



# *Delaware's Source Water Assessment and Protection Program*

Water Infrastructure Advisory Council  
Kent County Administration Bldg.  
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Douglas E. Rambo, P.G.  
Hydrologist IV  
Source Water Protection Program  
Division of Water





# Summary of Presentation

- ◆ A little Pre-Source Water History – Unfunded Mandates
- ◆ What is Source Water Protection?
- ◆ Overview of Delaware Source Water Program
- ◆ Definitions of Source Water, Wellhead, and Excellent Recharge Areas
- ◆ Delaware Source Water Protection Law
- ◆ Status of Local Ordinances and Comprehensive Land Use Plans
- ◆ Summary of Activities Related to Source Water Protection
- ◆ Resources for Regulators, Consultants, and Citizens





Why do we know that  
source water protection  
is important?





# *Colonial Source Water and Public Health - Wellhead Protection Example*

*Lord Delaware's  
Proclamation for Jamestown, Va.  
1610*

**"There shall be no man or woman dare to wash any unclean linen, wash clothes,...nor rinse or make clean any kettle, pot, or pan or any suchlike vessel within twenty feet of the old well or new pump. Nor shall anyone aforesaid, within less than a quarter mile of the fort, dare to do the necessities of nature, since by these unmanly, slothful, and loathsome immodesties, the whole fort may be choked and poisoned."**





- ◆ Recent studies by Texas A&M University and the New England Interstate Water Pollution Control Commission (NEIWPCC) show that **adding treatment to address contamination of the source can add approximately \$90.00 per 1MG pumped to the base cost of the water withdrawn for consumptive use.**





# *Pre-Source Water History and why set-aside funding?*

- ◆ Prior to the 1996 Amendments to the Safe Drinking Water Act (SDWA) – the SDWA was previously amended in 1986.
- ◆ For example: The 1986 amendments introduced the Wellhead Protection Program as an unfunded mandate whereby the States were required to staff and implement the program for delineating protection areas around public sources of drinking water. Delaware developed their program and was approved by EPA Region III in 1990.
- ◆ Also in the late 1980's the EPA increased the number of herbicides and pesticides required to be tested for in public drinking water when new sources were placed into use – adding to the requirements for the PWSS Program.





## *Pre-Source Water* continued

- ◆ This created a drain on State resources and forced many states to enter into priority agreements with EPA to determine which projects were most important.
- ◆ That is why the 1996 amendments included set-aside monies – so that states could fund the work required of them from EPA.





# ***WHAT IS SOURCE WATER PROTECTION?***

- **Source Water Protection (SWP)** is protecting our sources of public drinking water (including surface water and aquifers) from contamination.
- SWP is an unfunded mandate from the U.S. EPA included in the 1996 amendments to the Safe Drinking Water Act (SDWA). States were given funding for the Assessment phase of SWP, but SWP was envisioned to be a grass-roots effort by concerned citizens to take the information from Source Water Assessments and let their water systems and/or local governments know that contamination in drinking water is unacceptable and needs to be addressed.





# **Overview of the Delaware Source Water Protection Program**

<http://delawaresourcewater.org>



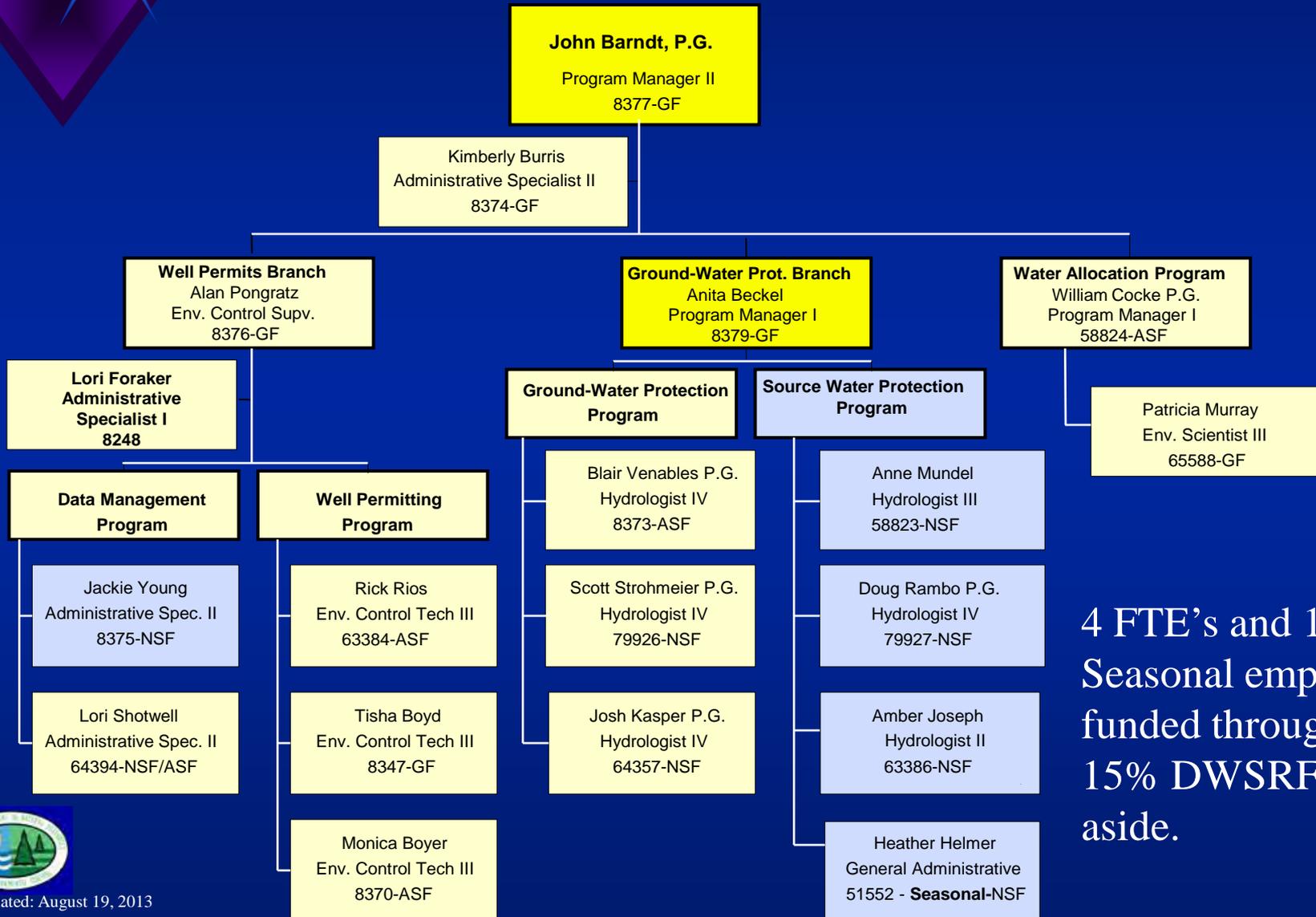


***WHO WE ARE...***

***DNREC SWPP***



# Division of Water /Water Supply Section



4 FTE's and 1 Seasonal employee funded through the 15% DWSRF set-aside.





# *SWAPP Staff Duties*

## *What we do...*

- ◆ Originate new and revise existing Source Water Assessments;
- ◆ Review all new public well permit applications;
- ◆ Oversight of Technical Contracts effectuated by the Program;
- ◆ Review of projects in the Preliminary Land Use Service (PLUS);
- ◆ Review of Source Water Protection Plans and Watershed Control Plans for water suppliers (e.g. City of Wilmington / United Water Delaware);
- ◆ SWP Ordinance assistance (development & review) to counties and municipalities;
- ◆ Technical reviews of contaminant investigations (e.g. Metachem, Delmar);
- ◆ Processing of Freedom of Information Act (FOIA) requests for well data;
- ◆ Review of new Underground Storage Tank Facilities;
- ◆ Representation on Committees and Boards (CTAC, USDA NRCS STC);
- ◆ Public Education and outreach



- ◆ Funding from the 15% Set-aside goes toward:
  - ◆ Salaries for the 5 SWAPP employees
  - ◆ Equipment (computers, office supplies, GPS units, etc.)
  - ◆ Data Management – Database updates and GIS software applications
  - ◆ Research – to gain better understanding of the geology and hydrogeology of Delaware.





## *It Starts with a Plan...*

- ◆ 1997 - U.S. EPA provided guidance to states on the minimum requirements for their Source Water Assessment Plans.
- ◆ All States and Tribes required to develop their own unique plans.
- ◆ Delaware's Source Water Assessment Plan (SWAP) was developed by DNREC with advice and concurrence from the Citizen and Technical Advisory Committee (CTAC).





OCTOBER  
1 9 9 9

THE STATE OF DELAWARE  
SOURCE WATER  
ASSESSMENT PLAN

Delaware's approach to protecting  
its sources of public drinking water

Delaware Department of Natural  
Resources & Environmental Control



# CTAC Representation

DNREC Divisions of Water, Watershed Stewardship, and Waste & Hazardous Substances (SIRS & TMS)





# Source Water Assessment Plan

- ◆ The SWAP described methodology for 4 key components of assessments – source water area delineation, potential contaminant source inventory, susceptibility determination, and dissemination to the public.
- ◆ Delaware SWAP was submitted to EPA for review in March 1999 and approved by EPA in October 1999
- ◆ DNREC has assessed over 500 systems – Community, Transient and Non-Transient Non-community **and continues to do so today.**
- ◆ Assessment reports are provided to water systems and DHSS-ODW. Assessments are updated as old wells are removed from use (abandoned) and new sources of supply come online.





