



Delaware Geological Survey

National Ground-Water Monitoring Network

Hb12-05

Hb12-07



Hb12-06

Tom McKenna

hydrogeology, databases, SQL, sensors, ...

David Wunsch

hydrogeology, leadership, SOGW Steering Committee (AASG), ...

Scott Andres (lead PI)

hydrogeology, databases, SQL, sensors, SOGW Data Standards & Management Work Group, ...

Changming He

hydrogeology, SQL, programming, sensors, ...

John Callahan

web services, gis, database, SQL, PHP, ...

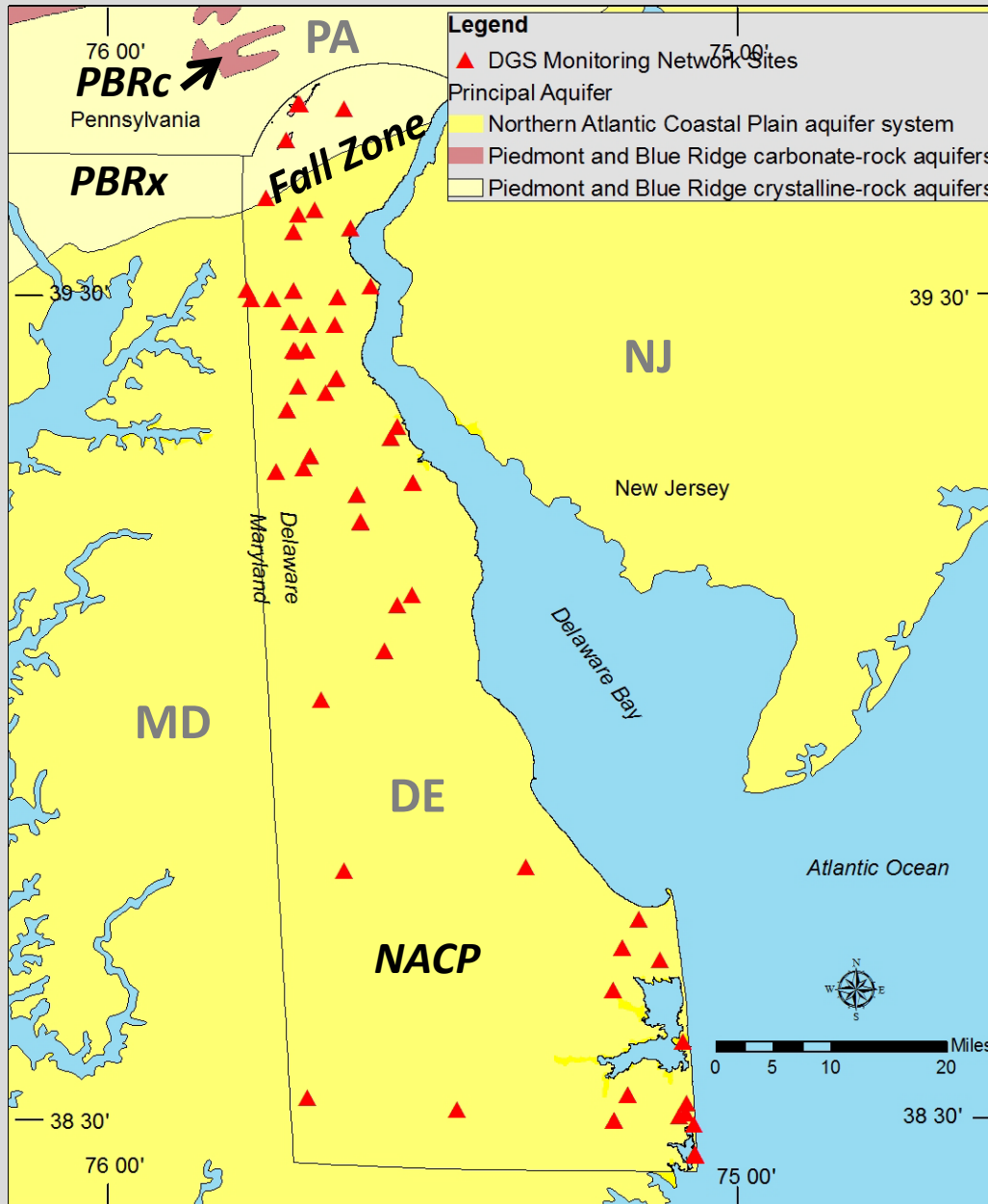


Description and Goals

Delaware Groundwater Monitoring Network



Delaware Groundwater Monitoring Network and Principal Aquifers



Principal Aquifers

Northern Atlantic Coastal Plain aquifer system (NACP)

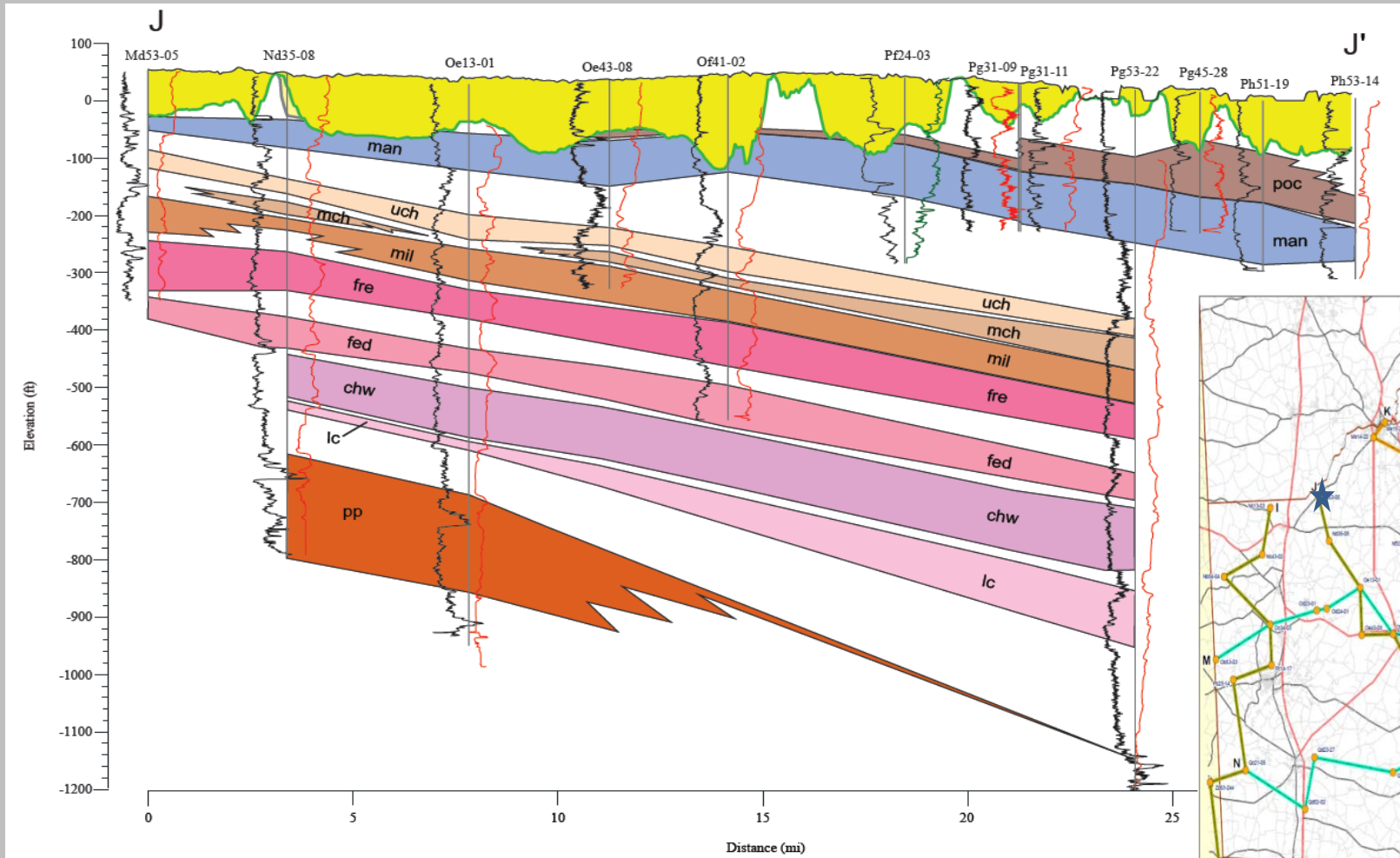
Piedmont and Blue Ridge crystalline rock aquifers (PBRx)

