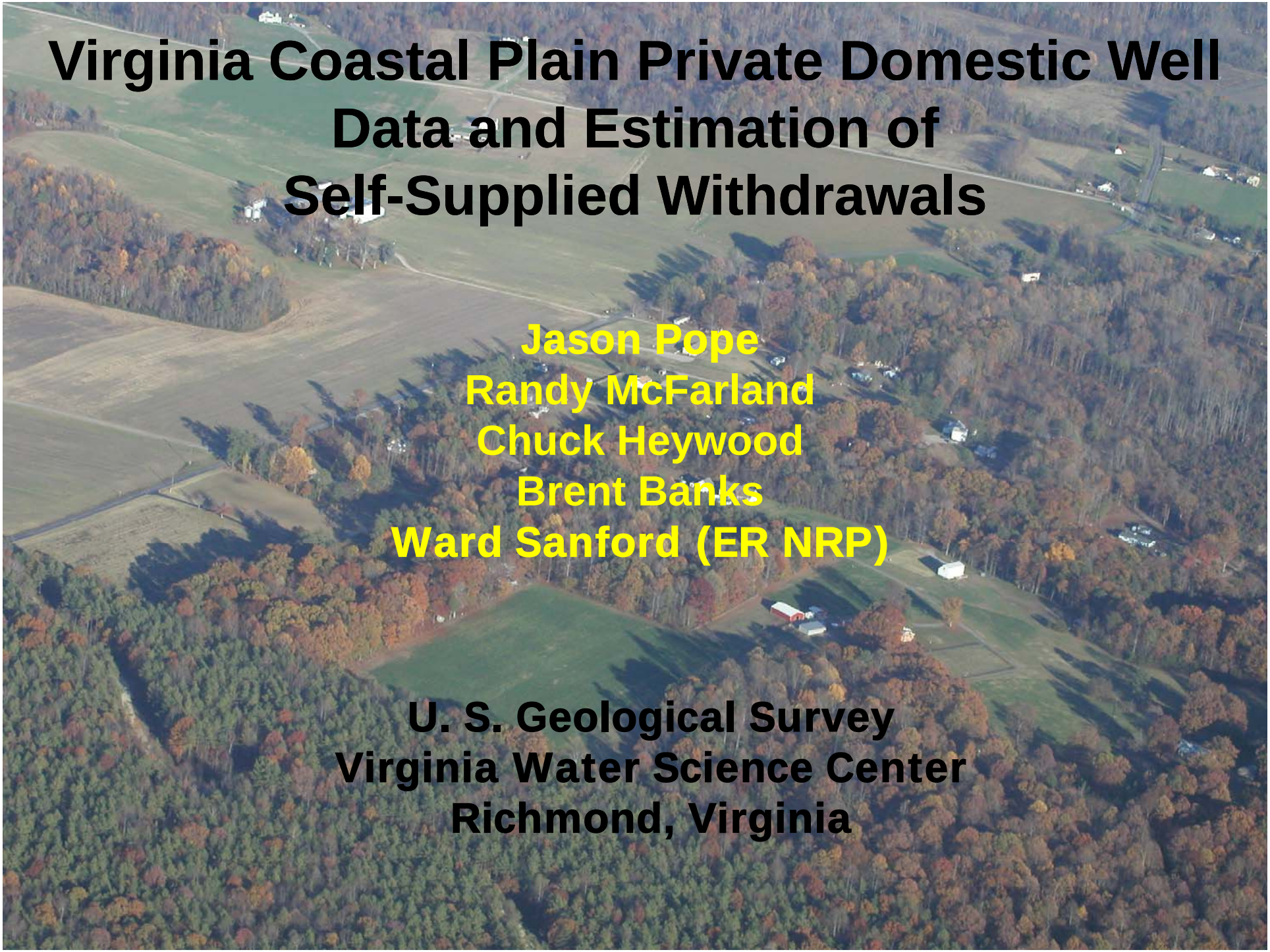


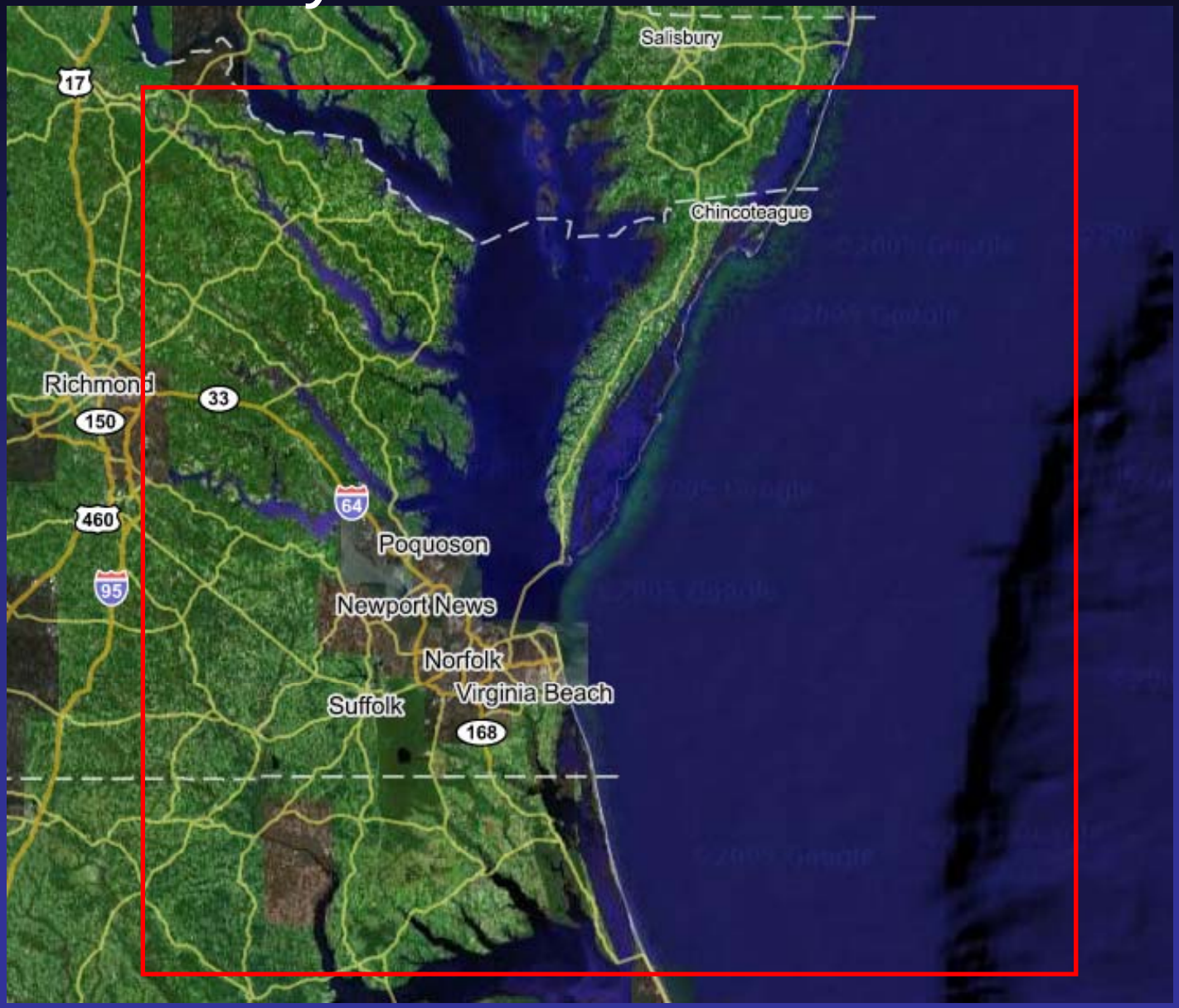
Virginia Coastal Plain Private Domestic Well Data and Estimation of Self-Supplied Withdrawals

Jason Pope
Randy McFarland
Chuck Heywood
Brent Banks
Ward Sanford (ER NRP)

U. S. Geological Survey
Virginia Water Science Center
Richmond, Virginia

Coastal Plain of Virginia with Adjacent Parts of Maryland and North Carolina

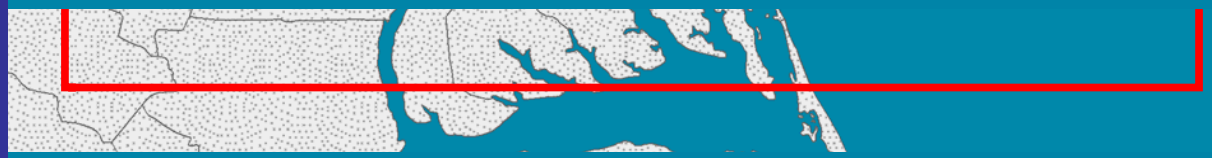
Coastal Plain of Virginia with Adjacent Parts of Maryland and North Carolina



Two Ground-Water Models

Virginia Eastern Shore Ground-Water Model

Virginia Coastal Plain Ground-Water Model



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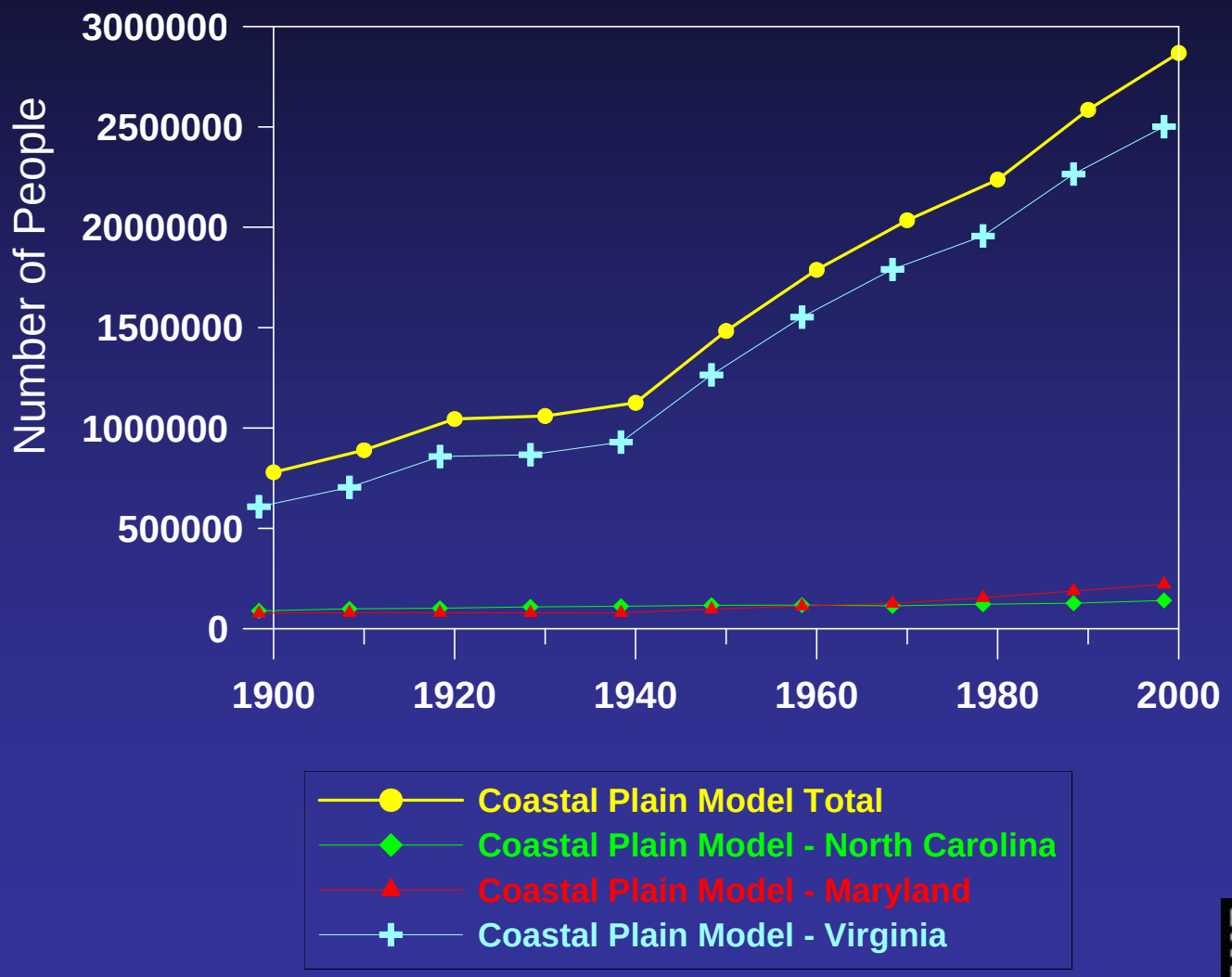
Total Population within Virginia Coastal Plain Model Domain



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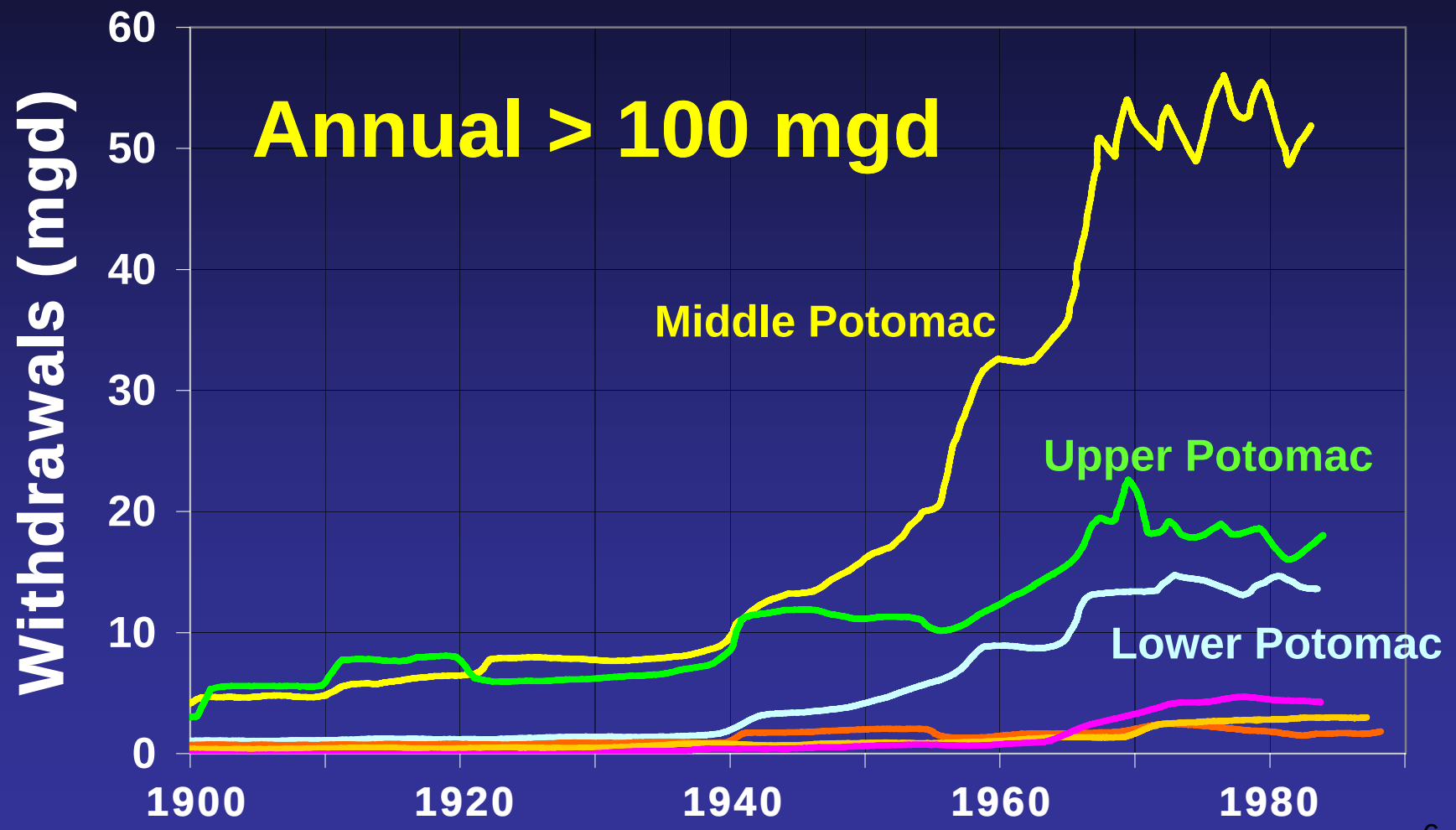
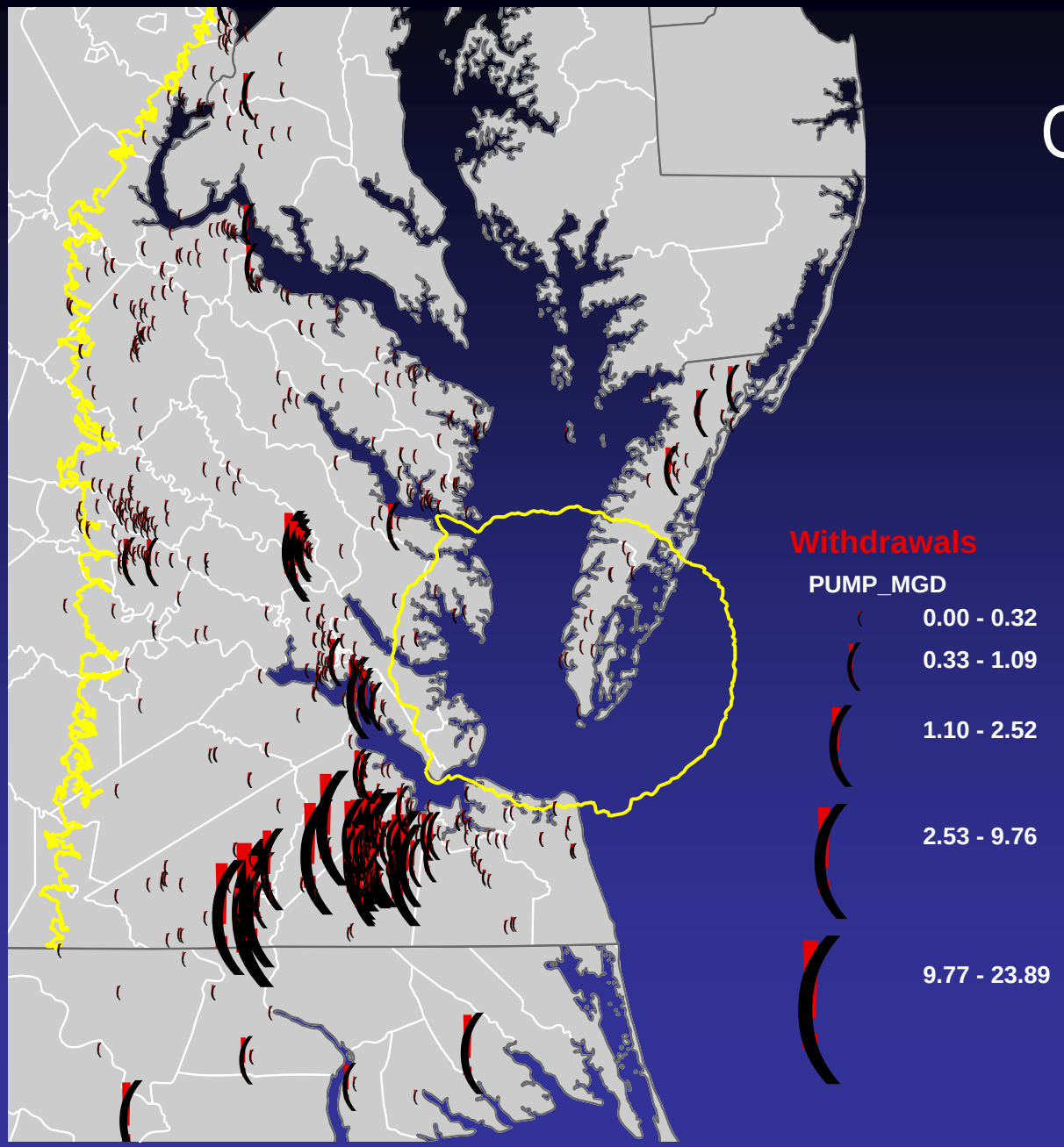
Reported Withdrawals from the Confined Aquifers of the Virginia Coastal Plain



