

Virginia Eastern Shore Model 2018-2019 Simulation of Potentiometric Groundwater Surface Elevations of Reported and Total Permitted Use

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Office of Water Supply
Water Withdrawal Permitting and Compliance
Water Planning Division



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1. VESM Model Background

The Virginia Eastern Shore Model¹ (VESM) is a SEAWAT² groundwater model which encompasses all of the Delmarva Peninsula within Virginia and part of the peninsula in southern Maryland. The original groundwater model was created by the USGS and simulates water levels within the aquifers and confining units of the Eastern Shore from 1900 through 2003 based upon historic pumping records. Water levels are simulated for the Upper, Middle, and Lower Yorktown-Eastover aquifers and confining units as well as the Eastville and Exmore Paleochannel aquifers.

For aquifers near coastal areas the increase in density across a transition zone from fresh groundwater to seawater significantly affects the direction of groundwater flow. The capacity of SEAWAT to simulate the variable-density form of the groundwater flow equation increases the accuracy of simulated water levels in the Eastern Shore aquifers.

The original VESM was updated and adapted for use in the VA-DEQ well permitting process in 2010 and is now referred to as VAHydroGW-ES. Water levels within the aquifers were simulated to respond quickly to changes in simulated pumping. Consequently, when repeating the 2003 stresses for 50 years the simulated water levels reached “equilibrium” very quickly and at the end of the simulation were very similar to those simulated with a steady-state version of the model. Because of the very short simulation time, and the similarity in simulated water levels, the steady-state version of the VAHydroGW-ES was used from 2010 through 2015 for modeling the water level impact of proposed withdrawals in the well permitting process. The steady-state version of the model does not simulated changes in salinity. For larger withdrawals and some smaller withdrawals located near the coastal areas it was necessary to simulate the potential for saltwater intrusion as part of the well permitting process. In order to do so the VESM was modified by repeating all of the 2003 stresses for each year through 2010. The 2010 total permitted pumping rates were then added to the model and repeated for 50 years. Changes in chloride concentrations due to a proposed withdrawal were observed at the end of the 50 years and used to assess the potential for water quality degradation.

Between the time that the VESM was updated and adapted for use in the VA-DEQ well permitting process in 2010 and the updates to the VAHydroGW-ES were completed as outlined in this report, the Virginia Coastal Plain Model³ (VCPM) was adapted for use in the VA-DEQ well permitting process in 2013. The VCPM is a SEAWAT groundwater model which encompasses all of the Coastal Plain within Virginia and parts of the Coastal Plain in northern North Carolina and southern Maryland. The original groundwater model was created by the USGS and simulates water levels within the aquifers and confining units of the coastal plan from 1890 through 2003 based upon historic pumping records.

¹ Sanford, W.E., Pope, J.P., and Nelms, D.L., 2009, Simulation of groundwater-level and salinity changes in the Eastern Shore, Virginia: U.S. Geological Survey Scientific Investigations Report 2009-5066, 125 p..

² Langevin, C.D., Thorne, D.T., Jr., Dausman, A.M., Sukop, M.C., and Guo, Weixing, 2008, SEAWAT Version 4: A Computer Program for Simulation of Multi-Species Solute and Heat Transport: U.S. Geological Survey.

³ Heywood and Pope, Simulation of Groundwater Flow in the Coastal Plain Aquifer System of Virginia, Scientific Investigation Report 2009-5039.

The updated and adapted VCPM is referred to as the VAHydroGW-VCPM model. The VCPM updating process included modifying the VCPM to simulate water levels for 50 years beyond the end of the historic portion of the model (1890 - 2012) – this 50 year portion of the model is referred to as the predictive portion of the model. The predictive portion of the model was based upon two scenarios: the *Total Permitted Scenario* and the *Reported Use Scenario*.

Similarly, the VAHydroGW-ES updates outlined in this report document the creation of a 50 year predictive portion of the model. The VAHydroGW-ES 50 year predictive model is also based upon two scenarios: the *Total Permitted Scenario* and the *Reported Use Scenario*. The 50 year *Total Permitted Scenario* is now used for evaluation of VA-DEQ groundwater withdrawal permit technical evaluations on the Eastern Shore as opposed to the steady-state version of the model used previously. This change was adopted for four primary reasons: first, the use of a 50 year VAHydroGW-ES model would match the approach used by the VAHydroGW-VCPM on the Coastal Plain; second, the VAHydroGW-ES water levels reach “equilibrium” before the end of the 50 year simulation; third, the release of a 64-bit version of SEAWAT significantly reduced the run time for a 50 year VAHydroGW-ES simulation; and fourth, the transient version of the model also simulated changes in salinity concentrations.

2. VESM Historic Model Updates

Water use data from 2004 through 2015 were obtained in electronic format from the Virginia DEQ’s VAHydro database. The Water Withdrawal Reporting Regulation requires annual reporting of monthly surface and groundwater withdrawals exceeding an average of 10,000 gallons per day. DEQ Office of Water Supply receives water use data from Groundwater Withdrawal Permit holders as a condition of their permits.

The VAHydroGW-ES encompasses all of the Delmarva Peninsula within Virginia and a portion of the Delmarva Peninsula in southern Maryland. Row and column assignments for withdrawals reported within Virginia were made using well locations (latitude and longitude) to plot the position on a GIS coverage of the VAHydroGW-ES finite-difference grid. Model layers for withdrawals were assigned based upon the top and bottom elevation of the withdrawal screens - using a land surface Digital Elevation Model (DEM) and the depths of the withdrawal screens. If necessary, adjustments to model layer assignments were made to align the assigned model layers with model layers containing the DEQ staff geologist’s assigned aquifer for each screen interval.

The historic portion of the VAHydroGW-ES was then updated by adding reported use pumping records from 2004 through 2015. For each year, the reported withdrawals were simulated at a constant rate (cfd) equivalent to the annual average for that year. Withdrawals from Maryland were simulated at the 2003 rates (the most recent year available at the time of the model execution). Boundary conditions, domestic withdrawals, and precipitation were simulated at the 2003 rates specified by the USGS in the original VAHydroGW-ES for the years 2004 through 2015.

Once the inputs to the historic VAHydroGW-ES were updated through 2015, the VAHydroGW-ES water level observations were updated with observed water levels from wells throughout the Virginia Eastern Shore. The VAHydroGW-ES aquifer hydraulic conductivity was recalibrated to reflect the updated inputs and observations. The results of the recalibration process are outlined in the report *Eastern Shore 2016 Model Updates and Recalibration* on file with the VADEQ. The updated and recalibrated VAHydroGW-ES model was then used to create the *VAHydroGW-ES 2015 Reported Use Simulation* and *VAHydroGW-ES 2016 Total Permitted Simulation* in November 2016. In September of 2017 the annual updates of the VAHydroGW-ES were performed to create the *VAHydroGW-ES 2016 Reported Use Simulation* and *VAHydroGW-ES 2017 Total Permitted Simulation*. In November of 2018 the annual updates of the VAHydroGW-ES were performed to create the *VAHydroGW-ES 2017 Reported Use Simulation* and *VAHydroGW-ES 2018 Total Permitted Simulation*.

The remainder of this report outlines the creation of the *VAHydroGW-ES 2018 Reported Use Simulation* and *VAHydroGW-ES 2019 Total Permitted Simulation*.

3. VAHydroGW-ES 2018 Reported Use Simulation

3.1 Model Preparation

The VAHydroGW-ES model (1900-2017) was updated with reported withdrawals for the 2018 calendar year. The *VAHydroGW-ES 2018 Reported Use Simulation* was created by taking the water levels and chloride concentrations at the end of the updated historic model (1900-2018) and using them as starting conditions for a 50 year predictive model. For this *VAHydroGW-ES 2018 Reported Use Simulation*, withdrawals from the Virginia Eastern Shore were simulated for the duration of the 50 year simulation using the average reported pumping for the 5 years from 2014 through 2018. Withdrawals from Maryland were simulated at the 2003 rates (the most recent year available at the time of the model execution). Boundary conditions, domestic withdrawals, and precipitation were simulated at the 2003 rates specified by the USGS in the original VESM for the duration of the 50 year simulation.

A total use of 7.32 million gallons per day (MGD) was assigned to all withdrawals in the *VAHydroGW-ES 2018 Reported Use Simulation*. A total use of 5.72 MGD was assigned to withdrawals within the Virginia Eastern Shore. Total use assigned to Maryland withdrawals was 1.60 MGD. A breakdown of the Virginia reported water use data by county appears in the Table 1.

Table 1. 2014-2018 Average Water Use Report -Withdrawals Modeled by County

| County | Use Allocated to Model (MGD) | Use Allocated to Model (%) |
|--------------|------------------------------|----------------------------|
| Accomack | 4.85 | 84.8% |
| Northampton | 0.87 | 15.2% |
| TOTAL | 5.72 | 100.0% |

The reported use amount allocated to each aquifer is shown in Table 2.

Table 2. Reported Use - Total Simulated Amount By Aquifer

| Aquifer | Use Allocated to Model (MGD) | Use Allocated to Model (%) |
|--------------------------|-------------------------------------|-----------------------------------|
| Surficial | 0.29 | 5.4% |
| Upper Yorktown-Eastover | 1.11 | 20.6% |
| Middle Yorktown-Eastover | 2.56 | 47.6% |
| Lower Yorktown-Eastover | 1.46 | 27.2% |
| Exmore Paleochannel | 0.27 | 5.1% |
| Eastville Paleochannel | 0.03 | 0.5% |
| TOTAL | 5.72 | 100.0% |

The *VAHydroGW-ES 2018 Reported Use Simulation* model outputs potentiometric water levels for each model layer. Water levels do not vary significantly between layers corresponding to a given aquifer. Consequently, the water levels from the end of the simulation for the uppermost model layer for each aquifer were analyzed. For each confined, regulated aquifer the water levels were assigned to corresponding Geographic Information System (GIS) grid cells then converted to an ArcView shapefile. The head values were then contoured using ESRI’s Spatial Analyst Spline tool. Smoothest contours were generated using the spline method (20 neighbors). The water levels from the end of the 50 year *VAHydroGW-ES 2018 Reported Use Simulation* are shown in Attachment A. The simulated chloride concentrations from the end of the 50 year *VAHydroGW-ES 2018 Reported Use Simulation* are shown in Attachment C.

3.2 VAHydroGW-ES Cells Violating the 80% Drawdown Criterion

The Upper, Middle, and Lower Yorktown-Eastover aquifer potentiometric water levels from the end of the *VAHydroGW-ES 2018 Reported Use Simulation* are all simulated above the critical surface for those aquifers.

4. VAHydroGW-ES 2019 Total Permitted Simulation

4.1 Withdrawals Simulated

9VAC25-610-110(D) (“Evaluation Criteria for permit applications”) of the GWMA Regulations requires the evaluation of proposed withdrawals in combination with all existing lawful withdrawals. This simulation was created by replacing the reported use amounts of the predictive portion of the *VAHydroGW-ES 2018 Reported Use Simulation* for all GWMA permit holders with the maximum annual withdrawal limit allowed under the terms of active permits – with the exception of Tyson Farms. Tyson Farms is currently permitted at 0.98 MGD and seeking an increased permitted pumping limit due to plant expansion. However, the final increased pumping limit has not been approved. For

the *VAHydroGW-ES 2019 Total Permitted Simulation*, Tyson Farms was simulated at the reported pumping amount for the year 2017 – 1.33 MGD.

All other withdrawals and model inputs from the *VAHydroGW-ES 2018 Reported Use Simulation* were not changed. For the GWMA permits that have been created or renewed after 2009 the permit amount was divided between the active wells of the permit based upon the apportionment table found in the permit’s technical evaluation. For all other GWMA permit holders the permitted amount was divided evenly between the active wells of the permit. For permits with a 10 or 15 year lump sum value, the lump sum value was divided evenly among the 10 or 15 year permit to obtain a yearly withdrawal rate. Once the total permitted yearly withdrawal rate was established for each permitted well, the permitted amount was then repeated for each year of 50 year the simulation.

Row and column assignments for permitted withdrawals within the Virginia Eastern Shore were made using well locations (latitude and longitude) to plot the position on a GIS coverage of the VAHydroGW-ES finite-difference grid. Model layers for withdrawals within the Virginia Eastern Shore were assigned based upon the top and bottom elevation of the withdrawal screens - using a land surface DEM and the depths of the withdrawal screens. If necessary, adjustments to model layer assignments were made to align the assigned model layers with model layers containing the DEQ staff geologist’s assigned aquifer for each screen interval. The VAHydroGW-ES utilizes the MODFLOW Multi-Node Well (MNW) package. The MNW package allows withdrawals so be assigned to multiple, consecutive (single aquifer withdrawals) or non-consecutive (multi-aquifer withdrawals) model layers. Modeled water extraction is allocated by the MNW package among assigned model layers based upon the layer hydrogeologic properties.

All of the permitted withdrawals simulated in the *VAHydroGW-ES 2019 Total Permitted Simulation* are listed in Attachment E. Table 3 outlines the withdrawal amounts in the *VAHydroGW-ES 2019 Total Permitted Simulation*. The total simulated withdrawal of 11.98 MGD is 4.66 MGD greater than the total amount reported as actual use.

Table 3. Simulated Total Permitted Withdrawals

| Withdrawal Source | Use Allocated to Model (MGD) | Use Allocated to Model (%) |
|--------------------------|-------------------------------------|-----------------------------------|
| GWMA Maximum Permitted | 10.38 | 86.6% |
| Maryland Reported Use | 1.60 | 13.4% |
| TOTAL | 11.98 | 100.0% |

A breakdown of the *VAHydroGW-ES 2019 Total Permitted Simulation* pumping data by county appears in the Table 4.

