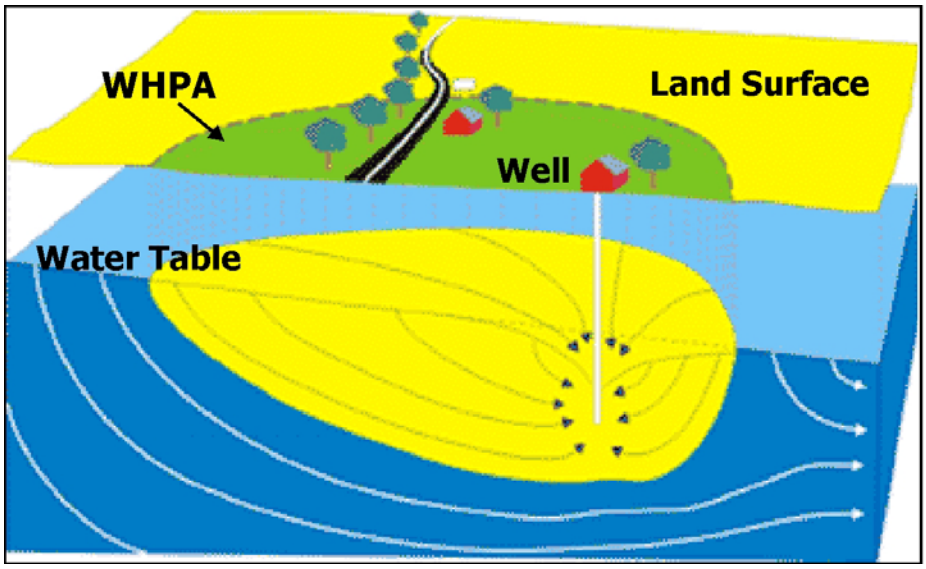
Source Water Assessment

for the St. Timothy's School

Baltimore County, MD



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MDE

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SUMMARY

The Maryland Department of the Environment's Water Supply Program (WSP) has conducted a Source Water Assessment for the Saint Timothy's School water system. The required components of this report as described in Maryland's Source Water Assessment Program (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 protecting the drinking water supply conclude this report.

The source of The Saint Timothy's School's water supply is an unconfined fractured-rock aquifer. The Source Water Assessment area was delineated by the Baltimore County Department of Environmental Protection and Resource Management in a wellhead protection study conducted in 1992 and has been modified in this document using U.S. EPA approved methods.

Point sources of contamination were identified within the assessment area from field inspections, contaminant inventory databases, and previous studies. The Maryland Office of Planning's 1997 digital land use map for Baltimore County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed. An aerial photograph and a map showing land use within the Source Water Assessment area are included in the report.

The susceptibility analysis is based on a review of the existing water quality data for the water system, the presence of potential sources of contamination in the WHPA, well integrity, and the inherent vulnerability of the aquifer. It was determined that the Saint Timothy's School water supply is susceptible to contamination by nitrate and radionuclides. This water supply is not susceptible to other inorganic compounds, volatile organic compounds, synthetic organic compounds, and microbiological contaminants.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Saint Timothy's School water system in Baltimore County. The Saint Timothy's School is located approximately five miles north of the City of Baltimore and is just outside of the city's water service area. The Saint Timothy's system serves a population of 220 and has 14 service connections. Saint Timothy's obtains its water supply from four wells.

In 1991 the Baltimore County Department of Environmental Protection and Resource Management conducted a wellhead protection study in which they delineated wellhead protection areas (WHPAs) for eleven community water systems in the rural outskirts of the County. This report summarizes the information from the completed wellhead protection study and also contains the required components of Maryland's Source Water Assessment Plan: delineation, contaminant source inventory, and susceptibility analysis.

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. The Saint Timothy's School presently obtains its water supply from four wells (Nos. 1 through 4). The wells are all located on the school property within approximately 500 feet of each other (Fig. 1). A review of the well completion reports and sanitary surveys of Saint Timothy's' water system indicates all of the wells were installed prior to the 1973 well construction regulations went into effect and may not meet the current construction standards. Inspection of the wells reveals that they are in good condition. Well Nos. 2, 3, and 4 terminate below grade, and each has either a pump or drain to prevent flooding of the casing. A summary of the well information is located in Table 1.