Coastal Plain Ground-Water Withdrawals

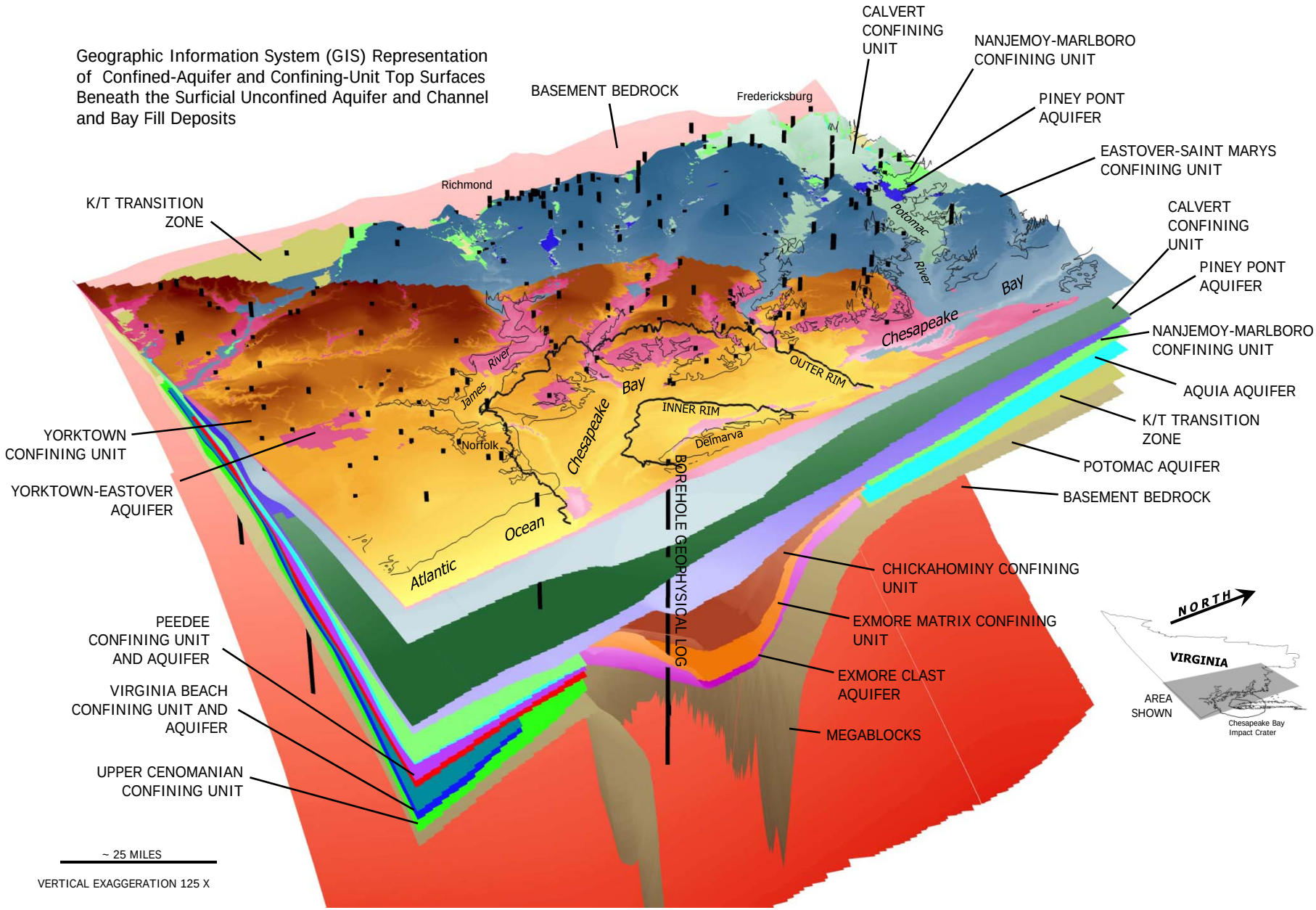
2000



Total
~ 100 mgd

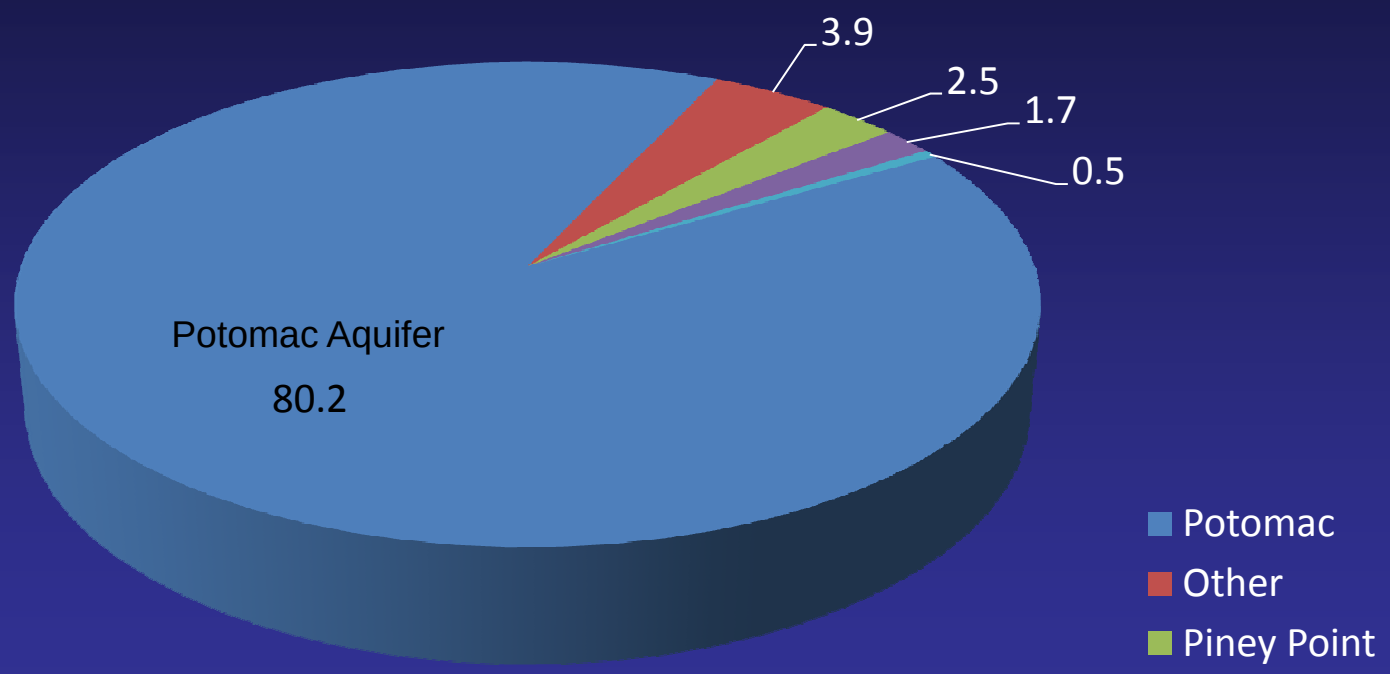
Virginia Coastal Plain Hydrogeologic Framework

Geographic Information System (GIS) Representation of Confined-Aquifer and Confining-Unit Top Surfaces Beneath the Surficial Unconfined Aquifer and Channel and Bay Fill Deposits



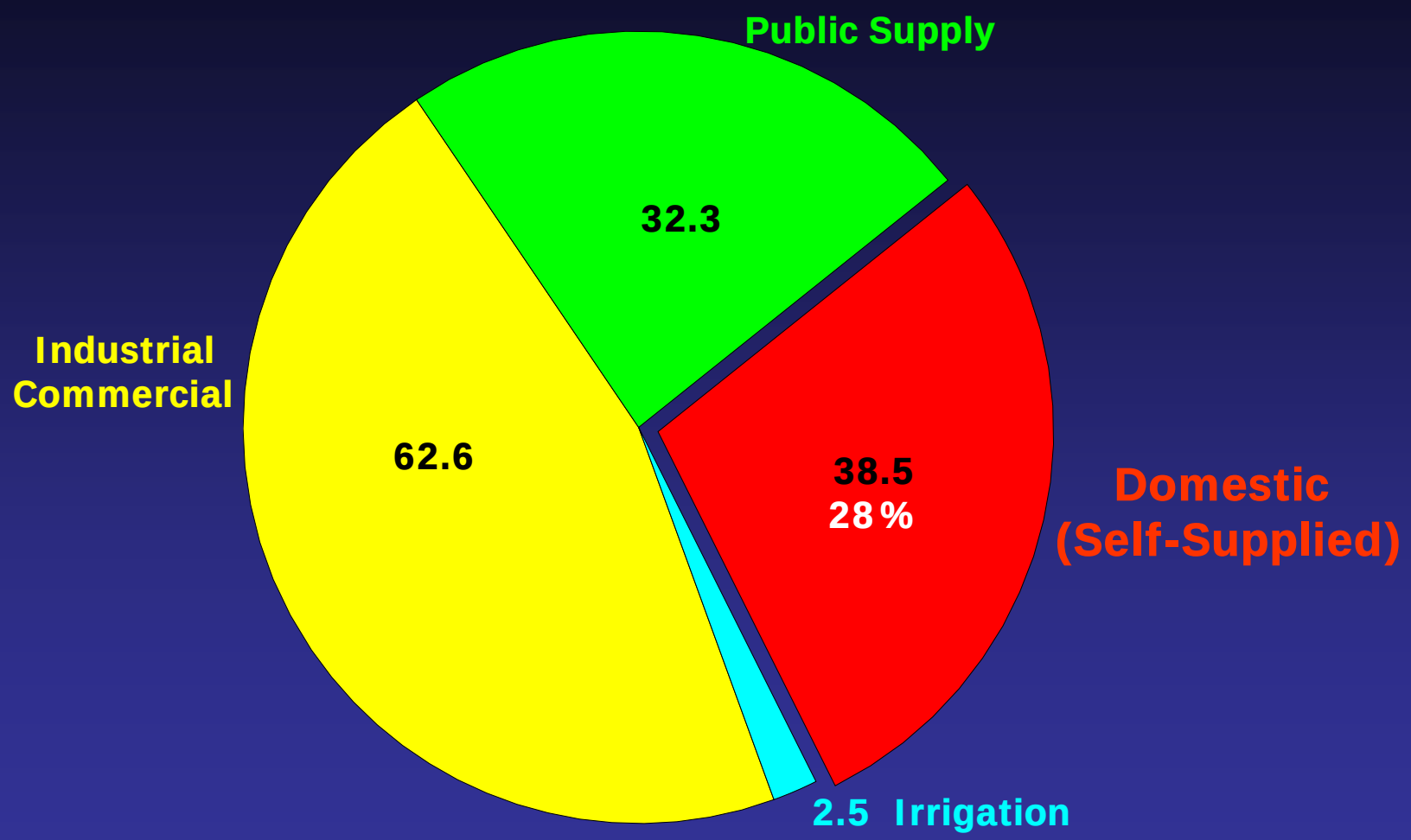
<u>REPORTED</u> Virginia Withdrawals by Aquifer in 2003 for Virginia Coastal Plain Groundwater Model

withdrawal values in Mgal/day



88.8 Mgal/day = 76% of Virginia Withdrawal Total in 2003

VIRGINIA COASTAL PLAIN GROUND-WATER WITHDRAWALS BY CATEGORY OF USE



2000 TOTAL = 137.4 million gallons per day

From "Estimated Use of Water in the United States in 2000"

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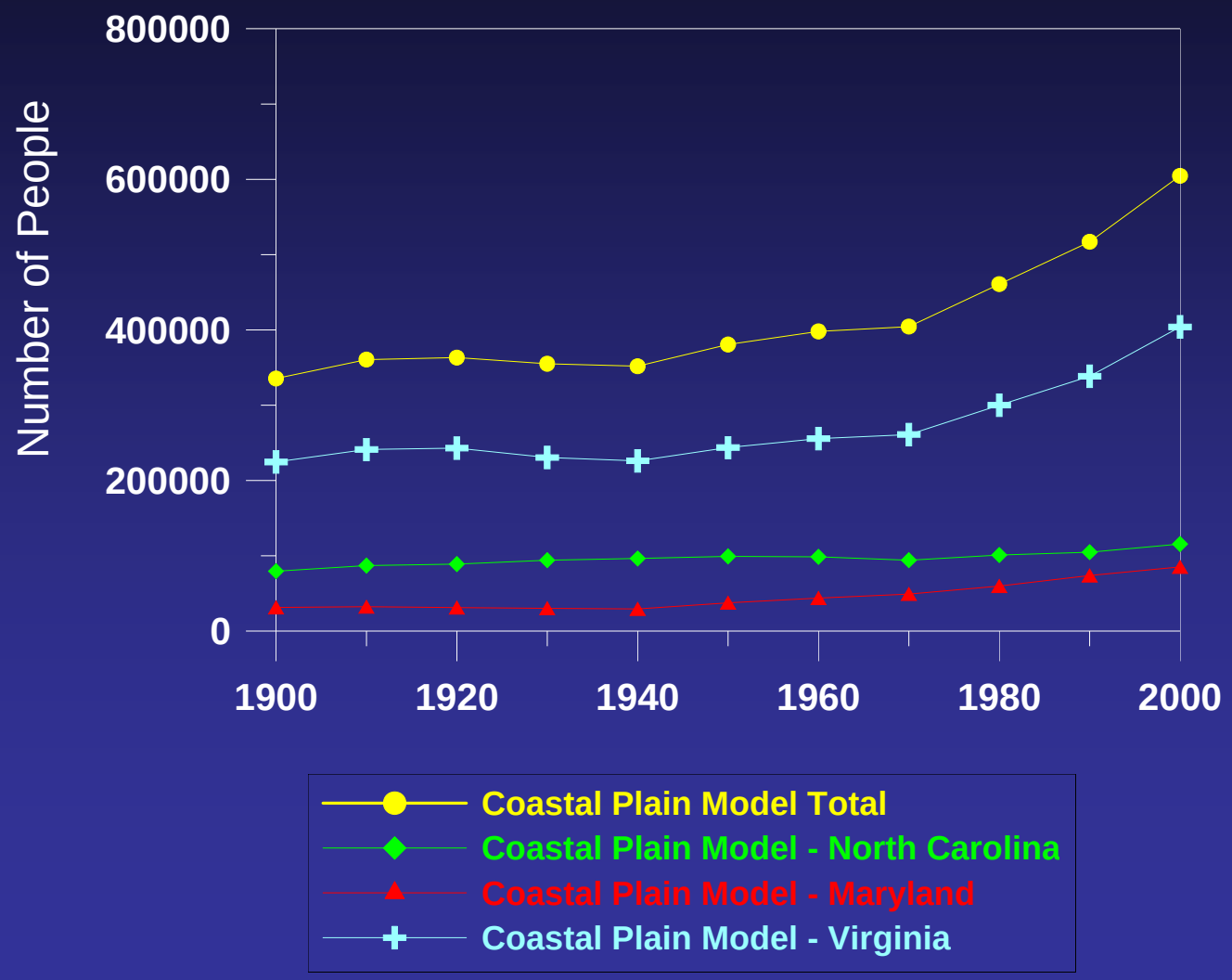
Estimating Water Use in the United States: A New Paradigm for the National Water-Use Information Program

Committee on USGS Water Resources Research,
National Research Council, National Academy of Sciences

- The scientific understanding of water use will be most effectively achieved by making water use science the focus. *Water use science* refers to the hypothesis-driven investigation of the behavior and phenomena that determine spatial and temporal patterns of water use.

- The NWUIP should be elevated to *a water use science* program, emphasizing applied research and techniques development in the statistical estimation of water use and the determinants and impacts of water-using behaviors.

Virginia Coastal Plain Model Population Served by Self-Supplied Domestic Ground-Water Withdrawals

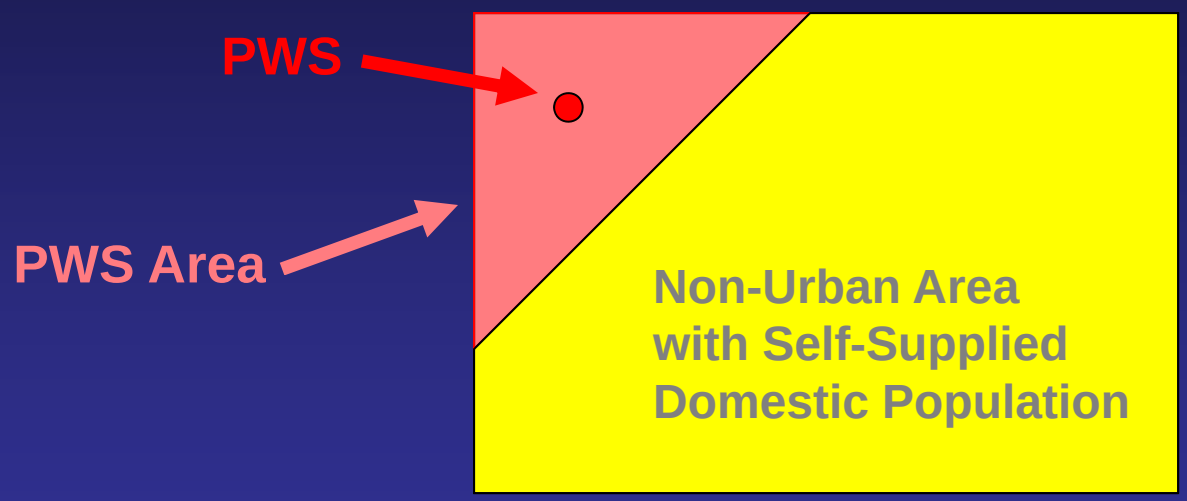


Estimating and Distributing Self-Supplied Domestic Ground-Water Withdrawals

Total Population of Geographic Area

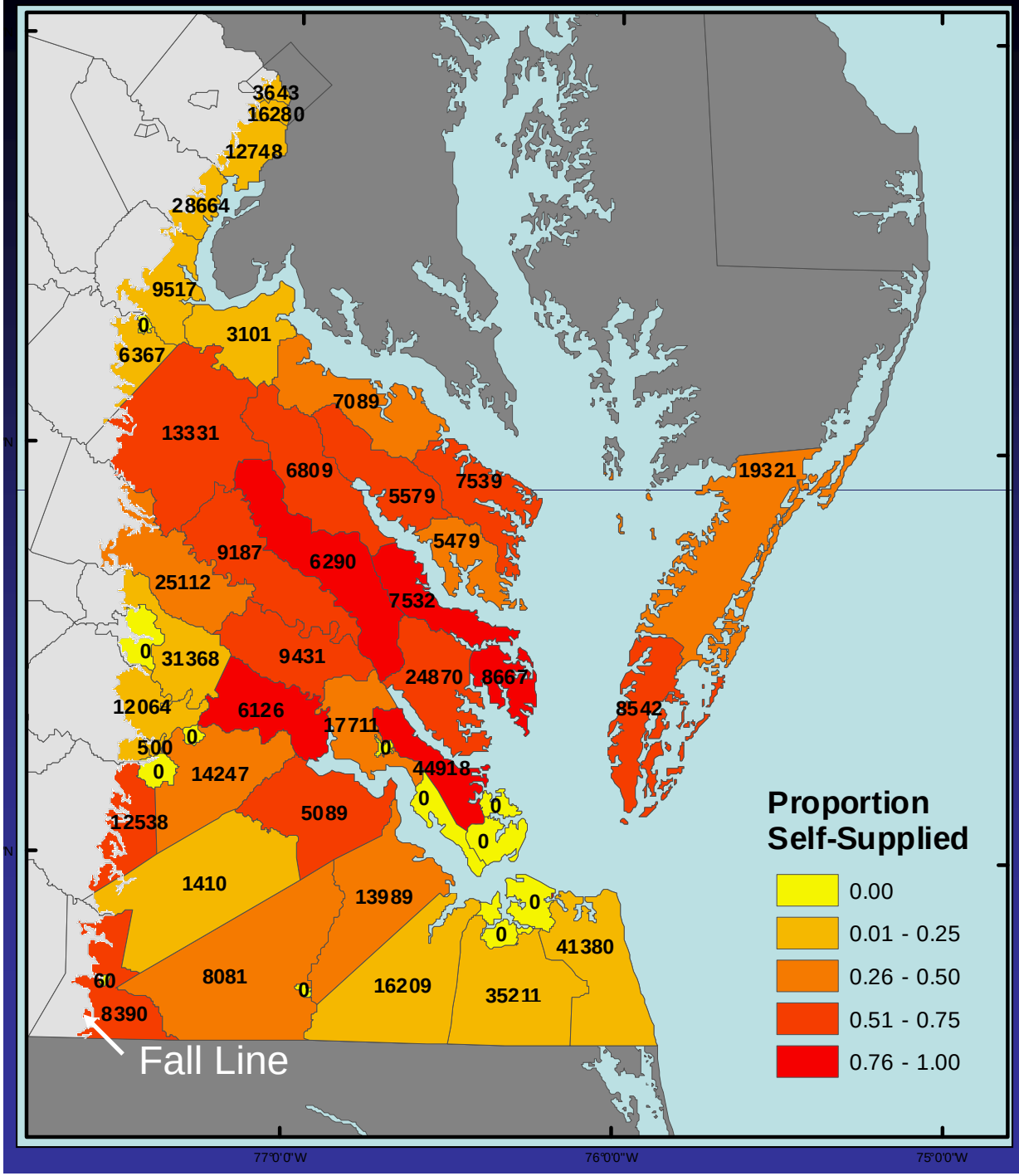
— Population Publicly Supplied

Domestically-Supplied Population



Domestically Supplied Population * **Per-Capita Domestic Water Use (75 for VA)** = **Withdrawal Rate (Gallons/day)**

Population Self-Supplied with Ground Water by Locality in the Coastal Plain of Virginia



2000 TOTAL

514,390 people

38.54 Mgal/day

Population Values in Number of People; Colors Indicate Percent of County Population Served by GW; Localities partially in Coastal Plain are shown partially shaded.

