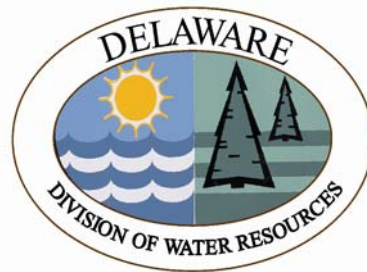
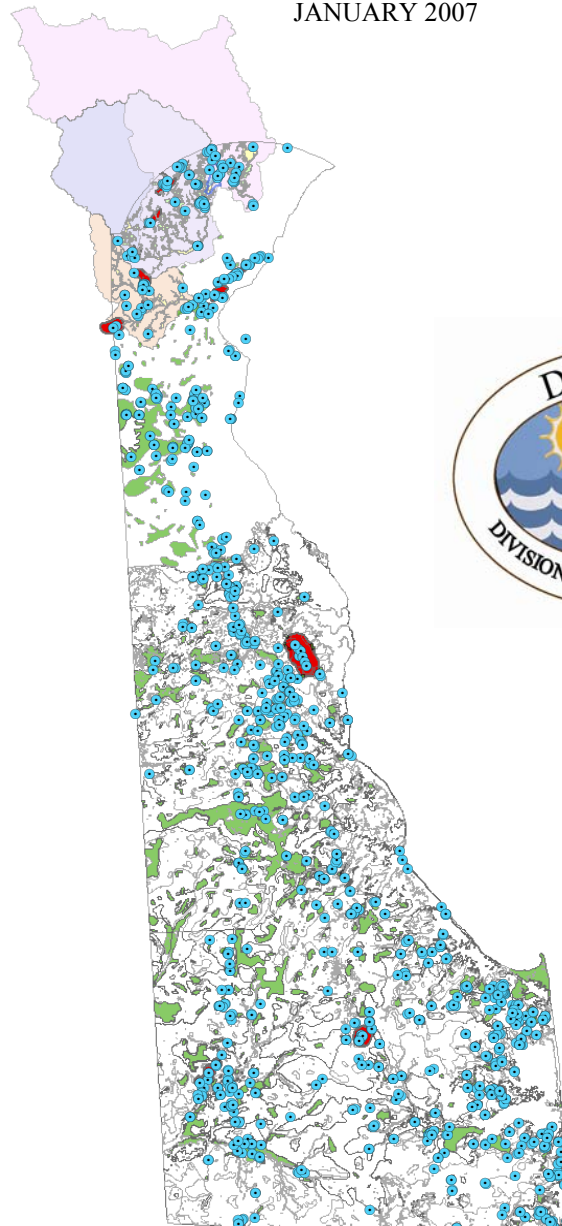


# SECOND REPORT TO THE GOVERNOR AND THE GENERAL ASSEMBLY

## DELAWARE SOURCE WATER ASSESSMENT AND PROTECTION PROGRAM

JANUARY 2007



Department of Natural Resources and Environmental Control and the  
Delaware Source Water Protection Citizen and Technical Advisory Committee





STATE OF DELAWARE  
DEPARTMENT OF NATURAL RESOURCES  
AND ENVIRONMENTAL CONTROL

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January 18, 2007

The Honorable Ruth Ann Minner  
Governor, State of Delaware  
Legislative Hall  
Dover, Delaware 19901

144<sup>th</sup> General Assembly  
Legislative Hall  
Dover, DE 19901

RE: 2<sup>nd</sup> Source Water Protection Program Report

Dear Governor Minner and Members of the 144<sup>th</sup> General Assembly:

It is my pleasure to provide you with the 2<sup>nd</sup> Progress report for the Delaware Source Water Assessment and Protection Program. This report, prepared by the Division of Water Resources with advice from the Source Water Citizens and Technical Advisory Committee, describes the progress that has been made in assuring the protection of Delaware's drinking water as required by Chapter 60 Section 6081 (a).

Our first task of assessing Delaware's drinking water source areas is nearly done with 96% of the over 500 public water system completed. Results of these assessments are now on the web at <http://www.wr.udel.edu/swaphome/index.html>. A key component of these assessments is the mapping of the critical watersheds for the surface water intakes and the mapping of wellhead protection areas for the public supply wells. The maps have been provided to the local government agencies and private system owners to aid them in protecting the quality and quantity of their sources of drinking water.

In 2005 the Division of Water Resources and the advisory committee completed and widely distributed a manual of protection measures that local governments can employ to protect the health and safety of their drinking water. Water Resources staff have been working in with municipal governments to incorporate wellhead areas and excellent recharge areas into their comprehensive plans and develop ordinances to assure adequate protection of wellhead and recharge areas by December 2007.

Finally, research projects funded by the Division of Water Resources are being carried out by the Delaware Geological Survey in order to provide Delawareans with a clear depiction of their water supply aquifers. These projects are outlined in this 2<sup>nd</sup> Report and are available on the web.

Thank you for your continued support of this important program and please call Kevin Donnelly or John Barndt at 739-9949 if you would like additional information on the important program.

Sincerely,

A handwritten signature in blue ink that reads "John A. Hughes".

John A. Hughes  
Secretary

*Delaware's Good Nature depends on you!*



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**Report to Governor Ruth Ann Minner and the Delaware General Assembly  
Delaware Source Water Assessment and Protection Program  
January 2007**

**I. Introduction**

The drinking water for the citizens of Delaware comes from surface water (streams) and ground-water sources (aquifers).

Seventy-five percent of the drinking water for New Castle County comes from the streams of the Delaware River Basin. Delaware shares this basin with Pennsylvania, New Jersey, and New York. The streams Delaware draws water from include the Brandywine Creek, Red Clay Creek, White Clay Creek, and the Christina River. Ground-water sources supply the remaining twenty-five percent of New Castle County's drinking water. Kent and Sussex Counties rely solely on ground-water for their drinking water supply.

The Delaware River Basin with its tributaries, runs for 330 miles and drains approximately 13,000 square miles of land surface (DE Riverkeeper, 2006). This drainage network originates in the Catskill Mountains of New York and Pocono Mountains of Pennsylvania. The land use activities and practices within the Basin can threaten water quality in Delaware. Release of contaminants in the far reaches of the tributaries of the Delaware River can ultimately be carried downstream and threaten Delawareans.

Ground-water is the sole source of public drinking water for Kent and Sussex Counties. There are approximately fourteen major aquifers south of the Chesapeake and Delaware (C&D) Canal that are util-

ized to provide drinking water to the public. Since ground-water originates from rainfall percolation through the land surface, land use activities and practices affect the quality of ground water. Public awareness has risen in response to water quality issues leading to coalitions, cooperatives, and civil groups joining in the efforts of governments to protect and improve the quality and quantity of drinking water.

The Delaware Source Water Assessment and Protection Program (SWAPP) formed in 1998 as a response an amendment to the Safe Drinking Water Act. "The goal of this program is to assess the susceptibility of public water sources to contamination and to promote and facilitate the protection of these public water system sources to complement traditional water treatment" (DNREC, 1999. p. xi).

