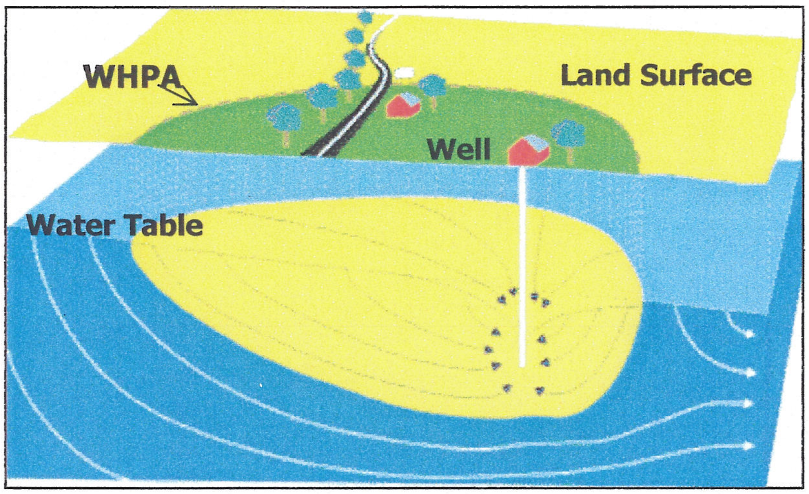
SOURCE WATER ASSESSMENT

for

TOWN OF WOODSBORO

Frederick County, MD



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Water Supply Program
June, 2005

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SUMMARY

The Maryland Department of the Environment's Water Supply Program (MDE-WSP) has conducted a Source Water Assessment for the Town of Woodsboro. 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 Woodsboro's water supply is an unconfined, carbonate, fractured rock aquifer. Woodsboro currently uses five wells (nos. 2, 2A, 3, 7 and 14). A sixth well (no.1) exists, but is not in use. A Source Water Assessment area has been delineated for the Town of Woodsboro using U.S. EPA approved methods specifically designed for each source.

Potential point sources of contamination within the assessment area were identified from MDE contaminant inventory databases. The Maryland Department of Planning's 2002 land use map for Frederick County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed.

The susceptibility analysis is based on a review of the existing water quality data for the Woodsboro 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 Woodsboro's well no. 1 is presently susceptible to contamination by microbiological contaminants. No treatment for the microbiological contaminants has been installed on well 1; consequently, the well should not be used and should be abandoned and sealed. This water supply is susceptible to nitrates and volatile organic compounds, but not presently susceptible to other inorganic compounds, radionuclides, or synthetic organic compounds. The system would be susceptible to radon if the EPA adopts the lower proposed MCL of 300 picoCuries per liter.

INTRODUCTION

The Town of Woodsboro is located approximately eight miles northeast of the City of Frederick, in Frederick County. Woodsboro's water supply system serves a population of 940 and has 419 service connections. Woodsboro presently obtains its water supply from five wells (Nos. 2, 2A, 3, 7, and 14). One other well (No. 1) is a stand-by well and has been determined to be ground water under the influence of surface water (GWUDI).

This document summarizes information from various studies and activities and also contains the required components of Maryland's Source Water Assessment Plan; delineation, contaminant source inventory, and susceptibility analysis.

WELL INFORMATION

A review of the well completion reports and sanitary surveys of Woodsboro's water system indicate that wells 1 and 2 were installed prior to the implementation of the 1973 well construction regulations. Well work conducted in 1999 extended the original casing depths of wells 1 and 2 from 35' and 36' to 76' and 100' respectively, with PVC inserts and packers. Table 1 contains a summary of the well construction data. The locations of the wells are shown in Figure 1.

PLANT ID	SOURCE ID	USE CODE	WELL NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	01	STANDBY	Well 1	FR-01-0039	200	76*	1952
02	02	PRODUCTION	Well 2	FR-03-4608	297	100*	1959
03	03	PRODUCTION	Well 3	FR-81-0518	600	41	1982
04	04	PRODUCTION	Well 2A	FR-88-1545	475	42	1990
05	05	PRODUCTION	Well 7	FR-88-1607	600	42	1990
06	06	PRODUCTION	Well 14	FR-88-1833	125	64	1990

Table 1. Town of Woodsboro Well Information * - well rehabbed from original

The Town has a ground water appropriation permit (FR1979G010) issued for a daily average of 79,000 gallons on a yearly basis and 98,000 gpd during the month of maximum use. Based on the semi-annual pumpage reports (1979-2004), water use has varied from 161,221 gpd avg in 2001 (estimated per capita use-190 gpdpc) to 40,673 in 1979 (estimated-81 gpdpc). Water use has exceeded the permitted amounts numerous years since about 1982, which appears to have been related to a high per capita demand, averaging about 150+/- gpdpc until 2002. A high per capita demand, temporal variation in use, and advanced age of a system usually suggest that there may be substantial leakage in the system. In this case, water use has declined substantially since 2001 (190 gpdpc) to 105 gpdpc in 2004. The State provided funding to upgrade the town's water distribution system in the 1990s, which could provide an explanation for the substantial decrease in use (i.e, replacing water lines fixed the leaks).