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Estimated Ground-water Withdrawals for Coastal Plain Localities

Locality	FIPS Code	Coastal Plain Proportion	Self-Supplied Proportion	Locality Ground-Water Withdrawal (Mgal/day)					Coastal Plain Ground-Water Withdrawal (Mgal/day)				
				Public Supply	Domestic	Industrial/ Commercial	Irrigation	Total	Public Supply	Domestic	Industrial/ Commercial	Irrigation	Total
Accomack County	51001	1.000	0.495	0.82	1.42	3.01	1.01	6.26	0.82	1.42	3.01	1.01	6.26
Alexandria, City of	51510	1.000	0.127	0.00	1.22	0.01	0.00	1.23	0.00	1.22	0.01	0.00	1.23
Arlington County	51013	0.857	0.022	0.00	0.32	0.00	0.04	0.36	0.00	0.27	0.00	0.03	0.31
Caroline County	51033	1.000	0.603	0.33	1.00	0.00	0.01	1.34	0.33	1.00	0.00	0.01	1.34
Charles City County	51036	1.000	0.885	0.04	0.46	0.00	0.07	0.57	0.04	0.46	0.00	0.07	0.57
Chesapeake, City of	51550	1.000	0.177	4.53	2.64	0.05	0.00	7.22	4.53	2.64	0.05	0.00	7.22
Chesterfield County	51041	0.413	0.112	0.00	2.22	0.34	0.01	2.57	0.00	0.92	0.14	0.00	1.06
Colonial Heights, City of	51570	1.000	0.030	0.00	0.04	0.00	0.00	0.04	0.00	0.04	0.00	0.00	0.04
Dinwiddie County	51053	0.694	0.737	0.00	1.36	0.00	0.06	1.42	0.00	0.94	0.00	0.04	0.99
Emporia, City of	51595	1.000	0.011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Essex County	51057	1.000	0.682	0.41	0.51	0.00	0.00	0.92	0.41	0.51	0.00	0.00	0.92
Fairfax County	51059	0.280	0.047	0.20	3.48	0.04	0.11	3.83	0.06	0.97	0.01	0.03	1.07
Franklin, City of	51620	1.000	0.000	1.11	0.00	0.00	0.00	1.11	1.11	0.00	0.00	0.00	1.11
Fredricksburg, City of	51630	1.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gloucester County	51073	1.000	0.715	0.00	1.87	0.00	0.01	1.88	0.00	1.87	0.00	0.01	1.88
Greensville County	51081	1.000	0.726	0.00	0.63	0.00	0.03	0.66	0.00	0.63	0.00	0.03	0.66
Hampton, City of	51650	1.000	0.000	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.03	0.03
Hanover County	51085	0.897	0.324	1.22	2.10	0.00	0.03	3.35	1.09	1.88	0.00	0.03	3.01
Henrico County	51087	0.560	0.214	0.16	4.20	0.00	0.08	4.44	0.09	2.35	0.00	0.04	2.49
Hopewell, City of	51670	1.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Isle of Wight County	51093	1.000	0.471	1.44	1.05	33.72	0.00	36.21	1.44	1.05	33.72	0.00	36.21
James City County	51095	1.000	0.368	9.63	1.33	0.01	0.00	10.97	9.63	1.33	0.01	0.00	10.97
King and Queen County	51097	1.000	0.949	0.01	0.47	0.00	0.00	0.48	0.01	0.47	0.00	0.00	0.48
King George County	51099	1.000	0.185	0.79	0.23	0.06	0.00	1.08	0.79	0.23	0.06	0.00	1.08
King William County	51101	1.000	0.699	0.53	0.69	19.47	0.01	20.70	0.53	0.69	19.47	0.01	20.70
Lancaster County	51103	1.000	0.474	0.41	0.41	0.00	0.00	0.82	0.41	0.41	0.00	0.00	0.82
Mathews County	51115	1.000	0.941	0.00	0.65	0.00	0.01	0.66	0.00	0.65	0.00	0.01	0.66
Middlesex County	51119	1.000	0.758	0.15	0.56	0.00	0.00	0.71	0.15	0.56	0.00	0.00	0.71
New Kent County	51127	1.000	0.701	0.17	0.71	0.00	0.01	0.89	0.17	0.71	0.00	0.01	0.89
Newport News, City of	51700	1.000	0.000	2.35	0.00	0.00	0.00	2.35	2.35	0.00	0.00	0.00	2.35
Norfolk, City of	51710	1.000	0.000	0.00	0.00	0.22	0.03	0.25	0.00	0.00	0.22	0.03	0.25
Northampton County	51131	1.000	0.652	0.26	0.64	0.05	0.57	1.52	0.26	0.64	0.05	0.57	1.52
Northumberland County	51133	1.000	0.615	0.16	0.57	0.02	0.00	0.75	0.16	0.57	0.02	0.00	0.75
Petersburg, City of	51730	1.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poquoson, City of	51735	1.000	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Portsmouth, City of	51740	1.000	0.000	0.00	0.00	0.42	0.04	1.60	0.00	0.00	0.42	0.04	1.60
Prince George County	51149	1.000	0.410	0.17	1.02	0.00	0.00	1.19	0.17	1.02	0.00	0.00	1.19
Prince William County	51153	0.413	0.247	0.64	5.20	0.10	0.04	5.98	0.26	2.15	0.04	0.02	2.47
Richmond County	51159	1.000	0.633	0.02	0.42	0.00	0.01	0.45	0.02	0.42	0.00	0.01	0.45
Richmond, City of	51760	0.915	0.000	0.00	0.00	0.02	0.06	0.08	0.00	0.00	0.02	0.05	0.07
Southampton County	51175	1.000	0.462	0.50	0.61	5.03	0.00	6.14	0.50	0.61	5.03	0.00	6.14
Spotsylvania County	51177	0.841	0.084	0.00	0.57	0.01	0.00	0.58	0.00	0.48	0.01	0.00	0.49
Stafford County	51179	0.711	0.145	0.00	1.00	0.01	0.01	1.02	0.00	0.71	0.01	0.01	0.73
Suffolk, City of	51800	1.000	0.255	5.39	1.22	0.06	0.00	6.67	5.39	1.22	0.06	0.00	6.67
Surry County	51181	1.000	0.745	0.13	0.38	0.00	0.18	1.00	0.13	0.38	0.00	0.18	1.00
Sussex County	51183	1.000	0.113	0.51	0.11	0.17	0.01	0.80	0.51	0.11	0.17	0.01	0.80
Virginia Beach, City of	51810	1.000	0.097	0.00	3.10	0.01	0.12	3.23	0.00	3.10	0.01	0.12	3.23
Westmoreland County	51193	1.000	0.424	0.91	0.53	0.02	0.04	1.50	0.91	0.53	0.02	0.04	1.50
Williamsburg, City of	51830	1.000	0.000	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01
York County	51199	1.000	0.798	0.07	3.37	0.00	0.00	3.44	0.07	3.37	0.00	0.00	3.44
Totals	---	---	0.156	33.06	48.31	62.85	2.64	148.31	32.34	38.54	62.56	2.46	137.36

Data for localities partially within the Coastal Plain are calculated from the proportion of the locality population within the Coastal Plain. Localities for which well data was collected for this study are not shaded in grey.

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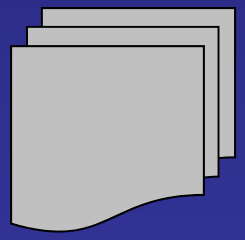
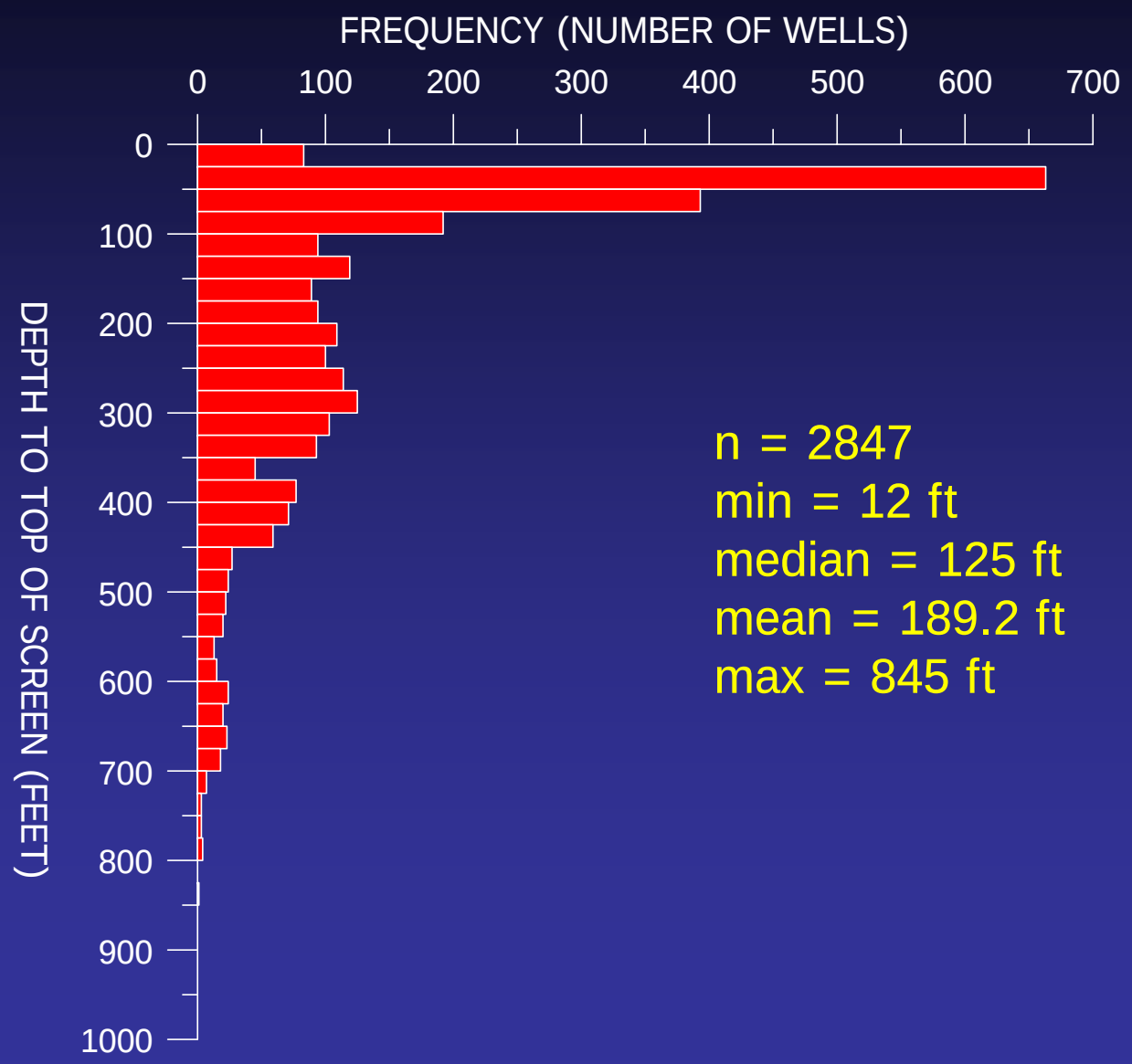
Construction Data for Private Domestic Wells

- ✓ Individual Homeowners
- ✓ Well Drillers
- ✓ Virginia DEQ (State Water Control Board)
- ✓ Virginia Department of Health
- ✓ Local Health Departments



- Well or Screen Depth
- No Well-Head or Screen Elevation
- No Aquifer Information
- No Digital Data (paper records only)

HISTOGRAM OF DOMESTIC WELLS DEPTHS IN THE VIRGINIA COASTAL PLAIN



n = 2847
min = 12 ft
median = 125 ft
mean = 189.2 ft
max = 845 ft

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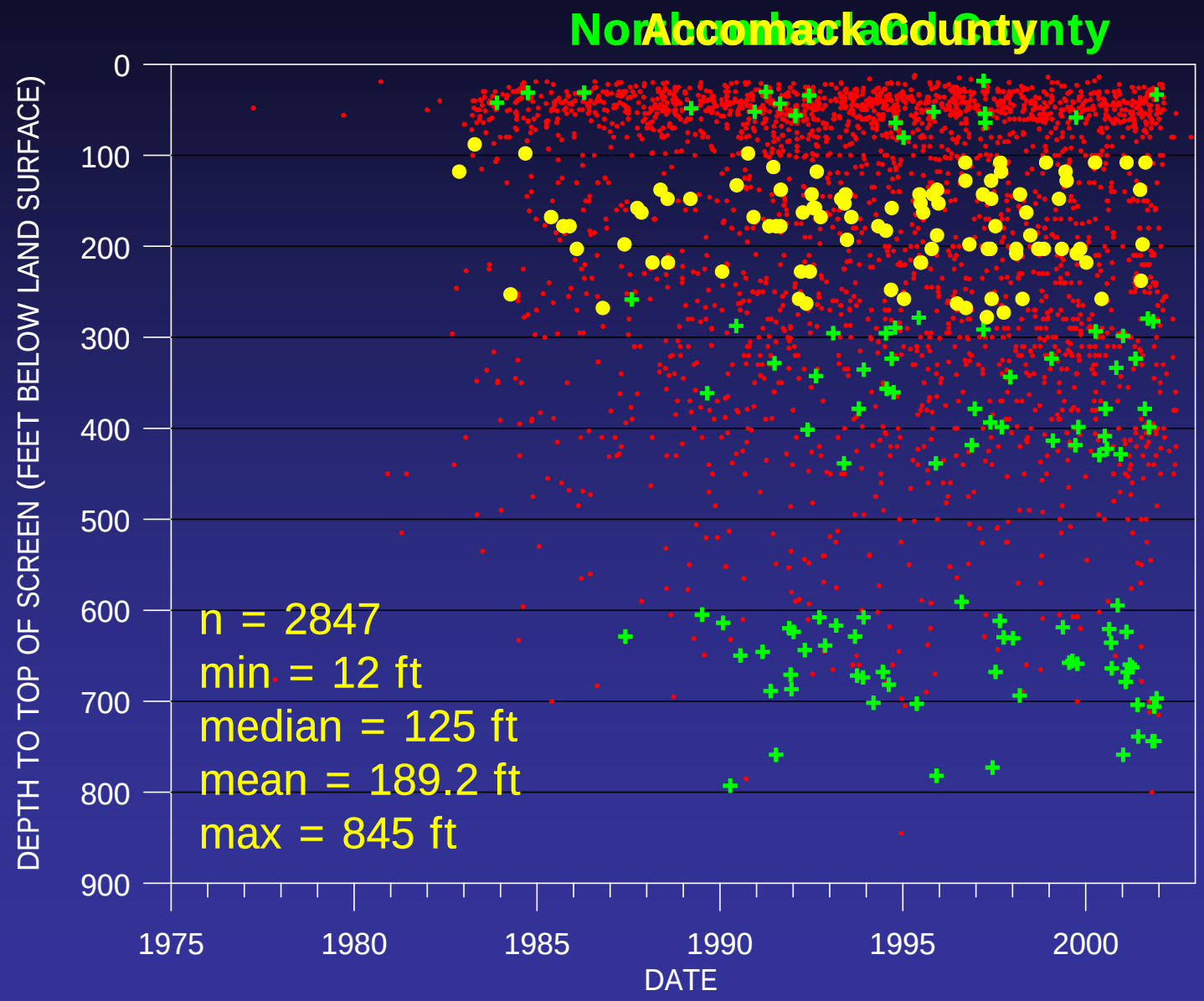
DEPTHS AND INSTALLATION DATES OF DOMESTIC WELLS SAMPLED IN THE VIRGINIA COASTAL PLAIN



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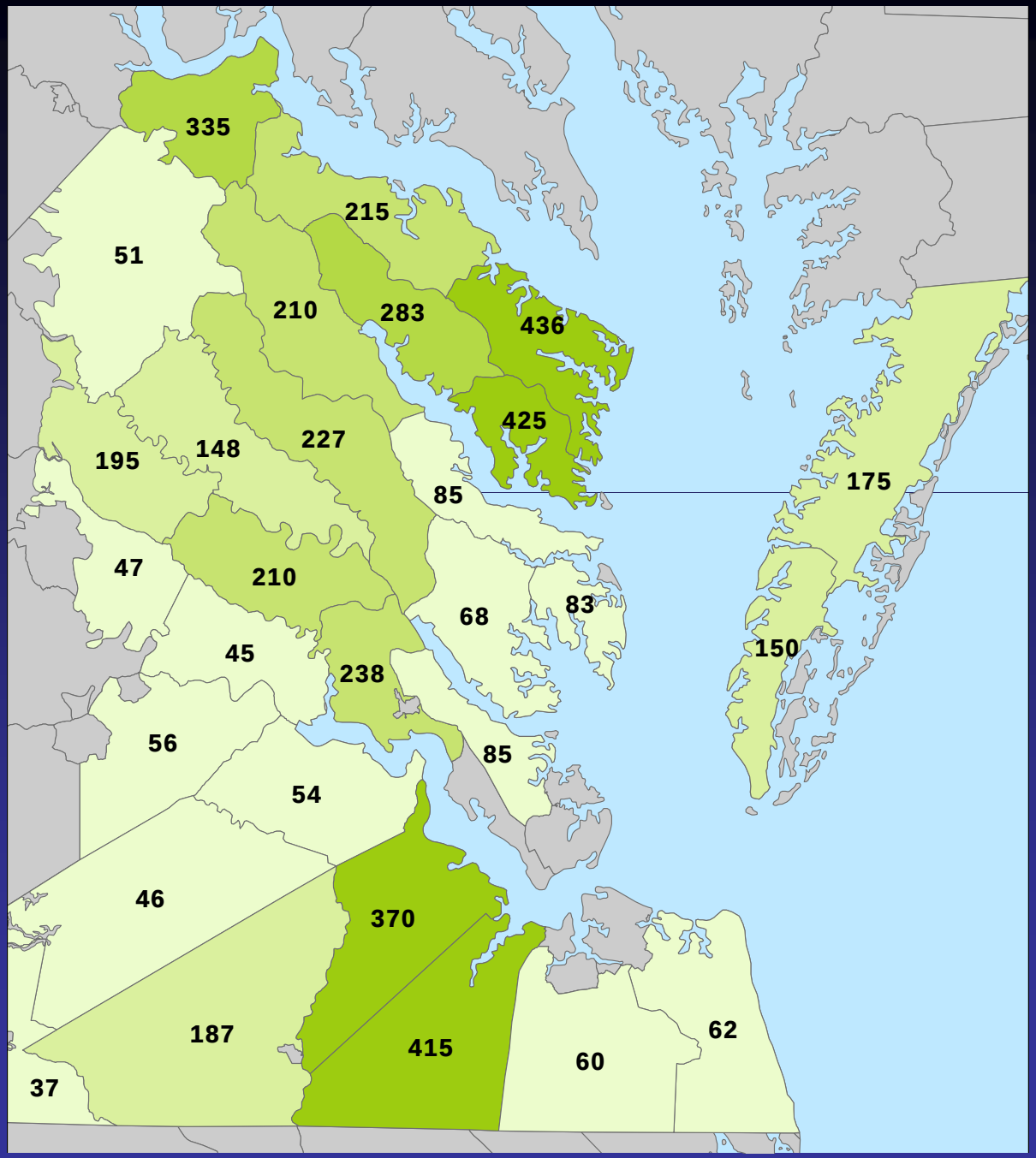

