STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

OFFICE OF THE
SECRETARY

PHONE: (302) 739-4403
FAX: (302) 739-6242

April 20, 2005

Dear Local Officials and Citizens:

As Secretary of the Department of Natural Resources and Environmental Control, it is my pleasure to deliver to you the "Source Water Protection Guidance Manual for the Local Governments of Delaware". This manual has been completed as required by Chapter 60 Section 6082 (a) and House Concurrent Resolution 32 dated January 2004. It was developed with substantial input from, and approval of the Source Water Protection Citizen and Technical Advisory Committee. In addition to input from the Committee, the Division of Water Resources (DWR) conducted two public workshops, the first in Georgetown in December 2004 and the second was held in Dover in February 2005. The Manual's format and content was improved based on this additional public input.

As you may know, Delaware has more than 500 public water supply systems that have over 1000 wells scattered throughout the state as well as several surface water intakes in northern New Castle County. Because of the diversity of our public water supply systems, we believe that a comprehensive Manual will be of greatest value to our citizens, county and local governments. The Manual provides information to local governments and the public on various measures that other communities, both here in Delaware and nationwide, are using to protect their drinking water resources. It also provides a compendium of measures which should be carefully considered and tailored to address local concerns pertaining to long-term protection of the quality and quantity of sources of drinking water. My staff and I do not endorse wholesale adoption of this Manual.

Doug Rambo and Todd Keyser from DWR's Source Water Protection program will be available to communities statewide to assist in adopting meaningful and practical measures to protect sources of drinking water. I encourage you to contact them at 302-739-4793 for assistance and to answer any questions.

Sincerely,

John A. Hughes
Secretary

Delaware's Good Nature depends on you!

Source Water Protection Guidance Manual for the Local Governments of Delaware

"A Toolbox for the Protection of Public Drinking Water Supplies in Delaware"

March 2004, Revised May 2005

prepared for
Delaware Department of Natural Resources and Environmental Control

prepared by
Water Resources Agency
Institute for Public Administration
College of Human Services, Education & Public Policy
University of Delaware

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Acknowledgements

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Delaware Source Water Assessment and Protection Program
Citizens and Technical Advisory Committee (SWP-CTAC)

Name	**Affiliation**	**Status**
Mr. Scott Andres	Delaware Geological Survey (Alternate for Mr. John Talley)	Technical
Mr. Kent A. Bacon	Culligan Water Conditioning	Technical
Mr. John Barndt	Source Water Protection, DNREC	Technical
Ms. Anita Beckel	Office of Dinking Water, Division of Public Health	Technical
Mr. Scott Blaier	Pesticides Section, DE Department of Agriculture	Technical
Mr. Donald Blakey, PhD	Kent County Levy Court	Citizen
Mr. Jeff Bross	Committee of 100	Citizen / Technical
Ms. Lori Spagnolo	Delaware Nature Society	Citizen / Technical
Dr. Eugene Campbell, MD	Delaware Public Health Association	Citizen
Ms. Dawn Marie Cook	United Water Delaware	Technical
Mr. Joseph Demul	AARP	Citizen
Mr. Joseph DiNunzio	Artesian Water Company	Technical
Ms. Sheila Dolan	Tidewater Utilities	Technical
Mr. Dale Dukes	Sussex County Council	Citizen
Ms. Laura Fairclough	Delaware Farm Bureau (Alt. for Mr. Bill Powers)	Technical
Mr. John Flaherty	Greenwatch Institute	Citizen
Ms. Lorraine Fleming	Christina Conservancy	Citizen

Mr. Anthony Gersitz	American Water Works Association	Technical
Dr. William Guertal	United States Geological Survey	Technical
Mr. George Haggerty	New Castle County Department of Land Use	Technical
Mr. B.J. Hardin	Sussex County Association of Towns	Citizen
Mr. Gilbert Holt	Town of Lewes Board of Public Works	Technical
Mr. Lloyd Hughes	AARP	Citizen
Mr. Anthony Joering	Committee of 100 (Alternate for Jeff Bross)	Citizen/Technical
Mr. Paul Jones	Delaware Association of Professional Engineers	Technical
Mr. Gerald Kauffman	Water Resources Agency, University of Delaware	Technical
Mrs. Nicole Minni	Water Resources Agency, University of Delaware	Technical
Mr. Stephen Lefebvre	Homebuilders Association of Delaware	Citizen
Mr. Hassan Mirajadi	Watershed Assessment, DNREC	Technical
Ms. Nancy Parker	Artesian Water Company	Citizen
Mr. Jigar Patel	Delaware Rural Water Association	Technical
Mr. Bill Powers	Delaware Farm Bureau	Citizen
Ms. Til Purnell	League of Women Voters / Friends of Herring Creek	Citizen
Mr. Alex Rittberg	Site Investigation and Remediation Branch, DNREC	Technical
Mr. Keith Robertson	Site Investigation and Remediation Branch, DNREC / (Alternate for Mr. Alex Rittenberg)	Technical
Ms. Joy Sikora	American Association of University Women / Inter-Group Council	Citizen
Ms. Lori Spagnolo	Delaware Nature Society	Citizen/Technical
Mrs. Marion Stewart	Civic League for New Castle County	Citizen
Mr. John Talley	Delaware Geological Survey	Technical
Mr. Kenneth Wicks	Delaware Council of Farm Organizations	Citizen
Mr. Stephen Williams	Whole Basin Management, DNREC	Technical
Mr. Robert Wittig	Commercial and Industrial Realty Council	Citizen/Technical
Mr. Martin Wollaston	Water Resources Agency, University of Delaware	Technical
Mr. George Wright	Delaware League of Local Governments	Citizen
Mr. Tad Yancheski	Tetra Tech, Inc. / Committee of 100	Technical

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ACRONYMS

BMP:	Best Management Practice
CFR:	Code of Federal Regulation
DEMA:	Delaware Emergency Management Agency
DGS:	Delaware Geological Survey
DNREC:	Delaware Department of Natural Resources and Environmental Control
DRWA:	Delaware Rural Water Association
DWSRF:	Drinking Water State Revolving Fund
FEMA:	Federal Emergency Management Agency
GIS:	Geographic Information System
NRCS:	National Resource Conservation Service
PCB:	Polychlorinated Biphenyl
PWS:	Public Water System
SDWA:	Safe Drinking Water Act
SWAP:	Source Water Assessment Plan
SWAPP:	Source Water Assessment and Protection Program
SWP-CTAC:	Source Water Protection Citizens and Technical Advisory Committee
USEPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
UST:	Underground Storage Tank
UDWRA:	University of Delaware Water Resources Agency
USDA:	United States Department of Agriculture
WHPP:	Wellhead Protection Plan
WRPA:	Water Resource Protection Area

CHAPTER 1: INTRODUCTION

1.1 Purpose of Manual

The State of Delaware Source Water Protection Law of 2001 (7 Del. C. 6081, 6082, 6083) requires local governments with year-round populations of 2,000 or greater to implement measures to protect the quality and quantity of public water supplies within delineated surface water, wellhead, and ground-water recharge areas by 2007. The purpose of this manual is:

1) To provide local governments with a concise listing of protection measures meant to protect drinking water and to comply with the legislation,
2) To encourage jurisdictions with year-round populations of less than 2,000 to adopt measures to protect their sources of public drinking water

This manual is an important component that provides basic information on how local governments might tailor their water protection efforts. This manual is not prescriptive. The manual is not intended to be adopted in total. This manual is an important tool that local governments can use to address their own drinking water resource protection challenges with the input of the local community.

Other individuals, groups, or corporations that own, use, govern, or seek to develop land within source water areas are encouraged to use this manual to comply with the laws and ordinances developed by local governments. Certain aspects of the tools recommended in this manual are subject to change. Local governments should be consulted before implementation. Delaware Code grants state and federal governments, not local governments, the right to regulate agricultural activities occurring on agriculturally zoned land.

This manual compliments existing regulatory authorities listed in the 2002 report by the Delaware DNREC: *A Compendium of Federal, State, and Local Regulatory Authorities that Support the Source Water Assessment and Protection Program in Delaware*.

1.2 Background

The Safe Drinking Water Act Amendments of 1996 required each state to file a Source Water Assessment Plan (SWAP) with the United States Environmental Protection Agency (USEPA) by February 1999. The goal of the SWAP is to identify and delineate the sources of public drinking water and evaluate the susceptibility of each source to known potential contaminants. The State of Delaware submitted its SWAP to the USEPA for review and received approval in November 1999. The Delaware SWAP outlines the three main tasks required by the USEPA:

1) Delineate the boundaries of the source water areas
2) Develop a contaminant inventory within the delineated areas, and
3) Assess the susceptibility to contamination of each public drinking water source.

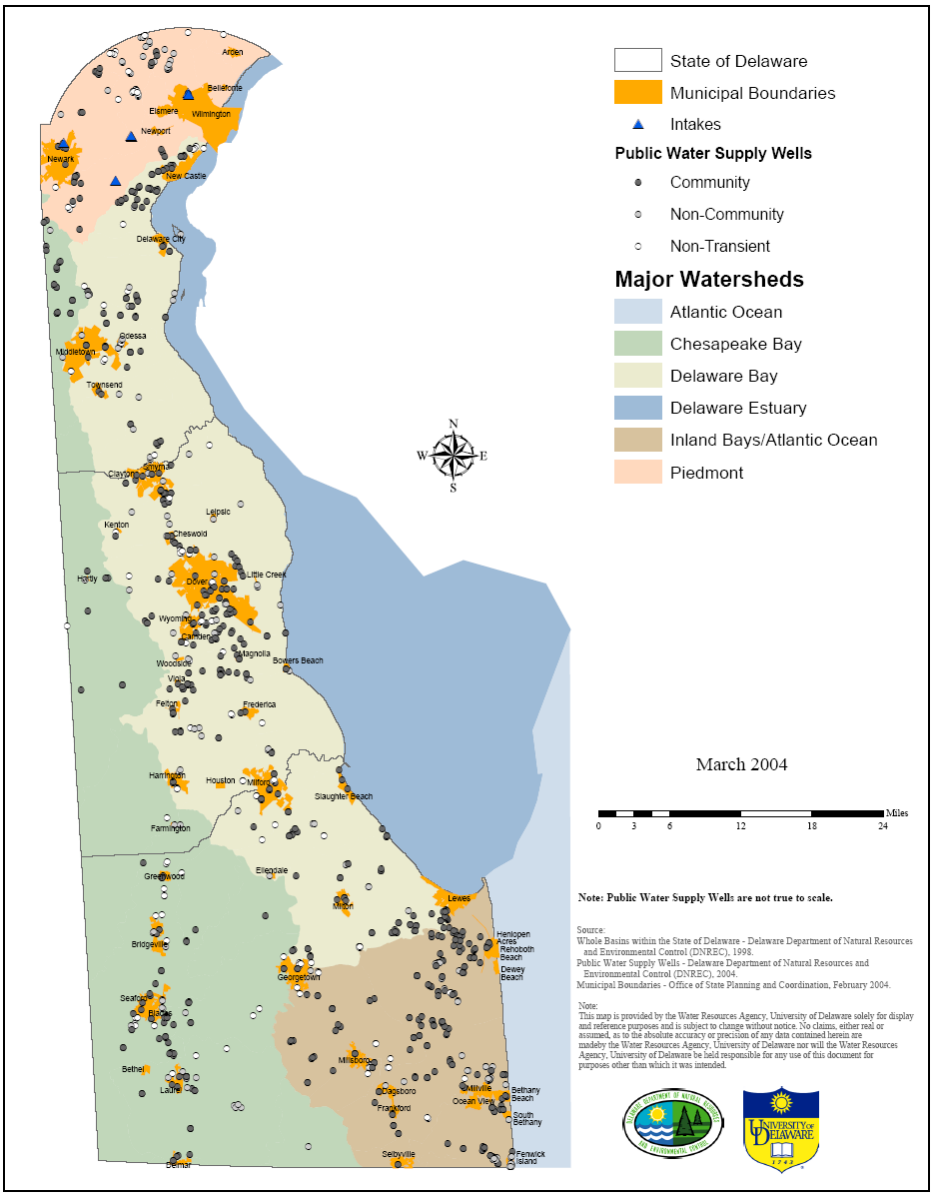
The following is a chronology of the Delaware Source Water Assessment Program:

1996	Congress passes the Amendments to the Safe Drinking Water Act that require each state to file a SWAP with the USEPA
June 30, 1998	DNREC invites public to participate in a workshop towards the development of the Source Water Assessment Plan
September 1998	First Citizens and Technical Advisory Committee (CTAC) Meeting
February 1999	Delaware completes its statewide SWAP
October 1999	Delaware receives approval of the SWAP from USEPA
March 29, 2001	DNREC completes the Town of Felton's susceptibility assessment, the first completed for groundwater supplies in Delaware
June 2001	Source Water Protection Law enacted
May 2002	The University of Delaware, Institute for Public Administration, Water Resources Agency completes five source water susceptibility reports for the only surface water intakes in the State along the Brandywine Creek, White Clay Creek, Red Clay Creek, Christina River, and Hoopes Reservoir
April 2003	Sussex County legislators request a meeting with DNREC Division of Water Resources to discuss SWP Measures and possible amendments to the SWP Law of 2001
December 2003	DNREC completes source water susceptibility reports for 350 public ground-water systems (68 % of the systems in Delaware)
January 2004	House Concurrent Resolution 32 asking CTAC to Expedite the Source Water Protection Guidance Manual from an original date of December 2004 to April 30, 2004
March 31, 2004	Deadline for submitting the completed Delaware Source Water Protection Guidance Manual to the General Assembly
September 2004	CTAC gives concurrence on draft SWP Guidance Manual
December 2004	Public Workshop on draft SWP Guidance Manual in Georgetown
February 2005	Public Workshop on draft SWP Guidance Manual in Dover

1.3 Scope of Work

In Delaware, public water supplies are derived from both surface water and ground-water sources. Figure 1.1 shows all the public water supply wells and surface water intakes in Delaware.

Figure 1.1 Delaware Public Water Supply Wells



In the northern part of the state, surface water from the White Clay Creek, Red Clay Creek, Brandywine Creek, and Christina River provides over 60 percent of public water supply. South of the Christina River Basin (south of Delaware City), ground water is the source of all public water supplies.

In 1987, the Water Resources Agency for New Castle County (WRANCC) worked with DNREC and the Delaware Geological Survey (DGS) to develop a set of maps for New Castle County that

depicted areas most critical for maintaining the quality and quantity of water resources utilized for public water supplies during new development. In 1990, WRANCC assisted the City of Newark and New Castle County in developing land use ordinances in order to protect public water supplies. These ordinances were adopted in September 1991 and form the basis for the source water protection technical guidance manual.

This manual includes draft ordinances that jurisdictions may adopt as well as the statewide mapping developed by DNREC through the Source Water Assessment and Protection Program (SWAPP) that delineates the areas most important to protect public water supplies. The manual also includes recommended best management practices (BMPs) to maintain the quantity and quality of public drinking water sources for the following land uses found in Delaware:

Residential	Combined Urban	Commercial
Recreation	Cropland	Extraction
Highways/Parking Lots	Industrial	Forest Land
Transportation	Confined Animal Feeding Operations (CAFOs)	Water/Wetlands

This source water protection guidance manual was developed according to the following steps:

1) *Literature Search* - Conduct a literature search and review and compile various wellhead, and recharge BMP manuals prepared by governments in the United States and Canada.

2) *Manual Outline* - In collaboration with DNREC and the SWP-CTAC, develop a detailed outline of the proposed Delaware Source Water Protection Guidance Manual according to the following format:
    a) Purpose of Manual/Legislation
    b) Source Water Area Delineations
    c) Comprehensive Land Use Planning
    d) Recommended Land Use Types/BMP Activities for Water Quality/Quantity Protection (Urban, Residential, and Agricultural Land Uses)
    e) Design of Sample Source Water Protection Ordinance(s)
    f) Appendices
    g) List of References
    h) Performance Criteria for Recharge BMP Design, Construction, Operation, and Maintenance Details
    i) Glossary/References

3) *Draft Manual* - Write a draft manual approximately 100 pages in length. Distribute the draft manual to the SWP-CTAC for review and comment.

4) *Final Manual* - Incorporate review comments and prepare 75 paper copies of manual for distribution. The manual will be prepared in a digital version for distribution via CD and for posting on the SWAPP website (www.wr.udel.edu/swaphome).

CHAPTER 2: ENABLING LEGISLATION AND MAPPING

2.1 Enabling Legislation

The foundation of the Delaware Source Water Protection Program lies in the Federal Safe Drinking Water Act Amendments of 1996 and Senate Bill 119, the Delaware Source Water Protection Law of 2001.

2.1.1 Federal Safe Drinking Water Act Amendments of 1996

In 1996, Congress amended the Safe Drinking Water Act (SDWA) to include provisions for source water protection. The program, coordinated nationally by the USEPA, requires all states to develop a plan for evaluating drinking water supply sources used by public water systems in their state by which they will conduct source water susceptibility assessments. Appendix A contains the portion of the Federal SDWA amendments that pertain to source water protection.

2.1.2 Delaware Source Water Protection Law of 2001 (7 Del. C. 6081, 6082, 6083)

In June 2001, the Delaware General Assembly passed Senate Bill 119, the Delaware Source Water Protection Law of 2001, now incorporated into Delaware Code as 7 Del. C. 6081, 6082, 6083 (Appendix B). It requires county governments and municipalities with year – round populations of 2,000 or more to develop maps delineating source water assessment, wellhead protection and excellent ground-water recharge areas, and regulations governing the use of land within those critical areas as part of the updates to 2007 Comprehensive Land Use Plans. It also obligates DNREC to provide technical assistance to local governments to adopt these measures. It also defines and clarifies source water and wellhead protection areas as critical areas as defined under Chapter 92, Title 29 of the Delaware Code. The bill also requires that a citizen and technical advisory committee be consulted in the implementation of the SWAP and closely related matters.

7 Del. C. 6081, 6082, 6083 also states that:

"By December 31, 2004, the Department shall develop a guidance manual, in conjunction with and with the substantial concurrence of the Source Water Protection Citizens Technical Advisory Committee, for desirable land uses within source water assessment areas that promote the long-term protection of public drinking water supplies, consistent with "Shaping Delaware's Future: Managing Growth in 21st Century Delaware, Strategies for State Policies and Spending".

2.1.3 House Concurrent Resolution 32

In January 2004, the Delaware General Assembly passed House Concurrent Resolution 32, changing the deadline of completion of the guidance manual to March 31, 2004.

2.2 Existing Water Resource Protection Area Ordinances

Since 1991, water resource protection area (WRPA) zoning ordinances have been a part of source water protection in the State of Delaware. Several WRPA ordinances (such as New Castle County and the City of Newark) limit the amount of impervious cover (such as roof and pavement) to 20% by right for new development in surface water, recharge and wellhead areas. WRPAs are defined as (1) surface water areas such as floodplains, limestone aquifers, and reservoir watersheds, (2) wellhead areas, or (3) excellent recharge areas. The purpose of impervious cover thresholds in WRPAs are to balance the need to protect drinking water sources with the right to economically develop land, minimize loss of recharge, and protect the quality and quantity of ground and surface water supplies.

According to the New Castle County and City of Newark Ordinances, new development in WRPAs may exceed the 20% impervious cover threshold within WRPAs, but not exceed 50% impervious, provided the applicant submits an environmental assessment recommending a climatic water budget and facilities to augment recharge. The environmental assessment must document that post-development recharge will be no less than predevelopment recharge when computed on an annual basis. Commonly, the applicant offsets the loss of recharge due to impervious cover by constructing recharge basins that convey relatively pure rooftop runoff for infiltration to ground water. Refer to *Supplement 1: Ground-Water Recharge Design Methodology* (a supplement to this manual) for the details on the design recharge facilities in Delaware water resource protection areas.

Local governments in Delaware are encouraged to adopt ordinances that protect ground and surface waters in WRPAs through a source water protection hierarchy (ranked in descending order of preference):

1) Preserve WRPAs as open space and parks by acquisition or conservation easement.

2) Limit impervious cover of new development to 20% within WRPAs.

3) Allow impervious cover of new development to exceed 20% within WRPAs (but no more than 50% impervious) provided the applicant develops recharge facilities that directly infiltrate rooftop runoff.

4) Allow impervious cover of new development to exceed 20% within WRPAs (but no more than 50% impervious) provided the applicant develops recharge facilities that infiltrate stormwater runoff from forested and/or grassed surfaces with pretreatment.

The following ordinances are part of current source water protection strategies in Delaware:

2.2.1 New Castle County Unified Development Code (1997, Amended 1998/1999) [1]

The New Castle County Unified Development Code (Appendix E) provides for the protection of natural resources in three ways. First, specific open space standards are proposed to protect each

[1] DNREC – Division of Water Resources. 2002.

natural resource by ensuring that some portion of the area remains undisturbed. Secondly, site capacity calculations are provided to regulate development of sites consistent with the level of protection. Lastly, specific use, protection, and mitigation standards are provided for each resource, including floodplains and floodways, riparian buffer areas, surface water bodies, steep slopes, water resources protection areas, the Cockeysville Formation, wellhead protection areas, and recharge areas. The New Castle County UDC limits the impervious cover of new development within WRPAs to 20% by right (10% in the Hoopes Reservoir watershed) or up to 50% provided the applicant prepares a climatic water budget to balance predevelopment and postdevelopment recharge and installs facilities to augment recharge.

2.2.2 Kent County Code Chapter 187 (2003)[2]

The Kent County Code Chapter 187 (Appendix F) establishes standards to ensure that developments are environmentally sound. It requires preservation of existing natural features (including excellent ground-water recharge areas and wellhead protection areas) as conservation of open space during the processes of excavation, construction or other land development activities. The Code also establishes minimum standards for the design and construction of improvements that aid in the use and enjoyment of land, such as streets, sidewalks, adequate drainage, and water/sewer facilities.