Piedmont and Blue Ridge carbonate rock aquifer (PBRc)

Wells in Delaware Groundwater Monitoring Network (n = 123)
- 13 major and local aquifers

Goal:
fill spatial gaps in monitoring

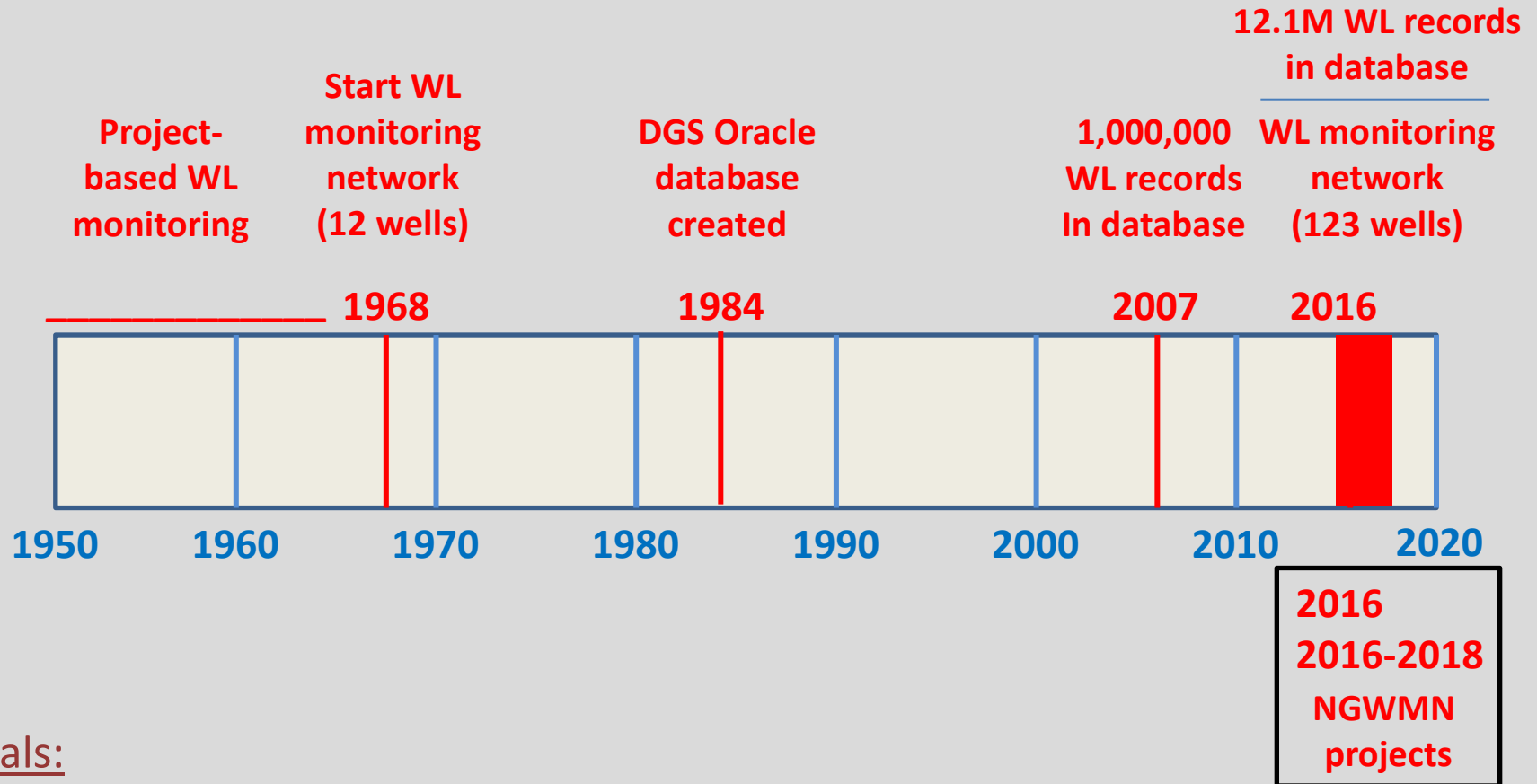
Atlantic Coastal Plain hydrostratigraphy in southern Delaware



Goals

- monitor multiple aquifers at one site
- monitor local/regional aquifers.

Delaware Groundwater Monitoring Network Timeline



Goals:

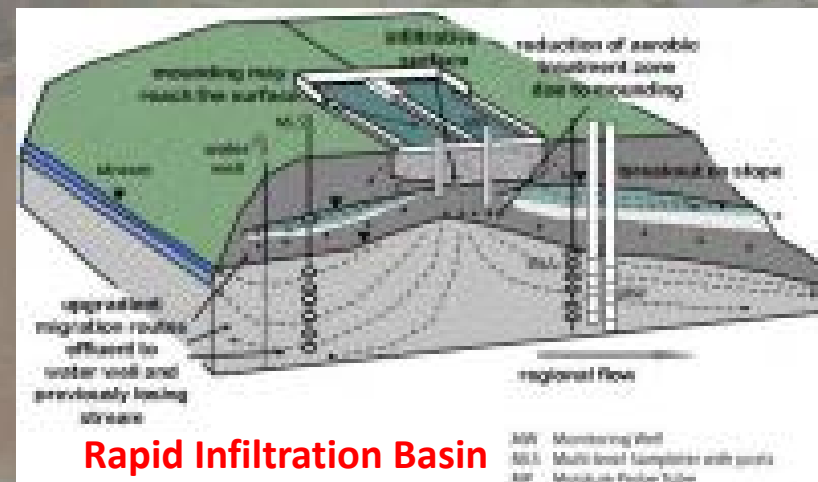
- install new wells in strategic locations in support of NGWMN and the Delaware network
- replace older “ad-hoc” wells (“wells of opportunity”) in the Delaware network
- funding (recent cuts) is needed to sustain long-term operations. NGWMN?

