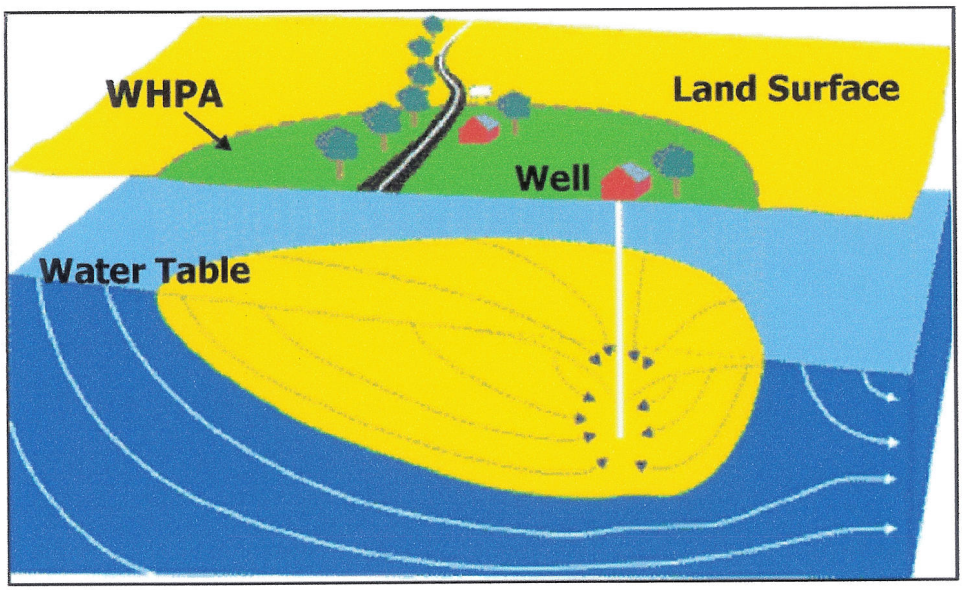
Source Water Assessment
for the Bradford Estates Water System
Frederick County, Maryland



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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 Bradford Estates 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 Bradford Estates' 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 Bradford Estates water supply is susceptible to nitrate, radon, and synthetic organic compounds. This water supply is not susceptible to other inorganic compounds, other radiological contaminants, volatile organic compounds, and microbiological contaminants.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Bradford Estates water system in Frederick County. The Bradford Estates community is located just south of interstate 70 approximately ten miles east of the City of Frederick. The water system serves a total population of 173 and has 64 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 Bradford Estates system currently obtains its water supply from two of the three wells that are located adjacent to residential properties within the community (Fig. 1). The third well (Well 1) is not currently connected to the system, but it may be used in the future if feasible and is therefore included in this report. A review of the well completion reports and sanitary surveys of Bradford Estates' water system indicates the wells were drilled after 1973 and should meet construction standards for grouting and casing. A summary of the well information is located in Table 1.

SOURCE ID	USE	SOURCE NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	UNUSED	WELL 1 - MARIANNE DR	FR-81-5226	425	40	1987
02	PRODUCTION	WELL 3 - BILLS CT	FR-81-5014	300	81	1987
03	PRODUCTION	WELL 2 - REYBURN CT	FR-81-5227	200	61	1988

Table 1. Bradford Estates well information

The Bradford Estates water system has an appropriation permit to draw water from the Marburg Schist formation for an average use of 15,900 gallons per day (gpd) and a maximum of 26,500 gpd in the month of maximum use. Based on the most recent pumpage reports, the average daily use was 11,899 gallons in 1999 and 10,700 gallons in 2000. The months of maximum use for the last two reported years were May 1999 and May 2000 with an average daily use of 15,869 and 13,536 gallons respectively.