This report to the Governor and General Assembly describes the status of source water protection efforts as required by Delaware Code, Title 7, Chapter 60, Subchapter VI, § 6081.

**II. Development of Delaware's Source Water Protection Program**

In 1996, the United States Congress amended the 1974 Safe Drinking Water Act (SDWA) by requiring states to take action to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and ground water wells. This amendment "enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public in-



formation as important components of safe drinking water” (EPA, 2004, Overview).

The United States Environmental Protection Agency (EPA) oversaw the implementation of the SDWA and required that each state’s Source Water Assessment Plan (SWAP) address several key elements. The SWAP must: (1) describe the approach to conducting the assessments; (2) delineate the boundaries of source water areas of public water systems; and (3) identify the origins of potential contaminants in the delineated area to determine the susceptibility of public water systems to those contaminants (USEPA, 1997). Finally, states were required to have public involvement in developing the plan (DNREC, 1999).

In 1998, DNREC requested participation from the public and formed the Delaware Source Water Protection Citizen and Technical Advisory Committee (CTAC). The role of the committee is to advise DNREC in the development and implementation of the Source Water Assessment Plan. In conjunction with one another, DNREC and CTAC developed the Delaware Source Water Assessment Plan according to the EPA guidelines (EPA, 1997). The EPA approved the Delaware Source Water Assessment Plan (SWAP) in October of 1999.

Based on the Delaware SWAP, Source Water Assessment Reports are prepared for each public water supply system. The report includes maps showing the location of the system, delineation of the wellhead protection area, the potential sources of point and non-point contaminants, and the land use within the delineation. The information is shown in table and figure format. The Department of Health and Social Services, Office of Drinking Water (DHSS-ODW), provides chemical and biological

analysis data for the reports. The susceptibility of the system to potential contaminants is determined by evaluating all available information.

A draft of each water system’s initial Source Water Assessment Report is sent to the system’s owners or operators for review and comment before the document is finalized. Final copies are provided to the water system owners. Copies are also available at DNREC, DHSS-ODW, and on the Delaware Source Water web site (DNREC, 2006). Water systems are required to include the assessment findings in their annual Consumer Confidence Reports (Del. Admin. Code §§ 4000 - 4400 - 4462, 2005).

The State of Delaware Source Water Protection Law called for the development of a manual to catalog Better Management Practices (BMPs) for use by local governments. DNREC Division of Water Resources published Source Water Protection Guidance Manual for Local Governments of Delaware in May of 2005. The revision expands the definition of source water to include excellent ground-water recharge areas as critical areas according to Delaware Code Annotated § 6083, (2006). The manual details Delaware’s source water legislation. It summarizes source water protection practices and the implementation strategies for source water protection.

### **III. Delaware Source Water Protection Citizen and Technical Advisory Committee**

The Safe Drinking Water Act set the responsibility for developing programs, making funding decisions and system improvements on the public (EPA, 1996). In 1997, DNREC requested public participa-

tion in the formation of the Delaware Source Water Protection Citizen and Technical Advisory Committee (CTAC). The committee formed in 1998. The Delaware General Assembly required DNREC to consult CTAC in matters pertaining to the Source Water Assessment Plan and related matters (Del. Code Annotated § 6084, 2006).

The Committee's members are from civic organizations, environmental consulting firms, conservation groups, public water system operators, public advocacy groups, and federal, state, county, and local governments (Table 1). The Committee's first official act was to assist DNREC in the preparation of Delaware Source Water Assessment Plan for submission to the EPA. After approval of the Plan, the committee chose not to disband in the public's interest.

In 2001, the Delaware General Assembly passed the Source Water Protection Law. This law expanded CTAC's authority to include advisement in the adoption of source water assessment, wellhead protection, and excellent ground-water recharge potential areas by counties and municipalities. The Committee has advised DNREC on revisions to the Source Water Assessment Plan, the release of potentially sensitive information, funding for projects, and the development of the Source Water Protection Guidance Manual for the Local Governments of Delaware.

CTAC meets quarterly. Meeting times, minutes, presentations, and announcements are available at the Source Water Protection web site at: <http://www.wr.udel.edu/swaphome/meetings.html>

#### **IV. Status of Source Water Assessments in Delaware**

The Delaware Division of Public Health defines four classifications of public water supply systems. The Source Water Assessment process addresses three of these. These classifications are Community Systems, Non-Transient Non-Community Systems, and Non-Community Systems. Community Systems are defined as public water systems that 'serve at least fifteen service connections used by year-round residents or serve at least twenty-five year-round residents' (e.g. city owned System). Non-Transient Non-Community Systems 'are not community systems and regularly serve at least twenty-five of the same people over six months per year' (e.g. schools). Non-Community Systems serve at 'least fifteen service connections or regularly serve an average of at least twenty-five individuals at least sixty days a year' (e.g. restaurants) (Delaware Code Annotated § 122, 2006).

In June of 2004, DNREC submitted the First Report to the Governor and the General Assembly regarding the progress of the Source Water Assessment and Protection Program.

The report showed that approximately 350 source water assessments had been completed for the 526 public water supply systems in Delaware. Approximately 84 systems have been added for an approximate total of 610 systems statewide. DNREC has completed approximately 587 assessments (Table 2). A majority of the outstanding systems are problematic in that they pre-date the current documentation process and require intensive fieldwork and documentation.

**Table 1. Delaware Source Water Citizen and Technical Advisory Committee**

Name	Affiliation	Status
Mr. Joseph Demul	AARP	Citizen
Mr. Lloyd Hughes	AARP	Citizen
Vacant	Delaware Public Health Association	Citizen
Mr. Kenneth Wicks	Council of Farm Organizations	Citizen
Mr. Mark Nardi	United States Geological Survey	Technical
Mr. Tad Yancheski	Tetra Tech, Inc. / Committee of 100	Technical
Mr. Nicholas DiPasquale	Duffield Associates / Committee of 100	Citizen/Technical
Mrs. Dawn Cook	United Water Delaware	Technical
Mr. Scott Koenig	City of Dover	Technical
Mr Gilbert Holt	Town of Lewes Board of Public Works	Technical
Mr. Joseph DiNunzio	Artesian Water Company	Technical
Ms. Nancy Parker	Artesian Water Company	Citizen
Ms. Sheila Shannon	Tidewater Utilities	Technical
Ms. Colleen Arnold	City of Wilmington	Technical
Mr. Anthony Gersitz	American Water Works Association	Technical
Mr. Jigar Patel	Delaware Rural Water Association	Technical
Mr. Vince Winkler	Delaware Farm Bureau	Citizen
Vacant	League of Women Voters/ Friends of Herring Creek	Citizen
Mrs. Marion Stewart	Civic League for New Castle County	Citizen
Ms. Lorraine Fleming	Christina Conservancy	Citizen
Ms. Jennifer Gochenaur	Delaware Nature Society	Citizen/Technical
Mr. John Flaherty	Greenwatch Institute	Citizen
Mr. Grier Stayton	DE Department of Agriculture Pesticide Section	Technical
Ms. Anita Beckel	Division of Public Health - Office of Drinking Water	Technical
Mr. John Talley	Delaware Geological Survey	Technical
Mr. Jerry Kauffman	Water Resources Agency	Technical
Mr. George Haggerty	New Castle County Dept. of Land Use	Technical
Mr. John Barndt	DNREC, Source Water Protection	Technical
Mr. Stephen Williams	DNREC, Watershed Restoration Coordinator	Technical
Mr. Hassan Mirsajadi	DNREC, Watershed Assessment	Technical
Mr. Alex Rittberg	DNREC, Site Investigation & Remediation Branch	Technical
Mr. Paul Jones	Delaware Association of Professional Engineers*	Technical
Mr. Stephen Lefebvre	Homebuilders Association of Delaware	Citizen
Mr. Robert Wittig	Commercial & Industrial Realty Council	Citizen/Technical
Mr. Sam Cooper	Sussex County Association of Towns	Citizen
Mr. George Wright	Delaware League of Local Governments	Citizen
Mr. David R. Burris	Kent County Levy Court	Citizen
Mr. Lynn J. Rogers	Sussex County Council	Citizen
Ms. Joy Sikora	AAUW / Inter-Group Council	Citizen
Mr. Walt Bryan	Del Mar Consulting Services Ltd.	Citizen/Technical
Mr. Bill Powers	Alternate: Delaware State Farm Bureau	Citizen
Mr. Scott Andres	Alternate: Delaware Geological Survey	Technical
Mr. Edward Hallock	Alternate: Division of Public Health Office of Drinking Water	Technical
Mr. Douglas Rambo	Alternate: DNREC, Source Water Protection	Technical
Mr. Hans Medlarz	Alternate: Kent County Engineering Department	Technical