Table 4. Simulated Total Permitted Withdrawals -Withdrawals Modeled by County

| County | Use Allocated to Model (MGD) | Use Allocated to Model (%) |
|---------------|-------------------------------------|-----------------------------------|
| Accomack | 7.61 | 73.3% |
| Northampton | 2.77 | 26.7% |
| TOTAL | 10.38 | 100.0% |

The *VAHydroGW-ES 2019 Total Permitted Simulation* amount allocated to each aquifer is shown in Table 5.

Table 5. VAHydroGW-ES 2019 Total Permitted Simulation – Pumping Amount By Aquifer

| Aquifer | Use Allocated to Model (MGD) | Use Allocated to Model (%) |
|--------------------------|-------------------------------------|-----------------------------------|
| Surficial | 0.99 | 9.5% |
| Upper Yorktown-Eastover | 3.03 | 29.2% |
| Middle Yorktown-Eastover | 3.92 | 37.7% |
| Lower Yorktown-Eastover | 1.78 | 17.1% |
| Exmore Paleochannel | 0.60 | 5.8% |
| Eastville Paleochannel | 0.07 | 0.7% |
| TOTAL | 10.38 | 100.0% |

The water levels from the end of the 50 year *VAHydroGW-ES 2019 Total Permitted Simulation* are shown in Attachment B. The simulated chloride concentrations from the end of the 50 year *VAHydroGW-ES 2019 Total Permitted Simulation* are shown in Attachment D.

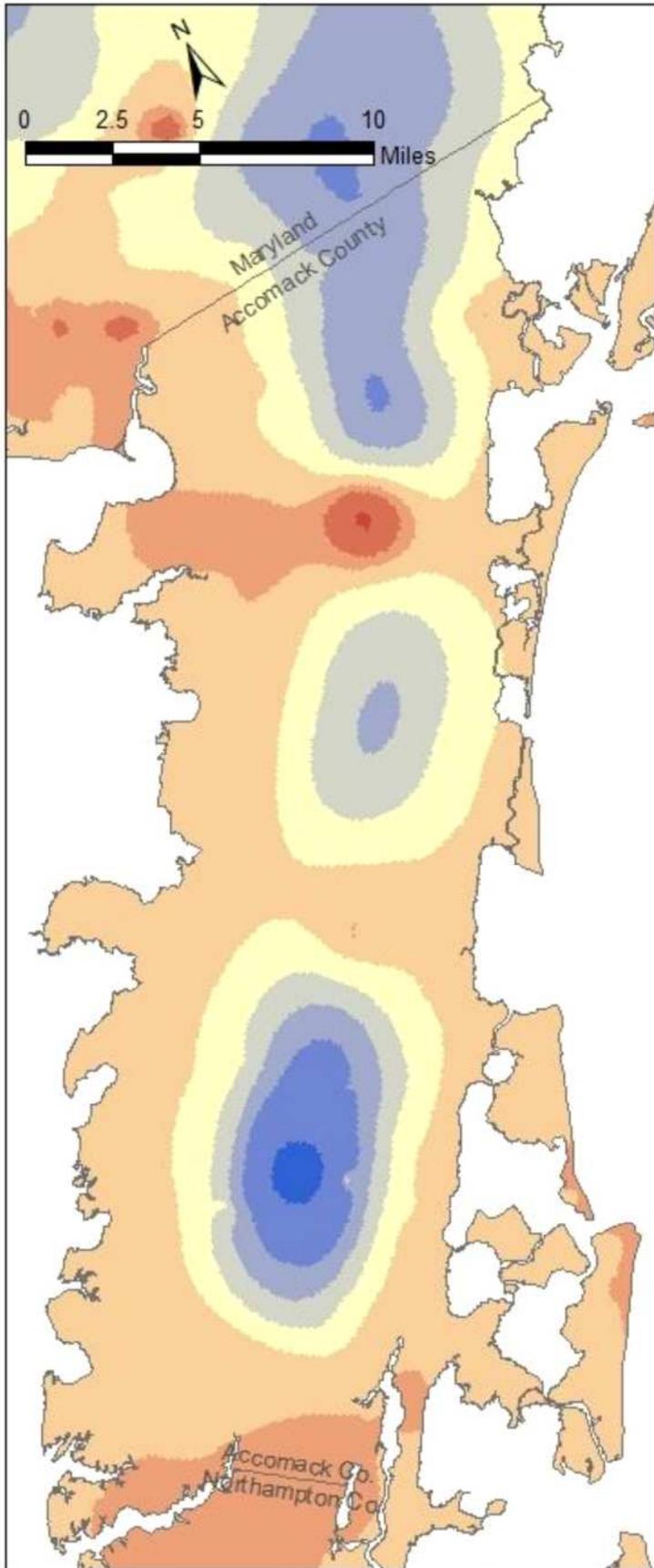
4.2 VESM Cells Violating the 80% Drawdown Criterion

The Upper, Middle, and Lower Yorktown-Eastover aquifer potentiometric water levels from the end of the *VAHydroGW-ES 2019 Total Permitted Simulation* are all simulated above the critical surface for those aquifers.