# *Purpose of Delaware Source Water Assessment and Protection Program*

- ◆ **Locate the Sources** of Delaware's Public Drinking Water
- ◆ **Determine the Susceptibility** of all Public Drinking Water Systems to contaminants

*[Note: Vulnerability = intrinsic to well or surface water intake; Susceptibility = Vulnerability x contaminant sources in SWA or contaminants detected in untreated water]*

- ◆ **Promote** measures that provide for long-term **Protection** and assurance of safe sources of drinking water
- ◆ Assure **Public Awareness and Involvement** in protection of sources of public drinking water





# Components of Delaware Source Water Protection Program

- ◆ Public Involvement in Development of the Source Water Assessment Plan  
- *Citizen and Technical Advisory Committee (1998-present)*
- ◆ **Delineation / Mapping of Source Areas for Public Drinking Water Supplies\*** - *~525 PWS Systems with more than 1,100 wells and 6 surface water intakes*
- ◆ **Identification of All Existing or Potential Sources of Contamination within Source Area\*** - *DNREC Site Index Database*
- ◆ **Determination the Susceptibility of Public Water Wells or Surface Water Intakes\***
- ◆ Public Notification of Susceptibility Determinations - *Consumer Confidence Reports: SWAPP Web Site; CTAC Meetings*



\* Components of Source Water Assessment Reports



# *Components of Source Water Assessment Reports*

- ◆ **Map of Wells and/or Surface water Intakes**
- ◆ **Map of Delineated Source Water Area**
- ◆ **Map of Potential sources of contamination**
- ◆ **Map of Land Use types**
- ◆ **Evaluation of Susceptibility to various classes of contaminants**
- ◆ **Copies provided to Water System, Office of Drinking Water**
- ◆ **Copies (without maps) available on SWAP website as they are finalized**



# *Public Water Supply Locations*

## ◆ GPS Locations Obtained for:

- ① 6 Community Surface Water Intakes
- ② ~650 Community Public Wells  
(e.g. municipalities, housing developments)
- ③ ~175 Non-Transient Non-Community Wells  
(e.g. schools, daycares)
- ④ ~300 Transient Non-Community Wells  
(e.g. restaurants, campgrounds)



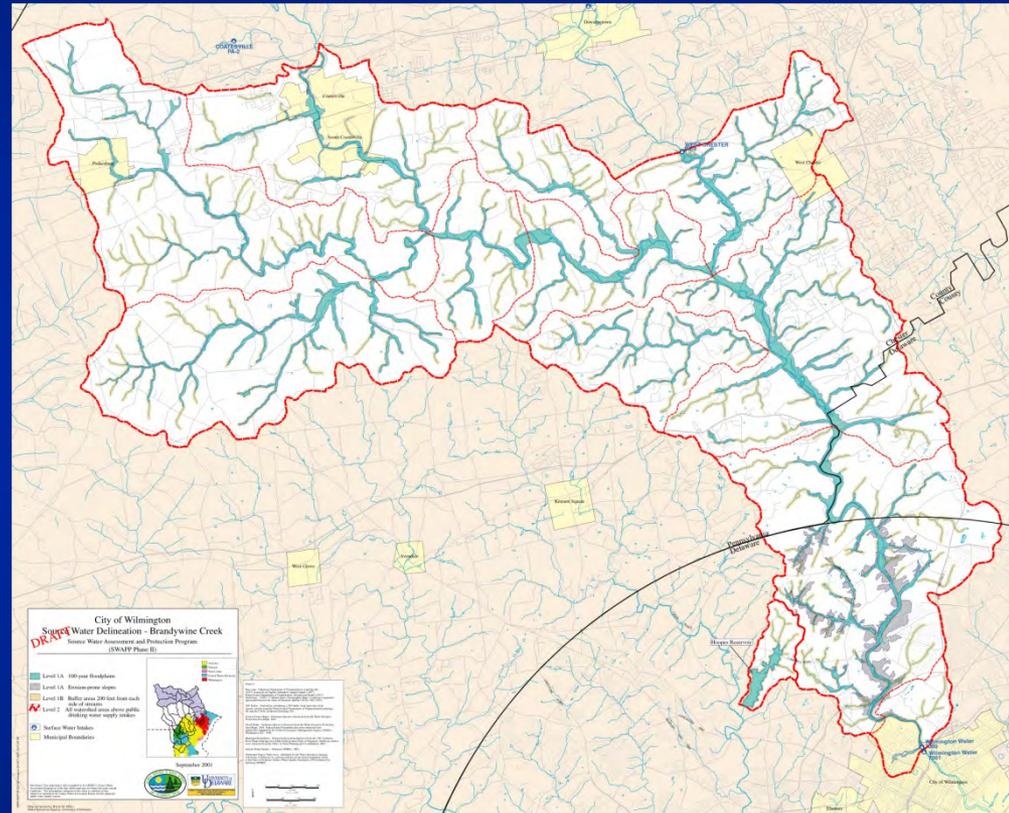
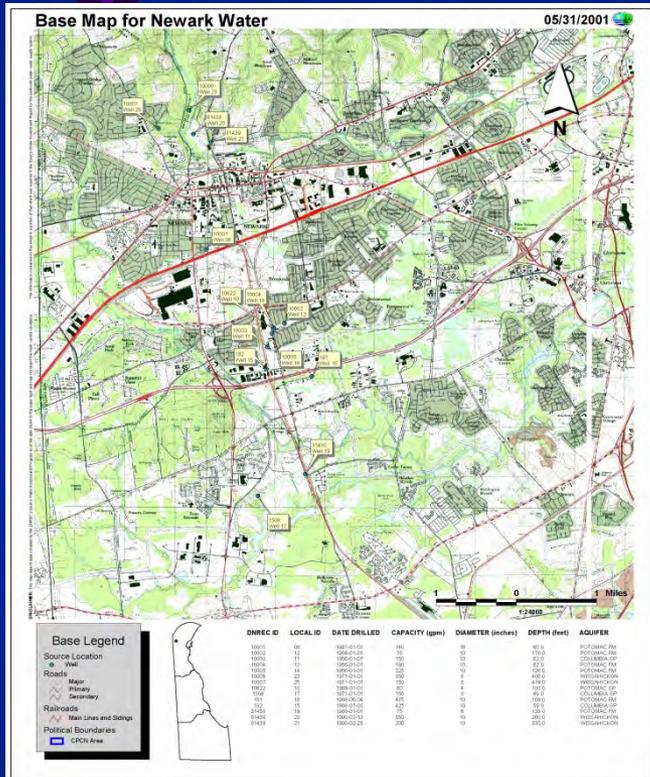


# *Assessments for Public Water Systems using Surface Water*

- ◆ **City of Wilmington** – Assessments for Brandywine Pump Station and Hoopes Reservoir
- ◆ **City of Newark** – Assessment for White Clay Creek (New reservoir also assessed)
- ◆ **United Water Delaware** – Assessment for Red Clay/White Clay Creeks at Stanton
- ◆ **United Water Delaware** – Assessment for Christina River (above Smalley's Pond)



# Location Map for Delaware Assessments



Groundwater

Surface water





# *Delineation Methods for Public Supply Wells*

## ◆ Fixed Radius

- ◆ 150-foot: Confined Aquifer wells
- ◆ 150-foot: Unconfined Aquifer Wells (<50,000 gal/Day)
- ◆ 300-foot /150-foot: New Castle County Class A WRPA
- ◆ Calculated Radius: Wells lacking sufficient data