Describe how DGS uses the data from its network

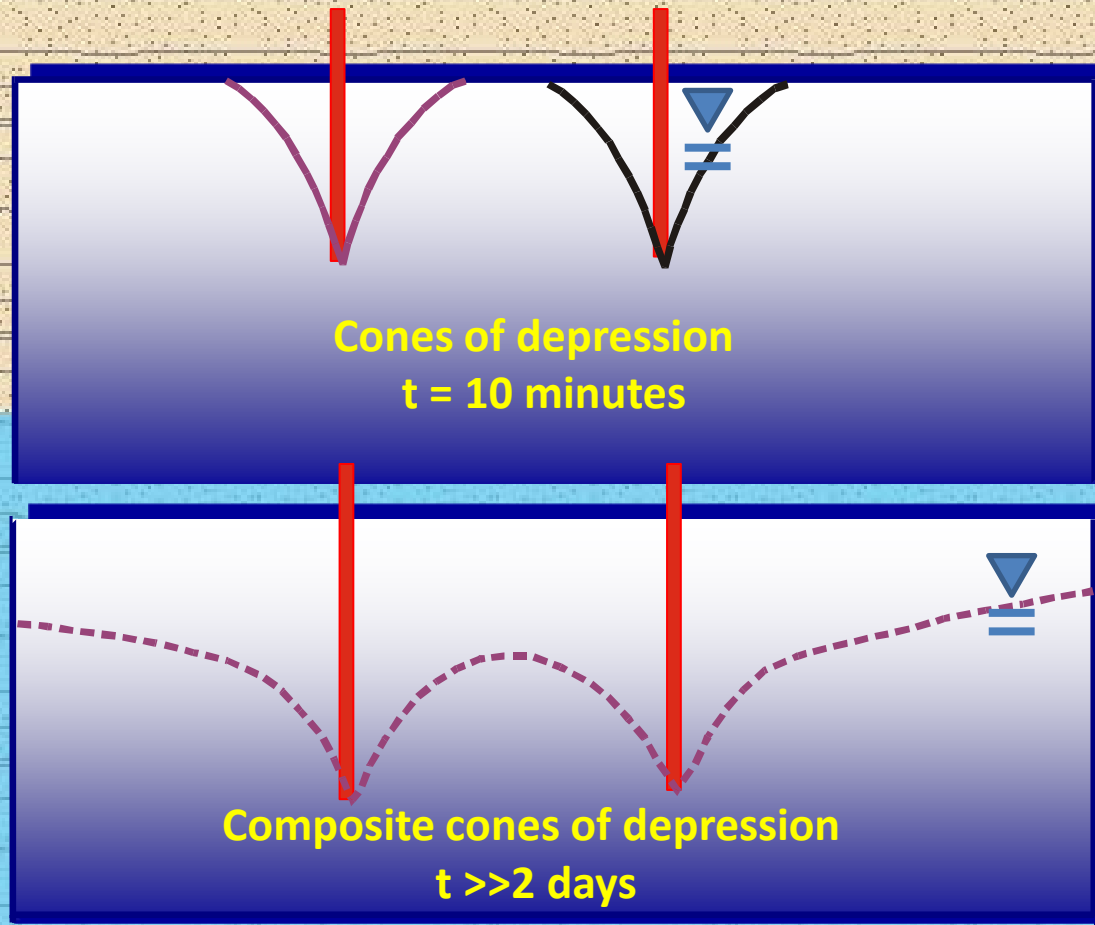


How DGS uses data from the network

- **Water resources management and regulatory issues**
 - Delaware Department of Natural Resources and Environmental Control (DNREC): Water Supply, Watershed Stewardship, Groundwater Discharges, Site Investigation and Restoration
 - pumping interference, drought monitoring, saltwater intrusion, rapid infiltration basins, TMDLs, contaminated groundwater
 - Support ranges from supplying data to complex interpretations
- **Water Supply Coordination Council** - water conditions for state (drought)
- **Private sector** - groundwater investigations that are typically site-based but can be at watershed scale
- **Research (DGS and university researchers)**
 - groundwater modeling (water availability,
 - wellhead protection, sea-level rise, ...)
 - groundwater- surface water interaction
 - understanding flow systems and aquifer connectivity



