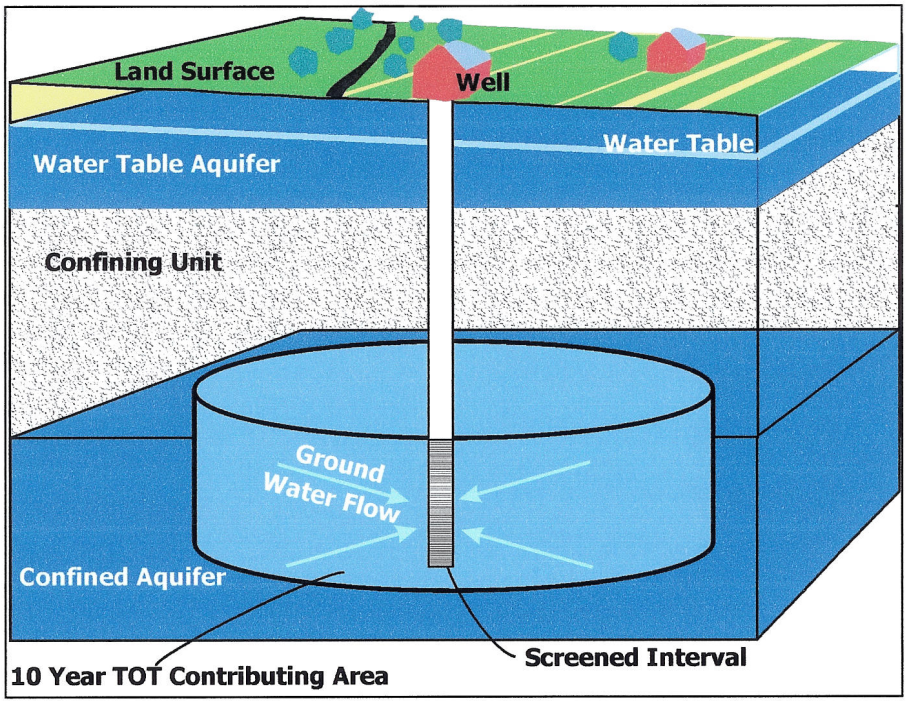
SOURCE WATER ASSESSMENT

FOR FORREST FARM AND VILLAGES AT LEONARDTOWN

ST. MARY'S COUNTY, MD



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SUMMARY

The Maryland Department of the Environment's (MDE) Water Supply Program (WSP) has conducted a Source Water Assessment for the Forrest Farm Water System and Villages at Leonardtown Water System. Both systems are owned and operated by the St. Mary's Metropolitan Commission and are therefore both covered in this report. The major components of this report as described in Maryland's Source Water Assessment Plan (SWAP) are: 1) delineation of an area that contributes water to the source, 2) identification of potential sources of contamination, and 3) determination of the susceptibility of the water supply to contamination. Recommendations for management of the assessment area conclude this report.

The source of Forrest Farm's water supply is a Coastal Plain confined aquifer--the Lower Patapsco. One well is currently being used to supply the water from this aquifer. The source water assessment area was delineated by the Water Supply Program using methods approved by the U.S. EPA.

The source of Villages at Leonardtown's water supply is also a Coastal Plain confined aquifer--the Aquia. One well is currently being used to supply the water from this aquifer. The Water Supply Program using methods approved by the U.S. EPA delineated the source water assessment area.

Potential sources of contamination within the assessment area were identified based on MDE site visits and a review of MDE's databases. Well information and water quality data were also reviewed. A map showing the source water assessment area and potential contaminant sources is enclosed.

The susceptibility analysis for the water supply systems at both Forrest Farm and Villages at Leonardtown is based on a review of the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. Forrest Farm's water supply is not susceptible to contaminants originating at the land surface due to the protected nature of confined aquifers. Due to the natural occurrence of arsenic in the Aquia aquifer, Villages at Leonardtown's water supply may be susceptible to arsenic. However, it is not susceptible to other contaminants originating at the land surface due to the protected nature of confined aquifers.