DNREC developed an in-house software application in 2001 to generate the Source Water Assessment Reports. The application utilized the then current ESRI ArcView GIS software and aerial images. Presently, DNREC is in the process of updating the program to accept more recent aerial images.

The Source Water Assessments are instrumental in identifying problem facilities. DNREC Division of Water Resources staff has worked with staff from other programs to address issues that pose a potential threat to drinking water sources. Staff has also worked with counties and municipalities to implement protection measures that will be included in county and municipality comprehensive land use plans.

## V. Potential Sources of Contamination to Sources of Public Drinking Water

The EPA's Safe Drinking Water Act Amendments of 1996 required the States to assess the susceptibility to contamination of source waters that supply public drinking systems (EPA, 1996). The scientific literature shows that contaminant potential to source water is from point and non-point source pollutants. Point source pollutants are referred to as 'Discrete Sources' in Source Water Assessments.

This category of contaminant is generated from a definable source, usually of a quantifiable concentration (Table 3).

Non-point source pollutants are not easily quantified because they do not have a definable source. The Source Water Assessment

**Table 2. Status of Source Water Assessments as of November 2006**

		Public Water Systems			
		Community	Non-Transient	Transient	Total
*Pre-EPA Audit(1999)	Total Systems	222	116	188	526
	Number Completed	219	107	177	503
Post EPA Audit	Systems Added	46	22	19	87
	Number Completed	44	22	19	85
Total Systems		268	138	207	613
Total Systems Completed		263	129	196	588
Percent Completed		98%	93.5%	94.7%	95.9%

\*The EPA audited the inventory of public water systems at the time the SWAP was accepted.

Report uses land use / land cover tables to determine the contaminant potential for non-point source pollutants. Contaminant potentials are rated for nine contaminant types: nutrients, pathogens, petroleum hydrocarbons, pesticides, PCBs, other organics, metals, other inorganics, and turbidity.

### A. Discrete Sources

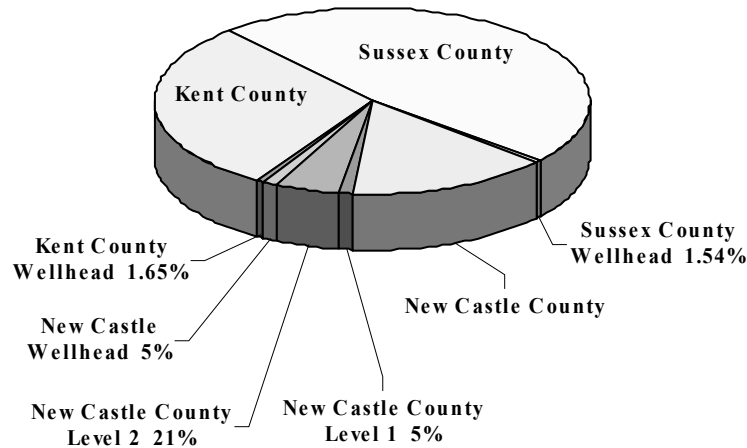
Delaware has an extensive inventory of discrete sources because of the interdisciplinary effort achieved during compilation of the whole basin assessment reports (DNREC, 1998, 2001a, 2001b, and 2005). Discrete source contaminants are categorized for inventoried hazardous waste sites statewide (Table 3). DNREC's Tank Management Branch, Solid Waste and Hazardous Waste Branch, and Site Investigation Research Branch (SIRB) collected the information and stored it in intranet databases

that are accessed when preparing the source water assessment reports. The potential of discrete sources to contaminate source water is dependant upon the proximity to the source water, the severity of the release, the nature of the toxin, and method of remediation. All discrete sources found within the delineated source water areas are rated by their contaminant potential. This rating is included in the source water assessment reports.

The hydrologic link between surface water and ground water is of importance in preparing source water assessments. The contaminant potential is ranked as a function of the area surrounding a given surface water body. The area within 200 feet of the surface water has the strongest interface with the ground water. This area is ranked as a Level 1 protection area because the potential movement of contaminants from ground water to surface water is very high. Under-

**Table 3. Categories of Discrete Source Contaminants in the Hazardous Waste Databases**

Animal Feedlot Operations	Pesticide Loading, Mixing, & Storage Facility
Combined Sewer Overflows	Salvage Yards
Domestic Septic Systems	State and Federal Superfund Sites
Dredge Spoils	Tire Piles
Golf Courses	Toxic Release Inventory
Hazardous Waste Generators	Underground Storage Tanks
Landfills / Dumps	Waste Sludge Application
Large On-Site Septic	Wastewater Spray Irrigation
National Pollutant Discharge Elimination System (NPDES)	Salvage Yards



**Figure 1. Land Area Delineated as Source Water Protection Areas.**

Wellhead protection areas are shown for each county. Level 1 and Level 2 source water protection areas of New Castle County are also shown. The land area of each county is shown to illustrate perspective of the amount of land that is delineated as Source Water Protection Ar-

ground tanks, hazardous waste generators (commercial enterprises that generate hazardous waste), and wastewater outfalls provide the greatest sources of discrete contaminants in Level 1 areas (Appendix A, Table A1). The remaining area within the drainage basin and upstream from the public drinking water systems intakes is ranked as a Level 2 protection area. The highest incidence of discrete source contaminants in Level 2 are from the categories underground storage tanks, hazardous waste generators, and superfund sites (Appendix A, Table A2).

