and ponds can be natural or man-made, and management depends on the desired use. For example, not all lakes are suitable for swimming, and different management practices will be applied to areas where swimming is encouraged and areas where it is not. Human actions, as well as natural phenomena, contribute to unwanted pond and lake conditions. Excessive plant growth, algal blooms, oxygen depletion, sediment build-up, bank erosion, and pests are the most common issues faced in the management of a lake or pond. In many cases there is a "quick fix" remedy that can eliminate the symptoms of a problem at least temporarily. However, the issue will return if the root cause of the problem is not addressed. A sound pond or lake management plan addresses not only management of the symptoms, but also remediation of the causes of common pond and lake issues. This fact sheet is the second in a series that addresses common lake and pond problems.

## Reducing Erosion and Removing Sediments

Shoreline erosion and sedimentation are physical problems that are usually the result of increased stormwater flows. Shoreline erosion results from water and ice hitting the bank from below, as well as runoff pouring off the land from above. In addition to simply filling in the lake or pond, these sediments can serve as a source of nutrients that can be released under low oxygen conditions resulting in algal blooms. Aquascaping and vegetated riparian buffers, discussed in more detail in Pond and Lake Management Part I, can help stabilize shorelines. Rooted plants hold soil particles in place so they are less likely to be eroded away by either wind or water. In larger lakes where erosion is the result of wave action, revetments can be used to stabilize banks and armor the bank against wave forces. The most common revetment is riprap. Loose rocks are placed on top of a filter blanket so that soil particles underneath will not wash away. Rootrap is also used to stabilize banks. It is similar to riprap; however, a layer of topsoil is provided, and vegetation is planted. The roots of the plants stabilize the structure by holding the rocks in place.

Sediments cause turbidity, fill up basins, and also may carry nutrients, heavy metals, or other toxins attached to the soil particles into the pond or lake. The sediments that build up in a pond or lake are the result of erosion of not only the local lake banks, but also areas upstream. Reducing the source of sedimentation by protecting stream banks from erosion can be used as a preventative measure against sediment build up. A great amount of sediment comes from the erosion of exposed land at construction sites or plowed agricultural fields. New construction sites around lakes should have the highest priority for erosion control including, but not limited to, the use of silt fences, diversions, detention basins, and replanting as soon as possible. Crop rotation, conservation tillage, contour stripping, and the use of vegetative buffer strips can be used to control erosion in agricultural areas in close proximity to a waterbody.

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Sediments settle from flowing waters as the flow velocities decrease. Diverting turbid water to a detention basin where it can slow and deposit its sediments before it enters the pond or lake will prevent the sediment from entering the pond or lake. The sediments suspended in the water can also be removed with trash screens or skimmers at storm water culverts, road ditches, or detention pond outlets. Proper cleaning and maintenance of these structures is necessary to prevent blocking and backup that could lead to flooding or other upstream problems.

The removal of the sediments and muck on the pond or lake bottom is referred to as dredging. In addition to simply deepening the lake, dredging can remove nuisance macrophyte plants, limit nutrient cycling, and remove contaminated sediments. If dredging seems to be a viable option, permits to dredge should be sought. Before dredging, the source of the sediments should be identified and efforts to reduce the source input should be made. Sometimes sediment buildup is a natural process, such as the sedimentation due to leaf litter from overhanging branches and decaying plant and algal matter. In small scale applications the muck can be simply scooped out with a metal bucket. Seines or slushers can also be used. When sediment is removed in this way, it contains less water and the dewatering time is much shorter. Small scale pumping systems can also be used to remove loose sediments. In more large scale applications, backhoes, front end loaders, or commercial dredging equipment is necessary. New Jersey Department of Environmental Protection (NJDEP) general wetland permits and stream encroachment permits are required to dredge. A lake lowering permit may also be required. These permits must include a dewatering plan and an approved dredge spoil disposal plan. Additional regulatory information can be found at: http://www.nj.gov/dep/landuse/njsa_njac.html.