## ◆ Ground-Water Models

All unconfined aquifer wells pumping over 50,000 gal/Day

- ◆ USGS MODFLOW
- ◆ US EPA WhAEM

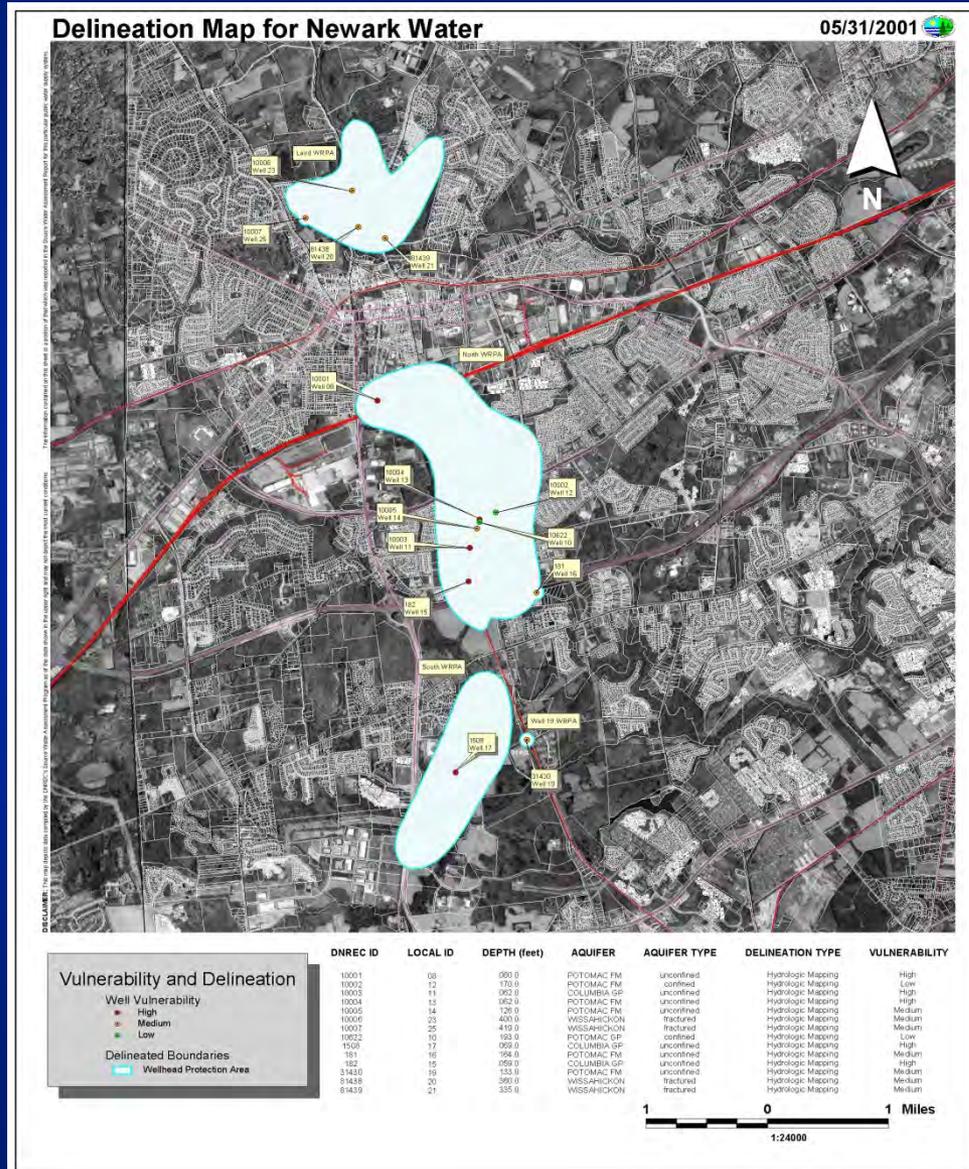
## ◆ Hydrologically Mapped

- ◆ New Castle County Class B WRPA





# WHPA Delineation Map for Delaware Assessments





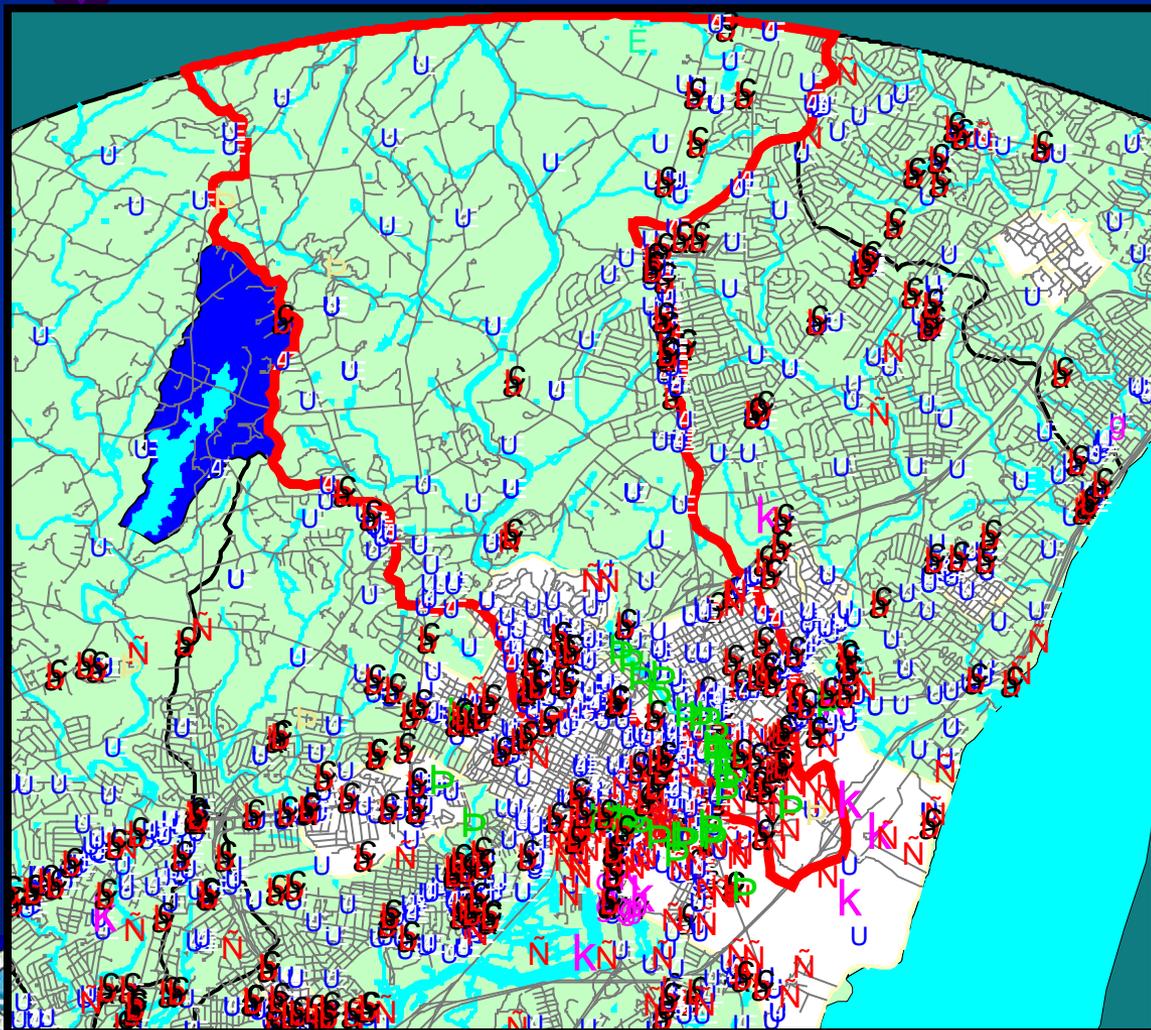
# *Contaminant Inventory (Discrete Point Sources)*

- ◆ Unregulated Hazardous Sites (CERCLA/HSCA)
- ◆ UST / LUST
- ◆ Landfills
- ◆ NPDES
- ◆ Tire Piles
- ◆ Hazardous Waste Generators
- ◆ TRI Facilities
- ◆ Salvage Yards
- ◆ Pesticides - S,M, & L
- ◆ Large On-Site Septic
- ◆ Domestic Septic Systems
- ◆ Waste Water Spray Irrigation
- ◆ Waste Sludge Application
- ◆ Animal Feedlot Operations
- ◆ Combined Sewer Overflows
- ◆ Dredge Spoils
- ◆ Golf Courses





# Potential Contaminant Sites in the Brandywine Watershed



- ✓ Potential Contaminant Sites
  - Animal Operations
  - Combined Sewer Overflow
  - Dredge Spoil Disposal Areas
  - Hazardous Waste Generators
  - Landfills & Dumps
  - Large On-site Septic
  - NPDES Outfalls
  - Pesticide Loading, Mixing & Storage
  - SIRB Sites
  - Salvage Yards
  - Sludge Application Sites
  - Spray Irrigation Sites
  - TRI
  - Tire Piles
  - Underground Storage Tanks
- ✓ Brandywine Creek Watershed
  - Brandywine Creek Watershed
- ✓ Roads
  - Roads
- ✓ Rivers & Streams
  - Rivers & Streams
- ✓ Town Boundaries
  - Town Boundaries
- ✓ Hoopes Reservoir
  - Hoopes Reservoir
- ✓ Watersheds
  - Watersheds



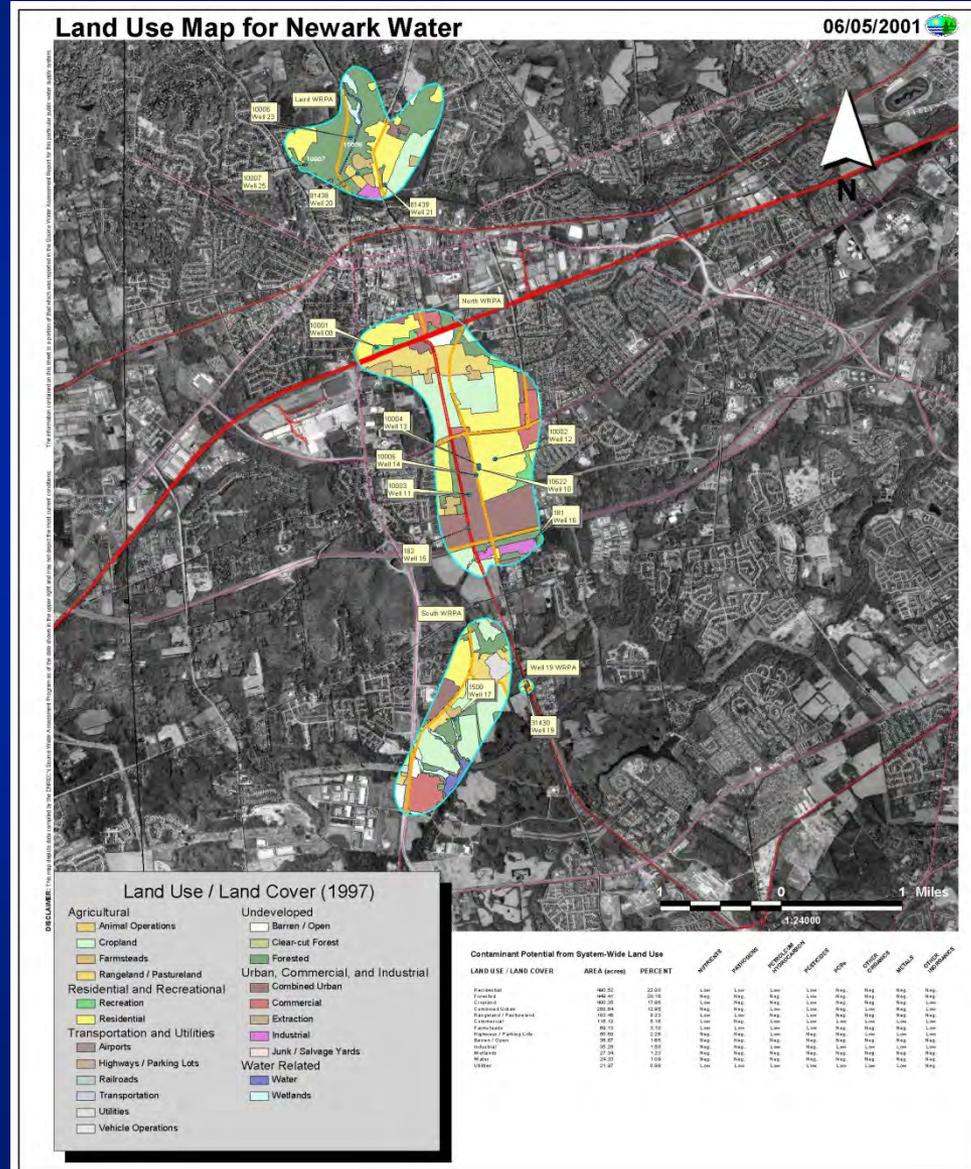
# *Land Use Inventory (Non-Point Sources)*

- ◆ Residential
- ◆ Commercial
  - ◆ Vehicle Operations
  - ◆ Junk/Salvage Yards
- ◆ Industrial
- ◆ Transportation
  - ◆ Highways/Parking Lots
  - ◆ Railroads
  - ◆ Airports
- ◆ Utilities
- ◆ Combined Urban
- ◆ Recreation
- ◆ Cropland
- ◆ Farmsteads
- ◆ Rangeland/Pasture
- ◆ Forest Land
  - ◆ Clear-cut Forest
- ◆ Wetlands
- ◆ Barren/Open
- ◆ Extraction





