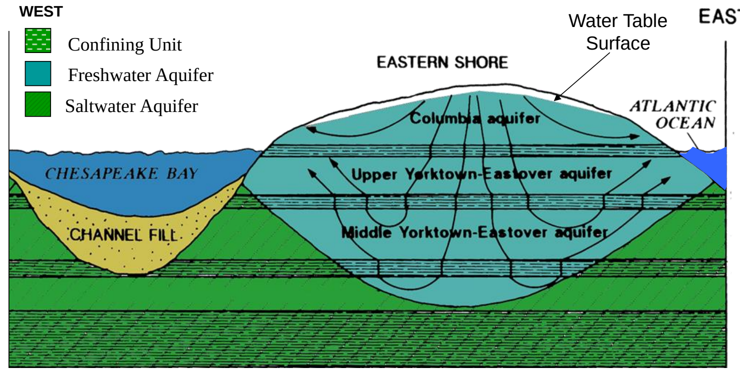
PALEOCHANNELS AND GROUNDWATER RESOURCES
Eastern Shore of Virginia

Fresh groundwater on the Eastern Shore of Virginia occurs as a lens that "*floats*" overtop denser saltwater in a manner similar to less dense ice floating on top of water (see ***Ghyben-Herzberg relation*** for reference). The lens is replenished by direct precipitation that falls on the Shore, infiltrates the soil and reaches the Columbia aquifer, the uppermost fresh groundwater body. The USGS estimated that about 12% of the precipitation falling on the Shore reaches the Columbia aquifer, or about 625 million gallons per day (MGD) on average in a normal year. Clays restrict water movement to the underlying Yorktown aquifers, the principal source of water on the Eastern Shore, and ***the USGS estimates only about 0.1% (about 9 MGD on average) of the precipitation falling on the Shore replenishes the Yorktown aquifers.***

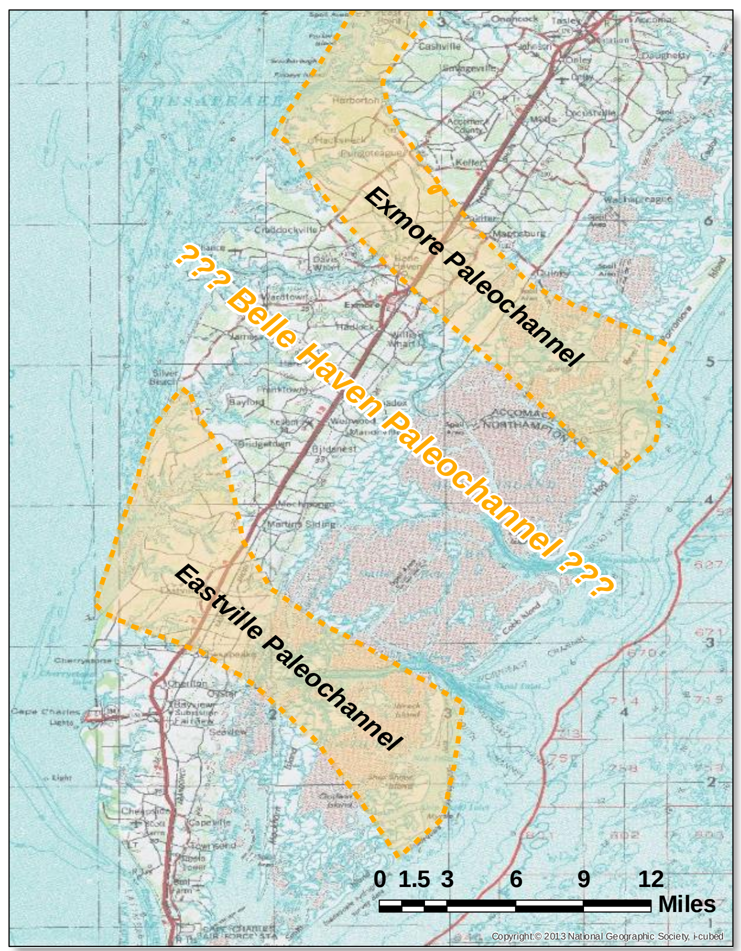


Above: Conceptual figure illustrating freshwater lens floating over saltwater with recharge to the deeper aquifers restricted by clay confining units. Paleochannels are not depicted in this figure.