HYDROGEOLOGY

Bradford Estates is in the Piedmont lowlands physiographic province of eastern Frederick County, which is characterized by gently rolling hills with some deeply-cut

valleys. This portion of the county is underlain by a series of meta-sedimentary and metavolcanic rocks that are structurally complex and the stratigraphic and structural relationships of these geologic units are poorly understood. Ijamsville and Marburg formations are mapped at the surface and either of these formations is likely to be encountered in the subsurface. The Marburg schist is described as a bluish-gray to green, fine-grained schist which is closely folded (Cleaves, et al., 1968). This formation is an unconfined, fractured rock aquifer whose primary porosity and permeability are small due to compaction and re-crystallization associated with metamorphism. Ground water moves principally through secondary porosity - fractures, fault planes, 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 (MDE, 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 geologic features that influence ground water flow. Fracture traces are surface expressions of vertical, closely spaced joints and fractures in the bedrock below. A fracture trace analysis has not been completed for the area around Bradford Estates, therefore the WHPA is based on topographic divides. 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 is estimated at 400 gpd/acre. The recharge area needed for the wells using an average use of 15,900 gpd and the drought year recharge rate is approximately 40 acres. The WHPA is delineated as the watershed drainage area upgradient of the wells and downgradient to the small tributary that flows east-west through the property. The WHPA is approximately 80 acres and is shown in Figure 2.

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 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 residential land and the remainder is agricultural and forested land.

Land Use Type	Total Acres	Percent of WHPA
Low Density Residential	58	71.8
Pasture	12	14.6
Forest	11	13.6
Total	81	100

Table 2. Land Use Summary

Pasture land may be associated with nitrate loading of ground water due to production and disposal of animal waste. Residential areas without sewer service may be a source of nitrate from septic systems. Additionally, residential areas may present 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 all of the WHPA is in an area of the county that is not planned for sewer service (Fig. 4).

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 a 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 Bradford Estates water system has one point of entry or plant, which has chlorination for disinfection, ion exchange for nitrate removal, and pH adjustment for corrosion control as its treatment.

A review of the monitoring data for Bradford Estates water indicates that the water supply meets drinking water standards. No contaminants were detected above 50% of an MCL, with the exception of nitrate. Radon is the only other contaminant present at a level of concern. The water quality sampling results are summarized in Table 3.

Contaminant Group	No. of Samples Collected	No. of Samples above 50% of an MCL
Inorganic Compounds (except Nitrate)	6	0
Nitrate	42	40
Radiological Contaminants	3	1
Volatile Organic Compounds	9	0
Synthetic Organic Compounds	17	1

Table 3. Summary of Water Quality Samples

Inorganic Compounds (IOCs)

A review of the data shows that nitrate levels in the water supply range from 4.7 to 9.9 ppm, which is very close to the MCL of 10 ppm (Table 4a). Nitrate was detected above the SWAP threshold level of 5 parts per million (ppm) in all but two samples collected. Nitrate removal treatment has been in use since September 2000 and decreased concentrations since that time reflect the use of this equipment and not the raw water quality. No other inorganic compounds were detected above 50% of an 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 Bradford Estates at 2580 pCi/L, which is above 50% of the higher proposed MCL. No other radionuclides have been detected in the water supply.

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)

A review of the data shows that one synthetic organic compound, Alachlor (Lasso) was detected above the above 50% of an MCL. The reported level on March 14, 1995 was 1.2 ppb and the MCL is 2 ppb. Alachlor is a herbicide used for pre-emergent control of annual grasses and broadleaf weeds in crops, primarily on corn and sorghum (57%) and soybeans (43%). Application to peanuts, cotton, vegetables and forage crops contributes to less than 1% of its use. Another SOC that has been detected at very low levels was atrazine, which is another commonly used herbicide. The sampling results for these contaminants are given in Table 4b.

Microbiological Contaminants

Raw water bacteriological data is available for each of the three production 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 coliform bacteria.

SAMPLE DATE	RESULT (PPM)
29-Mar-94	7.2
24-May-94	9.2
13-Jul-94	9.22
23-Sep-94	7.1
20-Dec-94	8.5
02-Jun-95	7.7
07-Jun-95	7.8
19-Sep-95	6.7
16-Nov-95	7.4
27-Feb-96	8.3
14-May-96	7.6
04-Sep-96	9.1
05-Nov-96	9.2
29-Jan-97	9.2
20-May-97	9.6
05-Aug-97	8.9
08-Oct-97	8.9
06-Jan-98	9.0
14-Apr-98	9.9
07-Jul-98	9.5
06-Oct-98	8.5