HYDROGEOLOGY

Woodsboro is located on the west edge of the Piedmont province in the Frederick Valley, which is underlain by Cambro-Ordovician carbonates and siltstones. The Woodsboro area is underlain by the Grove Limestone on its western side and by the Frederick Limestone on its eastern side. The consolidated sedimentary rocks of the basal conglomerate of the Triassic New Oxford Formation bound these formations to the north and west. The siliciclastic rocks of the Cash Smith shale and the Araby Formation (previously classified as the Antietam Quartzite) bound them to the east. An intrusive dike runs in a north-south direction through the center of town and figured prominently in a Wellhead Protection Plan previously developed by MDE, in 1997, for the town. The geology of the Woodsboro area is shown in Figure 2.

Well no. 1 obtains water from the Grove Limestone, while the remaining wells draw water from the Frederick Limestone. Both formations are water table carbonate rock aquifers that are susceptible to contamination, due to dominant flow through shallow epi-karst zones. In 2000, MDE determined that well no. 1 was under the influence of surface water. It was, also, determined in 2000 that the remaining wells were not under the influence of surface water.

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 WHPA represents the area around a well in which any contaminant present could ultimately reach the well. The source water assessment area for public water systems using wells or springs in fractured-rock aquifers is the watershed drainage area that contributes to the well or spring. The WHPA could be modified in carbonate aquifers to account for inflow from other watersheds. 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). The capture zone for a well, however, will be greatest during a drought, because the zone has to expand due to the reduced recharge in order to supply the annual average demand. Also, wells completed in carbonate rock aquifers may capture significant amounts of surface water, so the surface drainage area to such wells should be considered in any wellhead protection study.

In September 1997, MDE developed a Wellhead Protection Plan for the Town of Woodsboro. Due to the complexity of the geology in the area, it was determined that a Wellhead Protection Area (WHPA) could not be determined using an EPA approved groundwater flow model like the WHPA Code. In this case hydrogeologic mapping was used to identify the physical and hydrologic features that might control ground water flow.

In the 1997 study, it was suggested that a dye trace study be conducted to help delineate the WHPA, but that MDE did not have the resources to perform such work. A related dye trace study was subsequently completed in December 2001 for the Legore Quarry Zone of Influence (ZOI) geologic report. In the 1997 study, MDE used the location of the Woodsboro wells relative to geologic and watershed boundaries to delineate two WHPAs.

The first WHPA was for well no. 1, which has an area of 136 acres, an approximate length of 4000 feet, and a width of 2000 feet. The upgradient boundary is the basal conglomerate of the New Oxford Formation. The downgradient boundary is the diabase dike. The geologic data in Figure 2 was taken from the MDE GIS-Database, and is a portion of the small scale (1:250,000) 1968 Geologic Map of Maryland. A check of the source map (1938 Geologic Map of Frederick County) and other larger scale maps indicates that the diabase dike is actually between the two WHPAs. The eastward flowing tributary (West Branch) to Israel Creek forms the northern boundary of the WHPA and the watershed boundary of that stream forms the southern limit of the WHPA.

A second, single large, WHPA was delineated for wells 2, 2A, 3, 7 and 14, since they all were within the Israel Creek watershed. The area of the WHPA is 395 acres, with approximate length and breadth of 5,200 feet and 3200 feet, respectively. It is bounded on the west by the diabase dike and on the east by the Cash Smith/Araby formations. The north and south boundaries are the estimated limits of the recharge area for the five wells.

The WHPA should cover an area large enough to supply water at the average appropriated amount using effective recharge. The 2002 drought year base flow (effective recharge) in the Yellow Breeches Basin (PA), which has the best available data for carbonate recharge rates, was estimated by MDE (Hammond, 2000, revised 2004) to be 8.4 in/yr (625 gpd/acre). The recharge area for the five wells in service during the drought, using the average reported demand of 86,374 gpd and the 2002 baseflow value, would have been 138 acres. Adjusting for the increased water use in 2004 (98,899 gpd avg) and the effects of a drought on demand (110% multiplier), the estimated recharge area for the wells would have been 174 acres during the 2002 drought, or a value less than ½ of the calculated area for the second WHPA.

The subsequent dye trace, discussed below, and other hydrological evidence suggest that a re-evaluation of the WHPAs should be conducted. During that process, consideration should be given to extending the WHPA boundaries for the water supply to the nearest ridgelines, or topographic divides, to account for possible up-gradient zones of contribution outside of the capture zone of the wells.

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 5 potential point sources of contamination within the WHPA, and 7 others near the WHPA and up gradient of the town's wells, Table 2 and Figure 3. All of the point sources are included for historical purposes, since it is recommended that the WHPA be re-evaluated. Underground storage tanks (UST) were identified at three facilities. If they leak, USTs are potential sources of volatile organic compounds. One pesticide dealer was identified (Southern States). The Town of Woodsboro has a NPDES-municipal permit to discharge into Israel Creek, within the WHPA. Wastewater effluent can contain a variety of contaminants; including pathogens, partially treated organic compounds and inorganic compounds, such as nitrates or metals that are not completely removed by the treatment process. Laurel Sand and Gravel has two NPDES-industrial permits to discharge water into the West Branch and Legore Branch, both tributaries to Israel Creek, up gradient of the town's wells. Five other discharges are listed in the MDE database. Three are associated with quarry operations and one with the Woodsboro WWTP. The fifth discharger is a car and truck wash, the location of which could not be verified through a records search.

