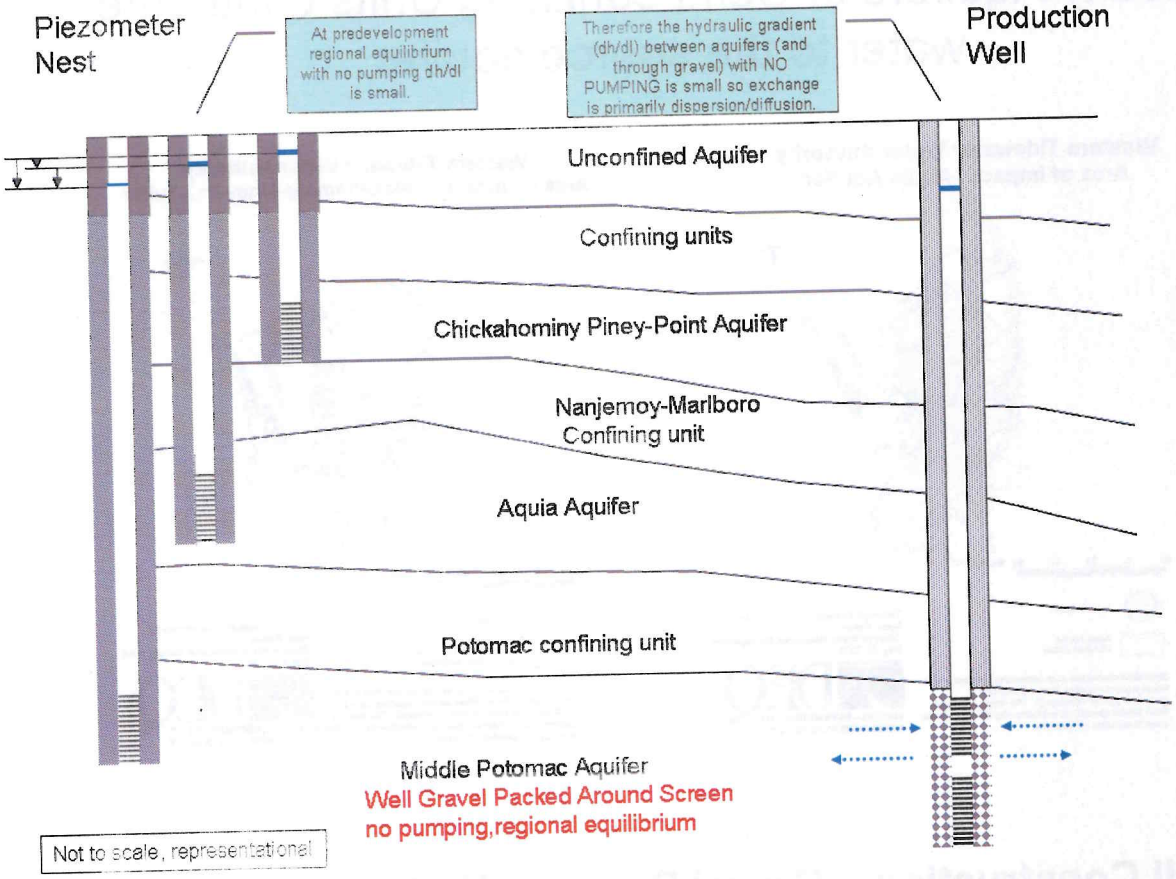
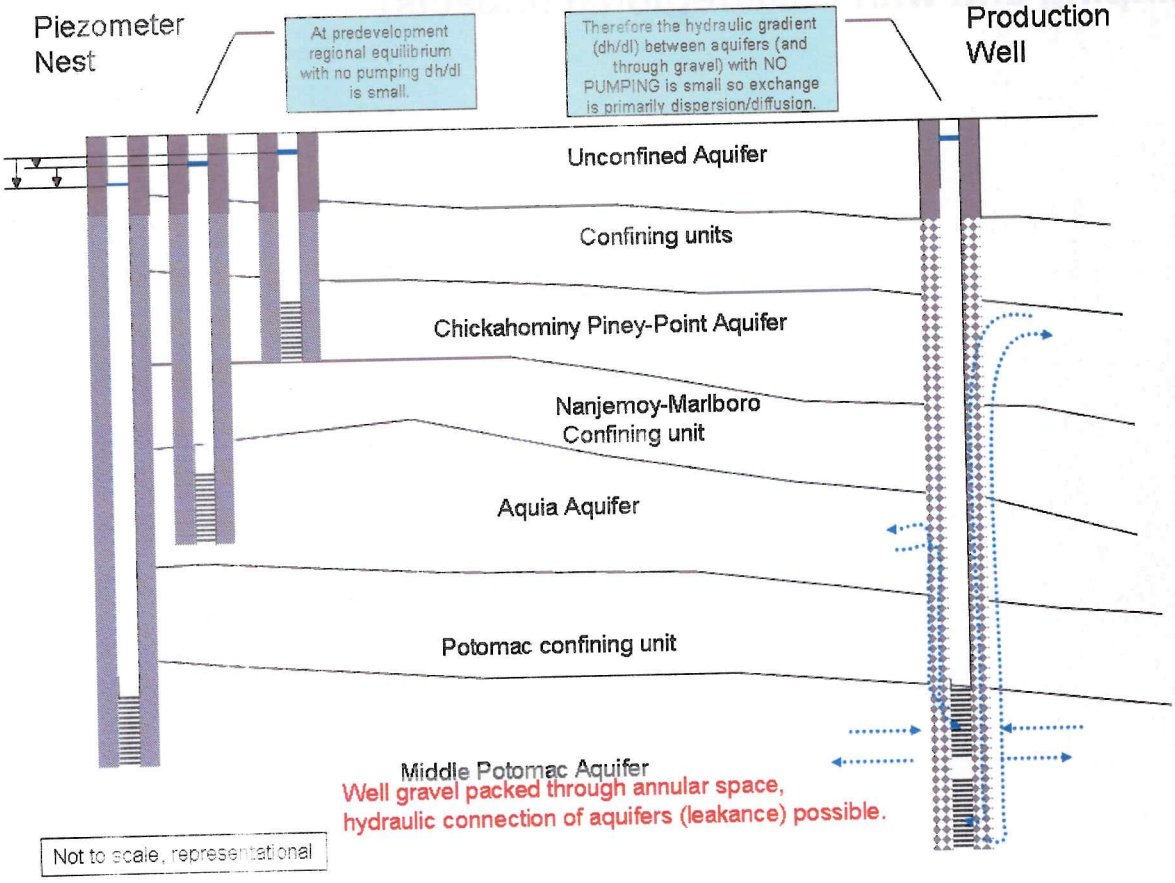
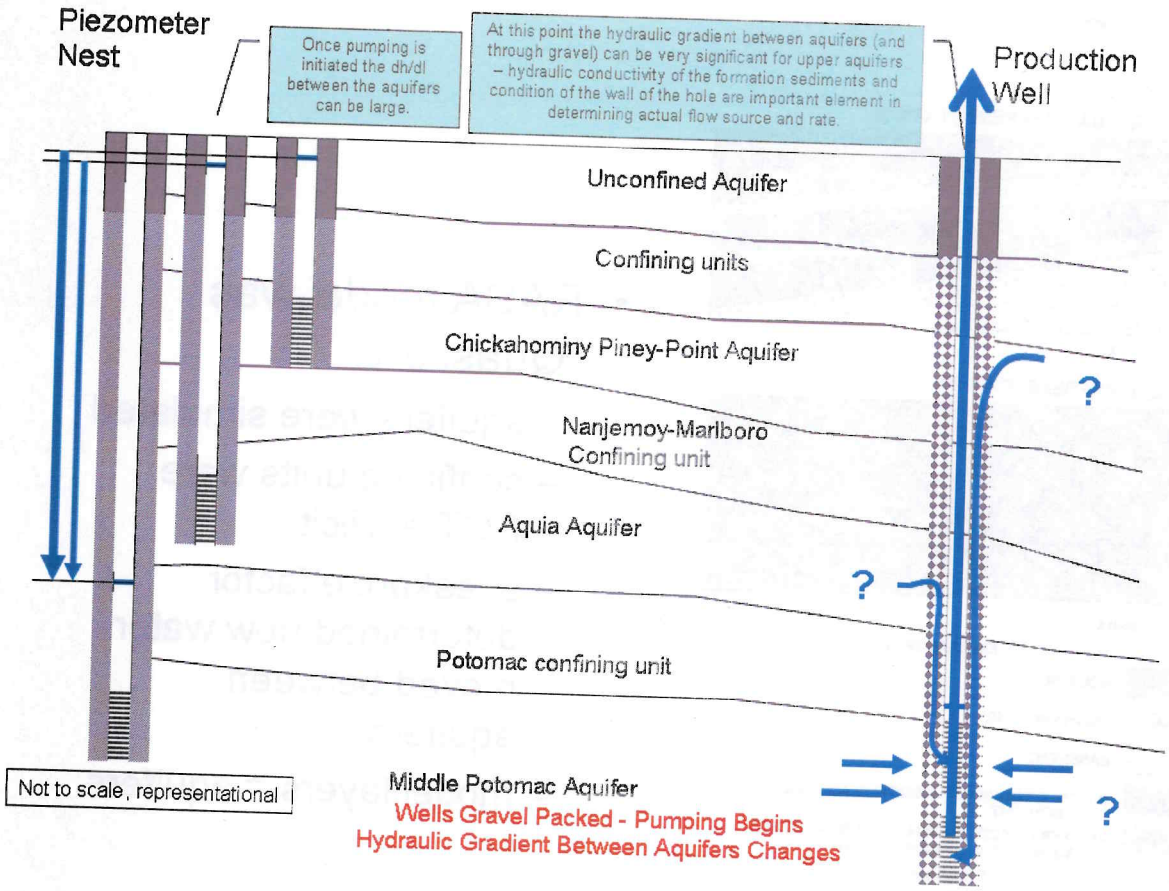
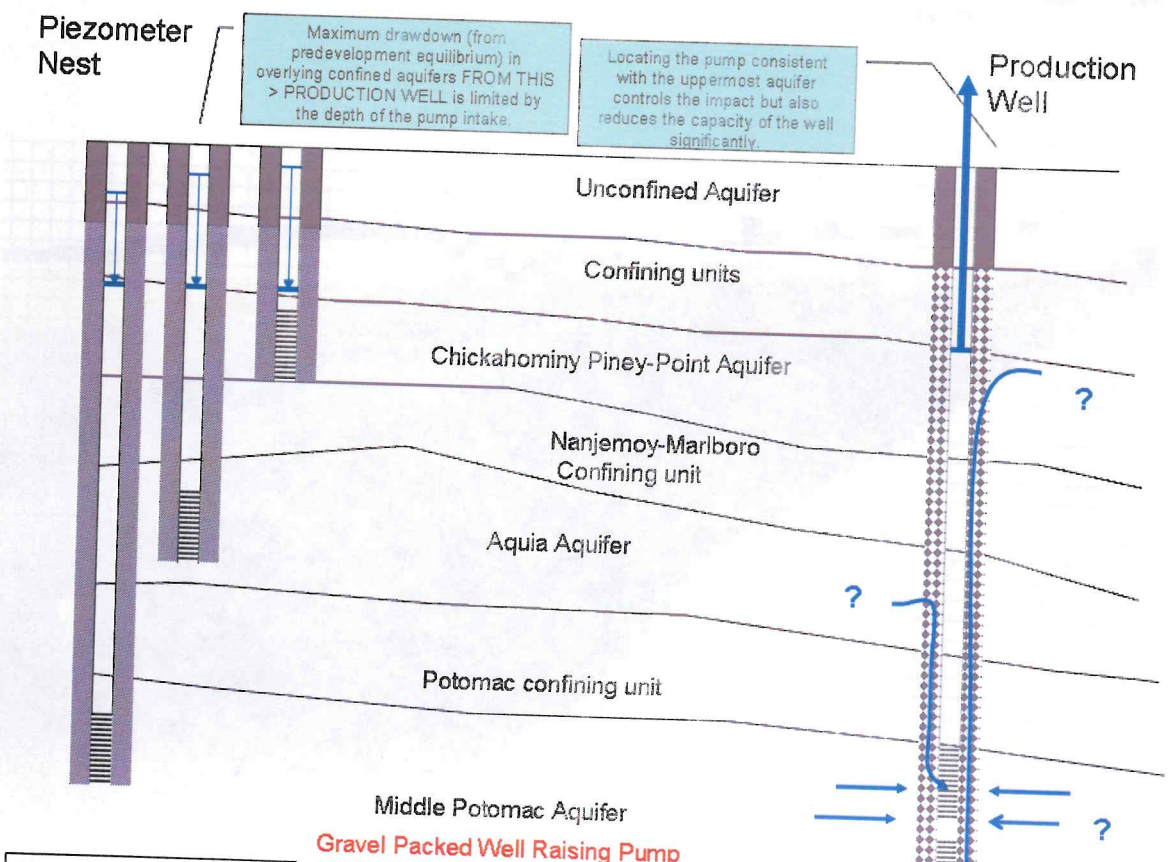

