CHAPTER 3 – PROTECTION OF POTABLE WATER SUPPLY

I. PROTECTION OF WATER IN LANCASTER COUNTY

The groundwater and surface water supplies of Lancaster County are recognized to be some of its most valuable natural resources. Lancaster's groundwater resources provide the County with 100% of its potable water supply. Meanwhile, the County's surface water provides a source of employment for the seafood industry, a major attraction for the tourism industry, a source of recreation for citizens, and a potential future water supply for the County. The health of the people, the economy, and the hope for future growth all depend on the quality of these important water resources.

The Lancaster County Potable Water Supply Study and Plan will assess the existing state of these resources, develop goals and objectives concerning the water supply, and present recommendations for protecting and enhancing the water supply in the future. The study will be divided into two sections. The first will examine the existing surface water conditions in Lancaster County. The second will investigate the existing groundwater conditions in the County. The plan will be realistic in that it recognizes that surface and groundwater resources are regionally shared and therefore require regional efforts to ensure their protection. However, the plan also recognizes that much can be done within the county's boundaries to protect our vital water resources. Recommendations proposed in this plan address the regional and local nature of these resources.

A. SURFACE WATER

Lancaster County is bordered by the Chesapeake Bay to the East and the Rappahannock River to the South. Many tidal water bodies meander through the County on the way to the Bay and River including Lancaster Creek, the Eastern and Western branches of the Corrotoman River, Carters Creek, Indian Creek, Dymer Creek, Tabbs Creek, and Antipoison Creek, as well as many smaller creeks. Combined, these water bodies give Lancaster County 330 miles of tidal shoreline.

Lancaster County also has many existing privately owned millponds that are categorized as surface water. These millponds are generally located in the freshwater sections at the headwaters of creeks and were created through the use of impoundment structures. Included in this group are Balls, Blakemore, Kamps, Chinns, Davis, Dunton, and Norris millponds.

1. Surface Water Quality

The quality of surface water is of vital importance to the Lancaster County community. First, many commercial fishermen, seafood industry owners, marina owners, and related employees depend on local waters for their livelihood. Second, citizens of the county enjoy living in a rural, scenic setting that is enhanced by views of, and access, to the water. Lastly, the water is a source of recreation for many in the Lancaster County community, as well as for many visitors to the area.

Agriculture is a major industry within Lancaster County and one whose activities can significantly affect the quality of surface water. Farmers, county officials, and the local Soil and Water Conservation District must work together in the development of nutrient management and other conservation plans that will provide protection to Bay waters while allowing farmers to maximize the productivity of farmland. Well owners may request a 400-foot buffer zone for protection from possible health hazards.

Conservation plans consider the existing conditions of each individual farm. The plan takes into account soil types, slope, drainage patterns, crop cover and animal populations. Based on the available data and using the Soil Conservation Field Office Technical Guide, a plan is drawn up that recommends the most appropriate conservation practices for each farm. Components of the plan may include grassed waterways for drainage, crop rotation, contour strips, water diversion structures, nutrient management, pesticide management, and herbicide management.

Farmers in Lancaster County generally control the use of fertilizers and pesticides as a matter of complying with law, but also as a matter of economics. With the high prices of fertilizer and pesticides, farmers are extremely careful to use only the amount of fertilizer and pesticide that can be absorbed into the soil rapidly. No-till farming is commonplace and has helped considerably to control runoff by limiting disruption to the soil and is strongly encouraged.

The map, Lancaster County Farm Plan Inventory CBLAD and NNSWCD Farm Plan Data, shows cultivated areas in Lancaster County. It draws a distinction between those farms for which a plan is on record and those for which a plan is not on record. While this map indicates a large number of farms for which a plan does not exist, or is not recorded, it is believed that many do have a plan. As mandated by the Chesapeake Bay Preservation Act, Lancaster County requires plans.

2. Measures of Surface Water Quality

a. Condemned Shellfish Grounds

One indicator of surface water quality is the location of condemned and seasonally condemned shellfish grounds. Every two years the Commonwealth of Virginia prepares a report on the quality of the State's Waters and presents it to the U.S. Environmental Protection Agency and the United States Congress. The document is called the 305 (b) Report to EPA and Congress and addresses how well the State is meeting the Federal Clean Water Act's goals of providing waters suitable for swimming and fishing. In this report, state waters are evaluated as to whether they are "Fully Supporting," "Fully Supporting But Threatened," "Partially Supporting," or "Not Supporting" concerning the goal of fishable waters. Local waters that have been condemned for shell fishing by the Virginia Department of Health fall under the category of Partially Supporting in regard to fishing.

Lancaster County has areas of condemned shellfish grounds. Typically, shellfish condemnation areas in Lancaster County are found in portions of creeks, where the salinity is lower and the tidal flush is decreased. Exceptions are Carter Creek, Greenvale Creek, Paynes Creek, Beach Creek, Lancaster Creek, and Mulberry Creek, which are all mostly, or totally, designated as condemned or seasonally condemned.

Locations of shellfish condemnations are important water quality indicators because the waters have been condemned due to elevated levels of fecal coliform bacteria. High levels of fecal coliform bacteria can be due to animal (domestic and wild) waste, failing septic systems, marinas, or the flushing characteristics of the particular water body.

b. Ambient Water Quality Monitoring

Another measurement of water quality that is addressed in the 305 (b) Report is ambient water quality monitoring results. The Virginia Department of Environmental Quality has designated monitoring stations at various locations in the different surface water bodies throughout the state. The stations are used to monitor four parameters including dissolved oxygen, pH, temperature, and fecal coliform bacteria. Data collected from each station is then assessed to see if it meets the Virginia Water Quality Standards for Dissolved Oxygen, pH, and Maximum Temperature. There are seven ambient water quality stations located in, or very close to, Lancaster County's boundaries further identified as follows:

W 22 (Station ID: 3-CRR003.38) - Corrotoman River near Red Buoy #6 in Lancaster County.

W 23 (Station ID: 3-RPP010.60) - Rappahannock River off Orchard Point near the Lancaster County and Middlesex County boundary in the Rappahannock River Basin.

W 24 (Station ID: 3-RPP017.72) - Near buoy #8 southwest of the mouth of Greenvale Creek near the Lancaster County and Middlesex County boundary in the Rappahannock River Basin.

W 25 (Station ID: 3-RPP025.52) - Near buoy #11 off Goose Point on the Middlesex County side in the Rappahannock River Basin.

W 9 (Station ID: 7-IND002.26) - Indian Creek opposite Kilmarnock Wharf on the Northumberland County side of the creek in the Chesapeake Bay Basin.

c. Nonpoint Source Pollution Monitoring (will be addressed below under "Threats to Surface Water Quality" section.)