ID*	Type	Facility Name	Address	Comments	Tax Map	Parcel
A	NPDES-ind (MD0003174)	Laurel Sand & Gravel	P.O. Box 1504, Laurel, MD	Legore Quarry	34	294
B	NPDES-ind (MD0003174)	Laurel Sand & Gravel	P.O. Box 1504, Laurel, MD	Legore Quarry	34	294
C	NPDES-ind (MD0003174)	Laurel Sand & Gravel	P.O. Box 1504, Laurel, MD	Legore Quarry	34	294
D	NPDES-ind (MD0055247)	Barrick LLC	P.O. Box 1504, Laurel, MD	Barrick Quarry	34	105
E	UST	N.Z. Cramer & Sons	101 Woodsboro/Creagerstown	Gasoline tank	950	868
F	Pest-dealer	Southern States	101 S.Adams St.		950	909
G	UST	Cornell Texaco	611 S. Main St.	Kerosine tank	950	959
H	UST	Evangelical Lutheran Church	101 S. Main St.	Heating oil	950	917
I	NPDES-mun(MD0058661)	Woodsboro WWTP	102 S. Main St.		42	45
J	NPDES-ind (MD0000761)	Lehigh Portland Cement	10642 Woodsboro Rd.	Laurel Hill Quarry	42	97
K	NPDES-ind (MD0062626)	Lehigh Portland Cement (truck wash)	10642 Woodsboro Rd.	Laurel Hill Quarry	42	97

Table 2. Potential Contaminant Sources in or near Woodsboro WHPA

Non-Point Sources

Based on the Maryland Department of Planning's 2002 Land Use map, the land use within Woodsboro's WHPA is primarily agricultural (cropland and pasture) (49.6%), with smaller proportions of residential areas (23.1%), and non-residential and other uses (27.3%), Figure 4. The residential land use is in the immediate vicinity of the town's well field. Table 3 outlines the distribution of land use within the WHPA.

Land Use Code	Land Use Type	Total Acres	% WHPA
11	Low Density Residential	54.0	10.2
12	Medium Density Residential	66.1	12.4
13	High Density Residential	2.4	0.5
14	Commercial	17.8	3.4
15	Industrial	21.3	4.0
16	Institutional	13.1	2.5
17	Extractive	5.7	1.1
18	Open Urban Land	39.4	7.4
21	Cropland	202.2	38.1
22	Pasture	61.3	11.5
41	Deciduous Forest	44.7	8.4
50	Water	3.0	0.6
	Total	531.0	100

Table 3. Land Use Summary of Woodsboro WHPA.

Agricultural lands (cropland and pasture) are commonly associated with nitrate loading of ground water and also represent potential sources of SOCs depending on fertilizing practices and use of pesticides. Pasture and residential areas are also sources of microbiological pathogens from human and animal wastes. Additionally, residential areas may be a source of nitrate and SOCs, if fertilizer, pesticides, and herbicides are not applied carefully to lawns and gardens.

The Maryland Department of Planning's 2002 digital sewer map of Frederick County shows that 55% of the WHPA has no planned sewer service, and is primarily forest or agricultural lands, Figure 5. The remaining area has existing sewer service or is planned for service in the near future. Table 4 summarizes the sewer service categories in the WHPA.

Service Category	Total Acres	Percent of WHPA
Existing Service	82.9	15.6
3 Year Planned Service	50.9	9.6
4 to 6 Year Planned Service	104.3	19.6
Not Planned for Service	292.8	55.2
Total	530.8	100

Table 4. Sewer Service Area Summary of Woodsboro WHPA

WATER QUALITY DATA

Water Quality data were reviewed from the Water Supply Program's database for Safe Drinking Water Act contaminants. All data reported is from the finished (treated) water unless otherwise noted. The methods used to treat the water supply are given in Table 5.

SYSTEM	PLANT ID	TREATMENT	PURPOSE
WELL 1	01	REQUIRED TO FILTER	MICROBIAL REMOVAL
WELLS 2, 2A, 3, 7 & 14	02-04	HYPOCHLORINATION	DISINFECTION

Table5. Treatment Methods in Woodsboro's Plants

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. A review of the monitoring data since 1993 for Woodsboro's water supply indicates that nitrates, Di(2-Ethylhexyl)Phthalate, and Radon-222 (proposed standard) exceed 50% MCL thresholds. In addition, other contaminants of concern were microbiological pathogens in well 1 and MTBE detected in Plants 1, 2 and 3.