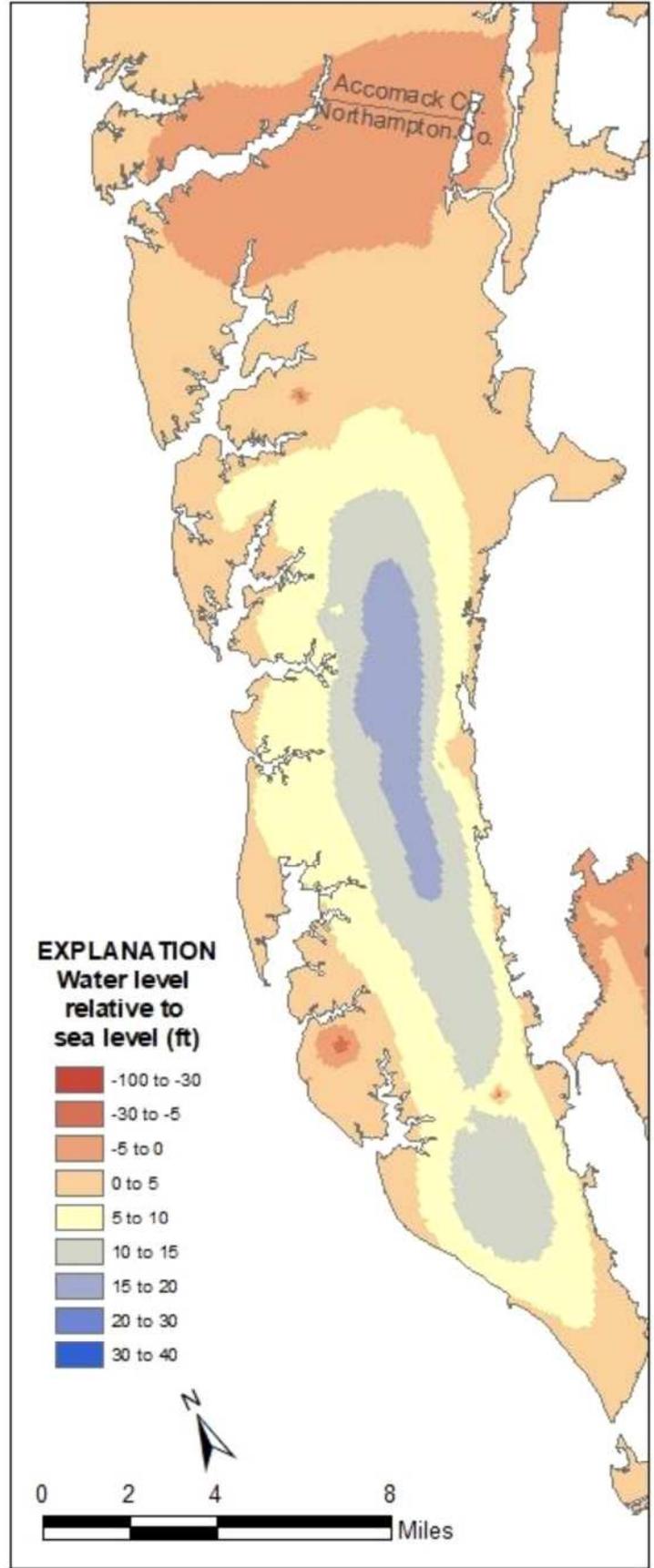
Attachment A

Simulated Potentiometric Contours VAHydroGW-ES 2018 Reported Use Simulation

VAHydro-ES 2018 Reported Use Simulation Upper Yorktown-Eastover Water Levels

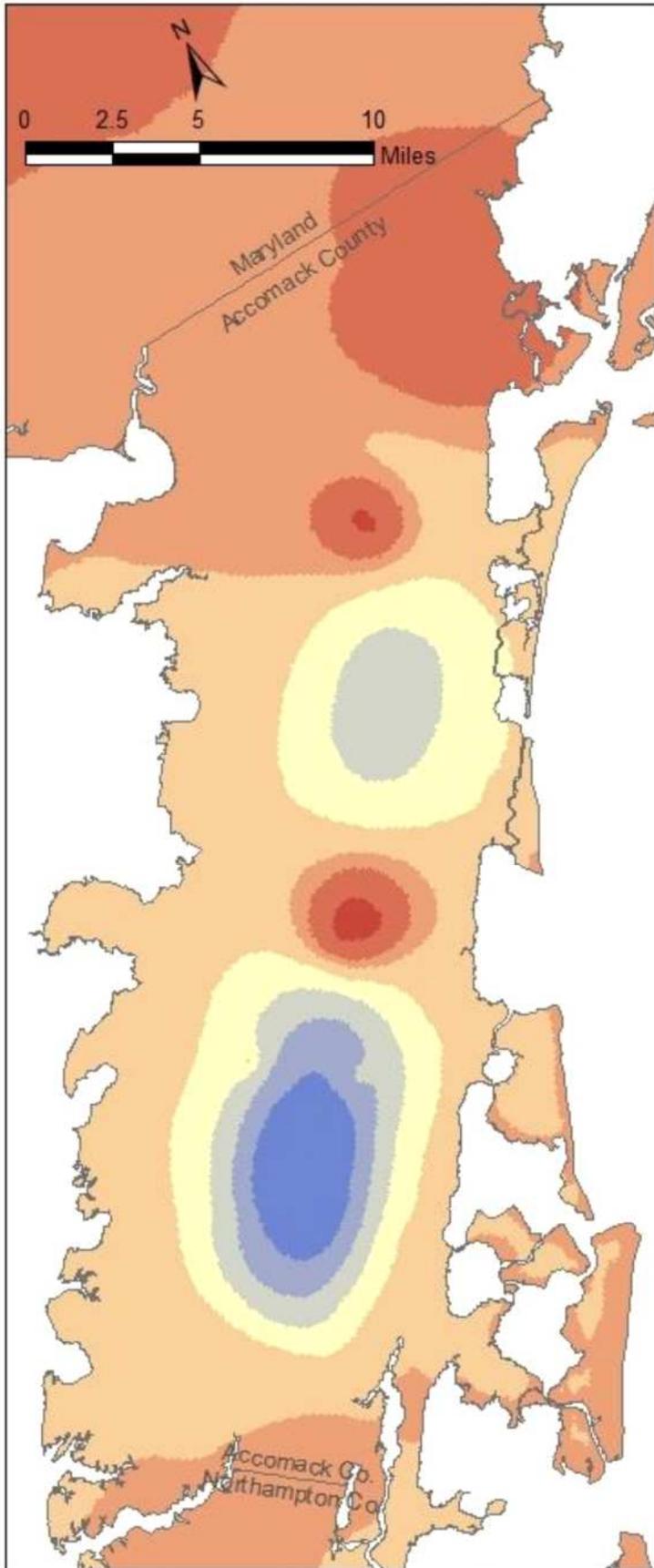


Accomack County

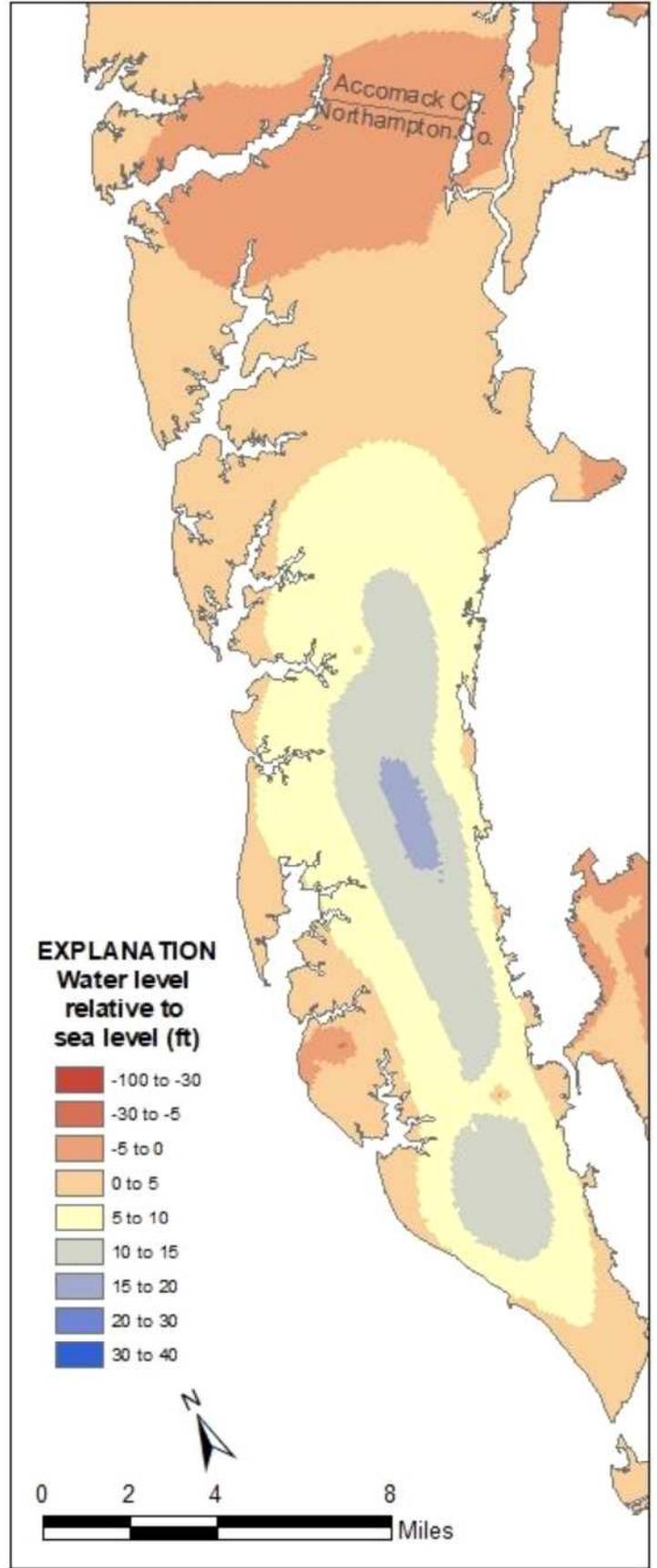


Northampton County

VAHydro-ES 2018 Reported Use Simulation Middle Yorktown-Eastover Water Levels



Accomack County

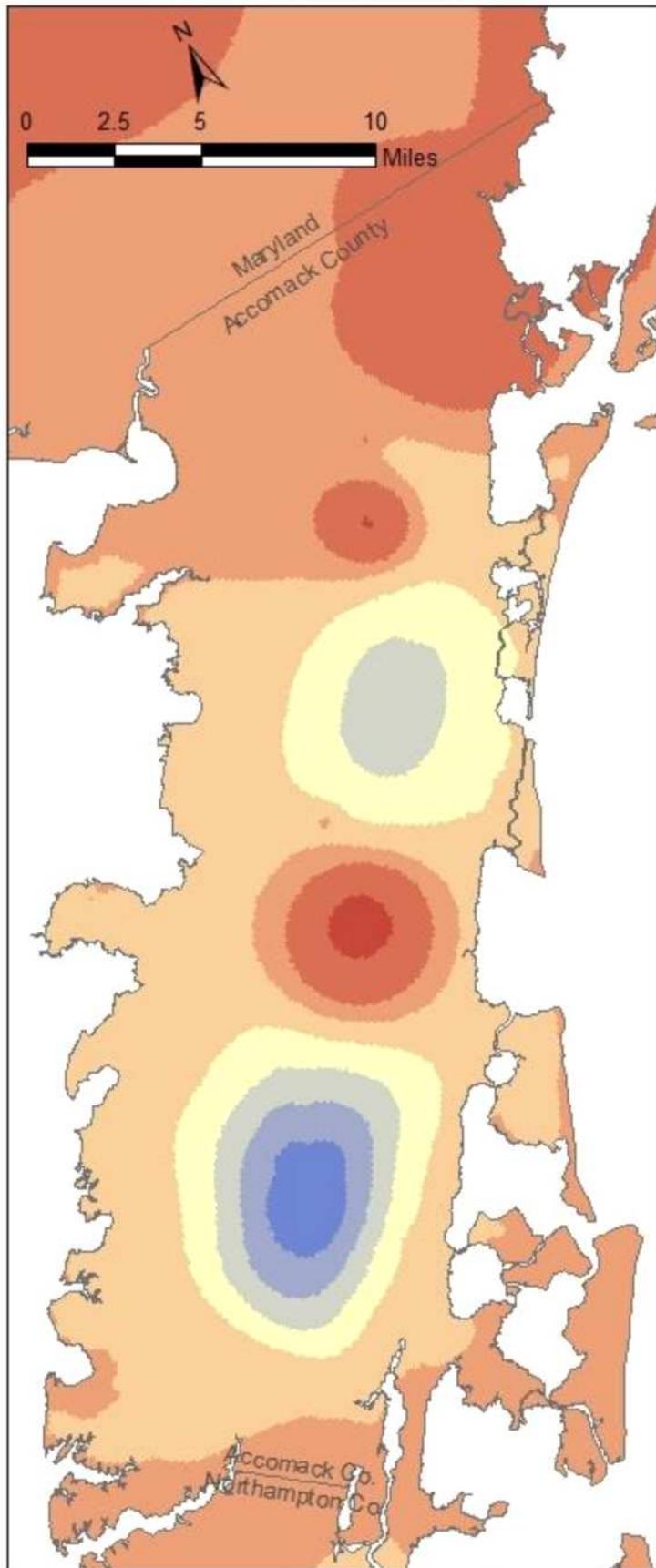


EXPLANATION
Water level
relative to
sea level (ft)

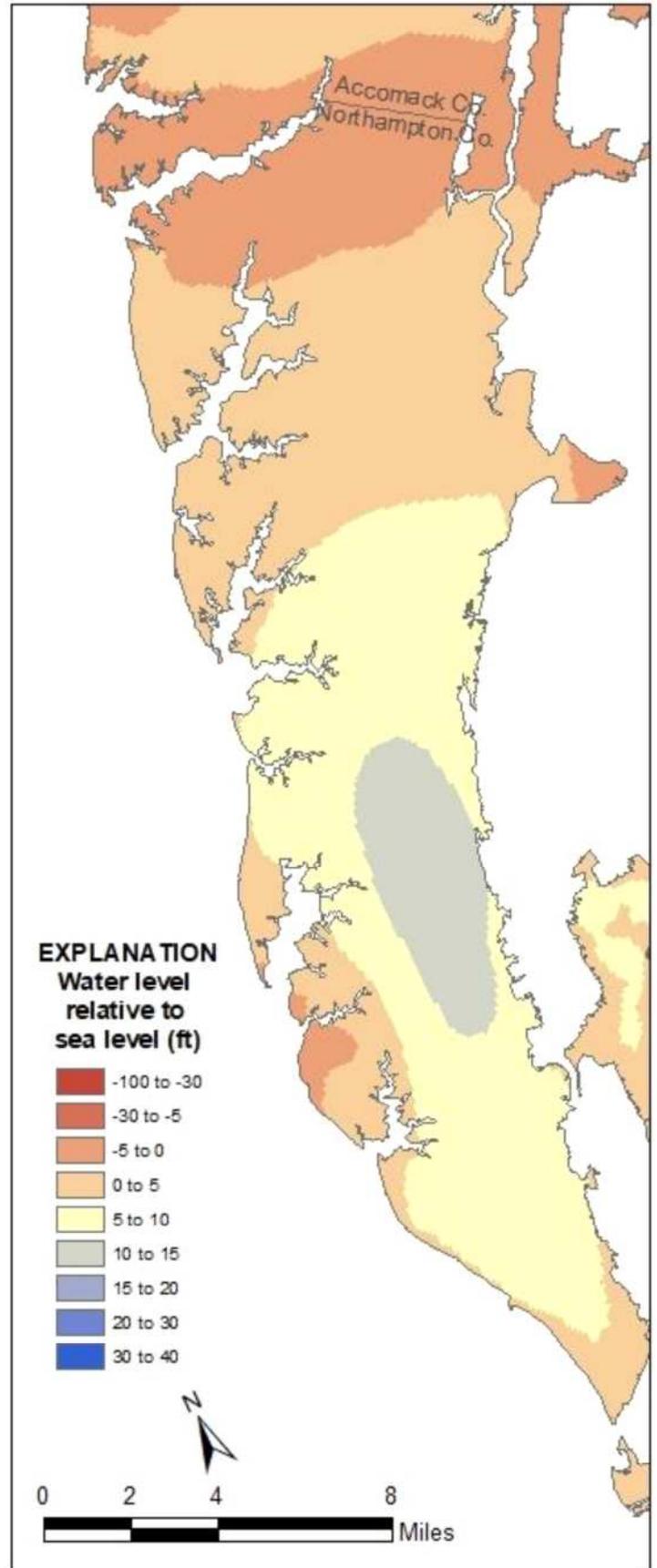
- 100 to -30
- 30 to -5
- 5 to 0
- 0 to 5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 30
- 30 to 40