# Land Use Map for Delaware Assessments



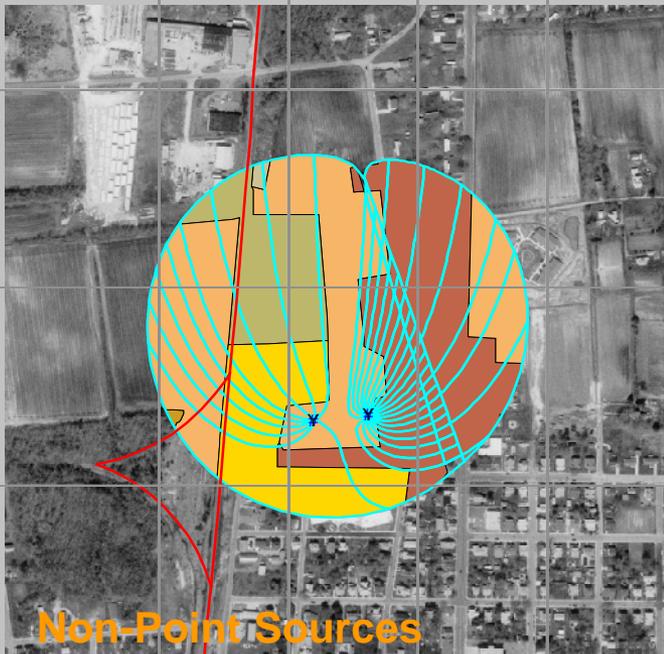


# *Consideration of Analytical Data from SDWIS and Special Studies*

- ◆ Prior 5-years of analytical data considered
- ◆ Untreated water samples only
- ◆ Recent PWS-specific water quality studies
- ◆ Analytical data used as a “trump” card for adjusting well susceptibility findings
- ◆ Interdepartmental coordination critical and constantly evolving (SWAPP/ODW)



# Medium town example susceptibility assessment SUMMARY



**MOST  
SUSCEPTIBLE**

**MODERATELY  
SUSCEPTIBLE**

**LEAST  
SUSCEPTIBLE**

7

6

5

4

3

2

1

**Nutrients  
Pesticides**

**Petroleum Hydrocarbons  
Other Organics  
Other Inorganics  
Metals**

**Pathogens  
PCBs**

Is It  
Surface Water/GWUDI<sup>1</sup>  
or Ground Water?

Ground  
Water

What is the  
Well Integrity<sup>2</sup>?

Good

Is the Well in Piedmont  
or Coastal Plain?

Coastal  
Plain

Is the Well Unconfined?

Yes

Is the Well Screen  
<100' deep?

No (Deep)

**Medium Vulnerability**



# **Definitions of Source Water, Wellhead, and Excellent Ground-water Recharge Areas**





# Definitions

- ◆ Source Water: untreated water from streams, rivers, lakes or underground aquifers that is used to provide public drinking water, as well to supply private wells used for human consumption.
- ◆ Wellhead: The physical upper terminus of a well.





# *“Wellhead” for Public Supply Well*





# *Map Delineation of Wellhead Protection Area*

- ◆ If in confined aquifer or pumping less than 50,000 gpd then fixed 150 foot radius (New Castle County uses 300 foot radius)
- ◆ Otherwise use model e.g. WhAEM, Modflow or other
- ◆ Require aquifer parameters – thickness, conductivity, porosity
- ◆ Require well parameters – pumpage
- ◆ Model complexity may require more information.





- ◆ Drinking water watershed: the contributing area of a watershed upstream of a surface water intake used for public drinking water supply that extends up to the next intake higher up in the watershed.