MEDIAN DEPTHS OF DOMESTIC WELLS FOR THE COASTAL PLAIN COUNTIES OF VIRGINIA

Depth in Feet

USGS
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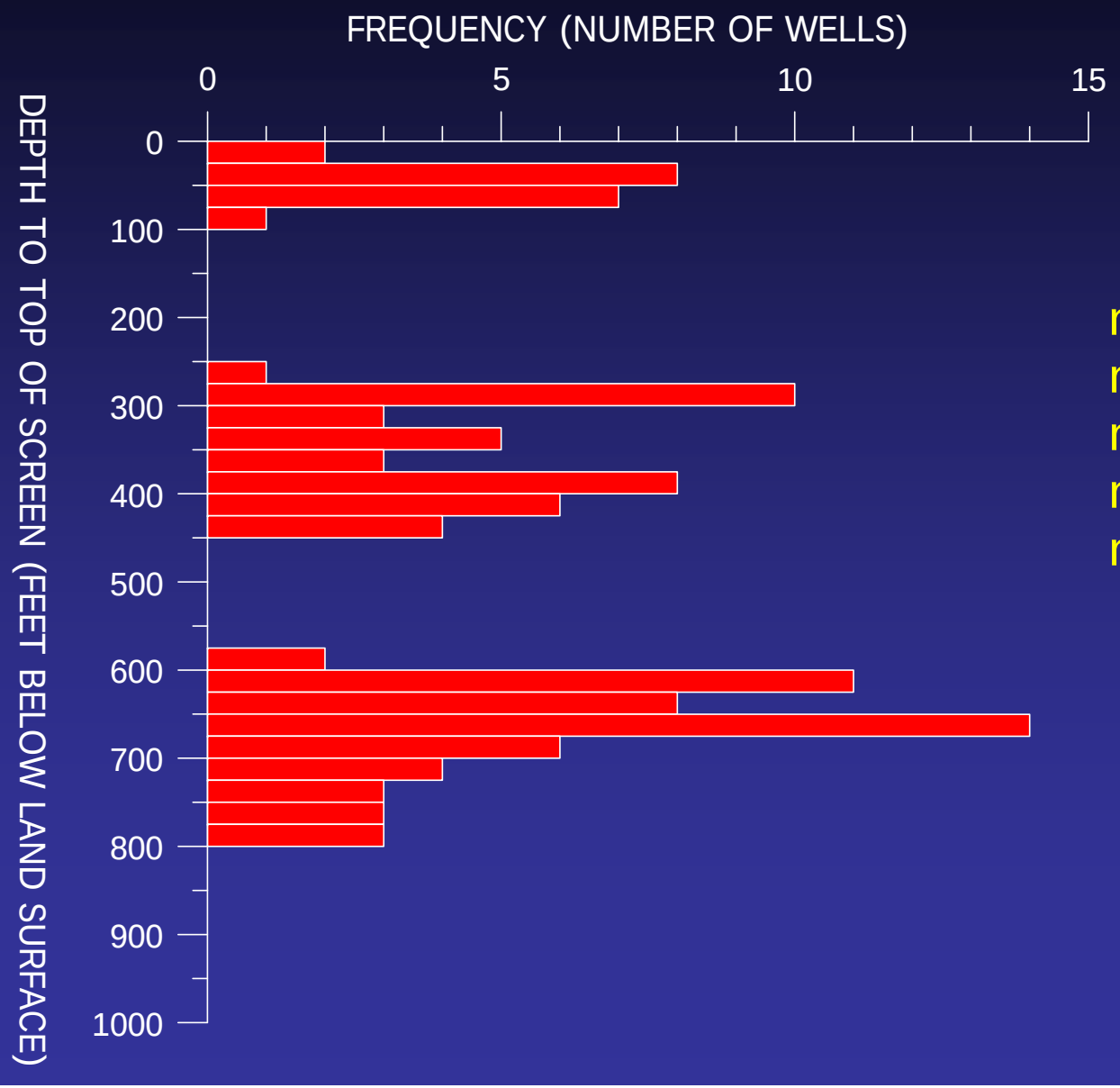
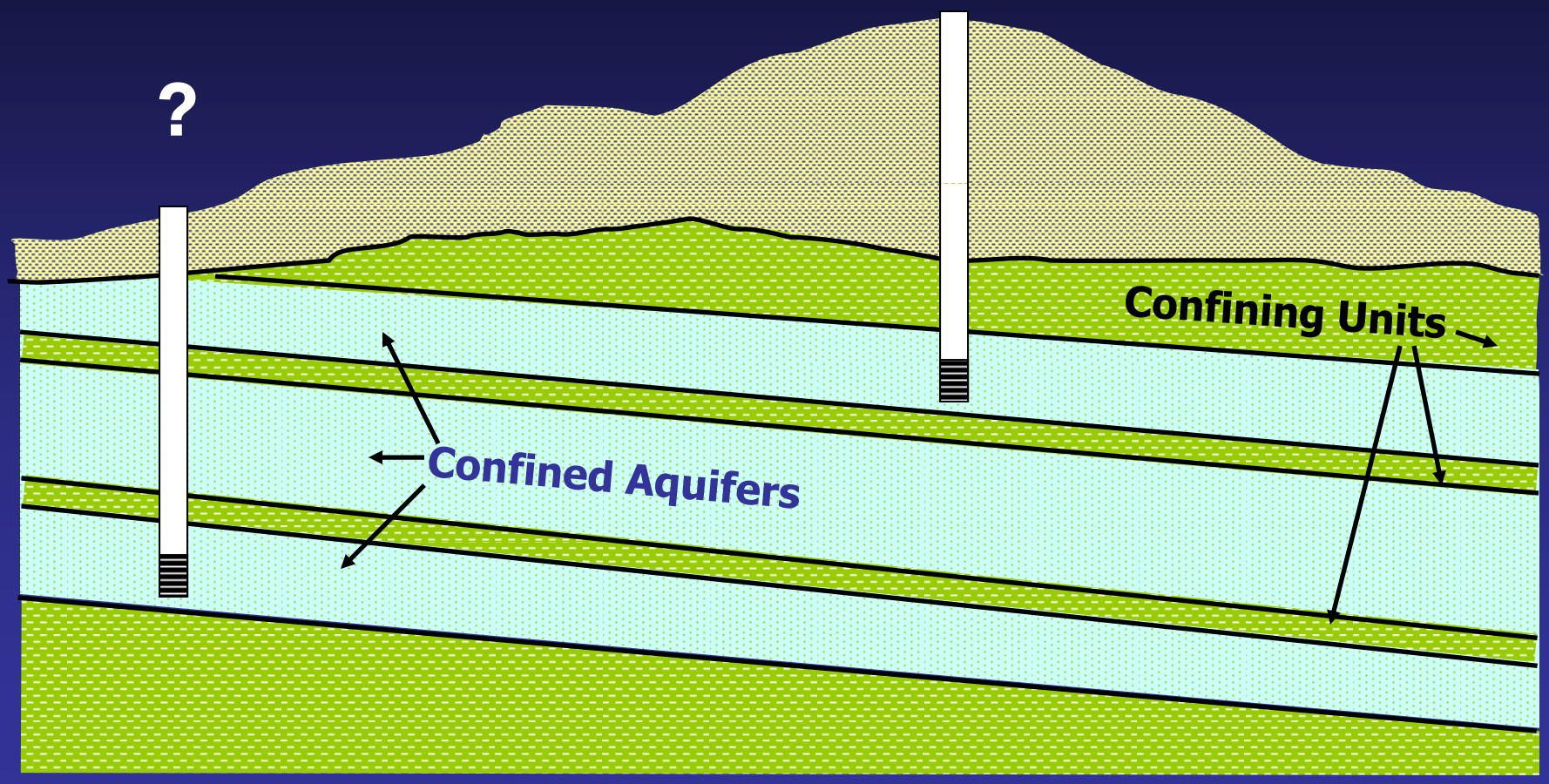
HISTOGRAM OF DOMESTIC WELLS DEPTHS IN NORTHUMBERLAND COUNTY

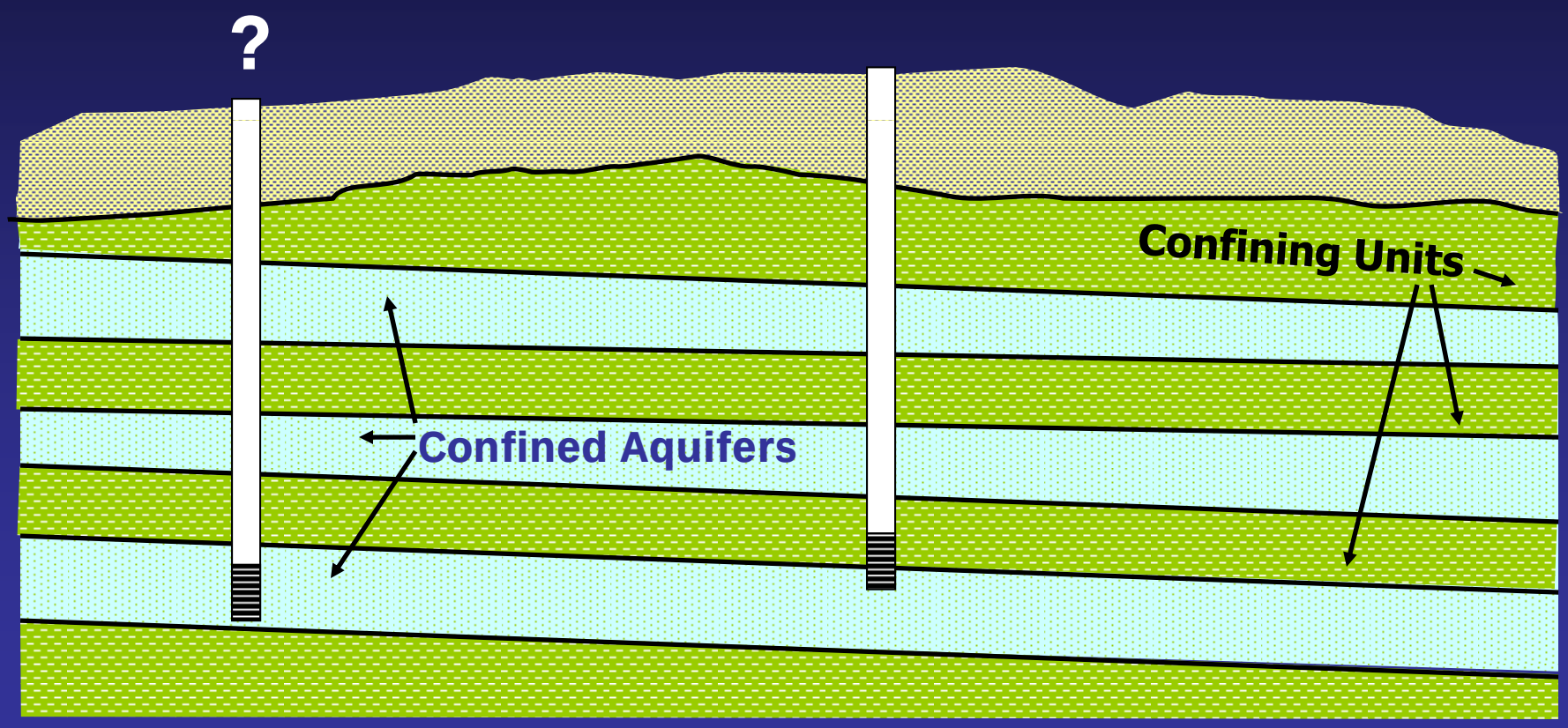


n = 115
min = 20
median = 435.5
mean = 459.2
max = 794

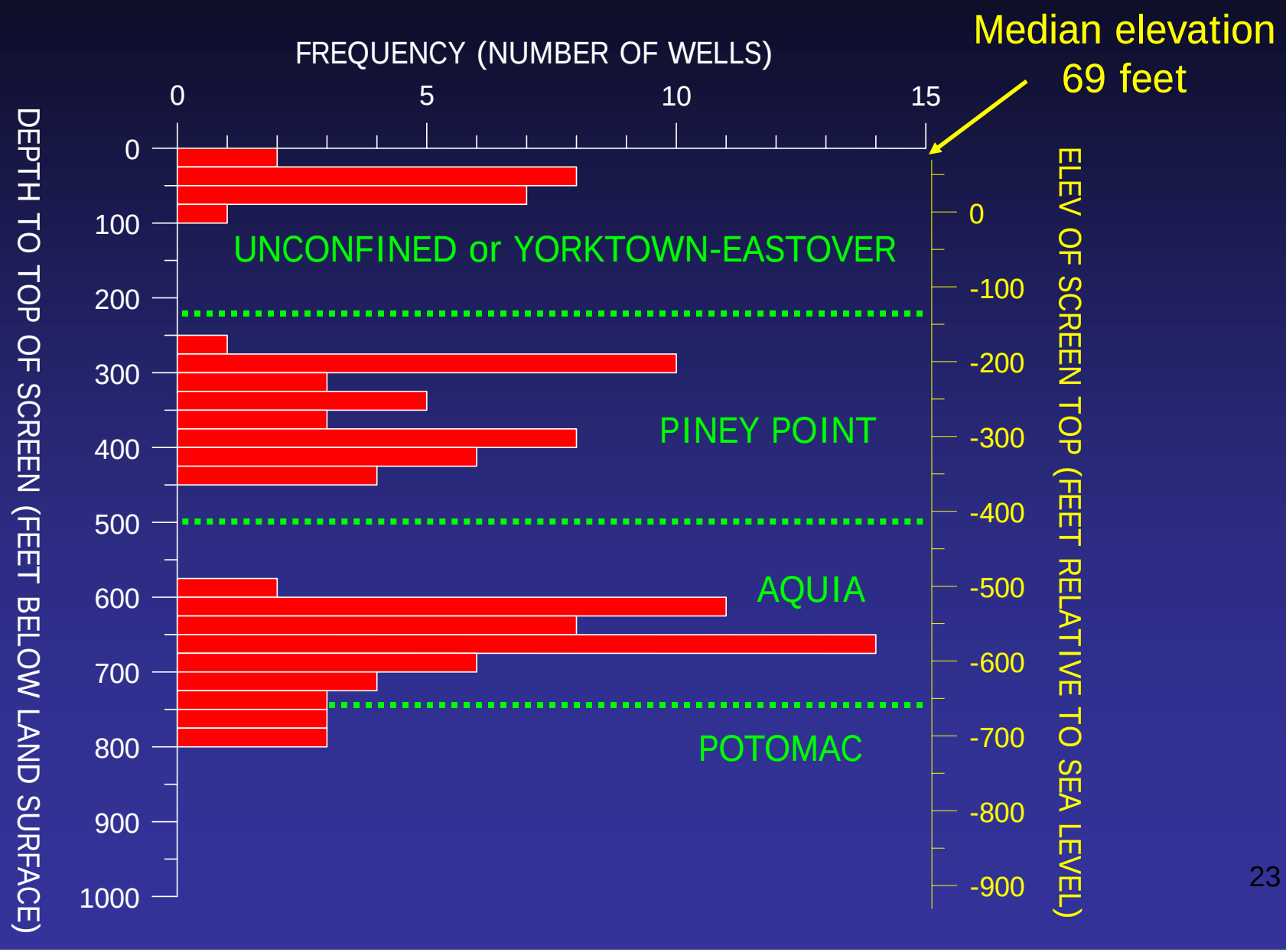
WHY WELL ELEVATION AND LOCATION INFORMATION IS IMPORTANT FOR WITHDRAWAL ALLOCATION



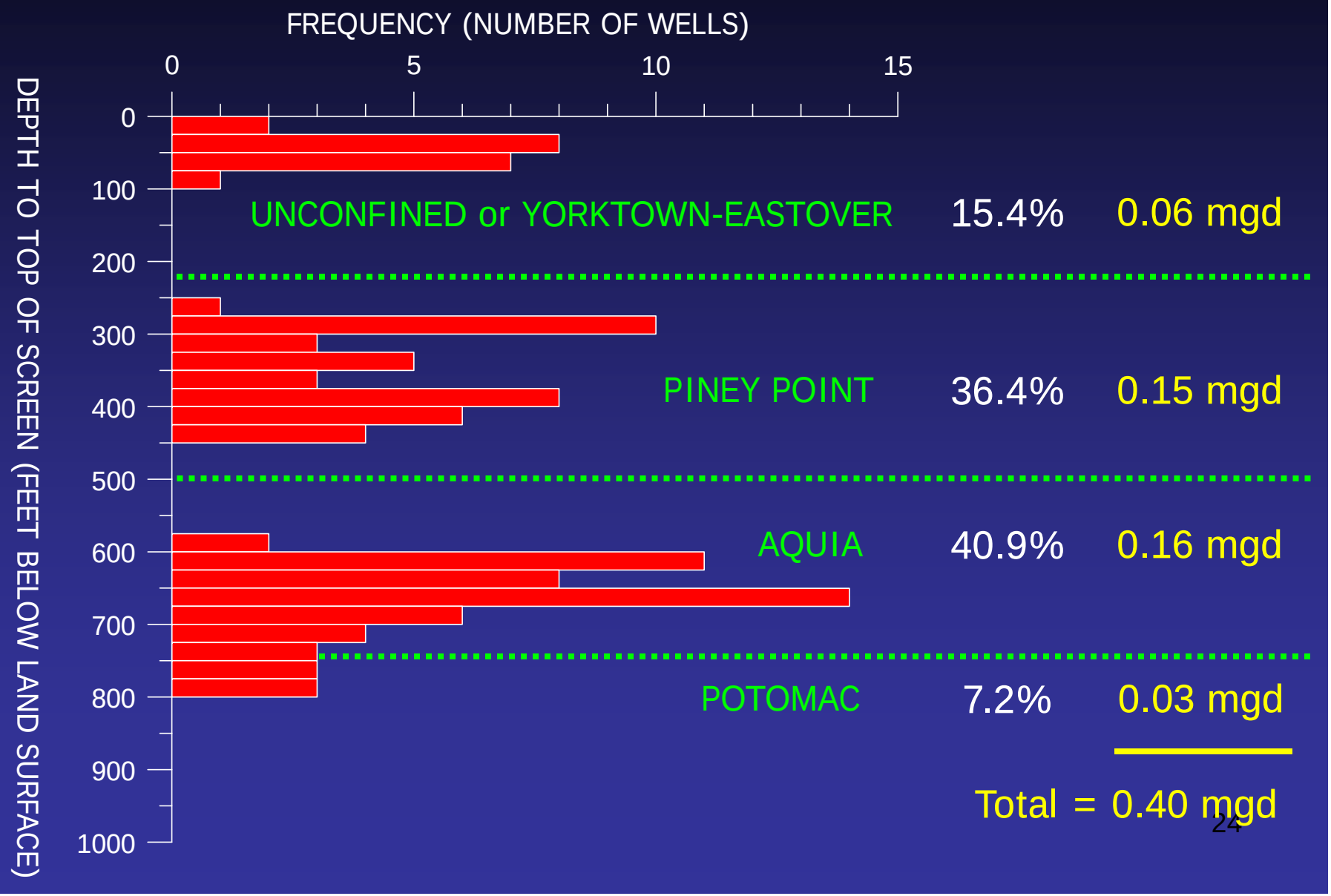
WHY WELL ELEVATION AND LOCATION INFORMATION IS IMPORTANT FOR WITHDRAWAL ALLOCATION



DOMESTIC WELLS DEPTHS IN NORTHUMBERLAND COUNTY



DOMESTIC WELLS DEPTHS IN NORTHUMBERLAND COUNTY



Estimated Proportion of Domestic Wells by Aquifer for Virginia Coastal Plain Localities

Locality	Sample Number	SURF	YTCZ	YEAQ	SMAQ	PPAQ	AQAQ	VBAQ	POCZ	POAQ	BSMT
Accomack County	96	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Caroline County	122	0.754	0.000	0.000	0.000	0.000	0.033	0.000	0.057	0.148	0.008
Charles City County	81	0.654	0.000	0.000	0.000	0.025	0.123	0.000	0.012	0.185	0.000
Chesapeake, City of	103	0.068	0.097	0.825	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Essex County	95	0.389	0.000	0.000	0.000	0.105	0.337	0.000	0.032	0.137	0.000
Gloucester County	96	0.000	0.073	0.865	0.000	0.063	0.000	0.000	0.000	0.000	0.000
Greensville County	51	0.759	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.241
Hanover County	110	0.427	0.000	0.000	0.000	0.000	0.073	0.000	0.036	0.464	0.000
Henrico County	90	0.656	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.333	0.000
Isle of Wight County	123	0.057	0.187	0.016	0.000	0.008	0.073	0.000	0.016	0.642	0.000
James City County	72	0.000	0.014	0.097	0.000	0.278	0.472	0.000	0.000	0.139	0.000
King and Queen County	109	0.303	0.037	0.000	0.000	0.303	0.257	0.000	0.009	0.092	0.000
King George County	101	0.129	0.000	0.000	0.000	0.000	0.129	0.000	0.050	0.693	0.000
King William County	107	0.449	0.000	0.000	0.000	0.028	0.234	0.000	0.019	0.271	0.000
Lancaster County	97	0.206	0.031	0.021	0.000	0.237	0.124	0.000	0.000	0.381	0.000
Mathews County	106	0.019	0.009	0.972	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Middlesex County	102	0.078	0.206	0.373	0.000	0.127	0.108	0.000	0.000	0.108	0.000
New Kent County	98	0.153	0.000	0.000	0.000	0.194	0.418	0.000	0.010	0.224	0.000
Northampton County	115	0.122	0.000	0.878	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northumberland County	110	0.055	0.091	0.009	0.000	0.336	0.073	0.000	0.018	0.418	0.000
Prince George County	102	0.000	0.010	0.696	0.000	0.000	0.000	0.000	0.078	0.216	0.000
Richmond County	93	0.194	0.000	0.000	0.000	0.484	0.312	0.000	0.000	0.011	0.000
Southampton County	123	0.195	0.008	0.033	0.000	0.000	0.024	0.000	0.089	0.650	0.000
Suffolk, City of	101	0.089	0.218	0.030	0.030	0.000	0.020	0.050	0.238	0.327	0.000
Surry County	107	0.000	0.262	0.346	0.000	0.000	0.047	0.000	0.075	0.271	0.000
Sussex County	86	0.000	0.442	0.349	0.000	0.000	0.000	0.000	0.012	0.198	0.000
Virginia Beach, City of	96	0.240	0.146	0.615	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Westmoreland County	113	0.372	0.000	0.000	0.000	0.133	0.398	0.000	0.018	0.080	0.000
York County	38	0.000	0.000	0.737	0.000	0.263	0.000	0.000	0.000	0.000	0.000
Total		0.217	0.065	0.264	0.001	0.083	0.113	0.002	0.029	0.222	0.005