Northampton County

VAHydro-ES 2018 Reported Use Simulation Lower Yorktown-Eastover Water Levels



Accomack County



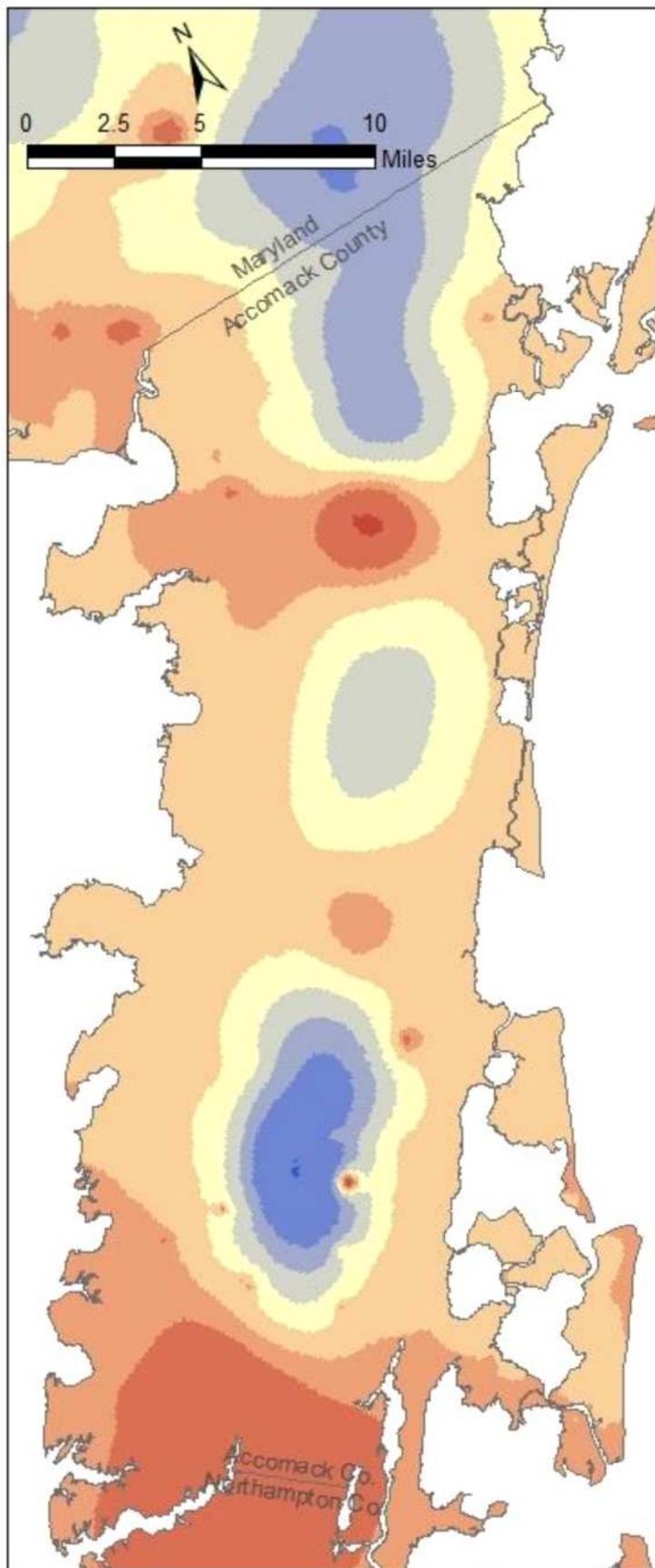
Northampton County

Attachment B

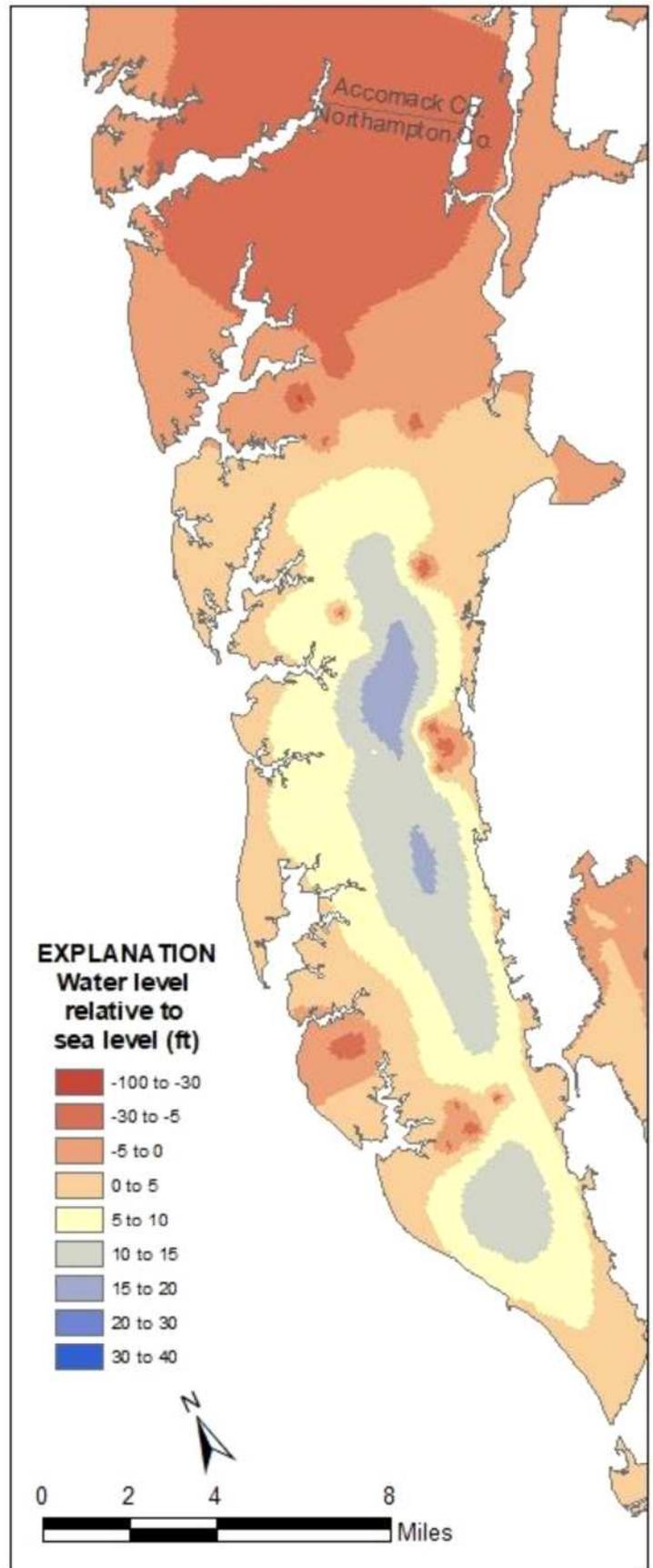
Simulated Potentiometric Contours

VAHydroGW-ES 2019 Total Permitted Simulation

VAHydro-ES 2019 Total Permitted Simulation Upper Yorktown-Eastover Water Levels

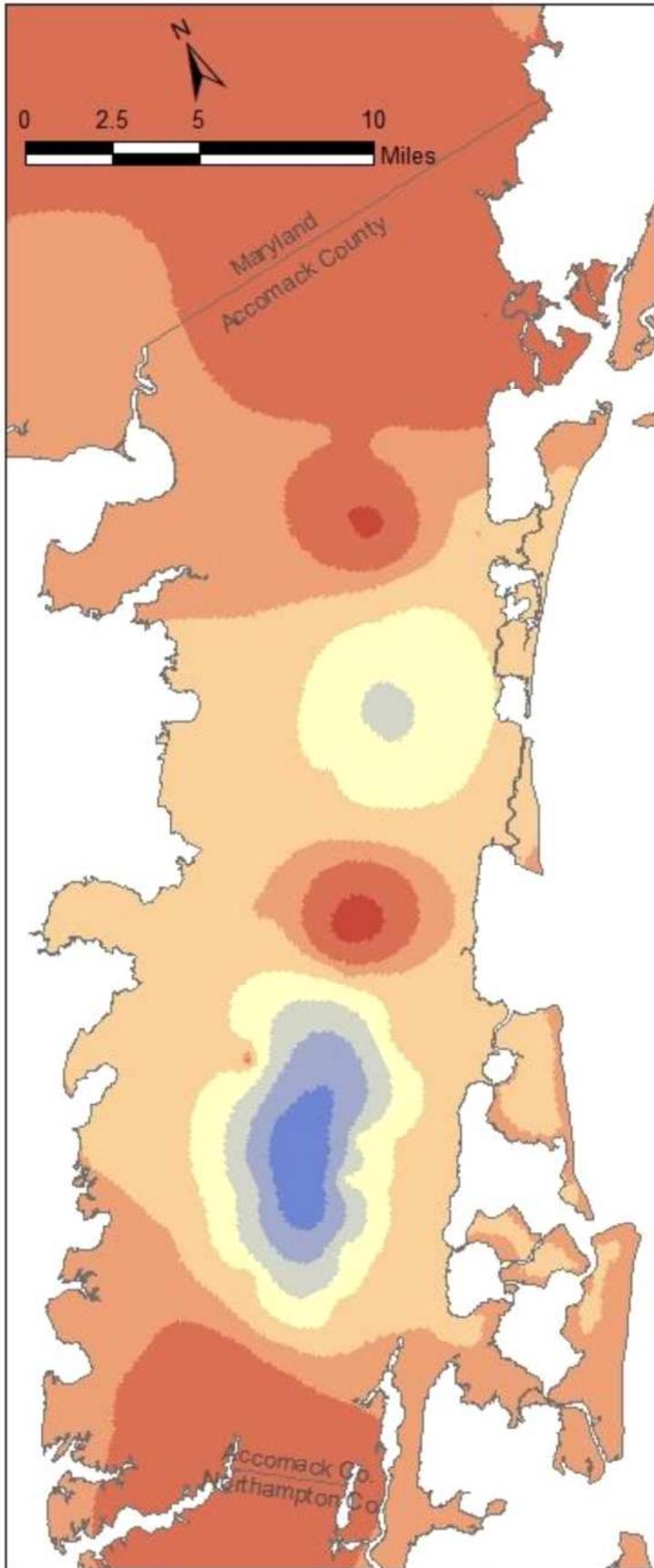


Accomack County

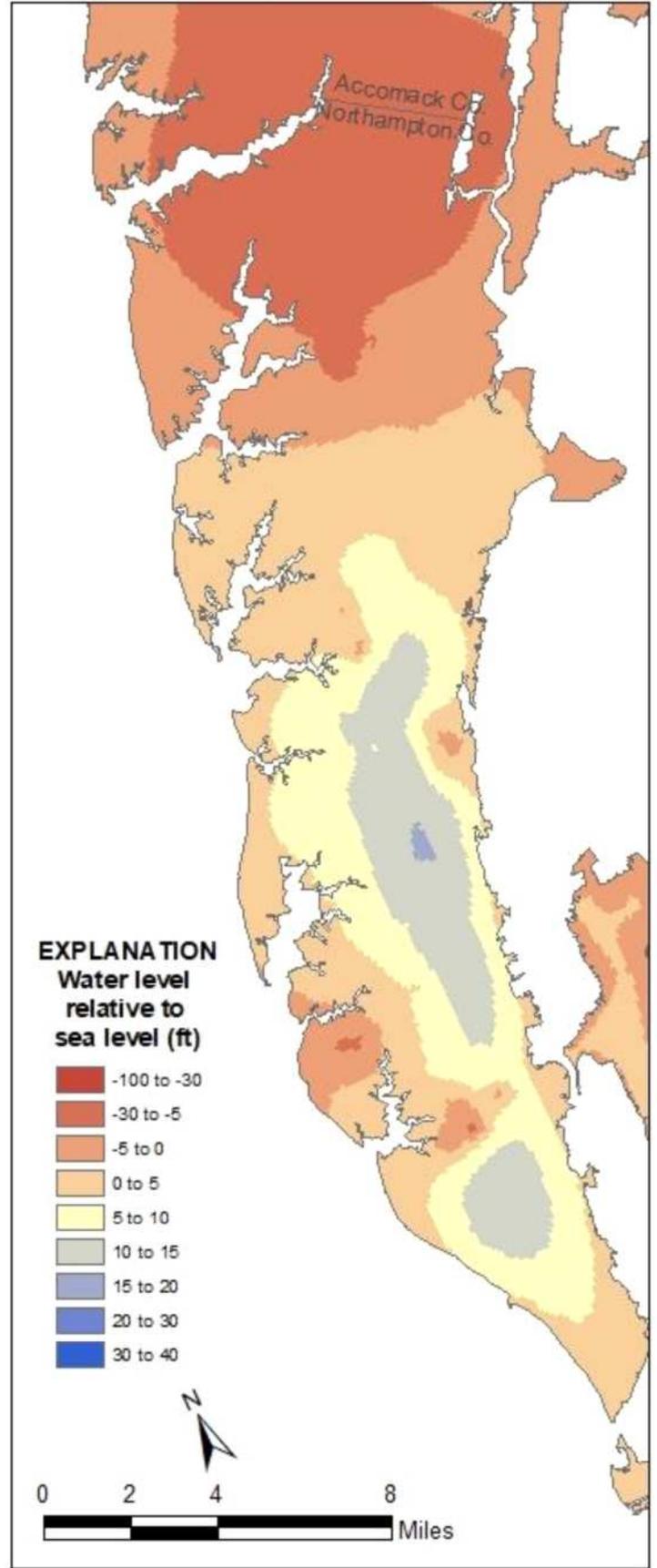


Northampton County

VAHydro-ES 2019 Total Permitted Simulation Middle Yorktown-Eastover Water Levels



Accomack County

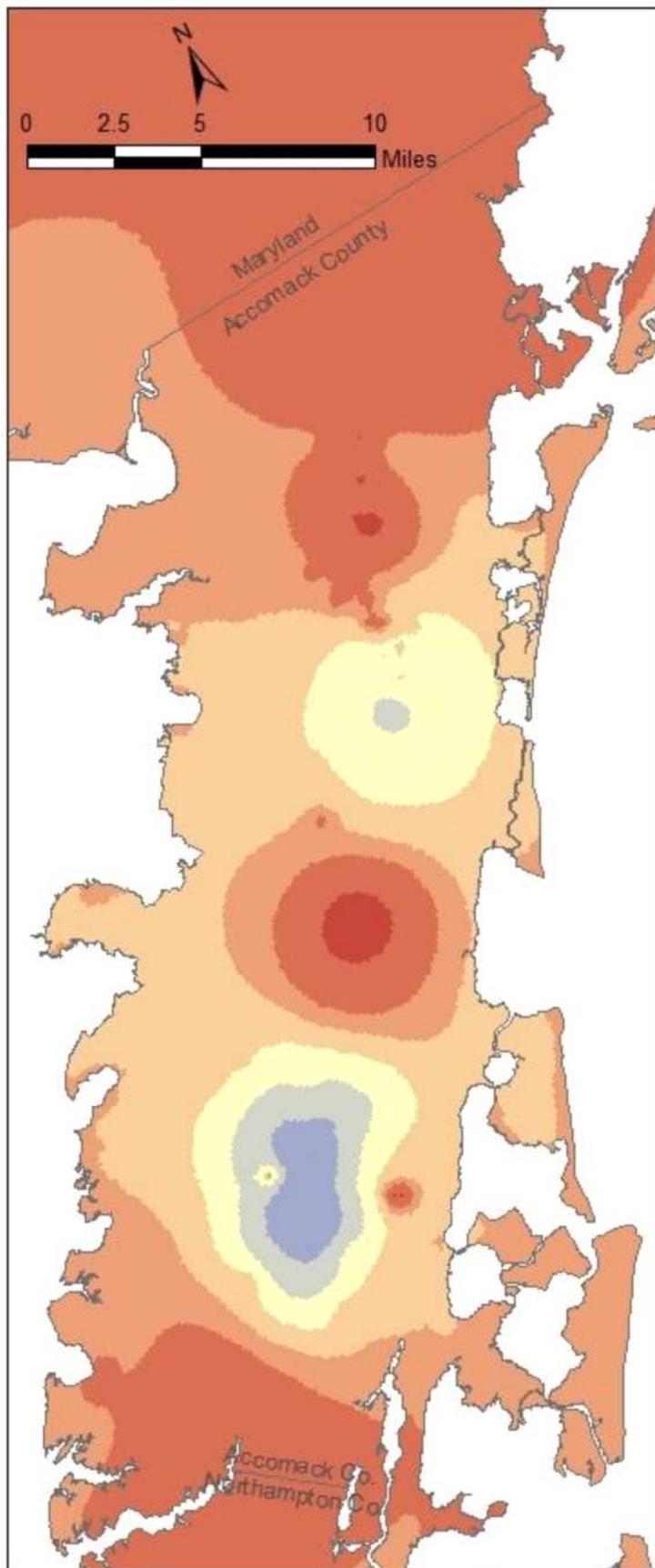


Northampton County

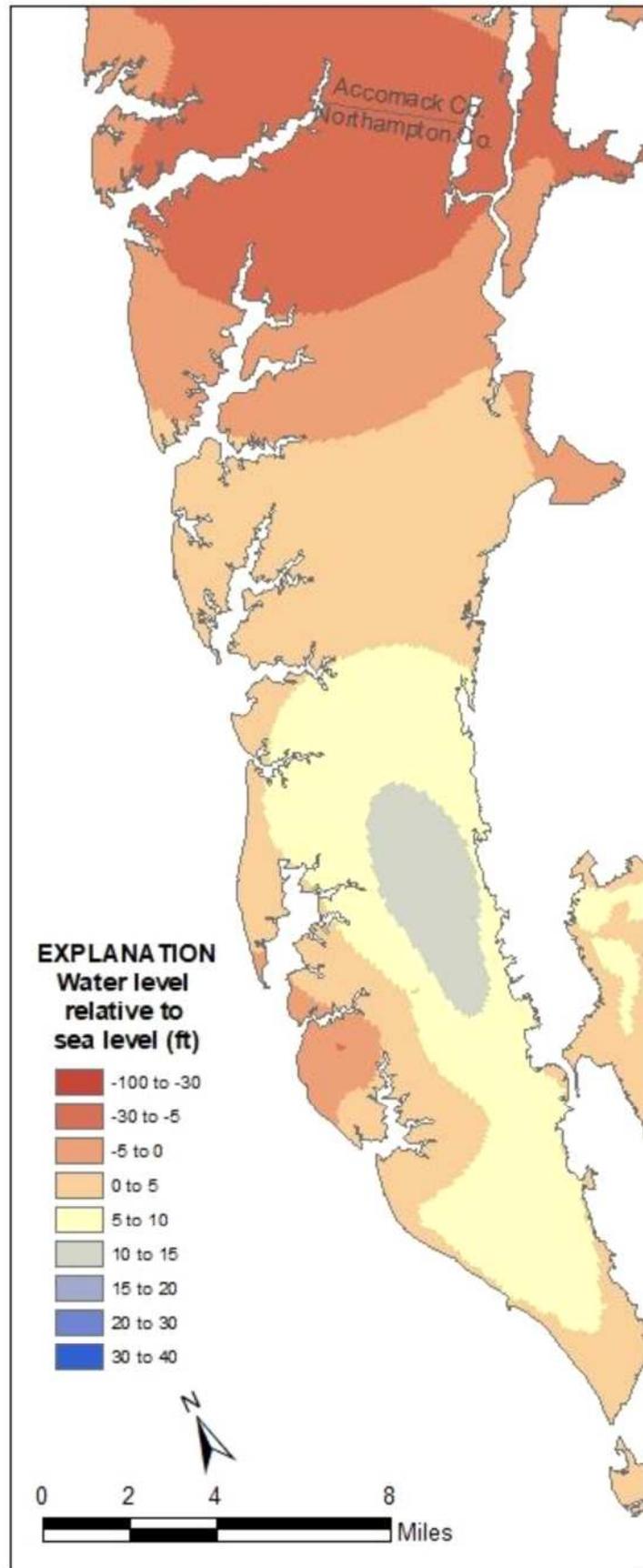
EXPLANATION
Water level relative to sea level (ft)

| | |
|--------------|-------------|
| Dark Red | -100 to -30 |
| Red | -30 to -5 |
| Orange | -5 to 0 |
| Light Orange | 0 to 5 |
| Yellow | 5 to 10 |
| Light Green | 10 to 15 |
| Green | 15 to 20 |
| Dark Green | 20 to 30 |
| Blue | 30 to 40 |