PLANT	SOURCE NAME	WELL PERMIT	TOTAL DEPTH	CASING DEPTH	APPROPRIATION PERMIT (*AMT IN GPD*)	AQUIFER
01	ST TIMOTHY 1	BA039489	132	21	BA1960G011 *(20,000)*	BALTIMORE GNEISS
01	ST TIMOTHY 2	N/A	N/A	N/A		
01	ST TIMOTHY 3	N/A	N/A	N/A		
01	ST TIMOTHY 4	N/A	N/A	N/A		

Table 1. St. Timothy's Well Information.

The Saint Timothy's School has an appropriation permit issued for an average use of 20,000 gallons per day (gpd) and a maximum of 25,000 gpd in the month of maximum use. The average daily use was 14,976 gallons in 1999 and 11,046 gallons in 2000. The

months of maximum use were May 1999 and June 2000 with an average daily use of 19,384 and 14,804 gallons respectively.

HYDROGEOLOGY

The Saint Timothy's School lies within the Piedmont physiographic province, which is characterized by gently rolling hills and valleys. The bedrock underlying the Piedmont is some of the oldest in the State and consists of Precambrian and Paleozoic metamorphic and igneous rocks. The Saint Timothy's wells draw water the Baltimore Gneiss formation. The Baltimore Gneiss is an unconfined, fractured rock aquifer, which is a silicic metamorphic formation that is exposed across a large area in the central portion of the county. The primary porosity and permeability are generally small due to the dense nature of the metamorphic rocks. Ground water moves principally through secondary porosity, fractures and joint openings, and is recharged by precipitation percolating through soil and saprolite. The Baltimore Gneiss is generally a low yielding aquifer unless major fracture intersections are encountered.

Ground water systems in crystalline rock tend to be localized and flow is within topographic divides towards the nearest perennial stream (Bolton, 1998). The water table is generally in the saprolite, which is characterized by high porosity and thus, the amount of storage often depends on the thickness of the saprolite. Stream valleys tend to follow fracture traces in Baltimore County (Nutter and Otton, 1969), and as a result wells drilled in draws and stream valleys tend to have higher yields than those on hilltops and slopes.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a previously delineated Wellhead Protection Area (WHPA) may be considered the source water assessment area for the system. A WHPA was delineated in 1992 for Well Nos. 1-4 using the US EPA WHPA code which requires the following input parameters: direction of ground water flow, ground water gradient, transmissivity of the aquifer, porosity of the aquifer, and pumping rate of the wells. The data used for aquifer parameters was mostly obtained from published reports for the specific aquifers and the pumping rates were determined from Saint Timothy's' ground water appropriation permit. The WHPA encompasses the land area estimated to contribute water to the wells that represents a 10-year zone of transport, and is modified by geologic and hydrologic boundaries. The original WHPA covered approximately 15 acres. The WHPA has been modified using a more conservative estimate of 400 gpd/acre recharge. This value is generally used by MDE to issue appropriation permits and represents drought year recharge. The recharge area for the wells using an average use of 20,000 gpd and the drought year recharge rate is calculated to be 50 acres. The new WHPA is approximately 48 acres and the boundaries follow topographic divides. Figure 2 shows the WHPA.

POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination are classified as either point or non-point sources. Examples of point sources of contamination are leaking underground storage tanks, landfills, discharge permits, large scale feeding operations, and CERCLA sites. These sites are generally associated with commercial or industrial facilities that use chemical substances that may, if inappropriately handled, contaminate ground water via a discrete point location. Non-point sources of contamination are associated with certain types of land use practices such as use of pesticides, application of fertilizers or animal wastes, or septic systems that may lead to ground water contamination over a larger area.

MDE staff inspected 2 facilities within the Saint Timothy's WHPA in October 1998 for ground water discharge violations and no violations were issued.