## Additional Resources:


Lake Management Short Course. January 17-18, 1997. Cook College, Rutgers University. New Brunswick.

McComas, Steve. 1993. Lake Smarts. Terrene Institute. Washington D.C.

Holdren, C.W. Jones & J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. and Terrene Inst., in coop. with Off. Water Assess. USEPA, Madison, WI.

Butler Sr., B. R. & Terlizzi, D. 1999. FS-766 Integrated Pond Management for Maryland. http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=86

Ohio Pond Management Bulletin 374-99. Ohio State University Extension. http://ohioline.osu.edu/b374/b374_4.html.



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# Pond and Lake Management Part III: Controlling Geese and Other Pests

Fact Sheet 1078

**Cooperative Extension**

*Christopher C. Obropta, Ph.D., P.E., Extension Specialist in Water Resources*
*and*
*Eileen Althouse, Graduate Assistant in Bioresource Engineering*

## The Need for Pond and Lake Management

Natural or man-made waterbodies such as lakes and ponds are valuable resources, and management depends on the desired use. For example, not all lakes are suitable for swimming, and different management practices will be applied to areas where swimming is encouraged and areas where it is not. Human actions, as well as natural phenomena, contribute to unwanted pond and lake conditions. Excessive plant growth, algal blooms, oxygen depletion, sediment build-up, bank erosion, and pests are the most common issues faced in the management of a lake or pond. In many cases there is a "quick fix" remedy that can eliminate the symptoms of a problem at least temporarily. However, the issue will return if the root cause of the problem is not addressed. A sound pond or lake management plan addresses not only management of the symptoms, but also remediation of the causes of common pond and lake issues. This fact sheet is the third in a series that addresses common lake and pond problems.

## Controlling Geese and Other Pests

Although ducks and other waterfowl can add an aesthetic quality to a pond or lake, their populations can grow to nuisance proportions. Large waterfowl populations contribute to excessive nutrient and elevated fecal coliform levels in the water. Goose and duck populations can be managed in a number of ways. They can either be discouraged from staying in the area or removed. Decoys and scarecrows can be used, but in time the birds become accustomed to them, and they are no longer effective. Another option is to deter ducks, and especially geese, through limiting their food supply. Ordinances that prohibit feeding the waterfowl have been used to limit the population. Canadian geese tend to forage on lawns and eat most lawn grasses. Geese are a tundra species, and they do not like to be in situations with limited line of sight. Tall plants along the bank or aquatics such as cattails, which extend up to the edge of the water, will help deter geese from inhabiting the area. Border collies have been used to chase waterfowl. Contractors can be hired to perform this service. It is permissible to harass Canada geese without a Federal or State permit, ***as long as these geese are not touched or handled by a person or the agent of a person (e.g., a trained dog).*** However, Federal and State permits are required to conduct any of the following activities:.

- capture Canada geese
- relocate Canada geese
- addle goose eggs or destroy eggs or nests
- kill Canada geese outside the hunting season

Recent changes to the Federal regulations make these permits much easier to obtain in many cases. Information on how to obtain permits can be obtained by contacting:

State Director
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control
RD#21, Box 360-C
Locust Grove Road
Pittstown, NJ 08867-9529 (908/735-5654)

# Pond and Lake Management Part III: Controlling Geese and Other Pests

Fact Sheet 1078

Muskrats and beavers can become a nuisance and can cause lake and pond problems. Muskrats burrow into banks and increase erosion when they feed on plants that stabilize shorelines. Beaver dams raise the level of a stream, or in some cases, an entire lake. Muskrats can be discouraged from burrowing into banks by anchoring chicken wire to the bank. Beavers can be forced to relocate by disassembling their dams or by applying a beaver repellant around the lodge, dam, or feeding areas. Trees can be protected by wrapping chicken wire around the trunk from the ground to a height of four feet. As a last resort, both muskrats and beavers can be trapped and removed from the area.