New Castle County has approximately 5 percent of land area designated as Level 1 protection areas and 21 percent in Level 2. The County has approximately 5 percent of land area delineated as wellhead protection areas. Kent County has approximately 1.65 percent of its land area delineated as well-

head protection area and Sussex County has approximately 1.52 percent (Figure 1).

The source water assessment reports identify and report the incidence of discrete source contaminants found in wellhead protection areas of public water supply wells. Wellhead protection areas are surface and subsurface areas surrounding a public water supply well where land use activities or impervious cover may adversely affect the quantity and quality of ground water moving toward the wells. Discrete source contaminants enter aquifers by infiltration through the soil profile and their rate of transport is increased by precipitation.

All Delaware counties have high incidences of contaminant potential from underground storage tanks, superfund sites, hazardous waste generators, and domestic septic systems. Sussex County, in particular, faces

discrete source contaminant potential from large community septic systems, animal feedlot operations, pesticide handling facilities, and wastewater spray irrigation systems (Appendix A, Table A3).

## B. Non-point Sources

Anthropogenic activities and natural processes generate non-point source contaminants. To adequately analyze environmental processes the United States Geological Survey (USGS) defined a system that interprets satellite images according to land use and land cover (Anderson, 1976). Surface water and ground-water contamination may occur from the activities associated with each land use and land cover category (Table 4). For example, nutrients, pesticides, and other chemicals are transported to

surface waters via runoff, and effluent from sewage-treatment plants and industrial discharges (Denver, 2004). By rating the contaminant potential of each category, it is possible to identify the likelihood of non-point source threats. The Source Water Assessment Plan rates contaminant potential by modifying the Anderson (1976) categories to combine several of them.

Since watershed systems direct the flow of surface runoff to streams, the land use activities in Delaware's four of Delaware's 41 watersheds have the potential to directly impact drinking water drawn from surface water sources. Brandywine Creek, Red Clay Creek, and White Clay Creek watersheds have large percentages of their areas in southern Pennsylvania (Figure 2). Ninety-four percent of the Christina River Watershed is in Delaware while only 6 % is

**Table 4. Land Use and Land Cover Categories for the Basin Systems Supplying Water to New Castle County.**

Land Use and Land Cover Categories for Delaware and Pennsylvania		
Airports	Extraction	Rangeland / Pastureland
Animal Operations	Farmsteads	Recreation
Barren / Open	Forested	Residential
Clear-cut Forest	Highways / Parking Lots	Transportation/Utility
Combined Urban	Industrial	Vehicle Operations
Commercial	Junk / Salvage Yards	Water
Cropland	Railroads	Wetlands
Land Use and Land Cover Categories Specific for Pennsylvania		
Agriculture*	Institutional	

\*Pennsylvania groups Cropland, Farmstead, Rangeland, and Animal Operations when determining Land Use and Land Cover Categories.

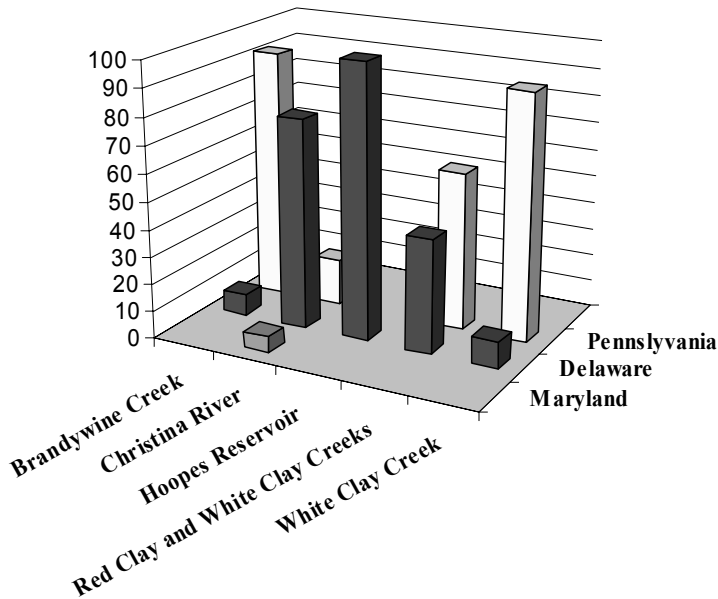
in Maryland. Hoopes Reservoir is the only surface water supply with its basin entirely within the borders of Delaware.

Land use activities upstream from surface water uptakes in Level 1 source water protection areas may contaminate source water directly. Activities within the basin delineated as Level 2 may not only contaminate ground water, but eventually surface water. Any contaminants in runoff are carried as water infiltrates the land surface and moves through the soil. This contaminated ground water will either enter the surface water from the surficial aquifers or can be drawn into wells.

The source water assessments delineate wellhead protection areas to ensure the integrity of public drinking water. Deep wells

drilled into confined aquifers and low volume wells in unconfined aquifers have at minimum, a one-hundred and fifty foot radius wellhead protection area. The wellhead protection areas surrounding public supply wells in unconfined aquifers that pump more than 50,000 gallons per day are delineated using a mathematical model. This type of well draws large quantities of water and can have much larger wellhead protection areas. Delineations of wellhead protection areas have been completed and made available to Delaware’s counties and municipalities. The Report identifies and discusses land use categories within the system’s combined wellhead area.

The three major land use and land cover categories in the wellhead protection areas of New Castle County are Residential,



**Figure 2. Percentage Land Area of Surface Source Water Basins in Delaware, Pennsylvania, and Maryland**



Cropland, and Commercial. The Utilities category has the highest contaminant potential followed by residential land use. In Croplands versus residential areas, metals are more likely to be potential contaminants than pathogens and petroleum hydrocarbons (DNREC, 1999). Cropland is the dominant land use in the wellhead protection areas of Kent and Sussex Counties (Figure 3, Appendix A Table A4).

## **VI. Status of County and Municipal Ordinances – On-going**

As part of the 2007 Comprehensive Land Use Plans, Delaware counties and municipalities with populations of 2,000 persons or more are required to adopt the overlay maps delineating wellhead protection and excellent ground-water recharge potential areas as critical areas. Counties and municipalities are to adopt ordinances governing the use of land within those critical areas designed to protect public water supply from activities and substances that may harm water quality and reduce overall water quantity (Del. Code Annotated § 6082, 2006).

Municipalities with less than 2,000 persons may adopt the overlay maps delineating wellhead protection and excellent ground-water recharge potential areas as critical areas. They may also adopt ordinances governing the use of land within those critical areas. (Del. Code Annotated § 6082, 2006).

DNREC has been directed to assist the counties and municipalities in developing their comprehensive plans and ordinances. DNREC has made the overlays of source water assessment, areas, wellhead protection areas and excellent ground-water recharge potential areas available to counties and municipalities for use in developing

their maps. DNREC has several publications available to assist counties and municipalities in their efforts. DNREC staff is also available for consultation.

