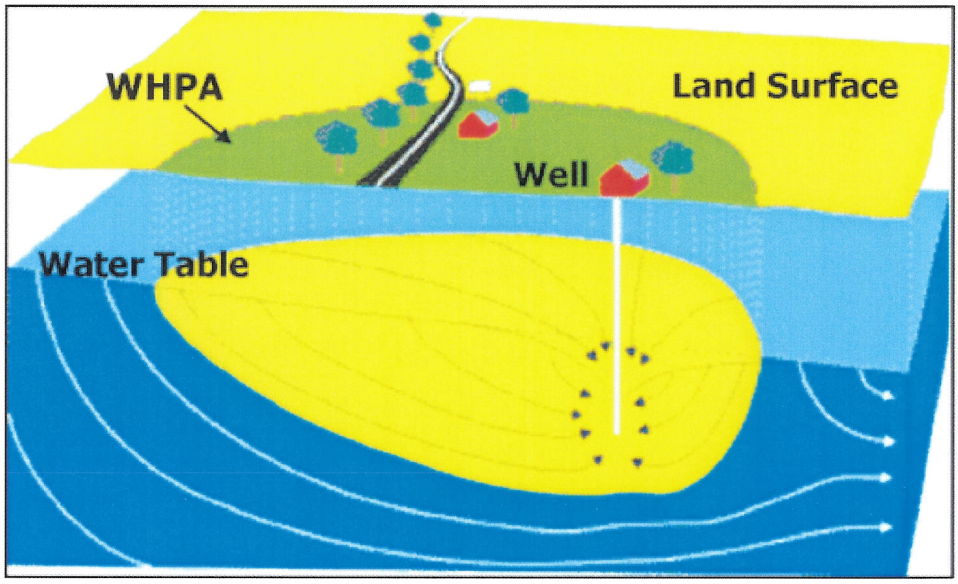
Source Water Assessment
for the Cambridge Farms Water System
Frederick County, Maryland



Prepared By
Maryland Department of the Environment
Water Management Administration
Water Supply Program
December 2002

MDE

TABLE OF CONTENTS

SUMMARY

The Maryland Department of the Environment's Water Supply Program (WSP) has conducted a Source Water Assessment for the Cambridge Farms 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 Cambridge Farms' water supply is an unconfined fractured-rock aquifer. The Source Water Assessment area was delineated by the WSP using U.S. EPA approved methods specifically designed for this source type.

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 2000 digital land use map for Frederick County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed. An aerial photograph and maps showing contaminant sources and 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 source water assessment area, well integrity, and the inherent vulnerability of the aquifer. It was determined that the Cambridge Farms water supply is susceptible to nitrate and some microbiological contaminants. This water supply is not susceptible to other inorganic compounds, radiological contaminants, volatile organic compounds, synthetic organic compounds, and surface water microorganisms.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Cambridge Farms water system in Frederick County. The Cambridge Farms community is located approximately seven miles southwest of the City of Frederick. The system currently supplies water to the Cambridge Farms and Briercrest Heights subdivisions on the north side of Route 340 near Jefferson. The water system serves a total population of 950 and has 352 service connections. The water system is owned and operated by the Frederick County Division of Utilities and Solid Waste Management.

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 Cambridge Farms system obtains it water supply from five wells (Table 1). The wells are located adjacent to residential properties (Fig. 1). A review of the well completion reports and sanitary surveys of Cambridge Farms' water system indicates that four of the five wells were drilled after 1973 and should meet construction standards for grouting and casing. Well 5 was drilled before construction regulations went into effect and therefore may not meet current construction standards. A summary of the well information is located in Table 1.