	Plant 01		Plant 02		Plant 03		Plant 04	
Contaminant Group	No. of Samples Collected	No. of Samples > 50% of an MCL	No. of Samples Collected	No. of Samples > 50% of an MCL	No. of Samples Collected	No. of Samples > 50% of an MCL	No of Samples Collected	No. of Samples > 50% of an MCL
Inorganic Compounds (except nitrate)	3	0	4	0	4	0	4	0
Nitrate	9	9	9	1	12	4	12	9
Radiological Contaminants	2	1	2	1	3	1	3	1
Volatile Organic Compounds (except MTBE)	13	0	15	0	14	0	8	0
MTBE	1		6		1		0	
Synthetic Organic Compounds	7	1	5	1	5	3	2	0

Table 6. Summary of Water Quality Samples for Woodsboro's Plants

Inorganic Compounds (IOCS)

No inorganic compounds were detected above 50% of an MCL, except nitrate, which has an MCL of 10 parts per million (ppm). The range and average nitrate levels at each plant were as follows: Plant 01, 3.7-9.9 ppm, average 6.9 ppm; Plant 02, 0.2-6.6 ppm, average 2.8 ppm; Plant 03, 1.7-5.8 ppm, average 4.2 ppm; and Plant 04, 3.6-6.8 ppm, average 5.4 ppm.

Volatile Organic Compounds (VOCs)

A review of the data shows that there were no VOC results above 50% of an MCL. Methyl-Tertiary-Butyl-Ether (MTBE) was detected at three of the plants. One sample in 1995 at Plant 1 had a level of 31 parts per billion (ppb). Six samples taken from Plant 02 had detectable levels of MTBE, declining from 18 ppb in 1995 to 2 ppb in 2004. One sample collected from Plant 03 had a level of 2.7 ppb in 2004. MTBE does not have an MCL but does have a taste and threshold level of 20-40 ppb.

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. Radon-222 results from all Plants (305-425 pCi/L) have exceeded the lower proposed MCL.

Synthetic Organic Compounds (SOCs)

SOCs were detected in five samples at levels above 50% of an MCL. These were all di(2-ethylhexyl)phthalate, for which the highest level reported was 8.7 ppb. The other SOCs detected were Atrazine (Plant 01, 0.204 ppb) and Dalapon (Plant 04, 0.53 ppb).

The laboratory reported di(2-ethylhexyl)phthalate in analysis of blanks concurrent with the samples from the water system.

Microbiological Contaminants

The Town was notified by MDE in on May 22, 2000 (Grace, 2000) that Well 1 was classified as "Ground Water Under the Direct Influence of Surface Water" (GWUDI) source as defined in COMAR and the Surface Water Treatment Rule. The determination was based on the results of bacteriological sampling and the presence of surface water indicators. At the same time, MDE notified the town that wells 2, 2A, 3, 7 and 14 were **not** GWUDI sources. The results of the GWUDI testing are shown in Tables 7a-c.

SOURCE	RAIN DATE	RAIN AMT	REMARKS	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
Well 1	7-Sep-98	0.5	WET SET 1	8-Sep-98	16.1	2.2
Well 1	7-Sep-98	0.5	WET SET 1	9-Sep-98	9.2	3.6
Well 1	7-Sep-98	0.5	WET SET 1	10-Sep-98	23.1	9.2
Well 1	7-Sep-98	0.5	WET SET 1	11-Sep-98	3.6	-1.1
Well 1	17-Sep-98	0	DRY	17-Sep-98	6.9	-1.1
Well 1	18-Jan-99	0.9	WET SET 2	18-Jan-99	23.1	5.1
Well 1	18-Jan-99	0.9	WET SET 2	19-Jan-99	23.1	12
Well 1	18-Jan-99	0.9	WET SET 2	20-Jan-99	23.1	16.1
Well 1	18-Jan-99	0.9	WET SET 2	21-Jan-99	23.1	23.1
Well 1	20-Sep-99	0	DRY	20-Sep-99	6.9	-1.1
Well 1	22-Sep-99		WET WEATHER SET	22-Sep-99	50	2
Well 1	22-Sep-99		WET WEATHER SET	23-Sep-99	130	8
Well 1	22-Sep-99		WET WEATHER SET	24-Sep-99	900	7
Well 1	22-Sep-99		WET WEATHER SET	27-Sep-99		
Well 1	11-Oct-99	1.5	WET SET	12-Oct-99	23.1	5.1
Well 1	11-Oct-99	1.5	WET SET	13-Oct-99	50	4
Well 1	11-Oct-99	1.5	WET SET	14-Oct-99	-1.1	-1.1
Well 1	6-Dec-99	0.5	WET WEATHER SET	6-Dec-99	-1.1	-1.1
Well 1	6-Dec-99	0.5	WET WEATHER SET	8-Dec-99	-1.1	-1.1
Well 1	6-Dec-99	0.5	WET WEATHER SET	9-Dec-99	-1.1	-1.1
Well 1	6-Dec-99	0.5	WET WEATHER SET	10-Dec-99	-1.1	-1.1
Well 1	4-Jan-00	0.5	WET WEATHER SET	4-Jan-00	-2	-2
Well 1	4-Jan-00	0.5	WET WEATHER SET	5-Jan-00	17	-2
Well 1	4-Jan-00	0.5	WET WEATHER SET	6-Jan-00	-1.1	-1.1
Well 1	4-Jan-00	0.5	WET WEATHER SET	7-Jan-00	30	-2
Well 1	12-Mar-00	1	WET WEATHER SET	12-Mar-00	500	4
Well 1	12-Mar-00	1	WET WEATHER SET	13-Mar-00	2.2	-1.1
Well 1	12-Mar-00	1	WET WEATHER SET	14-Mar-00	1.1	-1.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 7a. GWUDI data Woodsboro Well 1