Discuss Trans-Boundary issues and how they influence your network

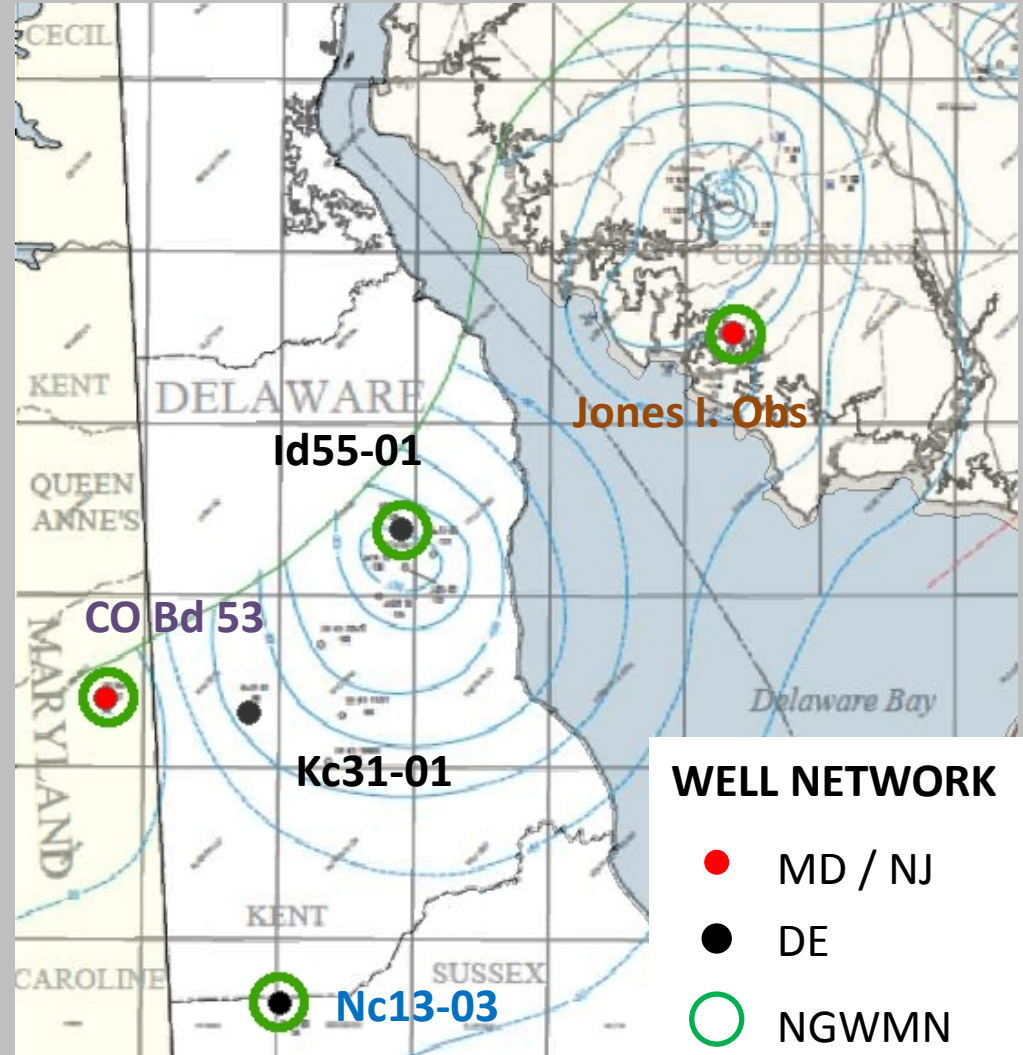
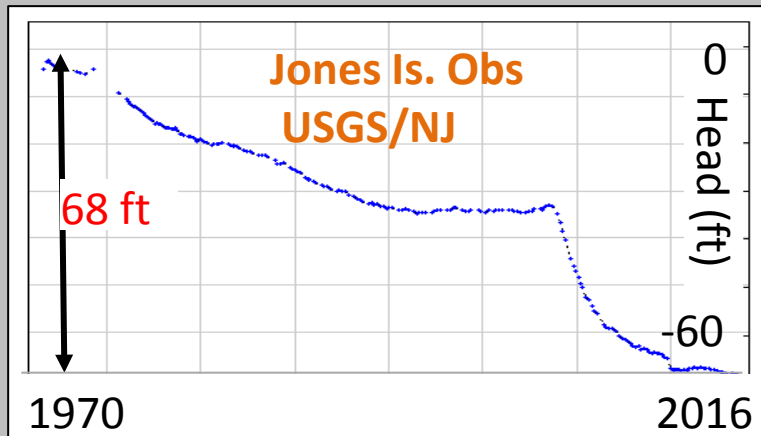
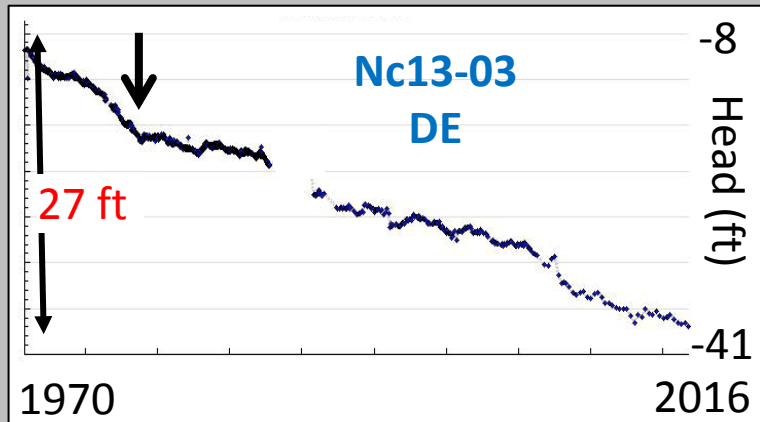
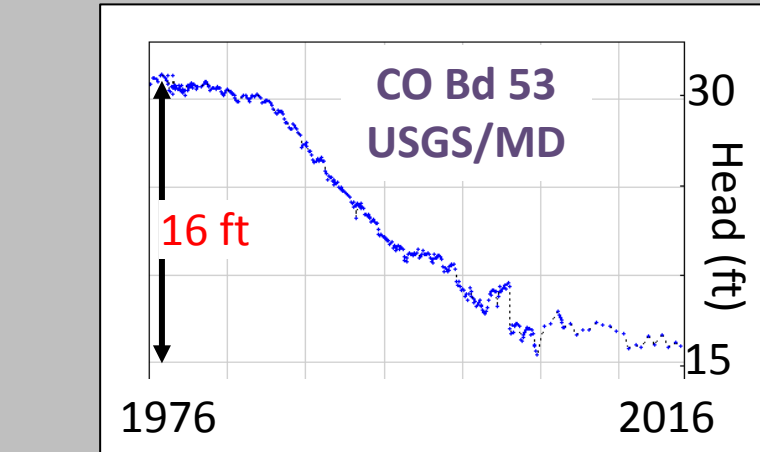


Trans-Boundary Aquifer

Piney Point Aquifer in DE, MD, NJ

DGS plans to install wells along DE/MD border

Potentiometric Surface, 1998



Depaul and Rosman (2015)

Describe an application of how DGS used network data (or NGWMN data) to help answer a management question



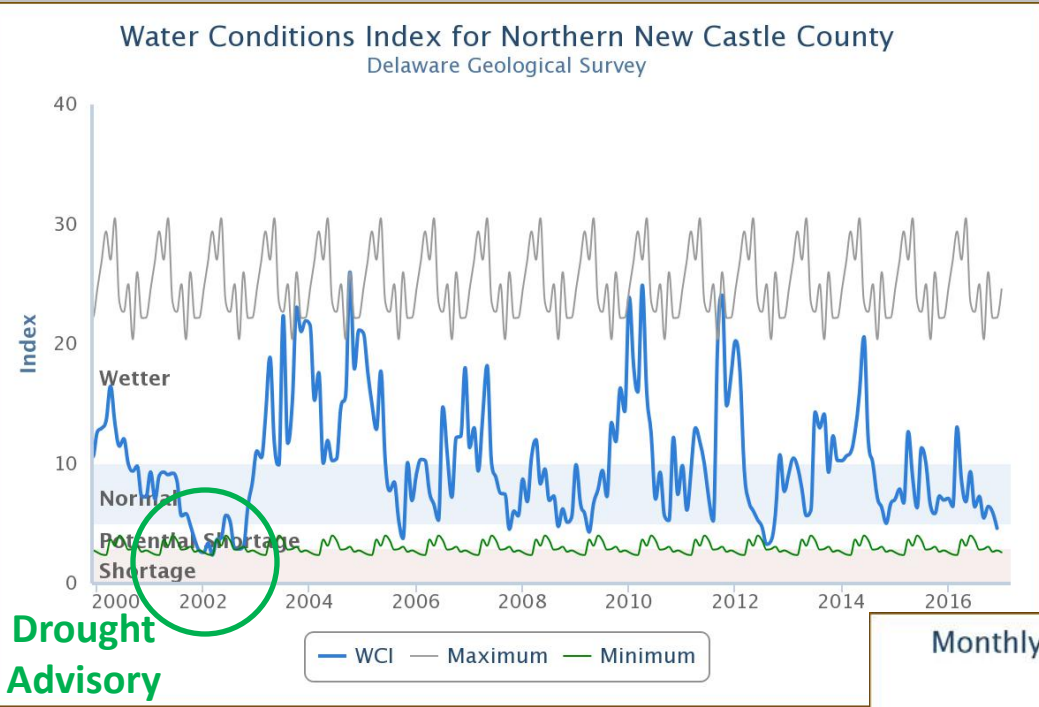
Addressing a management question with monitoring network data