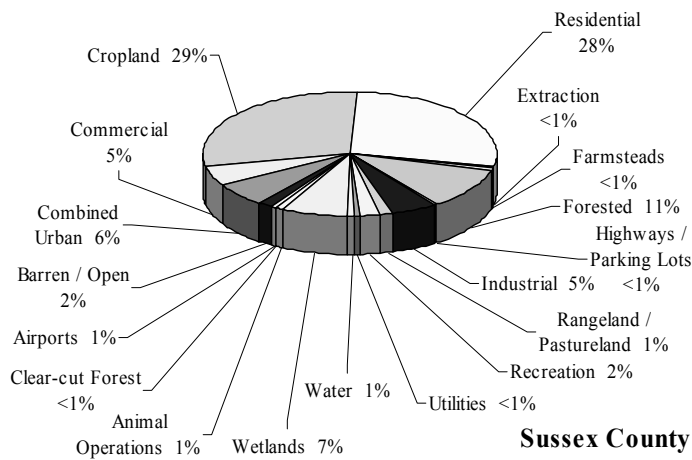
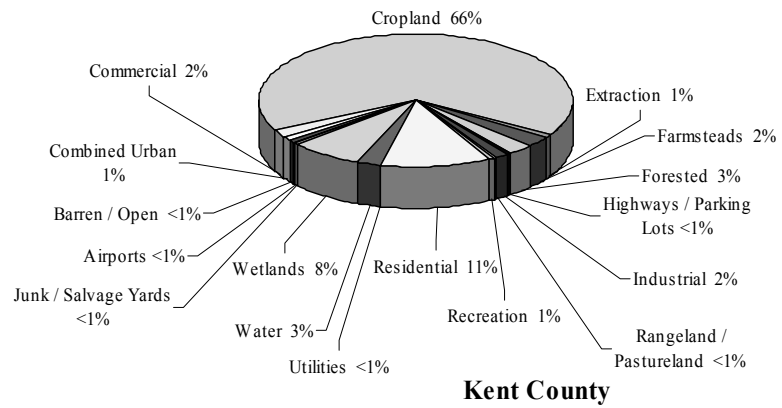
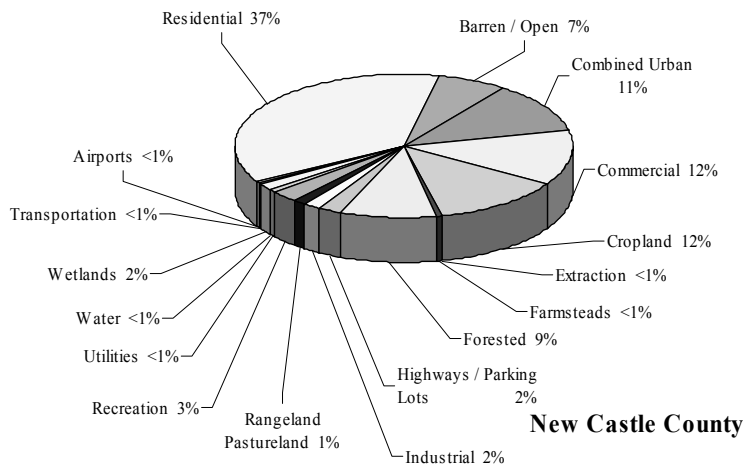
Delaware has 57 incorporated municipalities that are required to keep their comprehensive plans up to date (Del. Code Annotated § 702, 2006). Fifteen of these municipalities have populations of 2,000 or more persons and fourteen are required by to adopt ordinances to protect critical areas.

New Castle County and two municipalities have adopted ordinances. Two municipalities have prepared drafts and eight are working with consultants (Table 5). Seven municipalities have voluntarily participated in developing ordinances (Table 5).

## **VII. Status of Ground-Water Recharge Potential Mapping**

Andres (2004) defines “ground-water recharge” as a term that refers to both a process and a quantity of water. As a process, recharge is the action of the downward movement of water from the land surface through the soil profile to the water table aquifer. In terms of a quantity, it defines the amount of water that reaches the water table. Excellent recharge areas are near-surface areas within which precipitation infiltrates the land surface to the unconfined aquifer at a more rapid rate than other areas.

Recharge potential is determined by evaluating the water transmitting properties of a subsurface interval designated as land surface to a depth of twenty feet (Andres, 2004). The ability of this interval to transmit water is dependant on the amount of precipitation, the soil properties, and the interconnectedness of the adjacent intervals.



**Figure 3. Land Use/ Land Cover in Wellhead Protection Areas for New Castle, Kent, and Sussex Counties.**

**Table 5. Status of Municipalities and Counties in developing their Ordinances for Source Water Protection Areas.**

<u>County</u>	<u>Status</u>
New Castle	Adopted
Kent	Working with Delaware Rural Water Association
Sussex	Working
<b><u>Municipality (required)</u></b>	
Camden	Draft – Proposed voting in January 07
Dover	Working with Delaware Rural Water Association
Elsmere	No wellhead or excellent ground-water recharge areas
Georgetown	Working with Delaware Rural Water Association
Harrington	Working with Delaware Rural Water Association
Laurel	No known activity
Lewes	Working – Dependant on Sussex County Plan
Middletown	Draft
Milford	Working with consultant
Millsboro	No known activity
Newark	Adopted – Requires surface water update
New Castle	Working with Delaware Rural Water Association
Seaford	Working with Delaware Rural Water Association
Smyrna	Adopted – Requires excellent ground-water recharge update
Wilmington	Working with consultant and DNREC
<b><u>Municipality (voluntary)</u></b>	
Bridgeville	Draft
Cheswold	Adopted
Clayton	Working with Delaware Rural Water Association
Delaware City	Draft
Milton	Working with Delaware Rural Water Association
Rehoboth	Has Worked with Delaware Rural Water Association
Selbyville	Adopted

The soil properties include particle size, spacing between particles, and type of particle (i.e. sand, gravel, or mud).

completed the maps for Kent and Sussex Counties in 2003 with funding from DNREC (Andres, 2003a, 2003b).

Mapping of ground-water recharge areas began in 1990 and was completed in 2003 by the Delaware Geological Survey (DGS). The New Castle County map was prepared by DGS as a part of a project report for the Water Resources Agency of New Castle County (Butoryak and Talley, 1993). DGS

In 1990, DGS initiated a pilot study “to test the procedures for delineating ground-water recharge areas, with the expectation that recharge areas would become subject to land-use controls to safeguard areas for future water supply development” (Andres, 1991, pg 1).

DGS examined the “descriptive logs of drill holes and boreholes from selected water well drillers, test boring operators, geologists, and engineers, as well as descriptions of materials exposed in outcrops, borrow pits, drainage ditches, and hand auger borings” in preparing the maps (Andres, 2004, pg. 3). These sources allowed DGS to use computer models to analyze the water transmitting abilities of the areas and assign the recharge potential of the areas mapped by soil types.

The maps categorize ground-water recharge areas as excellent, good, fair, and poor. These categories are “indicators of how fast contaminants will move and how much water may become contaminated” (Andres 2004, pg. 1). Because excellent ground-water recharge areas move contaminants quickly, they are poor locations for storm-water management ponds from a water quality perspective.