SOURCE ID	SOURCE NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	WELL 1 4116 OLDBRIDGE LN	FR-81-5282	400	71	1987
03	WELL 3 4111 OLDBRIDGE LN	FR-81-5284	300	60	1987
04	WELL 4 4114 OLDBRIDGE LN	FR-81-5280	425	51	1987
05	WELL 6 HOLTER RD	FR-88-4458	425	73	1995
06	WELL 5 LONDONDERRY CT	FR-72-0469	220	19	1972

Table 1. Cambridge Farms well information

The Cambridge Farms water system has an appropriation permit to draw water from the Catoctin Metabasalt formation for an average use of 62,000 gallons per day (gpd) and a maximum of 100,000 gpd in the month of maximum use. Based on the most recent pumpage reports, the average daily use was 57,662 gallons in 1999 and 53,911 gallons in 2000. The months of maximum use for the last two reported years were June 1999 and July 2000 with an average daily use of 80,033 and 63,409 gallons respectively.

HYDROGEOLOGY

Cambridge Farms lies within the Blue Ridge physiographic province, which is bound by Catoctin and South Mountains. The Blue Ridge province is underlain by the oldest sequence of rocks in the County, which is composed of Precambrian gneiss, phyllite, and metabasalt and forms the core of the South Mountain anticlinorium exposed in the Middletown Valley (Duigon and Dine, 1987). The Cambridge Farms wells obtain water from the Catoctin Metabasalt formation, which is an important aquifer in the Middletown Valley due to its aerial extent. The Catoctin Metabasalt is an unconfined, fractured rock aquifer, composed of a dense green crystalline rock believed to be a series of metamorphosed lava flows (Meyer and Beall, 1958). The primary porosity and permeability of this aquifer are small due to the dense nature of the metabasalt. Ground water moves principally through secondary porosity, fractures and joint openings, and is recharged by precipitation percolating through soil and saprolite. Due to the low primary porosity, large production wells are not common in this formation unless significant, water-bearing fractures 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 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 Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. The source water assessment area for public water systems using wells in fractured-rock aquifers is the watershed drainage area that contributes to the well. The area should be modified to account for geological boundaries, ground water divides, and by annual average recharge needed to supply the well (MD SWAP, 1999).

Hydrogeologic mapping identifies the physical and hydrologic features that control ground water flow (EPA, 1991). Hydrogeologic mapping was used to identify drainage basin boundaries and hydrologic features that represent ground water divides. Fracture traces have not been mapped in the Cambridge Farms area, thus the source water assessment area follows watershed drainage boundaries. The WHPA should cover an area large enough to supply water at the average appropriated amount using effective recharge. Drought year base flow (effective recharge) in fractured rocks in this area is estimated to be 400 gpd/acre. The recharge area for the wells using an average use of 62,000 gpd and the drought year recharge rate is approximately 155 acres. The WHPA boundary follows topographic divides and covers an area of approximately 191 acres. 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.

Point Sources

A review of MDE contaminant databases and a site visit revealed no potential point source of contamination within the WHPA.

Non-Point Sources

The Maryland Office of Planning's 2000 digital land use for Frederick 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 made up of residential land, with smaller proportions of agricultural and forested areas.

Land Use Type	Total Acres	Percent of WHPA
Medium Density Residential	106	55.4
Cropland	72	37.4
Forest	14	7.1
Total	191	100

Table 2. Land Use Summary

Agricultural land may be 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 without sewer service may be a source of nitrate from septic systems. Additionally, residential areas may represent a source nitrate and SOCs if fertilizers, pesticides, and herbicides are not used carefully in lawns and gardens.

The Maryland Office of Planning's 1996 digital sewer map of Frederick County shows that most of the WHPA covers areas that have existing sewer service or are planned for sewer service (Fig. 4). However, most of the area shown as 3-year planned includes the Cambridge Farm subdivision which is now has sewer service. The remaining areas on the east side of Holter Road are not planned for service. Table 3 summarizes the sewer service categories in the WHPA.

Service Category	Total Acres	Percent of WHPA
Existing Service	27	14.0
3 Year Planned Service	92	48.2
Not Planned for Service	72	37.7
Total	191	100

Table 3. Sewer Service Area Summary

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database for Safe Drinking Water Act (SDWA) 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 greater than 50% of an MCL, this 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 Cambridge Farms water system has one point of entry or plant, which has chlorination for disinfection and polyphosphate addition and pH adjustment for corrosion control as its treatment.