## Additional Resources


Holdren, C.W. Jones & J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. And Terrene Inst., in coop with Off. Water Assess. USEPA, Madison, WI.

Butler Sr., B. R. & Terlizzi, D. 1999. FS-766 Integrated Pond Management for Maryland.
http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=86

Drake, David and J. B. Paulin. 2003. A Goose is a Goose? Identiying Differences Between Migratory and Resident Canada Geese. Rutgers Cooperate Research and Extension Fact Sheet FS1024.
http://www.rcre.rutgers.edu/pubs/download-free.asp?strPubID=FS1024

Paulin, J.B. and David Drake 2003. Positive Benefits and Negative Impacts of Canada Geese. Rutgers Cooperate Research and Extension Fact Sheet FS1027.
http://www.rcre.rutgers.edu/pubs/download-free.asp?strPubID=FS1027

USDA Fact Sheet on Goose Management:
http://www.aphis.usda.gov/ws/statereports/NJ/cagocommunity.pdf





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## Appendix D: SVAP Field Data Sheet

# Stream Visual Assessment Protocol

**(Modified by the Rutgers Cooperative Extension Water Resources Program, www.water.rutgers.edu)**

***PROJECT:***

Evaluators Name____________________________________Date___________________________Time_____________

Property Owners Name (if applicable)___________________________________________________________________

Stream Name___________________________________________________Grid ID______________________________

Reach Location____________________________________________________________________________________

Applicable Reference Site_____________________________________________________________________________

GPS Coordinates (in degrees, minutes, and seconds):________________________________________________________

Weather conditions today________________________________Past 2-5 days___________________________________

Active channel width_____ ft *Dominant* substrate (*circle one*): boulder cobble gravel sand silt mud

**Site Diagram:** Note direction of flow, pipes, photo locations, stream characteristics, stormwater infrastructure, & ditches.

Photo Notes: 1.________________________________ 2.__________________________________

3.____________________________________________ 4.__________________________________

5.____________________________________________ 6.__________________________________

7.____________________________________________ 8.__________________________________

9.____________________________________________ 10._________________________________

## Assessment Scores (1-Poor to 10-Excellent)

***<u>(facing upstream)</u>***

Channel Condition [ ]

Hydrologic Alteration [ ]
(Score only if Applicable)

Riparian Zone Left: [ ] Right: [ ]

Bank Stability Left: [ ] Right: [ ]

Water Appearance [ ]

Nutrient Enrichment [ ]

Barriers to fish movement [ ]

Instream fish cover [ ]

Pools [ ]

Invertebrate habitat [ ]

***Score only if applicable***

Canopy Cover [ ]
(use Manual for guidance)

Manure presence [ ]

Salinity [ ]

Riffle embeddedness [ ]
(look in riffles)

Macroinvertebrates Observed (optional) [ ]

Overall Score
(Total divided by number scored)
Left:_____ Right:_____ Average:_____

| | |
|---|---|
| < 6.0 | Poor |
| 6.1-7.4 | Fair |
| 7.5-8.9 | Good |
| > 9.0 | Excellent |

## Streamside Land Use:

(within 100 ft. of top of bank)
Check all that apply:

| Land Use Category | While Observed in the field | |
|---|---|---|
| | **Left Bank** | **Right Bank** |
| Forest | | |
| Pasture | | |
| Cultivated Field | | |
| Nursery | | |
| Residential | | |
| Commercial | | |
| Industrial | | |
| Other | | |

**Outfall Pipe 1:** (Photo #__ and mark on site diagram) GPS Coordinates____________________N
Diameter:___________in ____________________W

Headwall? YES NO Double culvert? YES NO Streambank at outfall eroded? YES NO

Pipe Material: concrete steel PVC Clay Other

Location of Pipe: in stream, at top of bank, in bank, out of/ under bridge, other__________________

Channel downstream eroded? YES NO

Pipe gathers water from (road, yard, farm, etc.):_____________________________________________