Table 2.1 Summary of Existing WRPA Ordinances in Delaware

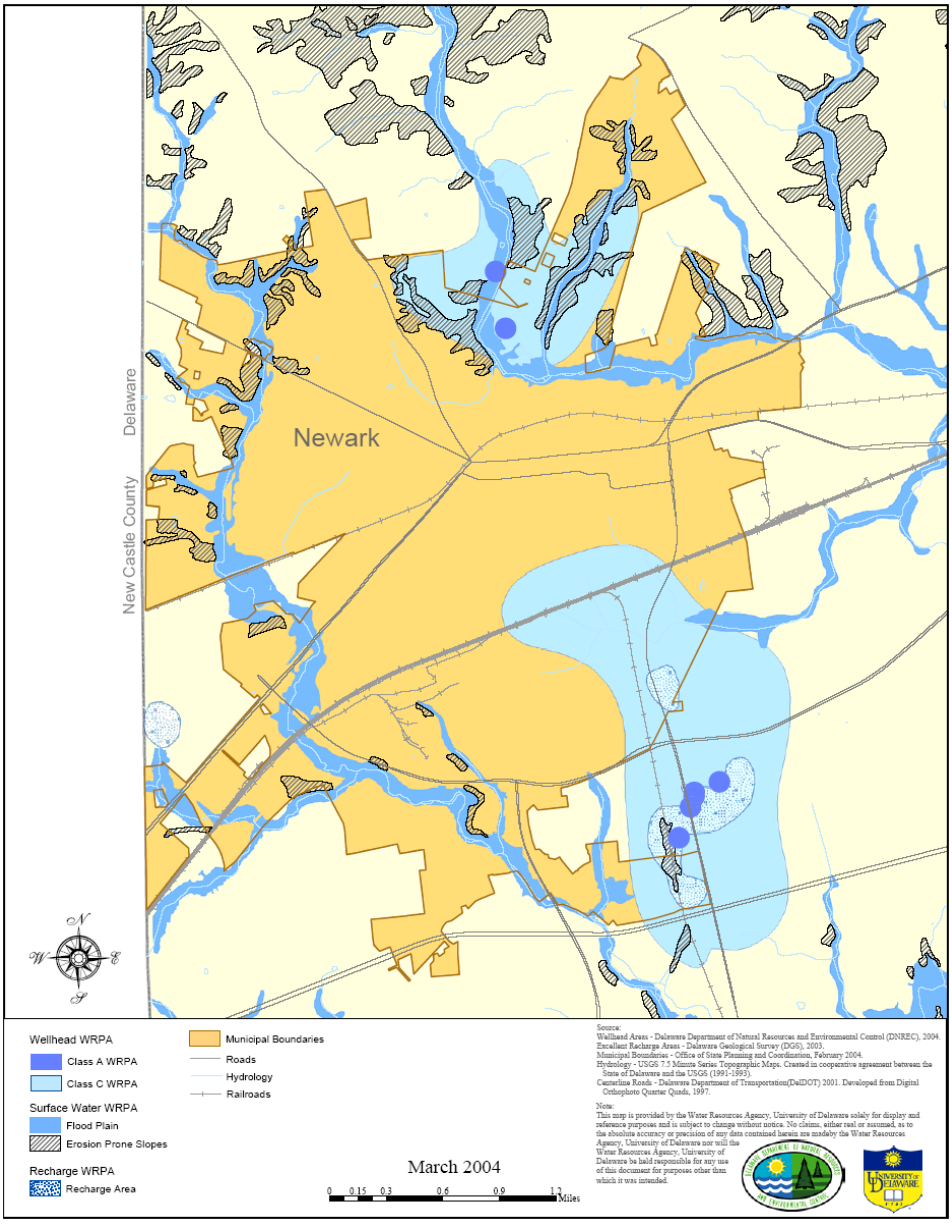
	Type of WRPA	**Impervious Cover Threshold**	**Uses Not Permitted**
New Castle County	Surface Water, Wellhead and Recharge	10 to 20 % by right, up to 50 % with facilities to augment recharge	Storage of hazardous substances and petroleum products
Kent County	Wellhead and Recharge	Preserved as open space or conservation area	Dumping, filling, debris disposal, draining, shrub, tree or vegetation removal.
Newark	Wellhead and Recharge	20 % for residential, or 50% for business uses	Storage of hazardous substances, petroleum, municipal or industrial or agricultural waste
Townsend	Wellhead and Recharge	30 % for residential in greenbelt, 50 % in downtown district	Storage of petroleum or any chemicals
Smyrna	Wellhead		Storage of hazardous materials, stockpiling manure, intensive agricultural practices, septic tanks or drain fields, sanitary landfills, underground storage tanks
Delmar	Wellhead		

[2] Kent County Chapter 187 - Subdivision and Land Development. 2003.

2.2.3 City of Newark Wellhead Protection Ordinance (Amended 1991) [3]

The Newark Wellhead Protection Ordinance (Appendix G) promotes public health, safety, and general welfare of the community by protecting the drinking water supply from pollution that may be associated with inappropriate land uses. The ordinance includes regulations governing delineation of wellhead resource protection areas, recharge protection areas, and nonconforming uses, as well as regulations for the determination of a technical advisory committee and enforcement options. The Newark ordinance, based in the water code, limits the impervious cover of new residential development within WRPAs to 20% and business uses to 50%.

Figure 2.1 City of Newark Water Resource Protection Area

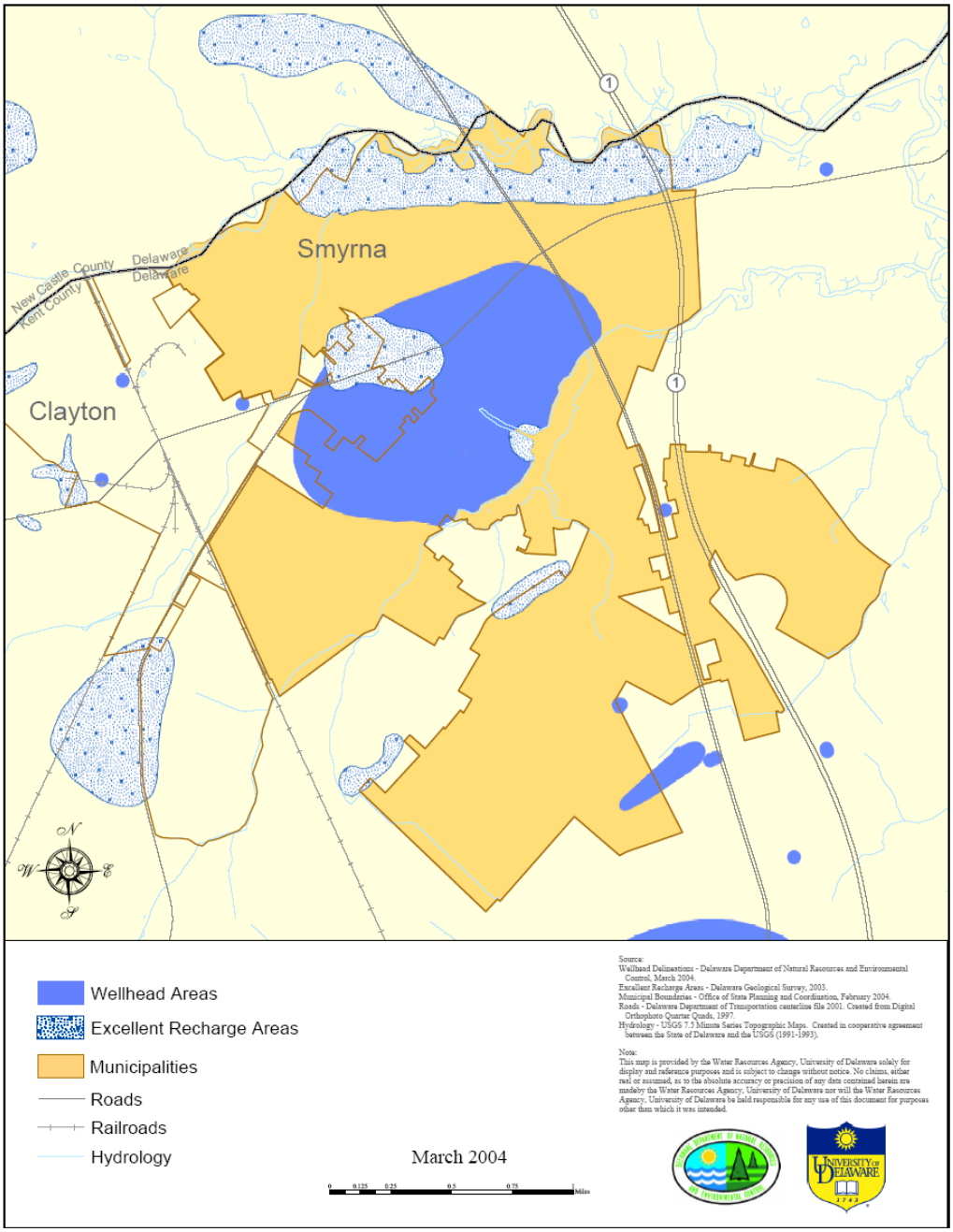


[3] DNREC – Division of Water Resources. 2002.

2.2.4 Town of Smyrna Wellhead Protection Ordinance (1998) [4]

The Town of Smyrna developed a wellhead protection overlay district through ordinance (Appendix I) to insure the provision of a safe and sanitary drinking water supply. Each district was established around wells owned by the Town and in use or proposed for potable water. The ordinance provides regulations on applicable areas, uses and overlay delineations.

Figure 2.2 Town of Smyrna Water Resource Protection Area



[4] DNREC – Division of Water Resources. 2002.

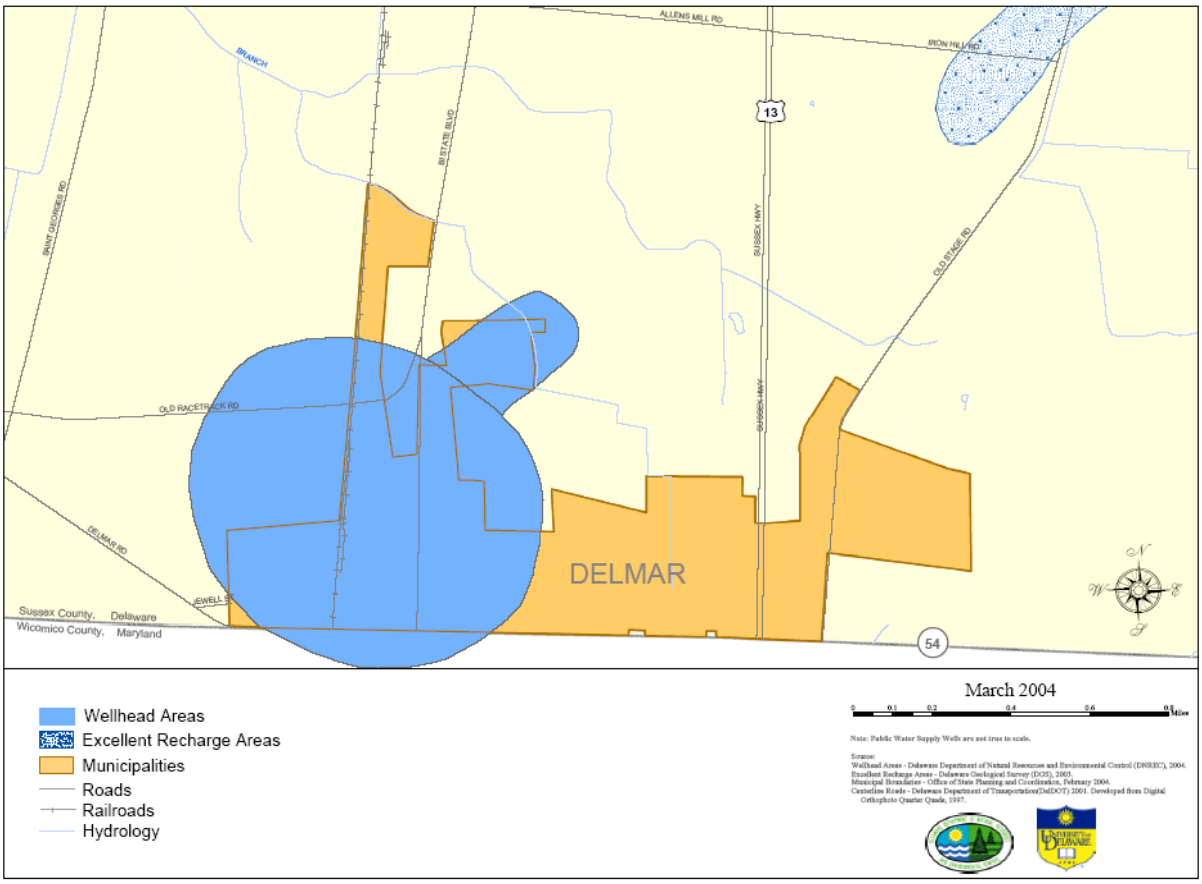
2.2.5 Town of Townsend Environmental Protection Regulations (2001) [5]

The Town of Townsend Environmental Protection Regulations (Appendix H) include a section that clarifies the environmental constraints and requirements for development in environmentally sensitive areas. This section includes regulations for development and delineation of water resource protection areas including wellhead Class A areas and recharge areas. The Townsend WRPA ordinance permits new development within recharge WRPAs provided the impervious cover does not exceed 30% for residential uses in the outlying greenbelt and 50% for new development in the downtown district.

2.2.6 Town of Delmar Wellhead Protection Ordinance (1962 and 1997) [6]

The Town of Delmar, recognizing the need for source water protection, established wellhead protection areas through an ordinance (Appendix J). They also provided water use regulations (with enforcement) covering the misuse of the water supply in lawn watering, using hoses to clean sidewalks, and car washing.

Figure 2.3 Town of Delmar Water Resource Protection Area



[5] DNREC – Division of Water Resources. 2002.
[6] DNREC – Division of Water Resources. 2002.

2.3 Source Water Protection Area Mapping

The Delaware Source Water Protection Law of 2001 also requires that:

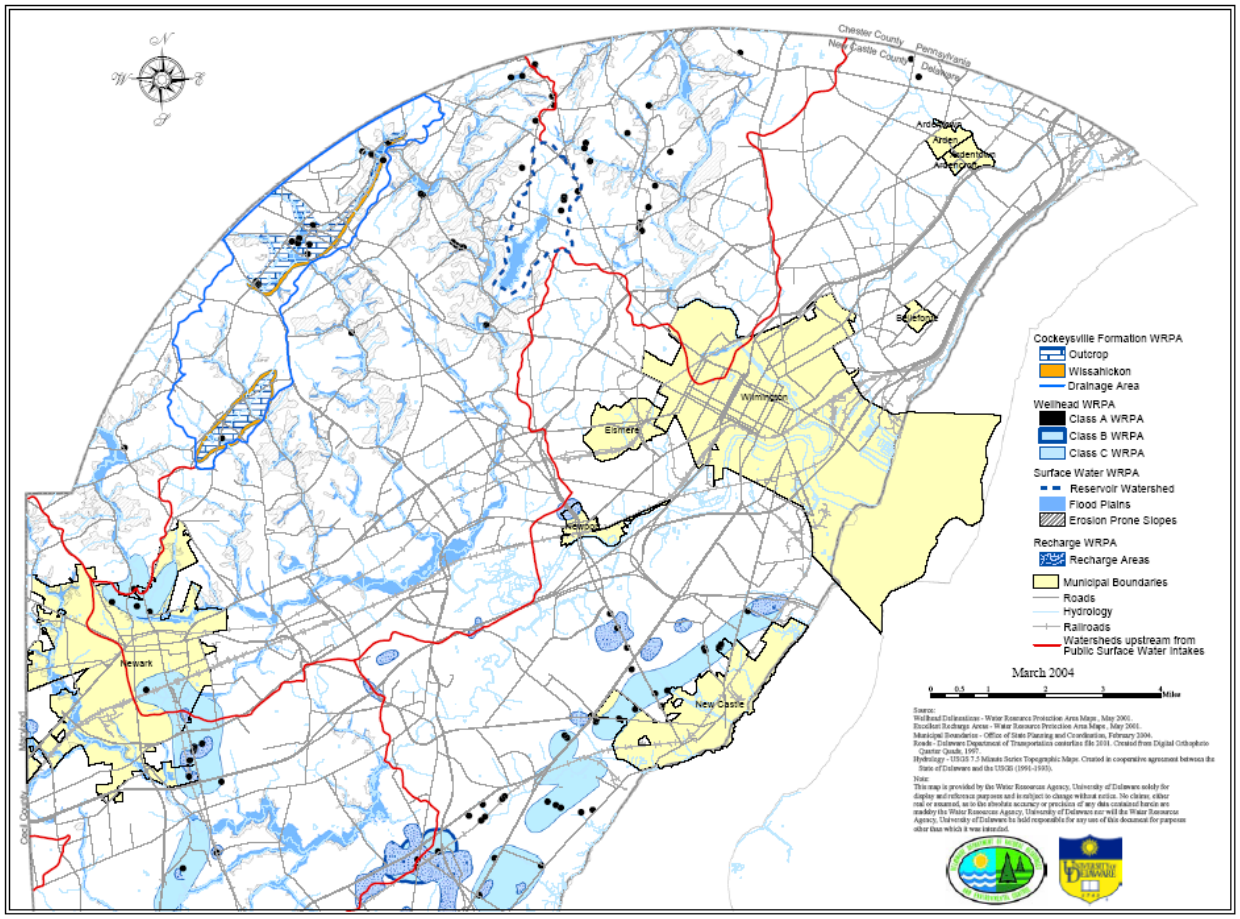
"The Department (DNREC) shall make source water assessment, wellhead protection, and excellent ground-water recharge potential area delineations available for maps developed as part of "Shaping Delaware's Future: Managing Growth in 21st Century Delaware, Strategies for State Policies and Spending" (December 1999)."

The following sections describe the status of surface water, wellhead protection, and ground-water recharge potential area mapping available for local governments in the state of Delaware.

2.3.1 Surface Water Resource Protection Areas

Surface water resource protection areas include the Cockeysville (limestone) Formation, reservoir watersheds, flood plains, and erosion-prone slopes protected by New Castle County Unified Development Code (adopted on December 31, 1997 and as amended). Figure 2.4 shows these areas for the City of Newark, City of Wilmington, and New Castle County, Delaware.

Figure 2.4 Northern New Castle County Water Resource Protection Area



2.3.1.1 Cockeysville Formation

The Cockeysville Formation is situated near Hockessin, Delaware, and 1) consists of outcrop areas that are directly underlain by limestone, and 2) land surface areas that drain to the areas underlain by the Cockeysville Formation (Cockeysville Formation Drainage Area). The location of the Cockeysville Formation were obtained from Plate 1 of a 1991 report by the Delaware Geological Survey titled *Summary Report, Geology and Hydrology of the Cockeysville Formation, New Castle County, Delaware*. The Cockeysville Formation Drainage area was derived from a watershed boundary delineated on United States Geological Survey (USGS) 7.5-minute topographic quadrangle maps. The delineated area methodology can be found in the 1999 DGS Report by Groot and Jordan titled, "The Pliocene and Quaternary Deposits of Delaware: Palynology, Ages, and Paleoenvironment". By New Castle County Code, new development in the Cockeysville areas is limited to 20% impervious cover by right.

The Cockeysville Formation creates environmentally sensitive areas because the limestone rocks that comprise the formation (calcite and dolomite) are fractured and subject to dissolution. The associated complex sub-surface drainage system, potential for rapid ground water movement, and sinkhole formations make the ground water in this area highly susceptible to contamination. In addition, recharge to this formation that is essential for maintaining the ground-water resource is limited by the relatively small outcrop areas. The formation currently supports public and private water supply wells producing an average of more than 1.5 million gallons per day.

2.3.1.2 Reservoir Watersheds

Reservoir watersheds include the two-square mile watershed that drains to the City of Wilmington's Hoopes Reservoir and drainage areas tributary to future reservoirs. The watershed boundary for Hoopes Reservoir was delineated from USGS quadrangle topographic mapping[7]. By New Castle County Code, new development in the Hoopes Reservoir watershed area is limited to 10% impervious cover.

2.3.1.3 Floodplains

This WRPA consists of the floodplain upstream from public water intakes situated at the Brandywine Creek at Wilmington, Red Clay/White Clay Creeks at Stanton, White Clay Creek at Newark, and Christina River at Smalleys Pond. It consists of the 100-year floodplain as defined by Federal Emergency Management Agency Flood Insurance Study mapping for New Castle County, City of Newark, and City of Wilmington, and flood hazard soils mapped by the New Castle County Soil Survey, United States Department of Agriculture (USDA) in1970. New Castle County Code permits no new development in the floodplain WRPA.

2.3.1.4 Erosion Prone Slopes

These steep slope areas are contiguous to and draining toward a floodplain or watercourse upstream of an approved public water supply intake. Erosion prone slopes consist of land with

[7] USGS 1993 and WRANCC 1987.

slopes in excess of 15% with soils of USDA Soil Conservation Service capability classifications Ive, Vie, Vis, and VIIIe as mapped by the Soil Survey of New Castle County (1970).

2.3.2 Wellhead Water Resource Protection Areas

Wellhead protection areas are surface and subsurface areas surrounding public water supply wells or wellfields where the quantity or quality of ground water moving toward such wells or wellfields may be adversely affected by land use activity. Such activity may result in a reduction of recharge or may lead to introduction of contaminants to ground water used for public supply.

There are three classes of Wellhead WRPAs, which are protected by ordinances in New Castle County, the City of Newark, and the Town of Townsend. These areas are delineated on a three map series entitled *WRPAs for the City of Newark, City of Wilmington, New Castle County, Delaware* (1993, revised May 2001), prepared by the UDWRA. In addition, the Delaware Wellhead Protection Plan (WHPP) provides wellhead delineation criteria for municipalities and counties that do not have specific wellhead protection ordinances. The WHPP sets a 150-feet radius of protection around wellhead WRPAs on all public water wells unless a county or municipality enacts a more restrictive ordinance.

Class A Wellhead WRPAs are the area within a 300-feet radius circle around all public water supply wells classified as public water systems as defined by Section 22.146 Public Water Systems (PWS) in the State of Delaware Regulations Governing Public Drinking Water Systems. Class A wells are community (public water purveyors), transient non-community (restaurants, stores, hotels, parks, etc.), and non-transient non-community (schools, daycare centers, office, factory). No development is permitted in this area by the New Castle County, Newark, and Townsend ordinances. New Castle County allows the protection area around the well to be reduced to a 150-feet radius provided a hydrogeological report is prepared by a Delaware Registered Geologist and submitted to the satisfaction of the DGS and the DNREC. The report must certify that 1) the minimum 60-day time of travel from a point to the public water supply well is maintained and 2) the well draws from a confined deep aquifer.

The Delaware Rural Water Association (DRWA), with the assistance of DNREC, has developed a five-step wellhead protection plan that helps smaller public water systems delineate wellhead protection areas and contingency plans. DRWA believes comprehensive wellhead protection plans should include the following steps:

1) Select a planning team
2) Define the wellhead protection area
3) Identify sources of contamination
4) Manage sources of contamination
5) Plan for the future and develop a contingency plan

Class B Wellhead WRPAs are the Glendale and Eastern States Wellfields along Route 40 in New Castle County. These wellhead protection areas have been delineated through the use of hydrogeologic mapping, analytical methods, and application of USEPA modular semianalytical models using a five year time of travel. The methodology is explained in a report by the DGS

entitled "Application of the EPA Wellhead Protection Area Models for Delineation of Wellhead Protection Areas in the Glendale and Eastern States Wellfield, New Castle County, Delaware" (January 1993).