Piezometer Nest
At predevelopment regional equilibrium with no pumping dh/dl is small.
Therefore the hydraulic gradient (dh/dl) between aquifers (and through gravel) with NO PUMPING is small so exchange is primarily dispersion/diffusion.
Production Well
Unconfined Aquifer
Confining units
Chickahominy Piney-Point Aquifer
Nanjemoy-Marlboro Confining unit
Aquia Aquifer
Potomac confining unit
Middle Potomac Aquifer
Well Gravel Packed Around Screen
no pumping,regional equilibrium
Not to scale, representational


Piezometer Nest
At predevelopment regional equilibrium with no pumping dh/dl is small.
Therefore the hydraulic gradient (dh/dl) between aquifers (and through gravel) with NO PUMPING is small so exchange is primarily dispersion/diffusion.
Production Well
Unconfined Aquifer
Confining units
Chickahominy Piney-Point Aquifer
Nanjemoy-Marlboro Confining unit
Aquia Aquifer
Potomac confining unit
Middle Potomac Aquifer
Well gravel packed through annular space,
hydraulic connection of aquifers (leakance) possible.
Not to scale, representational


Piezometer Nest
Once pumping is initiated the dh/dl between the aquifers can be large.
At this point the hydraulic gradient between aquifers (and through gravel) can be very significant for upper aquifers – hydraulic conductivity of the formation sediments and condition of the wall of the hole are important element in determining actual flow source and rate.
Production Well
Unconfined Aquifer
Confining units
Chickahominy Piney-Point Aquifer
Nanjemoy-Marlboro Confining unit
Aquia Aquifer
Potomac confining unit
Middle Potomac Aquifer
Wells Gravel Packed - Pumping Begins
Hydraulic Gradient Between Aquifers Changes
Not to scale, representational
?
?
?


Piezometer Nest
Maximum drawdown (from predevelopment equilibrium) in overlying confined aquifers FROM THIS > PRODUCTION WELL is limited by the depth of the pump intake.
Locating the pump consistent with the uppermost aquifer controls the impact but also reduces the capacity of the well significantly.
Production Well
Unconfined Aquifer
Confining units
Chickahominy Piney-Point Aquifer
Nanjemoy-Marlboro Confining unit
Aquia Aquifer
Potomac confining unit
Middle Potomac Aquifer
Gravel Packed Well Raising Pump
?
?
?