SOURCE	RAIN DATE	RAIN AMT	REMARKS	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
Well 2	7-Sep-98	0.5	WET SET 1	8-Sep-98	16.1	-1.1
Well 2	7-Sep-98	0.5	WET SET 1	9-Sep-98	6.9	2.2
Well 2	7-Sep-98	0.5	WET SET 1	10-Sep-98	2.2	-1.1
Well 2	7-Sep-98	0.5	WET SET 1	11-Sep-98	-1.1	-1.1
Well 2	17-Sep-98	0	DRY	17-Sep-98	1.1	-1.1
Well 2	18-Jan-99	0.9	WET SET 2	18-Jan-99	23.1	23.1
Well 2	18-Jan-99	0.9	WET SET 2	19-Jan-99	23.1	23.1
Well 2	18-Jan-99	0.9	WET SET 2	20-Jan-99	23.1	23
Well 2	18-Jan-99	0.9	WET SET 2	21-Jan-99	23.1	23.1
Well 2	20-Sep-99	0	DRY	20-Sep-99	50	8
Well 2	22-Sep-99		WET WEATHER SET	22-Sep-99	110	30
Well 2	22-Sep-99		WET WEATHER SET	23-Sep-99	80	30
Well 2	22-Sep-99		WET WEATHER SET	24-Sep-99	17	4
Well 2	22-Sep-99		WET WEATHER SET	27-Sep-99		
Well 2	29-Sep-99		WELL DISINFECTED 9/28	29-Sep-99	0	0
Well 2	9-Aug-99	0	DRY	9-Aug-99	6.9	-1.1
Well 2	11-Oct-99	1.5	WET SET	12-Oct-99	16.1	2.2
Well 2	11-Oct-99	1.5	WET SET	13-Oct-99	5.1	1.1
Well 2	11-Oct-99	1.5	WET SET	14-Oct-99	6.9	-1.1
Well 2	6-Dec-99	0.5	WET WEATHER SET	6-Dec-99	-1.1	-1.1
Well 2	6-Dec-99	0.5	WET WEATHER SET	7-Dec-99	-1.1	-1.1
Well 2	6-Dec-99	0.5	WET WEATHER SET	8-Dec-99	-1.1	-1.1
Well 2	6-Dec-99	0.5	WET WEATHER SET	10-Dec-99	-1.1	-1.1
Well 2	4-Jan-00	0.5	WET WEATHER	4-Jan-00	2	-2
Well 2	4-Jan-00	0.5	WET WEATHER	5-Jan-00	-2	-2
Well 2	4-Jan-00	0.5	WET WEATHER	6-Jan-00	1.1	-1.1
Well 2	4-Jan-00	0.5	WET WEATHER	7-Jan-00	-1.1	-1.1
Well 2	12-Mar-00	1	WET WEATHER SET	12-Mar-00	-1.1	-1.1
Well 2	12-Mar-00	1	WET WEATHER SET	13-Mar-00	-1.1	-1.1
Well 2	12-Mar-00	1	WET WEATHER SET	14-Mar-00	-1.1	-1.1
Well 2	12-Mar-00	1	WET WEATHER SET	15-Mar-00	-1.1	-1.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 7b. GWUDI data Woodsboro Well 2

SOURCE	RAIN DATE	RAIN AMT	REMARKS	SAMPLE DATE	TOTAL COLIFORM	FECAL COLIFORM
Well 3	7-Sep-98	0.5	WET SET 1	8-Sep-98	-1.1	-1.1
Well 3	7-Sep-98	0.5	WET SET 1	9-Sep-98	-1.1	-1.1
Well 3	7-Sep-98	0.5	WET SET 1	10-Sep-98	-1.1	-1.1
Well 3	7-Sep-98	0.5	WET SET 1	11-Sep-98	-1.1	-1.1
Well 3	17-Sep-98	0	DRY	17-Sep-98	-1.1	-1.1
Well 3	18-Jan-99	0.9	WET SET 2	18-Jan-99	-1.1	-1.1
Well 3	18-Jan-99	0.9	WET SET 2	19-Jan-99	12	-1.1
Well 3	18-Jan-99	0.9	WET SET 2	20-Jan-99	5.1	-1.1
Well 3	18-Jan-99	0.9	WET SET 2	21-Jan-99	3.6	-1.1
Wells 2A,7,14	7-Sep-98	0.5	WET SET 1	8-Sep-98	-1.1	-1.1
Wells 2A,7,14	7-Sep-98	0.5	WET SET 1	9-Sep-98	-1.1	-1.1
Wells 2A,7,14	7-Sep-98	0.5	WET SET 1	10-Sep-98	-1.1	-1.1
Wells 2A,7,14	7-Sep-98	0.5	WET SET 1	11-Sep-98	-1.1	-1.1
Wells 2A,7,14	17-Sep-98	0	DRY	17-Sep-98	-1.1	-1.1
Wells 2A,7,14	18-Jan-99	0.9	WET SET 2	18-Jan-99	1.1	-1.1
Wells 2A,7,14	18-Jan-99	0.9	WET SET 2	19-Jan-99	1.1	-1.1
Wells 2A,7,14	18-Jan-99	0.9	WET SET 2	20-Jan-99	2.2	-1.1
Wells 2A,7,14	18-Jan-99	0.9	WET SET 2	21-Jan-99	1.1	-1.1