Water Conditions Index for New Castle County

Evaluate drought conditions for potable water supply

used by

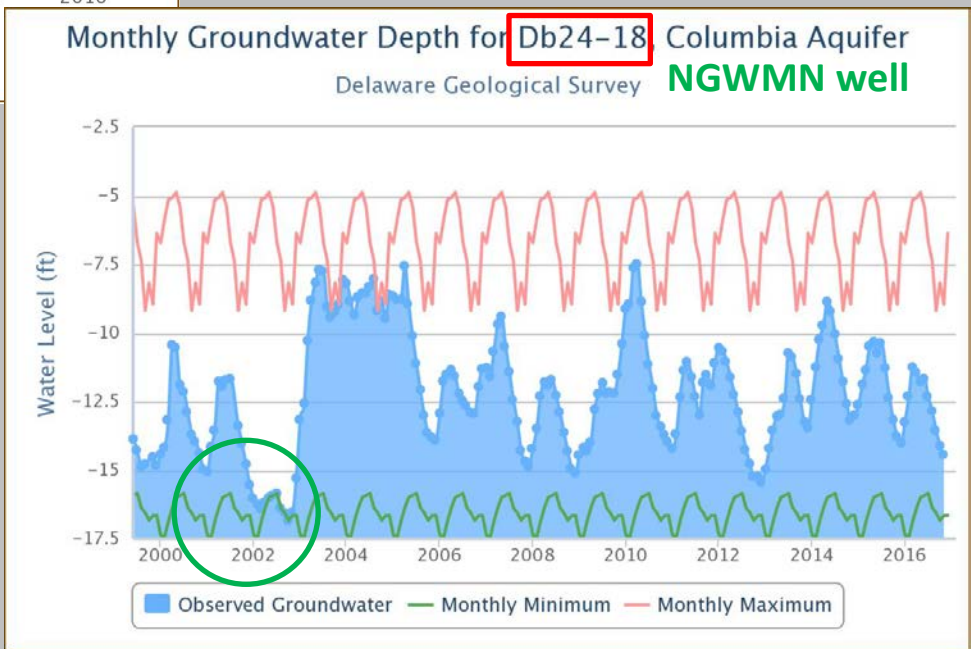
Water Resource Managers
Water Supply Coordinating Committee
Governor's Drought Advisory Committee



Drought Advisory

$$I = \frac{P * \sqrt{S} * (100 - L)}{POP}$$

- I = Water Conditions Index** for New Castle Co. (-)
- P = 6-month average precipitation**, (inches)
- S = current monthly average streamflow** in Brandywine Creek (cfs)
- L = depth to water in well Db24-18** (feet)
- POP = population of New Castle County** during current year (-)



Describe current DGS projects to become NGWMN data provider



Describe current projects to become NGWMN data provider status and plans

Year 1 (2016)

- **33 wells submitted to NGWMN (33 wl and 3 wq)**
 - well registry complete
 - web services for construction, lithology, water level and quality complete
 - final report in review to be submitted December 2016

Years 2 & 3 (2016-2018)

- **Plan to add 5 to 10 wells for water levels & 3 to 5 wells for water quality by June 2017**
- **test data migration process for completeness and accuracy (monthly)**
- **ensure that portal connections to DGS database developed in year 1 remain operational**

Screenshot of NGWMN portal with current sites displayed



NGWMN portal

Data available:

Summary

Basic Well Information

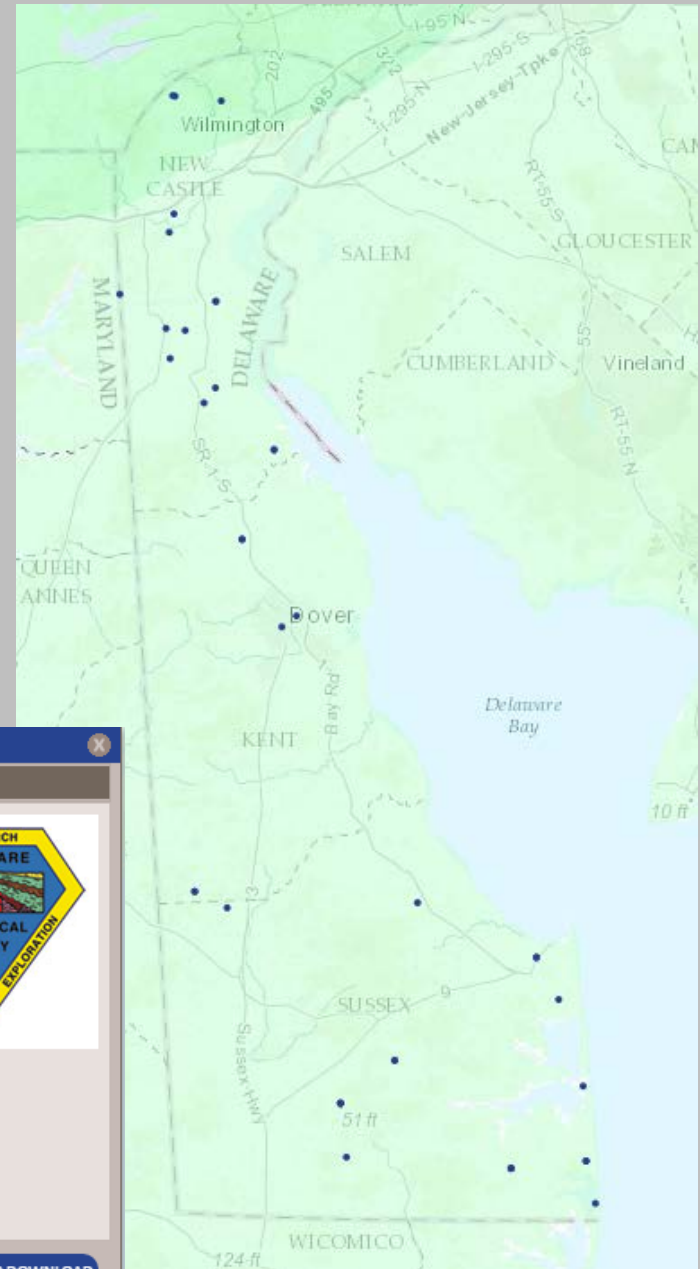
Web services ready to launch

Water Level

Water Quality

Lithology


Well Construction



Greenwood [X]