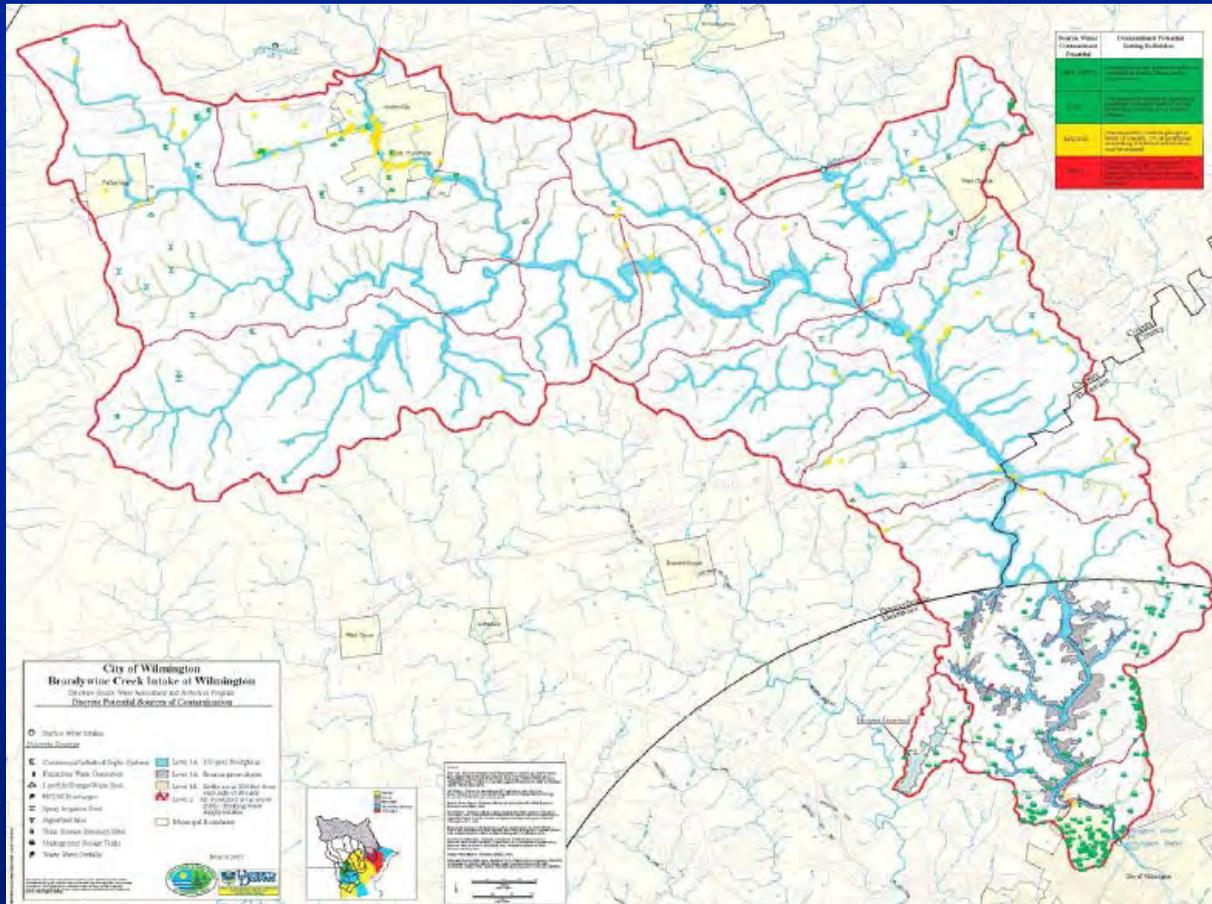


# *Brandywine River near Wilmington Supply Intake*



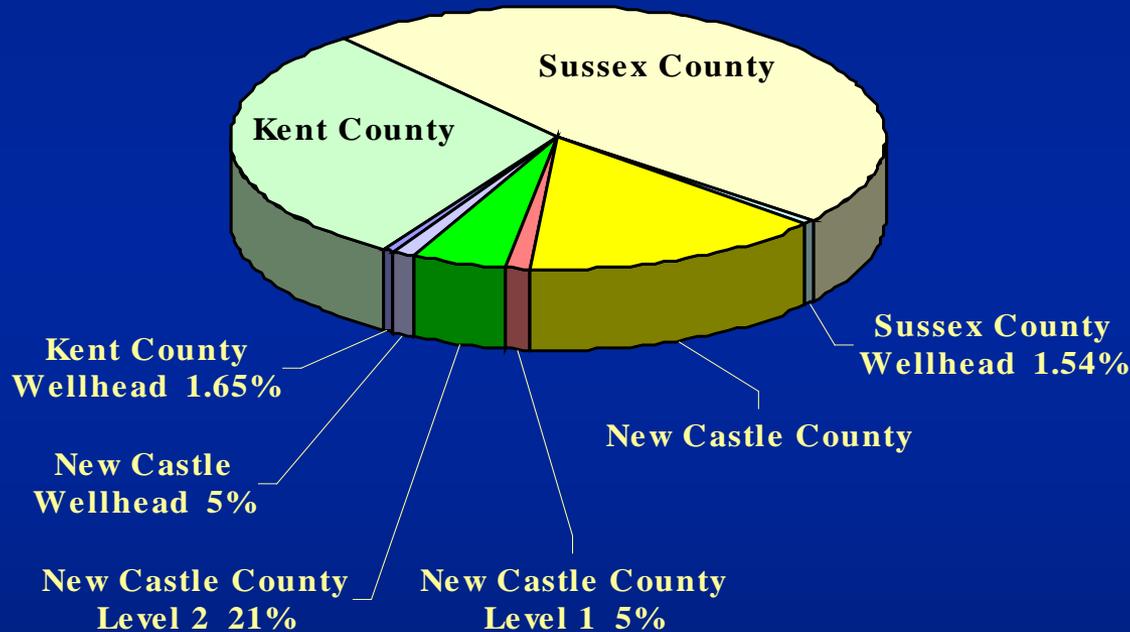


# Potential Contaminant Sources: Brandywine Creek Watershed above Wilmington Supply Intake





# Figure 1. Land Area Delineated as Wellhead/Surface Water Protection Area



**NCC → 26 % SW**  
**NCC → 5.0 % GW**  
**KC → 1.65 % GW**  
**SC → 1.54 % GW**





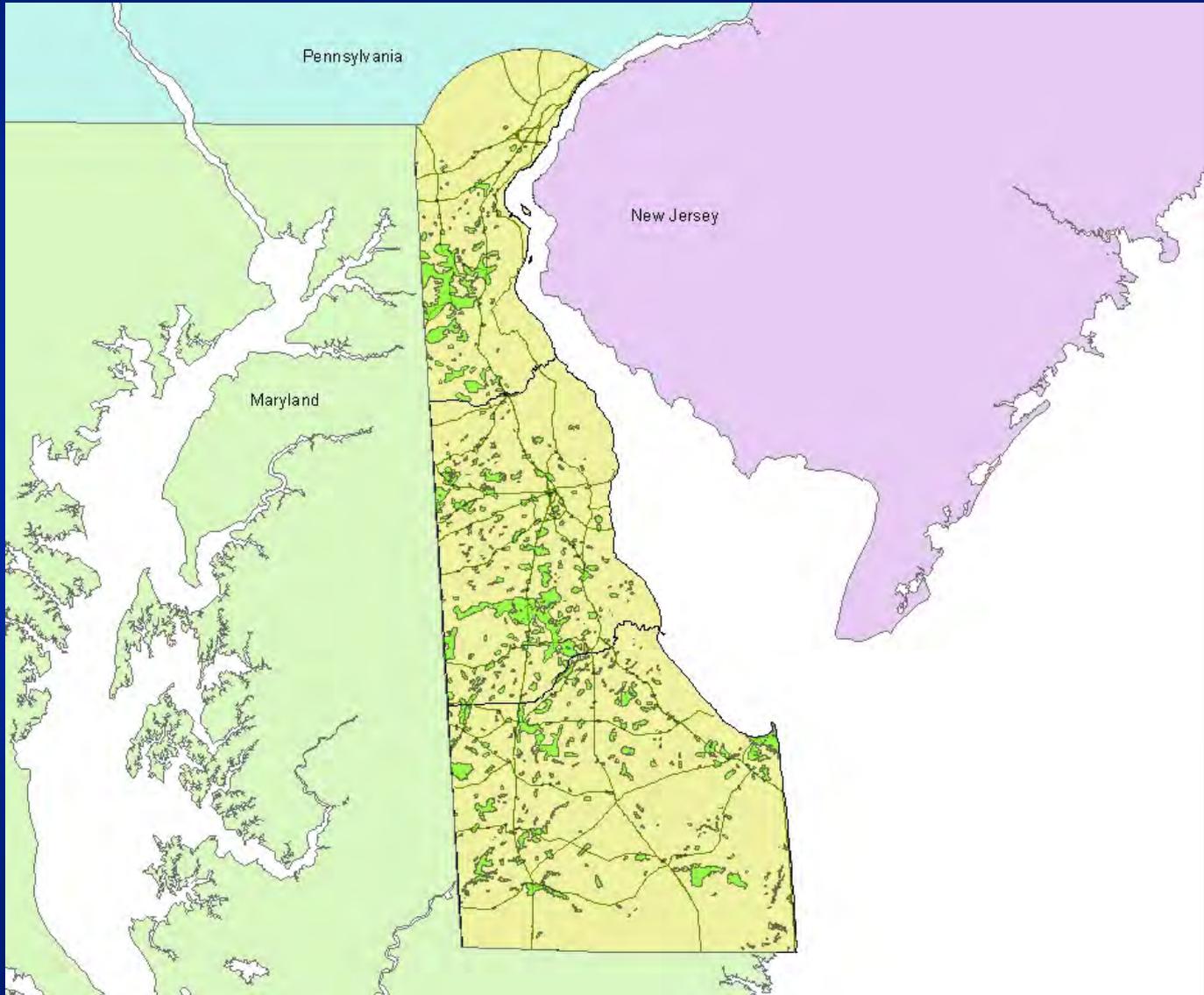
# Ground Water Recharge Potential Areas

<http://www.dgs.udel.edu/publications/ri66-ground-water-recharge-potential-mapping-kent-and-sussex-counties-delaware>

- ◆ Ground-water recharge potential maps show land areas characterized by the water-transmitting capabilities of the **first 20 feet below land surface**. Ground-water recharge potential mapping in **Kent and Sussex counties** was done using geologic mapping techniques and over 6,000 subsurface observations in test borings, wells, borrow pits, natural exposures, and ditches. Hydraulic testing of more than 200 wells shows that the four recharge potential categories (**excellent, good, fair, poor**) can be used as predictors of the relative amounts and rates at which recharge will occur. The Delaware Geological Survey conducted mapping for over a decade beginning in 1990.
- ◆ **New Castle County** used the same methodology to revise their recharge WRPA maps in the 1990's with only the excellent areas mapped.
- ◆ Only **Excellent areas** are addressed in the Delaware Source Water Law.

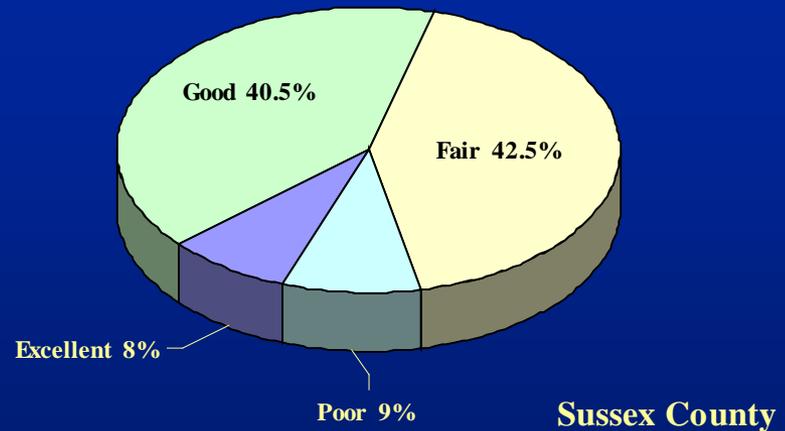
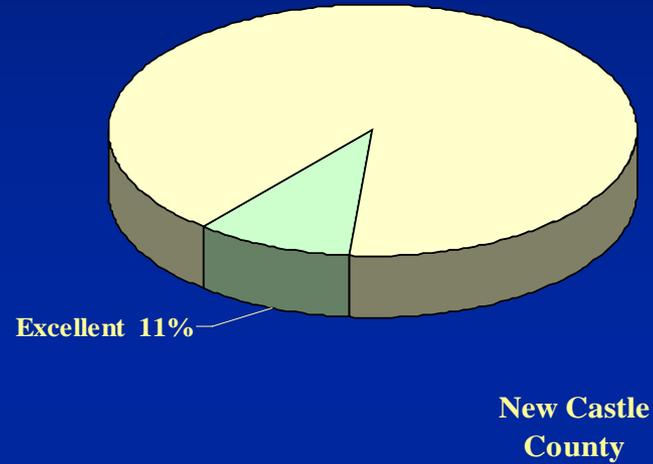
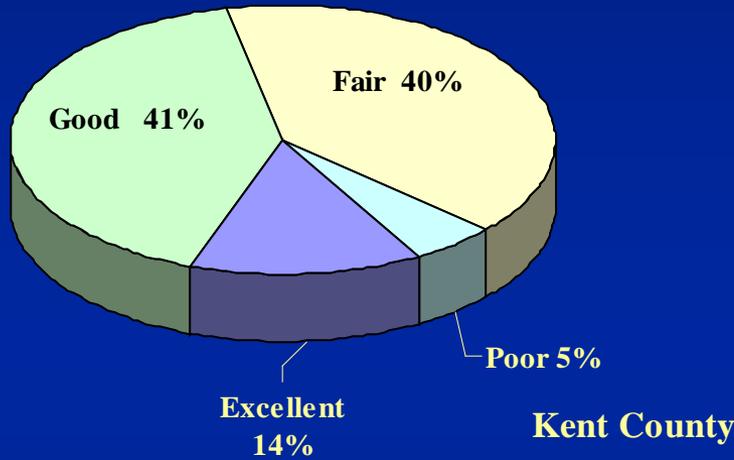


# *Excellent Ground-Water Recharge Areas*





# Ground-Water Recharge Potential Land Area by County



Kent - 14%  
New Castle - 11%  
Sussex - 8%





# Delaware's Source Water Protection Law (June 2001)

- ◆ Introduced as part of Governor Minner's Livable Delaware Initiative





# *Delaware Source Water Protection Law*

## Components of the Law:

- ◆ Definitions of critical areas
- ◆ Reporting on threats to public water systems (6081)
- ◆ Adoption of critical area maps and protective ordinances by Counties and Municipalities (6082)
- ◆ Preparation of a best management practices manual to assist local communities in land use decisions
- ◆ Adoption of critical areas by the Governor's Cabinet Committee on State Planning Issues (6083)
- ◆ Increased representation on the Delaware Source Water Citizen and Technical Advisory Committee (6084)