The ground-water recharge maps are used by state, county, and local governments in the development of the State mandated Comprehensive Land Use Plans and regulations governing land use. Kent County has 14% of its land surface categorized as excellent ground-water recharge area. New Castle and Sussex Counties have 9.7% and 8%, respectively (Figure 4). Digital copies of the maps are available online (Andres, 2003a, 2003b).

## **VIII. Summary and Status of Source Water Program Funded Projects**

### **A. Source Water Protection Guidance Manual for the Local Governments of Delaware - Completed**

Delaware Code, Title 7, Chapter 60, Subchapter VI, §6082, called for DNREC to

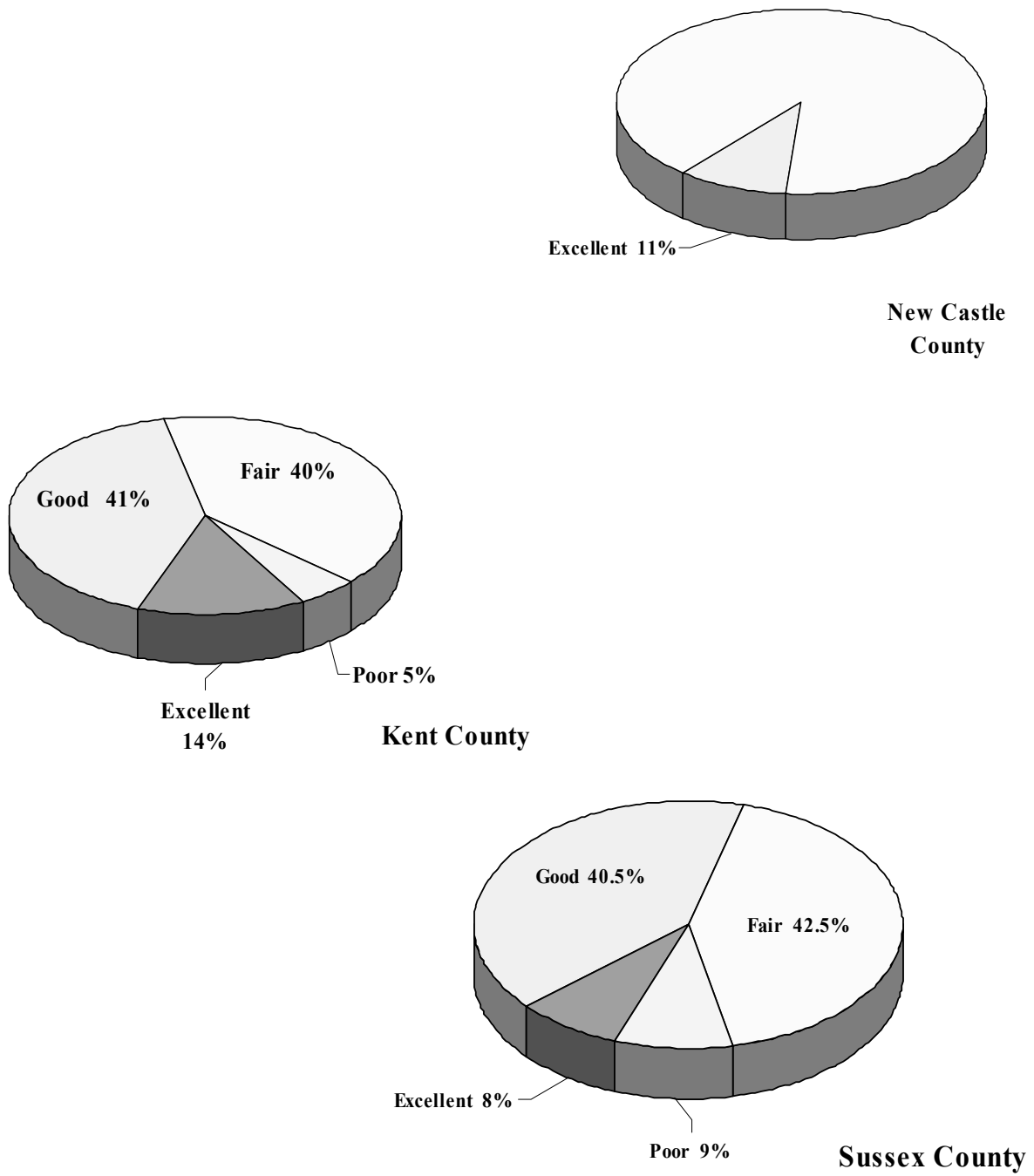
develop a guidance manual in concurrence with CTAC’s advisement. The intent of the manual is to assist counties and municipalities in the development of Comprehensive Land Use Plans and regulations or ordinances to identify and protect Critical Areas. The Code lists critical areas as well-head protection areas, excellent ground-water recharge potential areas, and source-water assessment areas (surface water).

DNREC published the Source Water Protection Guidance Manual for the Local Governments of Delaware as instructed by the legislature. Additional input from two public workshops improved the format and content of the manual and a revised document was published in May of 2005. The revision included two supplements. Supplement 1 is the Delaware Ground-water Recharge Design Manual (Kauffmann, 2005) and Supplement 2 is entitled, USDA Natural Resources Conservation Service – Delaware Conservation Practice Standards (NRCS-DE, 2005).

The Guidance Manual details pertinent legislation and existing ordinances, summarizes source water protection practices, contains strategies for the implementation of source water protection, and includes a model ordinance. The Manual and the Supplements are available through DNREC Division of Water Resources or online at: <http://www.wr.udel.edu/swaphome/publications.html>

### **B. Technology Enabled Permitting (TEP) Project - Well Database Migration – Completed**

“The technology-based redesign of the Well Permitting Processes began in 1995 with a pilot project that is now a successful on-line transaction processing system. Data entered



**Figure 4. Areas of Ground-water Recharge Potential by County.** The New Castle County study did not include the delineation of Good, Fair, and Poor ground-water recharge potential.

for permit applications is accessible to both in-house and field technicians” (DNREC, 2001, p. 14). In addition to information contained on the well permit the new system allows for online searches of completion reports and contaminant reviews in a Portable Document Format (PDF). This format allows for updates and additions to well profiles.

### **C. Mercury in the Surficial (Columbia) Aquifer on Long Neck Peninsula, Sussex County, Delaware - Completed**

DNREC funded the United States Geological Survey (USGS) in a joint study with the Delaware Geological Survey (DGS) to investigate the occurrence of mercury in public wells on the Long Neck Peninsula, Sussex County in January 2001. Samples from 22 private and public production wells revealed that the shallow ground-water (30-120 feet below land surface) contained less than 10 ng/L of mercury.

Five production wells in the communities of Pot Nets Bayside and Lakeside were found to have elevated concentrations of mercury (100-1,820 ng/L) (Koterba et al., 2006). The Maximum Contaminate Level (MCL) for mercury is 0.002 mg/L (1,820 ng/L equals 0.00182 mg/L).

The study also assessed the overall quality of the ground water on the peninsula. Elevated levels of nitrate-nitrogen, dissolved solids, and volatile organic compounds (VOCs) were found. These constituents are associated with anthropogenic land use activities (Koterba et al , 2006).