Point Sources

A review of MDE contaminant databases revealed no notable point sources of contamination within the WHPA. An above ground oil storage tank (AST) near was identified as a potential source of contamination in the original wellhead protection study (DEPRM, 1991). The capacity of the tank is unknown. This tank represents a threat to Well No. 2, because it is located within 50 feet of the wellhead, however it is an improvement from the underground tanks that previously serviced the school. All underground tanks were replaced by AST's and natural gas service several years ago, after a leak occurred in one of the tanks. AST's are generally better for ground water protection than underground tanks because a leak is much less likely to go unnoticed.

Non-Point Sources

The Maryland Office of Planning's 1997 Land Use map for Baltimore County was used to determine the predominant types of land use in the WHPA (Fig. 3). The land use summary is given in Table 2. The majority of the WHPA is institutional land (47%), which is covered by school, and cropland (31%). The remainder of the WHPA is smaller areas of residential (15%) and forested (7%) land. The Maryland Office of Planning's 1996 digital sewer map of Baltimore County shows that all of the WHPA is within an area of the county that is not planned for service.

Type	Area (acres)	% of WHPA
Residential	7.2	14.8
Institutional	22.9	47.3
Cropland	14.8	30.7
Forest	3.5	7.2

Table 2. St. Timothy's Land Use

Agricultural land (cropland) is commonly associated with nitrate loading of ground water and also represents a potential source of SOCs depending on fertilizing practices and use of pesticides. Residential areas may be a source of nitrate from

septic systems or lawn care practices. Additionally, residential areas may present a source of SOCs if pesticides and herbicides are not used carefully in gardens.

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database for Safe Drinking Water Act (SDWA) contaminants. A list of contaminants regulated under the SDWA is included in the appendix. 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 greater than 50% of a MCL, the written assessment will describe the sources of such a contaminant and if possible, locate the specific sources that are the cause of the elevated contaminant level. All data reported is from the finished (treated) water unless otherwise noted. The Saint Timothy's School water treatment plant currently has chlorination for disinfection, pH adjustment for corrosion control, and ion exchange for nitrate removal. The ion exchange unit was installed in 1997 in response to nitrate levels rising above the MCL.

A review of the monitoring data since 1993 for Saint Timothy's water indicates that the water supply meets drinking water standards, with the exception of nitrate. Of the inorganic compounds, nitrate was the only contaminant detected above the SWAP threshold level. Radiological contaminants were also present above 50% of an MCL. Volatile organic compounds have not been detected in the water supply. No synthetic organic compounds, other than Di(2-ethylhexyl)Phthalate (which is commonly associated with laboratory blanks) were detected. The water quality sampling results are summarized in Table 3. The most recent monitoring schedule, which outlines the sampling requirements, due dates, and sampling frequencies for the water system, is included in the appendix.

Contaminant Group	No. Of Samples Collected	No. of Samples Above 50% of an MCL
Inorganic Compounds (except Nitrate)	3	0
Nitrate	35	23
Radiological Contaminants	4	3
Volatile Organic Compounds	9	0
Synthetic Organic Compounds	3	0
Microbiological Contaminants*	4	0

Table 3. Summary of Water Quality Samples
* Raw Water Data

Inorganic Compounds (IOCs)

The most recent nitrate data shows that levels in the finished water fluctuate between 1.3 and 6.3 ppm (Table 4a). Prior to the installation of the ion-exchange unit, nitrate levels were consistently above 6 ppm and were as high as 12.5 ppm. The MCL for nitrate is 10 ppm. Nitrate was detected above the threshold level of 5 parts per million (ppm) in 23 of the 35 samples and above the MCL in seven samples. Table 4a lists all nitrate data available from 1993 to 2001. No other inorganic compounds were detected.