3. Sensitive Surface Water Features

Lancaster County is fortunate to benefit from an abundance of marine resources that are directly related to the quality of its surface water bodies. These natural resources include Submerged Aquatic Vegetation, Wetlands, and Shellfish Grounds. Descriptions of these features, their functions in the man-made and natural environments, and the extent of their presence in Lancaster County are given below.

a. Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV), or sea grass, is a valuable natural marine resource that is found adjacent to the shoreline in many parts of Lancaster County. SAV is important because it provides ideal habitat for blue crabs and juvenile finfish. SAV also acts to provide protection for molting crabs and is a source of food for waterfowl. Lastly, as evidenced by the important role it plays in the marine environment, SAV is also of great value to the County's commercial and recreational fisheries.

The amount of SAV in the waters around Lancaster County has generally been increasing since 1990 but can decrease in the short term as a result of excessive rain or other weather related conditions that affect the ambient quality of the water. The most current and accurate depiction of SAV can be found on the website:

http://www.vims.edu/bio/sav/sav04/segments/rppmh_page.html

b. Wetlands

Wetlands are defined by the United States Fish and Wildlife Service as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water". Generally, wetlands can be classified as either tidal or non-tidal. Locally, Lancaster County has approximately 4,504 acres of tidal wetlands and 1,349 acres of non-tidal wetlands (Figures were obtained using the Lancaster County Geographic Information System utilizing a digital National Wetland Inventory map layer.)

Wetlands are important natural resources that provide many benefits to the man-made and natural environments. Wetlands provide aesthetic, recreational, and economic benefits to the community. Furthermore, wetlands are spawning and nursery grounds for finfish and shellfish, feeding and wintering sites for migratory waterfowl, nesting habitat for shore birds, and homes to a wide variety of wildlife. Wetlands further serve as important areas for groundwater recharge, flood control, pollution absorption, and retention of sediment from storm water run-off (Pg 1, Atlas of National Wetlands Inventory Maps of Chesapeake Bay. U.S. Fish and Wildlife Services: September, 1986).

c. Shellfish Grounds

Lancaster County has a wealth of suitable shellfish grounds in the water adjacent to its shores. These grounds remain a valuable resource that should be protected. Oyster harvests in Virginia have nearly doubled since 2008 (*VMRC, 2017*) and the number of oysters being sold by aquaculture oyster growers in Virginia have gone from 10 million oysters to well over 40 million. Lancaster County is well situated to play a large role in this industry as well as benefiting from the ecological services these filter feeders provide.

4. Threats to Surface Water Quality

a. Role of Soils in Pollution

Pollutants generally affect water quality through two different methods: run-off and leaching. Run-off refers to water that is not absorbed by the soil, but is instead carried off by natural or man-made drainage courses to a surface water body. Leaching refers to water that is absorbed by the soil and percolates into the soil layers underneath. The effect of this type of pollution is usually felt on the groundwater supply in the water table aquifers, but not the artesian aquifers. The amount of run-off or leaching in a community is usually dependent on the present land cover. Generally, the more heavily an area is developed, the more susceptible the area is to run-off due to increased amounts of impervious land cover such as parking lots, buildings, and roads. The less intensely an area is used, the more the area is prone to leaching because of the extensive pervious groundwater recharge areas such as large tracts of farmland and forest.

Impacts from run-off and leaching are further complicated by the types of soils present in different areas of the County. Highly erodible soils have the potential to become a source of pollution in times of large run-off such as heavy rainstorms and melting periods after ice or snowstorms. This combination of a high amount of run-off and the presence of highly erodible soils can result in a higher concentration of sediments entering the county's surface waters. Furthermore, individual occurrences of pollution through leaching can be worsened through the presence of highly permeable soils. Awareness of these soil properties as they relate to existing and future land uses can help in pinpointing areas currently in need of mitigation efforts, as well as planning for the avoidance of further contamination of water resources through improper land use.

Lancaster County Soils that are highly erodible and the percent of each soil type:

1. Caroline very fine sandy loam, sloping eroded (0.17%)
2. Caroline clay loam, sloping, severely eroded (0.05%)
3. Caroline clay loam, strongly sloping, severely eroded (0.18%)
4. Craven silt loam, sloping, eroded (0.02%)
5. Craven clay loam, strongly sloping, severely eroded (0.21%)

6. Kempsville fine sandy loam, sloping, severely eroded (0.09%)
7. Matapeake silt loam, strongly sloping, eroded (<0.01%)
8. Sassafras fine sandy loam, sloping, severely eroded (0.46%)
9. Sassafras fine sandy loam, strongly sloping, eroded (0.07%)
10. Sassafras fine sandy loam, strongly sloping, severely eroded (0.08%)
11. Sloping sandy land (9.26%)
12. Steep sandy land (18.13%)

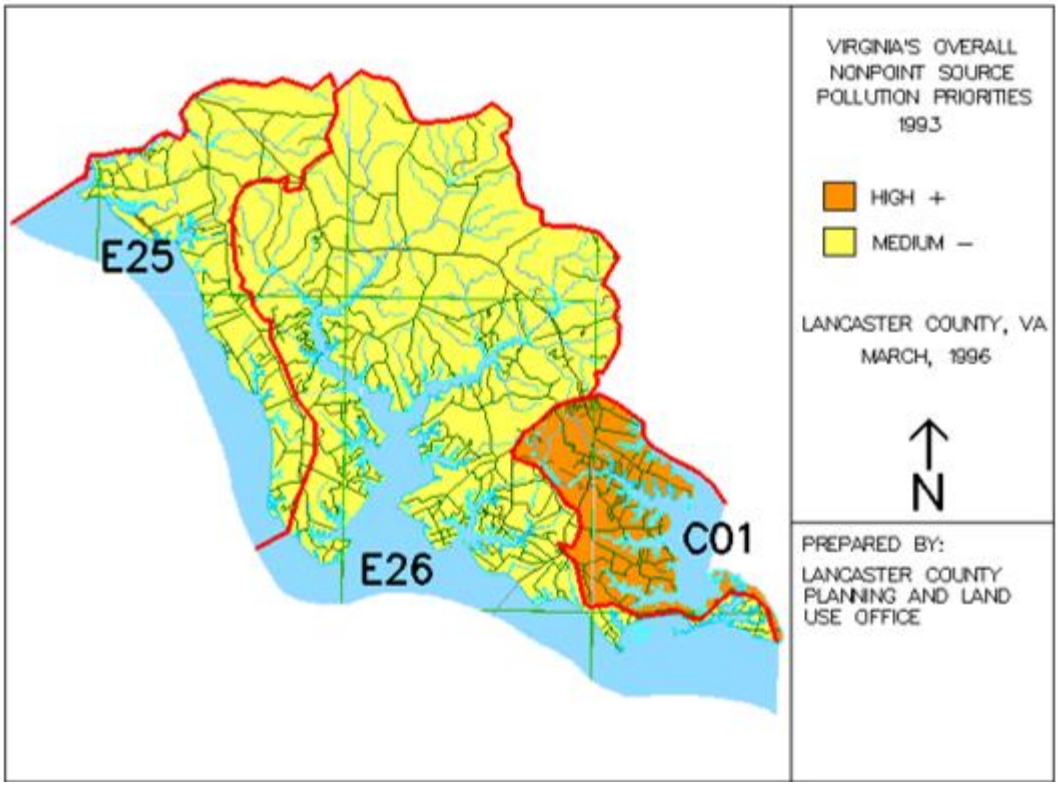
Lancaster County Soils that are highly permeable and the percent of each soil type:

1. Coastal Beach (0.48%)
2. Lakeland loamy fine sand, gently sloping (0.61%)
3. Rumford loamy sand, gently sloping (0.16%)
4. Rumford loamy sand, sloping, eroded (0.05%)
5. Sloping sandy land (9.26%)
6. Steep sandy land (18.13%)

b. Sources of Surface Water Pollution

(1) Non-point Source Pollution

One measure of the effect of pollution on the water quality of Lancaster County's surface water is found in the Virginia Non-point Source Pollution Watershed Assessment Report (VA Department of Conservation and Recreation; March, 1993). This report divides the State of Virginia into 491 different watersheds or hydrologic units. A watershed is defined as "a land area drained by a river/stream or system of connecting rivers and streams such that all water within the area flows through a single outlet." There are three state hydrologic units in Lancaster County: E25, E26, and C01. E25 and E26 are part of the Rappahannock River Basin and C01 is part of the Chesapeake Bay Coastal Basin as shown on the following map from the Virginia Department of Conservation and Recreation**.** This report compares water quality of hydrologic units throughout the state in order to prioritize nonpoint source pollution protection efforts.



c. State Hydrologic Units in Lancaster County

A brief summary of watersheds in Lancaster County is given below:

E25 - This watershed is cited as having "significant levels of urban use impacts due to urban erosion and nutrient loading, and the amount of disturbed urban land." However, this watershed is not described as having any significant water quality violations for fecal coliforms or pH levels. The state monitoring authority gives this watershed a final non-point source pollution rank of "MEDIUM -", with a rank of "High+" being the highest priority watersheds for state non-point source pollution protection efforts.

E26 - This watershed is not described as having any significant water quality violations due to fecal coliforms or pH level. Additionally, this watershed is not cited for having "significant levels of urban use impacts." The state monitoring authority gives this watershed a final nonpoint source pollution rank of "MEDIUM -", with a rank of "High+" being the highest priority watersheds for state non-point source pollution protection efforts.

C01 - This watershed is rated as a "medium priority watershed for agricultural non-point source pollution concerns. Due primarily to existing development, watershed C01 is rated in the top 10% statewide for urban pollution potential." Additionally, the watershed is cited as having a

large number of shellfish condemnations because of "urban non-point source influences." However, the watershed was not cited for having any significant violations of state water quality standards. The state monitoring authority gives this watershed a final non-point source pollution rank of "High+," with a rank of "High+" being the highest priority watersheds for state non-point source pollution protection efforts.

(2) Point Sources/Permitted Discharges

Point source pollution sources are often referred to as the "end of the pipe" type of pollution. This means that the discharge into the water body can be traced to a single, identifiable source. The Federal Water Pollution Control Act requires a uniform permit program nationwide which acts to regulate this type of pollution. In Virginia, the Department of Environmental Quality runs a permitting program named the Virginia Pollutant Discharge Elimination System (VPDES) that carries out the requirements of the federal act. VPDES is a permit program that establishes, on an individual basis, limits on the quantity and/or concentration of pollutants allowed in the discharge.

When a VPDES permit is issued, guidelines are established which discharged effluent is required to meet. Moreover, the owner of the discharging facility is required to monitor the quality of the effluent and report the results of testing to the state. Additionally, the Virginia Department of Health designates condemned shellfish areas around certain point source discharges to act as a buffer zone from the impact of the discharge. The chief industry utilizing these types of permits in Lancaster County is the seafood industry, with resort hotels a distant second.

(3) Septic Systems/Sewage Disposal

Approximately 89% of all private residences in Lancaster County utilize septic systems for sewage disposal purposes.

The potential for septic systems causing pollution of surface water bodies can stem from the initial improper siting of the system, or from the failing of aged or not properly maintained systems. Often septic systems have been placed in soils that can act to heighten the negative impact of the system. In soils with seasonally high water tables, the water table can rise into the septic systems' drain fields and intermix with the relatively untreated effluent. Furthermore, high water tables can cause pooling of septic effluent on the ground surface. During a rainstorm, pooled effluent can then quickly drain into nearby surface water bodies.

Highly permeable soils also can act to increase negative impacts of septic systems. These soils allow septic effluent to percolate more quickly

through soils underneath the drain field, while not allowing for proper filtration. If the effluent percolates before it is properly treated then it can become a threat to the ground or surface water that it acts to recharge. The combination of high water tables and highly permeable soils is particularly a problem in densely developed areas close to the county's shoreline. A high number of septic systems in conjunction with poor soil conditions can lead to elevated levels of fecal coliform bacteria in adjacent surface water bodies, which can then result in the condemnation of the area for shell fishing.

The Virginia Department of Health permits engineered systems for marginal soils, but frequent design failures have resulted in regulations to provide for professional maintenance of those engineered systems.

5. Potential of Surface Waters for Future Water Supply

Much of the surface water in Lancaster County is tidally influenced and has saline levels too high to be considered as a potential drinking water source without reverse osmosis treatment. Additionally, in the upper reaches of the creeks where the water is fresh enough to be used for drinking water, there is not enough stream flow to allow for direct intakes from the water body. However, at the headwaters of these creeks there are a number of existing millponds. Furthermore, with improved, higher impoundment structures there is the potential to create larger ponds or reservoirs. The existing millponds, or the potential new ponds, could be possible surface drinking water sources, subject to the Joint Permit Application review process for activities in the waters and wetlands of the Commonwealth of Virginia.

In 1973, the Northern Neck Planning District Commission conducted a water and sewage facilities plan for the Northern Neck that, until determined otherwise, remains valid in **2019** (Water Quality Management Plan - Planning District 17. Northern Neck Planning District Commission and Deward M. Martin and Associates, Inc.; Callao, VA: 1973). This plan recommended several possible impoundment sites for each of the counties of the Northern Neck. In most cases the proposed impoundment sites roughly coincided with existing millpond locations at the headwaters of the creeks. However, the proposed impoundments were usually larger than the existing millponds, with new impoundment structures located a little further downstream than the existing structures. Seven possible impoundment sites were identified in Lancaster County. They included:

Reservoir #: LBBI	Streams: Balls Branch, Lancaster Creek
Reservoir #: LCMI	Streams: Kamps Millpond
Reservoir #: LLBI	Streams: Little Branch, Corrotoman River
Reservoir #: LLB2	Streams: Little Branch, Corrotoman River
Reservoir #: LMSI	Streams: McMahon Swamp, Corrotoman River
Reservoir #: LMS2	Streams: McMahon Swamp, Corrotoman River
Reservoir #: LCRI	Streams: Upper West Branch Corrotoman River

Precise locations and boundaries for these reservoir locations can be viewed in the Future Land Use Map found in Chapter 7. The engineering drawings are available at the Northern Neck Planning District Commission.