Measurable amounts of mercury were recovered in soil and fill at the sites. This finding was initially attributed to atmos-

pheric deposition and redistribution associated with development. However, atmospheric deposition is an unlikely source of the contamination, since mercury levels were undetectable in the aquifer sediment. The specific event or source of the mercury in the Long Neck water supply is currently unknown. Based on the shallow depth and young age (circa 1970-1985) of the contaminated ground water, the source of the mercury is most likely a recent anthropogenic event that entered the aquifer through recharge (Koterba et al, 2006).

### **D. Geology and Extent of the Confined Aquifers of Kent County Delaware – Completed**

DNREC provided funding to DGS to update the geological framework of the seven confined aquifers of Kent County. New data from this study show previously unrecognized ranges and characteristics of Kent County aquifers. The findings of this study redefine our understanding of the hydrogeologic framework of Kent County (Mc Laughlin and Velez, 2006).

### **E. Hydrogeologic Assessment Project for Eastern Sussex County – Thickness and transmissivity of the unconfined aquifer of eastern Sussex County, Delaware - Completed**

Ground water from the Columbia surficial aquifer is the sole source of fresh drinking water for the rapid commercial and residential growth in Eastern Sussex County. Because data from the study show thickness (depths) and extent of the Columbia aquifer, informed decisions can be made regarding management of this important freshwater source. DNREC staff access this informa-

tion in their source water investigations as digitized overlays that project in ArcMap©, an ArcGIS© application.

#### **F. Arsenic in Delaware Soils – On-going**

In 2001, the EPA increased the maximum contaminant level of arsenic from 50 ppb to 10 ppb because of human health concerns (USEPA, 2002). DNREC in cooperation with Delaware Water Resource Center is funding a study of Delaware soils that have been impacted by industrial and agricultural inputs of arsenic (DWRC, 2006).

Sources of arsenic in Delaware soils include pesticides, fertilizers, poultry manure, and old tanneries. The study addresses the forms and fate of arsenic in soils and the potential movement of this contaminant into drinking water.

#### **G. Source Water Program Web Site – On-going**

Delaware's Source Water Assessment and Protection Program web site is located and maintained on the Water Resource Agency server at the University of Delaware. <http://www.wr.udel.edu/swaphome/index.html>.

The site contains historical information on the development of the Source Water Assessment and Protection Program, final source water assessments, guidance documents, loans, and published research papers. It also includes information about the Citizens and Technical Advisory Committee including membership, meeting summaries, and meeting schedule.

#### **H. Hydrogeologic Assessment Project for Western Sussex County – Thickness and transmissivity of the unconfined aquifer of western Sussex County, Delaware: On-going**

Ground water from the Columbia Surficial aquifer is the sole source of fresh drinking water for the commercial and residential growth in western Sussex County. Data from the study show the thickness (depths) and extent of the Columbia aquifer, informed decisions can be made regarding management of this important freshwater source. DNREC staff access this information in their source water investigations as digitized overlays that project in ArcMap, an ArcGis application.

#### **I. Geology and Extent of the Confined Aquifers of Sussex County Delaware – On-going**

DNREC provided funding to DGS beginning in 2006 to update the geological framework of the confined aquifers of Sussex County. New data from this study may redefine our understanding of the ranges and characteristics of the Sussex county aquifers.

#### **IX. Actions for Future Protection of Sources of Public Drinking Water Sources**

##### **A. Use of Existing Regulatory and Non-Regulatory Tools -- On-going**

DNREC Division of Water Resources has prepared a report titled, 'A Compendium of Federal, State, and Local Regulatory Authorities that Support the Source Water Assessment and Protection Program in Delaware' (DNREC, 2002a). The Report sum-

marizes existing laws, rules, and regulations that address source water protection in Delaware. The intent of the document is to present pertinent Federal, State, and local laws, rules, regulations, and policies in a concise format.

The Department will use the Compendium in conjunction with the Source Water Assessment Reports when addressing high contaminant potentials. The Compendium serves as a useful reference for public drinking water suppliers. The report is available online at:

<http://www.wr.udel.edu/swaphome/publications.html>.

### **B. Development of Local Source Water Protection Programs – On-going**

Source Water Program staff are working with local governments as they develop their Source Water Protection Plans in accordance with Executive Order No. 14 Regarding Gov. Minner’s “Livable Delaware” Agenda (DNREC, 2001b). Language for ordinances and regulations are contained in the Source Water Protection Guidance Manual for the Local Governments of Delaware (DNREC, 2005). Many municipalities have already submitted their Comprehensive Plans. The Source Water Program staff will continue their efforts with recommendations from CTAC.

### **C. Source Water Protection Loan Fund–On-going**

The Federal Safe Drinking Water Act (SWDA) of 1996, Section 1452, enabled the States to administer a state-revolving loan program. Delaware Safe Drinking Water Revolving Fund provides low-interest loans to assist public water systems in protecting

the drinking water supply in accordance with SWDA guidelines (Del Code Annotated Title 29 § 7903). Funds finance the cost of infrastructure to achieve or maintain compliance with SDWA requirements (USEPA-816-R-97-005). Funding is also available to purchase land or easements to protect drinking water sources. Nonprofit non-community water systems, publicly and privately owned community drinking water systems are all eligible to receive funding.

### **D. Evaluation of New Water Supply Wells and Intakes –On-going**

The Well Permitting Branch flags any well permit application that is in proximity to a known contaminant source and submits them for hydrogeologic review. Permit applications for allocated facilities within 2000 feet of a contaminant source are also sent for review.

During the review process all available information about the site, including ground water flow direction, monitor well data, and remediation status are examined. Permit application approval is based on the findings of the review.

### **E. Inventory of Above Ground Storage Tank Facilities On-going**

The DNREC Source Water Program staff has been in contact with the DNREC Tank Management Branch to determine the locations of above-ground storage tanks within source water protection areas. Once an inventory is established the tanks will be included in the Source Water Assessment Reports .



## **F. Inventory of Salt Storage Facilities Source Water Areas On-going**

The DNREC Source Water Program staff worked with the Delaware Department of Transportation (DelDOT) to inventory the State's salt storage facilities. Storage facilities within source water areas are evaluated for contaminant potential and included in the Source Water Assessment Reports.