RAIN AMT = inches TOTAL AND FECAL COUNT = 100 Col/ml (-1.1 = not detected)

Table 7c. GWUDI data Woodsboro Wells 2A, 3, 7 & 14

Dye Trace Study

Gary (2001) reported the results of dye trace studies used to evaluate the Zone of Influence (ZOI) for the Legore Quarry. Separate dyes were injected at four different points on September 18, 1998. Samples were taken at 33 recovery points, at approximately weekly intervals, until February 23, 1999, using activated charcoal samplers. The locations of the injection and representative recovery points are shown on Figure 6. About five pounds of Sulforhodamine B (Sr) were injected a Point A (Angleberger sinkhole). About four pounds of Fluorescein (Fl) were injected at point B (TB & H sinkhole). About five pounds of Rhodamine WT (Rhd) were injected at point C (Ghadhill well). Five pounds of Eosine (Eo) were injected at point D (Barrick Quarry sinkhole).

Due to the infrequent sampling, aliasing (the distortion of signal frequency by inadequate sampling) probably occurred. This would make it difficult to determine the flow controlling mechanism(s) of the system. Also, due to a lack of calibration of the spectroflourophotometer used to analyze the data, and a lack of stream flow measurements, a mass balance cannot be calculated to determine the relative amounts of dyes recovered.

Legore Quarry Dye Trace - August 1998 to February 1999

Site	Type	Dye	Test Weeks	Intensity	Site	Type	Dye	Test Weeks	Intensity
1	**stream**	**Eo**	**1,2**	**80,370**	16	stream	Fl	1	130
		Sr	1,2	70,420			Rhd	13,17-19	90,90,160,110
2	stream	Eo	1,2	42,143	**18**	**stream**	**Fl**	**1,2,12**	**205,125,120**
		Sr	1,2	42,58	19	spring	Fl	1?,18	55?,120
3	Well/toilet	Eo	1,2	17,104			Sr	1	55
		Sr	1,2	28,78	**20**	**spring**	**Eo**	**8**	**280**
4	spring	Fl	1,10	33,45			Sr	1,2	55,35
		Eo	1,2,8	32,50,18	21	stream	Fl	1	36
		Sr	1,2	42,17			Sr	1,2	43,34
5	stream	Fl	1,17	65,72?	22	stream	none		
		Eo	1	58	23	stream	Fl	1	15
		Sr	1	65			Eo	1,2	21,13
6J	Quarry sump	Fl	early,17	5-30+,140			Sr	1,2	31,17
		Sr	1,2	35,15	24	stream	none		
6P	Quarry pump	Fl	1-5,18,19	25,37,45,220,25,55,120	25	stream	Eo	2,8	25,28
		Eo	1,2	25,120	26	stream	Fl	1	72?
		Sr	1,2	35,25	29	well	Fl	1	30
7	stream	Fl	4,17-19	77,60,48,155			Sr	1	16
	Quarry discharge	Eo	2	40	30	Quarry sump	Eo	3-5,8,17	All less
		Sr	1,2	65,20			Sr	1,2	than 26
8	well/toilet	Eo	1,2,6	18,8,6	31	well 1	Fl	1	All
		Sr?	1,2,6	24,15,5			Eo	2-4,6	less than
9	stream	Fl	1,2	55,85			Sr	1,2	23
		Sr	1,8	42,51	32	well 7	Eo	1,4-6,8	All less
10	**stream**	**Sr**	**2-6**	**1000+,300,180,80,70**			Sr	1,2	than 20
11	**stream**	**Sr**	**2,3,4,6**	**1000+,170,260,100**	33	well 14	Fl	1,3,4,13	All
12	stream	Sr	1-5	30,320,120,130,120			Eo	1,2,4	less than
13	**stream**	**Fl**	**3,4,19**	**170,260,340**			Sr	1,2,4	38
		Sr	3-6	280,260,50,50	34	well 2A	Eo	1-5,12,13	All less
14A	Well/toilet	Eo	1,2	59,22			Sr	1,2	than 34
		Sr	1,2	26,13	35	well 3	Eo	1-4	All less
14B	pond	Eo	1,2,8	99,50,35			Sr	1,2	than 18
		Rhd	12,17	28,71	36	well 2	Fl	1	All
		Sr	1,2	47,43			Eo	1,3,4,6,12,13	less than
15	**spring**	Fl	1	80			Sr	1	45
		Rhd	**17-19**	**145,375,230**					