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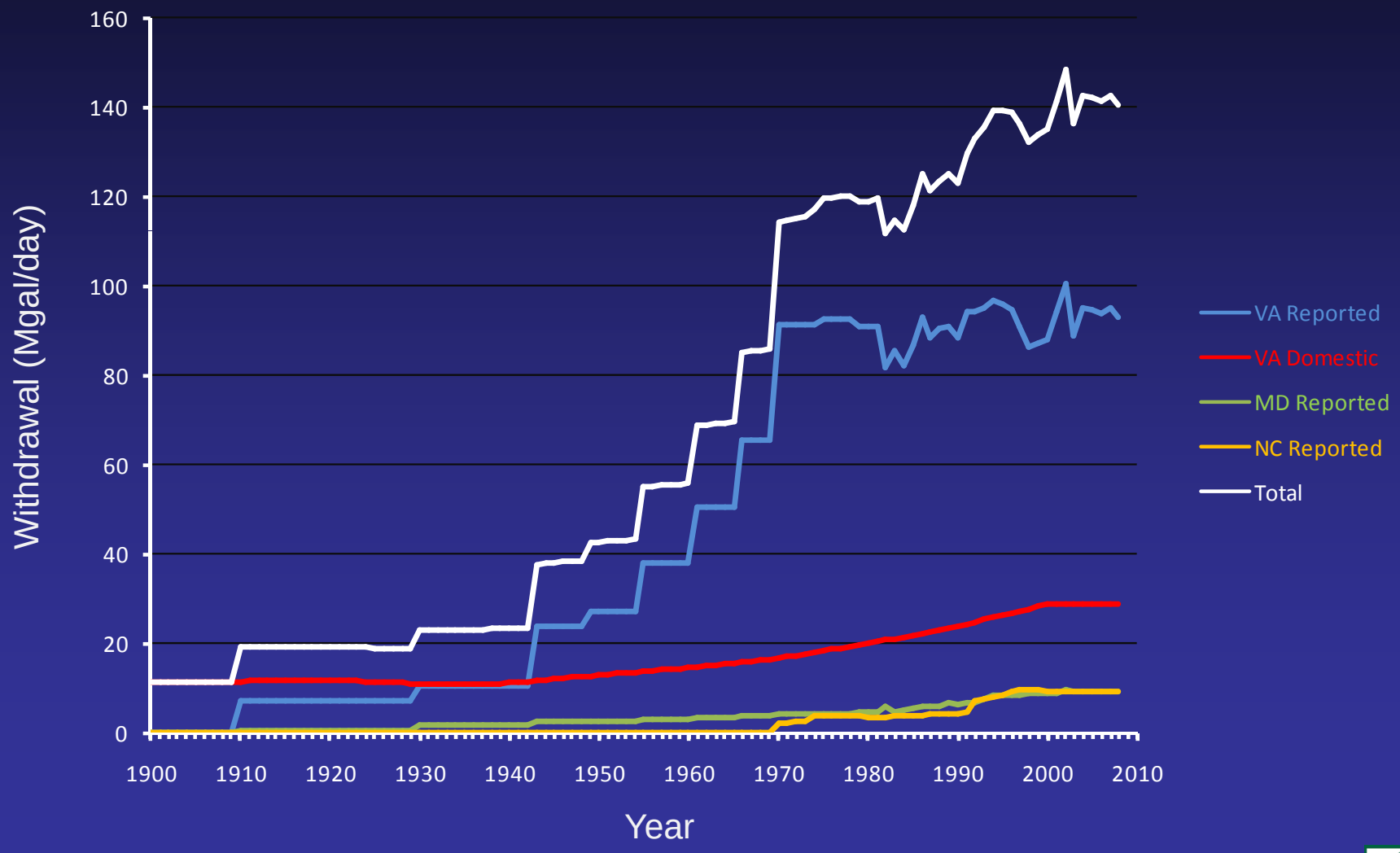
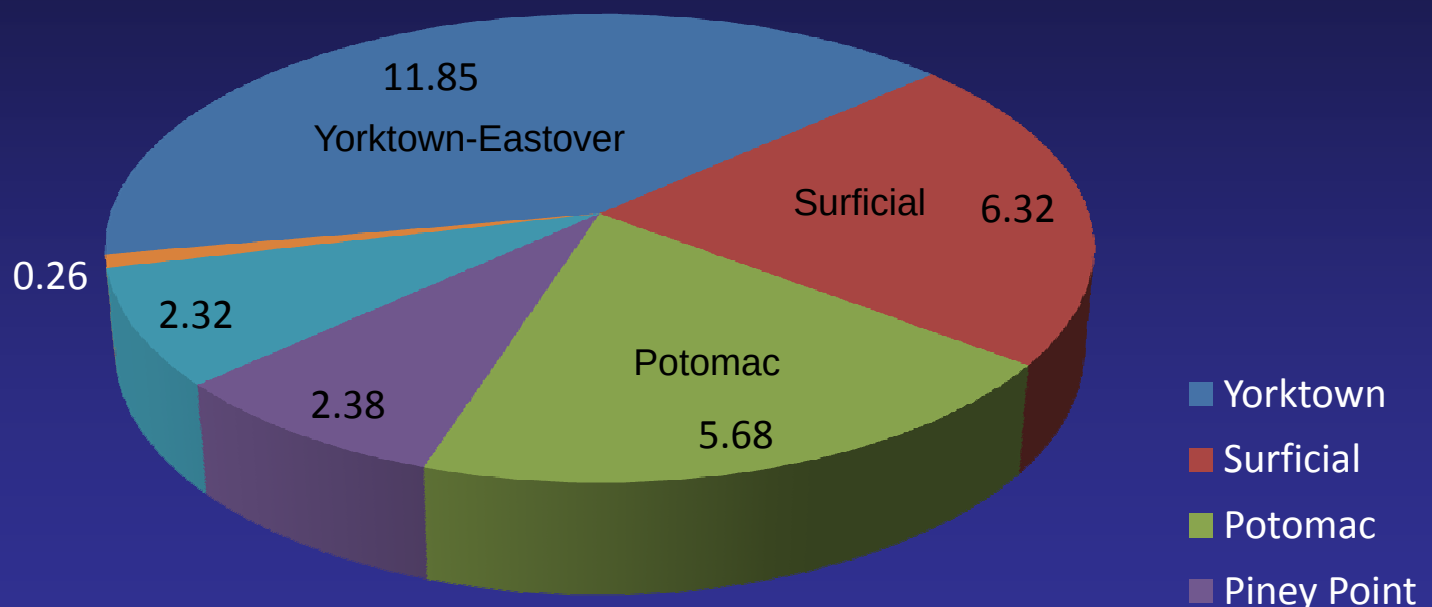
Reported and Estimated Withdrawals for Virginia Coastal Plain Groundwater Model

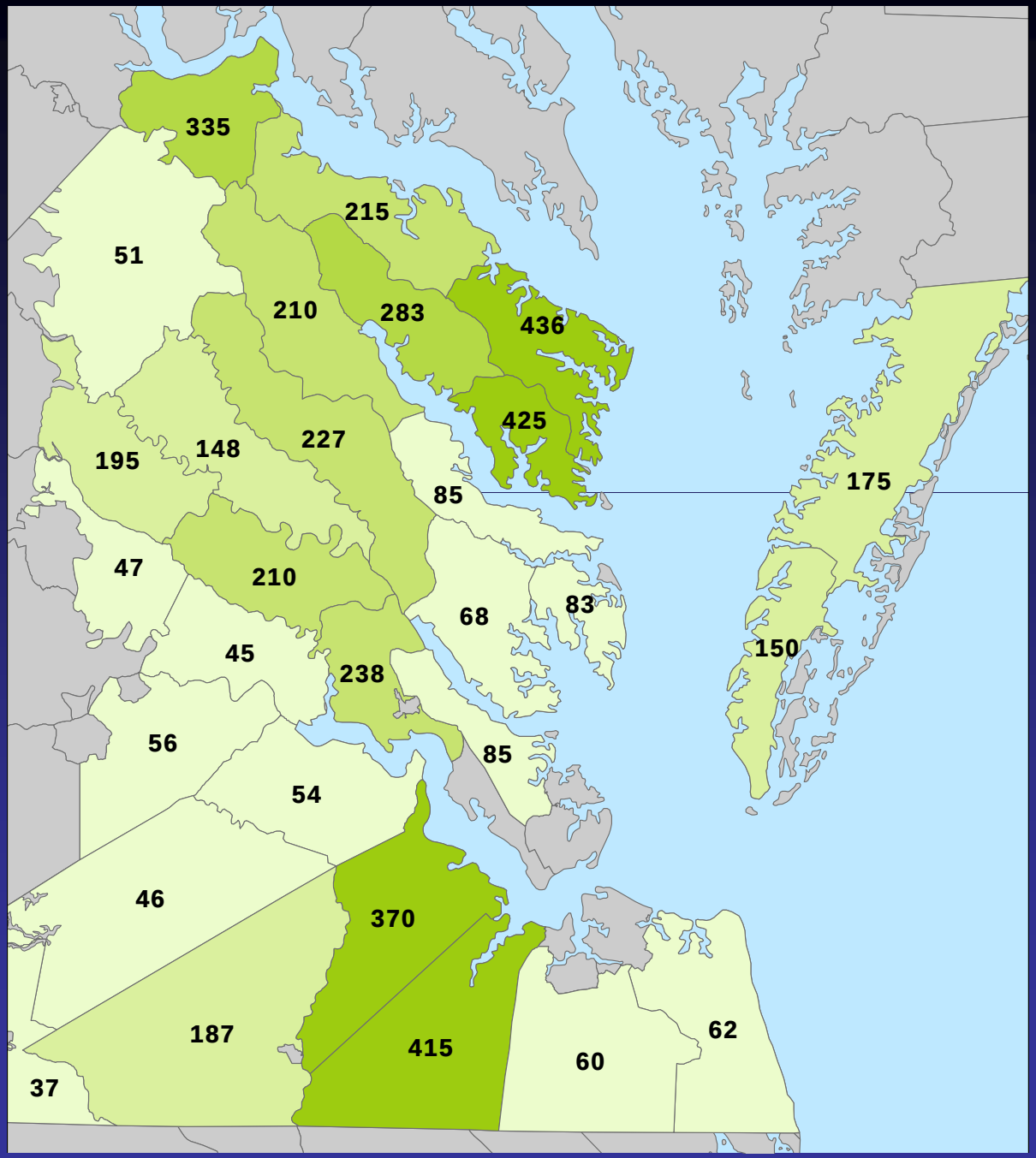


ESTIMATED 2003 Domestic Withdrawals in Virginia by Aquifer for Virginia Coastal Plain Groundwater Model

withdrawal values in Mgal/day



28.8 Mgal/day = 24% of Virginia Withdrawal Total in 2003



MEDIAN DEPTHS OF DOMESTIC WELLS FOR THE COASTAL PLAIN COUNTIES OF VIRGINIA

Depth in Feet

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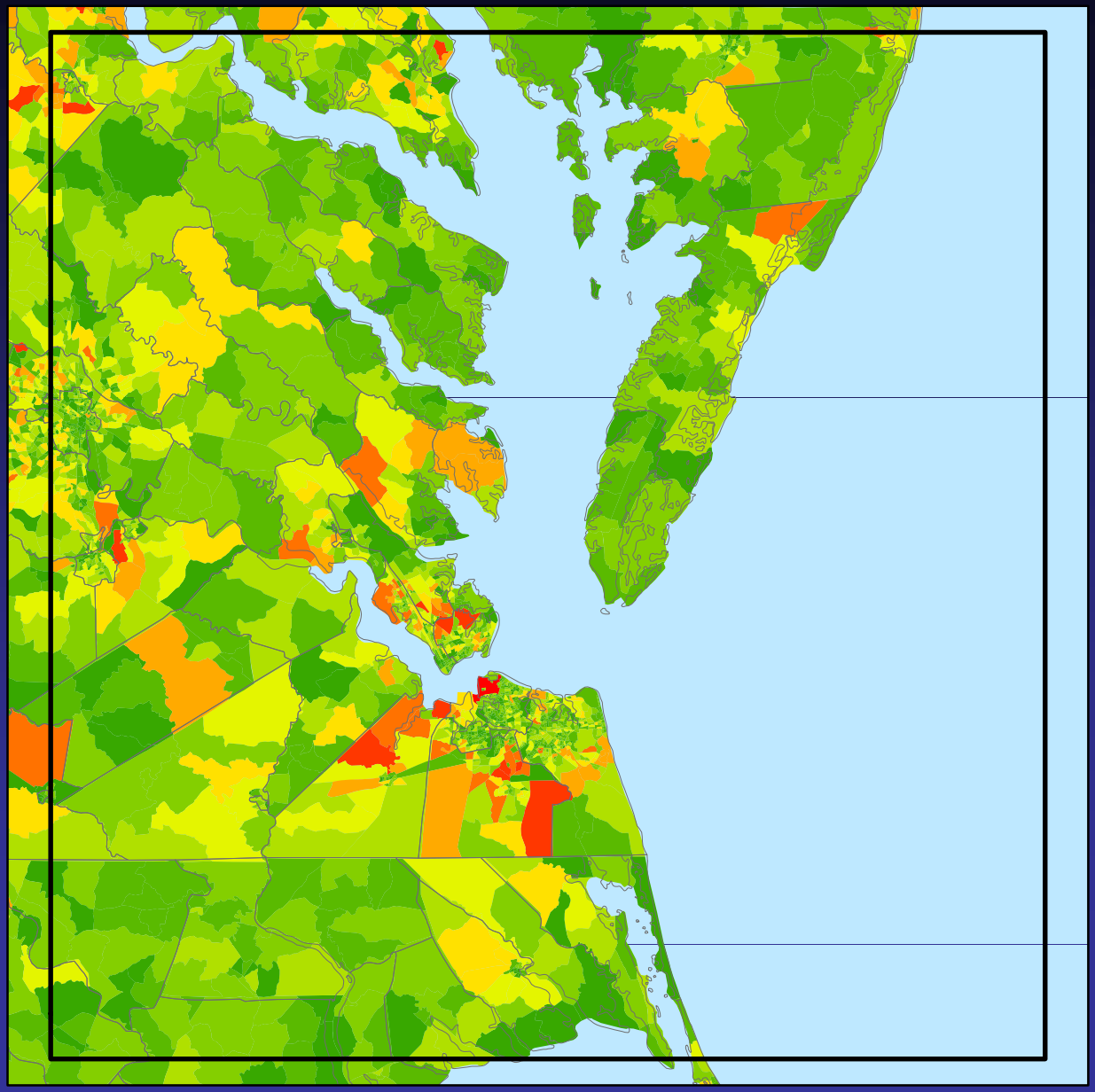
2000 Population by CBG for Ground-Water Model Domain



Number of People

- 0 - 768
- 769 - 1099
- 1100 - 1455
- 1456 - 1870
- 1871 - 2380
- 2381 - 3067
- 3068 - 4088
- 4089 - 5860
- 5861 - 10018
- 10019 - 20877

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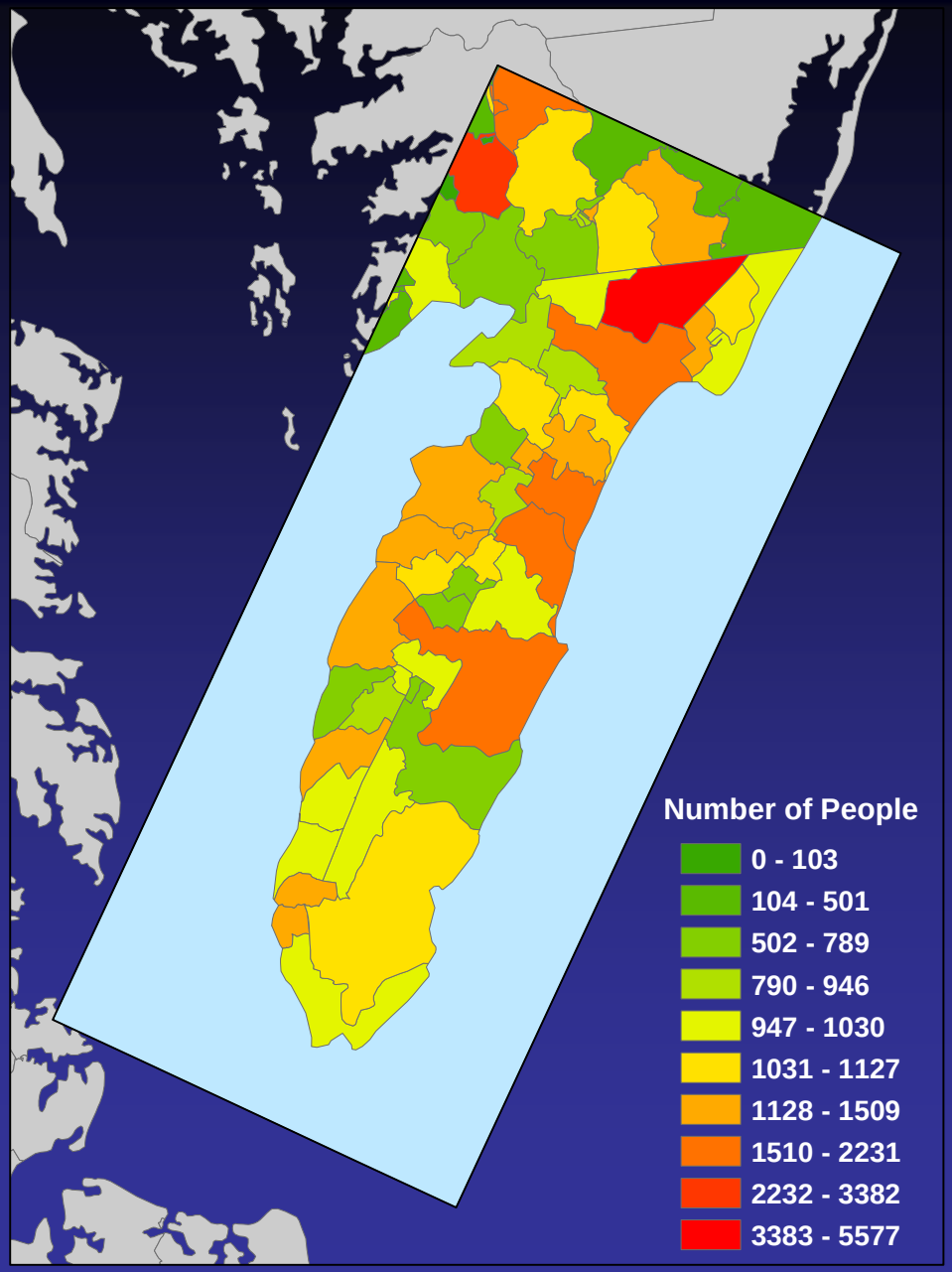

Eastern Shore Ground-Water Model: 2000 Population by Census Block Group

Total number of people in model domain = 73267

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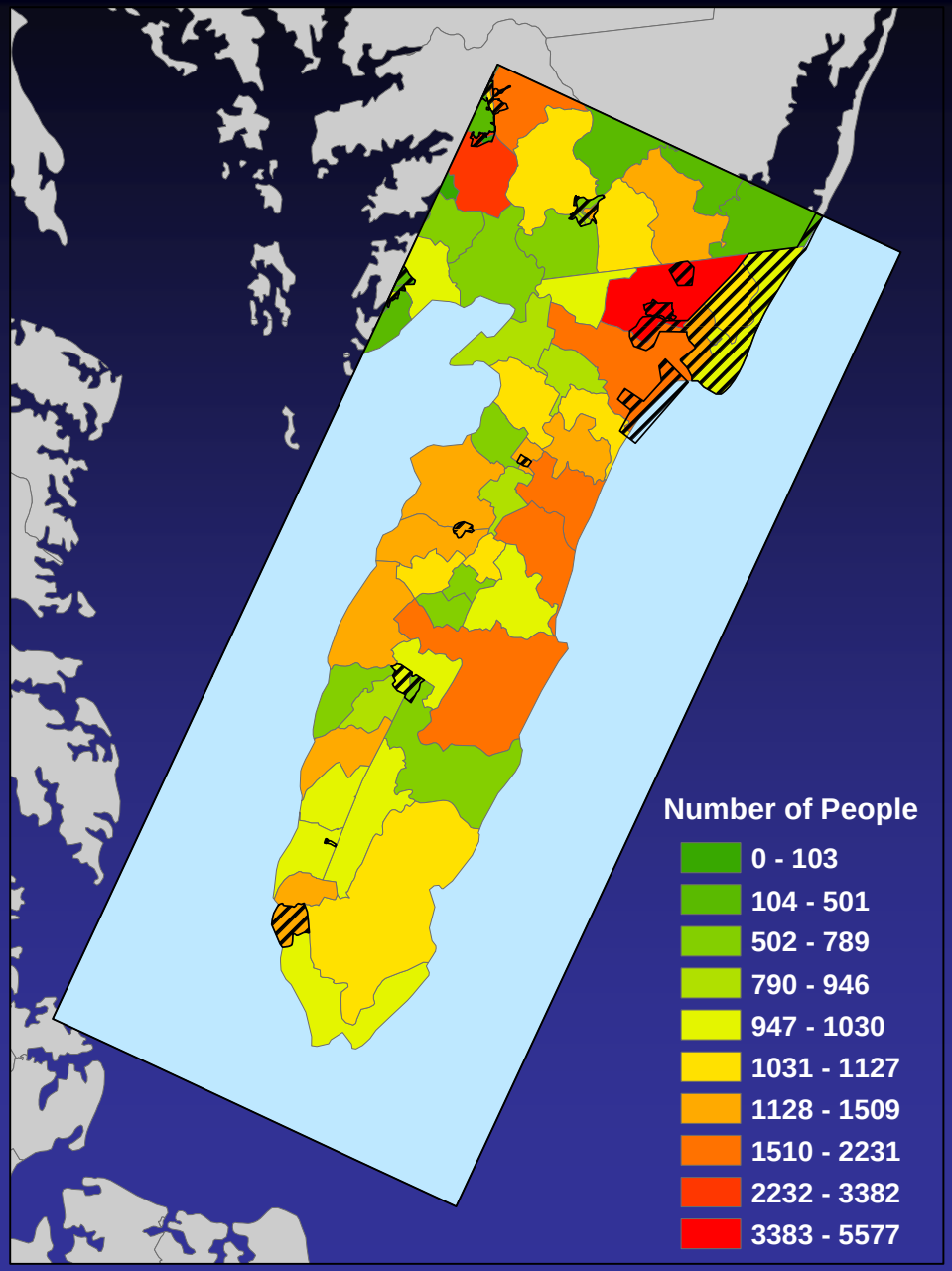