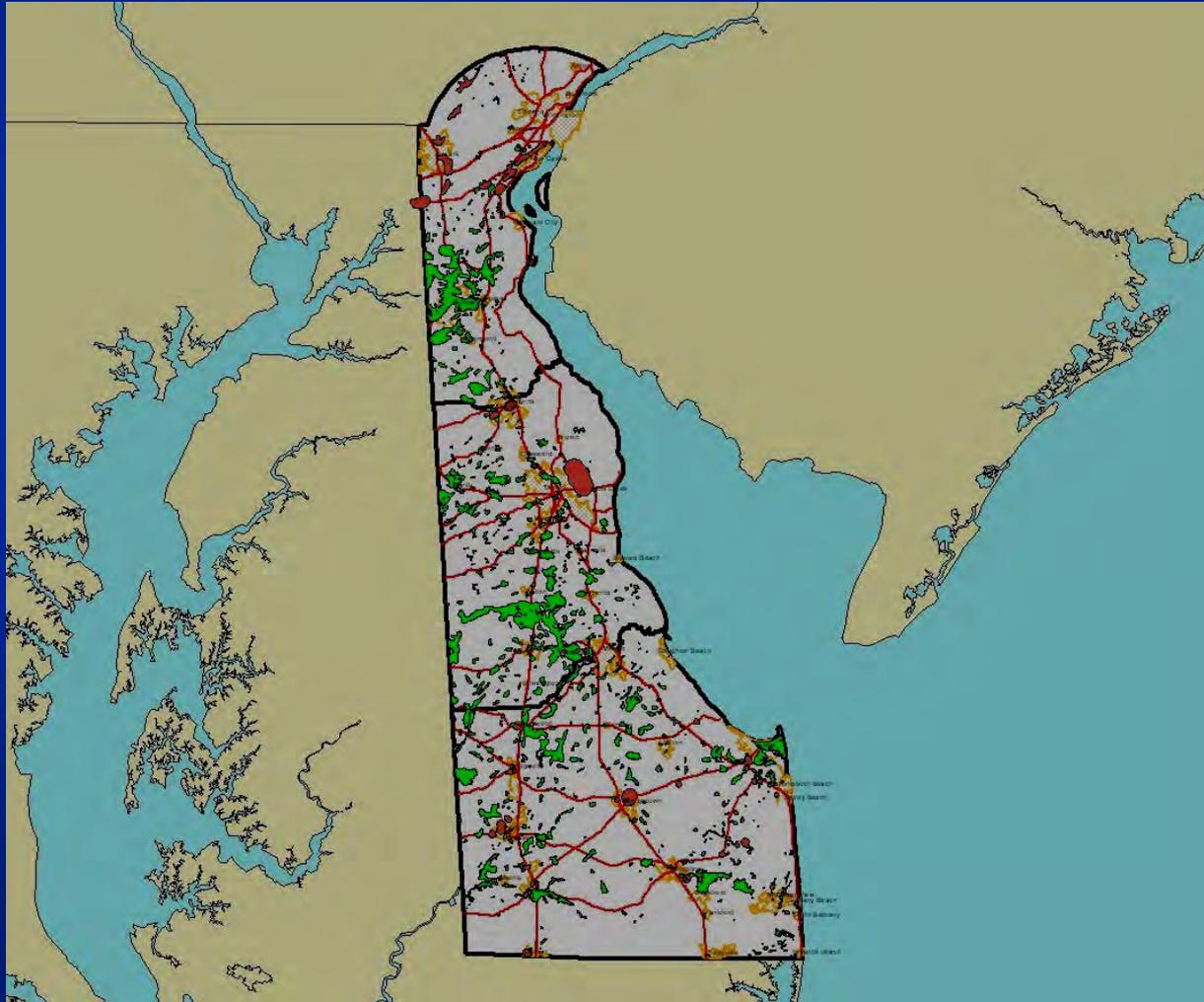
# *Description of Critical Water Resource Areas*

- ◆ **Wellhead Protection Area** – surface and subsurface area surrounding a public supply well through which contaminants could likely to reach the well
- ◆ **Source Water Assessment Area** – delineated area around a PWS well (a WHP area) or upstream of a surface water intake (watershed or basin) or drinking water supply reservoir
- ◆ **Excellent Ground-Water Recharge Potential Area** – very permeable soils mapped using a methodology developed by the Delaware Geological Survey



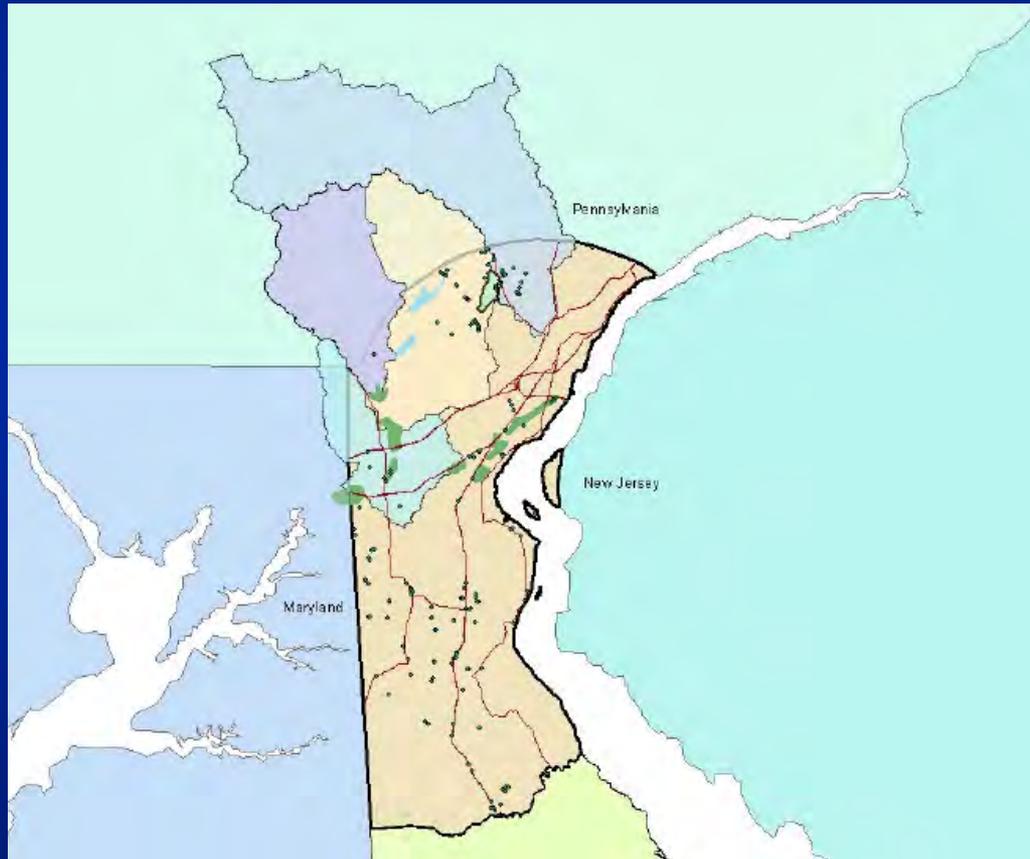


# *Map of Critical Areas – Wellhead and Recharge Areas*





# *Map of Critical Areas – Surface Sub-Watersheds above Intakes*





# *Reporting on Threats to Source Water Areas*

- ◆ DNREC is required to report to the General Assembly, beginning in 2003, potential threats to public drinking water systems including contaminants not yet regulated (e.g. looking at AST's, salt storage piles, road salting in Christina Basin )
- ◆ DNREC will periodically provide a report to the counties and municipalities, beginning in 2003, describing the availability of source water assessments
- ◆ <http://delawaresourcewater.org>





# *Adoption of Critical Areas by Counties and Municipalities*

- ◆ Counties and Municipalities with 2,000 or more persons shall include source water and recharge areas as critical areas in Comprehensive Land Use Plans by December 2007
- ◆ Counties and Municipalities with 2,000 or more persons shall adopt regulations designed to protect these critical areas from substances and activities that harm water quality and decrease overall quantity by December 2007
- ◆ Municipalities with less than 2,000 persons are encouraged to adopt similar measures





# *Communities with 2,000 or More Persons (2000/2010 census years)*

- ◆ Kent County\*
- ◆ New Castle County\*
- ◆ Sussex County\*
- ◆ Town of Camden\*
- ◆ City of Dover\*
- ◆ City of Harrington \*
- ◆ City of Milford\*
- ◆ Town of Smyrna\*
- ◆ City of Wilmington\*
- ◆ Town of Elsmere n/a
- ◆ Town of Middletown\*
- ◆ City of Newark\*
- ◆ City of New Castle\*
- ◆ Town of Georgetown\*
- ◆ Town of Laurel \*
- ◆ City of Lewes\*
- ◆ Town of Millsboro\*
- ◆ City of Seaford\*
- ◆ 2010 Town of Bridgeville\*
- ◆ 2010 Town of Clayton\*
- ◆ 2010 Town of Milton ?
- ◆ 2010 Town of Selbyville\*



◆\* Ordinance in place – may require updating \*Draft ordinances in progress

<http://delawaresourcewater.org/swstatus>



# *Preparation of Manual to Assist Local Communities in Source Water Protection*

- ◆ DNREC shall prepare a guidance manual describing protection measures and desirable land-uses that are appropriate for long-term protection of public drinking water supplies
  - ◆ <http://delawaresourcewater.org/publications>
- ◆ DNREC shall obtain CTAC review and concurrence on the manual





## *Source Water Citizen and Technical Advisory Committee*

- ◆ DNREC shall consult with the CTAC on matters related to implementation of the SWAP and this statute
- ◆ Added representation to the Source Water Citizen and Technical Advisory Committee
- ◆ CTAC meets twice a year in Dover – All information placed onto the SWAP web site and meetings advertised – DNREC and State Calendar<sup>53</sup>





# *Status of Local Source Water Protection Ordinances*

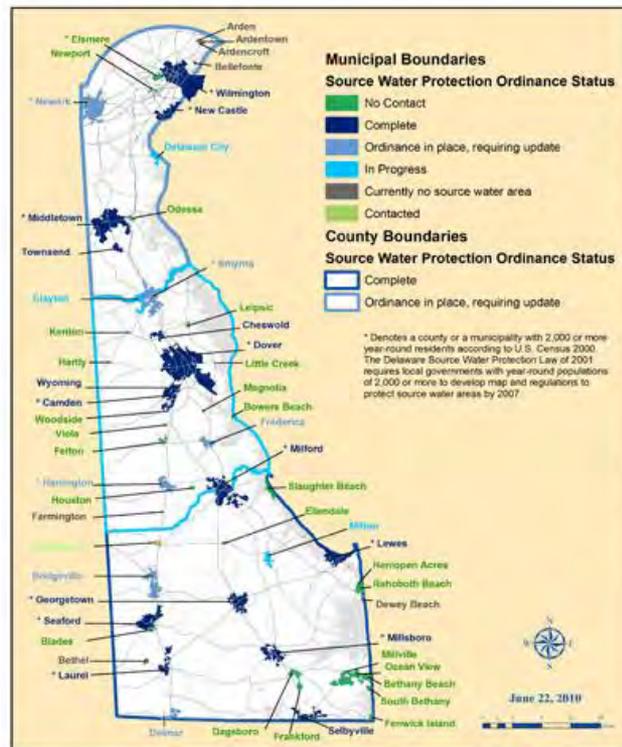
<http://delawaresourcewater.org/swstatus>



# Status of Source Water Protection Ordinances

The ordinances found on this page are ones we are aware of; it is best to check with the county or municipality for verification and updates. [Why Source Water Protection?](#) View this [map](#) of current and historic contaminant sites and find out why source water protection is important!