Conceptual Models

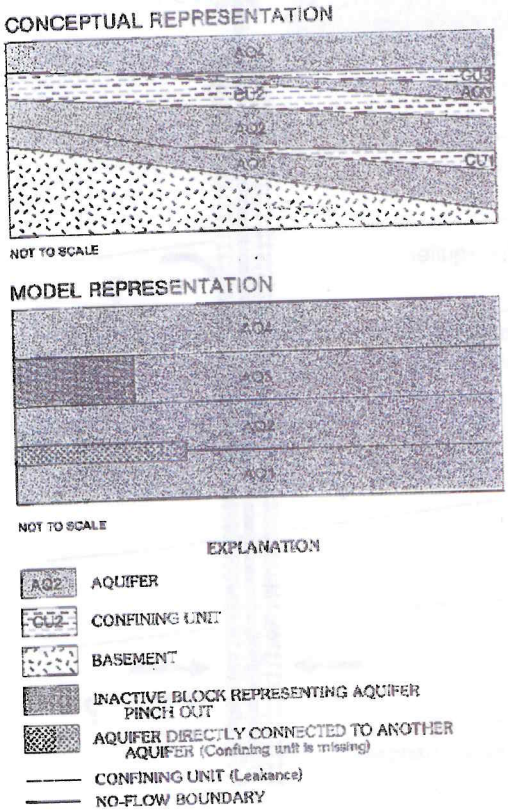
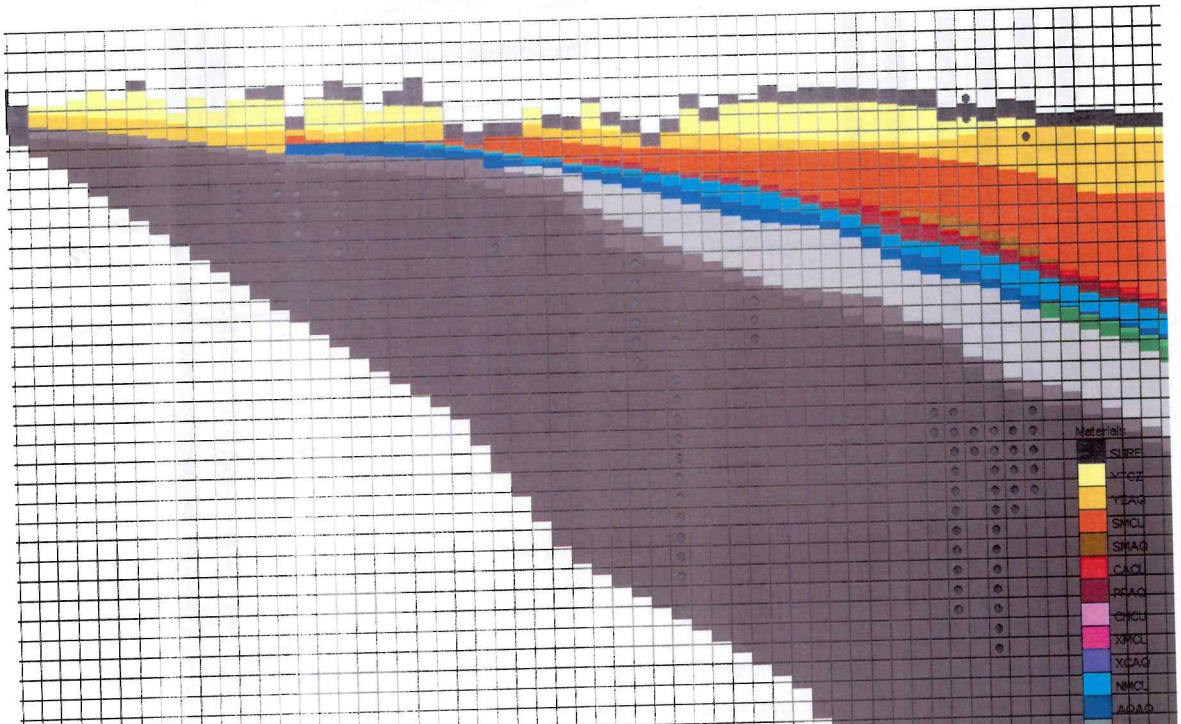
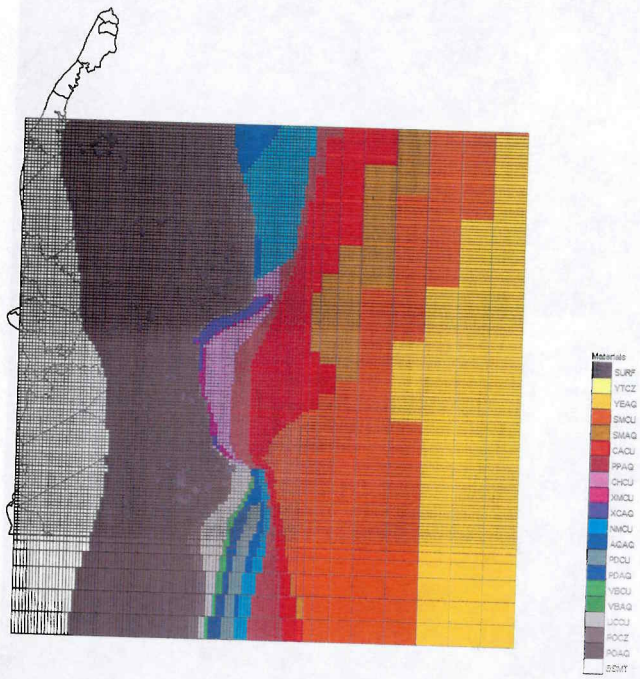


FIGURE 10.- Conceptual and model representations of aquifers and confining units.

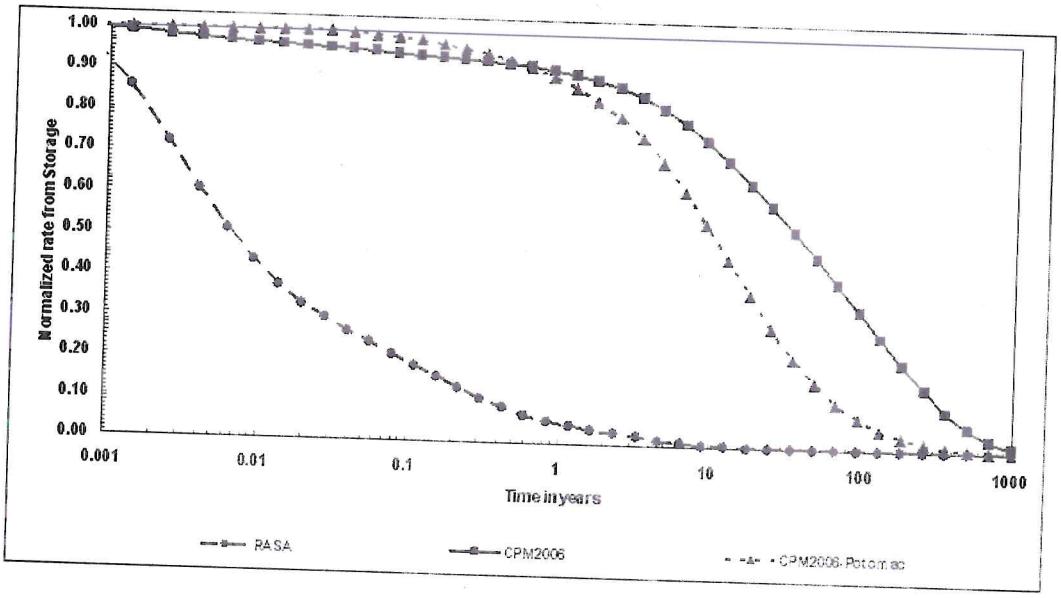
- RASA model was "Quasi 3-D"
  - aquifers were simulated
  - confining units were NOT explicit
  - a leakance factor determined how water moved between aquifers
  - model layers = aquifers

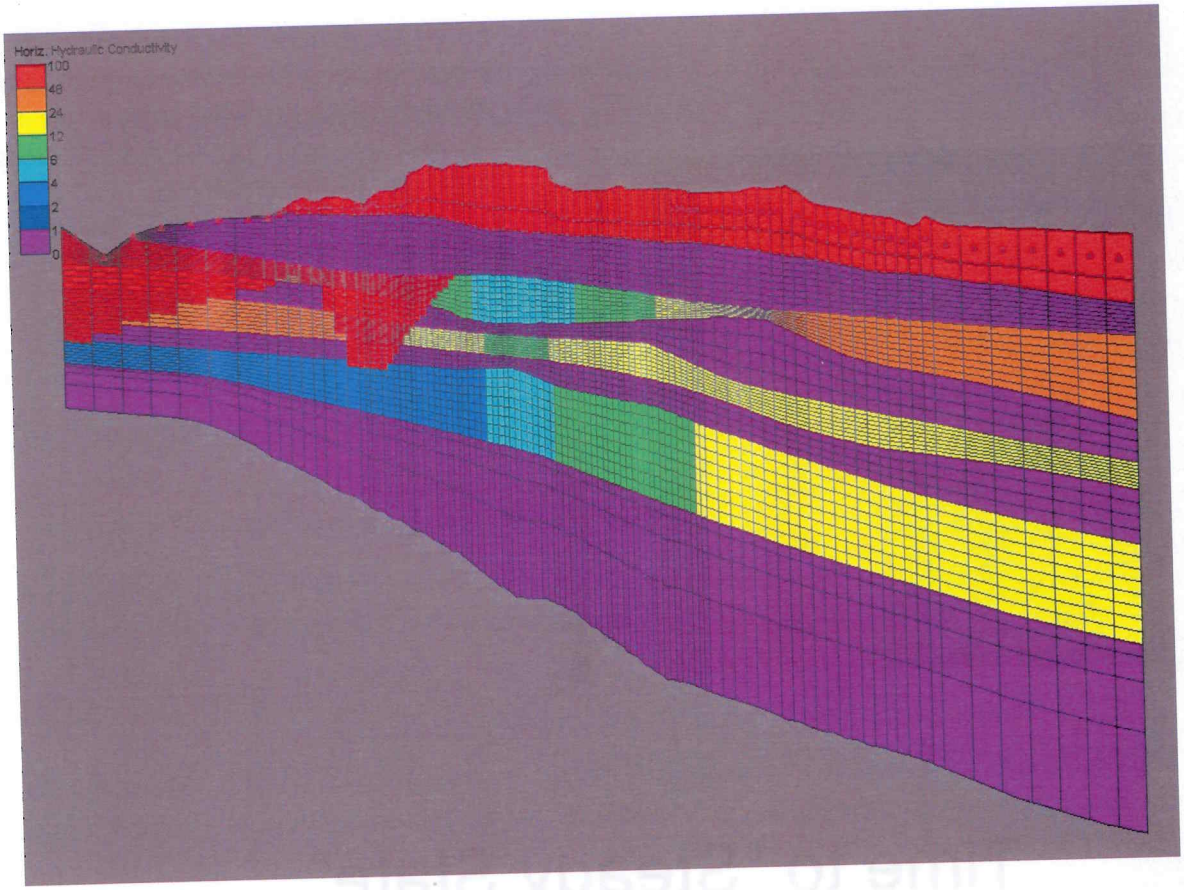




n Heywood model for mainland, any single model layer can be composed of multiple hydrogeologic units as the "slices" that make up the model layers are completely horizontal.