Due to the extreme difficulty of getting permits for reservoirs and the lengthy process involved, it is recommended that the county review the projected sites for their consistency with the development of population centers since 1973 and explore other sources of water such as water reuse and desalinization. Long term planning is highly desirable for such a complex subject.

B. GROUNDWATER

There are two types of aquifers and three types of water well construction in the County. An aquifer is an underground source where water can be pumped out of sediment to be used on the surface. It is not an underground river or lake. An aquifer which gets its water from rain and snow melt infiltrating the ground is called a “water table” aquifer because it hits a clayey layer which forms the bottom of the aquifer. An “artesian” aquifer is under pressure from confining layers of sediment above and below the aquifer. Thus when a well is drilled into this aquifer, the water shoots up in the well, sometimes coming above land surface. Flowing wells are no longer common in the area. Water pumps are set at the level to which the water rises rather than at the bottom of the well. Wells in the water table aquifer can be dug by hand or bored with a well rig. They are recognizable by their large diameter (24-48 inches). Artesian wells are drilled.

1. Groundwater Structure

As stated previously, Lancaster County residents are 100% dependent on groundwater for their drinking water supplies. Lancaster County's groundwater resources come from an underground system of aquifers that reflect the geology of the Coastal Plain Region of Virginia. Underground, the coastal plain is made up of unconsolidated gravels, sands, silts, and clays in addition to variable amounts of shells. This mixture of deposits rest on an underground rock surface called the basement, which slopes gently eastward. The basement rocks actually come out of the earth's surface at the fall line of the rivers, which is the dividing line between the Piedmont and Coastal Plain Regions of Virginia. As a point of reference the fall line of the Rappahannock River is at Fredericksburg, the fall line of the James River is at Richmond, and the fall line of the Potomac River is at Washington, DC. At the fall line the thickness of the coastal plain sediments is zero; however, going east from the fall line the basement rock slopes down and the coastal plain sediments become thick. At the coastline the coastal plain sediments are over 6,000 feet thick and continue to deepen under the continental shelf.

In 2006 the United States Geological Survey and the Virginia Department of Environmental Quality published a report of the aquifer system with maps of the approximate depth for each aquifer. These are based on far more extensive knowledge than was available for earlier hydrogeological reports. The study is available on line as U.S.G.S. Professional Paper 1731, The *Virginia Coastal Plain Hydrogeologic*

Framework. Copies of the aquifer maps are also available at the Lancaster County Planning and Land Use Office and the Lancaster County Health Department. The depths are presented from sea level, so it is necessary to add the altitude to get the depth for a well being drilled from the land surface. This data dramatically changes much of our understanding of groundwater sources. Artesian aquifers do not have significant recharge sources that can keep up with our current use.

Additional research data is being gathered at the state monitoring well station built in Northumberland County with information being transmitted to U.S.G.S. computers every 15 minutes from wells for each of the five aquifers. Data is available on line.

Contained in the Coastal Plain sediments are a system of underground aquifers, or water-bearing units. Aquifers are recharged at the fall line, except for the Potomac that is not recharged directly from the land surface. The Potomac aquifer offers the best source of potable water.

Each aquifer is separated from those above and below by clay confining beds, from which they get the name, confined aquifers. These confining beds act to trap the water in between, allowing water to escape up and down only at very slow rates. When the aquifers are tapped by a well, the pressure enhances the flow of the water upward. Throughout the Coastal Plain there is also an unconfined, water table aquifer. The water table aquifer is found between the ground surface and the top of the first confining bed. This aquifer is not pressurized and is the one used by shallow wells. This aquifer is recharged at ground surface level by rainwater and below the ground surface by water bodies such as creeks and rivers. Because this aquifer is unconfined and recharges from the surface, it is very susceptible to contamination. Anything that permeates the ground surface can quickly reach the water table aquifer.

Wells in Lancaster County tap five underground aquifers. Shallow wells utilize the Columbia and Yorktown-Eastover Aquifers, which are the water table aquifers. Deep wells, or artesians, tap the Chickahominy-Piney Point Aquifer and the deeper Potomac Aquifer. Detail on each of these aquifers is given below.

a. Columbia Aquifer (Water Table)

The water table aquifer in the higher elevated parts of the western and central, and throughout the entire eastern section of Lancaster County is actually an aquifer named the Columbia. The Columbia Aquifer is used as a drinking water supply. Sources of recharge are rain, ice, and snow.

Since the aquifer recharges primarily from the surface, it is very susceptible to contamination. Septic system discharge, agricultural and lawn fertilizers, leaking underground storage tanks, and improper disposal of hazardous home waste can cause contamination of this aquifer. However, the possibility of contamination from this aquifer to artesian aquifers is essentially negligible. Existing water table wells generally have inadequate construction standards and thus water from these

wells often fails tests for potability. It is possible to install treatment equipment designed for bacteria. Construction standards adequate to secure the sanitation of these wells have been demonstrated by SAIF Water Wells, Inc. and can be viewed on the website www.saifwater.org.

The groundwater supplies of the Columbia Aquifer usually fluctuate according to the seasons of the year. Graphs of water level variations in two water table wells charted by SAIF Water Wells, Inc. over a period of several years are available at www.saifwater.org.

Water samples from some wells in this aquifer have elevated levels of nitrate, above the Maximum Contaminant Level recommended by the U.S. Environmental Protection Agency. High nitrate concentrations in groundwater are the result of human activities, especially agricultural fertilization practices and septic systems.

b. Yorktown-Eastover (Unconfined, Water Table and Confined)

The Yorktown-Eastover Aquifer lies below the water table aquifer and is sometimes a confined artesian aquifer and sometimes in direct interchange with the water table aquifer. It is not possible to tell in advance of drilling which it is in any location. Therefore, the Department of Environmental Quality advises that it should be regarded as likely to be subject to surface contamination. Other problems which make this an unwise choice for water supply are heavy iron bacteria and sandy conditions which may make the well unserviceable in short order.

The Yorktown-Eastover Aquifer is not used heavily in Lancaster County.

c. Chickahominy-Piney Point Aquifer (Confined)

This confined aquifer is located approximately 200-425 feet below the ground surface in Lancaster County and averages 50 to 100 feet in thickness throughout its reach, with a maximum thickness of 140 feet in Lancaster County. Supply in this aquifer is not as susceptible to decreases due to local drought conditions. Hydrogen sulfide gas frequently gives water from this aquifer a sulfur smell. This can be minimized at the time of drilling with the correct storage tank, micronizers and/or bleedbacks in the water line. Treatment equipment is available for an existing well, but at considerable cost.

Water in this aquifer contains concentrations of sodium, dissolved solids, and fluoride, which decrease while moving west in the aquifer. Specifically, sodium concentrations exceed 20mg/L throughout most of the aquifer, fluoride concentrations exceed 2mg/L in the south-central part of the aquifer, and concentrations of sulfate, chloride, and dissolved solids exceed the U.S. EPA Secondary Maximum Contaminant Level in the eastern part of the aquifer (Pgs.