SUMMARY WELL LOG

Agency	Delaware Geological Survey
Site Name	Greenwood
Site #	Nc13-03
Site Type	WELL
Lat/Long(NAD83)	38.8257,-75.6160
Well Depth	630 ft
Local Aquifer Name	Piney Point
National Aquifer Name	Northern Atlantic Coastal Plain aquifer system
Aquifer Type	CONFINED
Water Level Network	Trend - Documented Changes
Water Quality Network	-
Additional info	link



RESEARCH DELAWARE GEOLOGICAL SURVEY SERVICE EXPLORATION

SELECT FOR DOWNLOAD

Describe NGWMN site selection and classification process



Describe your NGWMN site selection and classification process (water level)

Wells for water levels were selected from the DGS groundwater monitoring network:.

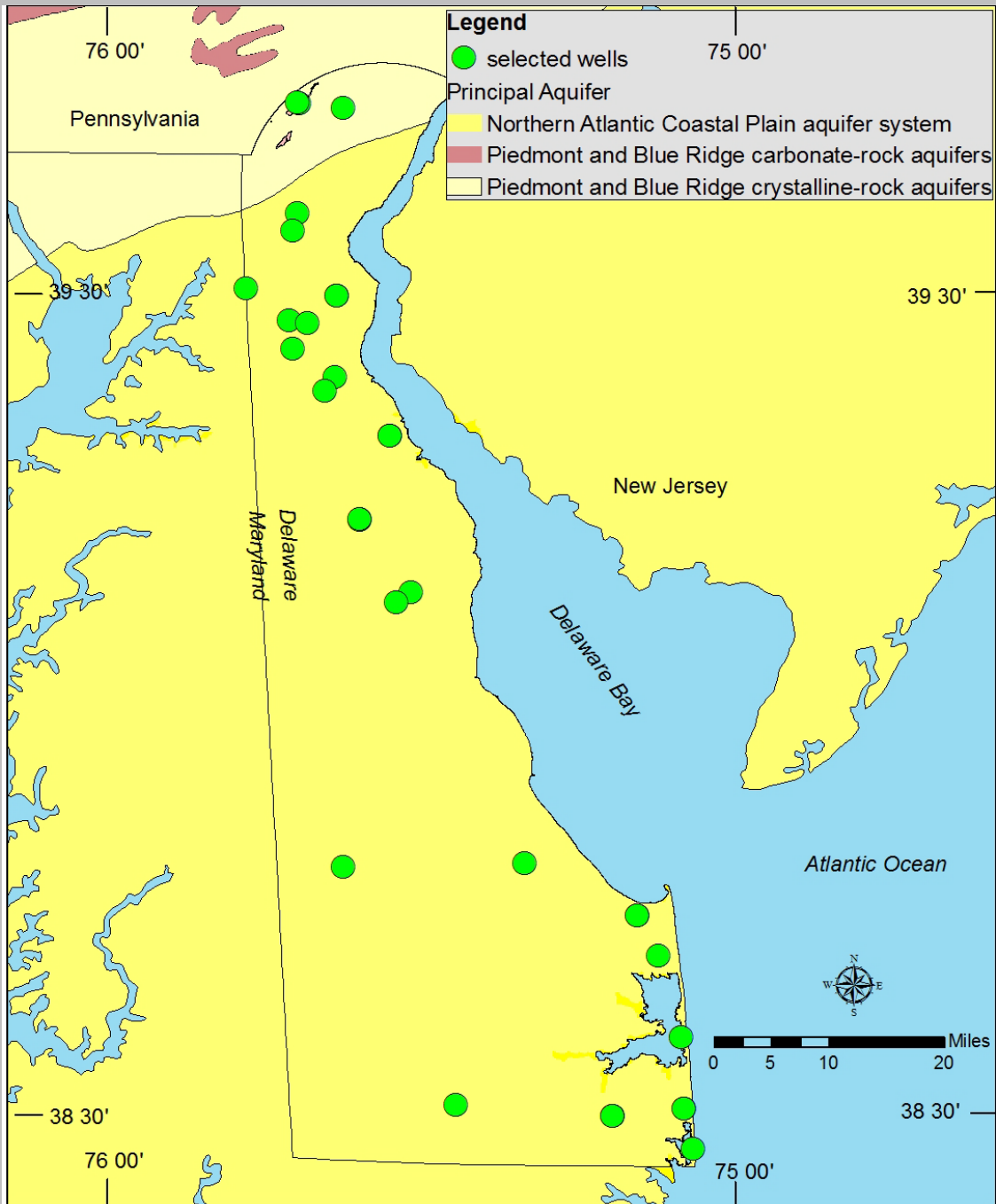
- use guidelines in tip sheets
- adequate period of record
- distributed with respect to location in map view
- in all three principal aquifers that are present in Delaware with partial coverage for 13 local aquifers.
- include both unconfined and confined settings
- where possible span updip to downdip transects within a local aquifer
- several sites have monitoring wells in multiple, layered aquifers to allow calculation of potential for vertical flow between aquifers

Subnetworks (background, suspect, known)

- inspected hydrographs and locations of pumping
- all wells for level monitoring fall into the “suspected change” or “known change” subnetwork categories., because of Delaware’s small size, intensive agricultural and urban development, and reliance on groundwater for water supply
- In future years, some new monitoring wells in remote areas will likely meet “background” subnetwork requirements for water levels.
- Water quality wells fall in the “suspected change” category

• **Monitoring Categories (trend, surveillance, special)**

- All wells for level and quality monitoring fit the “Trend” monitoring category as they have a minimum of monthly measurements for greater than five years.



Selected sites ●

WL monitoring

33 wells

All 3 principal aquifers

10 major/local aquifers

Many sites have nested wells

WQ monitoring

3 wells

2 major aquifers

Describe any differences between DGS data collection methods and NGWMN protocols

The only major difference in protocol was for data classification.

The National Map does not include the Piedmont and Blue Ridge – carbonate rock aquifer in Delaware likely because the outcrop area is too small for a national map. However, it is important as a water supply source in Delaware.