Eastern Shore Ground-Water Model: 2000 Population by Census Block Group, with Approximate Public Water Supply Areas Shaded

Estimated Domestic Self-Supply Population = 49,894

Estimated Public-Supply Population = 23,373

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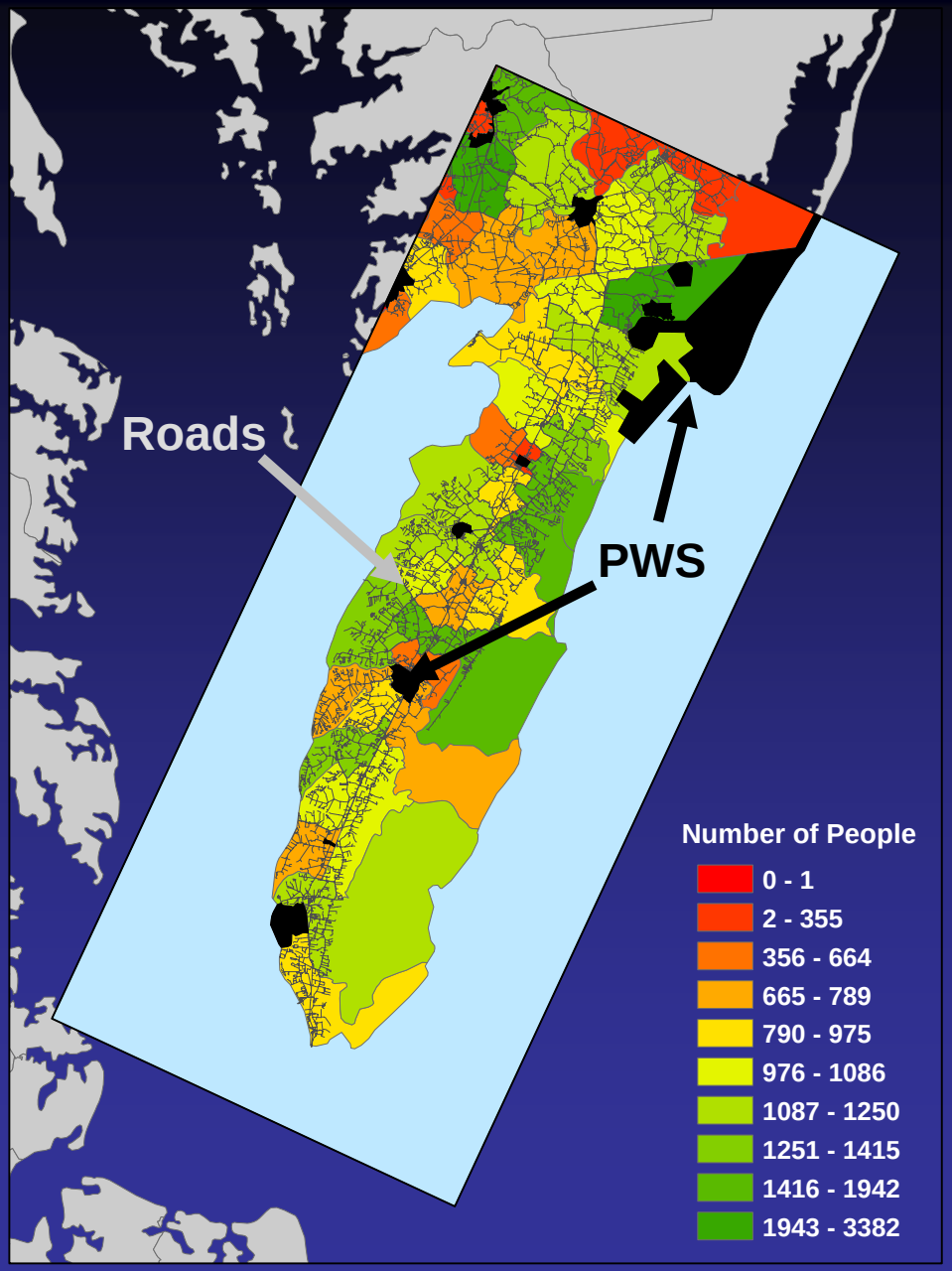

Eastern Shore Ground-Water Model: 2000 Census Block Groups:

Population Self-Supplied with Domestic Ground-Water

Roads in gray

Public-supply areas in black

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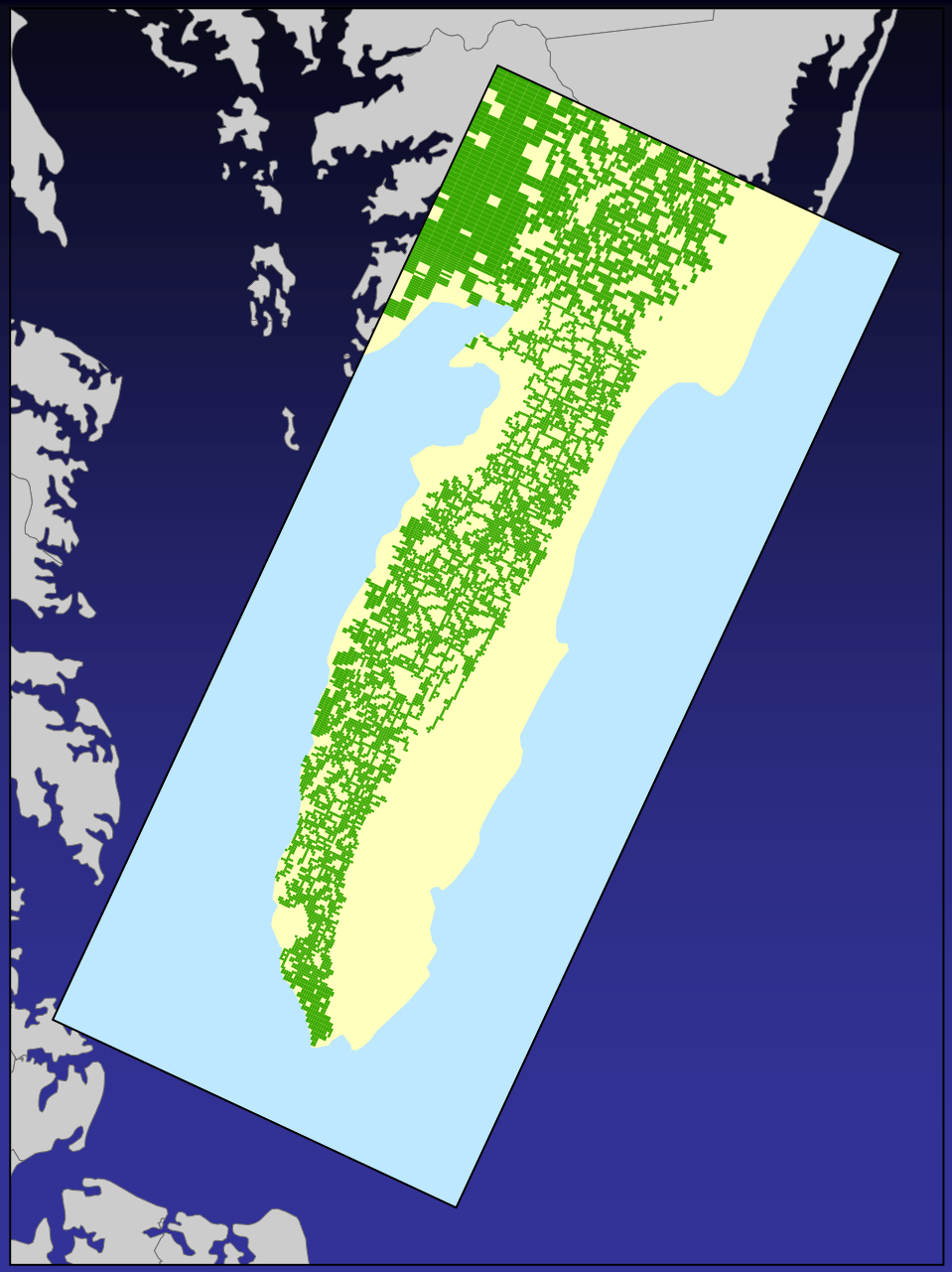
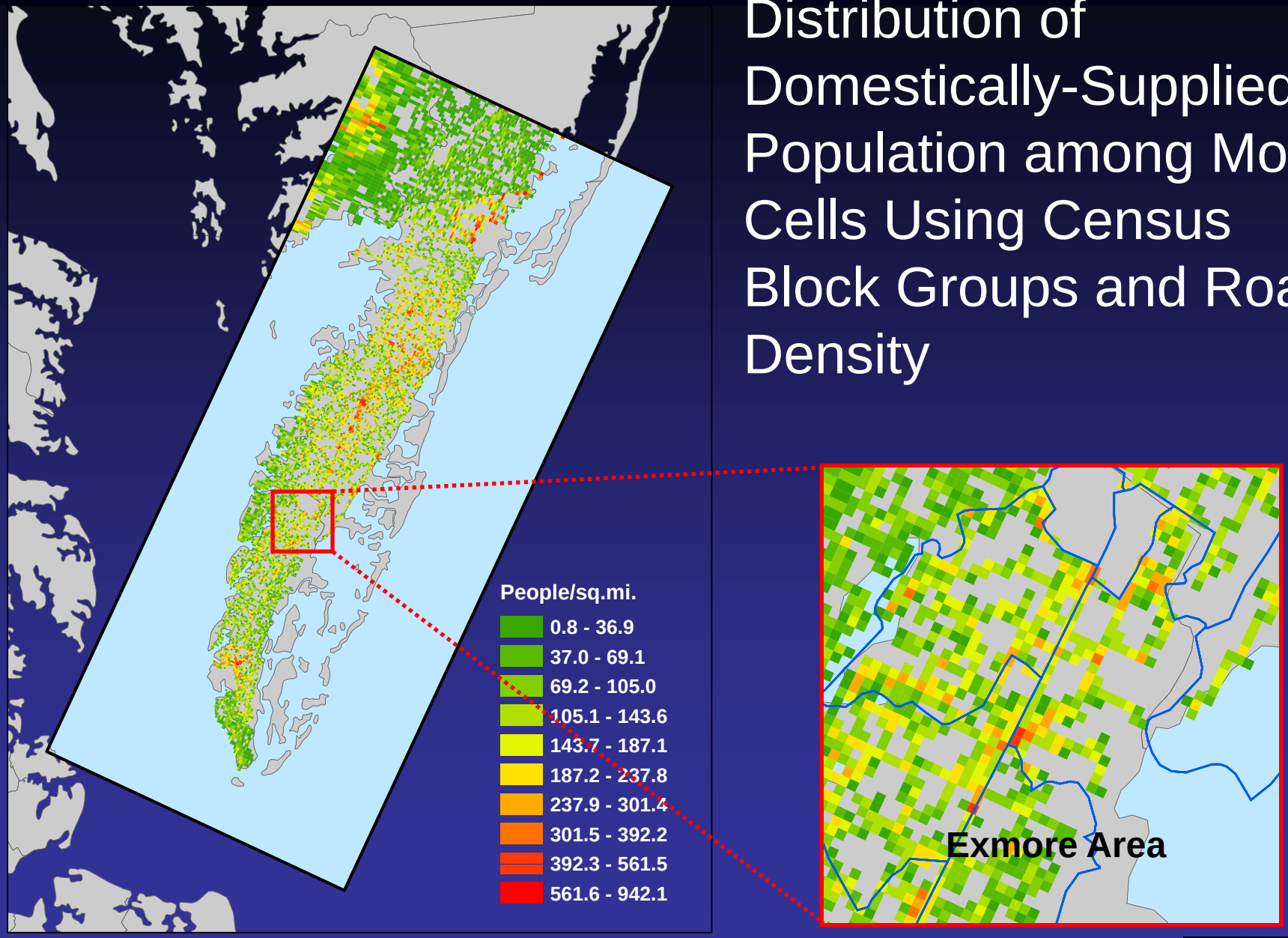


Eastern Shore Ground-Water Model:

Self-Supplied Domestic Model Cells with Roads

8908 Cells contain roads and are located outside Public Water Supply areas

Distribution of Domestically-Supplied Population among Model Cells Using Census Block Groups and Road Density



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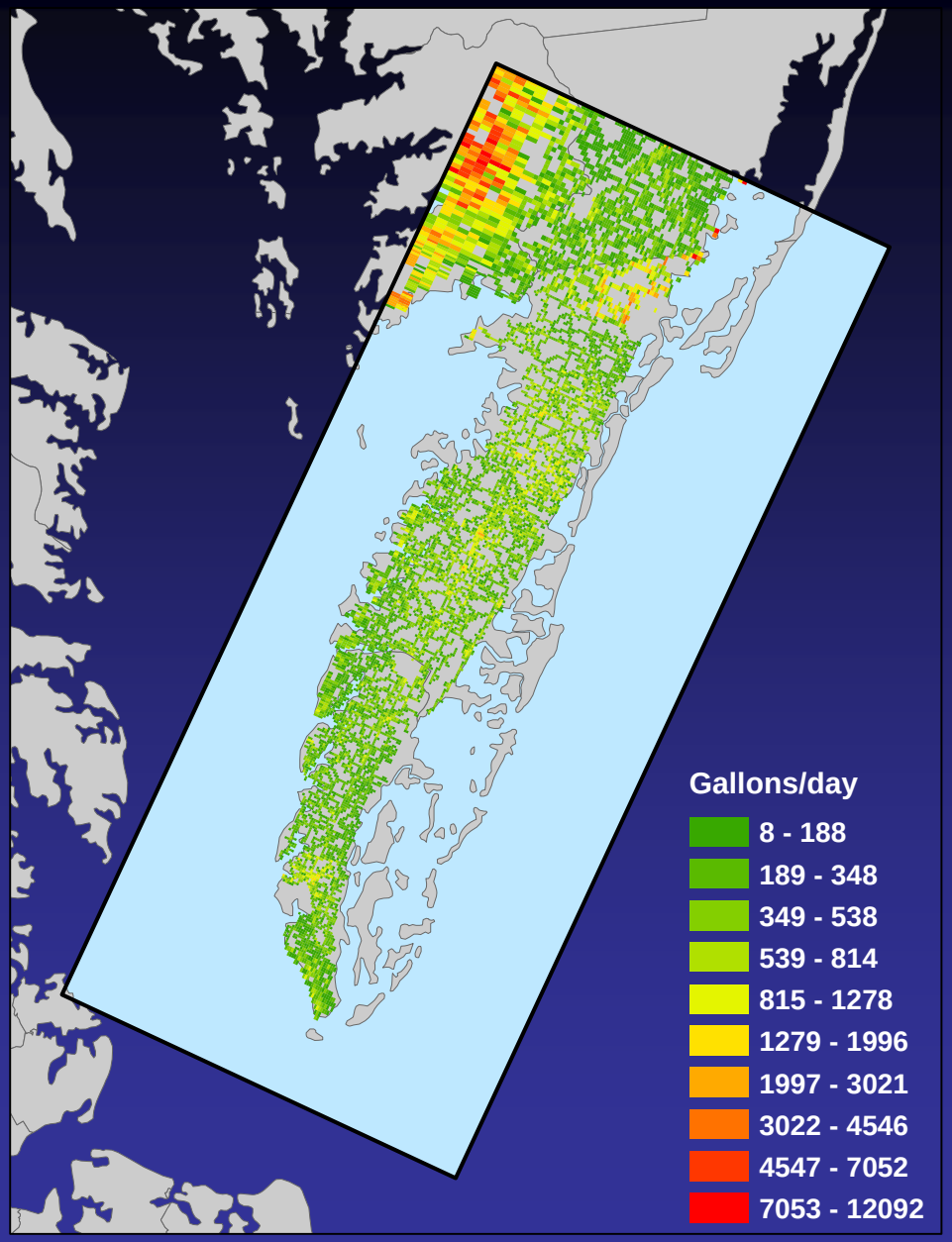

Distribution of Self-Supplied Domestic Ground-Water Withdrawals by Eastern Shore Model Cell

Total Self-Supplied Domestic Withdrawals = 3.74 Mgal/day

Withdrawal by County

Sommerset	0.71 Mgal/day
Worcester	0.30 Mgal/day
Accomac	2.00 Mgal/day
Sommerset	0.74 Mgal/day

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In general, the domestic self-supplied population and withdrawal rate for each model grid cell is calculated as follows:

Census Block Group Population − Publicly-supplied population in the CBG (from EPA Community Water Systems data) X Area % of CBG in Model Domain = Domestic self-supplied population in the CBG

Domestic self-supplied population in the CBG X Normalized street-density factor for each model grid cell in CBG but not in publicly-supplied area. = Domestic self-supplied population in the Model Grid Cell

Domestic self-supplied population in the Model Grid Cell X Per-capita domestic withdrawal rate (75 gal/day for Virginia) = Domestic withdrawal rate for each Model Grid Cell