VAHydro-ES 2019 Total Permitted Simulation Lower Yorktown-Eastover Water Levels



Accomack County



Northampton County

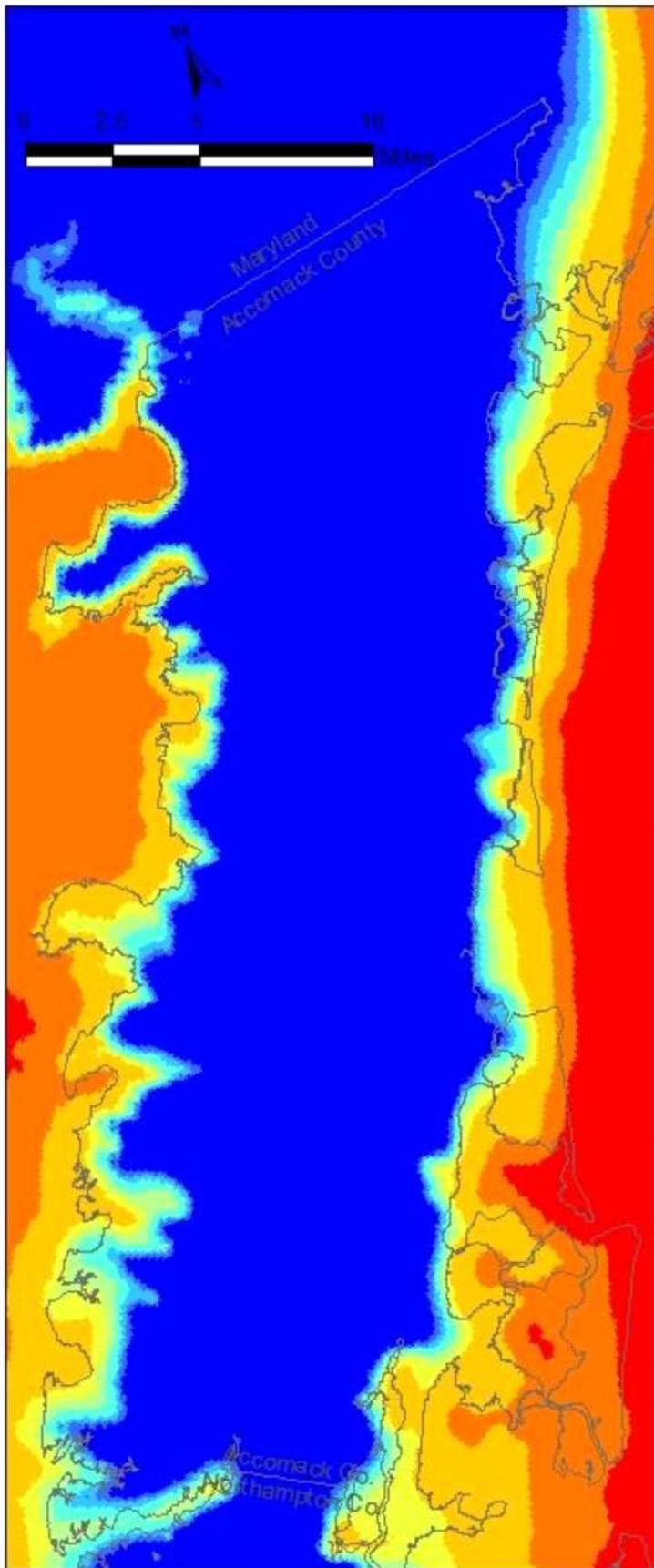
EXPLANATION
Water level
relative to
sea level (ft)

- 100 to -30
- 30 to -5
- 5 to 0
- 0 to 5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 30
- 30 to 40

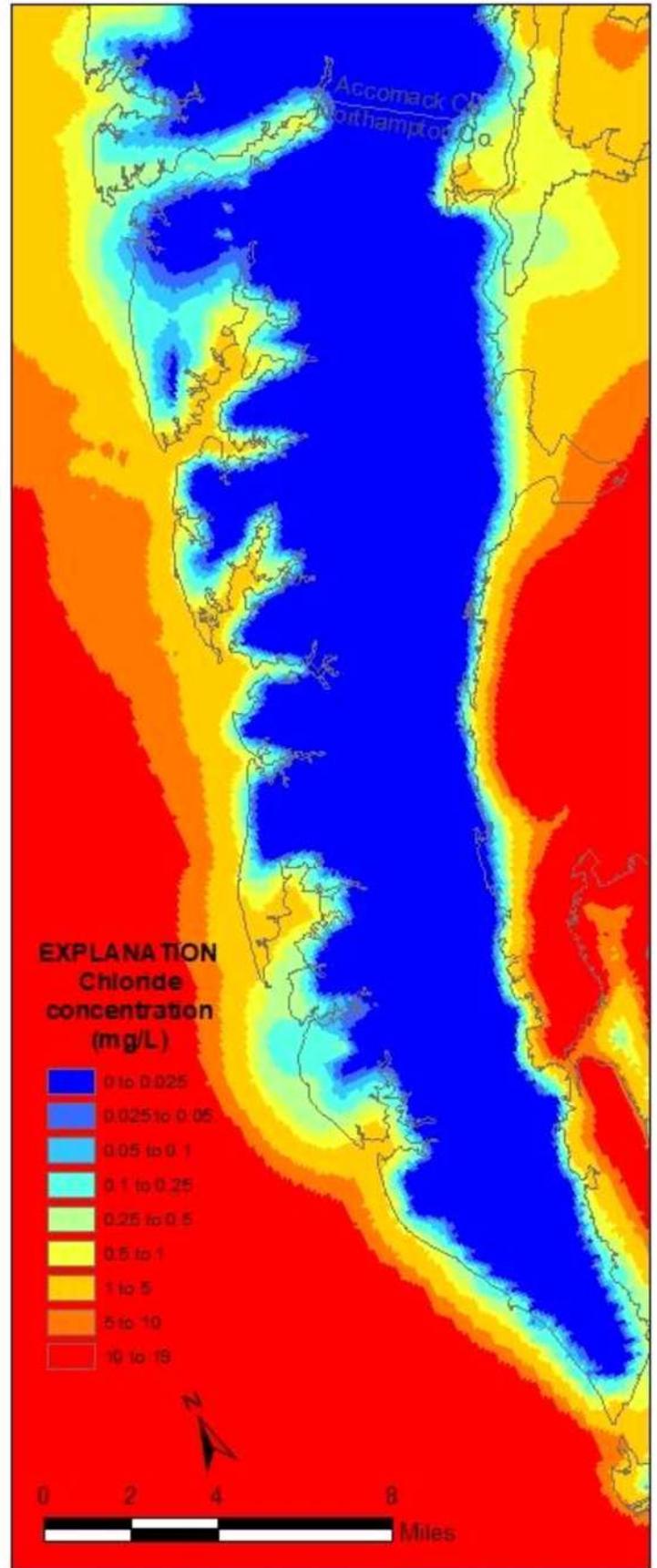
Attachment C

Simulated Chloride Concentrations VAHydroGW-ES 2018 Reported Use Simulation

VAHydro-ES 2018 Reported Use Simulation Upper Yorktown-Eastover Chloride Concentrations

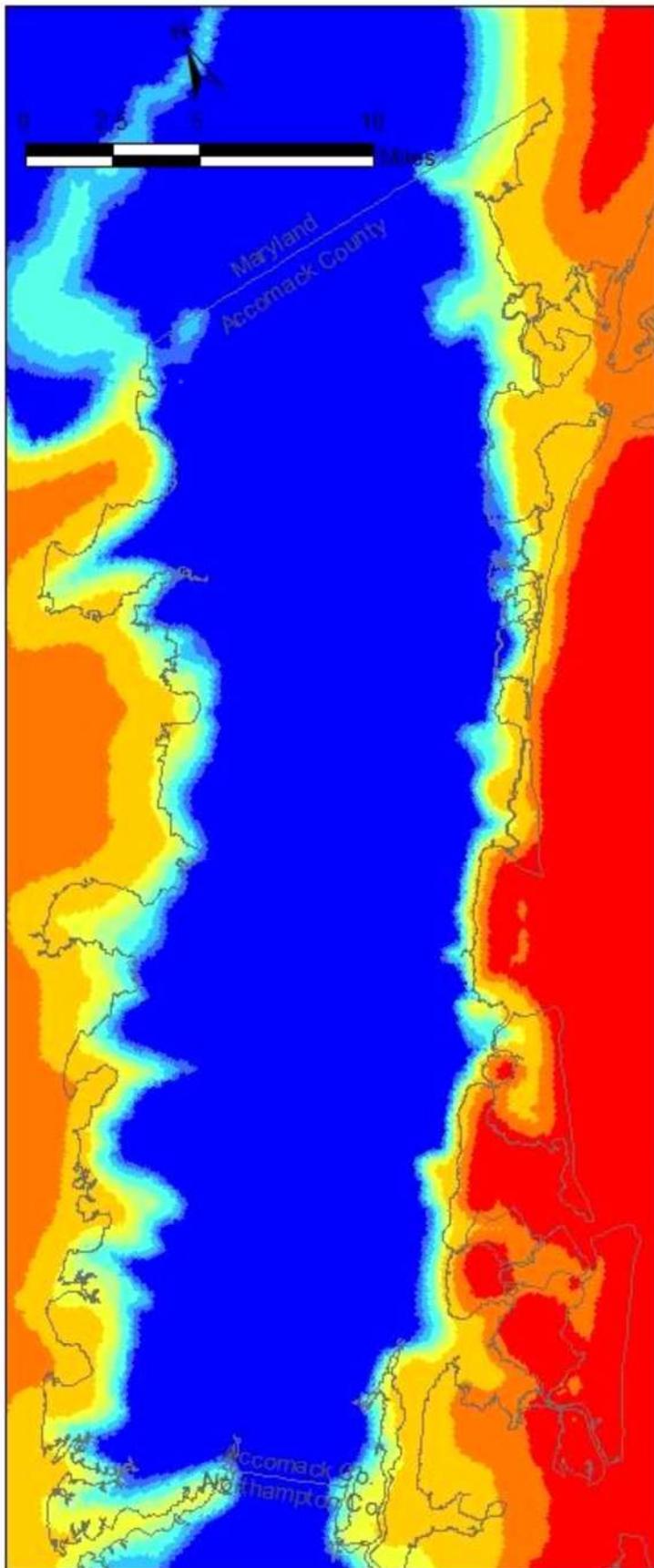


Accomack County

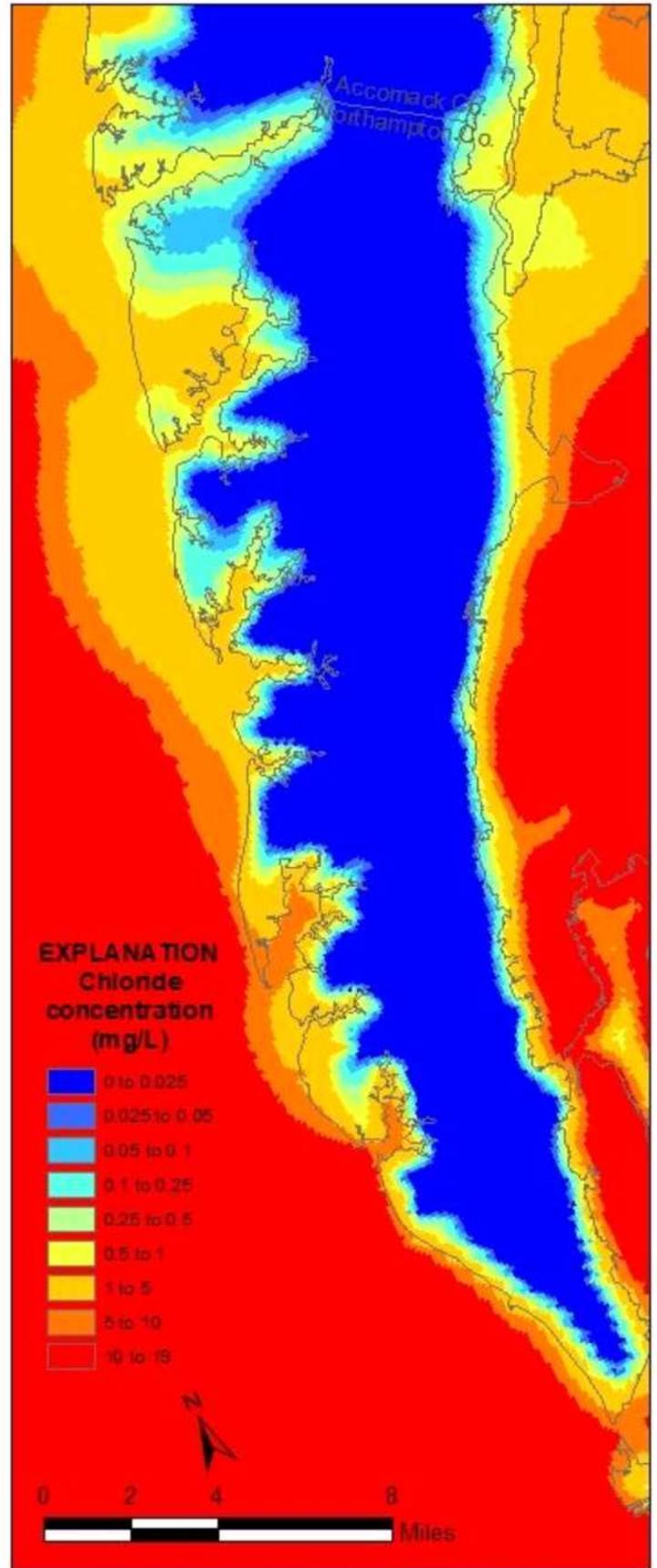


Northampton County

VAHydro-ES 2018 Reported Use Simulation Middle Yorktown-Eastover Chloride Concentrations