Sample Date	Result (ppm)
23-Dec-93	6.38
13-Jun-94	7.6
29-Dec-94	6.3
19-Feb-95	**10.95**
20-Mar-95	6.9
06-Dec-95	10.0
06-Feb-96	**10.2**
06-Feb-96	9.8
19-Feb-96	**10.95**
02-Jul-96	6.7
03-Sep-96	**12.5**
03-Dec-96	**10.4**
04-Mar-97	**11.1**
04-Mar-97	**11.1**
01-Apr-97	9.7
06-May-97	3.6
03-Jun-97	5.5
01-Jul-97	4.1

Sample Date	Result (ppm)
06-Aug-97	3.2
02-Dec-97	6.1
03-Mar-98	1.9
03-Mar-98	1.9
03-Jun-98	3.3
04-Aug-98	9.7
04-Aug-98	9.7
03-Nov-98	2.7
01-Dec-98	2.8
02-Feb-99	7.2
05-May-99	3.1
04-Aug-99	1.3
02-Nov-99	3.0
02-Nov-99	3.0
06-Dec-99	6.0
02-Feb-00	5.9
06-Feb-01	6.3

Table 4a. Nitrate Results from St. Timothy's Water Treatment Plant.
(MCL for Nitrate is 10 ppm, results in bold indicate greater than the MCL.)

Radionuclides

There is currently no MCL for Radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate of 4000 pCi/L for community water systems if the State has a program to address the more significant risk from radon in indoor air. The EPA received many comments in response to their proposed rule, and promulgation may be delayed. Only one Radon-222 result has been reported for Saint Timothy's but it is well above either of the proposed MCL's (Table 4b).

Gross Alpha and Gross Beta are measures of radioactivity from minerals known as alpha and beta emitters. Radium226 and Radium228 are measured if warranted by the gross alpha and beta levels. The combined MCL for Radium-226+228 is 5 pCi/L. The only available Radium result exceeds 50% of this MCL.

CONTAMINANT NAME	MCL	SAMPLE DATE	RESULT (pCi/L)
RADON-222	300	06-Feb-96	**25300**
GROSS ALPHA	15	13-Aug-97	**9**
RADIUM-226	5*	13-Aug-97	**1.96**
RADIUM-228	5*	13-Aug-97	**1.32**
GROSS BETA	50	13-Aug-97	16
GROSS ALPHA	15	13-Aug-97	**9.2**
GROSS BETA	50	13-Aug-97	16.2

Table 4b. Radiological Sample Results from St. Timothy's.
(Bold indicates greater than 50% of MCL)
*** MCL for Radium 226+228 combined**

Volatile Organic Compounds (VOCs)

A review of the data shows that VOCs have **not** been detected in nine samples collected since 1990.

Synthetic Organic Compounds (SOCs)

The only SOC detected was Di(2-Ethylhexyl)Phthalate which was reported at 1.9 ppb on Feb. 6, 1996. This contaminant has not been found in subsequent samples. Additionally, this contaminant is commonly found in laboratory blank samples and the method for analyzing this contaminant was just starting to be used in 1995 and had many false positive results. A review of the data shows that other SOCs have **not** been detected in three samples collected since 1996.

Microbiological Contaminants

Raw water bacteriological data is available for each of the wells from evaluation for ground water under the direct influence of surface water. All four wells were free of coliform bacteria.

SUSCEPTIBILITY ANALYSIS

The wells serving the Saint Timothy's School water supply draw water from unconfined fractured-rock aquifers. Wells in unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the wellhead protection area. Therefore, continued monitoring of contaminants is essential in assuring a safe drinking water supply. The *susceptibility* of the source to contamination is determined for each group of contaminants based on the following criteria: 1) the presence of potential contaminant sources within the WHPA, 2) water quality data, 3) well integrity, and 4) the aquifer conditions. Table 5 summarizes the susceptibility of Saint Timothy's's water supply to each of the groups of contaminants.

In the Piedmont region, if a well is constructed properly with the casing extended to competent rock and with sufficient grout, the saprolite serves as a natural filter and protective barrier. Properly constructed wells with no potential sources of contamination in their WHPA should be well protected from contamination.