Class C Wellhead areas are delineated in New Castle County and the City of Newark by the DGS and the DNREC through the interpretation of geologic and hydrologic reports and maps, water table maps, and best professional evaluation of available hydrogeological data.

The City of Smyrna and Town of Delmar have passed ordinances to protect wellhead areas. DNREC delineated the wellheads for these municipalities using computer-modeling techniques.

2.3.3 Ground-Water Recharge Water Resource Protection Areas

The DGS has delineated ground-water recharge potential areas for all three counties in Delaware. In 1993, the DGS delineated recharge areas that are referenced by the New Castle County, City of Newark, and Town of Townsend ordinances. In 2002, the DGS completed the delineation of ground-water recharge potential mapping for Kent and Sussex Counties, which provide the basis for future source water protection ordinances in these areas. Soils with excellent recharge potential are recommended for protection through source water resource protection area ordinances.

New Castle County – Recharge water resource protection areas are designated as having excellent potential for ground-water recharge. They were delineated using methodology described in a report prepared by the DGS entitled: *Delineation of Ground-Water Recharge Resource Protection Areas in the Coastal Plain of New Castle County, Delaware* (1993). Excellent recharge areas were determined from a grid of well completion reports and soil boring logs. A stack unit mapping approach was used to evaluate the recharge potential of soils to a depth of 20 feet below the ground surface. Soils with excellent recharge potential consist of mostly sand and material coarser than sand with a trace (0 to 10%) of silt or clay.

Kent and Sussex Counties – In 2002, DGS completed ground-water recharge potential maps in Kent and Sussex Counties (Figures 2.5 and 2.6) that show land areas characterized by their abilities to transmit water from land surface to a depth of 20 feet. The basic methods for mapping ground-water recharge potential are presented in *DGS Open File Report No. 34* (Andres, 1991) and were developed specifically for the geohydrologic conditions present in the Atlantic Coastal Plain of Delaware. Recharge maps are used in state and county resource protection programs and in digital ground-water flow modeling and geologic mapping research.

The only modification to the published method (Andres, 1991) is that flow-net analysis is not used to discriminate recharge areas from discharge areas. As a result, recharge potential has been mapped for almost all land areas not depicted as water, swamp, or marsh on USGS 1:24,000-scale topographic maps. A systematic methodology for mapping areas that have undergone significant filling, excavation, or regrading could not be developed; therefore, recharge potentials are designated as "pit/fill" for these areas. Approximately ten years of field, laboratory, and geographic information systems (GIS) work were invested in producing recharge potential maps. Over 6,900 well and test boring logs and more than 400 descriptions of outcrops and hand auger

borings were used for mapping in Kent and Sussex counties. About 600 of these were test borings drilled and logged by staff of the DGS for this project. Another 580 well and test boring logs were used for a similar mapping project in New Castle County (Butoryak and Talley, 1993). Single-well aquifer tests were completed in nearly 200 wells to establish the relationships between earth materials and hydraulic properties that are the basis for recharge potential characterization. More than 400 grain-size distribution tests were run on outcrop and borehole samples to test the accuracy of field descriptions.

The GIS data are distributed in the North American Datum of 1983, Universal Transverse Mercator Zone 18-North map projection, in meters. The GIS data are in ESRI, Inc., interchange format (E00) and can be imported into ArcView or ArcMap as coverages. The attribute "recharge" contains the recharge potential rating. Users should consult their user guide for instructions on how to import the data. A metadata file in .xml format is also included. These maps, developed through the application of generally accepted geologic principles and practices, represent our knowledge at the time of production. They were derived through interpretation of site-specific boring and outcrop exposure data located across the map area. Thus, the lines on the map must be considered on the basis of the scale at which they were mapped and the data from which they were derived. Because specific subsurface conditions between individual data points are not certain, precise location of any individual map feature requires investigation on a more detailed scale. Data used in constructing the map are available at the DGS offices (www.udel.edu/dgs).

Figure 2.5 DGS Ground-Water Recharge Potential for Kent County

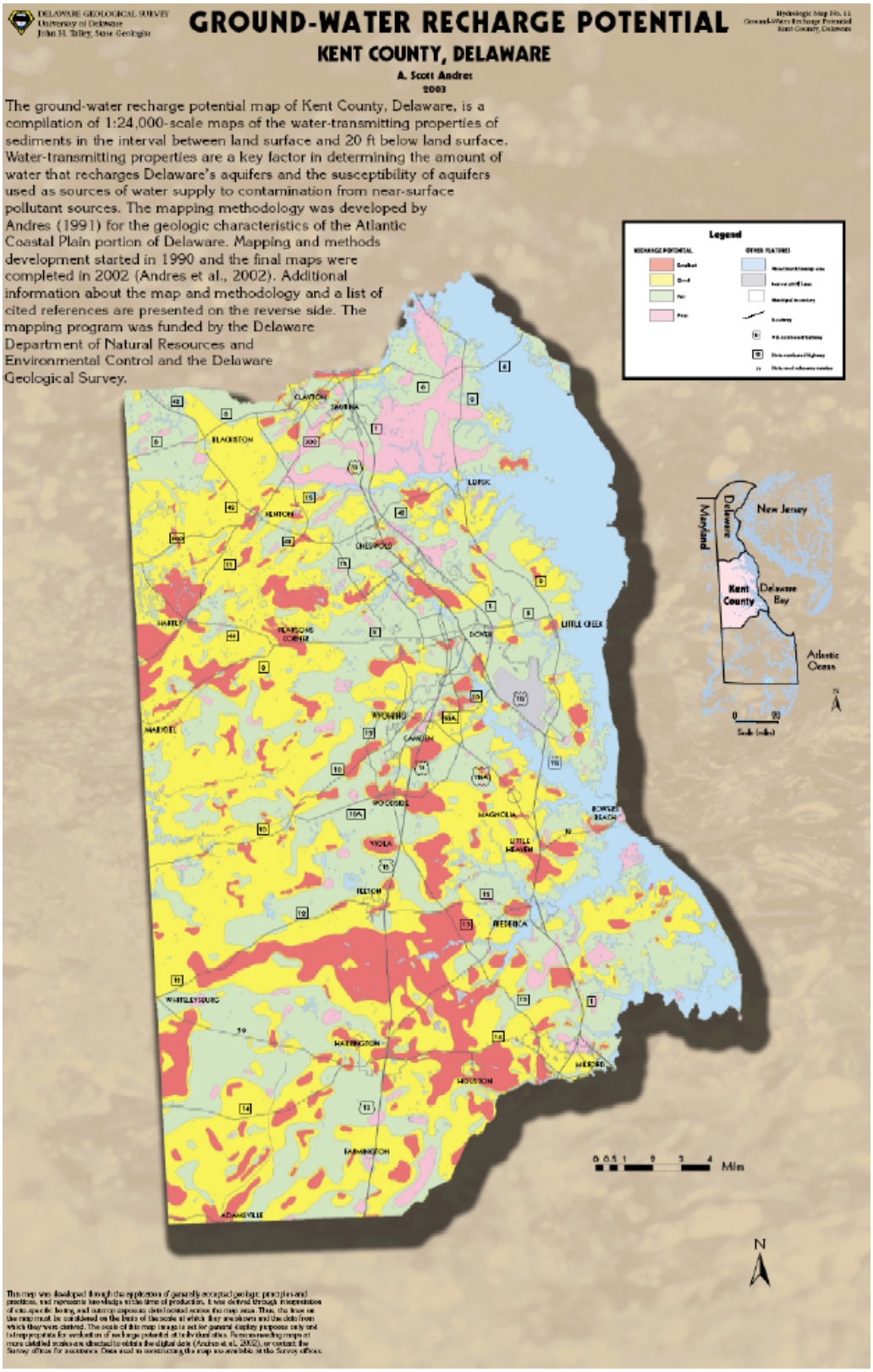


Figure 2.6 DGS Ground-Water Recharge Potential for Sussex County

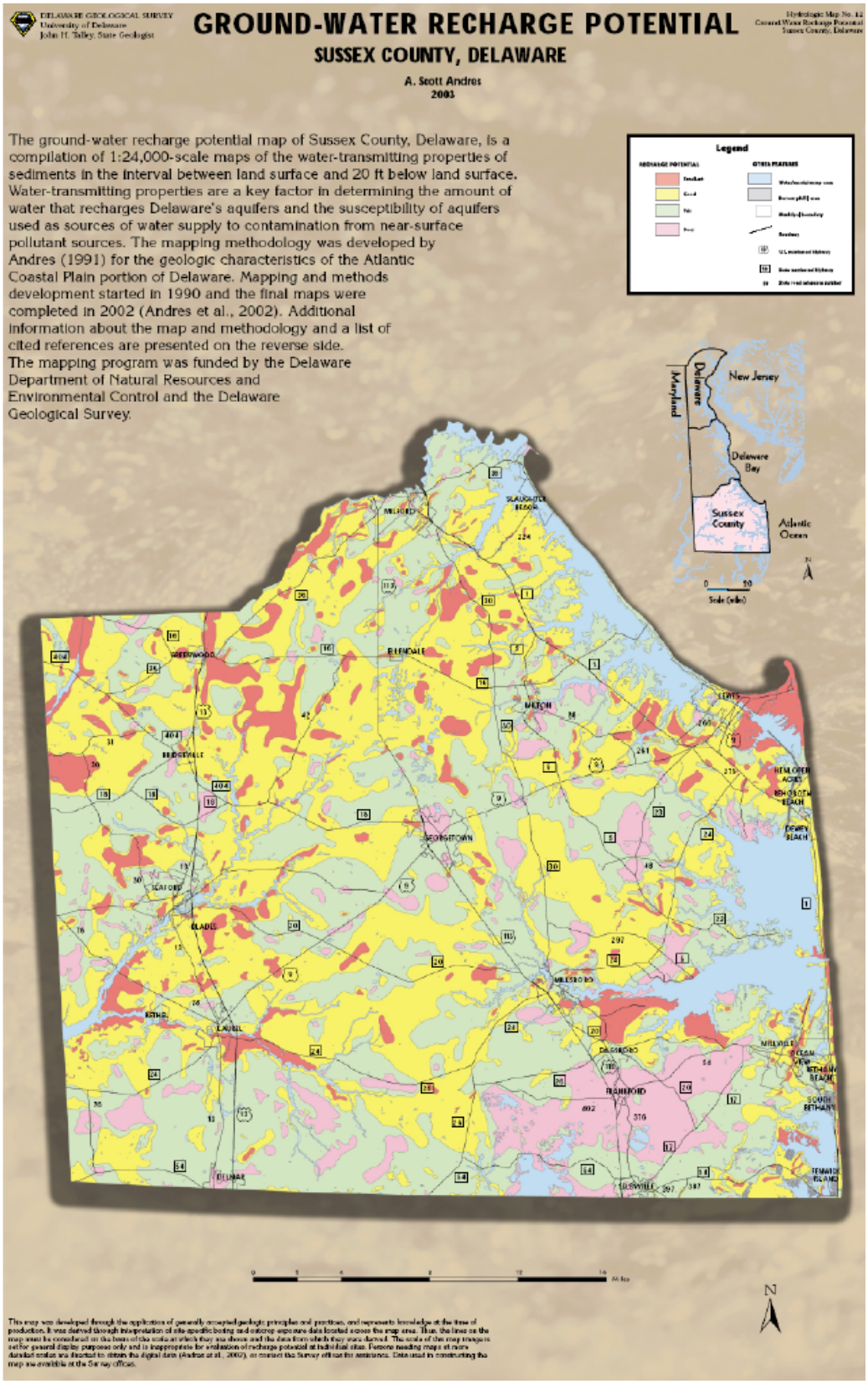


Table 2.2 shows the local governments in Delaware that have delineated WRPAs within their boundaries and WRPA ordinances adopted by local governments. Figures 2.7, 2.8, and 2.9 delineate the different types of WRPAs in the three counties in Delaware

Table 2.2 Status of Source Water Protection Area Mapping and Ordinances in Delaware

		Source Water Mapping (Is it mapped and do the counties and municipalities fall within the mapped source water areas?)			**WRPA Ordinance adopted by local government?**		
	Population	**Surface Water**	**Wellhead**	**Recharge**	**Surface Water**	**Wellhead**	**Recharge**
New Castle County* (unincorporated)	376,734	√	√	√	√	√	√
Arden	474						
Ardencroft	267						
Ardentown	300						
Bellefonte	1,249						
Delaware City	1,453		√				
Elsmere*	5,800						
Middletown*	6,161		√	√			
Newark*	28,547	√	√	√		√	√
New Castle*	4,862		√				
Newport	1,122			√			
Odessa	286		√				
Townsend	346		√	√		√	√
Wilmington*	72,664	√					
Kent County* (unincorporated)	70,629		√	√			
Bowers Beach	305		√				
Camden*	2,100		√	√			
Cheswold	313		√	√			
Clayton	1,273		√	√			
Dover*	32,135		√	√			
Farmington	75						
Felton	784		√	√			
Frederica	648		√	√			
Harrington*	3,174		√	√			
Hartly	78			√			
Houston	430			√			
Kenton	237		√	√			
Leipsic	203		√				
Little Creek	195		√	√			

		Source Water Mapping (Is it mapped and do the counties and municipalities fall within the mapped source water areas?)			WRPA Ordinance adopted by local government?		
	Population	**Surface Water**	**Wellhead**	**Recharge**	**Surface Water**	**Wellhead**	**Recharge**
Magnolia	226		√	√			
Milford*	6,732		√	√			
Smyrna*	5,679		√	√		√	
Viola	156		√	√			
Woodside	184			√			
Wyoming	1,141		√				
Sussex County* (unincorporated)	121,419		√	√			
Bethany Beach	903		√	√			
Bethel	184						
Blades	956		√	√			
Bridgeville	1,436		√	√			
Dagsboro	519		√	√			
Delmar	1,407		√			√	
Dewey Beach	301						
Ellendale	327		√	√			
Fenwick Island	342		√				
Frankford	714		√				
Georgetown*	4,643		√	√			
Greenwood	937		√	√			
Henlopen Acres	139		√				
Laurel*	3,668		√	√			
Lewes*	2,932			√			
Millsboro*	2,360		√	√			
Millville	259		√	√			
Milton	1,657		√	√			
Ocean View	1,006			√			
Rehoboth Beach	1,495		√				
Seaford*	6,699		√	√			
Selbyville	1,645		√				
Slaughter Beach	198		√				
South Bethany	492		√	√			

These municipalities/counties do not contain delineated source water protection areas within their boundaries.

* Denotes a county or municipality with 2,000 or more year-round residents according to U.S. Census 2000. The Delaware Source Water Protection Law of 2001 requires local governments wit year-round populations of 2,000 or more to develop maps and regulations to protect source water areas by 2007.

Figure 2.7 New Castle County Source Water Protection Area

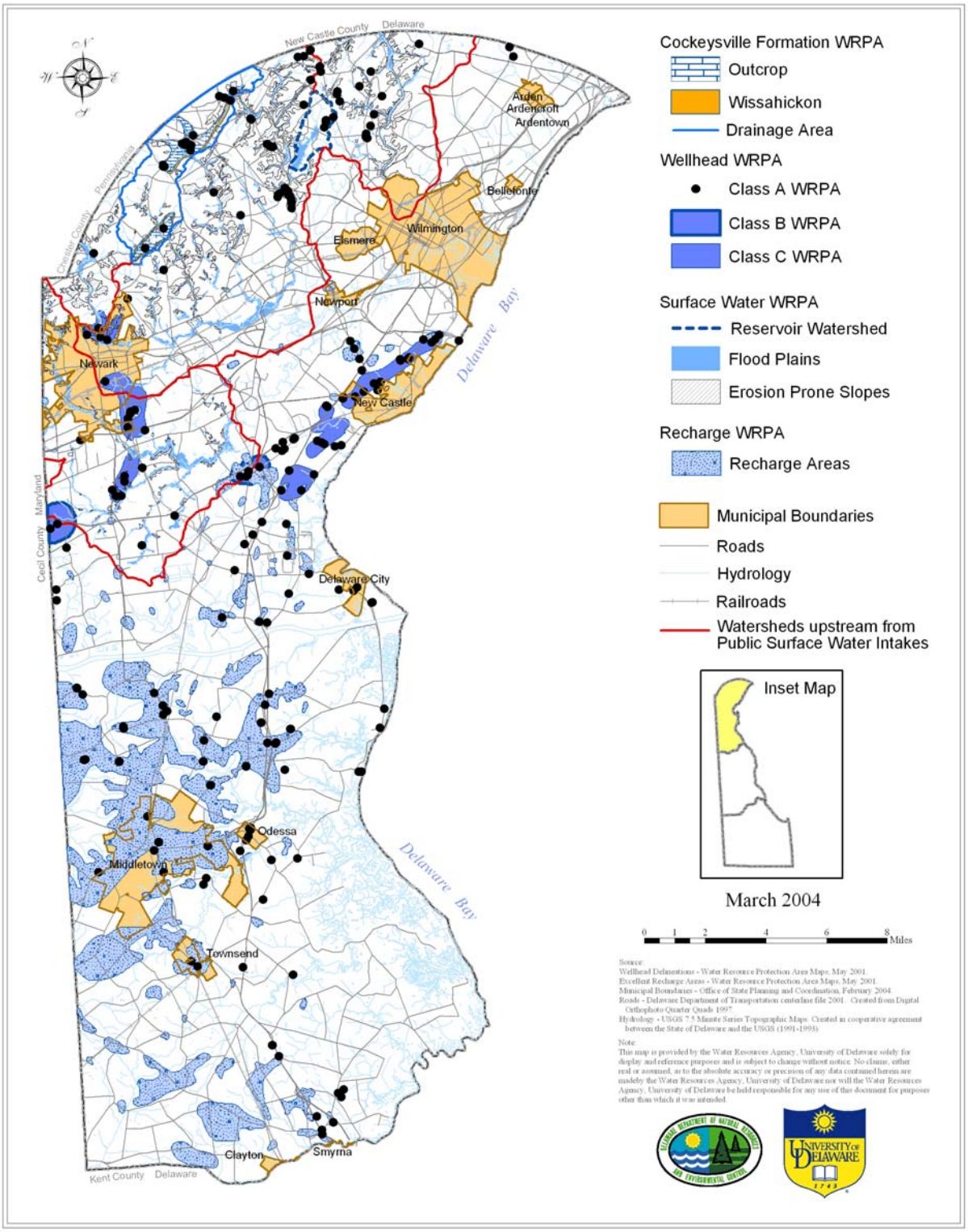


Figure 2.8 Kent County Source Water Protection Area

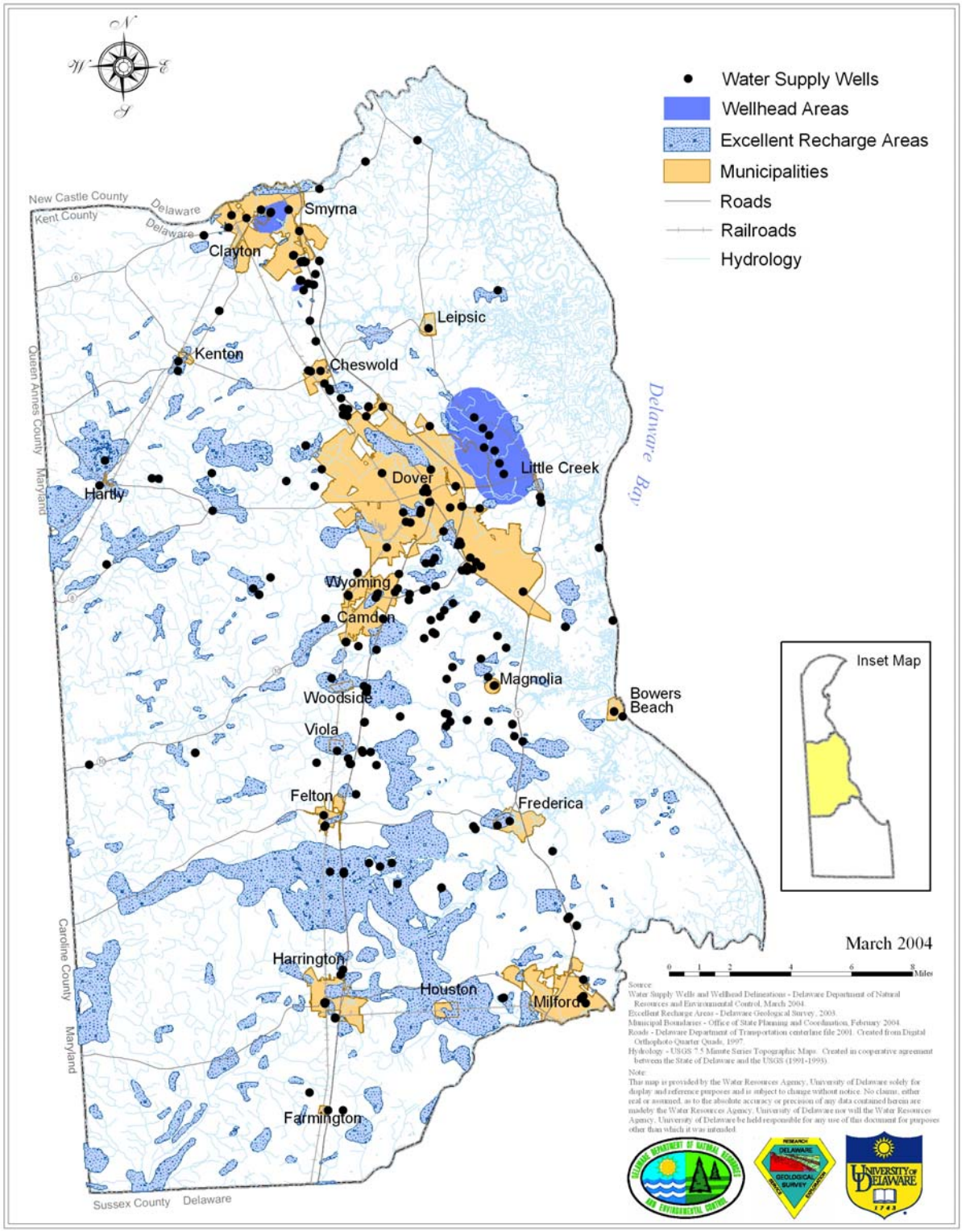
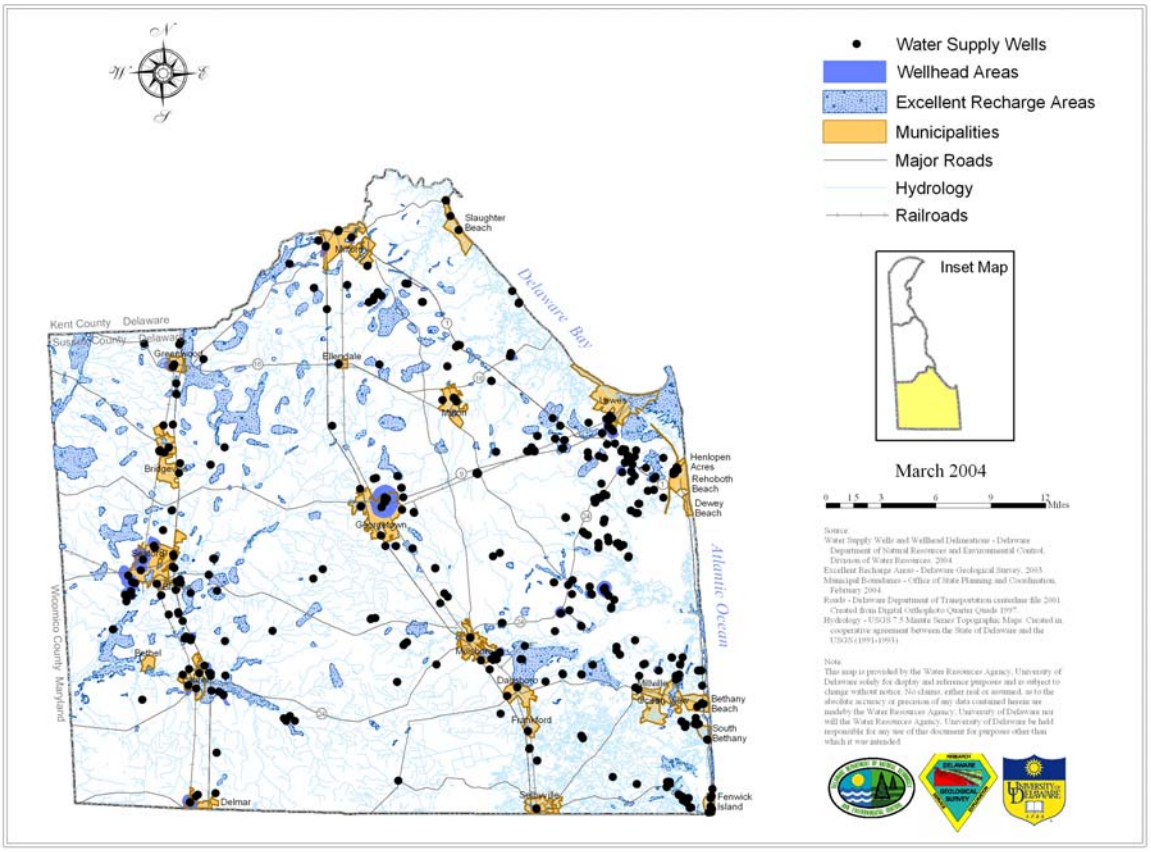