SAMPLE DATE	RESULT (PPM)
11-Jan-99	8.1
03-Feb-99	8.7
12-May-99	9.0
19-Jul-99	9.3
19-Jul-99	9.3
26-Oct-99	8.9
26-Oct-99	8.9
20-Jan-00	8.4
06-Apr-00	8.9
13-Jul-00	5.0
12-Oct-00	6.4
07-Feb-01	4.9
18-Apr-01	5.0
10-Jul-01	9.8 [1]
10-Jul-01	8.2 [2]
11-Jul-01	5.3
18-Oct-01	5.1
31-Jan-02	5.1
10-Apr-02	5.7
03-Jul-02	5.3
05-Sep-02	4.7

Table 4a. Nitrate Data from Bradford Estates water treatment plant

[1] Raw water data collected from Well 2

[2] Raw water data collected from Well 3

CONTAMINANT NAME	MCL (PPB)	SAMPLE DATE	RESULT[3] (PPB)
ALACHLOR (LASSO)	2	20-Jun-94	-0.1
ALACHLOR (LASSO)	2	14-Mar-95	1.2
ALACHLOR (LASSO)	2	15-May-95	0.84
ALACHLOR (LASSO)	2	07-Jun-95	-0.6
ALACHLOR (LASSO)	2	31-Jul-95	-0.3
ALACHLOR (LASSO)	2	17-Oct-95	-0.3
ALACHLOR (LASSO)	2	21-May-96	-1
ALACHLOR (LASSO)	2	13-May-97	-0.2
ALACHLOR (LASSO)	2	06-May-98	0.43
ALACHLOR (LASSO)	2	21-Jul-98	-0.2
ALACHLOR (LASSO)	2	11-Jan-99	-0.5
ALACHLOR (LASSO)	2	21-Apr-99	-0.1
ALACHLOR (LASSO)	2	10-May-00	-0.5
ATRAZINE	3	20-Jun-94	0.2
ATRAZINE	3	14-Mar-95	-0.5
ATRAZINE	3	15-May-95	-0.5
ATRAZINE	3	07-Jun-95	0.495
ATRAZINE	3	31-Jul-95	-0.5
ATRAZINE	3	17-Oct-95	-0.5
ATRAZINE	3	21-May-96	-1
ATRAZINE	3	13-May-97	-0.1
ATRAZINE	3	06-May-98	0.52
ATRAZINE	3	21-Jul-98	-0.1
ATRAZINE	3	11-Jan-99	-0.05
ATRAZINE	3	21-Apr-99	0.45
ATRAZINE	3	10-May-00	-0.5

Table 4b. SOC Data

[3] A negative symbol indicates less than the detectable level for the analysis method.

SUSCEPTIBILITY ANALYSIS

The wells serving the Bradford Estates 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 Bradford Estates' 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 95% of the samples at or above 5 ppm (Table 4a). 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 septic systems are all common sources of nitrate loading in ground water and are or were once present to some extent in the WHPA. Agricultural land in the WHPA has significantly decreased in the last ten years as the residential subdivision was built out. As less land is used for agriculture, fertilizer use may decrease; however fertilizing lawns in new residential subdivisions has often caused an increase in nitrate in ground water. In addition the entire WHPA is covered by residential land with on-site septic, which is likely a significant source of nitrate in the recharge area.

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 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. Radon is present in the water supply above 50% of the higher proposed MCL of 4000 pCi/L. 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.

The water supply is **not** susceptible to other radionuclides. Other radionuclides were not detected and thus, 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** susceptible to synthetic organic compounds. Alachlor and Atrazine have both been detected in several samples dating back to 1994 (Table 4b). A potential source of SOCs in the WHPA may be herbicide use in agricultural areas. Cropland once covered almost the entire WHPA and covered approximately 50% of the WHPA based on the 1997 land use data. These are two of the most common herbicides used on crops in the United States, and thus the presence of these contaminants is likely to be a remnant of the former land use.

Microbiological Contaminants

Wells 2 and 3 did not have coliform bacteria in their raw water samples and were determined not under direct influence of surface water. Thus, these wells 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	YES	NO	YES	YES
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	YES	NO	YES	YES
Microbiological Contaminants	YES	NO	NO	YES	NO

Table 5. Susceptibility Analysis Summary.

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 Bradford Estates 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, and (c) hazardous material disposal and storage.
- 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

- Bradford Estates' Contingency Plan was submitted 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

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

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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

Reinhardt, J. (1974), Geologic Map of the Frederick Valley, from Maryland Geological Survey Report of Investigations No. 23 (Plate 1).