Inorganic Compounds

Nitrate is present in 66% of samples at greater than 5 ppm (Table 4). The MCL for nitrate is 10 ppm. The majority of the results that exceeded 5 ppm were taken prior to 1997 and are indicative of the levels of nitrate present in the ground water without the benefit of nitrate removing treatment. Sources of nitrate can generally be traced back to land use. Fertilization of agricultural fields and residential lawns, residential septic systems, and areas with high concentrations of livestock are common sources of nitrate loading in ground water. Agricultural and residential areas cover a total of 45.5% of the WHPA. Horses are kept on the school property, which could present an additional source of nitrate, although horses are generally not densely concentrated in a small area like cattle or other livestock. An investigation into the cause of rising nitrate levels was conducted by MDE staff in 1996 and several possible sources of nitrate were identified including sewer lines, use of the athletic fields as pasture in the past, and manure storage.

Due to the levels of nitrate found, the vulnerability of the aquifer to land activity, and the presence of nitrate sources in the WHPA, the water supply **is** considered susceptible to this contaminant.

The water supply is **not** susceptible to inorganic compounds other than nitrate, based on water quality data and lack of potential contaminant sources within the WHPA.

Radionuclides

There is currently no MCL for Radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate of 4000 pCi/L if the State has a program to address the more significant risk from radon in indoor air. The EPA received many comments in response to their proposed rule, and promulgation may be delayed. Radon is present in the water supply at a level a six times greater than that of the higher proposed MCL of 4000 pCi/L. The median level of Radon-222 in gneiss-bedrock was found to be 2600 pCi/L and ranged from less than 80 to 13,000 pCi/L in a recent study of ground water quality in Baltimore County (Bolton, 1998). The source of radon in ground water can be traced back to the natural occurrence of uranium in rocks. Radon is prevalent in ground water of crystalline rock aquifers due to radioactive decay of uranium bearing minerals in the bedrock. The EPA has information on proposed regulations for radon in indoor air and drinking water on their web site (http://www.epa.gov/OGWDW/radon.html). Currently, it appears that the water supply **is** susceptible to Radon-222.

Other radiological contaminants detected in the water supply are shown in Table 4b. Radium226+228 exceeded 50% of the MCL in the only sample ever collected. The source of gross alpha radiation is also radioactive decay of uranium bearing minerals in the bedrock. Based on the Gross Alpha results and the nature of the aquifer the water supply **is** susceptible to radiological contaminants.

Volatile Organic Compounds

The above ground fuel tank located next to Well No. 2 presents a risk for VOC contamination if a major leak was to occur and made it to the well. However, a spill from an AST is very unlikely to contaminate the ground water and therefore the wells are **not** susceptible to volatile organic compounds. VOCs have not been detected in the water supply and additional potential contaminant sources were not identified within the WHPA.

Synthetic Organic Compounds

The wells are **not** susceptible to synthetic organic compounds. SOCs were not detected in the water supply. A potential source of SOCs in the WHPA may be pesticide use in the agricultural areas. However, because these contaminants have not been detected, it appears that any pesticides that may be used in the WHPA are degrading or being attenuated in the soil and are not reaching the wells.

Microbiological Contaminants

All three wells did not have coliform bacteria in their raw water samples and thus are considered **not** susceptible to microbiological contaminants.

Contaminant Group	Are Contaminant Sources Present in WHPA?	Are Contaminants Detected In WQ Samples?	Is Well Integrity a Factor?	Is the Aquifer Vulnerable?	Is the System Susceptible?
Nitrate	YES	YES	NO	YES	YES
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	YES	YES	NO	YES	YES
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	NO	YES	NO	NO

Table 5. Susceptibility Analysis Summary.

MANAGEMENT OF THE SOURCE WATER ASSESSMENT AREA

With the information contained in this report the Baltimore County DPW and the Saint Timothy's School are in a position to protect its water supply by staying aware of the area delineated for source water protection and evaluating future development and land planning. Specific management recommendations for consideration are listed below:

Form a Local Planning Team

- The school should contact the county to form a local planning team to begin to implement a source water protection plan. The team should represent all the interests in the community, such as the water supplier, home association officers, the County Health Department, local planning agencies, local business, developers, and property owners, and residents within and near the WHPA. The team should work to reach a consensus on how to protect the water supply.
- A management strategy adopted by Saint Timothy's should be consistent with the level of resources available for implementation. MDE remains available to assist in anyway we can help the process.
- MDE has grant money available for Wellhead Protection projects.