Time to "Steady State" (Stabilized in regulation)





In Sanford model for Eastern Shore, model layers are configured so they are coincident with hydrogeologic unit elevations (each model "slice" varies in thickness and elevation but is represents the same hydrogeologic unit throughout its spatial extent).

Self-Supplied Groundwater

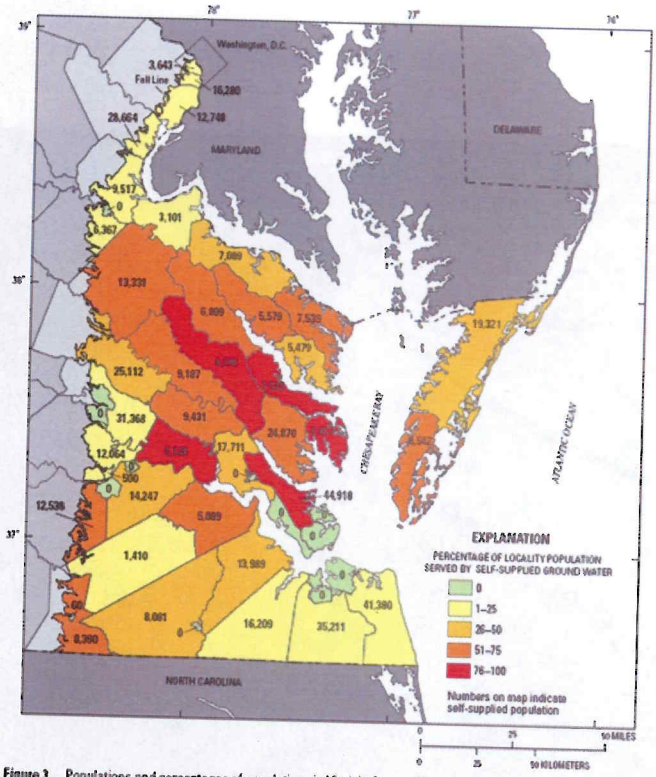
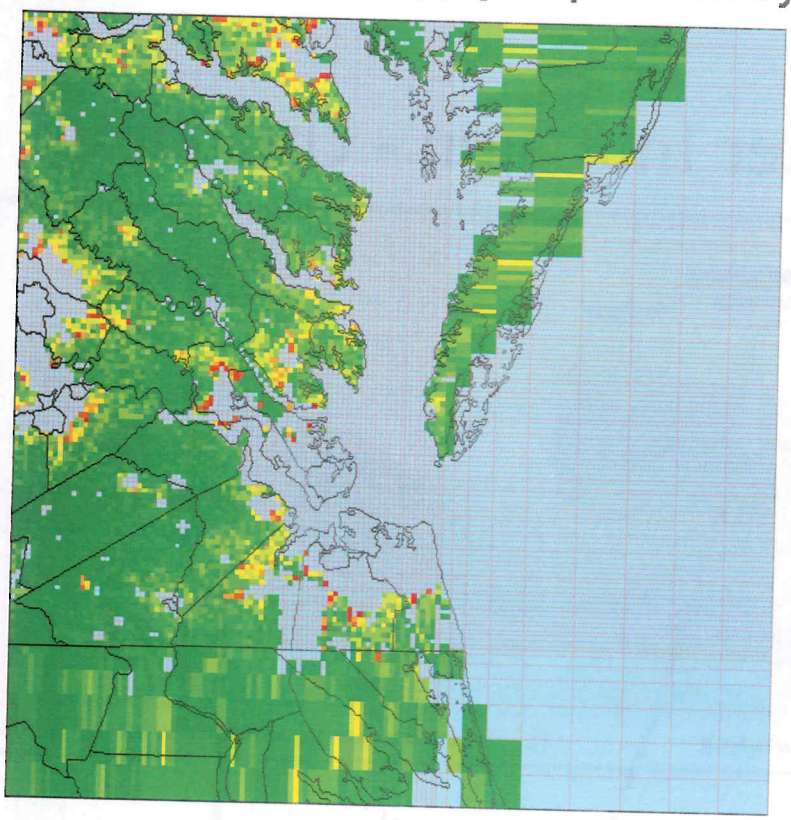


Figure 3. Populations and percentages of populations in Virginia Coastal Plain localities served by self-supplied ground water in 2000 (locations shown in fig. 1).

USGS Report

- Self-supplied groundwater users in 2000 based on a survey of VDH well permits.

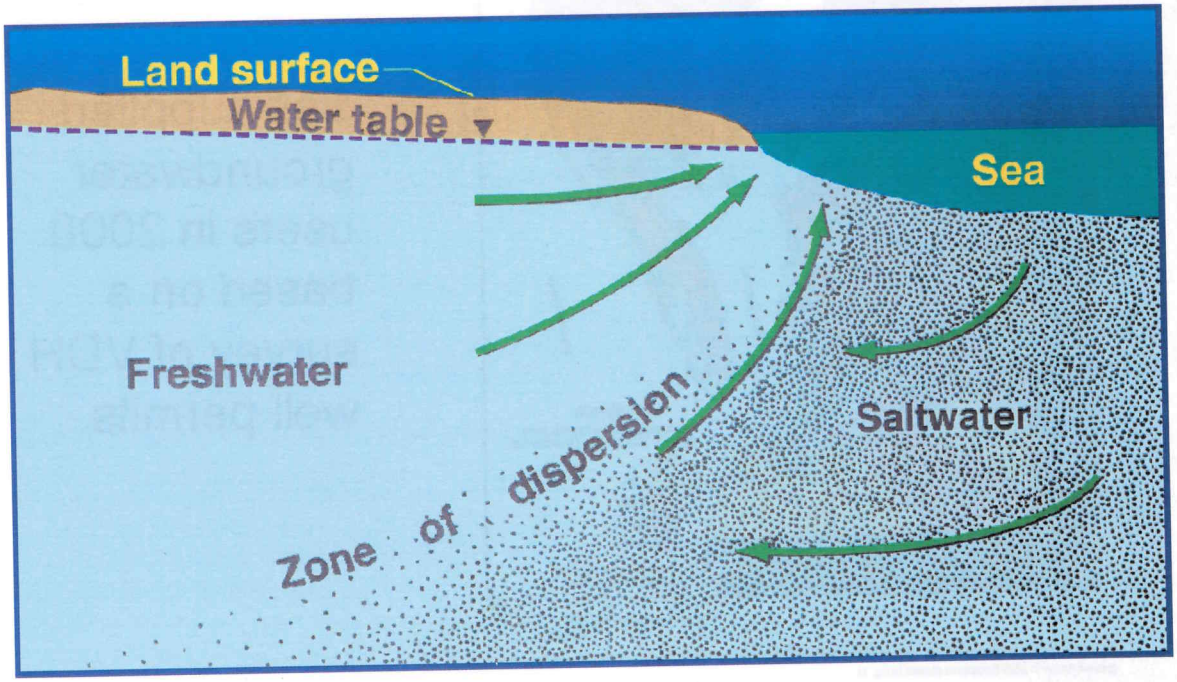
2000 Domestic Supply Population by Model Grid Cell



Census data and survey of VDH well records used to develop domestic withdrawal allocation