A review of the monitoring data for Cambridge Farms water indicates that the water supply meets drinking water standards. No contaminants were detected above 50% of an MCL, with the exception of nitrate. The water quality sampling results are summarized in Table 4.

Contaminant Group	No. of Samples Collected	No. of Samples above 50% of an MCL
Inorganic Compounds (except Nitrate)	8	0
Nitrate	29	10
Radiological Contaminants	2	0
Volatile Organic Compounds	10	0
Synthetic Organic Compounds	8	0

Table 4. Summary of Water Quality Samples

Inorganic Compounds (IOCs)

A review of the data shows that nitrate levels in the water supply range from 2.8 to 6.4 ppm, but are consistently below the MCL of 10 ppm (Table 5). Nitrate was detected above the SWAP threshold level of 5 parts per million (ppm) in 30% of samples collected. No other inorganic compounds were detected above 50% of an MCL.

SAMPLE DATE	RESULT (PPM)
29-Mar-94	4.3
05-May-94	4.8
25-May-94	6.4
13-Jul-94	5.9
23-Sep-94	5.6
20-Dec-94	4.8
16-Mar-95	4.4
02-Jun-95	4.6
12-Jun-95	4.8
28-Sep-95	5.3
14-Nov-95	5.4
29-Feb-96	6.2
15-May-96	5.8
05-Sep-96	6.3
06-Nov-96	5.0

SAMPLE DATE	RESULT (PPM)
28-Jan-97	4.9
23-May-97	5.3
05-Aug-97	3.7
08-Oct-97	3.2
06-Jan-98	3.0
07-Apr-98	3.1
07-Jul-98	3.3
18-Aug-98	3.0
06-Oct-98	2.8
20-Jan-99	3.4
12-May-99	3.8
05-Apr-00	4.2
05-Apr-01	4.7
03-Oct-01	4.3
03-Apr-02	3.5

Table 5. Nitrate Data from Cambridge Farms water treatment plant

Radionuclides

A review of the data shows that no radionuclides were detected above 50% of an MCL. 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. There are no Radon-222 result reported for Cambridge Farms.

Volatile Organic Compounds (VOCs)

A review of the data shows that VOCs have not been detected above 50% of an MCL. Disinfection byproducts grouped as trihalomethanes (THMs), are the only VOC's that have been detected, but at very low levels.

Synthetic Organic Compounds (SOCs)

No SOC's have been detected above 50% of an MCL, with the exception of Di(2-Ethylhexyl)Phthalate for which the highest level reported was 4.69 ppb. The phthalate 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.

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 (GWUDI). This data showed that the wells are not under the direct influence of surface water. The raw water quality was very good with very low turbidity and was free of fecal coliform. Some samples had positive total coliform results.

SUSCEPTIBILITY ANALYSIS

The wells serving the Cambridge Farms 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 6 summarizes the susceptibility of Cambridge Farms' 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 30% of samples at or above 5 ppm (Table 5). The MCL for nitrate is 10 ppm. Sources of nitrate can generally be traced back to land use. Fertilization of agricultural fields and residential lawns, and residential septic systems are common sources of nitrate loading in ground water and are each present to some extent in the WHPA. Agricultural land in the WHPA has significantly decreased in the last ten years as the residential subdivisions have been built out. As less land is used for agriculture, fertilizer use may decrease, however fertilizing lawns in new residential subdivisions can cause an initial increase in nitrate in ground water. Nitrate levels appear to be on a declining trend based on the available data.

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** susceptible to this contaminant.

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

Radionuclides

There is no available Radon-222 data for the water system, however other nearby water systems utilitzing the same aquifer have had reported low levels of radon and were considered not susceptible to this contaminant. The water supply is **not** susceptible to other radionuclides. The source of radionuclides in ground water is the natural occurrence of uranium in rocks. Based on the low levels of gross alpha and gross beta detected in the water supply, the aquifer is not a source of these contaminants in this area.

Volatile Organic Compounds

The water supply is **not** susceptible to contamination by VOC's. No potential sources were identified within the WHPA, and VOC's have not been detected in significant levels.