Flow appearance: clear turbid oily foamy colored other________

**Outfall Pipe 2:** (Photo # __and mark on site diagram) GPS Coordinates____________________N
Diameter:___________in ____________________W

Headwall? YES NO Double culvert? YES NO Streambank at outfall eroded? YES NO

Pipe Material: concrete steel PVC Clay Other

Location of Pipe: in stream, at top of bank, in bank, out of/ under bridge, other__________________

Channel downstream eroded? YES NO

Pipe gathers water from (road, yard, farm, etc.):_____________________________________________

Flow appearance: clear turbid oily foamy colored other________

**Drainage Ditch:** (Photograph #__ and mark on site diagram) GPS Coordinates ________________N
Width of ditch________ft ________________W
Begins at: _______________________ Ditch lining: stone, vegetation, concrete, mud, other________
Ditch is: Stable, Eroding Ditch Flow is: none, intermittent, steady
Stream channel downstream is: stable, eroded, silted Flow is: clear, cloudy, oily, foamy, colored
Ditch comes from:

**Drainage Ditch:** (Photograph #__ and mark on site diagram) GPS Coordinates _________________N
Width of ditch________ft _________________W
Begins at: __________________ Ditch lining: stone, vegetation, concrete, mud, other____________
Ditch is: Stable, Eroding Ditch Flow is: none, intermittent, steady
Stream channel downstream is: stable, eroded, silted Flow is: clear, cloudy, oily, foamy, colored
Ditch comes from:

**Comments & Suggestions:**
Do you have suggestions for remediation along this reach?

Given dry weather, is there any running water in nearby stormwater structures?

Access to this site…how far off of road is it? Accessible for large equipment, if necessary?

Debris, trash, litter?

Additional comments:

# Appendix E: Pollutant Loading Coefficients

| **NJDEP 1995/97 Land Use Type** | **Aerial Loading Source Analysis: Loading Rate Coefficients** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *TP* (lbs/ac/yr) | *TN* (lbs/ac/yr) | *TSS* (lbs/ac/yr) | *NH3-N* (lbs/ac/yr) | *LEAD* (lbs/ac/yr) | *ZINC* (lbs/ac/yr) | *COPPER* (lbs/ac/yr) | *CADMIUM* (lbs/ac/yr) | *BOD* (lbs/ac/yr) | *COD* (lbs/ac/yr) | *NO2+NO3* (lbs/ac/yr) |
| High/Med Residential | 1.4 | 15 | 140 | 0.65 | 0.2965 | 0.335 | 0.453 | N/A | 25.6 | 152.6 | 1.7 |
| Low/Rural Residential | 0.6 | 5 | 100 | 0.02 | 0.217 | 0.172 | 0.19 | N/A | N/A | N/A | 0.1 |
| Commercial | 2.1 | 22 | 200 | 1.9 | 0.955 | 0.873 | 0.784 | 0.002 | 42.1 | 662.6 | 3.1 |
| Industrial | 1.5 | 16 | 200 | 0.2 | 1.409 | 1.598 | 0.93 | 0.003 | 31.4 | N/A | 1.3 |
| Mixed Urban | 1 | 10 | 120 | 1.75 | 3.215 | 1.743 | 1.529 | 0.0025 | 67.2 | 184.8 | 3.55 |
| Agriculture | 1.3 | 10 | 300 | N/A | 0.071 | 0.089 | 0.027 | N/A | 15.45 | N/A | N/A |
| Forest, Water, Wetlands | 0.1 | 3 | 40 | N/A | 0.009 | 0.018 | 0.027 | N/A | 9.2 | 2 | 0.3 |
| Barren Land | 0.5 | 5 | 60 | N/A | N/A | 0.002 | N/A | N/A | 3.1 | N/A | N/A |
| N/A: Data not available from sources used. | | | | | | | | | | | |
| *The loading coefficients used in this table have been provided by the NJDEP in the "New Jersey Stormwater Best Management Practices Manual," February 2004.* | | | | | | | | | | | |