Figure 2.9 Sussex County Source Water Protection Area



CHAPTER 3: SUMMARY OF SOURCE WATER PROTECTION PRACTICES

3.1 Land Use Tools [8]

Land use tools, such as zoning ordinances and building codes, are often the most effective way to protect surface and ground-water sources. These tools provide flexibility to economically develop specific land parcels in environmentally sensitive ways given the unique opportunities and constraints of each property. They also require local officials to examine and evaluate their land use programs to determine whether changes should be made to better protect source water areas. The specific alternative land use tools used in any given situation will depend on state law, the types of land uses in the source water protection area, and the risks that land uses pose to the water supply.

Land use measures serve as critical tools for local governments to use in protecting their drinking water sources. Local governments are advised to consider the following "ground rules" developed by Kundell and DeMeo in *Source Water Protection: A Guidebook for Local Governments* when considering land use regulations:

- Does the authority exist to regulate private property?
- Is the regulation clear?
- Does the regulation comply with procedural due process requirements?
- Does the regulation comply with substantive due process requirements?
- Does the regulation violate the equal protection clause?
- Does the regulation unlawfully take private property without just compensation?
- Is the regulation based on a comprehensive land use, or other locally adopted plan?
- Is the purpose and intent of the regulation clearly spelled out in the local ordinance?
- Does the regulation include a process that provides for variances and special exceptions?
- Will the plans and regulations be revised and updated on a regular basis?
- Has the local community been included in development of proposed land use ordinances and regulations?

Local governments that apply these principles to their ordinances and regulations are more likely to have public support for protection of source water supplies.

3.1.1 Zoning Ordinances

A zoning ordinance is the basic legal instrument used by local governments to address land use matters. It divides land into districts, separating incompatible uses from each other while allowing other uses to coexist. A zoning code includes a map outlining the various districts that permit residential, commercial, industrial, agricultural, and other uses as well as a written portion that establishes the conditions under which land may be developed and used for particular purposes. Regulations may control the size and height of structures, building density, setback

[8] adapted from Kundell and DeMeo, 2000

requirements, and other conditions for each district. They may also restrict the development of specific activities that are potential sources of contamination such as landfills; wastewater treatment plants; business concerns that store, use, or process hazardous materials or contaminants of concern; and large animal feeding operations. A draft model ordinance developed for the Town of Middletown can be found in Appendix C. A shorter version draft water resource protection area ordinance for smaller municipalities is in Appendix D.

Local governments can use a variety of alternative zoning tools to protect surface and ground-water sources. These tools are usually implemented through local ordinances, but some may require state enabling legislation. Local governments should solicit citizen input before implementing any of these zoning tools. They may prohibit activities or land uses that present a risk of contamination in source water protection areas, establish performance and financially based protection measures, or require a permit or contractual agreement to conduct certain activities.

This manual is intended as a toolbox for local jurisdictions to use to protect the sources of their drinking water. The manual is not intended to be adopted in total. The zoning ordinances listed below may or may not be applicable to each local government.

Buffer and setback zoning designates linear or circular areas of land along the edges of streams, rivers, or reservoirs upstream of community water supply intakes. This tool is an important protection mechanism since land use restrictions in the zones reduce the adverse impacts of surface water runoff on drinking water sources. Buffers and setbacks provide water quality protection by filtering runoff that transports contaminants from land to water supplies. They can also minimize flooding, preserve wildlife habitat corridors, maintain stream bank integrity, protect aquatic habitat, and provide recreation areas. The most effective buffers and setbacks are naturally vegetated strips of land 50 to 400 feet in width. Exact determination of width is flexible, based on such factors as topography and slope, classification of the stream or water body, current and future land uses in the watershed, costs, and political realities.

Cluster development provides options for grouping units in a portion of the total development area. This tool is implemented through cluster zoning and planned unit developments that maintain the overall density of land parcels, but provide flexibility where development occurs and what lands are left in more natural conditions. Benefits of cluster development include surface and ground water protection, preservation of green space and natural features, and reduced capital outlay for roads, power lines, water lines, and sewer lines.

Conservation subdivision ordinances enable the developer to concentrate development on suitable parts of the land parcel, resulting in less impervious surface, reduced infrastructure costs, and better source water protection. They allow flexible development designs that are based on the natural features of the site, enabling the developer to protect stream corridors, wetlands, and other sensitive areas. This tool can direct the set-aside of a percentage of the development in a natural state, targeting the protection of sensitive areas.

Critical area zoning can protect highly vulnerable portions of the source water protection area. It imposes restrictions or prohibitions and requires review standards for developments in water

supply watersheds, areas with steep slopes, floodplains, wellhead protection zones, significant ground-water recharge areas, and similar sensitive areas. It often allows for non-intensive uses such as some types of agriculture or recreation fields that preserve the water quality functions of the land (e.g., floodplains that filter water pollutants).

Density or impervious cover standards protect water quality by limiting the impervious cover or concentration of facilities or activities generating or handling contaminants that singularly or in limited numbers may be acceptable, but threaten to pollute water supplies when aggregated. Density standards can increase the percentage of land that is able to absorb, filter, or immobilize pollutants.

Development agreements are binding legal contracts, usually between a landowner/developer and the local government, that specify how the development project will be implemented. Parties to the agreement negotiate permit conditions in exchange for public benefits (such as protection of water resources). This tool may be most useful in large developments where it is beneficial for all concerned that stable and predictable development will occur. On a less formalized basis, local governments may also negotiate ad hoc agreements with developers that identify development restrictions, public benefits, or amenities as conditions for permit approval.

Impact fees collect money from new development applicants based on a formula that calculates impacts on natural resources and local infrastructure caused by development. The fee structure is typically codified within the zoning ordinance. The local government applies the fees to offset the impacts on water quality. This may involve installing storm water infrastructure or acquiring critical land in the source water protection area. This tool may require state enabling legislation that authorizes local governments to enact and assess impact fees.

Large-lot zoning establishes minimum lot sizes that also provide water protection through the greater infiltration capacity of increased green space. On a watershed-wide basis, large-lot zoning is an important water management tool, but it must be weighed against other public policy concerns. Large-lot zoning can increase impervious surfaces (e.g., roads) and infrastructure costs, and can contribute to urban sprawl.

Overlay districts enforce additional zoning restrictions on top of underlying zoning. Land uses in overlay districts must then conform to the restrictions set for both zones. This approach can be used to identify and set additional protective measures such as impervious cover thresholds for water supply watersheds, wellhead protection areas, floodplains, wetlands, and significant ground-water recharge areas. The New Castle County Unified Development Code utilizes the overlay zoning district approach to protect water resource protection areas.

Performance-based zoning uses an impact assessment approach to determine the limitations of the ability of the land to handle proposed development and/or to set design standards to be met by the potential land uses. Proposed developments must meet stipulated restrictions or standards. The regulations can be based on sewage capacity, acceptable volume of surface water runoff, or other relevant factors established for the area in which they wish to locate.

Subdivision requirements set standards for public improvements, which can be designed to protect community water systems and source water supplies. In addition to identifying water

supply and wastewater management options, subdivision regulations specify site design, engineering, and construction requirements for streets, curbs, gutters, and other drainage structures; the use of impervious surfaces to protect on- and off-site water resources; requirements for on-site wastewater and erosion and sedimentation control; and dedicated areas for ground-water recharge or public amenities (such as open space).

New Public Water System Wells should be located far enough away from a subdivision boundary to limit the overlap of the WHPA onto adjacent properties. This specified location requirement would limit the impact that the new wellhead protection area would have on the neighboring property owners.

Transfer of Development Rights allow density transfers by establishing "sending" and "receiving" zones in a community or in a watershed. This allows "senders" to be paid for giving up development rights on their property. These rights are transferred to property in a receiving zone that can be developed more densely. This tool keeps lands in a sending zone in an undeveloped state to protect water resources as well as preserve agricultural and open space. Developers in receiving zones increase their profit by increasing density through the purchase of off-site development rights. Critical area development rights may also be purchased.

3.1.2 Building Codes

Local governments use building codes to protect the health, safety, and welfare of their citizens. Some standards may be required by the state, while other standards address local concerns. Building codes prevent fires, encourage sound, steady growth, and maintain funding eligibility for some types of grant assistance. Some aspects of building codes may be mandatory (such as electrical, plumbing, gas, and fire prevention), while other aspects are permissive (such as requirements relating to historic preservation, swimming pools, excavation and grading, and impervious surfaces).

Building codes that can be used as tools to protect source water include the following:

Building permit limitations are quotas on the number of permits issued in a specified time period or within a specified geographic area to limit the type, timing, distribution, or total amount of new construction. Such limitations are most commonly used to ensure that development and infrastructure expansion occur simultaneously.

Excavation, grading, and seeding codes regulate the amount and quality of surface runoff that leaves a site during and after construction.

Impervious surface codes control the proportion of a building site that can be covered by nonporous roads, roofs, parking lots, driveways, sidewalks, and other pavements without capturing and/or treating the runoff. These codes limit the generation of runoff and the pollutants it carries, while allowing development of any type and intensity to occur.

Onsite wastewater systems/septic systems provide means to treat wastewater from larger lots in rural areas. Further guidance regarding onsite wastewater systems and septic systems can be sought from:

- www.dnrec.state.de.us/dnrec2000/P2/septic
- www.epa.gov/owm/mtb/decent/index

Phased development codes regulate the timing of land-disturbing activities on a building site. This protection measure requires that construction be completed to a stage where exposed land is stabilized before another section of the site is placed under construction. By minimizing the amount of exposed land to that under active construction, runoff can be diminished and controlled by vegetative cover.

Porous pavement codes require the use of specific materials such as permeable asphalt, concrete, and crushed stone or gravel; open-celled pavers (such as concrete or plastic grids with voids that are filled with topsoil and seeded or filled with porous aggregate); grass; paving stones; and wood mulch. These materials can be used for street pavements, driveways, parking lots, sidewalks, bike and footpaths, pedestrian plazas, and courts where appropriate to increase the capture, infiltration, and treatment of runoff through the underlying soil.

Underground Storage Tanks[9] are constructed to store petroleum products and chemicals.

In New Castle County, the Unified Development Code states that underground storage tanks containing petroleum products or any hazardous substances listed in 40 CFR116 in an aggregate quantity equal to or greater than a reportable quantity as defined in 40 CFR 117 shall not be permitted in designated surface, wellhead, and recharge water resource protection areas.

In Kent and Sussex Counties, DNREC applies the following policy toward the construction of underground storage tanks in recharge and wellhead areas. DNREC recognizes the need to protect ground water in the State from leaking underground storage tanks. Title 7, Del. Code Section 7416 of the Underground Storage Tank Act provides that:

> "Because ground water protection and management is an underlying issue related to leaking underground storage tanks, information on the risks to ground water resources will be needed to facilitate implementation of the regulations. The Delaware Geological Survey shall, under the auspices and direction of the Committee, and in cooperation with the Department, examine the need for prioritizing possible leak risks. The Survey may assist the Committee by identifying areas where existing or abandoned leaking underground storage tanks would pose the most significant risk."

As a result, DNREC, in conjunction with DGS, developed guidelines and a set of maps which will be used to determine areas where additional measures, such as secondary containment or additional leak detection monitoring of underground storage tank systems, are required to protect ground water. The maps are a compilation of data from a variety of sources and include the locations of public water supply wells that obtain their water from unconfined and semi-confined

[9] DNREC – Division of Water Resources. 2002.

aquifers, valuable water resource areas where unconfined aquifers have high transmissivity, a ground-water recharge zone near Dover, and aquifer subcrop areas.

In general, DNREC is currently requiring secondary containment as required for all tanks installed within 1,000 feet of a public water supply system (a well which serves 25 or more people or which has more than fourteen connections) and in areas which have the potential to be used for public water supplies in the near future. The maps showing these areas are currently available for public review in DNREC's New Castle Office (391 Lukens Drive, New Castle).

DNREC also recognizes the need to develop a system for easily identifying registered underground storage tanks. Therefore, DNREC will develop a tag that can be distributed for attachment to all registered underground storage tanks. The owner will be able to attach the tag to the fill neck of the tank. This means of identification will facilitate the job of compliance inspectors and also will enable drivers of product delivery vehicles to identify registered and unregistered tanks quickly and easily.

The following BMPs are recommended to protect source water areas in Delaware:

- Sediment and Stormwater Control Best Management Practices
- Urban/Suburban Best Management Practices
    - Green Technology Best Management Practices
        - Bioretention Basins
        - Infiltration Basins
        - Dry Wells
        - Porous Pavement
    - Stormwater Wetland Areas
    - Wet Ponds
- Agricultural Best Management Practices

3.2 Sediment and Stormwater Control Best Management Practices

BMPs minimize the impact of land use changes and other human activity on the natural environment by effectively reducing the volume of runoff leaving a site, maintaining the volume of natural recharge, and preventing the discharge of pollutants into the source water system. This section contains information on sediment and stormwater control, suburban/urban BMPs, and agricultural BMPs. The tools recommended in this manual are based on current science and technology. Please be aware that certain aspects of the tools recommended are subject to change as new methods are discovered; proper authorities should be consulted before implementation.

The following requirements are taken directly from Delaware Sediment and Stormwater Regulations. For further information, contact DNREC Division of Soil and Water Conservation – Sediment and Stormwater Program, and see Appendix K for the full version of the regulations.

Sediment and Stormwater Program, Division of Soil and Water Conservation
Delaware DNREC, 89 Kings Hwy, Dover, DE 19901 Phone: 302-739-4411

Website: www.dnrec.state.de.us/dnrec2000/Divisions/Soil/Stormwater/StormWater.htm

New development in source water resource protection areas shall comply with the Delaware Standards for Erosion and Sediment Control which can be ordered from DNREC, Division of Soil Erosion and Sediment Control at the following web site: www.dnrec.state.de.us/dnrec2000/Divisions/Soil/Stormwater/Apps/ESC_order_form.pdf.

Exemptions, Waivers and Variances

The following activities are exempt from both sediment control and stormwater management requirement established by these regulations:

1) Agricultural land management practices, unless the local Conservation District or the Department determines that the land requires a new or updated soil and water conservation plan and the owner or operator of the land has refused either to apply to a Conservation District for the development of such a plan, or to implement a plan developed by a Conservation District;

2) Developments or construction that disturb less than 5,000 square feet;

3) Land development activities which are regulated under specific State or federal laws which provide for managing sediment control and stormwater runoff;

4) Projects which are emergency in nature that are necessary to protect life or property such as bridge, culvert, or pipe repairs and above ground or underground electric and gas utilities or public utility restoration. The emergency nature of a project may preclude prior plan review and approval, but subsequent inspection may necessitate sediment

control or site stabilization in accordance with the provisions of this Chapter. The appropriate plan approval agency shall be notified orally or in writing within 48 hours of the initiation of such emergency activity. The appropriate plan approval agency shall determine and approve of the emergency nature of a project. If the nature of the emergency will require more than 120 days to accomplish construction, formal approval shall be obtained for sediment control and stormwater management. These activities must comply with other State, federal and local requirements; and

5) Commercial forest harvesting operations that meet the requirements of the Department of Agriculture under Subchapter VI, Chapter 29, Title 3, or the Delaware Code.

Plan Application and Approval Process

A sediment and stormwater management plan, or an application for a waiver, shall be submitted to the appropriate plan approval agency by the developer for review and approval for a land disturbing activity unless otherwise exempted. The sediment and stormwater management plan shall contain supporting computations, drawings, and sufficient information describing the manner, location, and type of measures in which stormwater runoff will be managed from the entire development. The appropriate plan approval agency shall review the plan to determine compliance with the requirements of these regulations prior to approval. The approved sediment and stormwater management plan shall serve as the basis for water quantity and water quality control on all subsequent construction. The sediment and stormwater management plan shall not be considered approved without the inclusion of an approval stamp, with signature and date on the plans by the appropriate plan approval agency.

Approved plans remain valid for 3 years from the date of an approval, unless specifically extended or renewed by the appropriate plan approval agency. The basis for extension or renewal may include, but not limited to, the following items:

1) Failure to initiate the approved project for reasons acceptable to the appropriate plan approval agency such as funding or other agency permit delays; or

2) Time duration for a type of activity typically exceeds three years.

General submission requirements for all projects requiring sediment and stormwater management approval include the following information:

1) A standard application form.

2) A vicinity map indicating north arrow, scale and other information necessary to locate the property or tax parcel.

3) A plan at an appropriate scale accompanied by a design report and indicating at least:
    a) Name and address of:
        i) The owner of the property where the project is proposed;
        ii) The land developer; and

iii) The applicant.

b) The existing and proposed topography, as required on a case-by-case basis.

c) The proposed grading and earth disturbance including:
   i) Surface area involved; and
   ii) Limits of grading including limitation of mass clearing and grading whenever possible.

d) Stormwater management and stormwater drainage computations, including:
   i) Pre- and post-development velocities, peak rates of discharge, and inflow and outflow hydrographs of stormwater runoff at all existing and proposed points of discharge from the site;
   ii) Site conditions around points of all surface water discharge including vegetation and method of flow conveyance from the land disturbing activity; and
   iii) Design details for structural controls which includes diversions and swales.

e) Federal Emergency Management Agency flood maps and federal and state protected wetlands, where appropriate.

f) The appropriate plan approval agency shall require that plans and design reports be sealed by a qualified design professional that the plans have been designed in accordance with approved sediment and stormwater ordinances, regulations, standards and criteria. The appropriate plan approval agency may waive this requirement on a case-by-case basis.

3.3 Urban/Suburban Best Management Practices

The following design information is taken directly from:

Delaware Sediment and Stormwater Regulations (www.dnrec.state.de.us/dnrec2000/Divisions/Soil/Stormwater/StormWater.htm)

North Carolina Department of Environment and Natural Resources *Stormwater Best Management Practices* (dem.ehnr.state.nc.us/su/PDF_Files/SW_Documents/BMP_Manual.PDF)

United States Environmental Protection Agency *Preliminary Data Summary of Urban Storm Water Best Management Practices* (www.epa.gov/OST/stormwater/).

For further information, contact:
Sediment and Stormwater Program, Division of Soil and Water Conservation
Delaware DNREC, 89 Kings Hwy, Dover, DE 19901 Phone: 302-739-4411

Website: www.dnrec.state.de.us/dnrec2000/Divisions/Soil/Stormwater/StormWater.htm

Stormwater BMPs have the capability to remove up to 99% of the pollutants entering streams and aquifers. Table 3.1 summarizes estimated pollutant removal efficiencies for various stormwater BMPs.

Table 3.1 Estimated Stormwater BMP Pollutant Removal Efficiencies

	Dry Ponds	Wet Ponds	Wetlands	Filters/Bioswales	Infiltration
Bacteria	78%	70%	78%	37%	5%
Total Phosp.	19%	51%	49%	59%	70%
Nitrate Nitrogen	4%	43%	67%	14%	82%
TSS	47%	80%	76%	86%	95%
Cu	26%	57%	40%	49%	N/A
Zn	26%	66%	44%	88%	99%

Source: Schueler and Holland, 2000

The following BMPs provide designers with information on recommended source water protection practices. The Delaware DNREC recommends that designers give high priority to the use of green technology BMPs. Selection of the best practice for a given site is recommended by the designer with approval by the DNREC Sediment and Stormwater Program.

3.3.1 Green Technology Best Management Practices

Infiltration is the process where stormwater enters soil, thus controlling the rate and volume of runoff leaving the site. The following infiltration devices are recommended for implementation:

Bioretention: First developed by the Prince George's County, Maryland, Department of Environmental Resources, bioretention is a BMP that uses plants and soils to remove pollutants and allow recharge of water. Runoff is treated using the physical and biological processes of transpiration, evaporation, storage and nutrient uptake between soil and plants. The treated water infiltrates into the soil or is collected by a system that discharges the water into the sewer system or receiving waters[10].