Synthetic Organic Compounds

The water supply is **not** susceptible to synthetic organic compounds. The only SOC that has been detected in the water supply above 50% of an MCL was likely a false positive. A potential source of SOCs in the WHPA may be herbicide and pesticide use in agricultural areas, but based on water quality data these potential sources are not impacting the water supply.

Microbiological Contaminants

All wells did not have fecal coliform bacteria in their raw water samples and were determined to be not under direct influence of surface water. Therefore, the wells are **not** susceptible to microbiological contaminants that may be present in surface water such as *Giardia* and *Cryptosporidium*. Wells 3, 5, and 6 each had low levels of total coliform bacteria, which are ubiquitous in the environment, and *may* be indicators of organisms with longer survival rates such as viruses. Without additional data however, it is not possible to determine whether or not the water supply is susceptible to viral contamination. Wells 3, 5, and 6 **are** susceptible to total coliform bacteria but not fecal coliform bacteria. Wells 1 and 4 did not have total coliform bacteria present in raw water and therefore are not susceptible to microbiological contaminants.

Contaminant Group	Are Contaminant Sources Present in WHPA?	Are Contaminants Detected Above 50% of MCL?	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	NO	NO	NO	NO	NO
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants[1]	YES	YES [1]	NO	YES	YES – Total Coliform (Wells 3,5, 6 only)

Table 6. Susceptibility Analysis Summary.

[1] There is no MCL for total coliform. Presence is considered a violation in *finished* water samples.

MANAGEMENT OF THE SOURCE WATER ASSESSMENT AREA

With the information contained in this report the Frederick County Division of Utilities and Solid Waste Management is in a position to protect the Cambridge Farms 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 Division of Utilities and Solid Waste Management should continue to work with the County Planning Department and Wellhead Protection committee to implement a County Wellhead Protection Ordinance. The committee should ensure that all interests in the community are represented, such as the water supplier, home association officers, the County Health Department, local businesses, developers, and property owners, and residents within and near the WHPA.
- A management strategy adopted by the Division and the County 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, such as developing and implementing wellhead protection ordinances, digitizing layers that would be useful for wellhead protection (such as geology), and developing additional protection strategies. An application can be obtained by contacting the water supply program.

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 Division or MDE.
- Conduct educational outreach to residents of the community focusing on activities that may present potential contaminant sources. Important topics include: (a) compliance with MDE and federal guidelines for heating oil underground tanks (b) appropriate use and application of fertilizers and pesticides, (c) hazardous material disposal and storage, and (d) management of stormwater.
- 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.
- Annual raw water bacteriological testing is a good test for well integrity.

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 currently offered at zero percent interest and zero points. Contact the Water Supply Program for more information.

Contingency Plan

- Cambridge Farms Contingency Plan was submitted to and approved by MDE in November 2001. 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

- The Division should conduct their own field survey of the source water assessment area to ensure that there are no additional potential sources of contamination.
- Periodic inspections and a regular maintenance program for the supply wells will ensure their integrity and protect the aquifer from contamination.

Changes in Use

- The Division 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 the Water Supply Program should be notified 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.

Cleaves, E.T., Edwards, J., and J.D. Glaser, compilers, 1968., Geologic map of Maryland, Maryland Geological Survey, 1 sheet, scale 1:250,000.

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).

Duigon, M.T., and J.R. Dine, 1987, Water Resources of Frederick County, Maryland, MGS Bulletin 33, 101 pp.

Greenhorne & O'Mara, Inc., 1994, Cambridge Farms Subdivision Hydrogeologic Report in support of Water Appropriation Permit FR87G034 (unpublished reports).

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

RE Wright, Inc., 1992, Report on Hydrogeologic investigation of Cambridge Farms site. (Unpublished letters).