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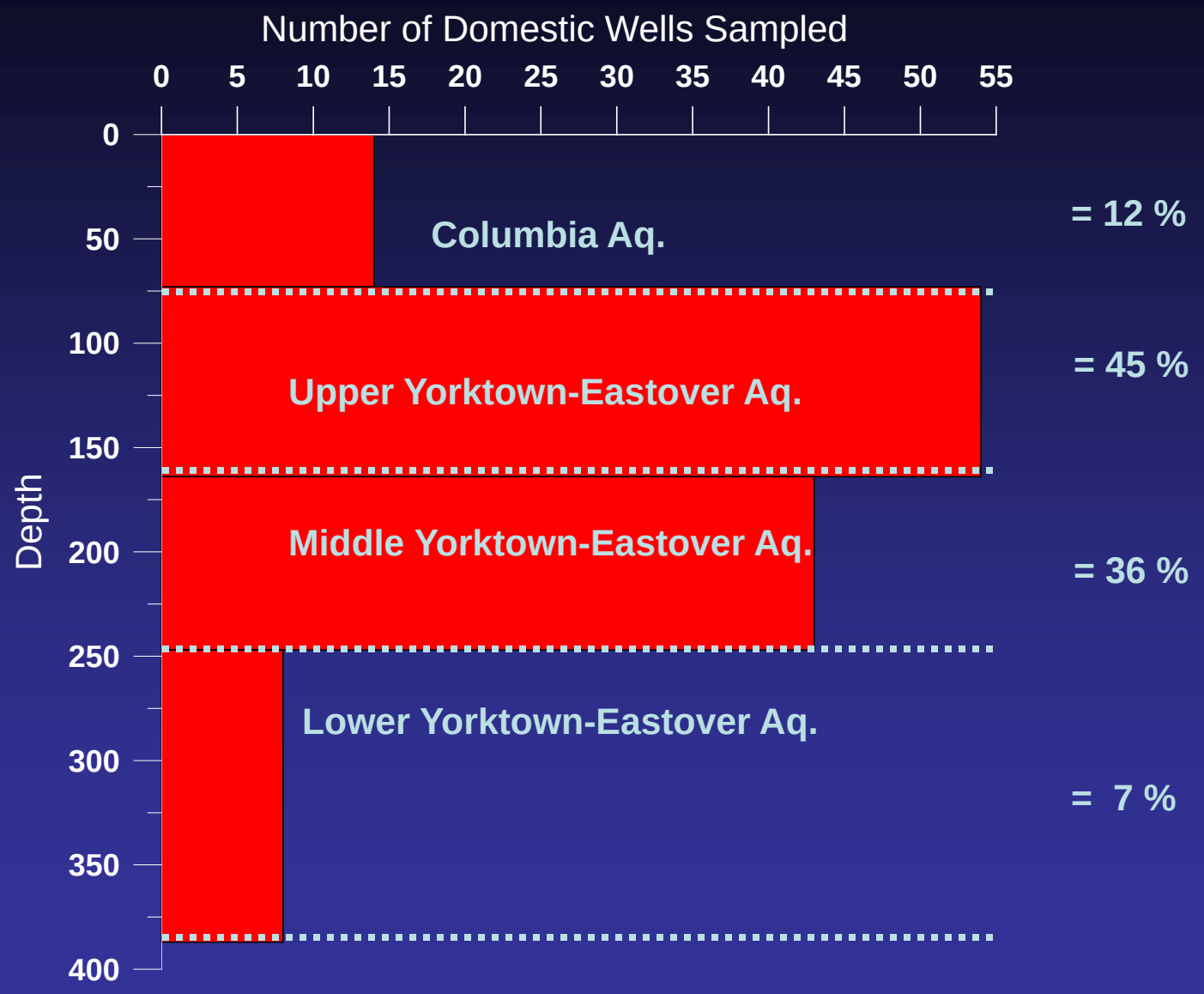
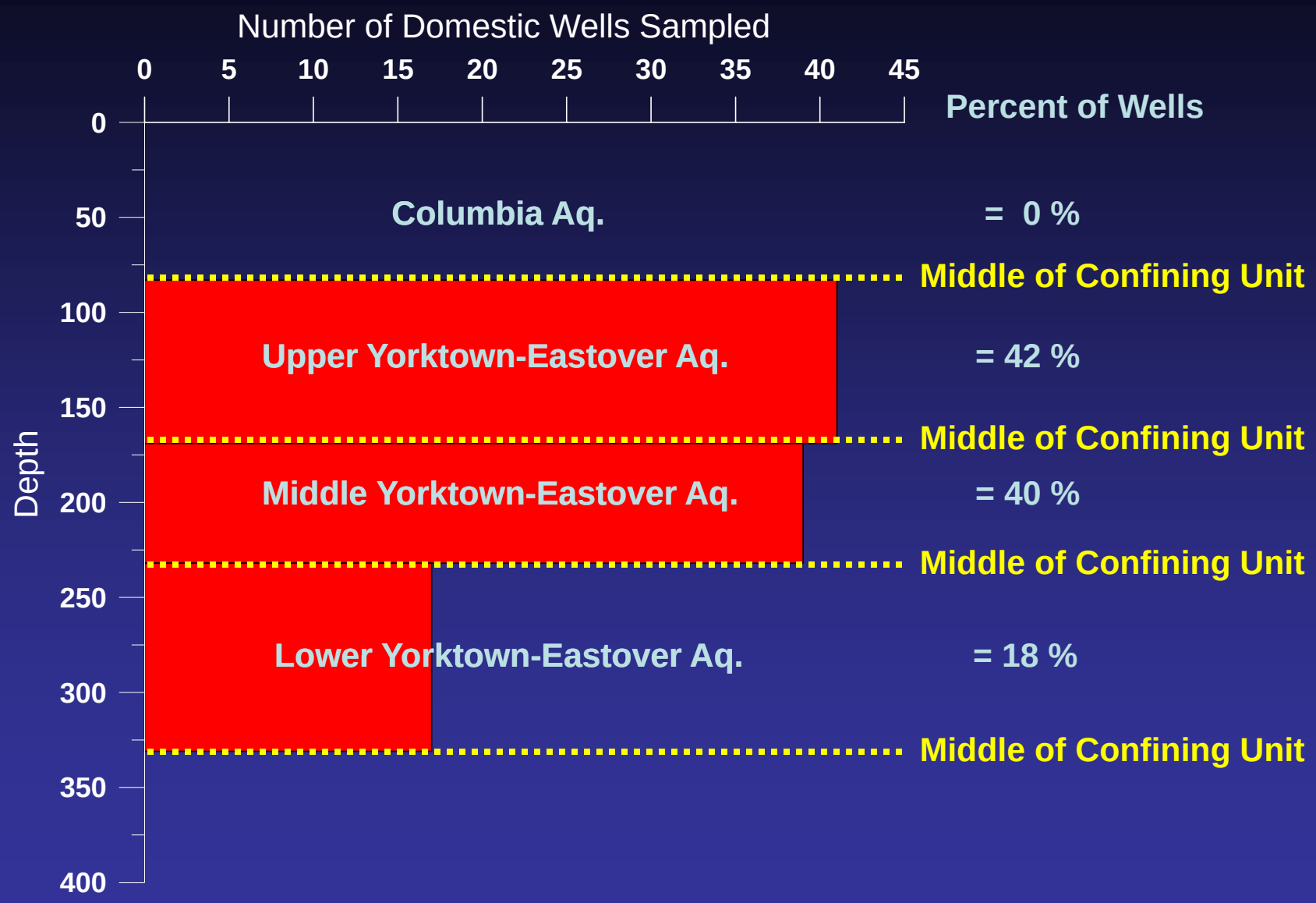
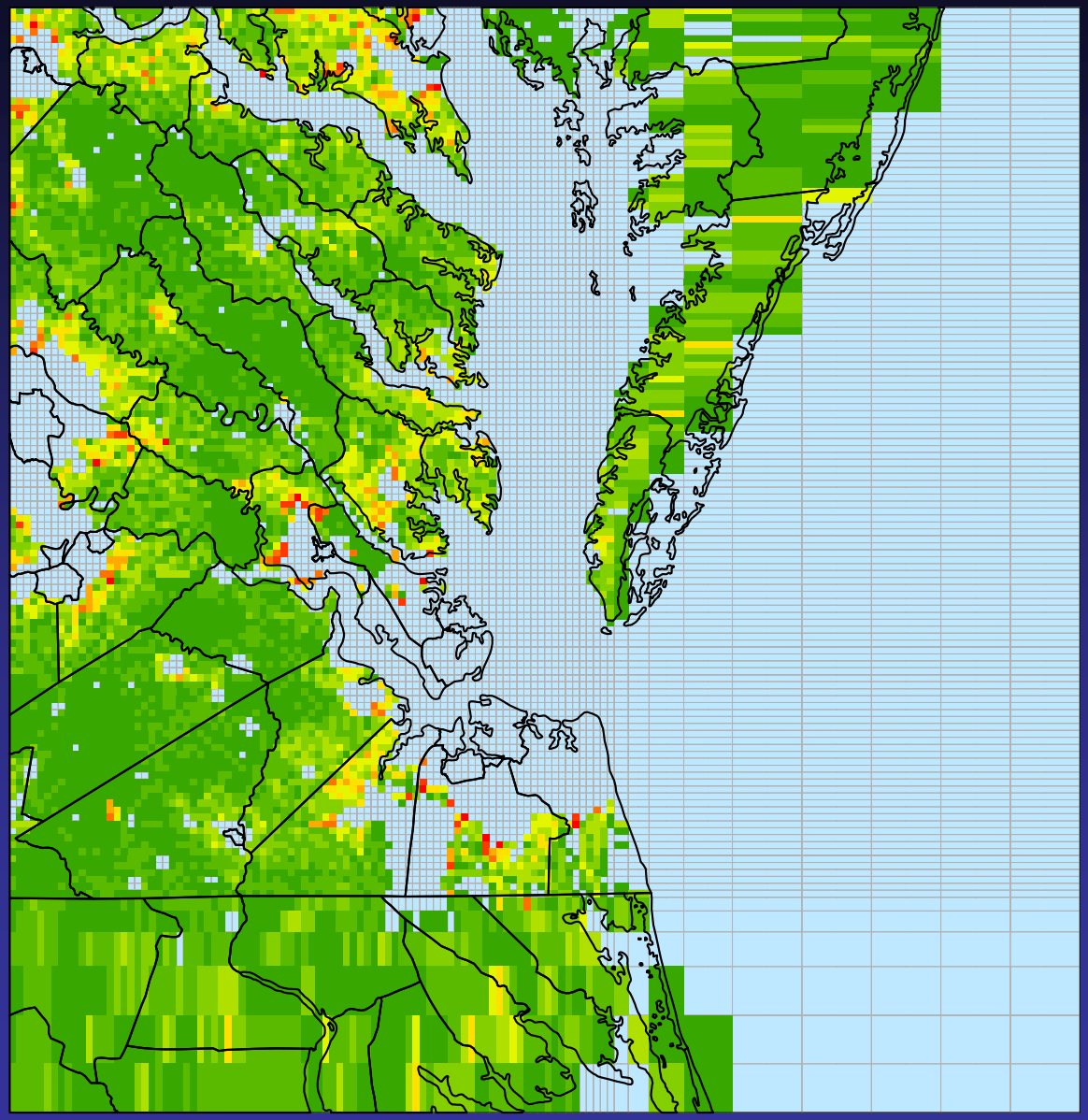
Domestic Wells by Aquifer for Northampton County



Domestic Wells by Aquifer for Accomack County



Coastal Plain Ground-Water Model
2000 Domestic Supply Population by Model Grid Cell



People/Sq. Mi.

- 1 - 26
- 27 - 53
- 54 - 88
- 89 - 134
- 135 - 192
- 193 - 260
- 261 - 347
- 348 - 459
- 460 - 630
- 631 - 1094

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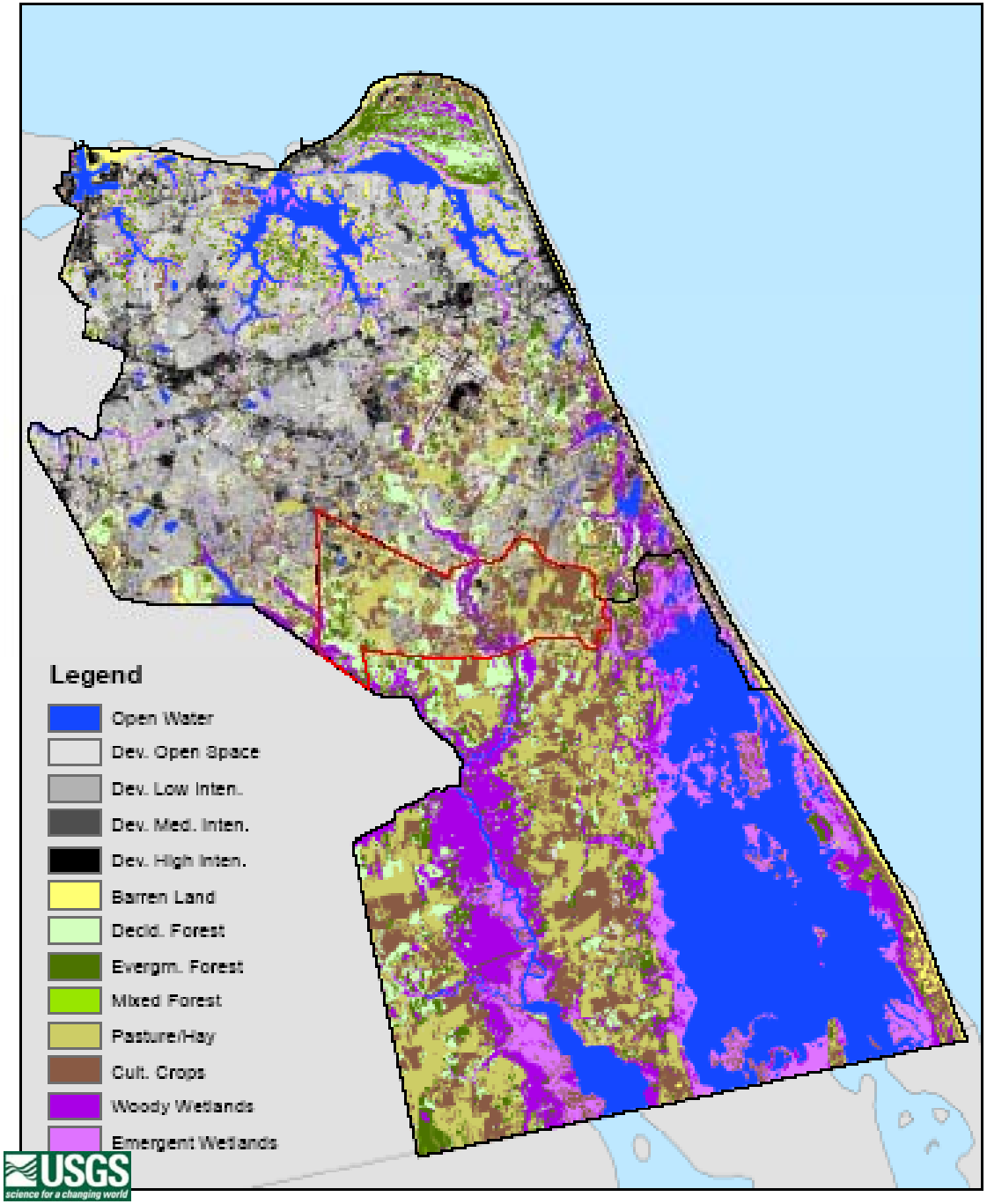
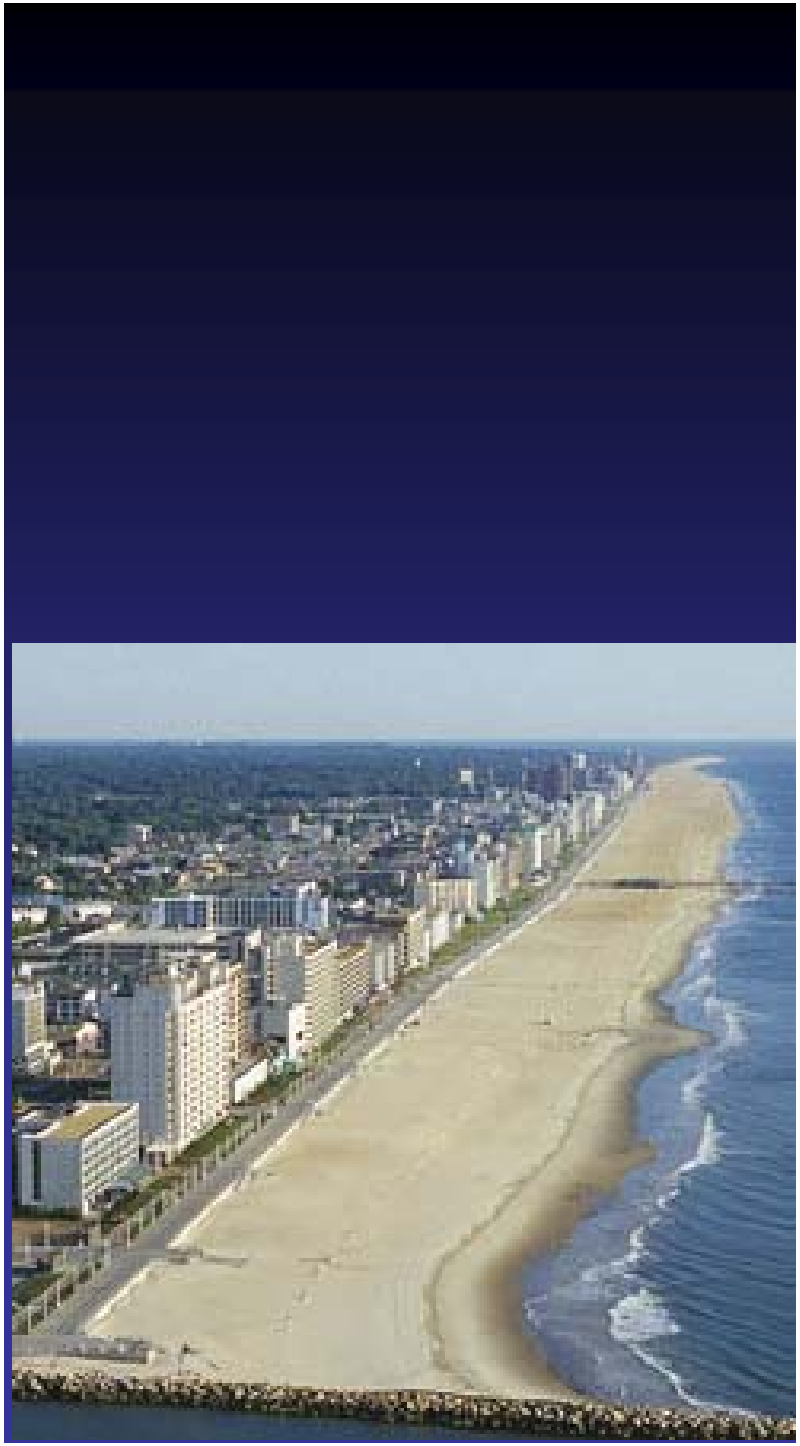
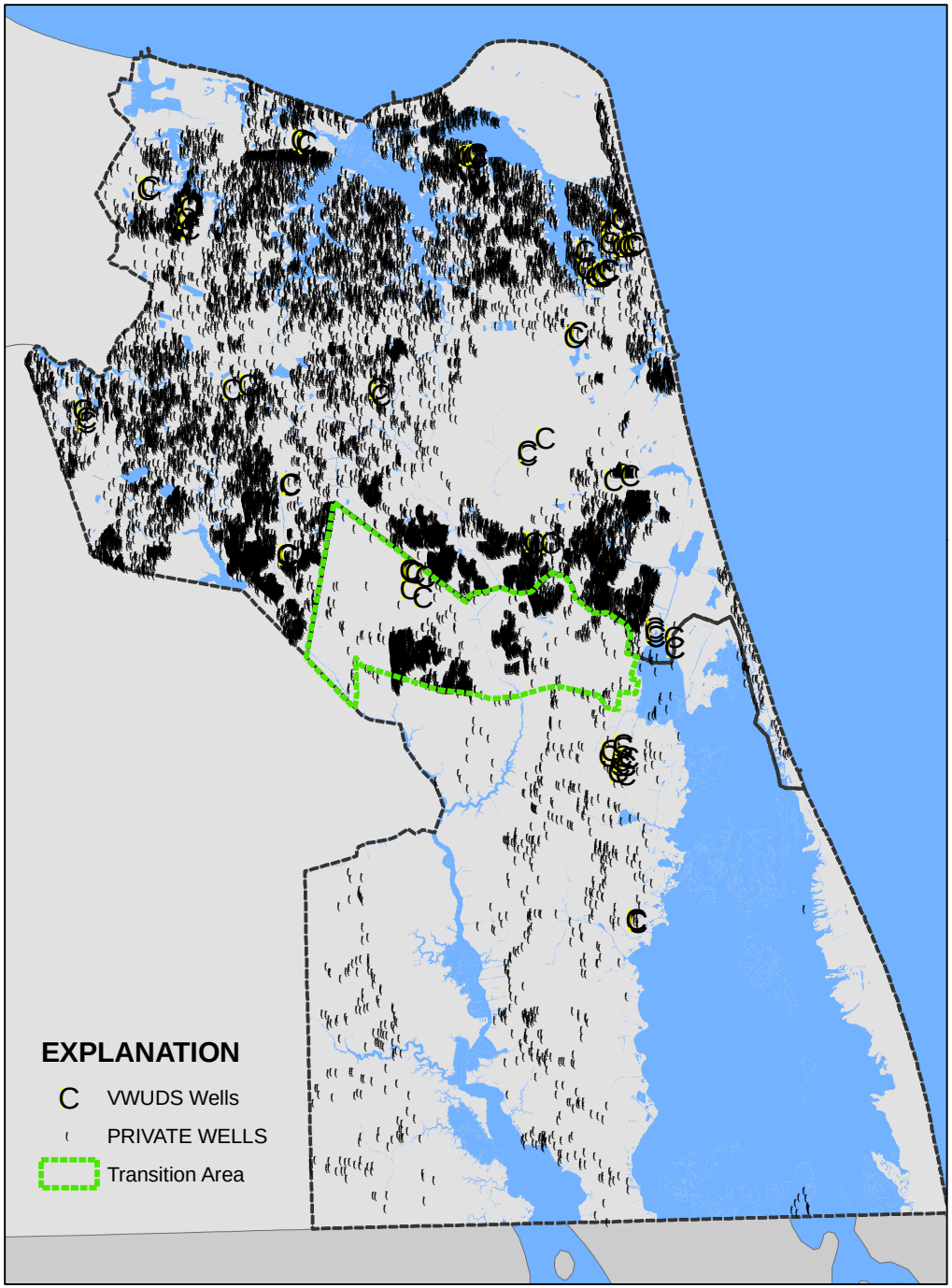
Water Use in Virginia Beach, VA

Virginia Beach 2001 MRLC Data







City of Virginia Beach

Regulated VWUDS Wells

94 wells in 2005
Mostly commercial (including golf)
Agricultural irrigation under-reported