INTRODUCTION

The Maryland Department of the Environment's (MDE) Water Supply Program (WSP) has conducted a Source Water Assessment for the Forrest Farm Water System and the Villages at Leonardtown Water System. Both systems are located within the vicinity of Leonardtown in St. Mary's County. Forrest Farm is located on the east side of Brown Road, east of Leonardtown, and pumps water from one well located in the Lower Patapsco. The system is owned and operated by St. Mary's Metropolitan Commission (METCOM) and currently serves approximately 20 homes. It is anticipated that this water system will eventually serve a total of 209 homes. The Forrest Farm water system was identified as a community water system in August 2003. Therefore, only limited sampling data is available. Villages at Leonardtown is located on the north side of Budds Creek Road, west of Leonardtown, and pumps water from one well in the Aquia aquifer. The system is also owned and operated by METCOM and currently serves approximately 25 homes. When the community is complete, it is expected to serve a total of 88 homes. The Villages at Leonardtown water system was only recently identified (May 2004) as a community water supply. Therefore, sampling data for this community system is also limited. Both water systems use chlorine as a disinfectant to provide a barrier for microbiological contamination that could occur due to breaks or cross connections in the storage and distribution systems. The focus of this report however is possible risks to the water supply sources and does not address treatment, distribution, or storage issues.

WELL INFORMATION

Well information was obtained from the Water Supply Program's database, site visits, well completion reports, sanitary survey inspection reports and published reports. A review of the well data and sanitary surveys of the systems indicates the wells serving these communities were drilled after 1973, when the State's well construction regulations went into effect, and meet current well construction standards for grouting and casing. Table 1 contains a summary of the well construction data.

SYSTEM NAME	SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH (ft)	CASING DEPTH (ft)	YEAR DRILLED	AQUIFER NAME
Forrest Farm	01	Well 1	SM-94-3424	906	762	2001	PATAPSCO
Villages at Leonardtown	01	Well	SM-94-2699	535	475	2000	AQUIA

Table 1. Well Information.

HYDROGEOLOGY

Ground water flows through pores between gravel, sand and silt grains in unconsolidated sedimentary rock aquifers such as the aquifers used by the Forrest Farm and Villages at Leonardtown water systems. An aquifer is any formation that is capable of yielding a significant amount of water. The transmissivity is a measure of the amount of water an aquifer is capable of producing and is related to the hydraulic conductivity

and the thickness of the aquifer. A confining layer is generally composed of fine material such as clay and silt, which transmits relatively very little water. Confined aquifers are those formations that are overlain by a confining unit. Confined aquifers are recharged from the water stored in the confining unit above and from precipitation that infiltrates into the formation where it is exposed at the surface.

The Leonardtown area lies within the Atlantic Coastal Plain physiographic province. This province, which in Maryland includes roughly the area east of Interstate 95, is underlain by unconsolidated clastic sediments of Lower Cretaceous to recent age, which thicken to the southeast so that they appear wedge-shaped. These sediments crop out in a concentric band that lies parallel to the Fall Line which marks the western boundary of the Coastal Plain.

Forrest Farm's well pumps water from the Patapsco formation, which is a confined multi-aquifer formation consisting of irregularly stratified interbedded, variegated (gray, brown and red) silt and clay and argillaceous, subrounded, fine to medium-grained quartzrose sand with minor amount of gravel (Hansen, 1972b). The top of the Patapsco formation in the Forrest Farm area is 632 feet below sea level.

Villages at Leonardtown's well pumps water from the Aquia aquifer, which is confined and is composed of fine to coarse-grained, greenish-brown sand that contains layers of grayish-green silt and clay, indurated calcite-cemented sand and fossil beds composed of shell debris (DNR, 1987). The top of the Aquia aquifer in the Villages at Leonardtown area is approximately 405 feet below sea level.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WMPA) is considered to be the Source Water Assessment Area (SWAA) for the system. Source Water Assessment Areas (SWAAs) were delineated for both the Forrest Farm and the Villages at Leonardtown wells using the methodology described in Maryland's Source Water Assessment Plan (1999) for confined aquifers in the Coastal Plain often referred to as the "Florida Method". The area is a radial zone of transport within the aquifer and is based on a 10 year time of travel (TOT), pumping rate and the screened interval(s) of the well or wells included in the SWAA, and the porosity of the aquifer (see illustration below for conceptual model). The Florida Method is a modification of Darcy's Law for radial flow to a well and the SWAA's were calculated using the following volumetric equation:

$$r = \sqrt{\frac{Qt}{\pi n H}}$$

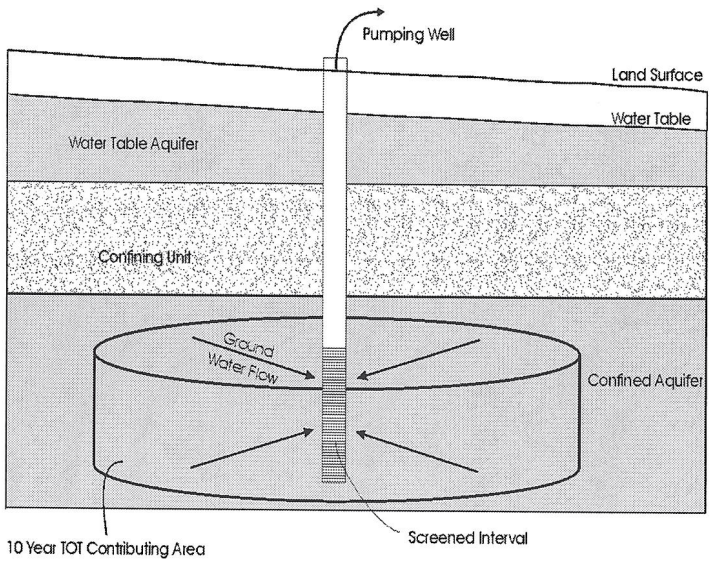
where r = calculated fixed radius (ft)
Q = pumping rate of well (ft^3/yr)
n = aquifer porosity (dimensionless)
H = length of well screen (ft)
t = time of travel (yr.)

METCOM has a water appropriation permit for the Forrest Farm subdivision for an annual average of 46,200gallons per day (gpd). The source well, SM-94-3424, has multiple well screen lengths for a combined well screen length of 75 feet. METCOM also has a water appropriation permit for the Villages at Leonardtown subdivision for an annual average of 19,500 gpd. The source well at this site, SM-94-2699, has a well screen length of 50 feet.

A conservative estimate of porosity (n) of 25% was used for the aquifer based on published reports. Using these parameters the radius was calculated with the above equation for the WHPA delineation (Table 2). The circle shown in Figure 1 and Figure 2 represent the aquifer zone of transport in the subsurface as illustrated below.

System/Well Name	Well pumpage (Q) in gpd	Well pumpage (Q) in ft3/yr	Screened interval in feet (H)	Aquifer	Calculated radius for WHPA in feet (r)	Acreage of WHPA	Comments on WHPA
FORREST FARM/WELL 1	46,200	2,254,255	75	PATAPSCO	618	27.5	
VILLAGES AT LEONARDTOWN/WELL	19,500	951,472	50	AQUIA	492	17.5	r = 600 used

Table 2. Parameters used for the Wellhead Protection Area delineations



Conceptual illustration of a zone of transport for a confined aquifer

POTENTIAL SOURCES OF CONTAMINATION

In confined aquifer settings, sources of contamination at the land surface are generally not a threat unless there is a pathway for direct injection into the deeper aquifer such as unused wells or along well casing that are not intact or have no grout seal. Wells that are not being used or maintained will eventually corrode and provide a pathway for contaminants present in the shallow aquifers at higher-pressure heads to migrate to the deeper aquifers.

Potential sources of contamination identified at the land surface have the potential to impact the shallow water table aquifer. Based on the MDE databases, no potential sources of contamination were identified within the Forrest Farm WHPA or the Villages at Leonardtown WHPA. Therefore, except for the direct injection of contaminants into the deeper confined aquifer, both Forrest Farm's and Villages at Leonardtown's water supply should be well protected from contamination.

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database and system files for Safe Drinking Water Act contaminants. The State's SWAP defines a threshold for reporting water quality data as 50% of the Maximum Contaminant Level (MCL). If a monitoring result is at or greater than 50% of a MCL, this assessment will describe the sources of such a contaminant and, if possible, locate the specific sources which are the cause of the elevated contaminant level. All data reported is from the finished (treated) water unless otherwise noted. The treatment currently used at Forrest Farms is pre-gaseous chlorination for disinfection.

Forrest Farm

A review of the monitoring data since February 2004 for Forrest Farm's water supply indicates that it meets the current drinking water standards for inorganic, microbiological, radiological, and organic compounds. The water quality sampling results are summarized in Table 3.

IOCs		SOCs		VOCs		Radionuclides	
No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL
3	0	1	0	4	0	3	0

Table 3. Summary of Water Quality Samples for Forrest Farm's Water Supply

Inorganic Compounds (IOCs)

No IOCs above 50% of the MCL have been detected in Forrest Farm's water supply.

Volatile Organic Compounds (VOCs)

No VOCs have been detected in Forrest Farm's water supply.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL have been detected in Forrest Farm's water supply.

Radionuclides

No radionuclides above 50% of the MCL have been detected in Forrest Farm's water supply.