Source Water Protection Ordinance Status Map



[New Castle County](#)   [Kent County](#)   [Sussex County](#)

Arden	Bowers	Bethany
Ardencroft	Beach	Beach
Ardentown	<a href="#">*Camden</a>	Bethel
Bellefonte	<a href="#">Cheswold</a>	Blades
Delaware	Clayton	<a href="#">Bridgeville</a>
City	<a href="#">*Dover</a>	Dagsboro
<a href="#">*Elsmere</a>	<a href="#">SWPOZ</a>	Delmar
<a href="#">*Middletown</a>	Farmington	Dewey Beach
<a href="#">*New Castle</a>	Felton	Ellendale
<a href="#">*Newark</a>	<a href="#">Frederica</a>	Fenwick
Newport	<a href="#">*Harrington</a>	Island
Odessa	Hartly	Frankford
<a href="#">Townsend</a>	Houston	<a href="#">*Georgetown</a>
<a href="#">*Wilmington</a>	Kenton	Greenwood
	Leipsic	Henlopen
	Little Creek	Acres
	Magnolia	<a href="#">*Laurel</a>
	<a href="#">*Milford</a>	<a href="#">*Lewes</a>
	<a href="#">*Smyrna</a>	<a href="#">*Millsboro</a>
	Viola	Millville
	Woodside	Milton
	<a href="#">Wyoming</a>	Ocean View
		Rehoboth
		Beach
		<a href="#">*Seaford</a>
		<a href="#">Selbyville</a>





# Summary of Activities Related to Source Water Protection





# Existing Source Water Protection Measures

- ◆ Numerous regulatory programs (UST, Solid Waste, Pesticides, etc.) have specific protection measures that address public drinking water sources --*DNREC compendium of existing authorities*
- ◆ Prioritization of sites by regulatory programs (*e.g. remediation of sites or BMP's for NPS problems*)
- ◆ Review of all new water well permits (*public and domestic*) for proximity to potential sources of contamination
- ◆ Regulation of Public Water Systems by Department Health and Social Services – *Sampling and treatment*
- ◆ Delaware Source Water Protection Legislation (2001)
- ◆ Water Treatment measures taken by Water Suppliers





# Compendium of Existing Federal, State, and Local Authorities

<http://delawaresourcewater.org/publications>

- ◆ Federal (e.g. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides the basis for regulation, sale, distribution and use of pesticides in the U.S. – application of pesticides near sources of drinking water.)
- ◆ State (e.g. DNREC UST policy for secondary containment in wellhead protection areas)
- ◆ Local (e.g. municipal ordinances limiting impervious cover in source water areas)





# Water Well Permit Review

- ◆ All water wells in Delaware require state permit
- ◆ All permits are screened against a *GIS project* prior to issuance
- ◆ *Well Permit GIS Project* contains points or polygons for all 'known' sites – e.g. LUST, Large Septic, Wastewater Spray, NPL, State HSCA, RCRA Corrective Action, etc.
- ◆ Wells near problem sites referred to technical staff for hydrologic review and special permit conditions







# Resources for Regulators and Consultants, and Citizens



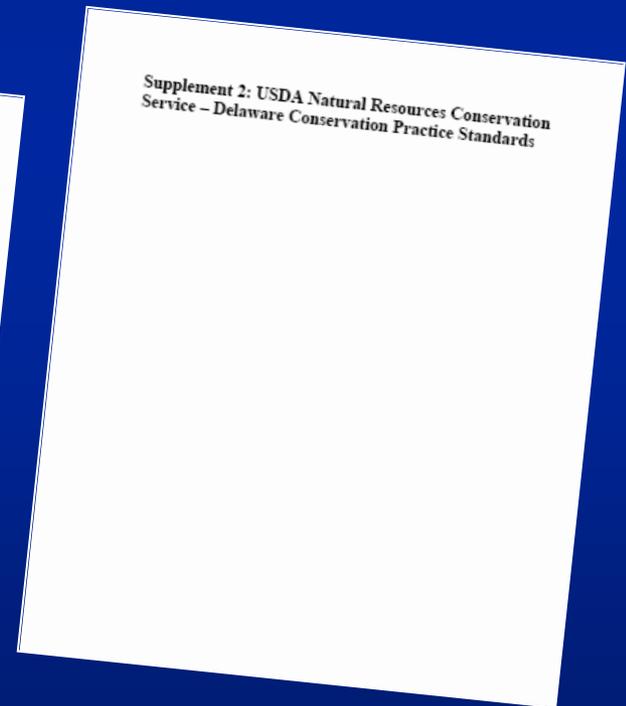
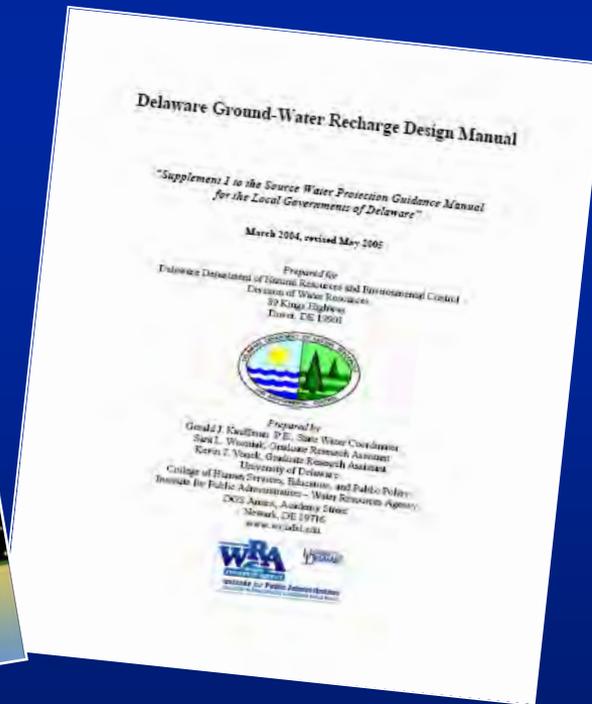
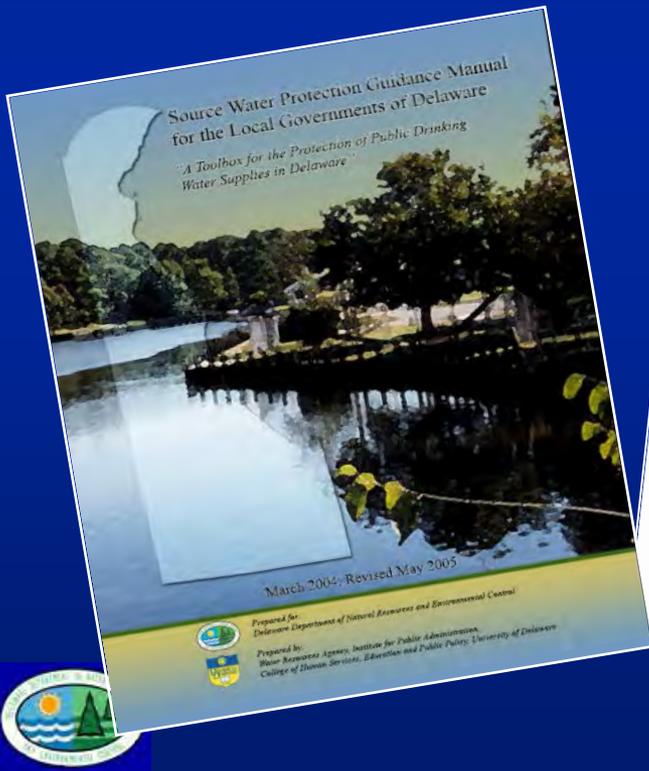


- ◆ The Source Water Program undertakes projects that aid in furthering the understanding of Delaware's Water Resources and allowing us to better define delineated areas around drinking water sources and offer solutions for the best way to protect them.
- ◆ Much of what the SWAPP has funded is freely available to the public on the SWAPP web page.



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

[http://delawaresourcewater.org/wp-content/publications/swapp\\_manual\\_final/swapp\\_guidance\\_manual\\_final\\_2005\\_05\\_02.pdf](http://delawaresourcewater.org/wp-content/publications/swapp_manual_final/swapp_guidance_manual_final_2005_05_02.pdf)



# B. Technology Enabled Permitting Project (TEPP) Well Database Migration – Completed

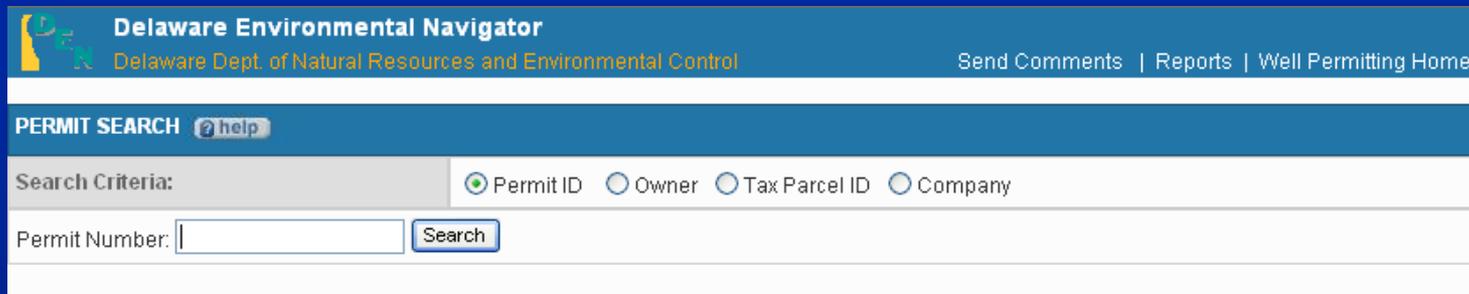


**Delaware Environmental Navigator**  
Delaware Dept. of Natural Resources and Environmental Control

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- [Search Existing Permit](#)
- [Reclassification Of Wells](#)



**Delaware Environmental Navigator**  
Delaware Dept. of Natural Resources and Environmental Control

[Send Comments](#) | [Reports](#) | [Well Permitting Home](#)