13, 14, and 15, USGS WRI Report 92-4175). See also U.S.G.S. Professional Paper 1772 Groundwater-Quality Data and Regional Trends in the Virginia Coastal Plain, 1906-2007 which is available on line.

d. Aquia Aquifer.

The Aquia Aquifer lies between the Piney Point and Potomac Aquifers, but is generally not considered a good source for water wells, as it is thin.

e. Potomac Aquifer (Confined)

This aquifer is located approximately 525-820 feet below the ground surface in Lancaster County. This aquifer has no significant source of surface recharge. Recharge occurs in much smaller amounts from vertical seepage between aquifers and along existing well conduits. This aquifer is not as prone to contamination as the water table aquifer. Supply of this aquifer is not susceptible to decreases due to local drought conditions either.

Certain parts of the county utilizing this aquifer have higher concentrations of sodium and fluoride in their drinking water. Sodium levels are approximately 230 mg/L in White Stone, 300 mg/L in Palmer, 400 mg/L in Foxwells, and as high as 500 mg/L at Windmill Point. Sodium levels in the artesian aquifers in the entire County exceed the USEPA advisory limits for persons with health conditions requiring limitation of sodium intake. The Virginia Department of Health has issued a fluoride alert for our area. It is recommended that the owners of artesian wells have their water tested for fluoride before using supplemental fluoride for children. Water table wells generally do not have high fluoride levels.

(1) Effects of Drawdown in the Potomac Aquifers

The Potomac Aquifer is heavily tapped for deep/artesian well supplies in Lancaster County and regionally. The aquifer is a principal source of groundwater for municipal, industrial, and agricultural use in the York-James, Middle, and Northern Neck Peninsulas of Virginia. In 2004 the Maryland Geological Survey released a report on the need to assess the sustainability of the Ground-water Resources in the Atlantic Coastal Plain and in 2006 began a cooperative effort with the U.S. Geological Survey (development in Maryland draws from aquifers shared with the Northern Neck of Virginia).

Due to heavy use there has been some regional draw down in the aquifer throughout the Coastal Plain Region. Draw down is caused by the withdrawal of large amounts of groundwater from the confined aquifers. The result of draw down is that water levels in the confined aquifers have declined and the underground flow of water has changed. This situation presents future problems for Lancaster County deep well users.

Several United States Geological Survey reports have studied the Coastal Plain groundwater aquifers, as well as the effect of drawdown caused by heavy pumping. According to one report, the decline in the level of water in the aquifers has changed the direction of ground-water flow toward the major pumping centers. When considering the Potomac Aquifer, these centers are located near the cities of Franklin, Williamsburg, Suffolk, and Alexandria and the towns of West Point and Smithfield.

Lastly, groundwater supplies that used to travel all the way to the coast to recharge surface water bodies with fresh water get detoured before they reach the surface water bodies. Impacts of this situation on the water quality of the Chesapeake Bay and its tributaries are unknown. (Specific data on water levels in wells monitored in Lancaster and surrounding counties by the United States Geological Survey, documentation of artesian aquifer recharge areas and declining water supplies, as well as a list of major water use areas can be seen in Appendix VII.)

2. Existing And Projected Demand For Groundwater in Lancaster County, VA

In 2010 there were 11,391 people in Lancaster County**.** Using a weighted average usage of 93 gallons per day for all citizens, countywide consumption was 1.06 MGD (million gallons per day). If local population increases, this daily demand will likely increase, as well.

New large commercial users, any one of which could use as much as all of Lancaster County combined, may very well affect overall availability. The Northern Neck is included in the Eastern Virginia Groundwater Management Area, which covers all areas east of Interstate 95 and west of the Chesapeake Bay. Any person or entity in this area must obtain a permit to withdraw 300,000 gallons or more of groundwater in one month.

3. Threats to Groundwater Supply

a. Septic Systems/Sewage Disposal

As discussed previously in the "Surface Water Section," individual homeowner sewage disposal systems can act to negatively impact groundwater supplies. The aquifers most susceptible to contamination from individual sewage disposal systems are the Columbia and the unconfined water table part of the Yorktown-Eastover. Localized soil conditions such as high water tables and highly permeable soils in conjunction with large concentrations of septic systems can threaten the quality of the water table aquifers.

An additional concern is the approved engineered wastewater treatment systems.

This is even more imperative given that these systems are almost always placed in areas with high water tables and/or percolation problems. Recent regulations by the Virginia Department of Health require monitoring and adequate maintenance of these systems.

b. Underground and Aboveground Storage Tanks

According to the Department of Environmental Quality's Underground Storage Tank database there are approximately 326 regulated underground storage tanks in Lancaster County (Local Inventory of Regulated Underground Storage Tanks can be viewed at the Lancaster County Planning and Land Use Office). Additionally, many people in the county have unregulated storage tanks which contain fuel for the home heating source or their personal vehicles. These underground storage tanks can be a possible source of contamination for groundwater in Lancaster County.

Regulated storage tanks in the county are all tanks over 110 gallons, except for residential/non-commercial tanks less than 1,100 gallons, farm tanks less than 1,100 gallons, and residential/commercial heating fuel tanks less than 5,000 gallons. Therefore, regulated tanks are generally the tanks found at most gas stations, convenience stores, and automobile distributors in the county. Current state regulations have strict requirements for the operation of regulated underground storage tanks. First, these tanks must be protected from corrosion if they are to be placed underground. Second, owners and operators of new and existing tanks must provide a method, or combination of methods for release detection. Additionally, these tanks are required to be monitored periodically by the owners for leaks. Lastly, the owner and operator must report, investigate, and clean up any spills and overfills in accordance with state regulations.

Residential underground storage tanks are not regulated by the Department of Environmental Quality. Most leaks are discovered and taken care of by the owners of the tanks. Information available from local oil companies suggests that problems with leaks are only found in areas with low groundwater tables. In areas with high water tables, water leaks into leaking tanks instead of fuel leaking out. Leaks in these cases will often be detected when water levels in the tank cause the
owner's furnace or heating source not to light. However, in areas with low water tables, fuel will often leak out and down when a leak occurs. Leaks in these cases will be detected only by noticing a drop in tank levels, or an increase in the usage of the fuel. The percentage of these tanks located underground is undetermined.

Aboveground storage tanks for home heating oil have also proven to be a serious hazard to water wells drawing from the surface aquifer. Even when the tank is secure, leaks around the valve and oil line have contaminated water wells beyond repair. Currently a program exists under the Virginia Department of Environmental Quality to replace water table (large bore) wells contaminated by

fuel oil with artesian wells.

c. Uncapped/Abandoned Wells

Uncapped and abandoned wells are potential sources for groundwater contamination. These wells act as direct conduits to the groundwater supply. Disposal of waste into these wells can quickly lead to contamination. Abandoned artesian wells may allow direct access to deep aquifers. Census figures for Lancaster County indicate that there are possibly several hundred wells in the county that are no longer used but have not been properly abandoned. Procedures for abandoning a well are established by the Virginia Department of Health and can be costly.

d. Improper Disposal of Household Hazardous Waste

Due to tightened regulations and prohibitive costs, many rural counties no longer operate their own landfills to dispose of solid waste. In the Northern Neck each of the four counties have switched to waste transfer types of waste collection and disposal. In Lancaster County, waste and recyclable material are collected at three transfer sites. Waste collected at these sites is then carried by a waste carrier to a large regional landfill in King & Queen County. Furthermore, marketable recyclable materials such as cardboard, paper, aluminum, and glass collected at these sites are sold by the county to generate revenue to support the costs of operating the collection centers.