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 FR1970G014
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 Point of Rocks
USGS Topographic 7.5 Minute Quadrangles for Point of Rocks
Maryland Office of Planning 2000 Frederick County Digital Land Use Map
Maryland Office of Planning 1996 Frederick County Digital Sewer Map

FIGURES

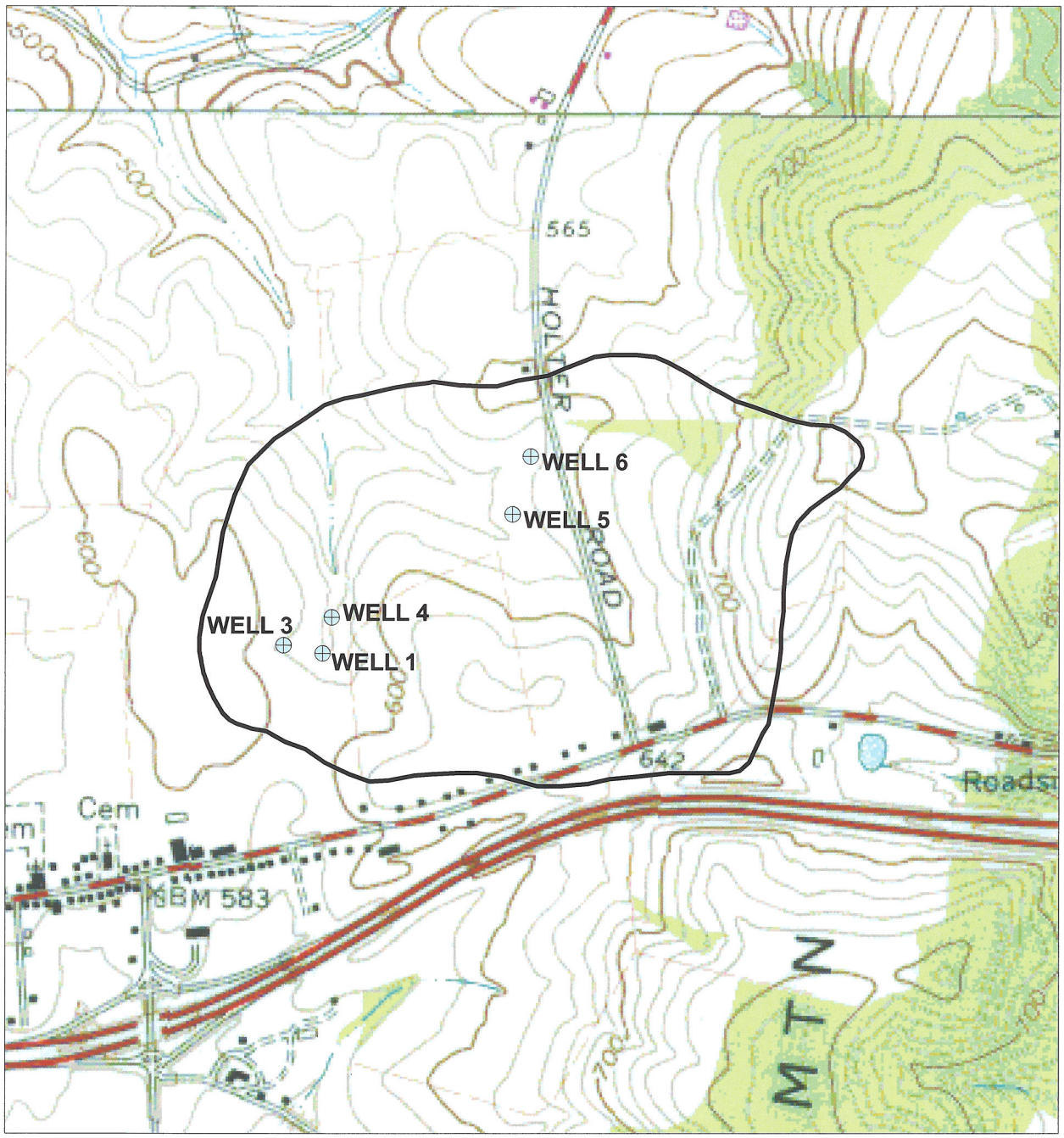


Figure 2. Cambridge Farms Wellhead Protection Area (WHPA).