In certain areas of the Shore, the clay that restricts downward movement of water is largely absent, and the rate that groundwater replenishes the Yorktown-Eastover aquifer may be substantially greater in these areas. The consequence is that ***there may be more sustainable groundwater in these areas than other portions of the Shore***. However, there is poor understanding concerning the extent and function of these features on the Shore's groundwater resources.

These preferential pathways for groundwater recharge were formed from old river channels (paleochannels) believed to be associated with the ancestral Susquehanna-Potomac River. In the past, when ocean levels were lower, the ancestral Susquehanna River cut across what is now the Eastern Shore of Virginia, incising a river channel in marine clays that now form the Yorktown-Eastover confining unit. Sands and gravels were deposited in the base of the channels with alternating sands and clays filling in the channel as the ocean levels rose.

As ocean levels lowered and rose again the sequence of paleochannels erroding into the marine sediments followed by an aggrading Eastern Shore peninsula continued. Three paleochannels shown on the adjacent figure were formed in this sequence, with the Exmore Paloechannel formed first, followed by a rising ocean that resulted in the peninsula extending further to the south. The next lower ocean stand resulted in formation of the Belle Haven Paleochannel, and after another ocean level rise and fall the Eastville Paleochannel. A fourth paleochannel, the Cape Charles Paleochannel formed more recently but is located off the southen end of the Eastern Shore and does not influce movement of groundwater.



Above: Map illustrating general extent of know paleochannels on the Shore. Two additional suspect paleochannels to the north are not shown.

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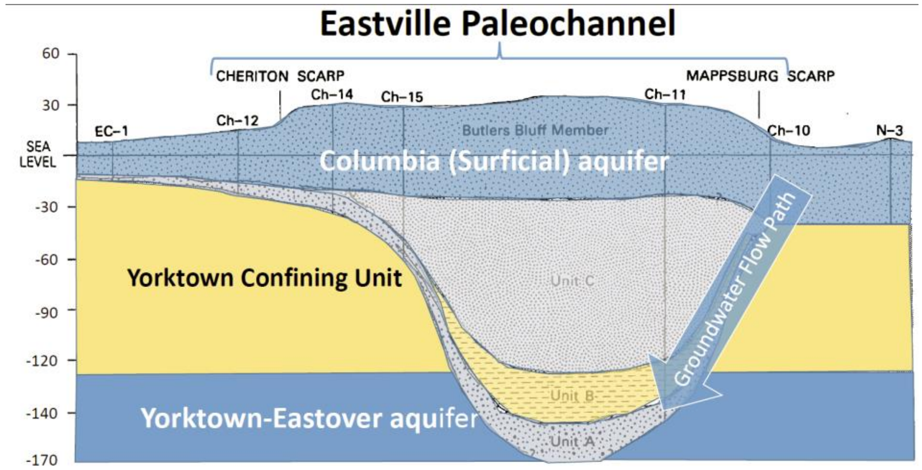
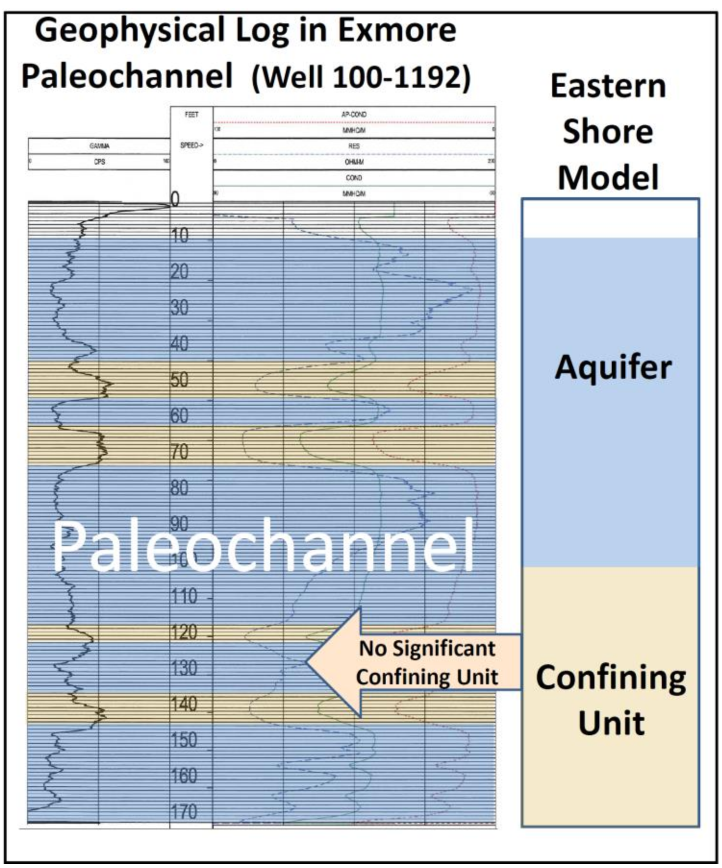
Eastville Paleochannel: Only the Eastville Paleochannel has documented research on its extent and distribution as reported in the ***USGS Professional Paper 1067G*** (Mixon 1985). The general sediment distribution in this paleochannel is a basal sand and gravel with finer grained sediments deposited over the sand and gravel as the sea level rose. There are few borings completed in the Eastville Paleochannel and the extent that the sediments are uniformly distributed as depicted in the cross-section is uncertain. ***It is likely that the sand and gravel provides a complete connection between the unconfined Columbia aquifer and the underlying confined Yorktown-Eastover aquifers. However, there are no hydraulic studies to verify this interconnection.*** While the general location of the Exmore Paleochannel has been delineated, depth and composition of this ancestral river channel has not been established. Even less is known on the Belle Haven Paleochannel, with much of the information obtained from studies conducted off-shore in the Bay and ocean.