However, due to limitations on the type of waste accepted by the regional landfill and the high costs of collection and proper disposal of household hazardous waste, there is a limited system in place for citizens to dispose of this type of waste. Lancaster County accepts household hazardous waste at the solid waste collection sites two Saturdays a year, one in the spring and one in the fall. Household hazardous waste can include used motor oil, paint thinners, solvents, antifreeze, etc. These limited options can lead homeowners to choose improper means for disposing of this type of waste, which in turn becomes a threat to groundwater supplies.

II. ASSESSMENT OF EXISTING CONDITIONS

A. SURFACE WATER

Lancaster County is fortunate to have large areas of surface water within its boundaries. Overall, the condition of these surface waters is good; however, there are some areas for concern. Non-point source pollution has caused some degradation of water quality in the E25 (Corrotoman River) and C01 (Chesapeake Bay) watersheds. The E25 watershed was cited as having significant levels of urban use impacts due to urban erosion and nutrient loadings, and the amount of disturbed land. This type of pollution can be attributed to new home or business construction, particularly on the water. The C01 watershed was

cited as having a large number of shellfish condemnations due to urban non-point source influences. This type of pollution can be attributed to high densities of septic systems, or a number of failing septic systems located close to surface water. The C01 watershed also was negatively impacted from agricultural non-point source pollution. However, despite being mentioned for these specific non-point source pollution impacts, none of the three watersheds were cited as having violations of state water quality standards.

Lancaster County's surface water resources also have potential, although limited, for use as a future potable water supply. In the County, there are no smaller fresh water streams that have suitable flow to allow for raw intake for drinking water purposes. Furthermore, saline conditions in the larger tidal portions of the County's surface water bodies make them unsuitable as a supply for drinking water. However, the County does have a large number of existing, privately owned millponds, as well as other possible locations for impoundment of fresh surface water supplies.

The existing millponds already serve an important function, since they act as areas of recharge for water table aquifers. Furthermore, the existing millponds are generally located at the headwaters of streams or creeks, and many have sparsely populated areas surrounding them. With enlarged impoundment structures, these millponds could be potential surface water supplies for drinking water. Lastly, all the millponds are located upstream of permitted discharges. This situation would prevent discharges from affecting millpond or reservoir waters.

B. GROUNDWATER

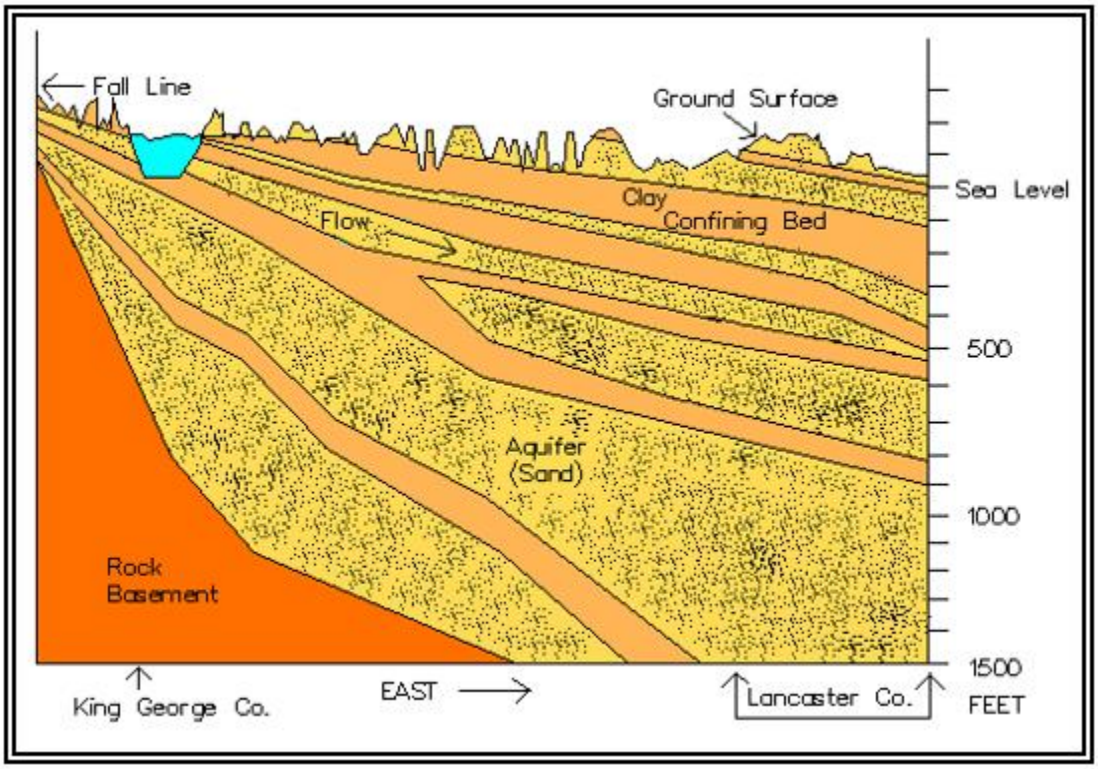
A technical presentation of aquifers under Lancaster County is available in *United States Geological Survey Professional Paper 1731, The Virginia Coastal Plain Hydrogeologic Framework* which is available on line. Plate 3, section CD-CD' is the map containing Lancaster County. A print copy of aquifer maps is available at the Lancaster Department of Health's Environmental Services office.