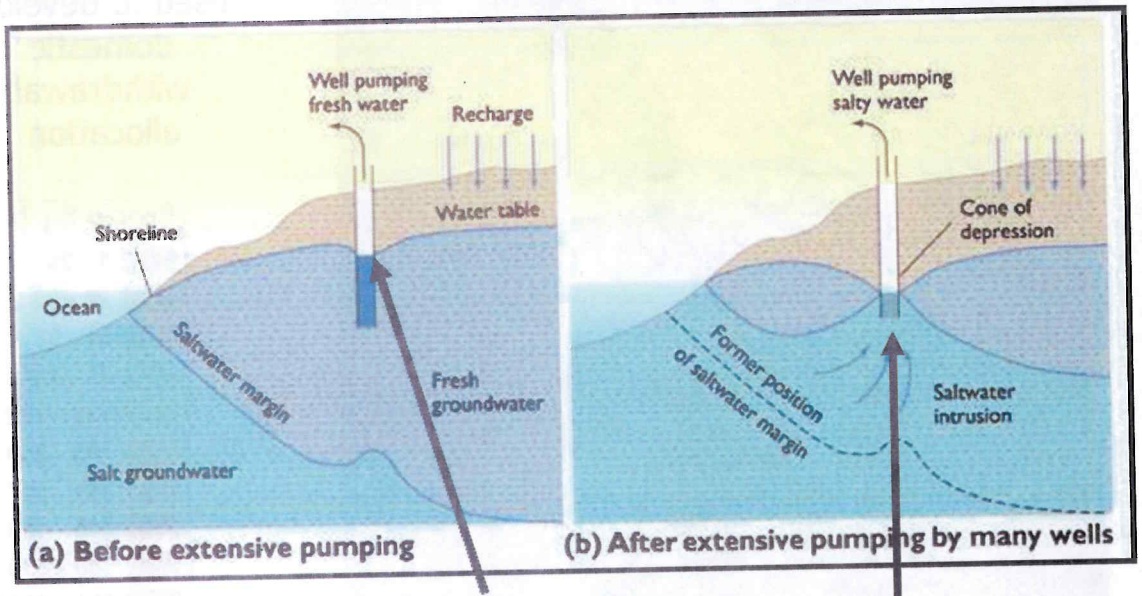
People/Sq. Mi.
- 1 - 26
- 27 - 53
- 54 - 88
- 89 - 134
- 135 - 192
- 193 - 260
- 261 - 347
- 348 - 459
- 460 - 630
- 631 - 1094

Salt Water Interface



Upconing

Salt Water Intrusion - Upconing



Pumping causes a cone of depression and...

...salt water upwards into the well

Heywood Model Framework

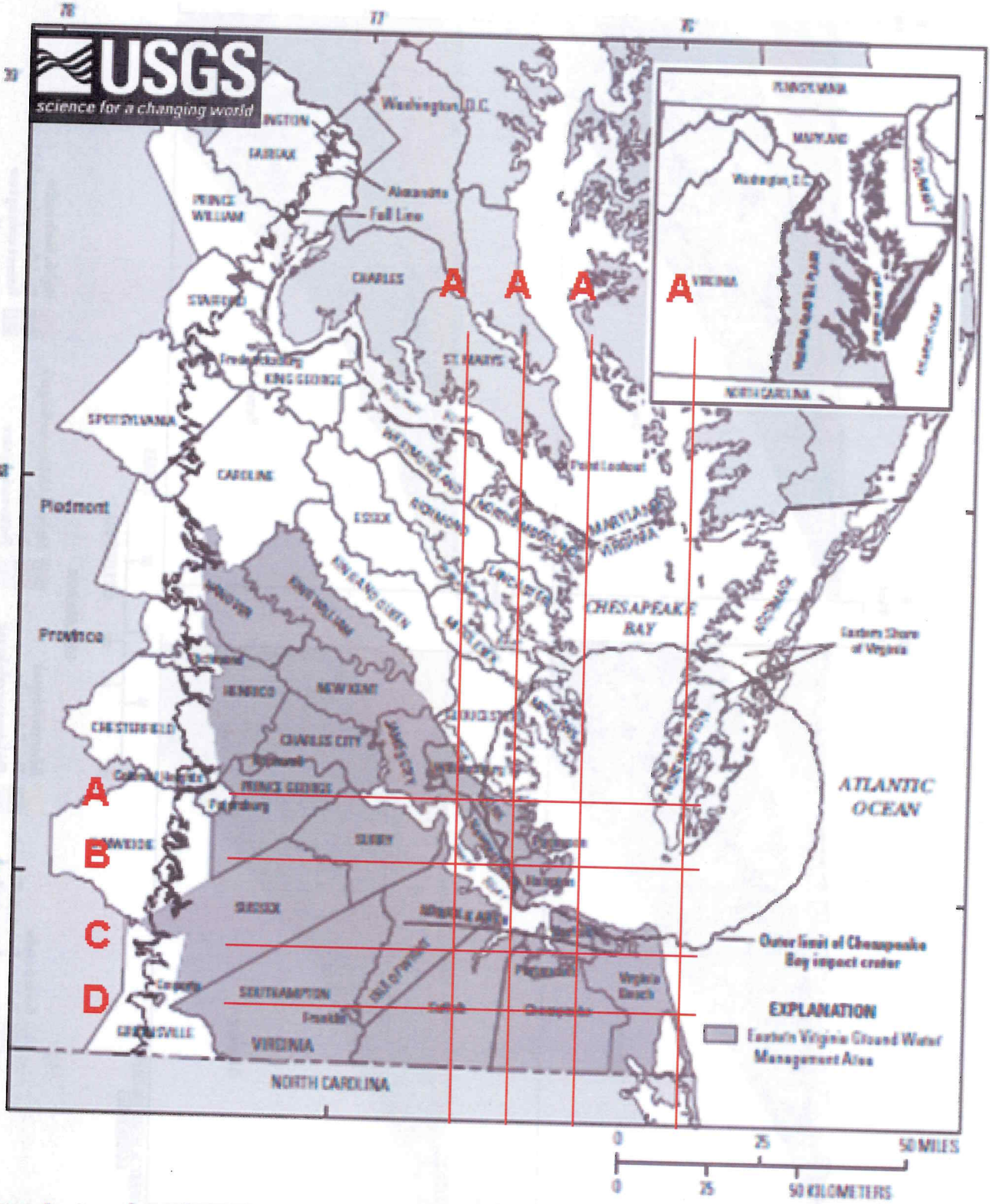


Figure 1. Locations of counties and independent cities, the Chesapeake Bay impact crater, and other important geographic and physiographic features of the Virginia Coastal Plain.

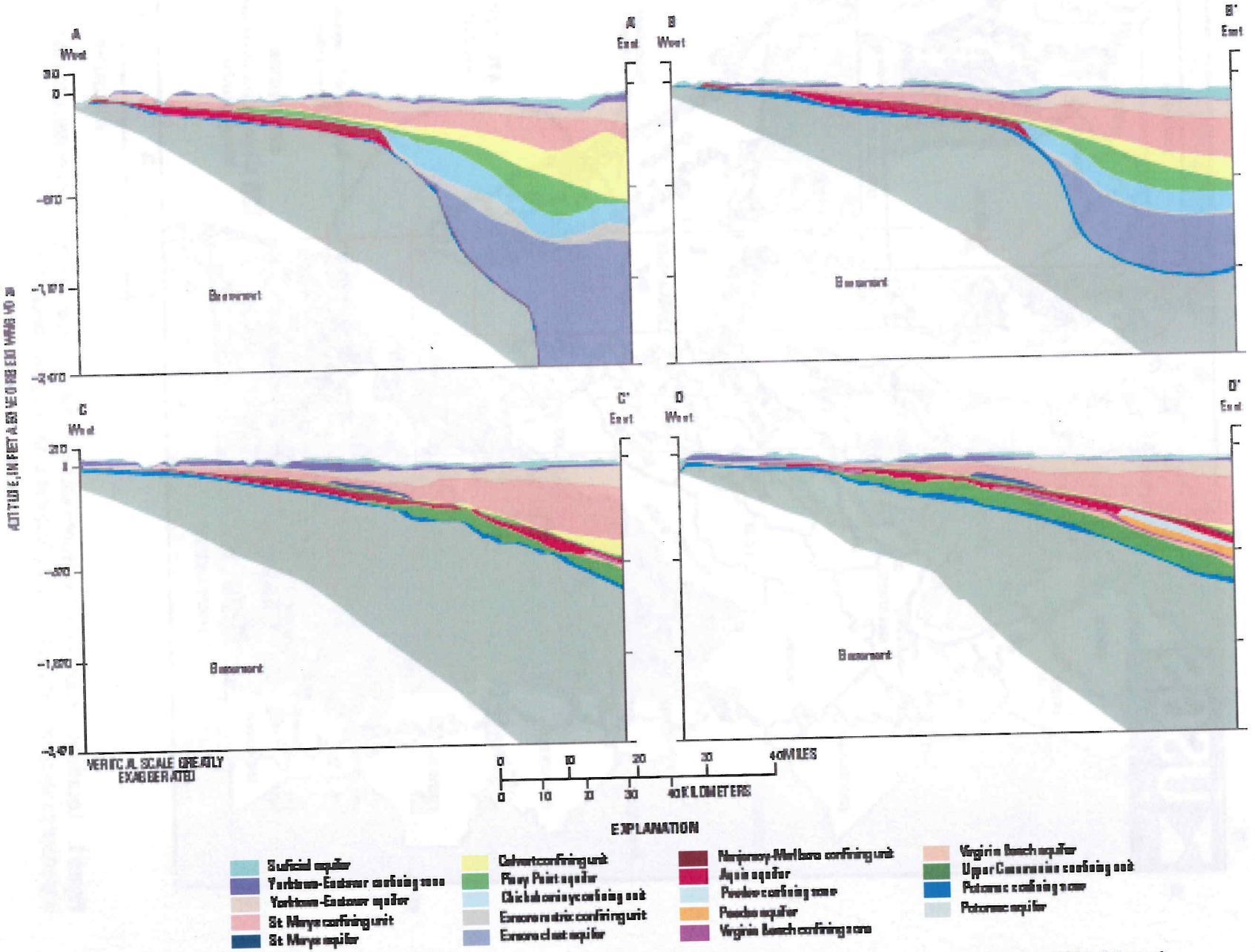


Figure 4. Vertical model cross sections showing distribution of hydrogeologic units from west to east along row 80 (A–A'), west to east along row 95 (B–B'), west to east along row 107 (C–C'), west to east along row 120 (D–D'), north to south along column 50 (E–E'), north to south along column 60 (F–F'), north to south along column 80 (G–G'), and north to south along column 87 (H–H'). (Locations of cross sections are shown in figure 3.)