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 FR1988G002
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 Damascus
USGS Topographic 7.5 Minute Quadrangles for Damascus
Maryland Office of Planning 2000 Frederick County Digital Land Use Map
Maryland Office of Planning 1996 Frederick County Digital Sewer Map

FIGURES

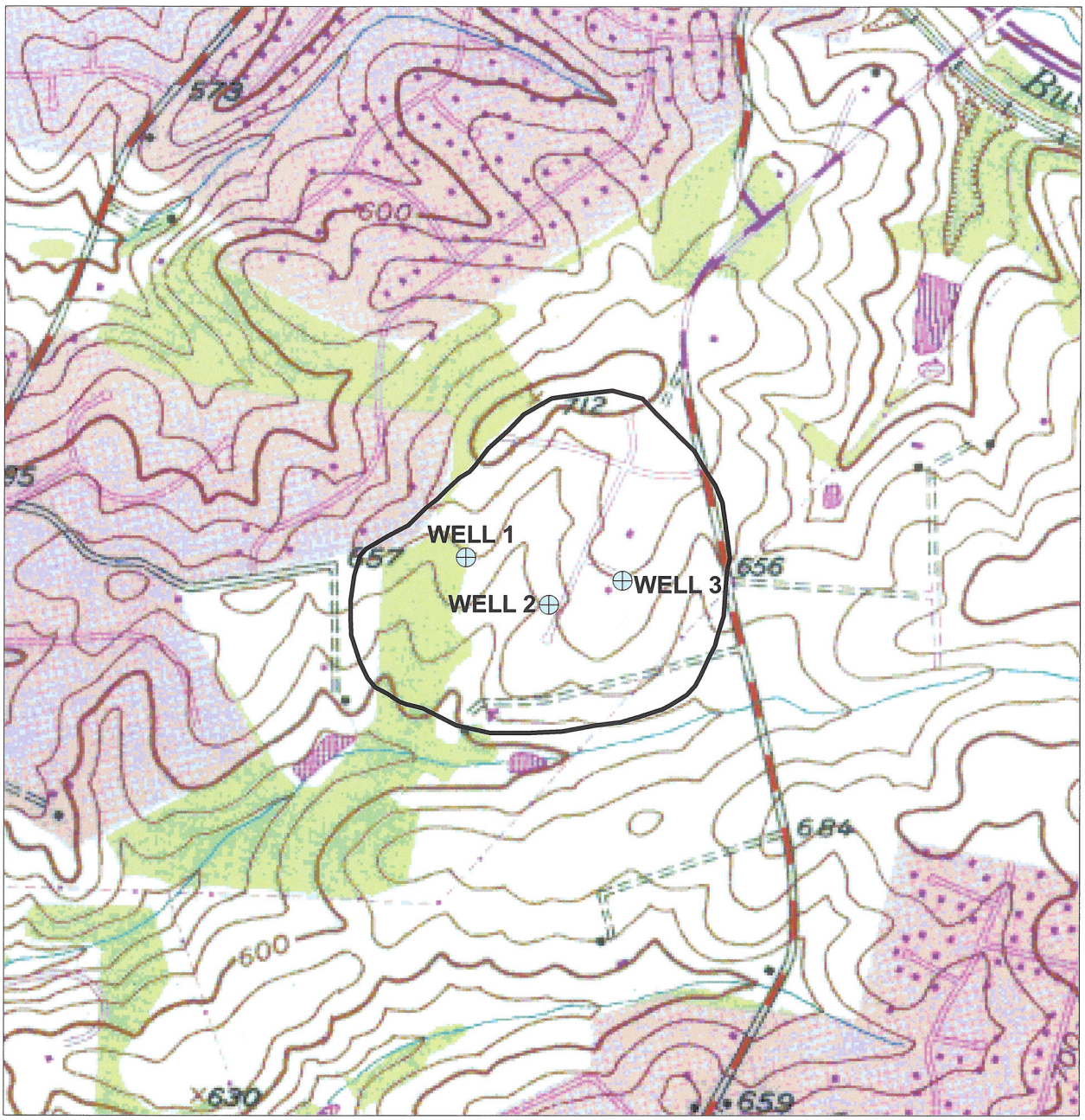

Figure 2. Bradford Estates Wellhead Protection Area (WHPA).