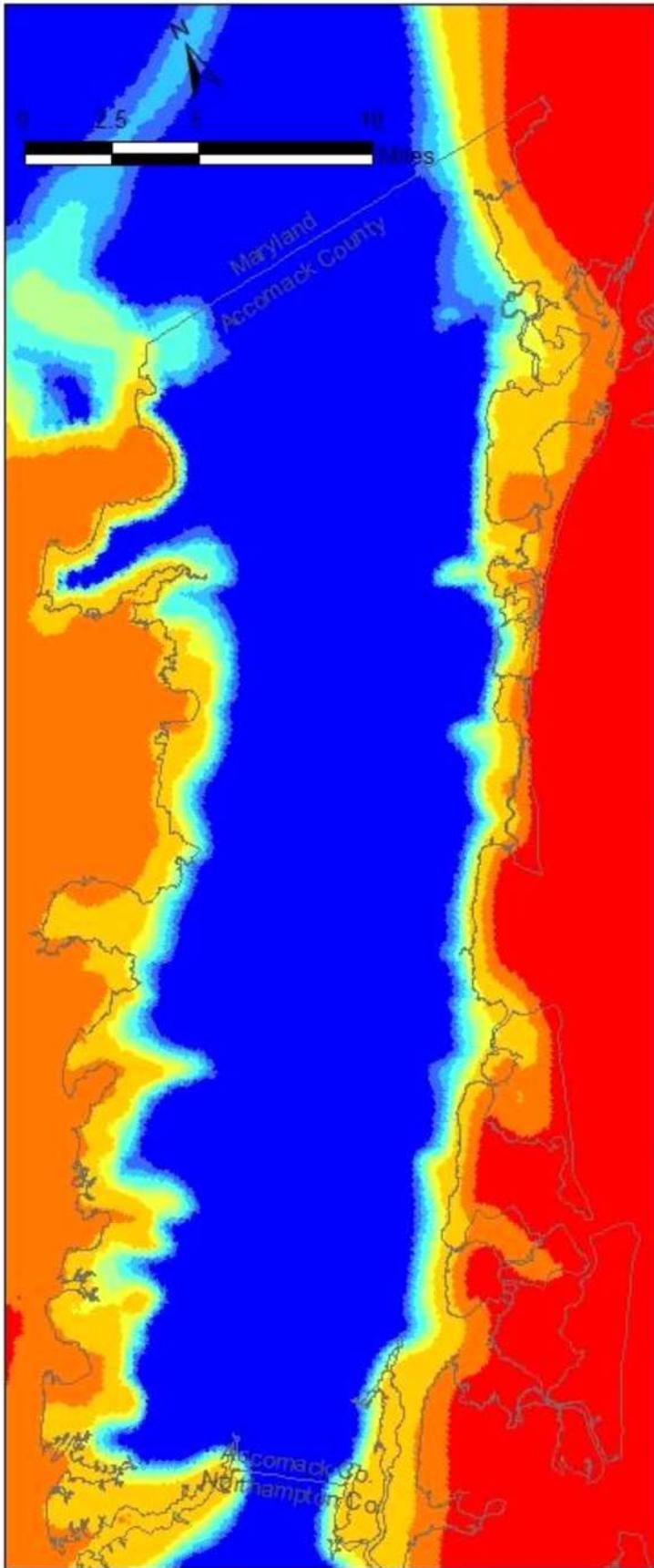


Accomack County

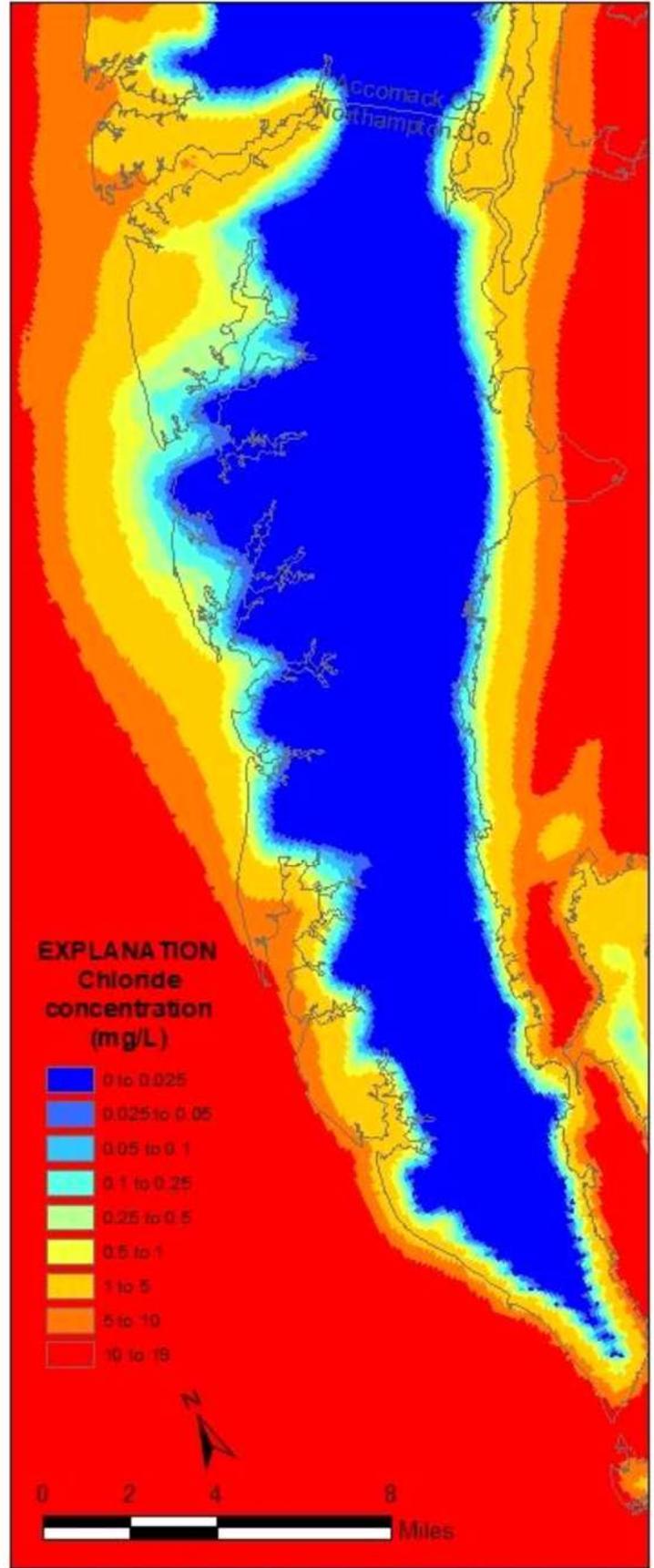


Northampton County

VAHydro-ES 2018 Reported Use Simulation Lower Yorktown-Eastover Chloride Concentrations



Accomack County



Northampton County

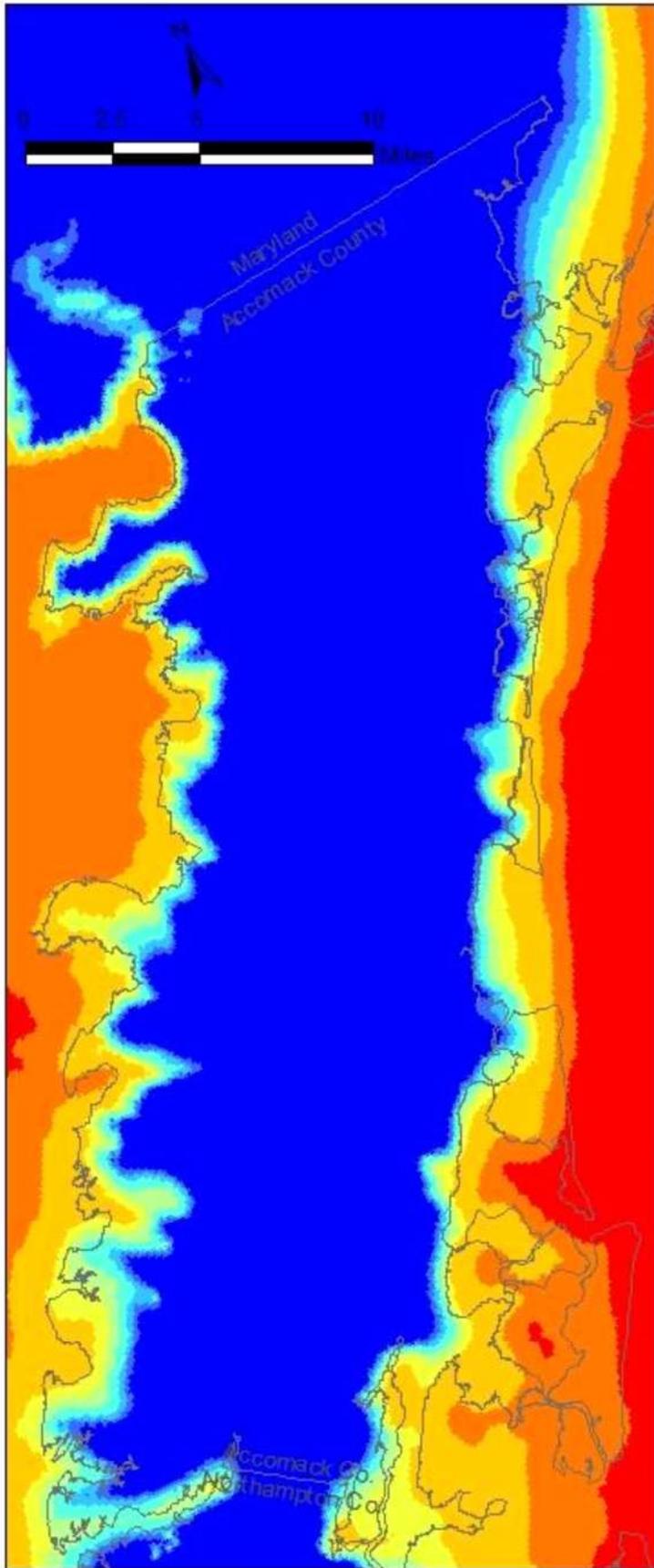
EXPLANATION
Chloride
concentration
(mg/L)

- 0 to 0.025
- 0.025 to 0.05
- 0.05 to 0.1
- 0.1 to 0.25
- 0.25 to 0.5
- 0.5 to 1
- 1 to 5
- 5 to 10
- 10 to 15

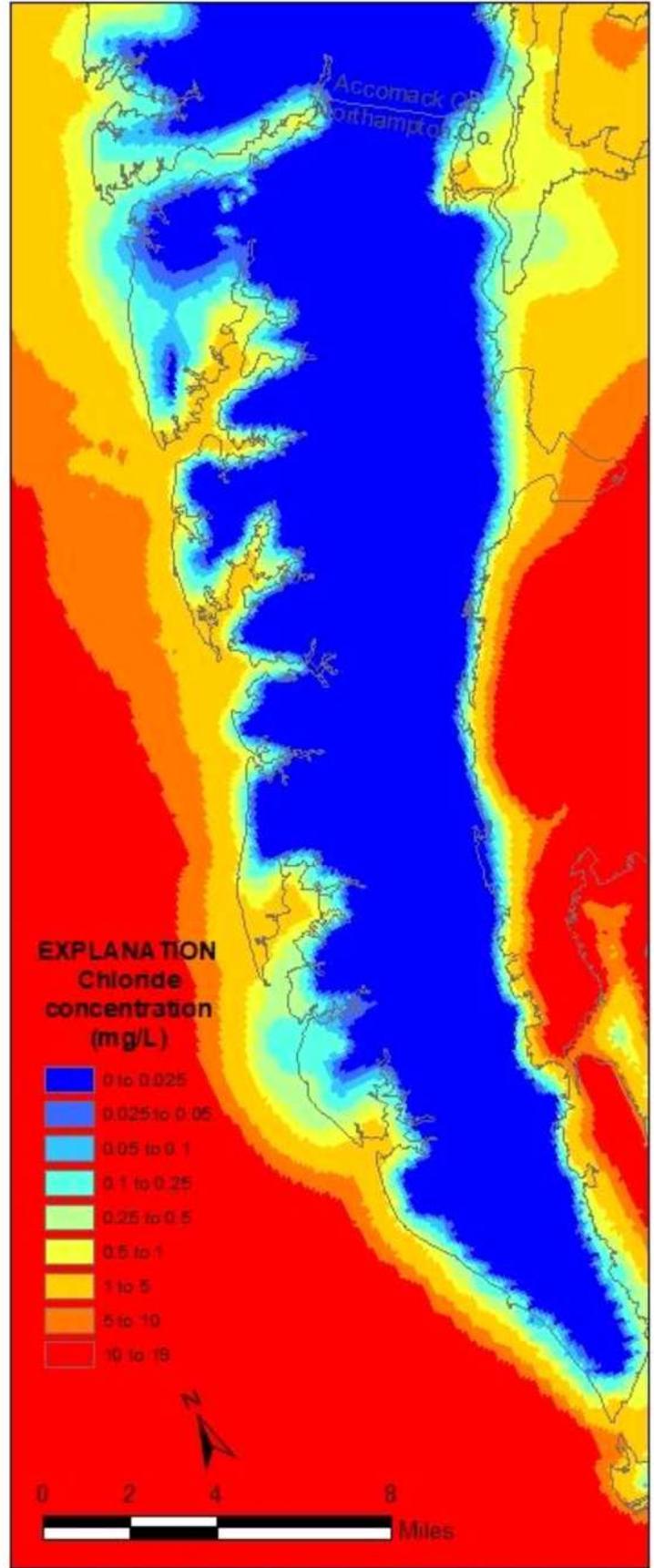
Attachment D

Simulated Chloride Concentrations VAHydroGW-ES 2019 Total Permitted Simulation

VAHydro-ES 2019 Total Permitted Simulation Upper Yorktown-Eastover Chloride Concentrations