Microbiological Contaminants

Routine bacteriological monitoring is conducted in the finished water for each community water system on a monthly basis and measures total coliform bacteria. Total coliform bacteria are not pathogenic, but are used as an indicator organism for other disease-causing microorganisms. A major breach of the system or the aquifers would likely cause a positive total coliform result despite disinfection and would require follow-up total and fecal coliform analysis.

Since January 2003 Forrest Farm has conducted routine bacteriological sampling 26 times. All samples have been negative for total coliform bacteria.

Villages at Leonardtown

A review of the monitoring data since July 2003 for Village at Leonardtown's water supply indicates that it meets the current drinking water standards for inorganic, microbiological, radiological, and organic compounds. The water quality sampling results are summarized in Table 4.

IOCs		SOCs		VOCs		Radionuclides	
No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL
3*	1	0	0	1*	0	1*	0

Table 4. Summary of Water Quality Samples for Villages at Leonardtown's Water Supply

*One sample is a raw water sample taken after well development.

Inorganic Compounds (IOCs)

IOCs above 50% of the MCL have been detected in Village at Leonardtown's water supply on one occasion. The only contaminant greater than 50% of the MCL was arsenic. The raw water sample taken in May 2000 indicated arsenic was less than

the method detection limit of 0.005 parts per million (ppm). Since that time, only one other sample for arsenic has been taken (July 2003) with a result of 0.006 ppm.

Volatile Organic Compounds (VOCs)

No VOCs have been detected in Village at Leonardtown's water supply on the raw water.

Synthetic Organic Compounds (SOCs)

No samples for SOCs have been taken at the Village at Leonardtown's water supply.

Radionuclides

No radionuclides above 50% of the MCL have been detected in Village at Leonardtown's water supply.

Microbiological Contaminants

Routine bacteriological monitoring is conducted in the finished water for each community water system on a monthly basis and measures total coliform bacteria. Total coliform bacteria are not pathogenic, but are used as an indicator organism for other disease-causing microorganisms. A major breach of the system or the aquifers would likely cause a positive total coliform result despite disinfection and would require follow-up total and fecal coliform analysis.

Since August 2003 Villages at Leonardtown has conducted routine bacteriological sampling 20 times with no positive results.

SUSCEPTIBILITY ANALYSIS

Both the well serving Forrest Farm's water system and the well serving Villages at Leonardtown's water system obtain water from a confined aquifer. Confined aquifers are naturally well protected from activity on the land surface due to low permeability sediments that provide a barrier for water movement from the surficial aquifers into the deeper aquifer. A properly constructed well with the casing extended to the confining layer above the aquifer and with sufficient grout should be well protected from contamination at the land surface. Wells that are not being used or maintained will eventually corrode and can provide a pathway for contaminants present in the shallow aquifers at higher-pressure heads to migrate to the deeper aquifers. The information that was used to conduct the susceptibility analysis is as follows: (1) available water quality data (2) presence of potential contaminant sources in the WHPA (3) aquifer characteristics (4) well integrity and (5) the likelihood of change to the natural conditions.

Forrest Farm

The susceptibility of Forrest Farm's water supply to the various contaminant groups is shown in Table 5 at the end of this section.

Inorganic Compound (IOCs)

No IOCs above 50% of the MCL have been detected in the Forrest Farm water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Forrest Farm's water supply **is not** susceptible to the other inorganic compounds.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in Forrest Farm's water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination in the aquifers, Forrest Farm's water supply **is not** susceptible to volatile organic compounds.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL were detected in Forrest Farm's water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Forrest Farm's water supply **is not** susceptible to synthetic organic compounds.

Radionuclides

No radionuclides above the 50% of the MCL were detected in Forrest Farm's water supply.

Since the natural occurrence of radionuclides is not present in water from the Aquia aquifer, Forrest Farm's water supply **is not** susceptible to other radionuclides

Microbiological Contaminants

Raw water monitoring for microbiological contaminants is not required of water systems in confined aquifers because they are considered naturally protected from sources of pathogens at the land surface. Routine bacteriological testing at Forrest Farm's has shown no positives for total coliform or fecal coliform. Therefore, Forrest Farm's water supply **is not** susceptible to microbiological contaminants.

CONTAMINANT TYPE	Are Contaminant Sources present in the WHPA?	Are Contaminants detected in WQ samples at 50% of the MCL	Is Well Integrity a Factor?	Is the Aquifer* Vulnerable?	Is the System Susceptible to the Contaminant
Inorganic Compounds	NO	NO	NO	NO	NO
Volatile Organic Compounds	NO	NO	NO	NO	NO
Synthetic Organic Compounds	NO	NO	NO	NO	NO
Radionuclides	NO	NO	NO	NO	NO
Microbiological Contaminants	NO	NO	NO	NO	NO

Table 5. Susceptibility Chart for Forrest Farm's Water Supply

Villages at Leonardtown

The susceptibility of Villages at Leonardtown's water supply to the various contaminant groups is shown in Table 6 at the end of this section.