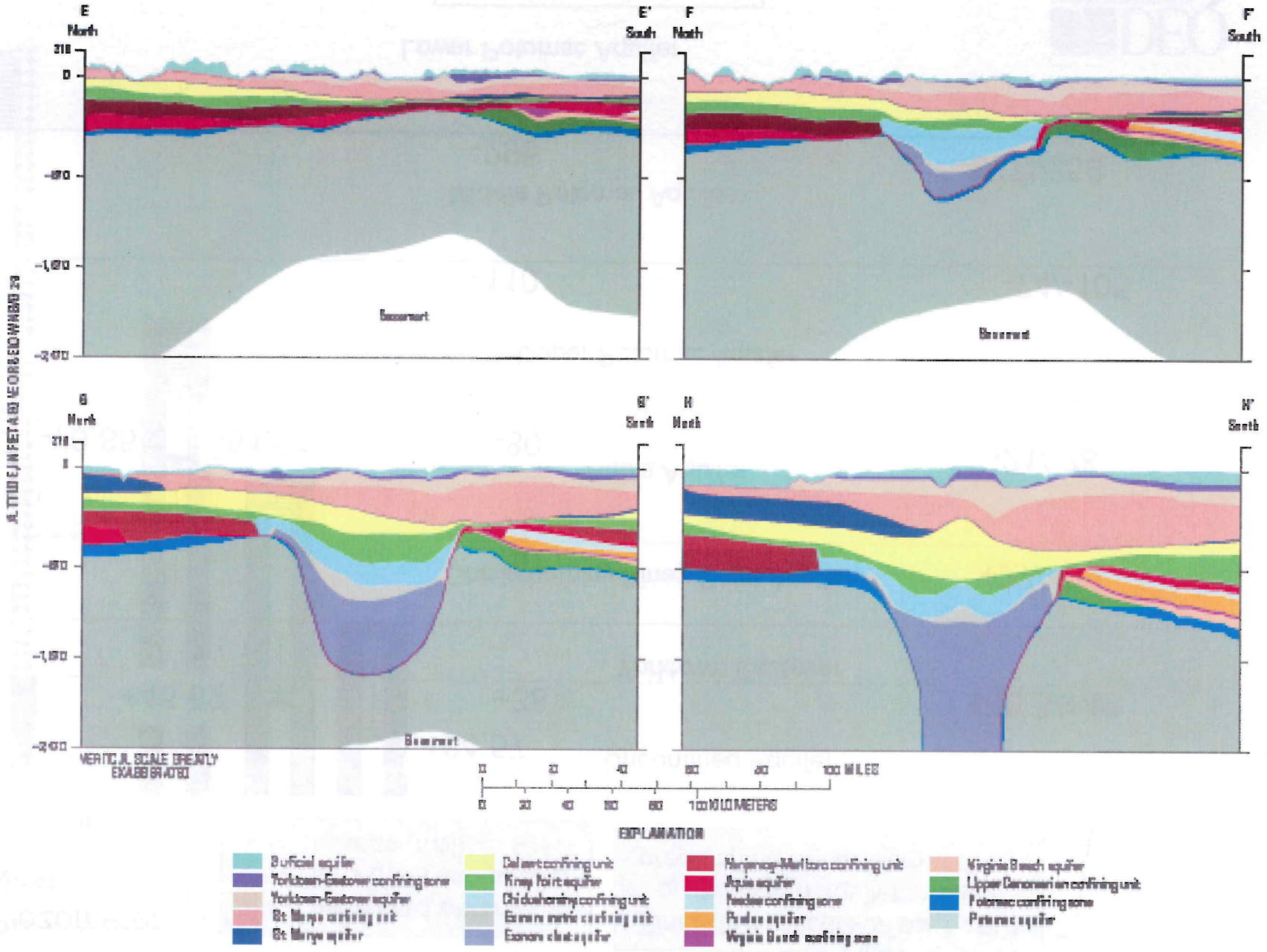
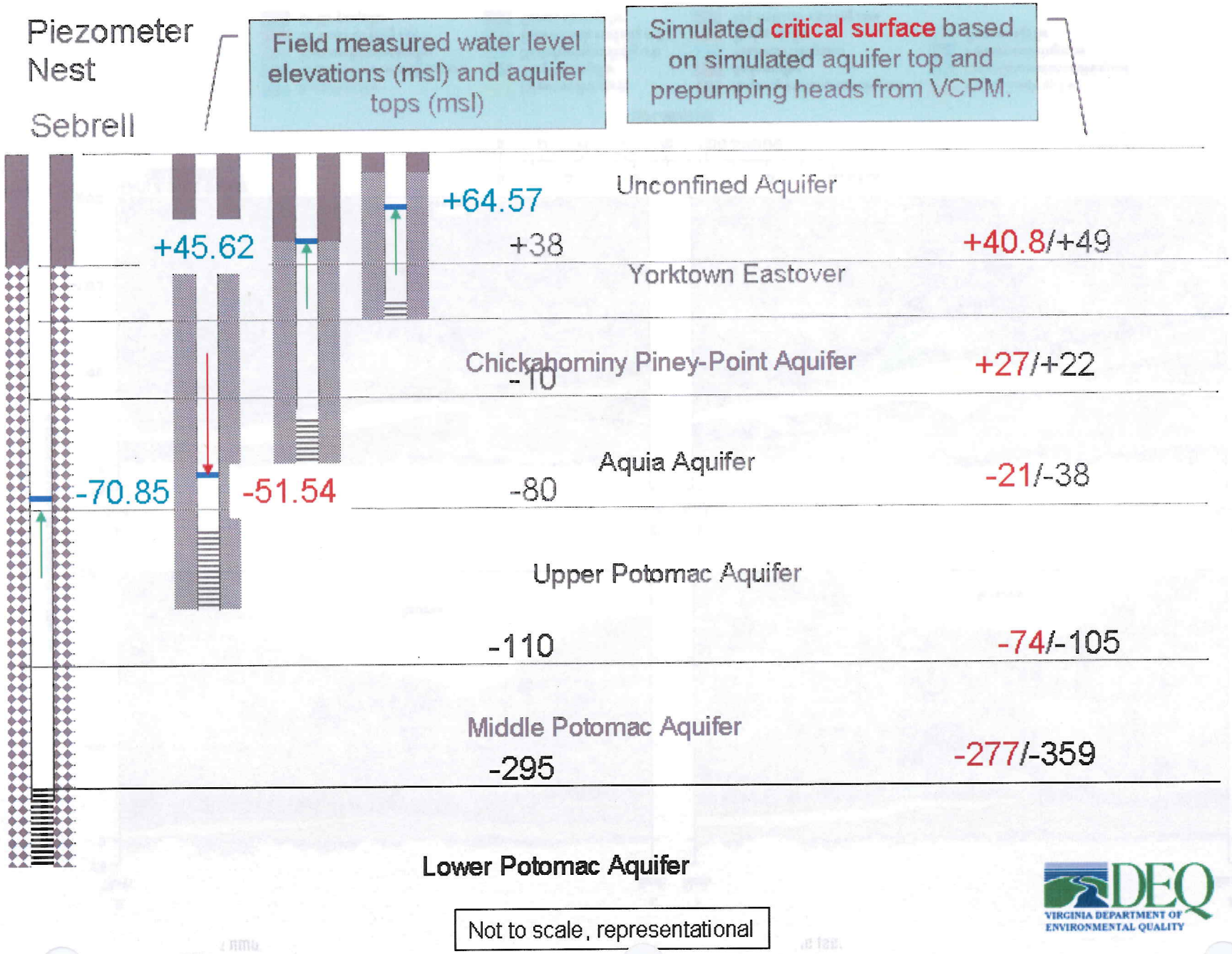


Figure 4. Vertical model cross sections showing distribution of hydrogeologic units from west to east along row 80 (A–A'), west to east along row 95 (B–B'), west to east along row 107 (C–C'), west to east along row 120 (D–D'), north to south along column 50 (E–E'), north to south along column 60 (F–F'), north to south along column 70 (G–G'), and north to south along column 87 (H–H'). (Locations of cross sections are shown in figure 3.)—Continued