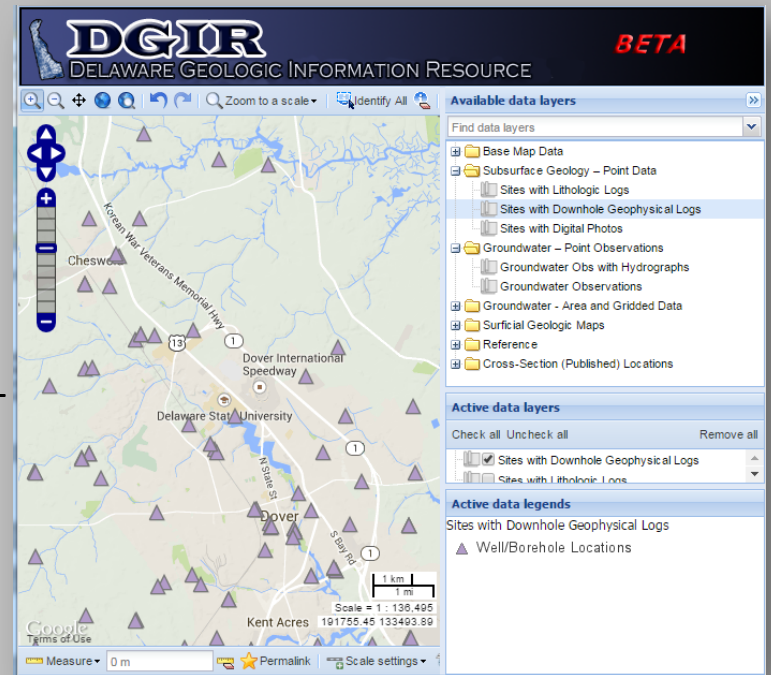


Describe any other data available on the DGS website



Other data available on DGS website

- DGIR (Delaware Geologic Information Resource): map-based data exploration inc. lith. (right)
- Data and Graphs of Water Levels for Wells with 20+ years or 100+ observations (below)
- Water Level Summary Statistics for Wells with 20+ years of data used in the Water Conditions Index (min, 25th perc., median, mean, 75th perc., max)
- Table of statistics for all wells with 4 or more observations (n, min, mean, max)
- Water Conditions Index



199 Items

TABLE LIST • MAP

DGS-ID▲	Data	Alt	Top	Bottom	Aquifer	Obs	Start	End
Bb34-34		259	145	298	cm	135	Mar 1977	May 2016
Bb34-40		252	45	60	cm	165	Mar 1979	May 2016
Bc43-01		339	8	164	ws	4320	Jan 1974	Apr 2016
Ca55-204		112	19	25	cl	2762	Nov 2006	Apr 2016
Cb12-10		177	103	410	cm	859	Jan 1978	May 2016
Db15-05		23	215	306	pti	375	Mar 1979	May 2016
Db22-53		60	11	16	cl	107	May 1986	Apr 1996
Db24-10		78	21	24	cl	282	Aug 1957	Dec 1986
Db24-17		77	17	22	cl	84	Jun 1986	Aug 1993
Db24-18		78	9	19	cl	5158	Aug 1993	May 2016
Db33-17		48	185	189	pti	1256	Oct 1980	Apr 2016
Db33-18		48	138	143	pti	529	Oct 1980	Feb 2014
Db33-19		48	35	39	cl	1015	Oct 1980	Apr 2016
Dc34-05		30	574	579	pti	2040	Aug 1975	Apr 2016
Dc34-06		29	183	188	ptu	2037	Sep 1975	Apr 2016

Text Search:

County

- 33 Kent County
- 58 New Castle County
- 108 Sussex County

Aquifer

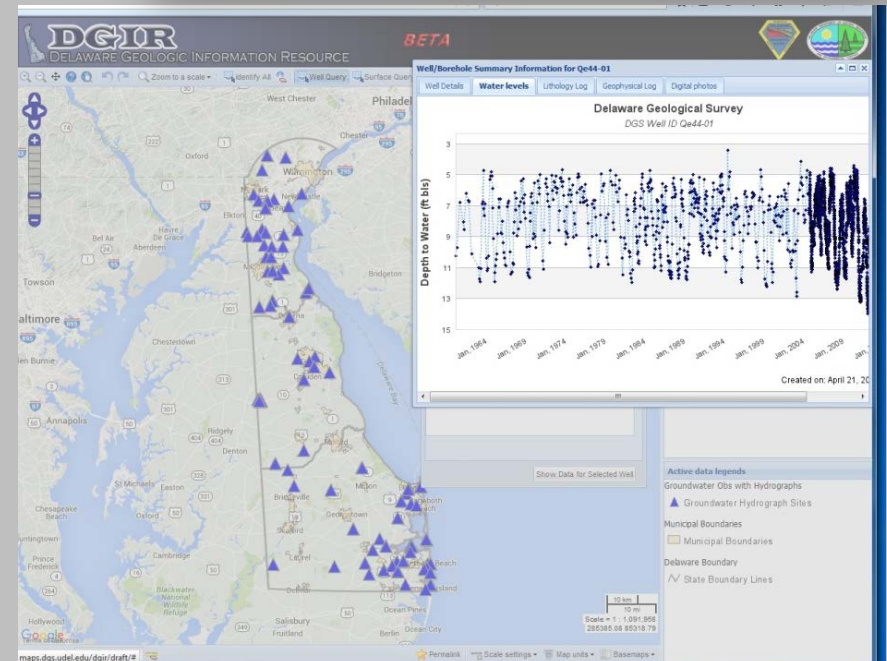
- 1 Chesapeake
- 3 Cheswold
- 3 Cockeysville
- 93 Columbia
- 3 Columbia-Pocomoke
- 2 Columbia-Rancocas