Public Awareness and Outreach

- The Consumer Confidence Report should list that this report is available to the general public through their county library, by contacting the town office or MDE.
- Conducting education outreach to the facilities that may present potential contaminant sources. Important topics include: (a) appropriate use and application of fertilizers and pesticides, (b) chemical storage, and (c) monitoring well installation.
- Road signs at the WHPA boundary are an effective way of keeping the relationship of land use and water quality in the public eye, and help in the event of spill notification and response.

Monitoring

- Continue to monitor for all Safe Drinking Water Act contaminants as required by MDE.
- Proper maintenance of the ion exchange unit will ensure that nitrate levels are kept below the MCL in finished drinking water.

Planning/ New Development

- Review the State's model wellhead protection zoning ordinances for potential adoption. Coordinate with Baltimore County Department of Planning to adopt a wellhead protection ordinance.

Land Acquisition/Easements

- Loans are available for the purchase of property or easements for protection of the water supply. Eligible property must lie within the designated WHPA. Loans are

Contingency Plan

- Saint Timothy's should have a Contingency Plan for its water system. COMAR 26.04.01.22 requires all community water systems to prepare and submit for approval a plan for providing a safe and adequate drinking water supply under emergency conditions.
- Develop a spill response plan in concert with the Fire Department and other emergency response personnel.

Contaminant Source Inventory Updates/ Inspections

- St. Timothy's School should conduct their own field survey of the source water assessment area to ensure that there are no additional potential sources of contamination.
- The facility should follow all tank testing and maintenance requirements for its above ground storage tanks as outlined in the State's oil control regulations (COMAR 26.10).
- Periodic inspections and a regular maintenance program for the supply wells will ensure their integrity and protect the aquifer from contamination.

Changes in Use

- Saint Timothy's is required to notify MDE if new wells are to be put into service. Drilling a new well outside the current WHPA would modify the area, therefore Saint Timothy's should contact the Water Supply Program if a new well is being proposed.

REFERENCES

Bolton, D.W., 1996, Network Description and Initial Water-Quality Data from a Statewide Ground-Water-Quality Network in Maryland: Maryland Geological Survey Report of Investigations No. 60, 167 pp.

Bolton, D.W., 1998, Ground-Water Quality in the Piedmont Region of Baltimore Coutny, Maryland, Report of Investigations No. 66, 191 pp.

Committee on Health Risks of Exposure to Radon, 1999, Health Effects of Exposure to Radon: BEIR VI, (http://www.epa.gov/iaq/radon/beirvi1.html).

Cross, F.T., N.H. Harley, and W. Hofmann, 1985, Health effects and risks from ^{222}Rn in drinking water: Health Physics, vol. 48, no.5, p. 649-670.

MDE, Water Supply Program, 1999, Maryland's Source Water Assessment Plan, 36 p.

Nutter, L.J. and E.G. Otton, 1969, Ground Water Occurrence in the Maryland Piedmont: Maryland Geological Survey Report of Investigations No. 10, 56 pp

U.S. Environmental Protection Agency, 1991, Delineation of Wellhead Protection Areas in Fractured Rocks: Office of Ground Water and Drinking Water, EPA/570/9-91-009, 144 pp.

OTHER SOURCES OF DATA

Water Appropriation and Use Permit BA1960G011
Public Water Supply Sanitary Survey Inspection Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
Department of Natural Resources Digital Orthophoto Quarter Quadrangles for Cockeysville
USGS Topographic 7.5 Minute Quadrangles for Cockeysville
Maryland Office of Planning 1997 Baltimore County Digital Land Use Map
Maryland Office of Planning 1996 Baltimore County Digital Sewer Map