Table 8a. Legore Quarry Dye Trace Data

Israel Creek Dye Trace - August 22 to October 26 2000				
Site	**Type**	**Dye**	**Test Weeks**	**Intensity**
1	**stream**	**Fl**	**multiple (max 6)**	**330(wk 6)**
3	Well/toilet	Eo	multiple (max 1)	21(wk 1)
5	stream	Fl	multiple (max 5)	31(wk 5)
6J	Quarry sump	Fl	multiple (max 9)	18(wk 9)
		Eo	1	17
6P	Quarry pump	Fl	multiple (max 6)	102(wk 6)
7	stream	Eo	*1*	230
	Quarry Discharge			
8	well/toilet	Fl	2	18
9	**stream**	**Eo**	**multiple (max 1)**	**1000+(wk 1)**
10	**stream**	**Eo**	**multiple (max 1)**	**1000+(wk 1)**
11	**stream**	**Eo**	**multiple (max 1)**	**1000+(wk 1)**
12	**stream**	**Eo**	**multiple (max 1)**	**1000+(wk 1)**
30	sump	Fl	2	135
		Eo	3	25
32	Well	Fl	3	25
		Rhd	3	19
33	Well	Fl	2	29
		Eo	3	11
34	Well	Fl	2	11
		Rhd	2	8
35	Well	Fl	8	19
		Rhd	8	12
36	Well	Fl	2	35
		Rhd	2	21

Table 8b. Israel Creek Dye Trace Data

The results of the Legore Quarry dye trace are shown in Table 8a. From these data, only a qualitative assessment should be made. To reduce clutter in making such a evaluation, only those (nine) recovery sites with high intensity readings are shown on Figure 6. This makes it easier to depict hypothetical flow controlling mechanisms for each trace.

The highest intensity levels recovered after injection of Sr at point A were recorded at sites 10 and 11 during the second week of the test, indicating that most of that dye was flushed downstream, since only low intensity levels were recorded at other sites. A follow-on trace of Israel Creek in 2000 produced similar results.

The highest intensity levels of Fl achieved after injection at point B occurred at site 18 during week 1, at site 6P during week 4, and at sites 7 and 13 during week

19. This could indicate that, initially, some dye was pulled toward the Legore Quarry and some may have spilled over into the Glade Creek watershed, possibly after working its way along the east-west fault shown on Figure 6. The much later dye recovery at sites 7 and 13 could be interference, since Fl is commonly used in automotive radiator coolants (anti-freeze), or the dye may have been flushed from storage after a storm event.

The Rhd injected at point C was only recovered at three sites, in the Glade Creek basin, with the highest intensity recorded at site 15 (week 19). The long period before recovery at a few sites suggests that the Gladhill well is not well connected to any regional ground water flow system. Point C is most likely in mountain wash sediments overlying the Grove Limestone, instead of the New Oxford Formation as shown in Figure 6.

The highest intensity levels of Eo recovered were at site 1, about 9,000 feet NE of point D, and at site 20, about 10,000 feet SW of the injection point. The sinkhole in which the dye was placed was located in or near the basal conglomerate of the New Oxford Formation. Significantly lower levels were recovered at 18 other sites, including all of the town's wells. These data indicate that the major portion of the dye may have traveled along strike in the New Oxford Formation, with lesser portions discharging at various points, and then moving topographically down gradient. Recovery continued throughout most of the test (weeks 1-6, 8, 12, 13, & 17 at various sites), indicating that Eo may have been bleeding out of storage. No Eo was recovered in Israel Creek between site 7 and sites (10-13), in the vicinity or down gradient of wells 2, 2A, 3, 7, and 14. This could be evidence of a losing stream reach, since some dye was recovered in the wells.

Three (Eo, Fl, and Sr) of the four dyes were recovered at relatively low intensities in the town's wells. What weight should be given to that data is in question, since similar low intensity levels were noted in Clear Spring's wells during a dye trace of that system. In that case, the water supply is considered GWUDI, while only Woodsboro's well No. 1 has been determined to be GWUDI.

The results of the Legore Quarry dye study indicate that a quantitative dye trace should be performed and used to re-evaluate the Woodsboro WHPA.

SUSCEPTIBILITY ANALYSIS

The wells serving the Woodsboro water supply draw water from unconfined, carbonate, 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 9 summarizes the susceptibility of Woodsboro's water supply to each of the groups of contaminants.

Due to the nature of the karst aquifer and the rapid movement of water through the aquifer coupled with the presence of potential contaminant sources within the WHPA, the water supply is considered vulnerable to all contaminants, since some levels of all major contaminants groups have been detected. At present, Woodsboro's water supply is can only be considered susceptible to nitrates and microbiological contaminants (well 1).