Yearly Avg. = 0.22 Mgal/day
September = 0.66 Mgal/day
December = 0.05 Mgal/day

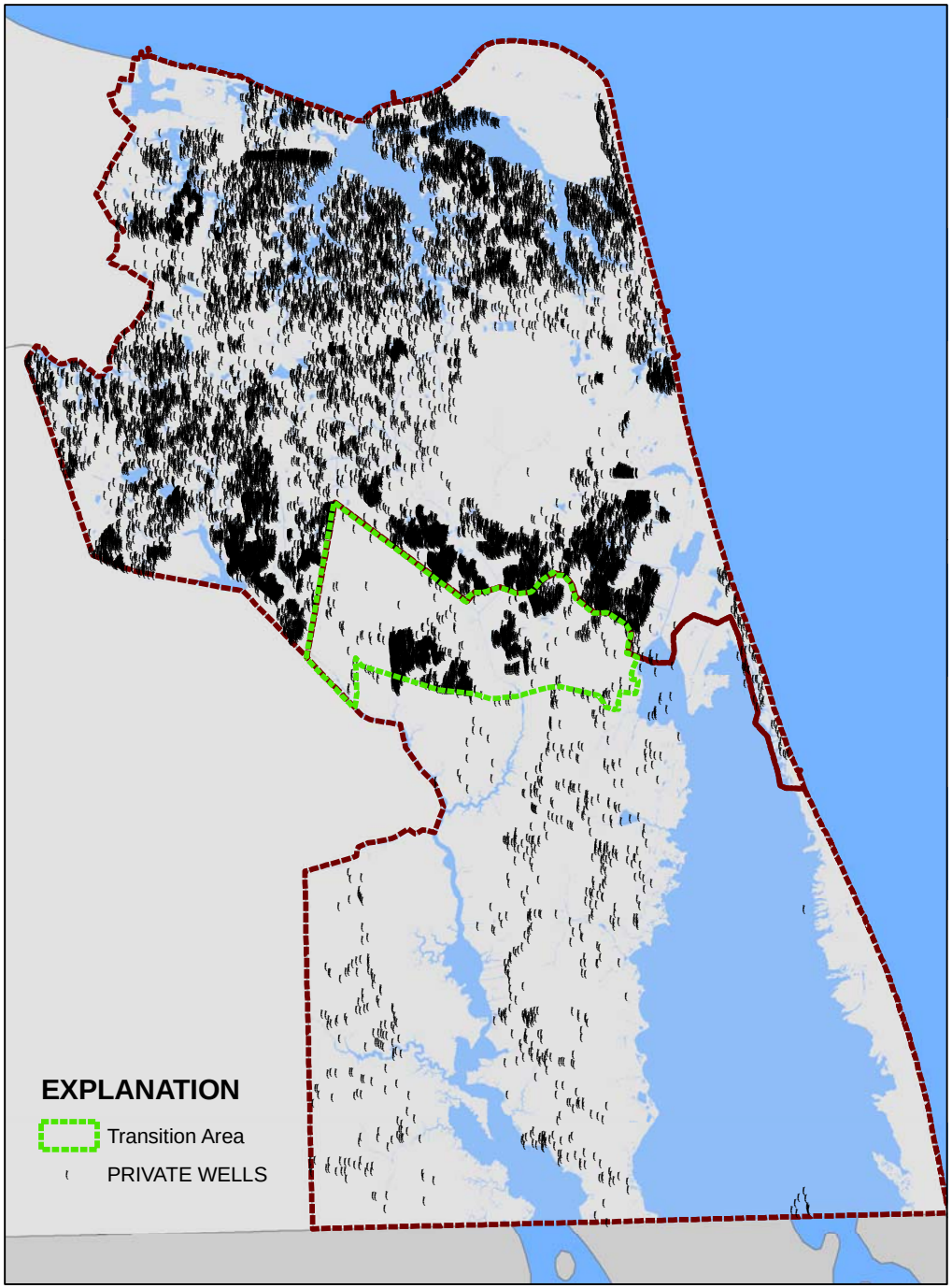
Private Wells

26,646 records from Virginia Beach Health Department

20,150 unique well addresses were located by parcel.

2,507 duplicate/incomplete addresses

2,933 complete addresses not located



City of Virginia Beach

Private Wells

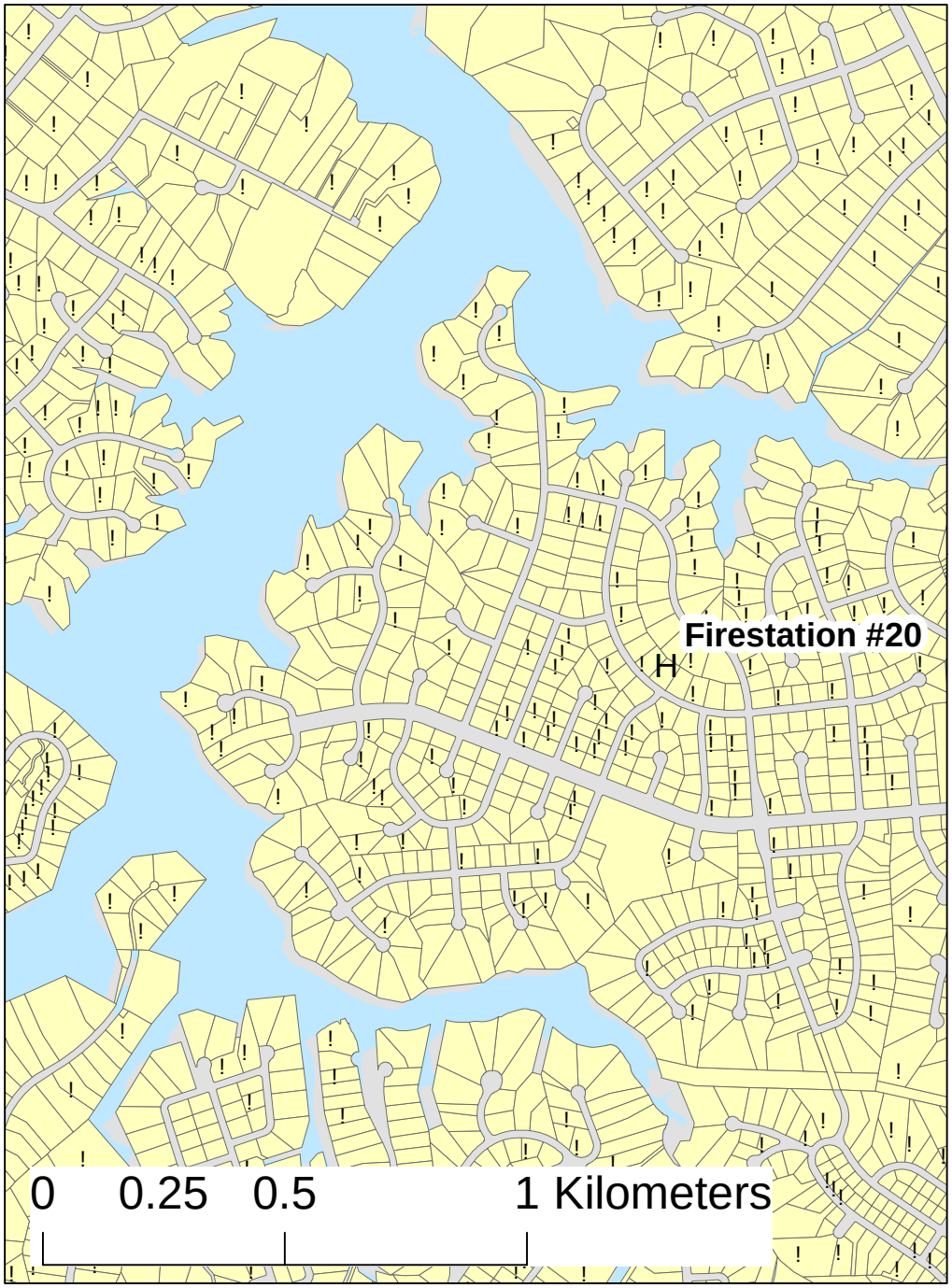
20,150 addresses
with at least one well located

(115 parcels with multiple wells)

Class IV (Irrigation)
17,082 = 85%

Class III (Domestic)
2,425 = 12%

Other/Not Available
643 = 3%



City of Virginia Beach

Northern Section Close-Up

19,441 Private Wells
Class IV (Irrigation)
16,822 = 86%
Class III (Domestic)
2,056 = 11%
Other/Not Available
563 = 3%

95% Single-Family Residences
2% Commercial/Industrial
1% Tax-Exempt (schools, etc.)

12% of all addresses have private well records, but this varies spatially

Northern Virginia Beach Water-Use Study

Widespread pumping for irrigation and summer-time use in Northern VA Beach

- Wells sometimes yield salty water
- How does ground-water use affect salinity?

Current USGS Study

- Compile information on water use and ground-water fluxes
- Geospatial (GIS) data
- Estimate water use where data absent
- Develop water balance for the shallow aquifers

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How to Determine Private Well Withdrawal Rates?

Withdrawal Rate =

$$\underbrace{\text{Pump Occurrence} \times \text{\% Pump Use} \times \text{\% Time Well Used}}_{\text{Survey Needed}} \times \text{Pumping Rate}$$

- Spatial variability of withdrawal rates needs to be known
- Sampling strategies?
- Sample population sizes?
- Sampling survey development?

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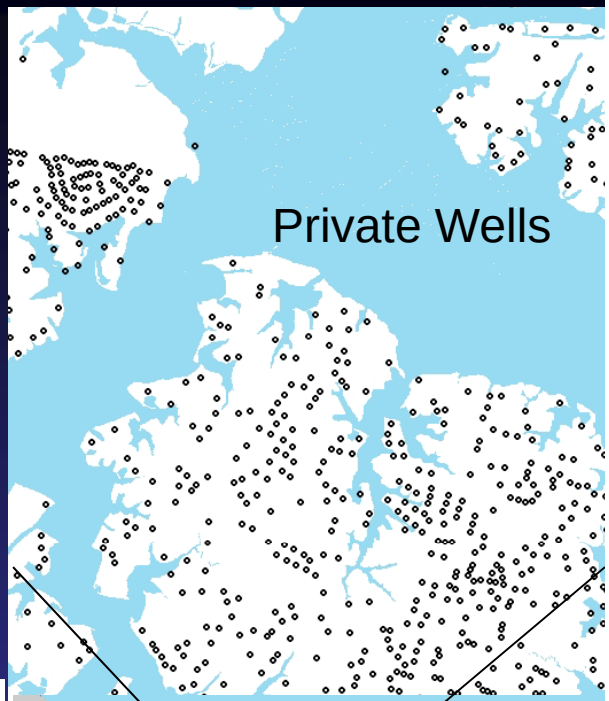
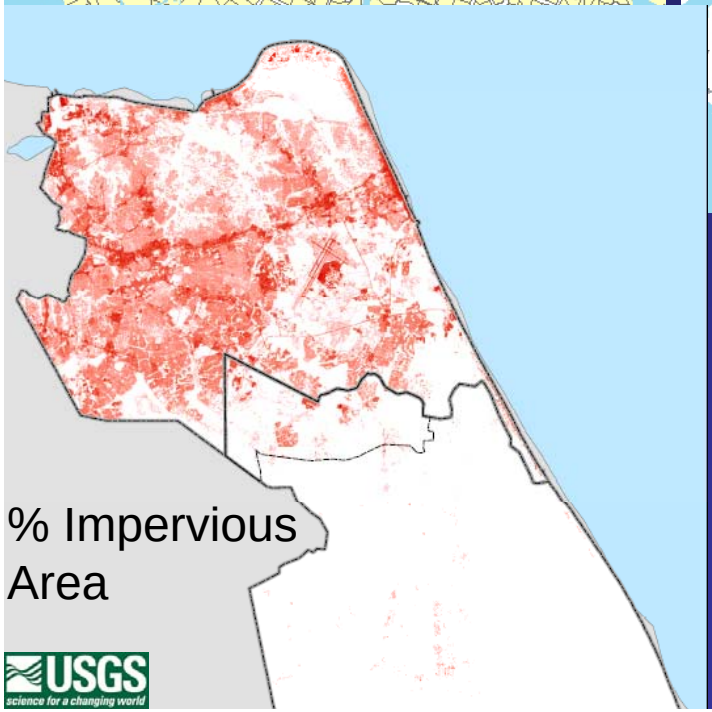
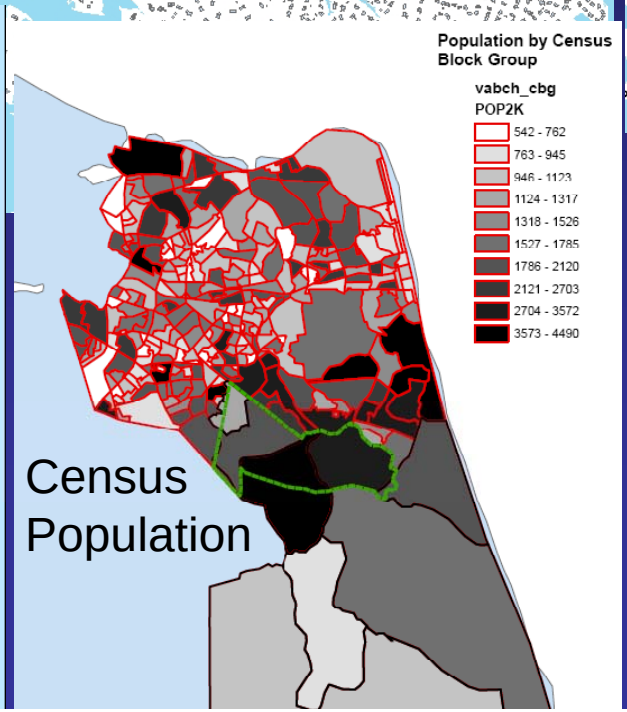
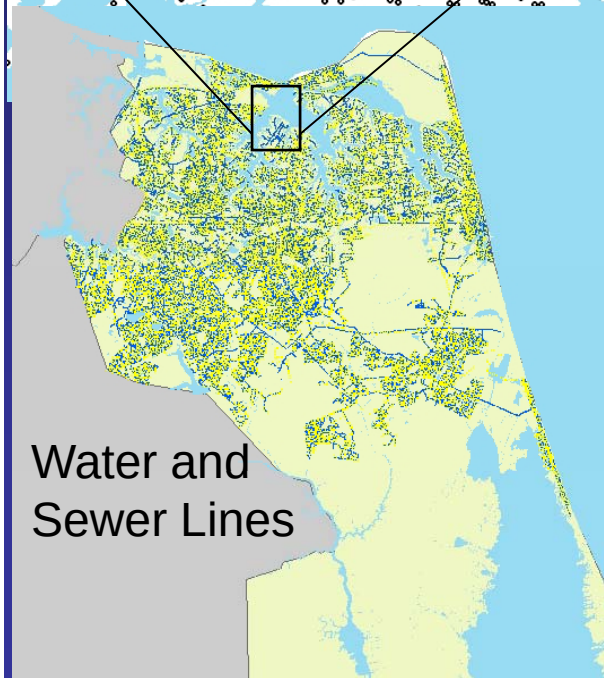
GIS Data already in hand









Estimating Water Use in the United States:
A New Paradigm for the National Water-Use Information Program

Committee on USGS Water Resources Research, National Research Council

A GREATER EMPHASIS ON SCIENCE

- The NWUIP appears to be viewed as a water use *accounting* program by many in the USGS Water Resources Division. Because of the significant differences in water use data collection procedures and in data quality from state to state, water use accounting alone cannot provide the estimates of water use that are needed by the nation. The committee found a compelling national need for unbiased science-based water use information. Long-term planning and management decisions need water use information that shows that water is an essential economic commodity and a vital natural resource. Investigations of the reliability and sustainable use of the nation's water resources require a fundamental understanding of the role of water use in the hydrologic cycle. The NWUIP should therefore be viewed as much more than a data collection and database management program.

- The scientific understanding of water use will be most effectively achieved by making water use science the focus of the NWUIP. *Water use science* refers to the hypothesis-driven investigation of the behavior and phenomena that determine spatial and temporal patterns of water use. This science will directly contribute to the development of techniques that improve water use estimation. Water use science also includes scientific assessment of the sustainability of water resources and the impact of water use on aquatic ecosystems, on the hydrologic cycle, and on the reliability and vulnerability of the nation's water resources.

Population and Area Information for Virginia Coastal Plain Counties and Independent Cities

Locality	FIPS Code	Coastal Plain Area (sq. mi.)	Area Proportion within Coastal Plain	Population Proportion within Coastal Plain	Total Population	Coastal Plain Population	Proportion Self-Supplied	Self-Supplied Coastal Plain Population	Census Household Size	Estimated Number of Domestic Wells
Accomack County	51001	466	1.000	1.000	38998	38998	0.495	19321	2.45	7895
Alexandria, City of	51510	17	0.982	1.000	128283	128283	0.127	16280	2.04	7972
Arlington County	51013	15	0.562	0.857	189453	162377	0.022	3643	2.15	1698
Caroline County	51033	504	0.937	1.000	22121	22121	0.603	13331	2.69	4963
Charles City County	51036	200	1.000	1.000	6926	6926	0.885	6126	2.59	2362
Chesapeake, City of	51550	351	1.000	1.000	199184	199184	0.177	35211	2.79	12617
Chesterfield County	51041	122	0.280	0.413	259903	107345	0.112	12064	2.73	4425
Colonial Heights, City of	51570	6	0.908	1.000	16897	16897	0.030	500	2.37	211
Dinwiddie County	51053	127	0.250	0.694	24533	17020	0.737	12538	2.58	4852
Emporia, City of	51595	2	0.913	1.000	5665	5665	0.011	60	2.43	25
Essex County	51057	269	1.000	1.000	9989	9989	0.682	6809	2.46	2768
Fairfax County	51059	88	0.224	0.280	973393	272488	0.047	12748	2.74	4660
Franklin, City of	51620	4	1.000	1.000	8346	8346	0.000	0	2.39	0
Fredricksburg, City of	51630	6	0.963	1.000	19279	19279	0.000	0	2.09	0
Gloucester County	51073	220	1.000	1.000	34780	34780	0.715	24870	2.62	9478
Greensville County	51081	173	0.582	1.000	11560	11560	0.726	8390	2.51	3337
Hampton, City of	51650	54	1.000	1.000	146437	146437	0.000	0	2.49	0
Hanover County	51085	246	0.513	0.897	86320	77472	0.324	25112	2.71	9282
Henrico County	51087	173	0.724	0.560	262300	146873	0.214	31368	2.39	13121
Hopewell, City of	51670	9	1.000	1.000	22354	22354	0.000	0	2.43	0
Isle of Wight County	51093	323	1.000	1.000	29728	29728	0.471	13989	2.61	5359
James City County	51095	153	1.000	1.000	48102	48102	0.368	17711	2.47	7183
King and Queen County	51097	333	1.000	1.000	6630	6630	0.949	6290	2.48	2536
King George County	51099	187	1.000	1.000	16803	16803	0.185	3101	2.70	1148
King William County	51101	285	1.000	1.000	13146	13146	0.699	9187	2.69	3412
Lancaster County	51103	124	1.000	1.000	11567	11567	0.474	5479	2.23	2460
Mathews County	51115	86	1.000	1.000	9207	9207	0.941	8667	2.32	3729
Middlesex County	51119	139	1.000	1.000	9932	9932	0.758	7532	2.27	3311
New Kent County	51127	224	1.000	1.000	13462	13462	0.701	9431	2.65	3555
Newport News, City of	51700	56	1.000	1.000	180150	180150	0.000	0	2.50	0
Norfolk, City of	51710	57	1.000	1.000	234403	234403	0.000	0	2.45	0
Northampton County	51131	211	1.000	1.000	13093	13093	0.652	8542	2.39	3572
Northumberland County	51133	188	1.000	1.000	12259	12259	0.615	7539	2.24	3367
Petersburg, City of	51730	27	0.947	1.000	33740	33740	0.000	0	2.38	0
Poquoson, City of	51735	19	1.000	1.000	11566	11566	0.000	0	2.75	0
Portsmouth, City of	51740	33	1.000	1.000	100565	100565	0.000	0	2.51	0
Prince George County	51149	281	1.000	1.000	34749	34749	0.410	14247	2.76	5154
Prince William County	51153	54	0.156	0.413	280813	116014	0.247	28664	2.94	9736
Richmond County	51159	195	1.000	1.000	8809	8809	0.633	5579	2.40	2322
Richmond, City of	51760	47	0.709	0.915	197790	181059	0.000	0	2.21	0
Southampton County	51175	607	1.000	1.000	17482	17482	0.462	8081	2.53	3188
Spotsylvania County	51177	81	0.193	0.841	90395	76038	0.084	6367	2.87	2219
Stafford County	51179	136	0.494	0.711	92446	65760	0.145	9517	3.01	3159
Suffolk, City of	51800	408	1.000	1.000	63677	63677	0.255	16209	2.69	6019
Surry County	51181	263	1.000	1.000	6829	6829	0.745	5089	2.61	1952
Sussex County	51183	508	0.987	1.000	12504	12504	0.113	1410	2.41	584
Virginia Beach, City of	51810	303	1.000	1.000	425257	425257	0.097	41380	2.70	15306
Westmoreland County	51193	247	1.000	1.000	16718	16718	0.424	7089	2.43	2921
Williamsburg, City of	51830	5	1.000	1.000	11998	11998	0.000	0	2.07	0
York County	51199	125	1.000	1.000	56297	56297	0.798	44918	2.78	16137
Totals	---	8,755	---	---	4,526,838	3,291,938	0.156	514,390	2.59	197,994

Well data was collected only for localities not shaded in grey.

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