Number of Obs

10 - 5180

Screen Top

0 - 630

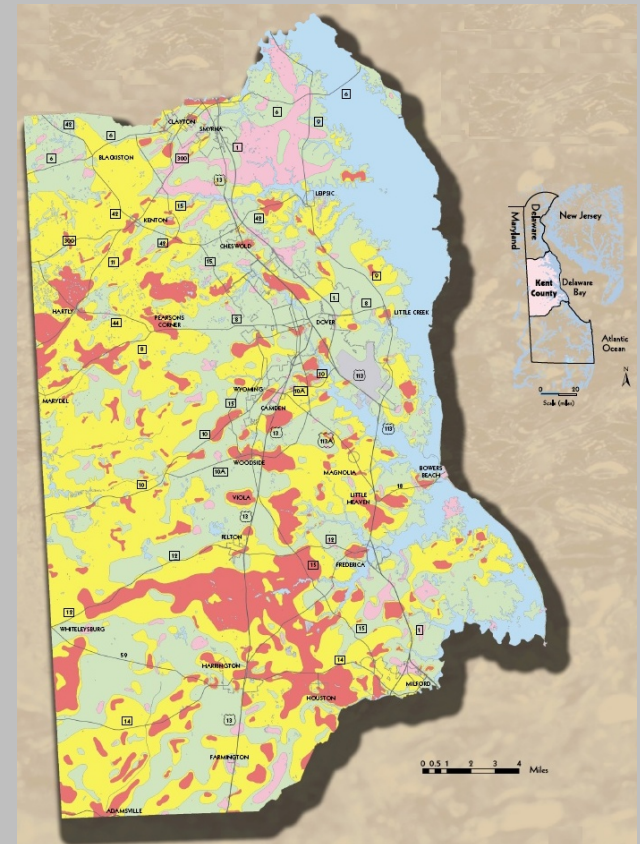
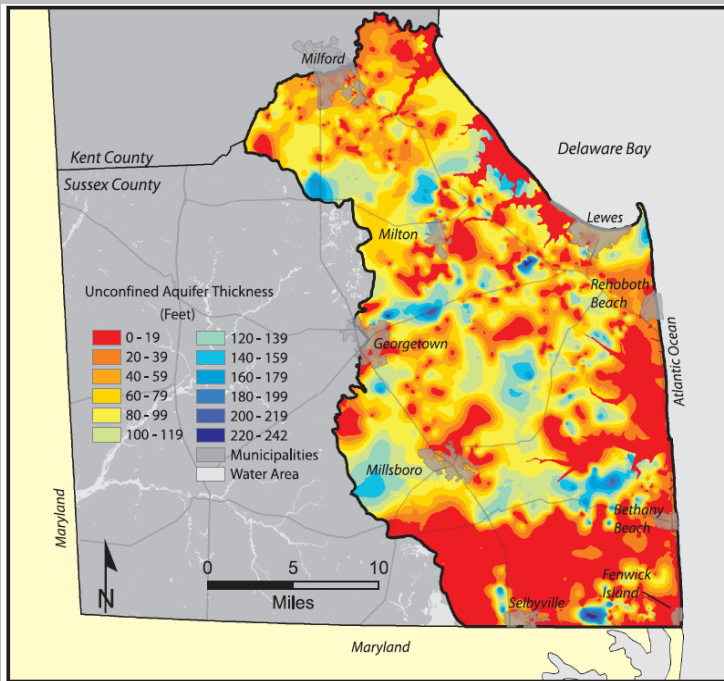


DGIR

unconfined aquifer thickness, recharge potential, water table depth/elevation, surficial geology, aquifer top and bottom ...)

Recharge Potential

Unconfined aquifer thickness



Many datasets also available as web services

Free Digital Publications DGS website

search capability

author, geologic unit, publication type, place, keyword

The screenshot shows the Delaware Geological Survey website. At the top, there is a navigation bar with links for Home, About the DGS, News and Activities, Maps & Directions, and Staff Directory. A search bar is also present. The main content area is titled "DGS Publications" and displays a list of 223 publications. The list includes columns for Title, Authors, and Date Published. On the left side, there are sections for "Read About..." (featuring a book cover titled "The Geology of Delaware"), "Share" (with social media icons), "Our Work" (with links to Projects, Publications, Digital Data, Water Resources, Annual Report, Water Conditions, and Delaware Geology), and "Publications Request Form". On the right side, there are filters for "Text Search:", "Publication Type" (with a list of 24 types), "Author" (with a list of 10 authors), "Geologic Units" (with a list of 9 units), and "Places".

The Delaware Geological Survey
Geologic and hydrologic research and exploration for Delaware

Home About the DGS News and Activities Maps & Directions Staff Directory

DGS Publications

223 Publications

[TABLE](#) • [TIMELINE](#) • [PREVIEW](#) • [CITATIONS](#) • [MAP](#)

Title	Authors	Date Published
B21D Using Numerical Models to Assess a Rapid Infiltration Basin System (RIBS), Cape Henlopen State Park, Delaware	He, C. and Andres, A.S.	Dec 2015
B21B Hydrogeology of a Rapid Infiltration Basin System (RIBS) at Cape Henlopen State Park, Delaware	Andres, A.S., Walther, E.F., Türkmen, M., and He, C.	Dec 2015
B21C Groundwater Quality and Monitoring of Rapid Infiltration Basin Systems (RIBS), Theory and Field Experiments at Cape Henlopen State Park, Delaware	Andres, A.S., Walther, E.F., Türkmen, M., He, C., Chirside, A.E.M., and Ritter, W.F.	Dec 2015
B21A Evaluation of Wastewater Treatment Options Used in Rapid Infiltration Basin Systems (RIBS)	Türkmen, M., Walther, E.F., Andres, A.S., Chirside, A.E.M., and Ritter, W.F.	Dec 2015
R179 Simulation of Groundwater Flow and Contaminant Transport in Eastern Sussex County, Delaware With Emphasis on Impacts of Spray Irrigation of Treated Wastewater	He, C. and Andres, A.S.	Aug 2015
GM23 Geologic Map of the Seaford West and Seaford East Quadrangles, Delaware	Tomlinson, J.L., Ramsey, K.W., and Andres, A.S.	Aug 2015
OFR50 Database of Quaternary Coastal Geochronologic Information for the Atlantic and Pacific Coasts of North America (additional information for sites in Peru and Chile)	Wehmiller, J.F. and Pellerito, V.	Feb 2015
GM22 Geologic Map of the Sharptown, Laurel, Hebron, and Delmar Quadrangles, Delaware	Ramsey, K.W. and Tomlinson, J.L.	Sep 2014
GM21 Geologic Map of the Trap Pond and Pittsville Quadrangles, Delaware	Tomlinson, J.L. and Ramsey, K.W.	Jun 2014
GM20 Geologic Map of the Millsboro and	Ramsey, K.W. and	Apr 2014

Text Search:

Publication Type

- 24 Bulletin
- 23 Geologic Map
- 12 Hydrologic Map
- 7 Information Series
- 6 Miscellaneous Map
- 49 Open File Report
- 79 Report of Investigation
- 23 Special Publication

Author

- 1 Adams, J.K.
- 1 Anderson, P.W.
- 40 Andres, A.S.
- 1 Bachman, L.J.
- 1 Baker, W.W.
- 5 Baxter, S.J.
- 1 Beall, R.M.

Geologic Units

- 9 alluvial deposits
- 3 alluvium and swamp deposits
- 3 Arden Granite
- 1 Arden Pluton
- 3 Ardentown Granitic Suite
- 1 Arundel Formation
- 4 Baltimore Gneiss

Places

Describe current NGWMN projects to enhance the Network (Objectives 3-5)

The current DGS projects do not address objectives 3-5. We are preparing a proposal for the latest NGWMN RFP (due January 27, 2017) that will focus on drilling wells to fill monitoring data gaps (Objective 5).



Questions?