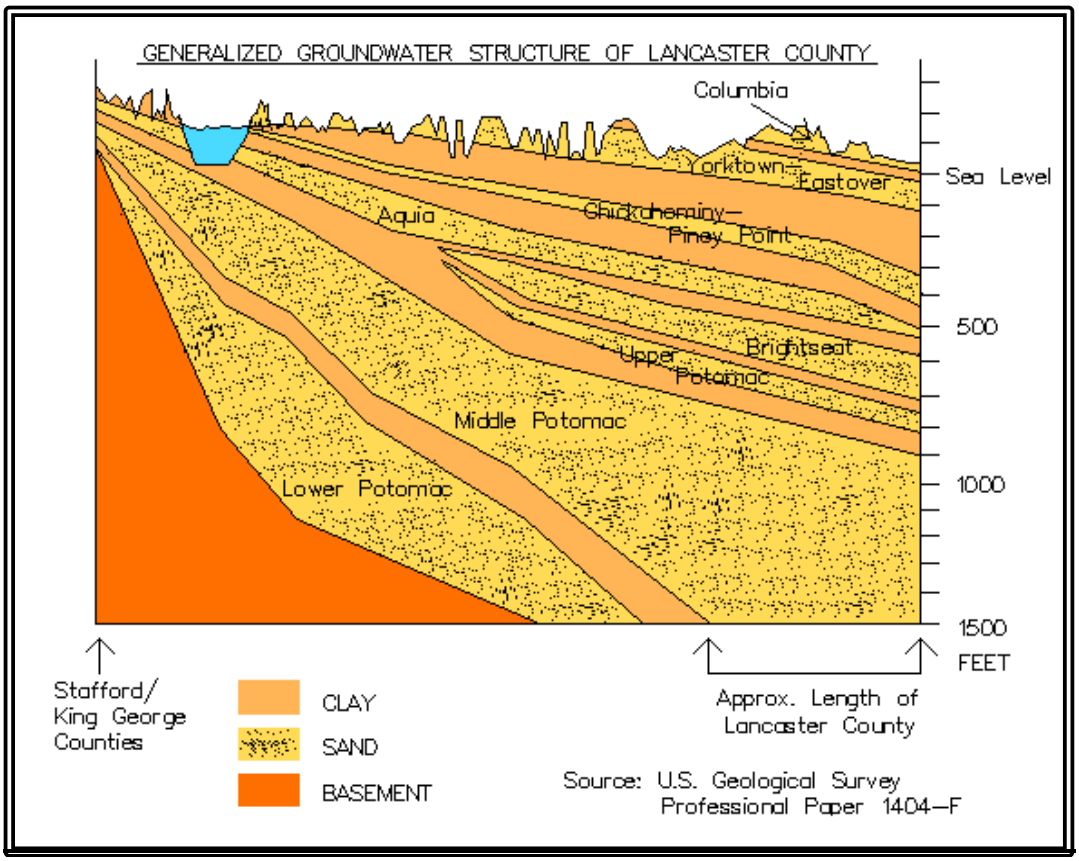
Recent research at the Surprise Hill Monitoring station in Northumberland County by the Virginia Department of Environmental Quality in conjunction with the United States Geological Survey has added to the knowledge of local aquifers. Water quality data on each of the aquifers is being collected there and is available on line at http://waterdata.usgs.gov/va/nwis/current/?type=gw. SAIF Water Wells, a local non-profit organization, has provided a consumer's report of our five aquifers which is available online at www.saifwater.org.

The Columbia is the principal water table aquifer, and the Yorktown-Eastover draws from the water table aquifer at some points and from a confined artesian aquifer at other points. The main users of the water table aquifers are owners of hand dug and machine bored wells. The water table aquifers are the most susceptible to pollution, and the recharge area is the land above the aquifers in Lancaster County. Direct threats include septic systems, underground storage tanks, improper disposal of hazardous home waste (oil, gas, etc.), and abandoned, uncapped wells. It has been the experience of SAIF

Water Wells in investigations and laboratory analyses of hundreds of water table wells that the primary causes of pollution are inadequately constructed and maintained wells and general lack of knowledge on the part of homeowners and plumbers as to what is needed to protect the water supply. Holes are often quite visible in the well curbs and caps, and interior inspections reveal unsealed damage from the installation of pipes.

Recent studies conclude that regional drawdowns due to heavy pumping of the deeper confined aquifers should cause concern and warrant further study. Specific plans for a more diverse water supply to include the use of surface water, or reservoirs will be made.





III. POTABLE WATER SUPPLY PLAN

A. GROUNDWATER

1. Water Table Wells

In Lancaster County, the water table aquifers are those most susceptible to contamination. Failing septic systems, agricultural fertilizers, hazardous home wastes, etc. can act to pollute water table aquifer resources. It is the responsibility of the well owner to obtain laboratory tests. Currently Virginia only requires a passing coliform bacteria sample to consider the water potable. "Potable" simply means it is reasonable to drink it. Coliform bacteria is not a health hazard, but simply a convenient way to indicate that other bacteria may be present that are potentially harmful. Because these wells are affected by rainfall and pollutants on the surface, bacteria levels may vary. Failure of a single sample is not adequate justification for condemning the well. Water purification equipment for the drinking water is a viable alternative. The well owner may wish to also test for nitrate and pesticides.

2. Abandoned Wells

The county will undertake a parcel specific inventory of all abandoned wells in the county. After wells are identified, an informative mailing will be prepared to send to each property owner with an abandoned well. The mailing will caution owners to protect the

well area and not to use it for disposal of solid or liquid waste. Furthermore, it will ask the owners if they would be interested in participating in a countywide permanent well abandonment.

3. Household Hazardous Waste Collection Day

To provide further protection to the County's groundwater resources Lancaster County has established a recurring Household Hazardous Waste Collection Day. This event is held at the existing solid waste refuse sites that, while currently done semi-annually, could be done on a more frequent basis as need dictates. The County obtains the services of a certified waste disposal contractor who has proper authorization to handle and dispose of this type of waste. The event is widely marketed to the public, and on this particular day Lancaster County residents are allowed to properly dispose of a reasonable amount of household hazardous waste at no cost. A charge is only applied when the amount offered for disposal exceeds a set level.

4. Groundwater Management Area (GMA)

Lancaster County is a part of the Eastern Virginia Management Area as of June 4, 2014 *(9 VAC 25-600-20).*

The County will encourage conservation efforts on the part of current and future users. Any future golf courses will be required to develop plans that include surface or recycled water sources for their needs rather than being totally dependent on groundwater withdrawals.

5. Drilling Test Monitoring Wells

To expand existing knowledge of the groundwater resources of Lancaster County and the Northern Neck, the County endorses recommendations made by the Department of Environmental Quality (then the State Water Control Board) to establish monitoring wells in Lancaster County and the Northern Neck. Additional monitoring wells are desirable to provide a more adequate information base on the decline of water in the artesian aquifers and possible tapping of deeper aquifers.

6. Regional Water Supply Plan

The 2003 Virginia General Assembly identified the need for a regulation for comprehensive water supply planning to protect water supplies for the future economic vitality and public health of the Commonwealth. The Virginia State Water Control Board responded to this mandate and adopted regulations on June 28, 2005 requiring all local governments and regional entities to prepare local and/or regional water supply plans. The Northern Neck Planning District Commission (NNPDC) and its ten localities supported meeting this legislative and regulatory requirement by developing a regional plan. The NNPDC retained the services of EEE Consulting, Inc. in Blacksburg, VA to assist in this effort.

On August 25, 2011, Lancaster County approved the Northern Neck Regional Water Supply Plan which includes a description of existing water sources, existing water uses, and existing water resource conditions; an assessment of projected water demand; a description of water management actions including drought response, contingency plans, and other water demand management information; a statement of need and an analysis that identifies alternatives to address projected water supply deficits; and maps identifying important elements of the plan such as existing water resources, proposed new sources, and significant existing water uses.