Infiltration basins: Designed to collect a certain volume of runoff, infiltration basins hold that volume and infiltrate it into the ground (normally no more than 48 hours after the two-year storm) in order to prevent mosquito breeding, odor problems and to ensure that the basin is ready to receive runoff from the next storm. Removal of pollutants (through filtration, adsorption and biological conversion) and ground-water recharge help infiltration basins restore and maintain the pre-development hydrology in a watershed[11].

Infiltration trenches and dry wells: Usually used to handle the water from parking lots and buildings, infiltration trenches and dry wells are ditches that fill with runoff and help infiltrate it into the soil. Filled with large crushed stone or created as concrete chambers, these BMPs can be compact or elongated depending on the area type. Due to the small amount of runoff they are able to capture (because of the types of areas they provide), they are typically used in combination with another BMP to control peak flows[12].

Porous pavement: Porous pavement is a system where runoff is infiltrated into the ground through a permeable layer of pavement. Those systems that are recommended are made of paving blocks with enough open area to allow water to pass through. This type of infiltration practice can be used in parking lots, roads, sidewalks and other paved areas. However, porous pavement systems are not suitable for all applications. Since porous pavement works only in low traffic areas without heavy equipment passage, it is a useful tool for residential driveways and streets and commercial parking areas[13].

Delaware Design Requirements[14]

Infiltration practices should be designed and constructed in accordance with the following criteria:

1) Areas draining to these practices must be stabilized and vegetative filters established prior to runoff entering the system. Infiltration practices shall not be used if a suspended solids filter system (pretreatment) does not accompany the practice. If vegetation is the intended filter, there shall be at least a 20 feet length of vegetative filter prior to stormwater runoff entering the infiltration practice. Infiltration practices that recharge runoff from rooftops will not require a pretreatment practice.

[10] North Carolina Department of Environment and Natural Resources. 1999.
[11] USEPA. 1999.
[12] North Carolina Department of Environment and Natural Resources. 1999.
[13] USEPA. 1999.
[14] DNREC – Division of Water Resources and Division of Soil and Water Conservation. 2001.

2) The bottom of the infiltration practice shall be at least three feet above the seasonal high water table, whether perched or regional, determined by direct piezometer measurements which can be demonstrated to be representative of the maximum height of the water table on an annual basis during years of normal precipitation, or by the depth in the soil at which mottling first occurs.

3) The infiltration practice shall have sufficient underlying soil permeability to hold and infiltrate the runoff from a 2-year storm within 48 hours.

4) Soils must have adequate permeability to allow water to recharge into the ground. Infiltration practices are limited to soils having an infiltration rate of at least 1 inch per hour. Initial consideration will be based on a review of the appropriate soil survey, and the survey may serve as a basis for rejection. On-site soil borings, textural classifications, and percolation tests must be conducted at the site of the proposed infiltration practice to verify actual site permeability and seasonal high water table conditions.

5) Infiltration practices greater than three feet deep shall be located at least 20 feet from basement walls.

6) Infiltration practices designed to handle runoff from impervious parking areas shall be a minimum of 150 feet from any public or private water supply well.

7) The design of an infiltration practice shall provide an overflow system with measures to provide a non-erosive velocity of flow along its length and at the outfall.

8) The slope of the bottom of the infiltration practice shall not exceed 5%. Also, the practice shall not be installed in fill material as piping along the fill/natural ground interface may cause slope failure.

9) An infiltration practice shall not be installed on or atop a slope whose natural angle of incline exceeds 20%.

Operation and Maintenance[15]

- Annual inspections must be conducted after a storm event to ensure infiltration performance.

- Grass filters should be mowed at least twice a year.

- Sediment deposits should be removed from pretreatment devices at least annually.

- Soil testing should be conducted annually so that the accumulation of toxins and heavy metals can be detected or prevented.

[15] North Carolina Department of Environment and Natural Resources. 1999.

- Vegetated areas should be mulched once the planting of trees and shrubs has occurred -- Ground cover established by seeding and/or consisting of grass should also be covered.

- Replacement of mulch layers may be necessary every 2 to 3 years in the spring.

- Plant material upkeep will include addressing problems associated with disease or insect infestations, replacing dead plant material, and any necessary pruning.

Advantages[16]

- Given that infiltration devices can often fit into areas with limited space, they may be the most cost-effective control available in some situations.

- There are situations where an infiltration device may be constructed beneath an impervious surface, thereby consuming no developable land.

- Infiltration devices put more stormwater into the soil, which more closely mimics the natural hydrology of the area and reduces the volume of water discharging into receiving streams.

- Increasing the amount of water entering the soil reduces the frequency of flooding and helps to maintain the shallow ground water that will support dry weather flows in streams.

- In general, pollutant removal should be as good as the best stormwater control practices.

- Planting systems, if sited properly, can improve the landscape value of the site, provide shade and wind breaks and absorb noise.

- Infiltration practices can address spatial constraints that can be found in intensely developed urban and suburban areas where the drainage areas are highly impervious. They can be used on small, urban sites that would not normally support the hydrology of a wet detention pond.

- The siting of infiltration devices can be very flexible allowing placement in areas such as parking lot islands, landscaped areas around buildings, the perimeter of parking lots, residential lots and other open spaces.

Disadvantages

- Infiltration can only be used where soils are permeable enough to infiltrate within 48 hours.

[16] North Carolina Department of Environment and Natural Resources. 1999.

- The greatest potential concern about infiltration practices is that infiltration of stormwater may contaminate ground water without proper pretreatment. To date, there is no evidence that recharge of stormwater via infiltration facilities has caused contamination of ground water.[17]

- Infiltration BMPs can experience reduced infiltrative capacity and even clogging due to excessive sediment accumulation. Regular maintenance is required to maintain the infiltrative capacity of the system[18].

3.3.2 Constructed Wetlands[19]

Stormwater wetlands are constructed systems designed to alleviate the impacts of stormwater runoff by temporarily storing runoff in shallow pools that create a suitable growth environment for wetland plants. Providing an excellent condition for pollutant removal, stormwater wetlands treat stormwater runoff in areas where ground water levels are close to the surface, allowing the necessary supply of water to sustain a system. Stormwater wetlands are not typically found in delineated natural wetland areas (protected under state and federal statute) and should not be confused with wetlands created to mitigate for the loss of natural wetlands.

Delaware Design Requirements[20]

Where existing wetlands are intended as a component of an overall stormwater management system, the following criteria shall apply:

- The only disturbance to the wetland, for the purposes of these regulations, shall be that disturbance caused by the stormwater management pond embankment placement and construction.

- The applicant can demonstrate that the intended or functional aspects of the stormwater management facility and wetlands are maintained or enhanced, or the construction in the wetland for stormwater management is the only reasonable alternative.

All other necessary state and federal permits can be obtained.

Operation and Maintenance[21]

- Wetlands that have no sediment pretreatment tend to accumulate sediment very rapidly and therefore need cleanout when they accumulate 6 inches of deposition, (which in most cases will take 5 to 10 years).

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[17] North Carolina Department of Environment and Natural Resources. 1999.
[18] USEPA. 1999.
[19] North Carolina Department of Environment and Natural Resources. 1999.
[20] DNREC – Division of Water Resources and Division of Soil and Water Conservation. 2001.
[21] North Carolina Department of Environment and Natural Resources. 1999.

- Wetlands tend to collect debris; it should be removed whenever it accumulates, or at least twice annually.

- Wetlands should be inspected annually or after a rain event to ensure that the basin is operating as designed.

- At a minimum, items that should be included in the inspection and corrected are clogging of the outlet or too rapid a release, erosion on the banks, erosion at the inlet and outlet, sediment accumulation and the need for removal, condition of the emergency spillway and woody vegetation in the embankment.

Advantages[22]

- Because stormwater wetlands are relatively efficient in removing sediment from the water column, they are also relatively efficient at removing pollutants, (such as phosphorus, trace metals, and hydrocarbons), that are absorbed to the surfaces of suspended particles.

- The plants that characterize a stormwater wetland can also be an advantage when considering aesthetics. Properly landscaped and maintained, a stormwater wetland can provide a natural, park like setting.

- The volume of most stormwater wetlands is such that they flush water through them within one week and thus do not become problem areas for mosquito breeding.

[22] North Carolina Department of Environment and Natural Resources. 1999.

Disadvantages[23]

- They occupy more land than other stormwater BMPs.
- Hydrophytic (water-loving) soils are required.
- Wetlands sited in watersheds that are too small will tend to dry out more frequently, and these can become a nuisance. (In most cases this can be avoided by proper sizing, and providing a drainage area of not less than 10 acres).
- There is a difficulty, at times, in finding sources for wetland plant material.
- Due to concerns with West Nile Virus, constructed wetlands in residential settings require special precautions.

3.3.3 Wet Detention Ponds[24]

Wet detention ponds provide significant removal of pollutants from stormwater runoff by maintaining a permanent pool of water with a target pollutant removal rate. Above the pool, a sediment forebay holds runoff from 1-inch rain event and releases water to the pool over a period of two to five days.

Delaware Design Requirements[25]

All ponds constructed for stormwater management shall be designed and constructed in accordance with the USDA Soil Conservation Service Small Pond Code 378 (September, 1990), as approved for use in Delaware (See Appendix L).

Any pond used for water supply purposes, or for irrigation, must obtain approval from DNREC for that use pursuant to Chapter 60.

Where ponds are the proposed method of control, the developer shall submit to the approving agency, when required, an analysis of the impacts of stormwater flows downstream in the watershed for the 100-year frequency storm event. The analysis shall include hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications of the proposed development (with and without the pond) on downstream dams, highways, structures, or natural points of constricted streamflows past which the timing effects would be considered negligible. The results of the analysis will determine the need to modify the pond design or to eliminate the pond requirement. Lacking a clearly defined downstream point of construction, the downstream impacts shall be established, with the concurrence of the approving agency, downstream of a tributary of the following size:

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[23] North Carolina Department of Environment and Natural Resources. 1999.
[24] North Carolina Department of Environment and Natural Resources. 1999.
[25] DNREC – Division of Water Resources and Division of Soil and Water Conservation. 2001.

1) The first downstream tributary whose drainage area equals or exceeds the contributing area to the pond; or

2) The first downstream tributary whose peak discharge exceeds the largest designed release rate of the pond.

The land set aside for pond maintenance shall be sized as follows:

1) The set aside area shall accommodate at least 2% of the stormwater management basin volume to the elevation of the 2 year storage volume elevation;

2) The maximum depth of the set aside volume shall be one foot;

3) The slope of the set aside area shall not exceed 5%; and

4) The area and slope of the set aside area may be modified if an alternative area or method of disposal is approved by the appropriate plan approval agency.

All ponds shall have a forebay or other design feature to act as a sediment trap. A reverse slope bench must be provided one foot above the normal pool elevation for safety purposes and all embankment ponds, having a normal pool, shall have a drain installed to facilitate maintenance.

Operation and Maintenance[26]

- Estimated annual operation and maintenance costs for wet detention ponds are 5% of construction costs (as found in a survey conducted by the State of Maryland on their wet detention basins).

- A permanent easement should be provided to assure easy access for maintenance. Care should be taken to secure all appropriate legal agreements from the easement.

- Annual inspections (or more frequent inspections) by the landowner or pond operator are strongly encouraged to ensure the proper operation. At a minimum, an inspection should include and address the following:

    - obstructions of the inlet and outlet devices by trash and debris
    - excessive erosion or sedimentation in or around the basin
    - cracking or settling of the dam
    - deterioration of inlet or outlet pipes
    - condition of the emergency spillway
    - stability of side-slopes
    - up and downstream channel conditions
    - woody vegetation in or on the dam

[26] North Carolina Department of Environment and Natural Resources. 1999.

Advantages[27]

- It is appropriate in areas where infiltration is impractical due to low infiltration rates of the underlying soils.

Disadvantages

- There are possible problems with mosquito breeding and health hazard due to drowning if landscaping is not included to prevent access to the stormwater pond.

[27] North Carolina Department of Environment and Natural Resources. 1999.

3.4 Agricultural Best Management Practices

Nutrient Best Management Practices, a manual written by the Delaware Department of Agriculture, Nutrient Management Commission is the source of recommended agricultural BMPs in source water protection areas. For more information on the recommended BMPs, contact your local conservation district, state nutrient management office or University of Delaware Cooperative Extension. Certain Natural Resource Conservation Service practice codes can be found in Appendix L or at: efotg.nrcs.usda.gov/treemenuFS.aspx?Fips=10001&MenuName=menuDE.zip.

University of Delaware Cooperative Extension:	New Castle	302-831-2506
	Kent	302-730-4000
	Sussex	302-856-7303
Conservation Districts:	New Castle	302-832-3100
	Kent	302-697-2600 ext. 3
	Sussex	302-856-7215 ext. 3
Delaware Nutrient Management Program	1-800-282-8685 or 302-698-4500	

The following agricultural best management practices are tools that can be implemented to protect source water areas in Delaware. While these practices are the currently "state of the art", they are subject to modification or discontinuation as technology and methods change.

Feed/Litter BMPs

1) *Feed Related Amendments*
2) *Poultry Litter Amendments*
3) *Roof Runoff Management in Feedlots*
4) *Stormwater Control in Feedlots*
5) *Pasture Stream Fencing*
6) *Temporary Stockpiling of Litter*

Manure Storage BMPs

7) *Temporary Field Storage*
8) *Manure Sheds*
9) *Dry Straw Based Manure Storage*
10) *Bunkers*
11) *Liquid Manure Handling Systems*
12) *Lagoons and Tank Systems*
13) *Slurry De-watering Systems*
14) *Fertilizer Storage*
15) *Nutrient Management Relocation*

Figure 3.1 Example Feed/Litter BMP

Daily Animal Mortality Handling BMPs

16) *Composters*
17) *Rendering for Large Animals*
18) *Freezer*
19) *Incinerators*
20) *Composting Catastrophic Mortality of Poultry Alternatives*
21) *Vegetable Waste (non permitted) Disposal*

Soil Analysis and Testing BMPs

22) *Pre Side-dress Soil Nitrate Test (PSNT)*
23) *Soil Test*
24) *Phosphorus Site Index*
25) *Phosphorus Saturation Ratio*
26) *Tissue Analysis*
27) *Stalk Nitrate Test on Corn*
28) *Manure Testing*
29) *Soil Structure Management*
30) *Manure Incorporation*
31) *Daily Spreading of Animal Manures*
32) *Timing of Manure Applications*

Figure 3.2 Example Manure Storage BMP

Nutrient Application Equipment Calibration and Adjustment BMPs

33) *Calibrating Poultry Litter Spreaders*
34) *Precision Farms*

Residue Management BMPs

35) *No-till and Strip Till*
36) *Mulch Tillage*
37) *Ridge Tillage*
38) *Seasonal*
39) *Cover Crops*
40) *Vetch*
41) *Scarlet Clover*
42) *Cereal Grain*
43) *Legumes*

Figure 3.3 Example Buffer Strip BMP

Buffer Strips BMPs

44) *Conservation Buffer*
45) *Riparian Forest Buffer*
46) *Filter Strips*
47) *Water Control Structure*
48) *Strategically Placed Wetland*

49) *Strategically Placed Sediment Removal*
50) *Grass Waterways*
51) *General Erosion Controls*
52) *Field Windbreak for Erosion and Odor Control*
53) *Irrigation Systems and Education*

1) *Feed Related Amendments*
Feeding strategies to reduce nutrient excretion in poultry litter and other manure have great potential today and into the future. With the addition of phytase to commercial broiler diets and the refinement of phosphorus requirements, excretion of phosphorus in litter is expected to decrease by more than 30%. As other cost-effective technologies are refined, such as vitamin D derivatives, the reduction of phosphorus in litter may well exceed 50% of today's values in the near future. Combined with more long-term strategies such as the inclusion of feed grains with higher available phosphorus content, the reduction in phosphorus may well be 70% less than litter just a few years ago.

2) *Poultry Litter Amendments*
Poultry litter amendments are one of several management strategies employed to reduce ammonia and odor emissions from poultry houses. These products can be added to litter, feed or water to chemically or biologically reduce the ammonia volatilization rate from litter. By reducing the ammonia losses from litter, the nitrogen content and value of the litter may be increased. Some aluminum, iron and calcium base acidic compounds have the added benefit, when used at rates above that typically required for ammonia control, of binding soluble phosphorus in litter. These products may be particularly beneficial for operations that must limit litter application due to high soil-test phosphorus or where the risk of soluble phosphorus losses from fields are high.

3) *Roof Runoff Management in Feedlots (NRCS Practice Code: 588)*
Roof runoff management in feedlots is a system of components for collecting, controlling and disposing of runoff from roofs that would otherwise enter a feedlot and become contaminated. Components may include but are not limited to: erosion-resistant channels, subsurface drains with rock filled trenches along building foundations below eves, underground outlets, roof gutters, downspouts and appurtenances.

4) *Stormwater Control in Feedlots*
Stormwater control in feedlots is a system of components for controlling runoff generated from a feedlot operation. Clean water from roofs and non-contaminated areas of the feedlot is kept separate from contaminated runoff leaving the feedlot. Contaminated runoff is to be captured, stored and safely disposed of as outlined in the nutrient management plan. Components may include, but are not limited to: underground outlets, diversions, grassed waterways, waste storage structures, and spray irrigation systems.

5) *Pasture Stream Fencing (NRCS Practice Code: 382)*
Pasture stream fencing is the installation of a suitable permanent structure that acts as a barrier between pastureland and a watercourse with the purpose of excluding livestock from the ditch or stream. The type of livestock using the pasture will determine the type of barrier used. Sheep and hogs may require woven wire fence, horses may require a wooden or non-

injurious type of fence, while cattle be controlled with barbed wire or electric fence. If the livestock depend on the watercourse for their water supply, a new watering facility may be required.

6) *Temporary Stockpiling of Litter*
On farm interim storage is not desired but is acceptable for no more than 14 days or it must be covered to prevent contact with storm water. Storing litter and other stackable manure in a permanent storage structure is the most desirable storage option, however, interim stockpiling of poultry litter on poultry farms may be necessary due to weather or transport considerations. This storage represents transitional stockpiling, pending relocation.

Manure Storage BMPs

7) *Temporary Field Storage (setbacks, 180 days, covers, etc.)*
Although the most efficient method of handling poultry litter is immediate movement from facilities to land or other use, timing and equipment considerations often require temporary storage of the litter before use. In situations where storage in a permanent structure is not possible, dry litter may be stockpiled temporarily on the farm or in crop fields. Proper construction of these temporary stockpiles will reduce moisture, preserve nutrients (particularly nitrogen), and reduce potential negative environmental impacts. The Delaware Nutrient Management Act requires that temporary stockpiles of litter be 100 feet from any body of water, drainage ditch, or road; 200 feet from any residence not located on the property; and be 6 feet high in a conical shape. In-field storage of litter is limited to 180 days, while on-farm storage is limited to 14 days. Stockpiles should be placed on the least pervious site or soils to preserve the quality of the litter and reduce the chances of nutrients moving from stockpiles to ground or surface waters.

8) *Manure Sheds (NRCS Practice Code: 313)*
A manure shed is a roofed building for stacking dry manure and protecting it from precipitation during the storage period. The shed needs to be large enough to accommodate the equipment delivering and removing the waste. The volume contained within the shed is based on the anticipated volume of manure plus bedding generated during the storage period as defined in the nutrient management plan. Spontaneous combustion of the manure in a shed can be a problem, so precautions should be taken.

9) *Dry Straw Based Manure Storage (NRCS Practice Code: 313)*
A dry straw-based storage structure is often called a stacking facility. It may be roofed or unroofed, and usually has sidewalls (or a curb), and a concrete floor. If runoff from the facility will occur, a cover or a system to filter (treat) the runoff or a system to collect and store the runoff will be required. The facility needs to be large enough to accommodate the equipment delivering and removing the waste. The volume contained within the facility is based on the anticipated volume of manure plus bedding generated during the storage period as defined in the nutrient management plan. The manure must contain enough straw to make the mixture stackable, and adsorb excess moisture.

10) A bunker, while generally not preferred, is a waste stacking facility with a curb or walls, an impervious floor, and typically has no roof. This type of facility is used where the waste material has a large amount of cellulose bedding in it, such as straw, wood chips, or saw dust. This type of facility is not suitable for waste material that has sand bedding, or little or no cellulose bedding. The size of the bunker is based on the anticipated volume of manure plus bedding generated during the storage period as defined in the nutrient management plan. If runoff from the facility will occur, a cover or a system to filter (treat) the runoff or a system to collect and store the runoff will be required.

11) *Liquid Manure Handling Systems (NRCS Practice Code: 312)*
A liquid manure handling system is a planned system in which all the necessary components are in place for collection, transporting, storing and disposing of liquid manure and contaminated runoff in a manner, which does not degrade air, soil, or water resources. Components may include, but are not limited to: debris basins, dikes, diversions, fencing, grassed waterways, spray irrigation systems, pond sealing or lining, subsurface drains, surface drains, waste storage ponds, waste storage structures, and waste treatment lagoons.

12) *Lagoons and Tank Systems (NRCS Practice Code: 359 (lagoon) and 313 (tank))*
A lagoon is a waste treatment impoundment made by construction of an embankment and/or excavating a pit or dugout. The purpose of a lagoon is to treat manure and wastewater and thereby reduce pollution potential. An impermeable liner is an essential component of a lagoon. A lagoon can be either aerobic or anaerobic in process, and will have an established minimum and maximum operating level. The size of the lagoon is based on the selected process and the number and type of animals in the operation.

A tank is a storage structure for liquid manure and wastewater. The volume of the tank is based on the anticipated volume of manure and bedding plus wastewater generated during the storage period as defined in the nutrient management plan. Tanks must be impervious and provide for agitation of its contents before emptying because the liquid and solid portions of the waste will separate during the storage period. Remixing of the contents is necessary for the proper removal of the waste material. Sand bedding can be very difficult to remix with the liquid portion of the waste, and will reduce available storage volume when it accumulates in the bottom of the tank.

13) *Slurry De-watering Systems*
A slurry de-watering system is a planned system with all the components in place for collection, transporting, storing and separating the liquid portion of the waste from the solid portion. Components may include but are not limited to settling tanks, greenhouse type drying facilities, mechanical solids separators, storage sheds, storage tanks, spray irrigation systems and composting facilities.