Legend

⊕ Wells

Wellhead Protection Area

N

500 0 500 1000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Damascus

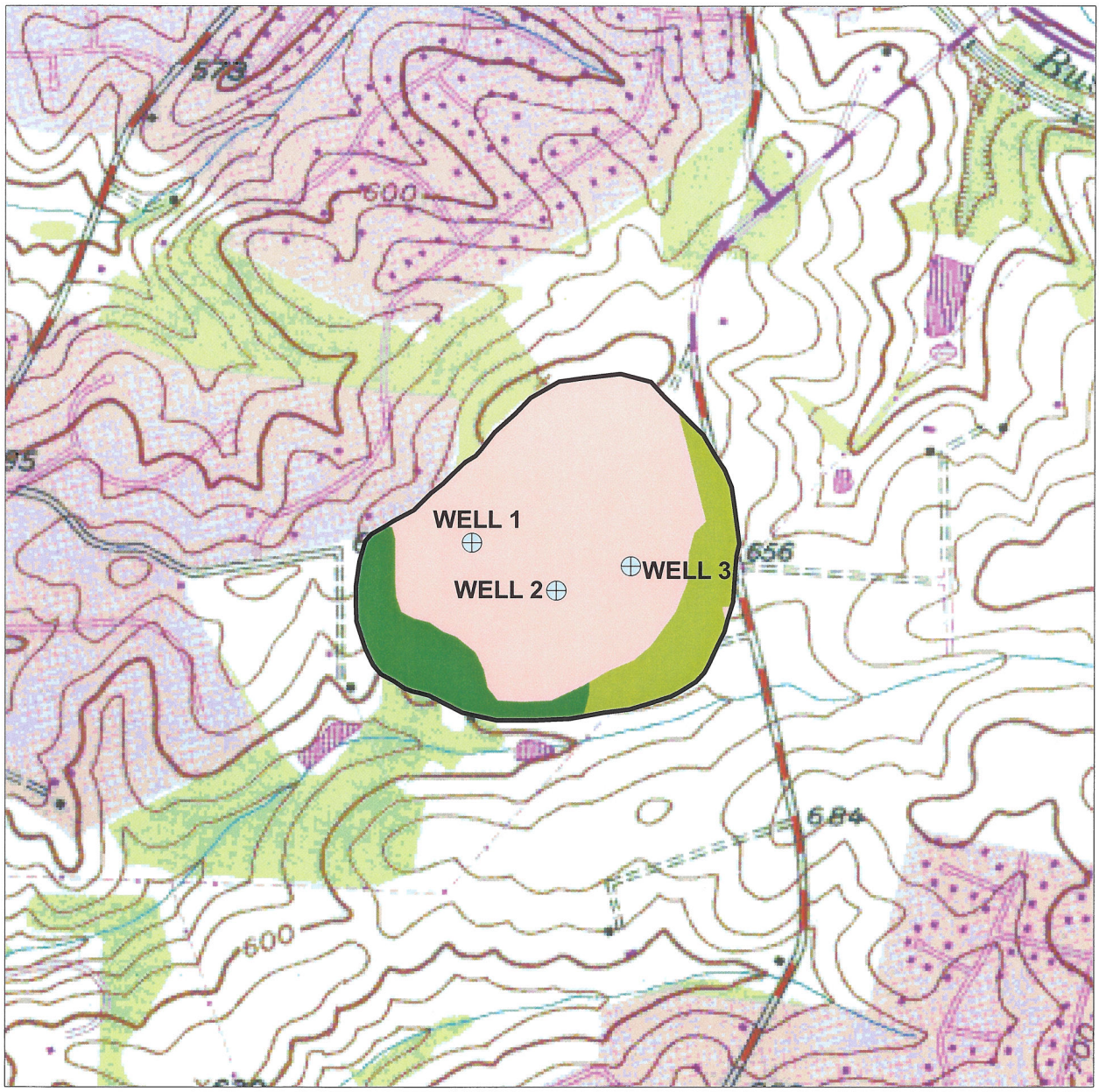

Figure 3. Land Use in the Bradford Estates WHPA.