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**Table A 1. Level 1 Discrete Source Contaminants by Basin**

	Brandywine Creek		Christina River-Smalley's Pond		White Clay Creek		Red and White Clay Creeks		Hoopes Reservoir	
	DE	PA	DE	PA	DE	PA	DE	PA	DE	PA
Hazardous Waste Generator	0	0	10	0	0	0	32	0	0	0
Landfill	0	1	0	0	0	0	0	1	0	0
Spray Irrigation Sites	0	3	0	0	0	8	0	1	0	0
Superfund Sites	1	0	5	0	0	0	7	0	0	0
Toxic Release Inventory	1	0	2	0	0	0	2	0	0	0
Underground Storage Tanks	19	0	14	0	1	0	25	0	1	0
Sludge Applicators	0	0	0	0	0	0	0	0	0	0
Salvage Yards	0	0	0	0	0	0	1	0	0	0
Tire Piles	0	0	0	0	0	0	1	0	0	0
Quarries	0	0	0	0	0	0	0	0	0	0
Septic Systems	0	7	0	0	0	1	0	5	0	0
NPDES	3	51	0	0	2	38	9	21	0	0
Waste Water Outfalls	0	9	8	0	0	4	0	21	0	0

**Table A 2. Level 2 Discrete Source Contaminants by Basin**

	Brandywine Creek		Christina River-Smalley's Pond		White Clay Creek		Red and White Clay Creeks		Hoopes Reservoir	
	DE	PA	DE	PA	DE	PA	DE	PA	DE	PA
Hazardous Waste Generator	0	0	10	0	0	0	32	0	0	0
Landfill	0	1	0	0	0	0	0	1	0	0
Spray Irrigation Sites	0	3	0	0	0	8	0	1	0	0
Superfund Sites	1	0	5	0	0	0	7	0	0	0
Toxic Release Inventory	1	0	2	0	0	0	2	0	0	0
Underground Storage Tanks	19	0	14	0	1	0	25	0	1	0
Sludge Applicators	0	0	0	0	0	0	0	0	0	0
Salvage Yards	0	0	0	0	0	0	1	0	0	0
Tire Piles	0	0	0	0	0	0	1	0	0	0
Quarries	0	0	0	0	0	0	0	0	0	0
Septic Systems	0	7	0	0	0	1	0	5	0	0
NPDES	3	51	0	0	2	38	9	21	0	0
Waste Water Outfalls	0	9	8	0	0	4	0	21	0	0

**Table A 3. Incidence of Discrete Source Contaminants Within Wellhead Protection Areas by County**

<b>Discrete Source</b>	<b>Delaware Counties</b>		
	<b>Kent</b>	<b>New Castle</b>	<b>Sussex</b>
Domestic Septic	895	1565	3138
Hazardous Waste Generators	3	169	28
Large On-Site Septic	2	0	14
NPDES	9	16	6
Underground Storage Tanks	74	435	154
Waste Water Spray Irrigation	1	0	2
Toxic Release Inventories	0	1	0
Superfund Sites	8	69	14
Animal Operations	0	0	11
Dredge Spoils	0	0	3
Landfills / Dumps	0	0	1
Pesticides L,M, & S	0	0	2

**Table A 4. Acres of Land Use and Land Cover Categories in Wellhead Protection Areas by County**

	Kent County	New Castle County	Sussex County
	Acres		
Airports	24.54	17.17	56.76
Barren / Open	31.05	755.37	141.82
Combined Urban	67.08	1308.37	581.88
Commercial	136.65	1421.95	452.18
Cropland	4344.18	1425.31	2690.48
Extraction	53.56	3.06	27.54
Farmsteads	162.82	56.73	42.14
Forested	175.6	1051.54	1010.52
Highways / Parking Lots	21.82	263.9	26.73
Industrial	98.86	176.06	450.54
Rangeland / Pastureland	9.7	136.5	117.28
Recreation	42.73	317.11	212.6
Residential	740.56	4186.52	2546.92
Utilities	1.61	46.37	45.32
Water	167.56	22.45	75.29
Wetlands	500.91	184.1	673.55
Junk / Salvage Yards	10.81	0	0
Vehicle Operations	0	32.94	0
Transportation	0	6.45	0
Animal Operations	0	0	72.41
Clear-cut Forest	0	0	10.32



## Appendix B: Completed Projects Reported 2004

### **I. Occurrence and Distribution of Selected Contaminants in Public Drinking-Water Supplies in the Surficial Aquifer in Delaware -- USGS Open-File Report 01-327**

<http://md.water.usgs.gov/publications/ofr-01-327/>

The United States Geological Survey sampled 30 randomly selected public drinking water supply wells from August through November of 2000. The wells draw from the unconfined surficial aquifer of Delaware. The samples were analyzed to assess the occurrence and distribution of selected nutrients, major inorganic ions, volatile organic compounds (VOCs), and pesticides. Ten of the wells were tested for radon and radium (Ferrari, 2002).

VOCs and pesticides were detected in low concentrations throughout the state. These concentrations were below the U.S. EPA's Primary Maximum Contamination Levels (MCLs). The study found levels of inorganic compounds and radionuclides were above the MCL in a few samples. Nitrate, iron and manganese were found statewide to be above the MCL with most of the samples from Sussex County (Ferrari, 2002). The results of the study were submitted to well system operators and Delaware Office of Drinking Water for review. Drinking water systems in excess of the MCL were brought into acceptable ranges.

### **II. Wellhead Protection Area Delineations for the Lewes-Rehoboth Beach Areas, Delaware (DGS Report of Investigations #65)**

<http://www.udel.edu/dgs/Publications/pubsonline/RI65.pdf>

At the request of the Source Water Protection Program, the Delaware Geological Survey (DGS) delineated the wellhead protection areas for the hydrologically complex Lewes-Rehoboth beach area of eastern Sussex County. Over 80 public wells and hundreds of domestic and commercial wells serve the area. The area is totally dependant on groundwater for potable, agricultural, and commercial needs (Andres, 2003).

DGS conducted this study by building on their previous work (Andres and Talley, 2001). The area is hydrologically complex. Using their maps and water quality data, DGS was able to delineate the wellhead protection areas using an advanced groundwater modeling program (Andres, 2003).

The resulting delineation were used in compiling the Source Water Assessment Reports for the Lewes Board of Public Works, Rehoboth Beach Water Department, and Tidewater Utilities.

### **III. Impact of Known or Suspected Contaminant Sources on Selected Public Drinking Water Supplies in Delaware**

<http://www.wr.udel.edu/swaphome/publications.html>

“This report represents a collaborative effort between the Department of Natural Resources and Environmental Control, the

Delaware Health and Social Services, the Department of Agriculture and the Water Resources Agency at the University of Delaware. This report represents an assessment of the potential impact of known and suspected hazardous substance release sites on the quality of Delaware's public drinking water" ( DNREC et al.,2002, p iii).

Thirty-nine public supply wells and four surface water intakes were included in this study. The criteria for inclusion rested on the water source's proximity to known hazardous sites. A total of eight surface water and fifty-three groundwater samples were analyzed for 188 chemicals. Samples were analyzed pre- and post-treatment to assess the effectiveness of the treatment protocol used by each system. Two drinking water systems in this study did not treat the water they provided.

Contaminants present in the untreated water were shown to be removed in the treatment process; confirming the effectiveness of the water treatment. The two systems that did not provide treatment were found to slightly exceeded EPA and Sate of Delaware proposed limits for one constituent. DPH recommended measures to correct the problem.

#### **IV. EPA Polygon and Data Reporting Project**

Delaware's Source Water Protection Program was chosen as one of three programs to participate in a pilot project by the USEPA and the Ground Water Protection Council. The purpose of the project was to determine if state databases were compatible with the EPA's Watershed Assessment, Tracking and Environmental Results (WATERS) database. This would al-

low the EPA to determine the extent of contaminants and susceptibility of public water supply systems. DNREC also provided the USEPA with GIS polygon layers of the source water protection areas in Delaware.





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