14) *Fertilizer Storage*
Various state laws govern the safe handling and storage of inorganic nutrients or fertilizers. For example, storing large quantities of liquid fertilizers may require construction of a permanent storage facility. DNREC should be consulted regarding the laws in your area. In general, when storing fertilizers on the farm you should consider proximity to animals or feed storage areas, proximity to water supplies, location and construction of the mixing area,

adequate labeling, and security (doors, locks, etc.). Storage areas should be routinely examined for leaks or spills, and to check the function of washing and first aid equipment. Potential problems can be minimized by storing only as much fertilizer as absolutely necessary in secured indoor facilities.

15) *Nutrient Management Relocation*
Animal Feeding Operations (AFOs) with inadequate land to apply animal waste or farms with high phosphorus, as determined by soil tests from an approved soil laboratory, should relocate nutrients to farms in need of nutrients or to alternative use projects. Receiving farms need a Nutrient Management Plan to ensure proper application rates and methods. Alternative use projects are active in Delaware and are defined as the use of animal manure other than the application of raw material on land. These projects generally provide a renewable or recyclable product for alternative market places. Cost assistance funds may be available to assist in the transportation cost of relocating manure.

Daily Animal Mortality Handling BMPs

16) *Composters (NRCS Practice Code: 317)*
A composter is a facility for the biological treatment of the normal daily accumulation of dead animals from an animal feeding operation. The facility usually includes bins in which the carcasses are placed in layers with a carbon source (typically straw, corn cobs, or saw dust), poultry manure (which provides nitrogen and deters scavengers) and a small amount of water in accordance to a recipe which is established in the nutrient management plan. The facility typically includes a roof and a concrete floor. The biological activity that breaks down the organic material generates heat that will sterilize the final product. The material being composted requires one turning during the composting process to assure that contents initially placed near the edge of the bin are moved to the center for proper heating. The size of the composter is based on the number and type of animals to be composted.

17) *Rendering for Large Animals*
Animal mortality should be disposed of in a way that prevents contamination of surface and ground waters. Burial of large animal mortality should not be considered due to the potential for surface and ground water contamination. While composting is the typical and preferred process of dealing with non-catastrophic animal mortalities, composting of large animal mortality, such as dairy cows or horses can be difficult due to animal weight and size. In the event of large animal mortality, rendering companies provide pick-up and delivery for a fee.

18) *Freezer*
A freezer is a unit capable of freezing and storing animal carcasses until they can be removed offsite for recycling or rendering. The capacity of the freezer is based on the maximum daily weight of animal carcasses produced during a typical growing cycle and the estimated time between emptying events.

19) *Incinerators (Ash disposal plan required) (NRCS Practice Code: 769)*
An incinerator is a device used to dispose of mortalities from a poultry-feeding operation by combustion. An incinerator requires an ash disposal plan. The ash disposal plan typically requires the use of an ash collection box or bucket, and disposal by land application on

cropland or through a community trash disposal system. The capacity of an incinerator is based on the maximum daily weight of animal carcasses produced during a typical growing cycle. All incinerators must be registered with DNREC. Under current DNREC policy, only double chambered incinerators with a burner in each chamber are approved for use in Delaware.

20) *Composting Catastrophic Mortality of Poultry*

The Delaware Nutrient Management Commission has identified composting as the preferred method of disposing of catastrophic mortality of poultry and other animals. Composting occurs when organic materials, such as dead birds, go through rapid decomposition in the presence of oxygen, water, and an adequate carbon source. Constructing a "wind row" composting pile can accommodate large quantities of poultry mortality. These piles are approximately 12 feet wide and 6 feet high. In these dimensions, the piles contain approximately 300 pounds of mortality per linear foot. Specific guidelines for constructing wind-row composting piles are available at: www.agnr.umd.edu/MCE/Publications/PDFS/FS717.pdf.

Alternatives to composting may be disposal of dead animals in a sanitary landfill. In the event of a very serious, extremely communicable disease, mass burial on the infected premise may be conducted as agreed upon by State Agricultural and Environmental officials. In general, burial setbacks include distance from a well, stream, dwelling, animal facilities, roadways and seasonable ground water table. Burial for catastrophic events is the least preferred method for disposal and must be conducted with the highest biosecure methods available in order to prevent a communicable disease outbreak. For dead animals of several hundred pounds, the pathogenic incinerator at the Delaware Department of Agriculture may be used. Capacity of this incinerator is 200-300 pounds per hour.

21) *Vegetable Waste (non permitted) Disposal*

Vegetable production generates waste by-products that have the potential to contribute nutrients. These byproducts should be managed in a manner that prevents nutrient contamination to surface and ground waters. Consideration should be given to the amount of raw waste generated, the nutrient content of the waste product, and recognition that nutrient loading depends on the way in which the waste is handled after harvest. Most vegetable waste, such as sweet corn fodder, cull ears and husks should be provided as a green manure recycled and applied to production fields. In the case of interim storage in any location other than a roofed and permanent structure, set back and time limits (14 days) associated with manure storage will also pertain to storing vegetable waste. Proper management of vegetable waste represents an efficient use of nutrients that are available for capture by future crops or cover crops.

Soil Analysis and Testing BMPs

22) *Pre Side-dress Soil Nitrate Test (PSNT)*

The PSNT is an in-season tool to help corn producers optimize their nitrogen (N) management. The idea of the PSNT is that a soil test, taken at the appropriate time, can provide information on the N status of a cornfield and allow the farmer to make necessary side-dress applications of N if necessary. Soil samples are collected when

corn plants are 6-12 inches tall (ideally 10-12 inches) at the whorl. A "sample" is a collection of at least 15, 12-inch cores and should represent an area of similar soil type and management history not to exceed 20 acres. Laboratory analysis of the soil sample will reveal the amounts of readily available nitrate-N (NO3 -) in the soil, and tables provided by Delaware Cooperative Extension can then be used to calculate necessary additions of N.

23) *Soil Test*

Soil testing is an integral part of any nutrient management program because it is the only way to reliably assess the contribution of the soil to plant nutrient requirements. Two of the most important elements of soil testing are determining the size of the area to be sampled and the number of samples to be collected. Samples should be collected to represent an area no larger than 20 acres, if possible. Each soil sample should consist of a minimum of 15 cores to minimize the impact of a single abnormal core. Samples should be collected from the appropriate depth, for most elements this depth is 6-8 inches. Soil testing involves not only the collection of samples, but also interpretation of laboratory results. University of Delaware Cooperative Extension has information available to aid operators in making management decisions based on soil test results for phosphorus (P), potassium (K), and many other nutrients. Although the Nutrient Management Law requires soil samples used with a nutrient management plan to be no older than three years, more frequent testing will promote better nutrient management.

24) *Phosphorus Site Index*

The Phosphorus Site Index (PSI) is a field-rating system designed to assess the relative risk of phosphorus movement from fields to ground or surface waters. The PSI assesses this risk by considering site-specific information such as soil types, landforms, and management practices. This information allows managers to focus BMPs in areas of highest environment concern. Environmental concerns with phosphorus center around eutrophication, defined as "an increase in the fertility status of natural waters that causes accelerated growth of algae or water plants".

25) *Phosphorus Saturation Ratio*

The Phosphorus Saturation Ratio (PSR) is an indicator of the ability of the soil to retain phosphorus (P). This ability is measured by the ratio of extractable P to iron and aluminum available to tie up that P. As the ratio increases (soils become more saturated with P), the quantity of P that can be lost from the soil by erosion, surface runoff, and leaching increases. Research has shown that an increase in P loss occurs at PSR levels above approximately 20%. PSR is included in soil test reports generated by the University of Delaware soil testing lab.

26) *Tissue Analysis*

Tissue testing is a valuable tool for in-season assessment of the availability of a number of essential plant elements. Such assessments are an important part of any nutrient management program. Some common elements determined in routine plant analysis include nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), and sulfur (S). As with soil testing, the collection, handling, and analysis of plant samples must be done properly to obtain useful results. University of Delaware Cooperative Extension has information available to aid operators in making management decisions based on tissue test results.

27) Stalk Nitrate Test on Corn

The end-of-season corn stalk nitrate test is a simple, inexpensive tool that can be used to assess the nitrogen (N) status of a corn crop at the end of the growing season. This test makes use of the fact that corn plants either remove N from, or accumulate N in, the lower stalk based on soil N availability. Studies over a wide range of conditions have found remarkably similar relationships between the amount of N found in the lower stalks late in the growing seasons and the likelihood that corn had been under or over-fertilized. Plant samples are collected after the corn is mature, usually 2 weeks after "black layering." University of Delaware Cooperative Extension has a publication; "End-of-Season Corn Stalk Nitrate Testing to Optimize Nitrogen Management" to aid operators in interpreting the results of their cornstalk tests.

28) Manure Testing

Manure testing is an integral part of any nutrient management program because animal manures vary widely in their nutrient composition. The four most common elements of manure testing are determining moisture, nitrogen (N), phosphorus (P) and potassium (K) content. There may also be situations where micronutrient or metal contents are critical. Delaware Cooperative Extension recommends that manure samples be collected for the smallest "unit" practical because of potential for enormous variability between different loads, manure types, etc. University of Delaware Cooperative Extension has information available to aid operators in collection and handling of manure samples.

29) Soil Structure Management

Soil "structure" refers to the way soil particles such as sand, silt, clay, and organic matter are arranged or "held together." Maintaining good soil structure is extremely important, and the single biggest threat to structure is compaction. Compaction is most commonly caused by animals or equipment and is essentially a "crushing" of the soil. This crushing eliminates pore spaces that are critical for water infiltration, water-holding capacity, and proper root development; each of which can severely limit yields. Compaction can be controlled by following some basic guidelines: avoiding wet fields, using rotational grazing, reduced tillage, deep tillage or ripping, and using certain crop rotations. (Refer to extension, etc. for more information.)

30) Manure Incorporation

Incorporation of surface-applied animal manures is an important practice for both economic and environmental reasons. Manure spread on the surface and not worked into the soil may lose most of the volatile nitrogen compounds as ammonia gas to the atmosphere. This lost nitrogen is not available for plant growth, and has been identified as a possible air quality contaminant contributing to acid rain. Manure that is surface-spread on long slopes or areas with high erosion potential is susceptible to runoff from a rainfall event immediately following application. This runoff can transport nutrients form the field into surface waters. Immediate incorporation of manure can avoid these problems. In situations where incorporation is not consistent with other management objectives (e.g. no-till fields) other methods of preventing runoff should be employed as described in other best management practices (e.g. Residue management, buffer strips, etc.)

31) *Daily Spreading of Animal Manures*

Daily spreading of animal manures is generally not recommended. However, in situations where the operation MUST haul on a daily or very frequent basis, the following guidelines should be considered to minimize odors and environmental threats, and maximize the utilization of manure nutrients. Spreading during cooler, less-humid portions of the day, considering wind speed and direction in relation to neighboring farms or homes, and establishing buffer or "no-apply" zones near roads and residences, will help to minimize odor problems. Immediate incorporation will reduce odors, prevent physical movement of manure to waterways, and conserve valuable nitrogen.

32) *Timing of Manure Application*

Applying manure at the correct time is important to ensure efficient and cost effective use of nutrients. Application of manure at times when nutrients are unavailable for crop uptake should be avoided. Spreading manure on frozen ground, snow covered ground or saturated soil should be avoided to prevent possible runoff. The efficient use of nutrients means selecting the appropriate rate of each nutrient and applying each in a uniform, timely manner. Application of nutrients during favorable weather conditions can reduce the potential for nutrient losses from runoff or leaching.

Nutrient Application Equipment Calibration and Adjustment BMPs

33) *Calibrating Poultry Litter Spreaders*

To be an effective source of crop nutrients, poultry litter should be applied evenly and at known rates. Dry litter is commonly applied with a spinner-type spreader. This equipment allows for both even application and a considerable range in application rates. Wet manure, such as that found in breeder or layer operations, is more commonly applied with "flail-type" spreaders. For all types of application equipment the basic procedure for calibrating is to collect litter on tarps that can be weighed in the field. When used properly, this method provides information on both the rate of application and the uniformity of coverage. An excellent step-by-step reference for calibrating manure spreaders can be found at: www.usr.sonet.net/usr/ke4rop/litter/index.htm.

34) *Precision Farming*

Precision farming or site-specific management utilizes several technologies with a goal of increasing operating efficiencies such as boosting yields, reducing input costs, and improving profit margins. Technologies such as geographic information systems (GIS), automated machine guidance, in-field remote sensing, mobile computing, telecommunications, and advanced information processing when linked with the Global Positioning System (GPS) provide potential improvements to farm practices. The application method and timing is critical to proper nutrient management.

Residue Management is the management of the amount, orientation, and distribution of crop and other plant residue on the ground surface year round. Residue management improves water quality, while reducing soil erosion, increasing infiltration, increasing organic matter, improving soil structure, and reducing compaction and crusting.

Residue Management BMPs

35) *No-till and Strip Till (NRCS Practice Code: 329A)*
Uniformly distributed crop residues are left undisturbed from harvest to planting. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disc openers, in-row chisels or rototillers. Weed control is accomplished primarily with herbicides. Cultivation may be used for emergency weed control.

36) *Mulch Tillage (NRCS Practice Code: 329B)*
Soil is disturbed prior to planting. Tillage tools such as chisels, field cultivators, discs, sweeps or blades are used. Weed control is accomplished with herbicides and/or cultivation.

37) *Ridge Tillage (NRCS Practice Code: 329C)*
Crop residues are left undisturbed from harvest to planting. Planting is completed in a seed bed prepared on ridges with sweeps, disc openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are rebuilt during cultivation.

38) *Seasonal (NRCS Practice Code: 344)*
Managing the amount, orientation, and distribution of crop and other plant residues on the soil surface during part of the year, while growing crops in a clean tilled seedbed. This practice reduces erosion and improves water quality.

39) *Cover Crops*
A cover crop is any crop planted in a field to provide protection to the soil during a period when row crops are not being grown. This period can be a relatively short time such as a couple of months between spring and fall crops, or a longer time, such as six months between fall harvest and spring planting. Which type of cover crop is best depends on many factors, including crop rotation and management goals. For example, is the goal simply to reduce erosion, scavenge nitrogen, put nitrogen back into the soil (i.e., legumes), or a combination of these and other objectives? During winter, recommended grass species include cereal rye, wheat, and barley although any winter-hardy annual species can be used. Broadleaf species that can be used include winter rape and other leafy Brassica crops. Legume cover crops such as hairy vetch and annual or perennial clovers can be grown to reduce erosion. However, these species are not efficient for scavenging nitrogen from previous crops. During summer, grasses such a sudangrass, sorghum-sudangrass hybrids, and others can be effective in protecting soil and trapping nutrients. Non-grasses such as buckwheat also can be effective cover crops. To maximize cover crop benefit, plant as early as possible, optimize soil-to-seed contact, and plant at the upper end of the suggested seeding rate range. The cover crop should be maintained as late into the spring as practical without running the risk that it will deplete sub- and topsoil moisture levels to the point of being injurious to the next crop.

40) *Vetch*
Hairy vetch is the most efficient nitrogen-fixing legume often fixing 50 to 100 or more pounds N/acre, dependant upon planting date and plant life. Nitrogen is released to the next crop rapidly.

41) *Scarlet Clover*
Scarlet clover, also referred to as crimson clover, is not as effective as hairy vetch at fixing N but will fix 60 to 90 or more lbs N/A plus increase availability to the next crop of other nutrients such as P and the micronutrients. Nitrogen release is also rapid.

42) *Cereal Grain*
Cereal grains planted solely as cover crops and other crops used as cover should be monitored closely in the spring to prevent excessive soil moisture loss in seasons with below average winter or spring rainfall. If adequate rainfall is received, time the destruction of the cover crop by tillage, herbicide, or other mechanical crop injury and destruction with the growth stage and subsequent crop growth so nitrogen and other nutrients will be mobilized at a time suitable for crop uptake.

43) *Legumes*
Many legume cover crops release nitrogen very rapidly after incorporation or destruction. To slow this release, include cereal rye, winter oats, or other high carbon winter crop when seeding the legume. Legumes are appropriate cover crops for fixing atmospheric nitrogen for subsequent grass crops. Legumes can help make phosphorus and micronutrients more available to subsequent grain crops.

Buffer Strips BMPs

44) *Conservation Buffer*
Conservation buffers are areas or strips of land maintained in permanent vegetation to help improve water quality. The vegetation can be cool season grasses, warm season grasses, and/or trees and shrubs. Buffers can trap sediments, take up nutrients, provide valuable wildlife habitat, and provide shading of the stream. The size of the buffer depends on the intended use of the buffer. The minimum width should be 10 feet for limited sediment entrapment with a preferred minimum width of 24 feet, while the minimum width for a wildlife buffer is 35 feet.

45) *Riparian Forest Buffer (NRCS Practice Code: 391)*
Riparian forest buffers are an area of trees and/or shrubs located adjacent to and up gradient from water bodies.

46) *Filter Strips (NRCS Practice Code: 393)*
A filter strip is a strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forestland), and environmentally sensitive areas. A filter strip is designed to trap sediments in surface runoff and utilize excess nutrients.

47) *Water Control Structure (NRCS Practice Code: 587)*
A water control structure is a device that conveys water, controls the direction or rate of flow or maintains a desired water surface elevation. These are typically used to control the depth and discharge of water in open channels, ponds, and wetlands. They can also be used for water quality control, such as sediment reduction and temperature regulation.

48) *Strategically Placed Wetland (NRCS Practice Code: 656)*
A strategically placed wetland is a constructed shallow water ecosystem designed to simulate natural wetlands, and placed in a location that will receive runoff from farmsteads and crop fields. It is designed to control storm water runoff and is effective in utilizing excess nitrogen. This practice is not intended to treat animal waste or runoff from feedlots. Strategically placed wetlands shall be located outside the limits of wetlands of any classification. Components may include inlet screening device to prevent debris from entering the wetland; embankments; overflow structure to maintain proper water level, and control flow from the wetland; and wetland plants. The wetland must be sized to contain the design storm and bypass larger events, while providing the needed detention time for treatment of the target contaminant. All federal, state, and local laws, rules and regulations governing the discharge to waters of the state must be complied with.

49) *Strategically Placed Sediment Removal (NRCS Practice Code: 638)*
Strategically placed sediment removal is a short embankment or a combination ridge and channel typically constructed across the slope and minor watercourses. They are used to trap and collect sediment, reduce on-site erosion, reduce the sediment content of runoff, reduce peak rate of flow at down-slope locations, reduce flooding and reduce gully erosion.

50) *Grass Waterways (NRCS Practice Code: 412)*
A grassed waterway is a natural or constructed swale, shaped or graded and established in suitable vegetation for the safe conveyance of runoff. Grassed waterways are used to transport surface runoff from terraces, diversions, or natural concentrations without causing erosion or flooding and thereby protecting or improving water quality. The size and shape of the grassed waterway will be based on the anticipated flow rate and the slope of the waterway and the type and height of the vegetation.

51) *General Erosion Controls (NRCS Practice Codes: 350, 362, 393, 561, 600)*
Erosion controls are a combination of practices that are constructed or installed with the purpose of preventing or minimizing the loss of soil from a farmstead and cropland. Components may include sediment basins (350); diversions (362), filter strips (393), heavy use area protection (361), and terraces (600). Diversions are used to divert clean runoff away from areas that are susceptible to erosion. Terraces are used to shorten the slope length in a crop field. Filter strips are grassed areas placed across the slope below cropland or farmsteads for the purpose of catching and trapping soil particles in the runoff as it passes through. Heavy use area protection consists of covering the soil in an area that gets heavy use, such as farmsteads and farm lanes with a surface that will protect the underlying soil from erosion. Typically, gravel, concrete, or asphalt is used. Sediment basins are used to trap sediment once erosion has occurred, and prevent its transport offsite.

52) *Field Windbreak for Erosion and Odor Control (NRCS Practice Code: 394)*
A strip of trees or shrubs established adjacent to a building, feedlot, or field can reduce erosion, conserve energy, control snow deposition, prevent wind damage, provide shelter for livestock, improve water quality, reduce noise pollution, provide wildlife habitat, and improve landscaping. The major benefits of trees around the perimeters of buildings include increasing production efficiency, demonstrating proactive environmental stewardship, and fostering good neighbor relations. Properly established windbreaks can reduce heating

and cooling costs, minimize structural damages from wind, and prevent air-borne diseases from entering and exiting your farm. Planting trees around farms also offers environmental benefits and represents good stewardship. Another important aspect of trees is their ability to filter odor and noise, thus decreasing the likelihood of odor and noise-related complaints from neighbors.

53) *Irrigation Systems and Education*

Irrigation can be a great benefit to nutrient management planning. It helps normalize yields during periods of dry weather. When a consistent supply of water is provided, plants can utilize the nutrients that are available. This in turn reduces the amount of residual nutrients and lessens the likelihood of leaching into the ground water. Your local conservation district, the state nutrient management office, and Delaware Cooperative Extension provide additional nutrient management information.

3.5 Non-regulatory Water Resource Protection Approaches [28]

Non-regulatory measures are important in protecting drinking water sources. Pollution prevention, restoration of contaminated sites, acquisition of important parcels of land or interest in that land, water conservation and reuse, public education, and emergency planning all help to ensure that local water sources provide safe drinking water. Non-regulatory measures also provide opportunities for improving quality of life and involving citizens in meaningful activities that better their communities.

3.5.1 Conservation and Reuse

Quality of drinking water is often directly linked to the amount of water in the drinking water source (water quantity). For example, the more water in a surface water supply, the greater its potential to assimilate and dilute contaminants during spills, (depending on the characteristics of the pollutant). The more water that remains in an aquifer, the greater it's potential to prevent the inflow of surface water or the intrusion of pollutants such as saltwater. Therefore, the amount of water that is used locally can affect the quality of local supplies.

The volume of water in source water supplies at any one time can be affected by reducing water demand. Local government can manage water supply demand through conservation activities and replenishing water supplies through water reuse, thereby protecting the source water supply for drinking water use. Conservation can be achieved through a variety of local government actions:

Development regulations require or encourage the preservation of native vegetation adapted to normal rainfall conditions and/or require the use of xeriscape landscaping.

Public information campaigns and provisions for technical assistance promote water-conserving practices, provide low-flow fixtures, and offer water audits to homes and businesses.

Water pricing by municipalities and private suppliers can assess water to reflect the full cost of securing, protecting, treating, and distributing water to residents.

Water use restrictions (either voluntary or mandatory) are the firmest form of water conservation measures and are generally applied during droughts and other unusual circumstances by the Governor's Drought Advisory Committee.

Reuse of highly treated wastewater has been implemented successfully in many areas. Rather than discharging treated effluent to surface waters, water can be reclaimed for a number of uses to help protect the quality and supply of the drinking water source.

Direct potable reuse is reclaimed wastewater, treated at the highest level, fed directly into drinking water treatment systems.

[28] Section 3.3 adapted from Kundell and DeMeo, 2000.