Inorganic Compound (IOCs)

IOCs above 50% of the MCL have been detected in the Villages at Leonardtown's water supply on one occasion. The contaminant detected greater than 50% of the MCL was arsenic in a sample taken in July 2003. This is the only finished water sample that has been taken at this system analyzed for arsenic.

Some chemical elements (e.g. arsenic) are naturally occurring in the aquifer and in some instances can reach concentrations that pose a risk to water supply. In the case of confined aquifers, this is generally more problematic than contaminants at the land surface.

Based on the natural occurrence of arsenic in the aquifer and its presence in the water samples, Villages at Leonardtown's water supply **may be** susceptible to arsenic. Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Villages at Leonardtown's water supply **is not** susceptible to the other inorganic compounds.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in Villages at Leonardtown's water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination in the aquifers, Villages at Leonardtown's water supply **is not** susceptible to volatile organic compounds.

Synthetic Organic Compounds (SOCs)

No samples for SOCs have been taken at Villages at Leonardtown's water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Villages at Leonardtown's water supply **is not** susceptible to synthetic organic compounds.

Radionuclides

No radionuclides above the 50% of the MCL were detected in Villages at Leonardtown's water supply.

Since the natural occurrence of radionuclides is not present in water from the Aquia aquifer, Villages at Leonardtown's water supply **is not** susceptible to other radionuclides

Microbiological Contaminants

Raw water monitoring for microbiological contaminants is not required of water systems in confined aquifers because they are considered naturally protected from sources of pathogens at the land surface. Routine bacteriological testing at Villages at Leonardtown's has shown no positives for total coliform or fecal coliform. Therefore, Villages at Leonardtown's water supply **is not** susceptible to microbiological contaminants.

CONTAMINANT TYPE	Are Contaminant Sources present in the WHPA?	Are Contaminants detected in WQ samples at 50% of the MCL	Is Well Integrity a Factor?	Is the Aquifer Vulnerable?	Is the System Susceptible to the Contaminant
Arsenic	NO	YES	NO	YES	MAYBE
Inorganic Compounds	NO	NO	NO	NO	NO
Volatile Organic Compounds	NO	NO	NO	NO	NO
Synthetic Organic Compounds	NO	NO	NO	NO	NO
Radionuclides	NO	NO	NO	NO	NO
Microbiological Contaminants	NO	NO	NO	NO	NO

Table 6. Susceptibility Chart for Villages at Leonardtown's Water Supply

MANAGEMENT OF THE WELLHEAD PROTECTION AREA

Specific management recommendations for consideration are listed below:

Public Awareness and Outreach

The Consumer Confidence Report should include a summary of this report and indicate that the full report is available to the general public through the county library, or by contacting the operator or MDE.

Monitoring

Continue to monitor for all required Safe Drinking Water Act contaminants. Annual raw water bacteriological testing is a good check on well integrity.

Contaminant Source Inventory Updates

Conduct a survey of the WHPA and inventory any potential sources of contamination, including unused wells that may not have been included in this report. Keep records of new development within the WHPA and new potential sources of contamination that may be associated with the new use.

Well Inspection/Maintenance

Work with the County Health Department to ensure that there are no unused wells within the WHPA. An improperly abandoned well can be a potential source of contamination to the aquifer. All unused wells must be abandoned and seal as per State well construction regulations.

Water operation personnel should have a program for periodic inspections and maintenance of the supply wells and backup wells to ensure their integrity and protect the aquifer from contamination.

Changes in Use

The system is required to notify the MDE Water Supply Program if new wells are to be added or an increase in water usage is proposed. An increase in use or the addition of new wells may require revisions to the WHPA.

REFERENCES

Maryland Department of the Environment, Water Supply Program, 1999, Maryland's Source Water Assessment Plan, 36 p.

Maryland Department of Natural Resources (DNR), 1987, The Quantity and Natural Quality of Ground Water in Maryland: DNR Water Resources Administration.

United States Environmental Protection Agency, Office of Ground-Water Protection, 1987, Guidelines for Delineation of Wellhead Protection Areas.

SOURCES OF DATA

Water Appropriation and Use Permit No. SM2000G004
Water Appropriation and Use Permit No. SM1998G025
Public Water Supply Inspection Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database
St. Mary's County ADC Map (2000)