B. SURFACE WATER

1. Inventory Septic Systems

As part of the effort to ensure continued protection of Lancaster County's Surface and Groundwater Resources, the County is exploring resources to inventory and map existing septic systems. This effort would help to pinpoint high concentrations of septic systems in the County, which could act cumulatively to deteriorate the quality of Lancaster's surface and groundwater supplies. Information obtained from this inventory will be valuable in developing a future land use map for Lancaster County. Additionally, once compiled this information would aid in any future efforts to identify and prioritize areas for efficient placement of a wastewater treatment plant. Inventories done to date have included only permitted systems and do not account for systems placed prior to 1985.

2. Identify Possible Impoundment Areas

Lancaster County will take action as necessary to ensure that potential reservoir sites are protected for use as such. This step will take priority in its own right without waiting for any further coordinated efforts.

3. Continue Present Enforcement Levels

To ensure continued protection of the quality of Lancaster County's surface water bodies, the County will continue its present, active enforcement of the Erosion and Sediment Control Act and the Chesapeake Bay Preservation Act, which requires that all septic tanks be inspected and/or pumped at least once every five years.

IV. GOALS AND OBJECTIVES FOR LANCASTER COUNTY POTABLE WATER SUPPLY PLAN

GOAL #1: **Protect and improve quality of surface waters of Lancaster County to ensure their continued benefit to the economy, recreation, and health of the County.**

Objective: Continue strict enforcement of the Chesapeake Bay Preservation Act and Erosion and Sediment Control Act Regulations to ensure protection of the water quality of the Chesapeake Bay and its tributaries.

Objective: Explore possible water impoundment areas presented in this plan for Lancaster County and determine which are appropriate for the distribution of population and development that has occurred since the initial engineering study.

Objective: Develop strengthened county ordinances to ensure protection of proposed impoundment areas.

GOAL #2: **Develop methods to prevent groundwater pollution in order to protect the supply of groundwater in Lancaster County and to ensure that an adequate future supply exists for the continued growth of the County.**

Objective: Encourage the upgrading of well structure, removal of environmental hazards near wells, wellhead protection measures, and regular laboratory analyses of water samples.
Objective: Develop a method of collecting waste oil in the county to give residents a safe disposal option.

Objective: Discourage the placement of water table wells near agricultural operations.

Objective: Discourage the installation of wells in the Yorktown-Eastover Aquifer. Classify all wells in this aquifer as "water table" rather than "artesian" regardless of the drilling method used.

Objective: Collect and analyze data that will show the impact on Lancaster County of draws from the aquifers in other jurisdictions.

Objective: Encourage the use of better construction methods for bored wells which can minimize the potential for bacterial contamination. A video and manual are available at www.saifwater.org showing a model well that has had consistently good results in follow-up sampling.

GOAL #3: **Develop methods to improve and protect groundwater quality in Lancaster County to ensure the continued safe health of the local people and the economy.**

Objective: Work in coordination with existing community organizations and the health department in efficiently utilizing existing local resources to improve drinking water quality.

Objective: Identify possible funding for community well improvements and locate abandoned wells.

Objective: Strongly support Department of Environmental Quality proposals to drill test wells in the county to monitor water quality problems.

GOAL #4: Develop methods to ensure the continued availability of potable water.

Objective: Actively participate in efforts on a state and regional basis to address the issue of over pumping of artesian aquifers by other localities in Virginia and Maryland.

Objective: Support efforts to extend the Eastern Virginia Groundwater Management Area to the Northern Neck and Middle Peninsula of Virginia.

Objective: Explore technology and alternative sources of potable water including water reuse that would enable the County to have diverse sources of water for the future.

Objective: Support water conservation measures through building ordinances.

GLOSSARY OF TERMS

"Shallow well" has been commonly used here to mean a large diameter well that was either machine bored or dug by hand. It is not an adequate technical term for use in this Comprehensive Plan. The United States Geological Survey generally uses the word to mean wells less than two feet deep. Bored wells in Lancaster County may be up to 100 feet deep. The term "water table well" is used herein to refer to wells drawing water from aquifers in unconfined sediment near the ground surface which are fed by rain and snow melt.

Construction methods - Artesian wells in the county have generally been drilled with water pressure and have small diameter pipes. But small diameter pipes are not necessarily tapping an artesian aquifer. This construction method has been used for wells that are actually in the water table aquifer in unconfined sediment that is subject to infiltration from the surface in this area. In some parts of the commonwealth drilled wells with small diameter pipes are less than 40 feet deep.

"Artesian" refers to aquifers that are confined by layers of sediment which keep the water under pressure. When a well is drilled into an artesian aquifer the pressure of the aquifer will

cause the water to rise in the pipes. The County no longer has flowing artesian wells where the water naturally rises above the ground surface. The confining layers prevent contamination from the ground surface.

Terms and measurements used for further understanding of groundwater quality descriptions are listed and detailed below. They have been obtained from the following United States Geological Survey Report:

Water-Resources Investigations Report 92-4175, "Quality of Groundwater in the Coastal Plain Physiographic Province of Virginia." Focazio, Michael J.; Speiran, Gary K.; and Rowan, M. Eileen; U.S. Geological Survey; Richmond, VA: 1993.

Chloride - The U.S. EPA has established a SMCL for chloride of 250 mg/L. (U.S. Environmental Protection Agency, 1990c;) Furthermore, the State of Virginia maintains an antidegradation standard for chloride in groundwater in the Coastal Plain of 50 mg/L (Commonwealth of Virginia, 1988)

Dissolved Solids - This refers to the measure of the concentration of all dissolved material in the water. The U.S. EPA SMCL for dissolved solids is 500 mg/L (U.S. EPA, 1990c). The State of Virginia's antidegradation standard for dissolved solids in groundwater in the Coastal Plain is 1,000 mg/L. (Commonwealth of Virginia, 1988)

Fluoride - The U.S. EPA has established both an MCL of 4.0 mg/L and an SMCL of 2.0 mg/L for fluoride. The State of Virginia enforces a standard of 1.8 mg/L. (Commonwealth of Virginia, 1982)

MCL - This refers to Maximum Contaminant Levels, which is a U.S. Environmental Protection Agency (1990a) designation. Reported MCL's are set for health concerns. This is the maximum permissible level of a contaminant in water that is delivered to any user of a public-water system. These levels are enforceable.

SMCL - This refers to Secondary Maximum Contaminant Levels, which is a U.S. Environmental Protection Agency (1990a) designation. Reported SMCL's are set for aesthetics (such as taste or odor) or for limits on properties that affect use of the water (such as chemical aggressiveness, or potential for the water to deposit solid chemicals). These levels are not enforceable.

Sodium - Presently, there are no Federal drinking water regulations concerning sodium; however, the State of Virginia maintains an antidegradation standard for sodium in groundwater in the Coastal Plain of 100 mg/L. The State also advises that persons on sodium-restricted diets avoid drinking water with sodium concentrations greater than 20mg/L, if the restriction is severe, and 270 mg/L, if moderate.