Indirect potable reuse is reclaimed wastewater discharged to a surface water body or to an aquifer for subsequent withdrawal as a drinking water supply.

Indirect non-potable reuse is reclaimed wastewater used for agricultural irrigation, landscape irrigation, industrial processes, or other non-drinking water uses.

The connection between water quantity and water quality cannot be overstated. Although considering water quantity issues when planning for water quality protection may seem complicated, in the long run it can make source water protection easier and cheaper.

3.5.2 Emergency Response Planning

It is important to develop an emergency plan to ensure timely and responsible response to natural disasters, accidents, or acts of vandalism that disrupt the delivery of safe drinking water. In emergency situations that threaten contamination or failure of the source water supply, local government should be prepared to provide an alternative drinking water supply, even if another entity or a private company usually provides this service.

The development of an emergency response plan should involve water utility personnel, local planning staff, local elected officials, and the local (or regional) emergency coordinator or official. Other key local representatives, such as police, fire, and medical personnel, need to be part of the team to ensure that emergency situations in the source water protection area receive priority attention in a coordinated manner. If an emergency response plan exists, the team can review and update it based on source water assessment information and protection goals. The plan should also be consistent with Delaware and Federal Emergency Management Agency (DEMA and FEMA) requirements.

The emergency response plan should answer "what if" questions that enable a water system to react thoughtfully to an emergency situation before it becomes a crisis. For example the following questions developed by Kundell and Demeo in *Source Water Protection: A Guidebook for Local Governments*, should be answered within the plan.

- What if a spill or leak caused a pool of contamination in close proximity to the water intake or wellhead?
- Is the surface water intake or ground water well threatened?
- Is there an emergency response mechanism in place sufficient to contain the spill?
- Should the intake or well be shut down?
- Is a contingency plan in place to divert supply from other sources?
- Can an alternative and safe supply of water be provided for a short period of time until the threat subsides?
- Is there funding available to pay for an alternate source of water for a short period of time?
- Is providing an alternative source of water an option?
- Is a public notification program in place?

In addition to planning for short-term emergencies, the emergency response plan should develop options to long-term or permanent contamination of the water supply source and disruption to the

water supply service. In this case, where could a long-term alternative water supply source be located? Critical elements include:

- Identification of possible disruption or contamination threats
- Designation of an emergency coordinator for the public water supply
- Equipment and material resources
- Procedures to shut down and isolate the threatened or contaminated well or intake from the distribution system
- Procedures to coordinate with county and state emergency response agencies
- Procedures to effectively communicate with water users
- Sources of emergency water for drinking and other household uses as well as sources of equipment to transport, disinfect, and distribute the water
- Procedures to decontaminate the distribution system and well or intake
- Sources of emergency funds and procedures for requesting and dispersing such funds
- Replacement surface water intake or ground water well

The emergency response plan should involve intergovernmental mutual aid agreements with neighboring jurisdictions for water supplies for both short- and long-term emergencies. These discussions may go so far as to consider the merits of interconnecting water supply lines to ensure uninterrupted service in the event of contaminated source water supplies or other emergency events. Even if the physical interconnection of water lines and pumping facilities is cost prohibitive, local governments can enter agreements with other water systems to supply drinking water during emergencies. At a minimum, the emergency plan should contain a resource inventory that lists the equipment and expertise of adjacent jurisdictions or nearby water suppliers that could be made available in times of emergency.

Emergency response plans support local government efforts to supply safe and reliable drinking water to residents. They not only develop a comprehensive response to disasters and emergencies; they also promote disaster prevention, planning, training, and public education. Plans that describe existing emergency services, support resources, emergency responses, communication, alternative water supplies, remediation, emergency source development and review, and update procedures help protect source water supplies from current and future threats.

3.5.3 Land Acquisition

The acquisition of land or interest in land (e.g., conservation easements or purchase of development rights) provides protective buffers around reservoirs, priority stream segments, wetlands, and other critical areas within the source water protection area. Ownership of key land areas empowers a community to prohibit or control activities that could impair drinking water quality. Public ownership preserves wildlife habitat, provides recreational opportunities, reduces flood damage and enhances pollution prevention efforts and restoration values.

Communities can target and acquire land parcels themselves, or they can work with other groups to protect land. Local and regional land trusts are independent nonprofit organizations formed to accomplish resource protection goals. Local land trusts often have personnel with expertise in negotiating and working through the financial and legal aspects of acquisitions. Land trusts have

successfully worked with local governments to protect drinking water sources by acquiring land within wellhead protection areas and in critical areas of water supply watersheds. One may purchase the land depending on financial flexibility and benefit to the donor; the land may then be permanently deeded to the other party depending on the long-term goals of the community and the land trust and the capacity to care for the land.

There are three general methods for land acquisition that local governments or land trusts, alone or in partnership, can undertake:

Conservation easements sever development rights from a piece of property. For example, the community or land trust might identify the floodplain corridor of a drinking water supply as critical to remain in a natural state to achieve source water protection goals. The local government may acquire a conservation easement for the floodplain by purchasing the landowner's right to develop, clear, or otherwise alter the corridor but leaving ownership of the land to the individual. Conservation easements can be either purchased or received as a donation.

Donations of land and conservation easements to local governments and land trusts usually provide some tax benefit to the donor. The local government can encourage contributions by contacting potential donors and providing incentives for them to donate land. It is important, however, that local governments and land trusts prioritize the parcels of land that will contribute to source water protection goals so that they may decline offers of parcels that are unwanted or have little source water protection value.

Outright land purchases by the community or a land trust can be accomplished at the fair market value of the property or possibly at a bargain price. The amount paid for land depends on the location of the parcel, the skills of the negotiator, and the conservation intent of seller.

The Drinking Water State Revolving Loan Fund is available to acquire land and conservation easements as part of the national source water protection program. To qualify for funding under this program, properties must be identified in an approved state plan as contributing to the protection of a drinking water source. Local governments, water suppliers, and land trusts can work in partnership to identify and acquire key land holdings from willing sellers. Each of these groups has special knowledge of and expertise in identifying properties that support source water protection goals.

3.5.4 Pollution Prevention

It is often order if magnitude easier and less expensive to prevent source water pollution than it is to clean it up after it occurs. The financial cost of cleaning up a contaminated water supply can be high, and the cost to public health and the environment can be incalculable. Proper site management and good pollution prevention practices can help avoid costly cleanup and liability issues. Therefore, protecting source water supplies through pollution prevention measures is becoming more a necessity than an option for local governments. Pollution prevention related to source water protection includes activities that reduce the generation or release of hazardous substances and other contaminants.

Disposal activities relate to the long-term fate of solid and hazardous waste, including household hazardous waste. Inappropriate positioning and operation of disposal facilities can have a significant impact on water sources. Local government activities may include hazardous waste "amnesty collection days" that allow residents to bring hazardous materials to a central location for collection and subsequent controlled disposal.

Management activities for contaminants and polluting behaviors may include protocols and practices for wastewater treatment plants, septic systems, and storm water control; standards for storing hazardous substances, petroleum products, pesticides, and fertilizers; or programs to cap or plug abandoned wells.

Source reduction activities are the most effective pollution prevention measure because potential contaminants are either not used or used at a reduced level. The threat of contamination, therefore, is reduced. Examples of source reduction activities include education programs to help homeowners reduce the application of fertilizers and pesticides, the modification of industrial practices to use less or reuse toxic materials, and integrated pesticide management programs used on golf courses and agricultural fields.

Education activities stress pollution prevention as a part of source reduction, management, and disposal efforts. Education measures may involve a public information campaign focusing on storm drains, maintaining shoreline and stream-side vegetative buffers, appropriate use of fertilizers and pesticides, boat and lawn mower engine maintenance, and household hazardous materials handling and disposal. Education may be coupled with technical assistance focused on developing the technical, financial, and managerial capacity of the community water system to comply with drinking water standards. Such an approach includes training for water system operators under a certification program.

*Home*A*Syst* and *Farm*A*Syst* are two programs that provide education tools to homeowners. The programs involve a partnership between government agencies and private business that helps individual citizens to prevent pollution on farms, ranches, and in homes. The programs help individuals determine what risks could potentially threaten their health and financial security. They address such issues as the quality of well water, new wells and abandoned wells; livestock waste storage; storage and handling of petroleum products; managing hazardous wastes; and nutrient management. A system of step-by-step fact sheets and worksheets help individuals identify the behaviors and practices that are creating those risks. All information gathered is confidential; individuals decide what changes they need to make and when to make them. For more information, consult:
*Home*A*Syst*: www.uwex.edu/homeasyst/
*Farm*A*Syst*: www.uwex.edu/farmasyst/

In addition, the following websites provide information that can be accessed for homeowner education campaigns:
www.bae.ncsu.edu/bae/programs/extension/publicat/wqwm/ag439_21.html
www.nrcs.usda.gov/feature/backyard/

3.5.5 Public Education and Awareness

Public awareness and education are essential source water protection tools. Annual consumer confidence reports raise public awareness of the quality of the community drinking water as well as issues relative to its protection. These reports provide an excellent opportunity for water system operators to conduct parallel public education campaigns. These campaigns create an environmentally literate public and enhance awareness of local concerns.

Community water and wastewater systems education efforts identify:

- Who operates the community water system;
- Ground water or surface water source that supplies drinking water;
- Per capita water consumption, seasonal water use, and use by sector;
- Who operates the wastewater treatment system;
- Where and how the community discharges its wastewater;
- The number of wastewater system users (including industrial users and any pre-treatment requirements); and
- The difference between storm water systems and sanitary sewers.

Source Water Protection education describes:

- Why source water protection is important;
- The source water protection area including designated zones of protection;
- The importance of identifying threats before they become problems;
- Potential significant threats to source water supplies;
- How protection options compare in terms of water quality, cost, and ability to develop;
- Remediation vs. prevention, available technology, and costs; and
- Any impacts to local property owners within the source water protection area.

Individual actions that support local protection include:

- Why public input is important;
- Involvement opportunities for local citizens;
- Proper handling of household solvents and hazardous materials;
- Proper waste disposal and recycling opportunities;
- Proper septic system installation and maintenance;
- Proper closure of abandoned wells;
- Best management practices for the application of pesticides and fertilizers; and
- Water conservation practices for homes and industries.

Emergency management education programs explain:

- Why emergency planning is important;
- Hazardous materials that are transported on routes through the community; and
- Community emergency preparedness plans and disaster response procedures

Education campaigns can use multiple outlets for affecting public awareness, including: utility bill inserts, newsletters, community forums and meetings, local government websites, and newspaper and radio coverage. Community groups can also assist in promoting public awareness

though various projects, such as stenciling water protection advice at storm drains, the mouths of culverts, drainage curb cuts, heads of swales, and other entries to the storm water drainage system. In addition, public awareness campaigns encourage residents to become “eyes of the community” by using a pollution hotline number to report violations of protection measures.

3.5.6 Site Restoration

At times, source water protection may be accomplished only through restoration of critical stream segments and watershed areas to a former natural condition. Restoration includes a variety of actions that help correct problems resulting from current and past land use practices. Some activities can be managed at the local level using non-regulatory approaches, while others may involve a state or national program (e.g., restoration of superfund sites). Because this guidebook focuses on local protection tools, restoration is included as a non-regulatory approach to source water protection.

There are three general methods for site restoration:

- *Nonintervention approaches* remove a contaminating facility or activity and allow the source water to recover on its own.

- *Partial approaches* involve actions (such as BMPs) that assist or speed-up the natural recovery that is already under way.

- *Active approaches* involve the installation of measures to restore the hydrogeologic structure and function of the source water.

Regardless of the strategy, the first step in restoration is to stop the impact of the activity or condition that impairs or threatens to contaminate the source water quality. This may involve rehabilitation of industrial sites through a USEPA-sponsored brownfields program or cleanup of underground storage tanks (UST) through a DNREC Division of Air and Waste Management Program. Restoration may also require the relocation of certain facilities and operations because the characteristics of the contaminants that are used or stored there simply pose too great a risk. While perhaps not the easiest option, relocating some facilities or land uses outside critical areas in the source water protection area may be the cheapest and best option for protecting the water source. Although land acquisition costs may be associated with relocation, the long-term cost of instituting the highly technical and engineered solutions involved in the active restoration approaches may make reclaiming a drinking water source infeasible.

CHAPTER 4: IMPLEMENTATION STRATEGIES FOR SOURCE WATER PROTECTION

When designing and implementing a source water protection program, factors that focus resources, measure progress, and provide a check on burdensome activities help tremendously. Source water protection actions should be targeted to geographic areas of priority such as recharge and wellhead areas. Approaches should be selected that can be best applied to specific threat situations. Water monitoring efforts should be included in the protection program to measure progress. Issues of equity in paying for and carrying the burden of protective actions should also be considered. These factors can all be considered prior to defining funding needs and pursuing funding options. Local governments can maximize their chances of receiving financial support by focusing on actions that target the most significant pollution sources and yield the highest return on investment in a fair and equitable manner.

4.1 Prioritizing Actions [29]

Source water protection activities can be prioritized by: existing or future threats, degree or location of threat, effectiveness of protection strategy, or funding options.

4.1.1 Corrective and Preventive Approaches

Approaches can be grouped into two categories: actions that correct existing threats to drinking water quality and actions that prevent future threats. To ensure that the community water supply remains safe for both current and future residents, the local source water protection strategy will need to include both corrective and preventive water protection actions.

Corrective source water protection includes actions that reduce or eliminate existing threats to the community water system. Remedial measures are generally required to address existing threats to drinking water quality. Local governments will find that more technical and financial assistance is available to address remedial types of protection measures. This consideration might influence prioritization of protection strategies.

Preventive measures exclude future actions from becoming a threat to drinking water quality or eliminate the possibility of future threats. Although the corrective measures may have funding priority, it is almost always easier and cheaper to prevent source water contamination than it is to clean or remediate the water supply or to find alternate sources of drinking water.

4.1.2 Protection Zones and Areas

Another prioritization strategy is the use of protection zones or areas. Many of the delineation methods used to define the boundary of the source water protection area will divide it into priority zones or areas.

[29] Chapter 4 adapted from Kundell and DeMeo, 2000.

A high priority zone directs protection in the area closest to the water supply intakes. This zone is the most significant to protect from current and potential threats. In Delaware, these areas include the Class A Wellhead areas and surface water resource protection areas including floodplains, Cockeysville formation, Cockeysville drainage area, and Hoopes Reservoir.

A *mid-priority zone* is the area next to the high priority zone, moving away from the intake. This zone directs protection actions to reduce contaminants to a specific level or local standard. Class B and C Wellhead areas and excellent ground-water recharge potential areas would fall into this category in Delaware.

A *lower priority zone*, furthest from the intake, directs protection approaches toward ongoing low-level management actions. This would include the watershed areas upstream from the intakes yet outside of the floodplain; and good, fair and poor ground-water recharge potential areas.

Dividing the source water protection area into sub-watersheds or stream segments, or establishing buffers and setbacks is another way to target protection activities. Efforts can be focused on the segments closest to the drinking water source intake where contaminants represent the highest threat to water quality.

4.1.3 Watershed Protection

Watershed protection measures are among the most effective means for local governments to protect drinking water sources. Unlike health-based, land use, and land management measures that institute a particular type of control, which may address a specific source of pollution, watershed protection seeks to implement a comprehensive protection strategy. At its heart watershed protection requires consideration of water, land, and human activities in an integrated framework. Watershed protection, therefore, involves setting locally meaningful standards and establishing local protection approaches that integrate these elements. Over the long run, watershed protection may be the most effective and the most cost-effective strategy for source water protection.

4.2 Recognizing Specific Threats

The location of potential contamination sources will be identified during the source water assessment process. However, determining how and when to use the various protection tools can be confusing. If a community faces threats to its drinking water supply from a specific type of activity, the following table may help identify which of the tools in the source water protection toolbox will be the best control option.

Table 4.1 Local Tools Used to Combat Specific Threats[30]

Activity	Source	Local Tools
Construction		
Residential/Commercial	Runoff from disturbed land; Runoff from impervious surfaces	• Zoning codes: Critical area zoning, floodplain management • Impact fees • Buffers and setbacks • Development agreements • Subdivision regulations: Site design, sediment and erosion • control • Building codes: Porous pavement, impervious surfaces limits, excavation, grading and seeding, phased development • BMPs: Grass swales, infiltration basins, runoff ponds • Pollution Prevention: Source reduction and management, education
Industrial/Transportation	Runoff from disturbed land; Runoff from impervious surfaces	• Zoning codes: Critical area zoning, floodplain management • Impact fees • Buffers and setbacks • Development agreements • Building codes: Porous pavement, impervious surfaces limits, excavation, grading, seeding, phased development • BMPs: Grass swales, infiltration basins, runoff ponds • Pollution prevention: Source reduction and management
Industry		
Storage tanks (above and below ground)	Hazardous and nonhazardous materials and waste	• Zoning codes: Critical area zoning, floodplain management • Buffer and setback zones • Restoration: Re-siting and remediation • Pollution prevention: Source reduction, management and disposal, education • Emergency response planning
Injection wells	Hazardous and nonhazardous waste; Industrial process water disposal	• Zoning codes: Critical area zoning, floodplain management • Buffer and setback zones • Restoration: Remediation • Pollution prevention: Source reduction, management and disposal, education • Emergency response planning
Land application	Industrial waste; Industrial sludge; Petroleum refining waste	• Zoning codes: Critical area zoning, floodplain management • Buffer and setback zones • BMPs: Runoff ponds, constructed wetlands • Pollution prevention: Source reduction and disposal, education

[30] adapted from Kundell and DeMeo, 2000

Landfills	Industrial hazardous and nonhazardous waste	• Zoning codes: Siting, critical area zoning, floodplain management • Buffer and setback zones • BMPs: Runoff ponds • Pollution prevention: Source management and disposal, education
Activity	**Source**	**Local Tools**
Industry		
Material transfer operations	Hazardous and nonhazardous material and waste	• Zoning codes: Siting, critical area zoning, floodplain management • Buffer and setback zones • BMPs: Runoff ponds • Pollution prevention: Source management and disposal, education • Emergency response planning
Pipelines	Hazardous and nonhazardous material and waste	• Utility requirements • Buffer and setback zones • Pollution prevention: Source reduction and management, education • Emergency response planning
Surface impoundment	Waste lagoons and storage ponds	• Zoning codes: Siting, overlay districts, critical area zoning, floodplain management • Buffer and setback zones • Restoration: Re-siting • Pollution prevention: Source reduction, management and disposal, education • Emergency response planning
Superfund sites	Hazardous waste; petroleum releases	• Buffer and setback zones • Restoration: Remediation • Pollution Prevention: Source reduction and management
Radioactive storage and disposal	Hazardous wastes from hospitals and laboratories; transportation spills	• Buffer and setback zones • Restoration: Remediation • Pollution Prevention: Source reduction and management • Emergency response planning
Permitted discharges	Toxic releases; Air emissions; Water discharges; Hazardous waste disposal	• Pollution Prevention: Source reduction, management, disposal and education • Emergency response planning
Permitted facilities	Solid waste disposal	• Zoning codes: Siting • Solid waste ordinance • Buffer and setback zones • BMPs: Grass swales, runoff ponds and wetlands • Pollution Prevention: Source reduction, management and education.

Mining		
Injection wells	Oil and gas activity disposal; Mineral extraction disposal	• Pollution Prevention: Source reduction, management and education • Restoration: Re-siting and remediation • Emergency response planning
	Hydrocarbon releases	• Restoration: Re-siting and remediation • Pollution Prevention: Source reduction, management, disposal and education • Emergency response planning
Pipelines	Hydrocarbon releases	• Pollution Prevention: Source management and education
Stockpiles/Waste piles	Mining and mine drainage; Quarrying; Mineral extraction; Tailing piles	• Buffer and setback zones • BMPs: Runoff ponds and wetlands • Pollution Prevention: Source reduction, management, disposal and education
Activity	**Source**	**Local Tools**
Urban (commercial and residential)		
Storage tanks (above and below ground)	Hazardous and Nonhazardous materials and waste	• Zoning codes: Siting, critical area zoning, floodplain management • Buffer and setback zones • Restoration: Re-siting and remediation • Pollution prevention: Source reduction, management and disposal, education • Emergency response planning
Stockpiles/ Waste piles	De-icing salts storage	• Buffer and setback zones • Pollution Prevention: Source reduction, management and education • Restoration: Re-siting and remediation
Cemeteries/ Graveyards	Chemical and pathogenic contamination	• Zoning codes: Siting • Buffer and setback zones • Restoration: Re-siting and remediation
Ground water / Surface water cross connection	Unused wells; Abandoned wells; Broken sewer and storm water drains	• Stormwater management: Intergovernmental coordination and consistency, stormwater infiltration facilities • Restoration: Remediation
Land application	Fertilizer; Pesticides/Herbicides; Wastewater	• Zoning codes: Siting, overlay districts, critical area zoning, floodplain management • Buffer and setback zones • BMPs: Nutrient loading standards, fertilizer limits • Pollution prevention: Source management and disposal, education
Landfills	Municipal Landfills; Open dumps; Scrap tire piles	• Zoning codes: Siting • Solid waste ordinance • Buffer and setback zones • BMPs: Grass swales, runoff ponds and wetlands • Pollution Prevention: Source reduction, management and education • Restoration: Re-siting and remediation

Impervious surfaces	Runoff from streets, roads and parking lots	• Subdivision requirements: Site design • Building codes: Impervious surface limits, porous pavement • BMPs: Grass swales, infiltration basins • Stormwater management: Intergovernmental coordination, stormwater infiltration facilities
Permitted Discharges	Air emissions; Water discharges; Solid and hazardous waste disposal	• Pollution prevention: Source reduction, management and education
Septic tanks	Individual houses; multi-family units; small businesses	• Zoning codes: Siting, overlay districts, floodplain management, critical area zoning • Building limitations • Subdivision regulations: Site design, on-site wastewater controls • Restoration: Remediation
Activity	**Source**	**Local Tools**
Urban (commercial and residential)		
Disposal wells	Stormwater drainage; Automobile service station disposal	• Zoning codes: Siting, overlay districts, floodplain management, critical area zoning • Stormwater management: Intergovernmental coordination, infiltration facilities • Pollution Prevention: Source reduction, management and education • Emergency response planning
Surface impoundment	Cesspools; Waste lagoons	• Zoning codes: Siting, overlay districts, floodplain management, critical area zoning • Subdivision regulations: Site design, on-site wastewater controls • Pollution Prevention: Source reduction, management and education • Emergency response planning
Other		
Saltwater Intrusion	Saltwater	• Conservation and reuse • Awareness and education
Transportation corridors	Runoff from disturbed sites and impervious surfaces; Herbicide application; Hazardous and Nonhazardous materials and waste spills	• Zoning: Siting of highway and road location, critical area zoning, overlay districts, floodplain management • Buffers and setbacks • Subdivision regulations: Site design, sediment and erosion control • BMPs: Grass swales, excavation, grading and seeding, runoff ponds • Stormwater management: Intergovernmental coordination and agreements, infiltration facilities • Emergency response planning

4.3 Funding

Funding needs for source water protection may vary widely depending on a number of variables, including the nature of the water source, the risks associated with the potential or actual contamination sources, and the consumer base. From the federal perspective, source water protection is intended to be integrated into existing protection programs to reduce the need to establish a new funding channel. However, the focus of this funding effort is on eliminating redundancies in source water protection by using existing programs, thereby reducing the need to fund repetitive efforts.