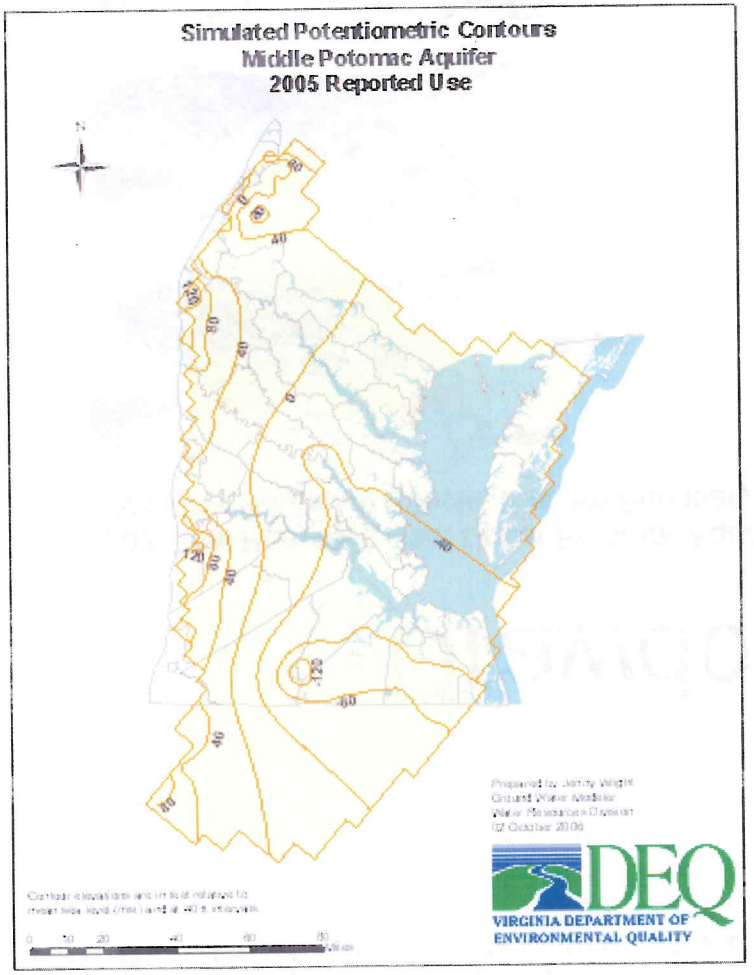
Sebrell Observation Well Nest

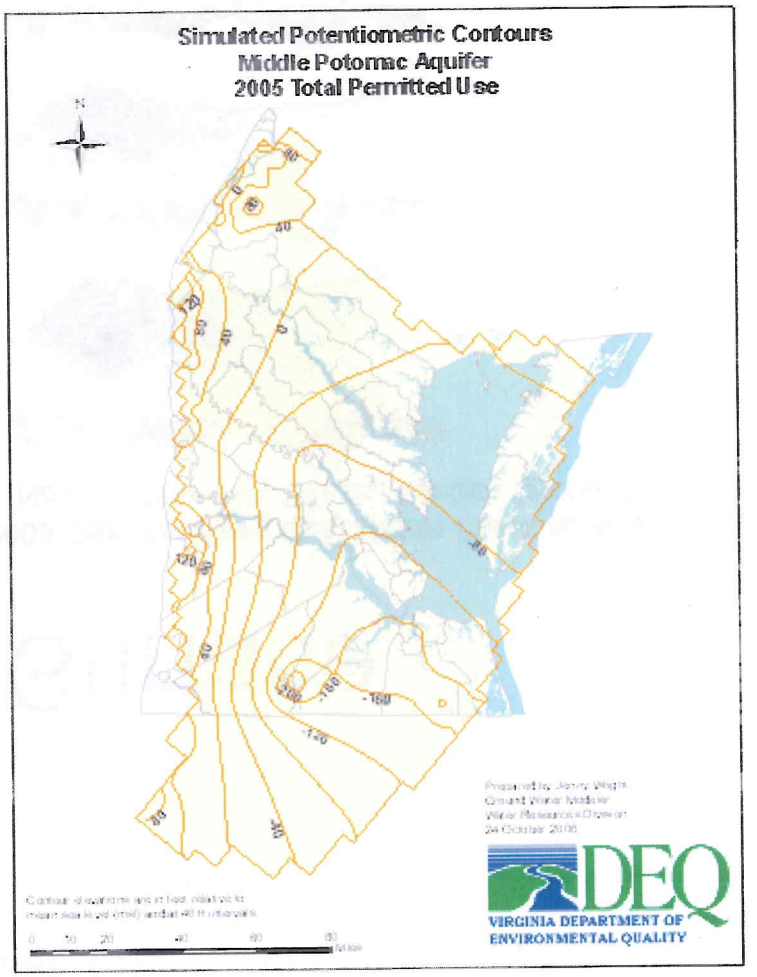


Model Simulations – Reported Use and Total Permitted Simulation

Simulated Use : Simulated Permitted Maximum

aka "Total Permitted"

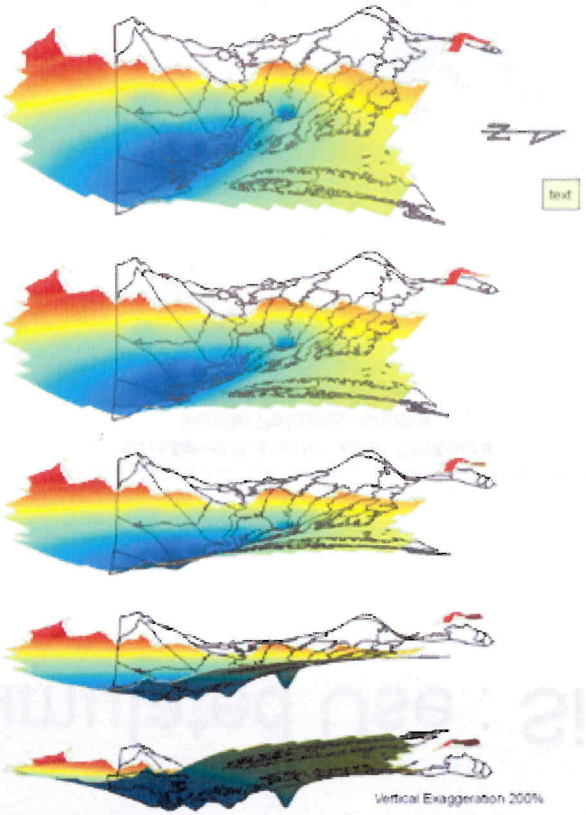




Simulated Potentiometric Surface – Upper Potomac Total Permitted Example

Drawdown Surface

2003 Total Permitted Use: Upper Potomac Aquifer
No Flow Boundary Effects, Eastern Boundary.



Active Model Area Upper Potomac Aquifer

Simulated Potentiometric Surface (feet msl)

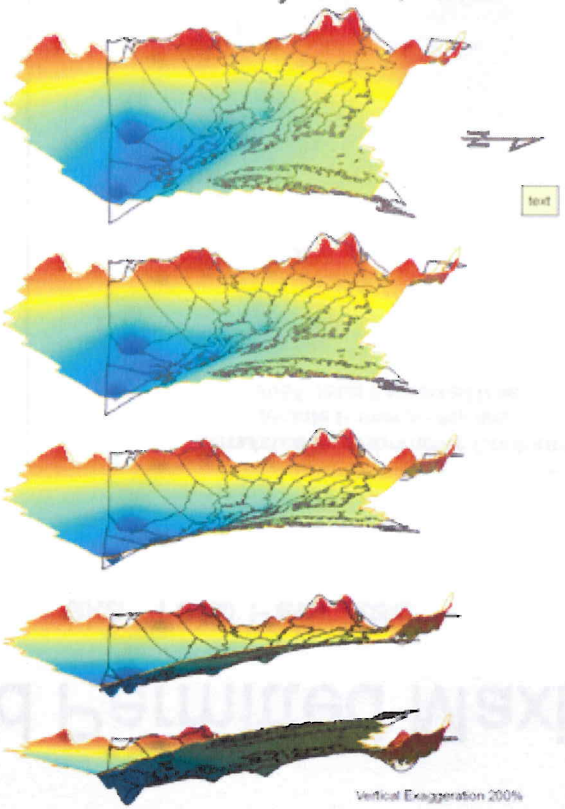
High : 127.826

Low : -168.528

Prepared by Beverly Quinlan
Ground Water Data Manager
Water Resources Division
March 1, 2005

DEQ
Virginia Department of Environmental Quality

2003 Total Permitted Use: Middle Potomac Aquifer
No Flow Boundary Effects, Eastern Boundary.



Active Model Area Middle Potomac Aquifer

Simulated Potentiometric Surface (feet msl)