Legend

Wells

Wellhead Protection Area

N

500 0 500 1000 Feet

Base Map: USGS Topographic 7.5 Minute Quad for Point of Rocks

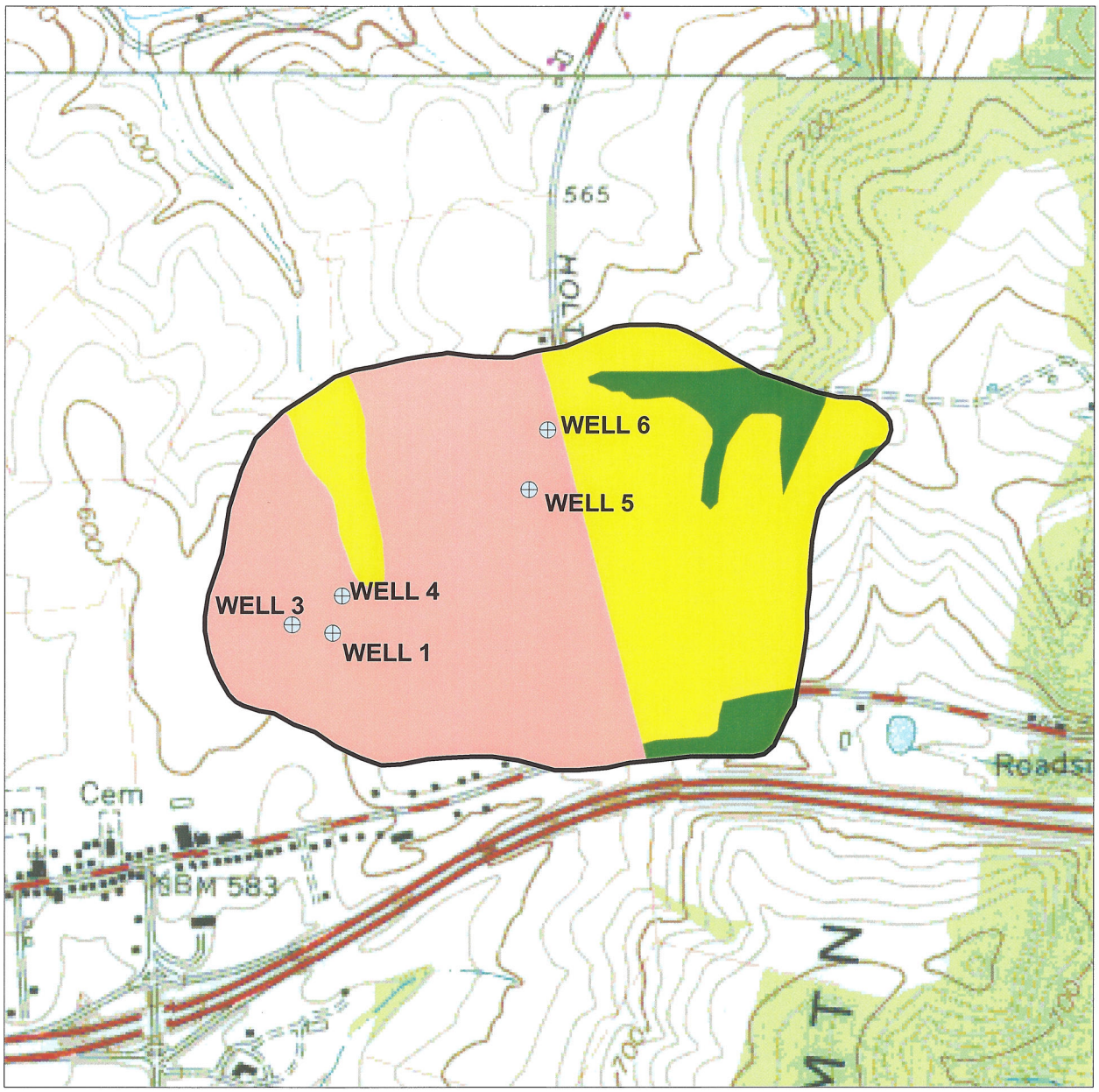


Figure 3. Land Use in the Cambridge Farms WHPA.