4.3.1 Source Water Loan Funds [31]

A loan fund approved by the USEPA is available to provide financial resources to public water system purveyors to purchase land or conservation easements for the long-term protection of sources of drinking water in Delaware.

The low-interest loan funding will be made available to water systems when their source water assessments, (conducted under the SWAPP), have been completed. The assessments delineate the land most critical to public water supply wells or surface water intakes.

Criteria for loan eligibility includes the following:

- Land area must be located within a delineated source water protection or wellhead protection area;
- The purchase must support the long-term protection of the water quality of the source of public drinking water;
- The landowner must be a willing seller;
- The size of the loan must not exceed 50 percent of the funds allocated for the fiscal year in which they are requested;
- Conservation easements must be recorded in the deed;
- The land cannot be resold for purposes other than protecting public drinking; and
- Applicants must meet the State of Delaware Revolving Loan Fund loan criteria.

In addition to protecting the long-term quality of clean drinking water sources, the Source Water Protection Loan Fund allows for preservation of valuable ground-water recharge areas, creation of open space, and coordination with other environmental resource protection efforts. Conservation measures such as tree planting (to reduce nutrients) and creation of low impact recreation areas such as hiking and natural areas are activities that can occur as a result of the program.

4.3.2 Livable Delaware Funding [32]

Livable Delaware funding has been set aside to assist municipalities and counties with issues relating to development, transportation, land use regulation, and planning goals and objectives of

[31] DNREC, 26 April 2001 and SWAPP website www.wr.udel.edu/swaphome/.
[32] For more information consult the following www.state.de.us/planning/ld_local_assist.pdf.

the Livable Delaware Initiative. These funds are intended to assist governments with limited planning staff meet the requirements of their charters, the goals of their comprehensive plans, and regulations included in the State Code.

Counties and municipalities are eligible to receive up to a 50 percent match (to a limit of $10,000) of project costs. Grants from the Livable Delaware funding are intended to match funds provided by municipal governments and counties, including in-kind services. Matches of in-kind staff support from a municipality or county will be considered. Grants are awarded on a continuing basis. Grant awards are based on the evaluation of the application and the supporting documentation as well as the availability of funds.

4.3.3 More Federal/State Funding Tools

Other federal/state funding options may be more easily accessed for specific protection projects. There are many funding mechanisms that are administered by the federal government and awarded through state programs. Individual source water protection activities may be eligible for assistance under programs listed in the following Table 4.2.

Table 4.2 Summary of Funding Programs[33]

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
DNREC Dairy Best Management Practices Loan Program	To provide a source of low interest financing for managing dairy and milking parlor waste and manure in an environmentally sound and cost effective manner	Eligibility is open to any dairy producer with a producer or supplier contract with one of the following dairy cooperatives or milk processors that participates in the loan program: Land O' Lakes and Dairy Farmers of America, Inc.	Minimum loan of $5,000 and maximum loan of $100,000	
DNREC Poultry Best Management Practices Loan Program	To provide a source of low interest financing for managing poultry manure, dead poultry, and other sources of poultry related pollution in an environmentally sound and cost-effective manner	Any poultry producer with a grower contract with one of the following integrators that participates in the loan program: Allens Hatchery, Inc., Mountaire Farms of Delmarva, Inc., Perdue Farms, Inc., Townsends Inc., Tyson Foods	Minimum loan of $1,000 and maximum loan of $60,000	
USEPA Drinking Water State Revolving Fund Set-asides	Loans for the acquisition of land or easements for source water protection or for implementation of source water protection measures, or direct assistance for wellhead protection programs		Up to 31% of the DWSRF capitalization grant may be used for set aside activities	
USEPA Clean Water State Revolving Fund	To capitalize state loan funds for wastewater treatment facilities and other water quality management activities, including nonpoint source, estuary projects, and stormwater and sewer overflow protection	The funds are used to make low interest loans to communities, individuals, and others for water quality improvement activities.	Approx. $3 billion in water quality projects annually	No local match required

[33] adapted from Kundell and DeMeo, 2000

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
USEPA 319 Grants (Nonpoint Source Implementation)	To implement nonpoint source projects, including installation of BMPs with applicability for source water assessment and protection	States and local governments, Indian tribes, nonprofit organizations	Formula grants to states	Beneficiaries, except for tribes, are required to provide 40% match
USEPA Public Water System Supervision Grants	To ensure public water system compliance with Safe Drinking Water Act requirements, including inventory of drinking water systems, technical assistance, sanitary surveys, data management, laboratory certification, enforcement, and emergency planning	Grants to states, tribes and regional agencies for direct implementation	Approximately $500,000 according to appropriations and allotment	States are required to provide 10% match
USEPA 106 Grants (Water Pollution Control Program Support)	To support the prevention and abatement of surface and ground water pollution from point and nonpoint sources including wellhead protection	States, tribes and interstate water pollution control agencies		
USEPA Water Quality Cooperative Agreements (104b 3 Grants)	To support innovative demonstration projects for addressing stormwater, CSO, sludge, pretreatment, mining, animal feeding operations, and other pollution sources relating to the National Pollutant Discharge Elimination System program. This includes research, investigations, experiments, training, surveys, and studies related to the causes, effects, extent and prevention of pollution			
USEPA Pollution Prevention Incentives for States	Demonstration projects of pollution prevention or infrastructure in a wide range of sectors	State agencies and municipalities, federally recognized tribes, U.S. territories and possessions	Varies: Maximum amount is $80,000	50% nonfederal share required

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
USEPA Brownfields Cooperative Agreements	To prevent, assess, safely clean up and sustainably reuse brownfields	States, cities, towns, counties, U.S. territories, and Indian tribes	Up to $200,000 granted	No matching share required
USEPA Superfund Technical Assistance Grants	To obtain technical assistance in interpreting information regarding the site	Groups affected by an NPL site. All groups must be incorporated as nonprofit organizations	Up to $50,000 additional funds may be available	20% nonfederal share required; may use in-kind contributions
USEPA Environmental Justice through Pollution Prevention (EJP2)	To use pollution prevention resources for addressing environmental problems in low income, high minority areas	Any incorporated nonprofit organization, federally recognized Indian tribal government, state, city, county or local government	Up to $100,000 granted	No matching share required
USEPA Environmental Justice (EJ)	To address environmental justice issues	Any affected community group, nonprofit organization, university, or tribal government; must be incorporated	Up to $20,000 granted	No matching share required
USEPA Community/University Partnership (CUP)	To efficiently address local environmental justice issues	Institutions of higher education which have formal partnerships with one or more community groups	Up to $250,000	5% nonfederal share required
USEPA Solid Waste Management Assistance (SWMA)	Demonstration projects of solid waste source reduction, reuse, recycling, and improved landfill technology	Nonprofit entities, state and local governments	Limited funds available; typical award less than $50,000	No matching share required
USEPA Sustainable Development Challenge (SDC)	To encourage environmentally and economically sustainable business practices	Local governments, tribes, territories, educational institutions and incorporated nonprofit organizations	Up to $250,000	20% nonfederal share required

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
USEPA Environmental Education (EE)	For projects which design, demonstrate or disseminate environmental education practices, methods, or techniques	Local, tribal, or state education agencies, colleges and universities, nonprofit organizations, state environmental agencies, and noncommercial educational broadcasting agencies	Up to $25,000 granted regionally; $25,001 - $250,000 nationally	25% nonfederal share required
USEPA Wetlands Protection: Development Grants	To support development or enhancement of new and existing state wetlands and their protection, management or restoration programs	States, tribes, and local governments		Entities must provide a 25% match of the total cost of the project.
USDA Agricultural Management Assistance	To voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations	Agricultural Producers/Landowners	Up to $150,000 per year per person	Cost share in which entities must provide 25% of the total cost of the project
USDA Conservation Reserve Enhancement Program (CREP)	To improve and protect water quality of streams and wildlife habitat in the watersheds of the Chesapeake, Delaware and Inland Bays			
USDA Conservation Reserve Program	To establish protective covering on cropland and marginal pastureland	The land must be owned or operated by the applicant for at least 12 months, enrolled in the Water Bank Program or contain other environmentally sensitive land	Annual rental payments for up to 50%, not to exceed $50,000, of the cost of establishing land cover	Long-term rental payments and cost-sharing assistance
USDA Conservation Security Program	To promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private working lands	Private Working Land Owners	Up to $45,000 annually	No matching share required

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
USDA Watershed Protection and Flood Prevention	For carrying out improvements to protect, develop, and utilize the land and water resources in small watersheds	State or local agency, county, municipality, or nonprofit entity	100% for flood prevention; 50% for nonmuncipal water management construction	50% cost share required on some projects
USDA Wetlands Reserve Program	To restore wetlands on private property in exchange for retiring marginal agricultural land	Landowners must have owned the land for at least 12 months, and it must be restorable and be suitable to provide wildlife benefits		Financial incentives and technical assistance
USDA Water and Waste Disposal Systems	For water, sewer, and stormwater projects, including the installation, repair, improvement, and expansion of rural water and waste disposal facilities	Public entities, nonprofit organizations, and federally recognized Indian tribes in rural areas		Direct loans, guaranteed loans and grants
USDA Environmental Quality Incentives Program (NRCS)	To help producers in complying with environmental laws and regulations, including clean water	Farmers and ranchers who establish conservation practices and systems	Cost sharing and incentive payments through 5 to 10 year contracts	Min. 25% for cost share Max. $10,000/person and $50,000 over life of contract
USDA Soil and Water Conservation Assistance	To voluntarily address threats to soil, water, and related natural resources, including grazing land, wetlands, and wildlife habitat	Agricultural Producers/Landowners	Up to $150,000 per year per person	Cost share in which entities must provide 25% of the total cost of the project
USDA Stewardship Incentive Program	To encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy	Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity		
USDA Conservation Technical Assistance	Voluntary conservation technical assistance in planning and implementing conservation systems	Land-users, communities, units of state and local government, and other Federal agencies		

Grant Program	Purpose	Eligible Applicants	Award Amount	Matching Share
USDA Resource Conservation and Development	To accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in designated RC&D areas	State, tribal and local units of government and local nonprofit organizations in rural areas		
USDA Watershed Surveys and Planning	For the development of coordinated water programs and related land resources in watersheds and river basins	Federal, state and local agencies. Priority on agricultural nonpoint sources, wetland preservation, and floodplain management	Planning assistance	
NOAA Coastal Zone Management Awards (CZMA)	For hazard mitigation, providing public access, protecting wildlife and fisheries habitats, and managing land uses that impact water quality	Coastal states and territories whose CZMA programs have been approved by the Secretary of Commerce	Allocations are based on a formula including population and shoreline miles	State match of 50% required for some programs
Department of Commerce Economic Development Administration, Public Works and Development Facilities	To support long term development and growth in distressed communities. This includes the funding of water and sewer projects primarily serving industry and commerce	Public, tribal and nonprofit entities		Matching grants
HUD Community Development Block Grants	To develop viable urban communities by providing housing and a suitable living environment, including water, sewer and other facilities	Entitlement communities must be either a central city in a Metropolitan Statistical Area, a city with population above 50,00 in the MSA, or an urban county of at least 200,000 people. Funds are also awarded to states for distribution to smaller (nonentitlement) communities	Formula grants	
FEMA Hazard Mitigation Grant Program	To implement long term hazard mitigation measures following a major disaster declaration	States and local governments, certain nonprofits, and Indian tribes	Up to 75% of total eligible costs	Match funds or in kind services required

4.3.4 Local Funding Tools

Historically, provision of water supply (including funding to secure, treat, and distribute water) has been considered a local responsibility. Some states provided grant and loan support, but most commonly, it was left to the local government to finance and implement water supply options. This is still true, even though some federal funds are now available. The most common local government funding options include:

- *General tax revenue* (i.e. property tax) that is used to pay for the drinking water system capital costs and operation;

- *Rates and surcharges* for drinking water service that adequately reflect the cost and value of drinking water, including source water protection;

- *Revenue bonds* typically used for large capital outlays but can be guaranteed through charges and other revenues;

- *Water utility surcharges* that are established primarily for wellhead protection program and other land acquisition;

- *Fee systems* in which communities charge permit fees, plan review fees, or facility inspection fees for regulated entities that pose a potential threat to ground water quality by using or storing hazardous materials; Fees can be based on the service provided or benefit received, including potential negative environmental impacts. Examples include:
    - Access Rights
    - Bond Issuance Fees
    - Connection Fees
    - Construction Fees
    - Franchise Fees
    - Inspection/Monitoring/Testing Fees
    - Licensing and Recreational Fees
    - Local Aquifer Protection Fees
    - Local Water/Wastewater Utility User Fees
    - Permitting Fees
    - Product Registration Fees
    - Professional Certification Fees
    - Septic System Impact Fees
    - Solid Waste Disposal Fees (Tipping Fees, Septage/Sludge Fees)
    - State Public Water Supply Withdrawal Fees
    - Tolls
    - Transporter Fees
    - Water Rights Application Fees
    - Well Permit/Pumping Fees

- *Private funds* in which areas can work with foundations and corporations such as the William Penn Foundation or The DuPont Company to protect source water supplies through the use of grants.

Local governments may be most successful in funding source water protection programs if they approach funding options by considering a menu of opportunities. A combination of federal, state, and local financing mechanisms may provide more funds that go further toward source water protection than does seeking a single funding tool. Finally, existing protection programs that have a goal other than source water protection, but that can be used to meet overlapping objectives, offer an important funding option that should not be overlooked.

These innovative ideas are a part of *A Guidebook of Financial Tools: Paying for Sustainable Environmental Systems*. For further details consult the link at: www.epa.gov/efinpage/guidbkpdf/tools1-5.pdf.

4.4 Partnerships

Partnerships are an integral aspect of implementing and maintaining an effective source water protection program. There are key opportunities for groups to be involved in setting source water protection goals and strategies for reaching those goals. In many cases, threats to source water relate to actions taken or not taken by people living, working and playing in the vicinity of the water source. The following lists potential partners that Delaware municipalities can work with in order to create a successful source water protection program:

4.4.1 Federal

- U.S. Department of Agriculture – Natural Resource Conservation Service
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

4.4.2 State

- Delaware Department of Agriculture
- Del. Dept. of Health and Social Services, Div. of Public Health – Office of Drinking Water
- Delaware Department of Natural Resources and Environmental Control
- Delaware Geological Survey
- Delaware League of Local Governments
- Office of State Planning and Coordination
- University of Delaware, Institute for Public Administration, Water Resources Agency

4.4.3 Private

- American Association of Retired Persons (AARP)
- American Association of University Women
- American Farmland Trust
- Brandywine Conservancy
- Commercial and Industrial Realty Council
- Delaware Association of Professional Engineers
- Delaware Council of Farm Organizations
- Delaware Nature Society
- Delaware Public Health Association
- Delaware Rural Water Association
- Delaware State Farm Bureau
- The DuPont Company
- Environmental Finance Center at the University of Maryland
- Greenwatch Institute
- Homebuilders Association of Delaware
- League of Women Voters
- Longwood Gardens
- The Nature Conservancy
- Trust for Public Lands
- William Penn Foundation

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GLOSSARY

AQUIFER: A water-bearing geological formation that will yield water to a well or spring. Aquifers can be classified as confined, semi-confined or unconfined.

BASIN: The surface area that drains into a surface water system.

BACKGROUND LEVEL: Generally, the amount of a substance that occurs naturally in the environment.

BEST MANAGEMENT PRACTICES (BMPs): Structural, nonstructural and managerial techniques that are recognized to be the most effective and practical means to control nonpoint source pollutants yet are compatible with the productive use of the resource to which they are applied. These are used in both urban and agricultural areas.

CHLORINATION: A method of disinfecting water using chlorine gas or chlorine-based chemicals (either drinking water or wastewater).

COMBINED SEWER OVERFLOW: Flow of wastewater and runoff in a combined sewer in excess of the sewer capacity. It represents the flow that cannot be treated immediately and is frequently discharged directly to a receiving stream without treatment, or to a holding basin for subsequent treatment and disposal.

COMMUNITY PUBLIC WATER SUPPLY: A public water supply which serves at least fifteen (15) service connections used by year round residents or regularly serves at least twenty-five (25) year round residents.

CONFINED AQUIFER: An aquifer bounded above and below by impermeable beds (such as silt or clay) or beds of distinctly lower permeability than that of the aquifer itself and containing ground water which is everywhere at a pressure greater than atmospheric and from which water in a well will rise to a level above the top of the aquifer.

CONTAMINANT: Any substance, either man-made or natural which is concentrated enough to degrade water quality to a degree that renders such water harmful to public health and safety, or to the environment.

CONTAMINANT SOURCE INVENTORY: A list of possible contaminant sources within the delineated source water assessment areas. The inventory process includes: reviewing existing data on the locations of potential contaminant sources, identifying likely sources for further information, and verifying the accuracy and reliability of data sets.

DELINEATION: The process of defining and/or mapping a boundary that approximates the areas that contribute water to a particular water source used as a public water supply.

DOMESTIC WELL: A well primarily used for potable non-public water supply purposes which serves three or fewer dwelling units.

EFFECTIVE POROSITY: The volume of void spaces through which water or other fluids can travel in a rock or sediment divided by the total volume of the rock or sediment.

EROSION: Wearing away of soil by running water, wind, or ice; erosion is the process by which the earth's surface is shaped and occurs even in remote, uninhabited areas at a slow rate (geologic erosion); of more concern is accelerated erosion caused by people's activities.

EROSION-PRONE SLOPE: These are areas consisting of lands with soils that are easily eroded.

FLOODPLAIN: Any land area susceptible to being inundated by flood waters from any source.

GROUNDWATER: Any water naturally found under the surface of the earth.

GROUNDWATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER: Any water beneath the surface of the ground with (i) significant occurrence of insects or other macroorganisms, algae, or large diameter pathogens such as Girardia lamblia or (ii) significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlates to climatological or surface water conditions.

HAZARDOUS WASTE: Any waste material that is potentially dangerous, including explosives, radioactive materials, and chemicals.

HYDRAULIC GRADIENT: The gravity or pressure gradient which controls the lateral flow of ground water through an aquifer.

INFILTRATION: The entry of water (from precipitation, irrigation and snowmelt) into the soil profile.

INFILTRATION RATE: The rate at which water applied to the surface of the ground can enter the soil.

NON-TRANSIENT NON-COMMUNITY WATER SYSTEM: A public water system that is not a community water system and that regularly serves at least twenty-five (25) of the same persons over six (6) months per year.

NON-COMMUNITY PUBLIC WATER SUPPLY: A public water supply which has at least fifteen (15) service connections or regularly serves an average of at least twenty-five (25) individuals daily at least sixty (60) days out of the year. Also referred to as a Transient Non-Community Public Water Supply.

NONPOINT SOURCE POLLUTION: Pollution of surface or ground water supplies originating from land use activities and/or the atmosphere, having no well-defined point of entry.

PERCOLATION: Downward movement of water through the unsaturated soil profile or rock units to the water table.

PERCOLATION RATE: The rate at which water moves through unsaturated granular material or rock toward the water table.

POINT SOURCE POLLUTION: Pollution of surface or ground water supplies at well-defined, usually manufactured “points” or locations; discharges of treated wastewater from municipal and industrial treatment plants are common point sources of pollution.

PUBLIC DRINKING WATER SYSTEM: A community, non-community, or non-transient non-community water system, which provides piped water to the public for human consumption. The system must have at least five service connections or regularly serve at least 25 individuals daily for at least 60 days.

RECHARGE AREA: Land area over which precipitation infiltrates into the soil and percolates downward to replenish an aquifer.

SALINITY: The quality of water based on its salt content; salinity is usually expressed in parts per thousand (seawater is typically 32-36 parts per thousand).

SATURATED THICKNESS: The thickness of an aquifer that is fully filled with water.

SEMI-CONFINED AQUIFER: An aquifer which is overlain by a layer of sufficiently less permeability (such as very fine sand) than the aquifer itself but through which significant amounts of water can pass into the aquifer.

SEPTIC SYSTEM: An onsite system designed to treat and dispose of domestic sewage; a typical sewage system consists of a tank that receives wastes from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent remains after decomposition of the solids by bacteria in the tank.

SITE INDEX DATABASE: The DNREC database developed for whole basin assessments that is used to characterize the relative environmental release potential of a discrete potential source of contamination.

SOURCE WATER: Any aquifer or surface water body from which water is taken either periodically or continuously by a public water system for drinking or food processing purposes.

SOURCE WATER ASSESSMENT AREA: The delineated area which contributes water to a public water supply system. This is called a wellhead protection area for a well and a watershed or basin for a surface water intake.

SUSCEPTIBILITY: The relative likelihood that a public water supply might draw water contaminated at concentrations at levels of public health concern to public health.

SUSCEPTIBILITY DETERMINATION: An evaluation of conditions in the source water assessment area to determine the potential for contaminants to impact public drinking water quality.

SURFACE WATER: Lakes, ponds, streams, rivers, and other water bodies, which lie on the land surface.

TRANSMISSIVITY: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

UNCONFINED AQUIFER: An aquifer in which no relatively impermeable layer exists between the water table and the ground surface and an aquifer in which the water surface is at atmospheric pressure.

UNSATURATED ZONE: Partially saturated soil and rock units above the water table.

VULNERABILITY: The relative ease with which contaminants, if released into a source water area, could move and enter a public water supply well or intake at concentrations of concern. Vulnerability includes consideration of such factors as aquifer characteristics, well or surface water intake integrity, and well screen depth.

WATERSHED: An area of land bounded by drainage divides which contributes runoff to one specific delivery point in a stream network; large watersheds may be composed of several smaller “subwatersheds”, each of which contributes runoff to different locations that ultimately combine at a common delivery point.

WATER TABLE: The upper boundary of the saturated zone of an unconfined aquifer.

WELLHEAD PROTECTION AREA: The surface and subsurface area surrounding a water well or wellfield supplying a public water system through which contaminants are likely to move toward a reach such well or wellfield.