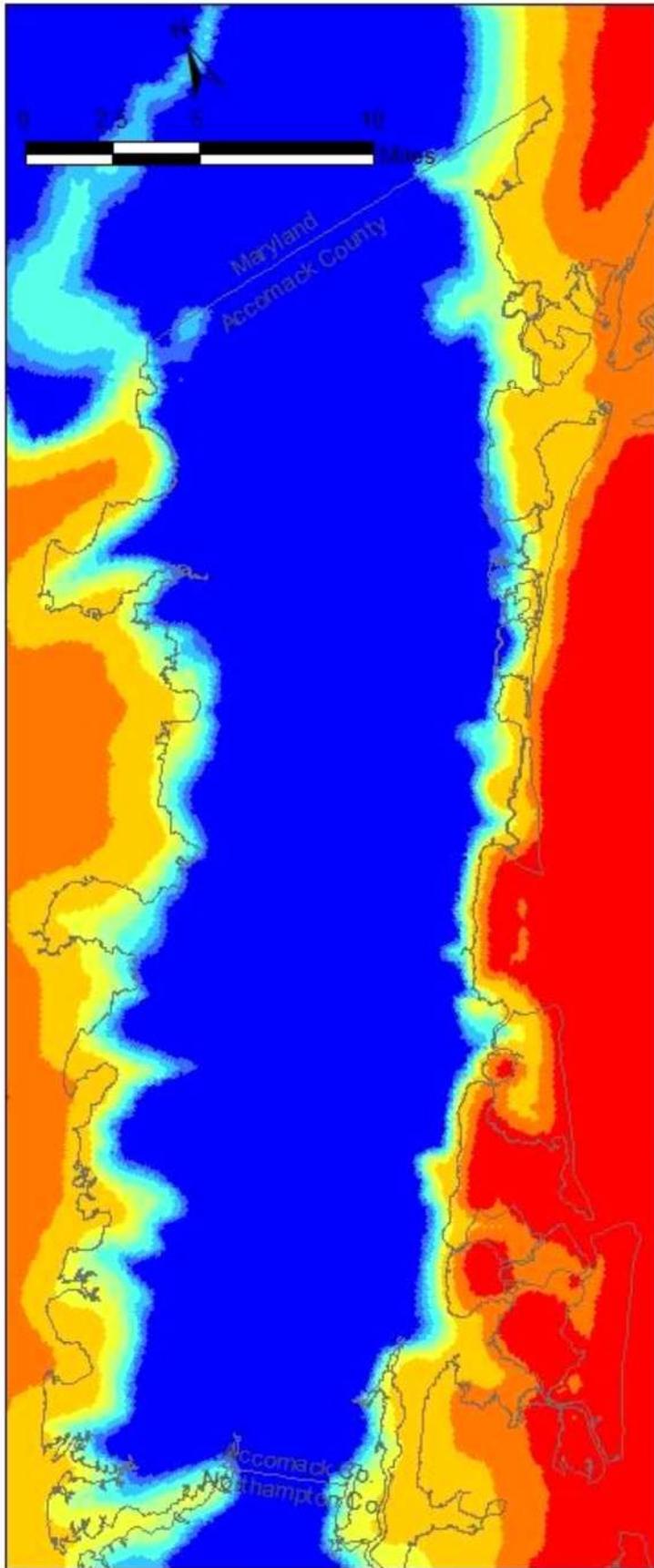


Accomack County

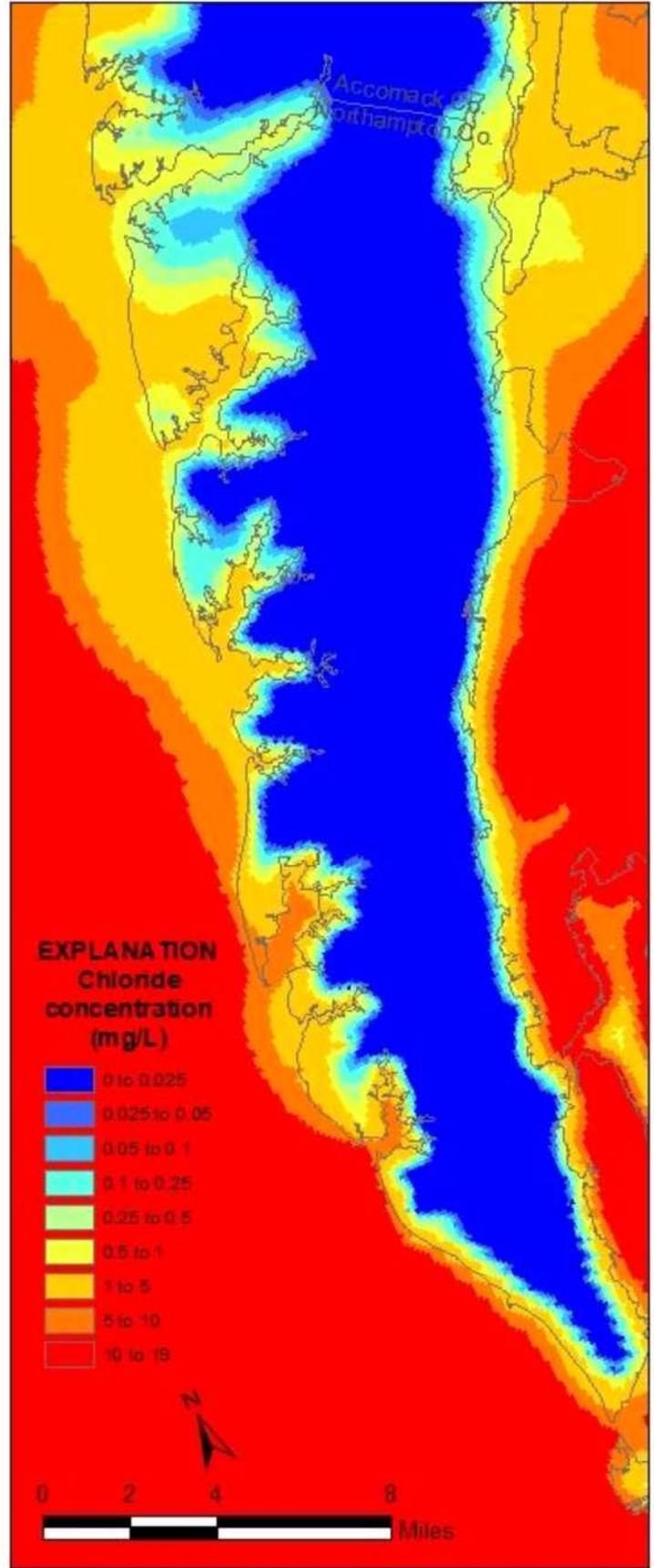


Northampton County

VAHydro-ES 2019 Total Permitted Simulation Middle Yorktown-Eastover Chloride Concentrations

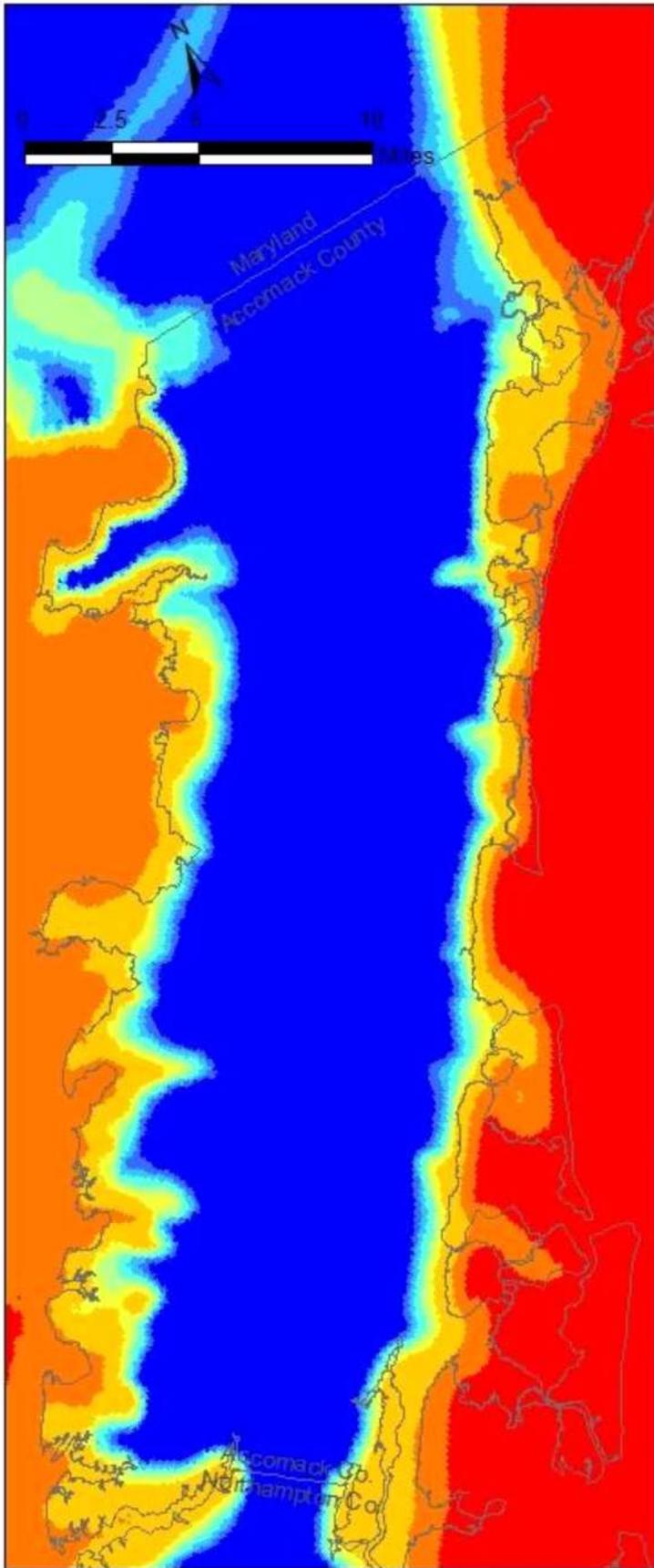


Accomack County

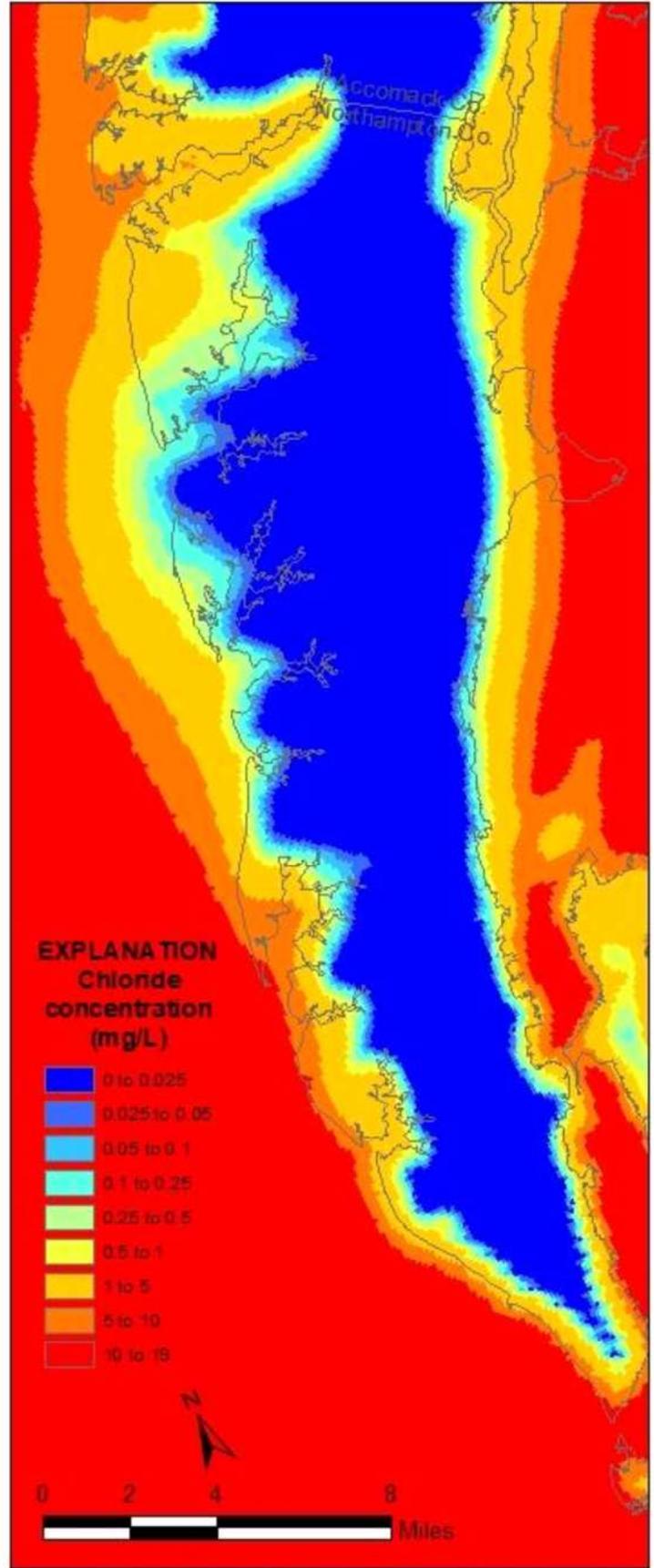


Northampton County

VAHydro-ES 2019 Total Permitted Simulation Lower Yorktown-Eastover Chloride Concentrations