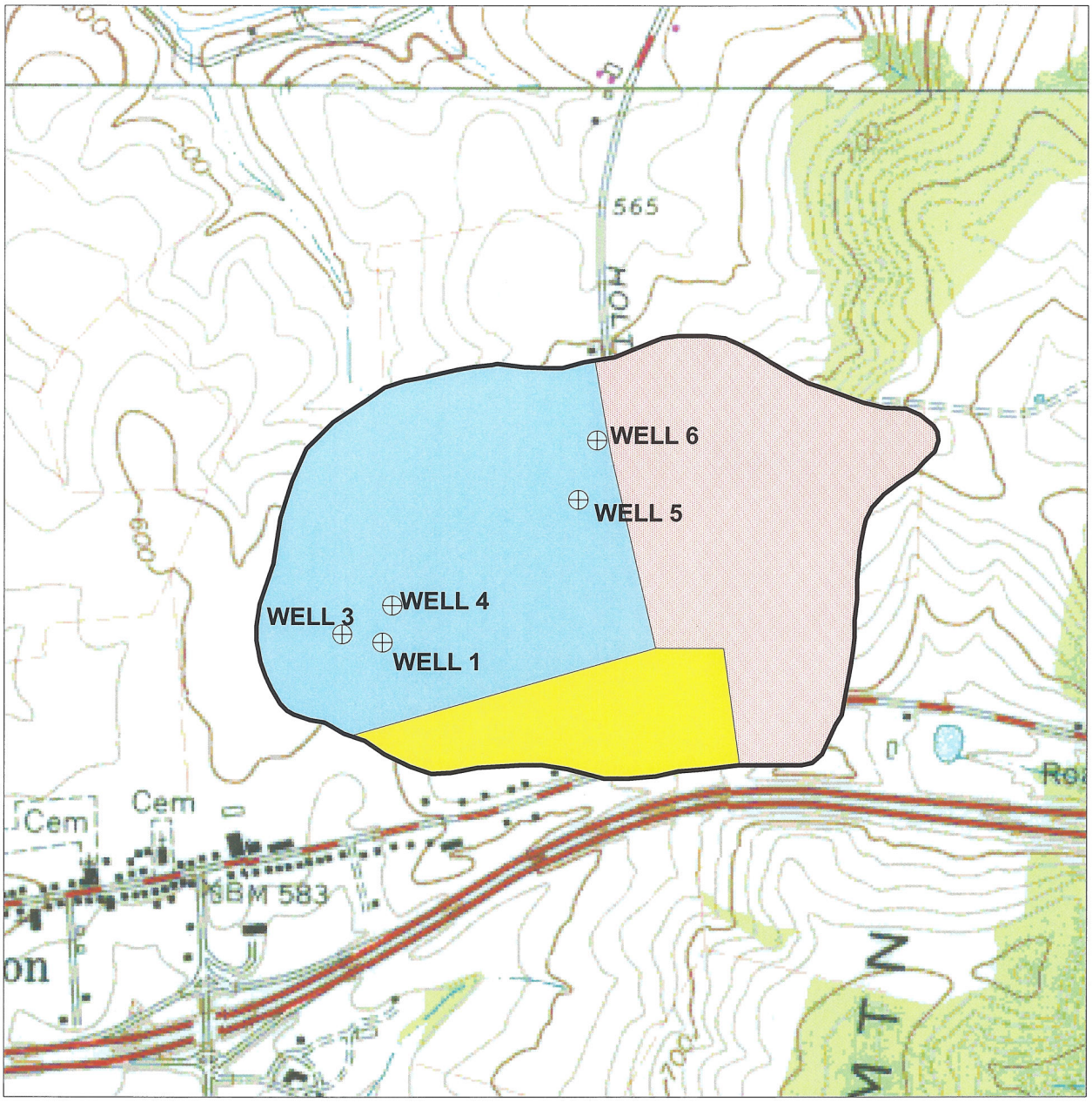


Figure 4. Sewer Service Areas in the Cambridge Farms WHPA.