FACT SHEET

Land Subsidence

Eastern Virginia's increasing vulnerability to sea level rise

Reductions in land subsidence will be measured at the SWIFT Research Center in Suffolk, Virginia.

The Sustainable Water Initiative for Tomorrow (SWIFT) aims to purify HRSD's already highly treated water through additional advanced water treatment to produce drinking-quality water and then use this valuable resource to replenish the Potomac Aquifer, eastern Virginia's primary source of groundwater. One of SWIFT's multiple environmental benefits includes reducing the rate of land subsidence. Hydraulic modeling suggests that SWIFT could reduce or eliminate land subsidence due to over-pumping of the groundwater in many areas, and even reverse it in others, while positively increasing water levels in nearly the entire Potomac aquifer. Reducing land subsidence will improve our region's resiliency to the negative impacts of sea level rise and provide years of added use of highly valuable developed land and ecologically important wetlands.

What is land subsidence?

Land subsidence describes the **sinking or lowering** of the land surface. Most land subsidence in the United States is caused by human activities, such as groundwater withdrawals and petroleum extractions. In eastern Virginia, homes and industries remove approximately 155 million gallons of groundwater from the Potomac aquifer every day. This unsustainable rate of removal has reduced water levels in the aquifer by over 200 feet since the early 1900's and continues to lower them by several feet each year. As the amount of water within the aquifer decreases, the pressure decreases as well. With diminishing pressures, the aquifer begins to **compact** due to the weight of the ground above it- and the land surface sinks with it. Extensive groundwater pumping has compacted the Potomac aquifer at rates of 1.5 to 3.7 millimeters each year, accounting for more than half of the total observed land subsidence.

Areas experiencing significant levels of groundwater withdrawals from industrial uses, such as Franklin and West Point, which both house economically-important paper mills, are producing **cones of depression** and sinking at even faster rates. While these areas are considered "hotspots," water levels have decreased within the entire Potomac aquifer. As a result, water-using industries in eastern Virginia are facing reductions in how much groundwater they are allowed to withdraw while new water-using industries are being inhibited from moving to the region. This significantly hinders

Hampton Roads is second only to New Orleans as the largest population center at risk of the negative economic, environmental and human health impacts of sea level rise.

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swift Sustainable Water Initiative for Tomorrow

opportunities for economic growth.

Why is HRSD concerned with land subsidence?

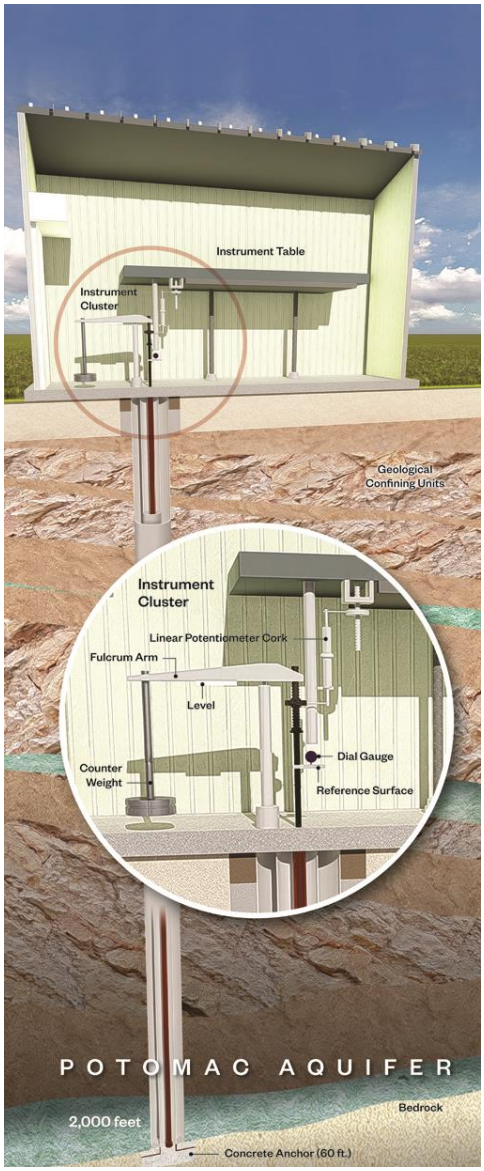
Land subsidence contributes to over 50% of the rate of **relative sea level rise** in Hampton Roads. Relative sea level rise considers changes in sea level as well as changes in land. The combination of sinking land and rising seas helps explain why the southern Chesapeake Bay region displays the highest rate of relative sea level rise on the Atlantic Coast, with Hampton Roads following only New Orleans as the second largest population center at risk of the negative economic, environmental and human health impacts of sea level rise.

Land subsidence is especially detrimental to the Chesapeake Bay region because it is low-lying and flat. The wetland and coastal ecosystems in this region are highly vulnerable to the effects of increasingly severe and frequent flooding, as are its historical sites. The buildings, bridges, military structures, and other infrastructure in Hampton Roads are also at risk- including HRSD's 13 wastewater treatment plants and 500 miles of underground pipes. Research suggests that between 59,000 and 176,000 of residents living near the shores of the southern Chesapeake Bay could be permanently inundated or regularly flooded by 2100, with $9 to 26 billion in property damages and 120,000 acres of ecologically valuable land lost. By adding up to 120 million gallons each day of the water that would otherwise be discharged to the James, Elizabeth or York rivers back into the Potomac aquifer, SWIFT would help protect these valuable resources.

How will we know SWIFT is reducing land subsidence?

HRSD will measure SWIFT's progress at reducing land subsidence through a **borehole extensometer** installed by the United States Geological Survey (USGS) at the SWIFT Research Center in Suffolk, Virginia. An extensometer measures the difference between the land surface height and the bedrock below. At the SWIFT Research Center, it is anchored in bedrock 2,000 feet below land surface and attached to above-ground instruments with a steel rod. Because it is anchored to bedrock, the steel rod is not affected by vertical movements such as shifts in the earth's plates; therefore, USGS geologists can use it as a comparison tool to accurately measure changes in the heights of the land around it over time. Geologists may combine these measurements with other data to determine how much of total land subsidence is caused by aquifer compaction.

Extensometers have been used to accurately measure land subsidence and determine the connection between groundwater removal and land subsidence elsewhere in eastern Virginia. In Franklin, Va., a USGS extensometer showed 24.2 millimeters of aquifer compaction between 1979 and 1995. This compaction correlated to decreases in groundwater levels due to withdrawals. When the Franklin paper mill reduced groundwater use between 2002 and 2015, ground level in the area rebounded 32 millimeters. The ability of Hampton Roads' land and the Potomac aquifer to "bounce back" after decades of unsustainable groundwater withdrawals supports scientists' optimism in SWIFT's potential to reduce, eliminate and even reverse land subsidence across eastern Virginia.



USGS geologists will analyze data produced by an extensometer installed at the SWIFT Research Center to determine changes in land subsidence.