Accomack County



Northampton County

Attachment E

Permits Simulated

VAHydroGW-ES 2019 Total Permitted Simulation

| PERMIT | OWNER | FACILITY | PERMITTED PUMPING (MGD) | PERMITTED PUMPING (%) |
|-----------|--|---|-------------------------|-----------------------|
| GW0033100 | Accomack County | Accomack County Office Buildings Waterworks | 0.016 | 0.16% |
| GW0069600 | Ace 1971 and Gigi 1971 Trust | Hogneck Farm* | 0.024 | 0.23% |
| GW0075000 | Ali Razwan | Shore Livestock | 0.025 | 0.24% |
| GW0072700 | Andrew Morey | Morey Farm | 0.024 | 0.23% |
| GW0074300 | Anthony Czarniak | Levi's Farm | 0.021 | 0.20% |
| GW0077400 | Antonio Rogers | Rogers Poultry Farm | 0.008 | 0.07% |
| GW0046001 | Ballard Brothers Fish Company Incorporated | Cherrystone Family Camping Resort* | 0.017 | 0.16% |
| GW0037901 | Bayshore Concrete Products -Cape Charles | Bayshore Concrete Products Corp Cape Charles* | 0.040 | 0.38% |
| GW0074200 | Bill Davis | Last Hurrah Farm | 0.031 | 0.30% |
| GW0078100 | Burke Palmer Booth | Pixies Poultry Farm | 0.007 | 0.07% |
| GW0041201 | Cape Charles Town of | Cape Charles Municipal Corporation | 0.173 | 1.66% |
| GW0044600 | Captain's Cove Utility Company Incorporated | Captain's Cove Utility Company, Inc. | 0.222 | 2.13% |
| GW0070700 | Charles D Tankard | Tankard Farm* | 0.037 | 0.36% |
| GW0062101 | Charles D Tankard | Wyatt Farm* | 0.021 | 0.20% |
| GW0077700 | Chi H Kim | Bethel Poultry Farm | 0.006 | 0.06% |
| GW0049600 | Chincoteague Bay Trails End Association, Inc | Trails End Utility Company Incorporated | 0.069 | 0.66% |
| GW0044200 | Chincoteague Town of | Chincoteague Town of | 0.601 | 5.77% |
| GW0078200 | Claude G Linton | C&C Farm | 0.005 | 0.05% |
| GW0078000 | Claude G Linton | Log Cabin Farm | 0.004 | 0.03% |
| GW0043301 | Commonwealth Chesapeake Company LLC | Commonwealth Chesapeake Power Station* | 0.068 | 0.66% |
| GW0073200 | Contrell Brown | Contrell Brown and Son Farm | 0.007 | 0.07% |
| GW0071400 | Curtis H. Jones & Son Inc. | Jones 2 Farm* | 0.018 | 0.17% |
| GW0070500 | Curtis H. Jones & Son Inc. | Jones 3 Farm* | 0.056 | 0.54% |
| GW0070900 | Curtis H. Jones & Son, Inc. | Jones 1 Complex | 0.099 | 0.95% |
| GW0068300 | Dalbys LLC | Long Farm | 0.017 | 0.16% |
| GW0074400 | Dan V Luu | Luu Farm | 0.029 | 0.28% |
| GW0076000 | Danny Huynh | Tai Dat Farm | 0.026 | 0.25% |
| GW0070200 | David B. Tankard Jr. | Bobtown Farm* | 0.031 | 0.29% |
| GW0069700 | David B. Tankard Jr. | David's Nursery* | 0.267 | 2.56% |
| GW0067101 | Del Monte Fresh Production Inc | Bull Farm aka Evans Oaks Farm | 0.259 | 2.49% |
| GW0047301 | Del Monte Fresh Production Inc | Mappsville Facility & Labor Housing* | 0.008 | 0.08% |
| GW0069300 | Del Monte Fresh Production Inc | Outten Farm* | 0.085 | 0.81% |
| GW0059800 | Del Monte Fresh Production, Inc. | Dennis Road MLC | 0.006 | 0.06% |
| GW0047600 | Del Monte Fresh Production, Inc. | Duer Home Farm* | 0.020 | 0.20% |
| GW0055700 | Delmarva Enterprise | Dreamland Homes | 0.033 | 0.32% |
| GW0070400 | Donald L. Fitchett and David F. Mason | Home Farm & Fitchett Farm* | 0.061 | 0.58% |
| GW0069500 | Dublin Farms, Inc. | Seybolt Farm* | 0.053 | 0.51% |
| GW0043701 | Eastern Shore Yacht and Country Club | Eastern Shore Yacht and Country Club* | 0.026 | 0.25% |
| GW0045401 | Eastville Town of | Eastville Town of | 0.049 | 0.47% |
| GW0072800 | Edward Thornton | Thornton Farm (Ed, Pat, and Brandy Sue Farm) | 0.022 | 0.21% |
| GW0060501 | Eleanor Bull Lambertson | C and H Farms Incorporated* | 0.020 | 0.19% |
| GW0072900 | ET and Jan Trader | Trader Farms-E.T. Trader, T&H, and Jan Trader | 0.026 | 0.25% |
| GW0038801 | Exmore Town of | Exmore Town of | 0.167 | 1.60% |
| GW0074100 | FPNA Farms Inc | FPNA Farms Inc | 0.011 | 0.10% |
| GW0061401 | George T Sharp | Edgewater Farms* | 0.024 | 0.23% |

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| GW0075800 | Giuse Farm, LLC | Giuse Farm | 0.031 | 0.30% |
| GW0073700 | Goodman Poultry Farms, LLC | Tanner Farm | 0.022 | 0.21% |
| GW0073800 | Hai Tran | Mason Farm | 0.021 | 0.20% |
| GW0068900 | Hermitage Farms Nursery | Hermitage Farms Nursery | 0.157 | 1.51% |
| GW0077300 | Hien Tran | Fulushou Farm | 0.025 | 0.24% |
| GW0076400 | Hop Van Nguyen | Nguyen and Emily Poultry Farm | 0.009 | 0.08% |
| GW0076300 | Hop Van Nguyen | Peter and Mary Poultry Farm | 0.009 | 0.09% |
| GW0073500 | Horace Edward Kelley III | Eddie Kelley Farm | 0.033 | 0.31% |
| GW0072400 | IF Acquisition, LLC | The Ivy Farm, Inc.* | 0.019 | 0.18% |
| GW0073600 | Iqbal Mohammad | Elahi LLC | 0.018 | 0.18% |
| GW0075700 | Iqbal Mohammad | Dennis Farm | 0.046 | 0.44% |
| GW0072500 | Ish Farm, LLC | Ish Farm | 0.032 | 0.30% |
| GW0077000 | James H. Justice | Justice Poultry Farm, Inc. | 0.007 | 0.06% |
| GW0070300 | Jeffery L. Shelley | Shelley Farm* | 0.034 | 0.32% |
| GW0074000 | Jessica L. Thomas LLC | Chicken Bacon Ranch (former K&D Farm) | 0.013 | 0.12% |
| GW0077600 | Kenneth Blair | Davis Wharf Farm | 0.012 | 0.12% |
| GW0077800 | Kevin Vu | Brittany Farm | 0.016 | 0.15% |
| GW0065601 | Kuzzens Inc | Bowen Farm* | 0.100 | 0.96% |
| GW0065901 | Kuzzens Inc | Christian/Ames Farm* | 0.202 | 1.94% |
| GW0070600 | Kuzzens Inc | Doughty-Drewer Complex | 0.286 | 2.75% |
| GW0053800 | Kuzzens Inc | Kuzzens KMC Camp | 0.006 | 0.06% |
| GW0065701 | Kuzzens Inc | Machipongo Farm | 0.179 | 1.72% |
| GW0071600 | Kuzzens Inc | Mappsville North Complex* | 0.020 | 0.19% |
| GW0070100 | Kuzzens Inc | Marshall-Johnson-Grapeland Complex* | 0.324 | 3.12% |
| GW0069100 | Kuzzens Inc | Melfa Farm* | 0.151 | 1.45% |
| GW0069200 | Kuzzens Inc | Painter Complex* | 0.158 | 1.52% |
| GW0069900 | Kuzzens Inc | Tipton Farm* | 0.142 | 1.37% |
| GW0070000 | Kuzzens Inc | Walker Farm* | 0.024 | 0.23% |
| GW0074900 | Le Ung | Seaside Farm | 0.027 | 0.26% |
| GW0074500 | McChicken Farms, LLC | McChicken Farms | 0.027 | 0.26% |
| GW0077500 | McChicken Farms, LLC | Turlington Poultry Farm | 0.007 | 0.07% |
| GW0074600 | Miller Time, LLC | Miller Time Farm | 0.021 | 0.20% |
| GW0076100 | Minh Thanh Luu | Steven Farm | 0.033 | 0.32% |
| GW0073100 | Mohammad Afzal Chattha | Chattha Livestock Poultry Farm | 0.026 | 0.25% |
| GW0078900 | Mr. & Mrs. Grasyon C. Chesser, Jr. | Holden Creek Gun Club* | 0.040 | 0.38% |
| GW0074800 | Ngu Ba Do | Johnathan Farm | 0.033 | 0.32% |
| GW0075600 | Nicholas J. Thomas, LLC | Wisharts Point Farm | 0.011 | 0.10% |
| GW0038700 | Northampton County | Bayview Community | 0.014 | 0.14% |
| GW0049700 | Northampton County | Northampton County Government Complex | 0.036 | 0.34% |
| GW0049200 | Onancock Town of | Onancock Town of | 0.221 | 2.12% |
| GW0072300 | Pacific Tomato Growers, Ltd. | Sunripe Camp | 0.004 | 0.04% |
| GW0054700 | Parksley Town of | Town of Parksley Water Works | 0.080 | 0.77% |
| GW0077200 | Payne Poultry Farm, LLC | Against the Wind Farm | 0.014 | 0.13% |
| GW0053900 | Perdue Farms Incorporated | Perdue Farms Incorporated | 1.918 | 18.42% |
| GW0069800 | Phillip Custis | Custis Farm* | 0.144 | 1.39% |
| GW0076600 | Phillip Greene | Greene's Poultry Farm | 0.021 | 0.20% |
| GW0075100 | Ray Newman | Highway Farm* | 0.108 | 1.04% |
| GW0071200 | Ray Newman | Newman Farms* | 0.241 | 2.31% |
| GW0037301 | Riverside Healthcare Association | Riverside Shore Rehabilitation Center | 0.014 | 0.14% |
| GW0076900 | Ronnie and Barbara Matthews | RW and Matthews Farms | 0.008 | 0.08% |
| GW0072600 | Ryan Brady | Brady Farms | 0.027 | 0.26% |

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| GW0074700 | Sanns Farm, LLC | Sanns of the Shore | 0.040 | 0.38% |
| GW0047901 | Shore Health Services, Inc. | Shore Memorial Hospital | 0.082 | 0.79% |
| GW0077900 | Son Nguyen | Turkey Run Farm | 0.027 | 0.26% |
| GW0075200 | Spuddog Farm Property, LLC | Spuddog Poultry Farm | 0.014 | 0.14% |
| GW0039201 | Sun Sunset Beach RV LLC & Sun Communities | Sunset Beach Resort & Campground | 0.017 | 0.16% |
| GW0070800 | Tankard Nurseries LLC | Lumber Hall Farm* | 0.127 | 1.22% |
| GW0078500 | Teresa Farms LLC | Teresa Farm | 0.035 | 0.34% |
| GW0073300 | Thomas A Davis | Davis Farm | 0.026 | 0.25% |
| GW0075300 | Thomas Family Farms, LLC | Thomas Farm | 0.011 | 0.11% |
| GW0073400 | Tri Tran | Eagle, Birdie, Superior Farm | 0.015 | 0.15% |
| GW0076800 | Tri Tran | Elite Farm | 0.012 | 0.12% |
| GW0076700 | Tri Tran | Excel Farm | 0.010 | 0.10% |
| GW0053500 | Triangle Enterprises, Inc. | Triangle Mobile Home Park | 0.018 | 0.17% |
| GW0073900 | Tull LLC | Holland Homestead, Backwoods, & Horsey Poultry | 0.015 | 0.15% |
| GW0078400 | Tyler Ames | Summer's Rest Farm | 0.027 | 0.26% |
| GW0049900 | Tyson Farms, Inc. | Tyson Farms, Inc. | 1.327 | 12.75% |
| GW0039301 | US NASA -Wallops Flight Facility | Goddard Space Flight Center - Island System | 0.032 | 0.30% |
| GW0034600 | US NASA -Wallops Flight Facility | Goddard Space Flight Center - Main Base | 0.300 | 2.88% |
| GW0054000 | Va. Dept. of Conservation and Recreation | Kiptopeke State Park | 0.010 | 0.09% |
| GW0075400 | Van T. Tran | Van Tran Farm | 0.053 | 0.51% |
| GW0046301 | Virginia Landings - National American Corp | Virginia Landing Campground | 0.016 | 0.16% |
| GW0075500 | Vision Quest Enterprises, LLC | Vision Quest Farm | 0.021 | 0.20% |
| GW0075900 | Vy Nguyen | Kylie Farm | 0.041 | 0.39% |
| GW0073000 | William Davis Lovell and Therese B. Lovell | Old Mill Farms | 0.033 | 0.32% |
| GW0061101 | William M Daley | Broadleaf Farms | 0.010 | 0.10% |
| GW0071000 | Willis Family Limited Partnership | Seaford Farm* | 0.069 | 0.66% |
| GW0042501 | YMCA of South Hampton Roads | YMCA Family Campground | 0.013 | 0.13% |

*Lump sum permit – simulated value was calculated as the permit term total allowed pumping divided by the number of years in the permit term.