High : 158.886

Low : -212.992

Prepared by Beverly Quinlan
Ground Water Data Manager
Water Resources Division
March 1, 2005

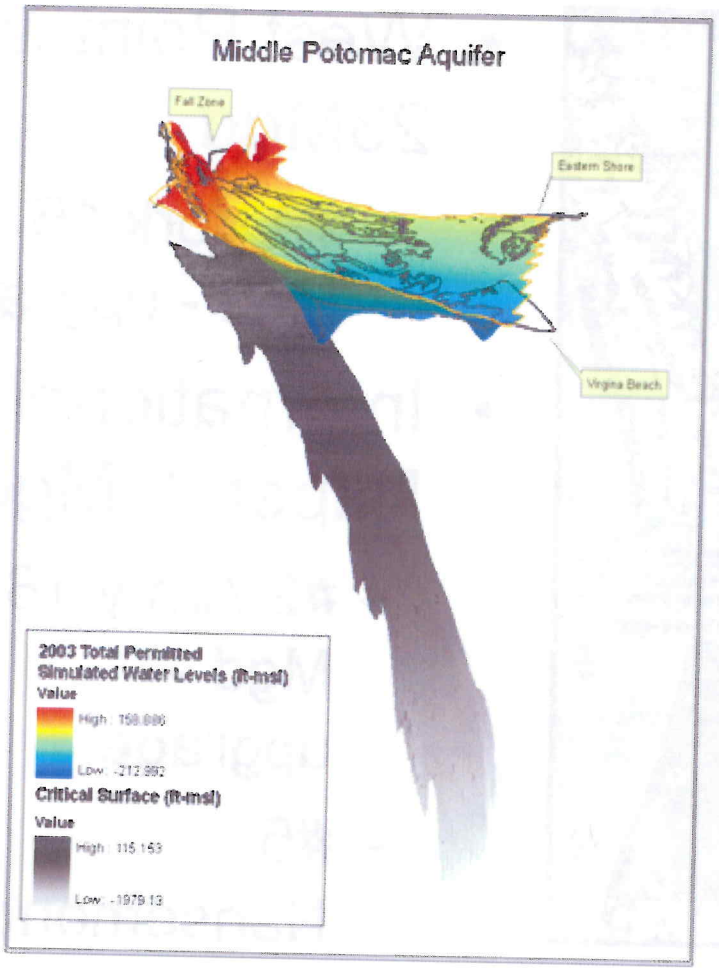
DEQ
Virginia Department of Environmental Quality

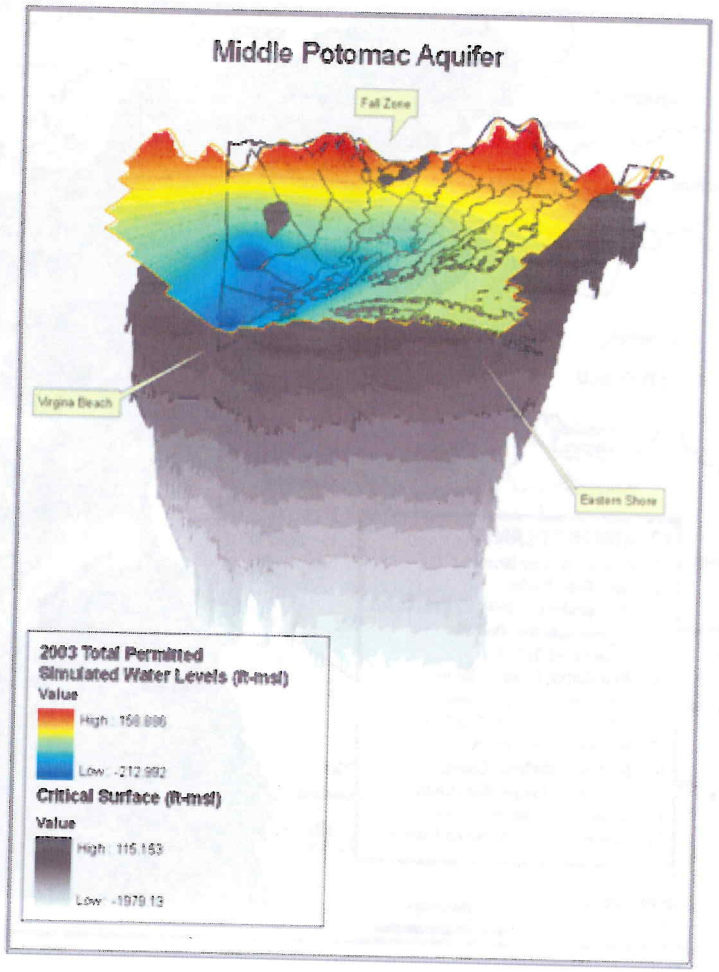
Simulated Potentiometric Surface and Middle Potomac Critical Cells

The Potomac Problem

It's the water levels AND the geology…

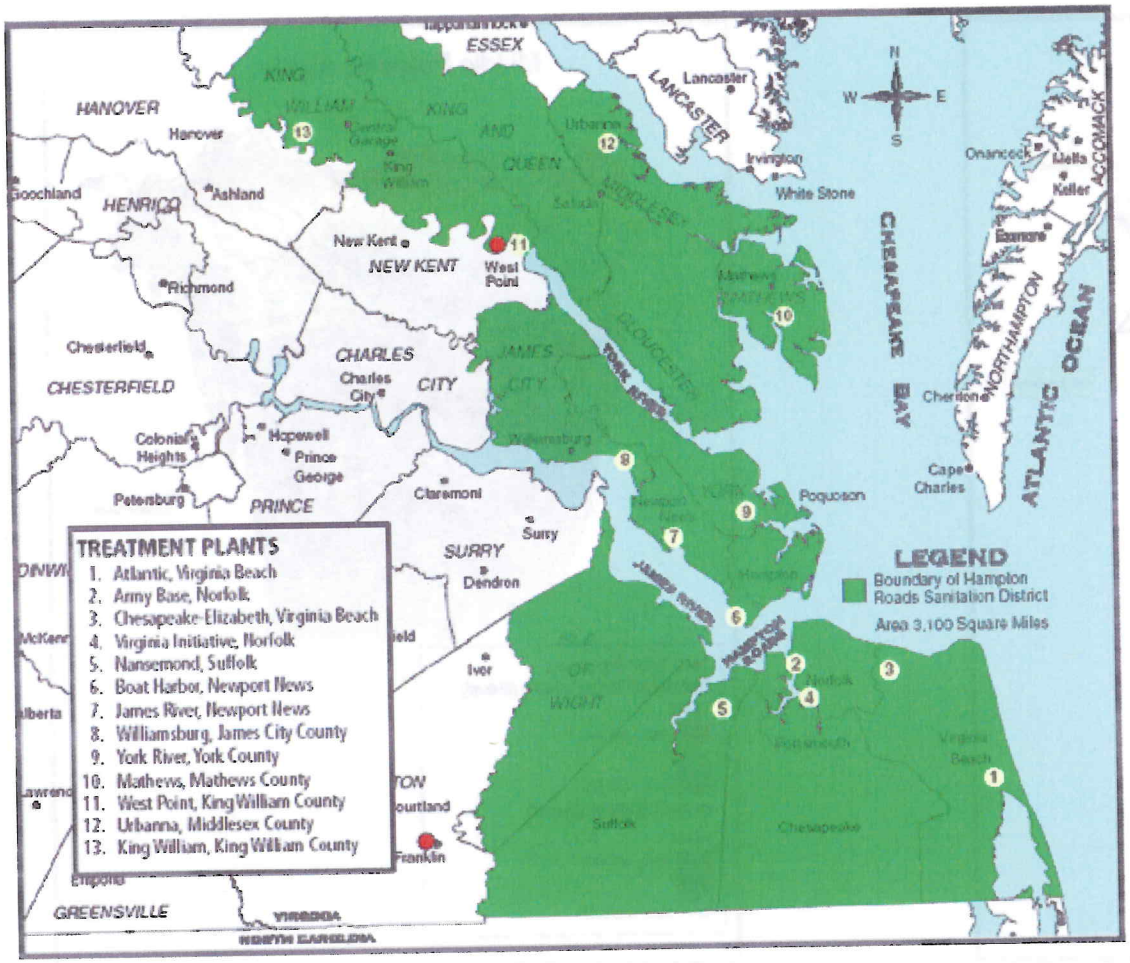
vertical scale greatly exaggerated





Regional Water Reuse Map

HRSD Potential Reuse Water



- West Point Mill 23Mgd
  - #9 York 15 Mgd - upgrade
- International Paper 37Mgd
  - #2 Army 18 Mgd – upgrade
  - #5 Nansemond 30 Mgd