**PERMIT SEARCH** [help](#)

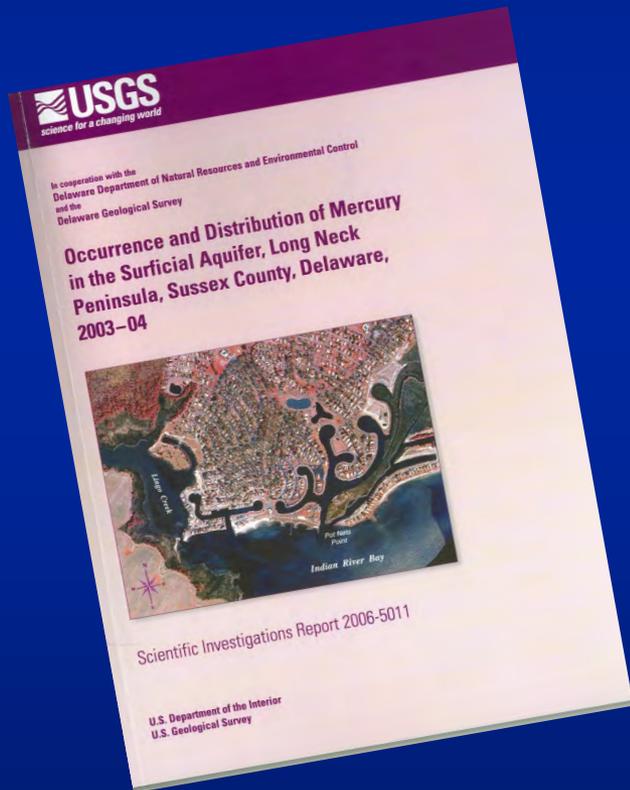
Search Criteria:  Permit ID  Owner  Tax Parcel ID  Company

Permit Number:



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

<http://md.water.usgs.gov/publications/sir-2006-5011/index.html>



## ◆ 5 Production Wells

## ◆ Exceeded MCL

- ◆ Hg
- ◆ NO<sub>3</sub>
- ◆ TDS
- ◆ VOC<sub>s</sub>

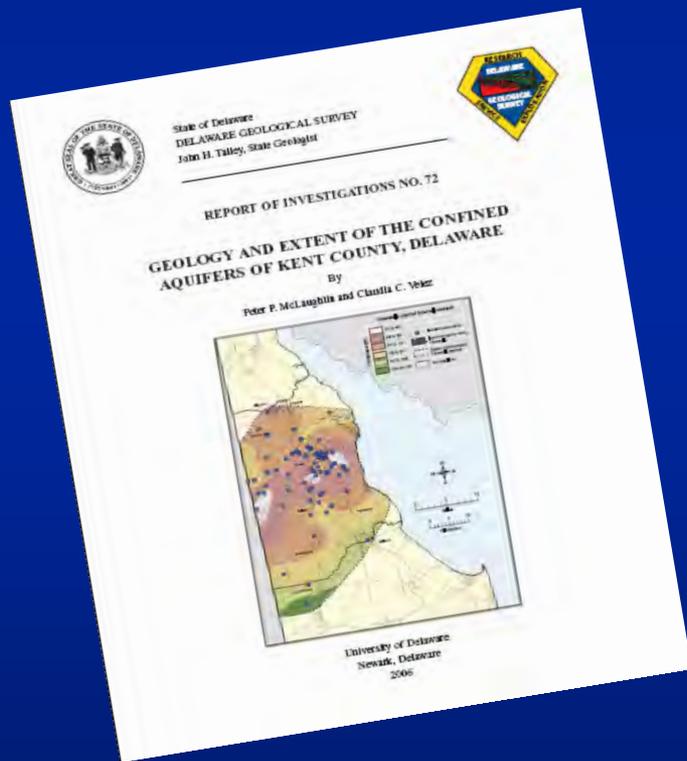
## ◆ Related to historic land use activities within WHPAs





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

<http://www.dgs.udel.edu/publications/>



Redefines the hydrological framework of Kent County

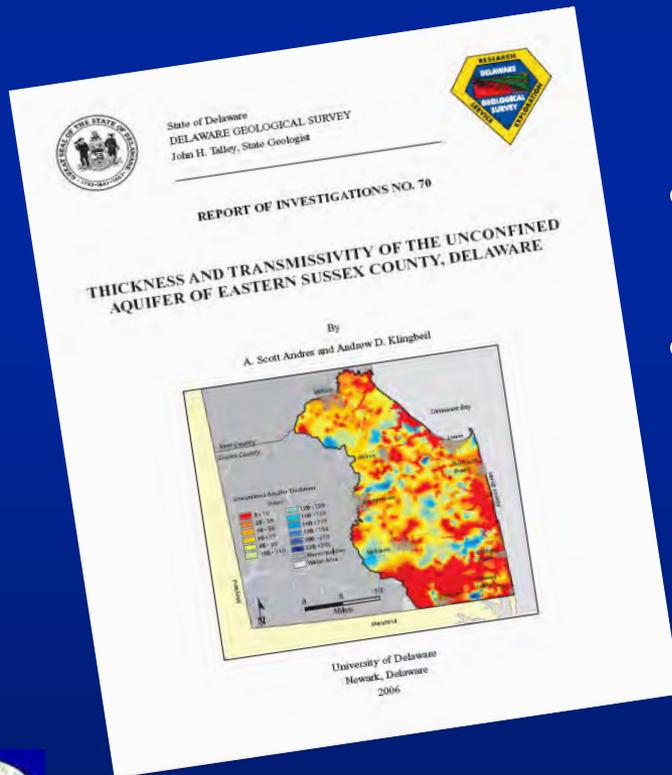
Better characterizes the available aquifers used for drinking water

Updates the previous comprehensive study done in 1968





*E. Hydrogeological Assessment Project for Eastern Sussex County – Thickness and transmissivity of the unconfined aquifer of eastern Sussex County, Delaware – Completed*  
<http://www.dgs.udel.edu/publications/>



- Use in source water investigations
- GIS applications





# *F. Arsenic in Delaware Soils –Completed*

FATE AND TRANSPORT OF ARSENIC IN DELAWARE SOILS:  
ASSESSING POTENTIAL IMPACTS ON WATER QUALITY

*Final Report*

SUBMITTED BY:

Dr. D. L. Sparks  
Dr. J. Thomas Sims  
Jennifer Seiber  
Sheila Gardner  
Department of Plant and Soil Sciences  
College of Agriculture and Natural Resources  
University of Delaware  
Newark, DE 19717-1303

SUBMITTED TO:

Richard Greene  
DNREC, DWR, Watershed Assessment Branch  
820 Silver Lake Blvd., Suite 220  
Dover, DE 19904-2464  
Ph: (302) 739-4590

FEBRUARY 23, 2007

UNIVERSITY OF DELAWARE

Fate and Transport of Arsenic  
in Delaware Soils: Impacts on Water Quality

Through University of Delaware Department  
of Plant and Soil Sciences & Delaware  
Water Resources Center



<http://delawaresourcewater.org/publications.html>





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

**Delaware Source Water Protection Program**  
State of Delaware

HOME DNREC DHSS IPA-WRA EPA

### Home Page

The Source Water Assessment and Protection Program (SWAPP) was created by Congress as part of the Safe Drinking Water Act Amendments of 1996. The goal of the SWAPP is to better protect public drinking water resources by providing local and state governments, and the public more information about those resources. The susceptibility of each source of public drinking water to various types of contamination will be determined and published. Congress has provided funding through the U.S. EPA to the states to support their efforts in conducting these assessments.

The Delaware Department of Natural Resources and Environmental Control (DNREC) has the lead role in the development and implementation of the Delaware SWAPP. The Delaware Division of Public Health and the Water Resources Agency, Institute for Public Administration at the University of Delaware, closely supports its work. A SWAPP Citizen and Technical Advisory Committee (CTAC) was formed at the start of this program in 1998 and continuing to assist in developing and implementing Delaware's SWAPP and ensures public involvement.

To join our new list-serve send an email to: [join-dnrec\\_source\\_water\\_protection@lists.state.de.us](mailto:join-dnrec_source_water_protection@lists.state.de.us)

**EVENTS**

- [National Estuaries Day, Sept. 28th at Bellevue Park](#)
- [Coast Day, Oct. 6th at UD in Lewes](#)
- [CTAC Meeting, November 6, 2013](#)

**INFORMATION**

- [Contact Information](#)
- [CTAC Meetings](#)
- [Advisory Committee](#)
- [News and Events](#)
- [Source Water Funding](#)

**RESOURCES**

- [Source Water Loan Fund](#)
- [Source Water Assessments](#)
- [Source Water Ordinances](#)
- [Publications](#)
- [Mapping Resources](#)
- [Conservation](#)
- [Useful Links](#)

<http://delawaresourcewater.org>



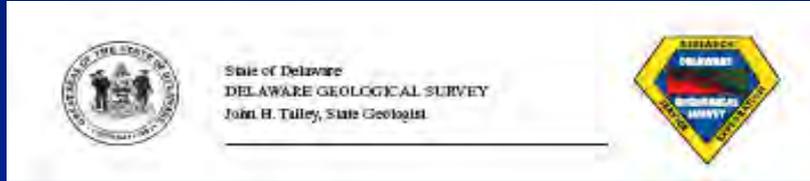


State of Delaware  
DELAWARE GEOLOGICAL SURVEY  
John H. Tulley, State Geologist



*H. Hydrogeological Assessment Project for  
Western Sussex County – Thickness and  
transmissivity of the unconfined aquifer of  
western Sussex County, Delaware – Completed*





- I. *Geology and Extent of the Confined Aquifers of Sussex County, Delaware (DGS) – Digital Products in Review / Report Currently in Development*
  
- J. *Evaluation of Rapid Infiltration Basins in Delaware (DGS)  
- Completed*





# K. DGIR: Delaware Geologic Information Resource

<http://maps.dgs.udel.edu/dgir/draft/>  
**Completed**

Enabling the Delaware Geological Survey to bring previously mapped geologic/hydrologic data online and available to the public.





# L. *USGS Reports on Occurrence of Selected Contaminants in Public Drinking Water Supplies in the Surficial Aquifer of Delaware*

- ◆ First issued in 2002 and revised in 2010





# *Thank You*

DNREC

Division of Water

Source Water Assessment & Protection Program

89 Kings Highway

Dover, DE 19901

Phone: (302) 739-9945

Fax: (302) 739-2296

[DNREC\\_SWAPP@state.de.us](mailto:DNREC_SWAPP@state.de.us)

<http://delawaresourcewater.org>