Above: Generalized cross-section of the Eastville Paleochannel taken from USGS PP 1067G. Cross-section show the preferential groundwater flow path from the Columbia aquifer to the underlying Yorktown-Eastover aquifer..

Eastern Shore of Virginia Groundwater Model: The USGS developed a groundwater model for the Eastern Shore of Virginia, as documented in the ***USGS Scientific Investigations Report 2009-5066*** (Sanford, et.al., 2009). This model was based on an earlier USGS model developed by Richardson (USGS WSP 2401, 1994). In this model the paleochannels were not explicitly defined (as shown on the adjacent figure), rather two (Exmore and Eastville) were assigned values that were thought appropriate for the structures. The Belle Haven Paleochannel is excluded from the model. As noted in the report "*The exact spatial configuration of these channels is not known*". Also noted in the report: "*there are too few water-level observation data in the paleochannels to estimate the values of hydraulic conductivity for the channel*", and the channels were "assigned" values. As a consequence, there is scant information in support for the model correctly simulating flow within and through the paleochannels. As illustrated on the adjacent graphic the sediments in the Exmore Paleochannel are far more complex and likely far more permeable than represented in the current model.



Above: Comparison between Exmore Paleochannel sediments observed in borings and assumed sediments in the Eastern Shore Groundwater Model.

Recommendations: The current groundwater model used to maintain sustainable use of the groundwater resource does not adequately represent influence of paleochannels that comprise almost 1/3 of the area on the Shore. ***1) Additional research on hydraulic properties within the paleochannels must be completed.*** This research can be completed in concert with research currently conducted by DEQ in the Coastal Plain system west of the Bay. ***2) A major revision to the Eastern Shore Groundwater Model must be completed and the model calibrated within the paleochannels.*** The DEQ is in the process of major revisions to the Coastal Plain model and revisions to the Eastern Shore Model should be included.

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