Legend

Wells

WHPA

Frederick County 2000 Land Use

Low Density Residential

Cropland

Pasture

Forest

N

500 0 500 1000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Damascus

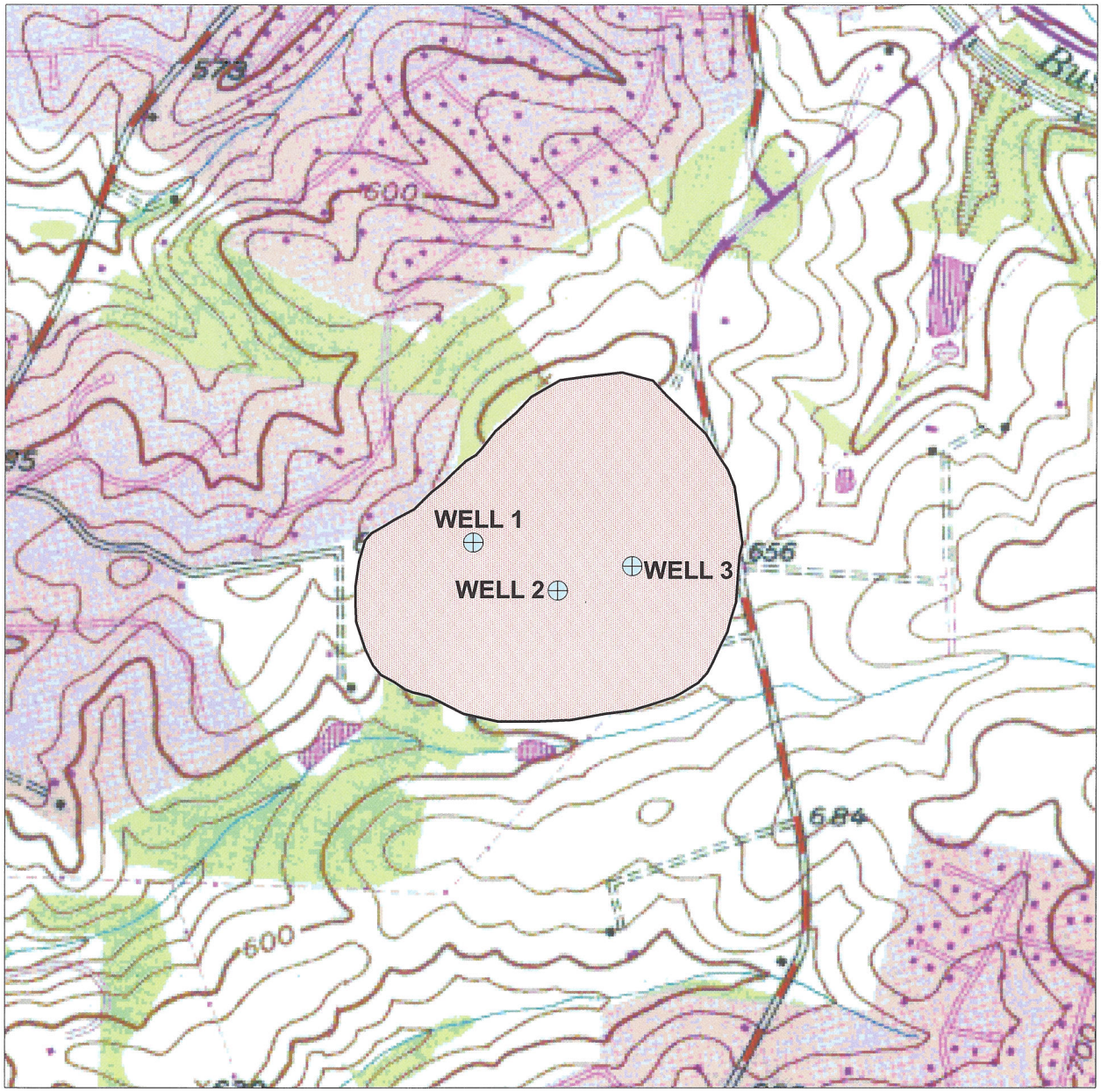

Figure 4. Sewer Service Areas in the Bradford Estates WHPA.

Legend

Wells

WHPA

Sewer Service Areas

Not Planned for Service

N

500 0 500 1000 Feet

Base Map: USGS Topographic 7.5 Minute Quad for Damascus