Inorganic Compounds (IOCs)

All results were less than 50% the MCL for all inorganic compound levels, except nitrate. 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. The residential areas within the WHPA that have no planned sewer service and the septic systems serving the existing homes may be a source of contamination observed for the wells. Except for well 2, the levels in the water supply suggest that it is presently susceptible to nitrates. Due to the vulnerability of the aquifer to land activity and the presence of nitrate sources in the WHPA and levels in all sources except well 2, the water supply is susceptible to nitrate, but not to other inorganic compounds.

Radionuclides

The source of radionuclides in ground water is the natural occurrence of uranium in rocks. The water supply is **not** susceptible to radionuclides; however, the results from all of Woodsboro's Water Plants (305-425 pCi/L) have exceeded the lower proposed MCL of 300 pCi/L and may be susceptible to radon-222.

Volatile Organic Compounds (VOCs)

While the water supply has not yet experienced levels of contamination of regulated VOC's, there are known contaminant sources in the WHPA, and MTBE has been detected at three of the town's plants. MTBE is a fuel additive used to reduce carbon monoxide and ozone levels caused by auto emissions. There is no national regulatory standard for MTBE in drinking water; however, MDE has adopted an action level of 20 ppb. A common source of MTBE is leaking gasoline storage tanks. Other sources include atmospheric deposition, stormwater runoff and residential uses of fuels. Due to the presence of underground storage tanks in close proximity to the water supply and past history of MTBE detections, the water supply is considered vulnerable to VOC contamination.

Synthetic Organic Compounds (SOCs)

Three SOCs were detected, one of which was above 50% of a MCL. That one was Di(2-ethylhexyl) phthalate, for which the highest level reported was 8.7 ppb. This contaminant is commonly found in laboratory blank samples. The method for analyzing this contaminant was started in 1995 and had produced many false positive results. The other SOCs detected were Atrazine and Dalapon, both of which are related to runoff associated with herbicide use. Atrazine is commonly used for row crop production and Dalapon in utility right-of-ways.

The wells are **not** presently susceptible to synthetic organic compounds. Potential sources of SOCs in the WHPA may be pesticide or herbicide use in agricultural and residential areas. The Southern States facility in Woodsboro maintains secondary containment for the storage of all pesticide products. The level of SOCs were detected were significantly below MCLs and are not likely to rise due to long term trends of reduced herbicide usage.

Microbiological Contaminants

The presence of fecal coliform bacteria in Well 1 of the Woodsboro water supply indicates its susceptibility to pathogenic microorganisms. Pathogenic protozoa, viruses, and bacteria normally associated with surface water can contaminate the wells through these connections. Sources of these pathogens are generally improperly treated wastewater, waste material from mammals, and urban runoff in developed areas. Pastureland and discharges from septic systems are the most likely sources of fecal contamination in the WHPA. As a GWUDI source, Well 1 is susceptible to bacteria, viruses, protozoa, and increased turbidity. If the source were to continue to be used as part of the Town's water supply, a filtration system should have been installed by November 30, 2001 to treat for the microbiological contaminants. On October 19, 2001, Donald Aukamp (ARRO Group) notified MDE that the town had decided to shut off Well 1 from the water supply and would be seeking a replacement well. Since the Town has not indicated a desire to use this well in the future or made plans to install the necessary treatment, Well 1 should be abandoned and sealed.

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?[1]
Nitrate	YES	YES	NO(2)	YES	YES
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	NO	NO(3)	NO	NO	NO
Volatile Organic Compounds	YES	NO(4)	NO	YES	YES
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	YES	NO(2)	YES	YES

Table 6. Susceptibility Analysis Summary.

1. At present time.
2. Poor construction of Well 1 is possible and the well is a GWUDI source.
3. Radon-222 detected in all plants above 300 Ci/L
4. MTBE detected in plants 01, 02, and 03.

MANAGEMENT OF THE WHPA

The information in this report can assist Woodsboro and Frederick County to better protect the Town's water supply. The report identifies the areas of concern, lists potential contaminant sources, and assesses the risk to the water supply. Specific management recommendations for consideration are listed below:

Form a Local Planning Team

- Woodsboro should form a local planning team to begin to implement the town's wellhead protection plan. The team should represent all the interests in the community, such as the water supplier, the County Health Department, local planning agencies, local business, developers, farmers and residents within and near the WHPA. The team should work to reach a consensus on how to protect the water supply.

- 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 from 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 the facilities and residents of the community focusing on activities that may present potential contaminant sources. Important topics include: (a) compliance with MDE and federal guidelines for gasoline and heating oil UST's, (b) monitoring well installation and maintenance of UST's, (c) appropriate use and application of fertilizers and pesticides, and (d) hazardous material 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.

Local Ordinace

- Woodsboro can develop an Ordinance for Wellhead Protection using MDE's model ordinance as a template.

Monitoring

- Continue to monitor for all Safe Drinking Water Act contaminants as required by MDE.
- Annual raw water tests for microbiological contaminants are recommended.

Well 1

- Woodsboro should properly abandon and seal Well 1 as no plans have been presented by the Town to construct the necessary treatment to this well to make it a safe source of water.

Land Acquisition/Easements

- The Town park provides protection to the Town's wells. If the Town would like to add to this preserved area, the Department has loan money available. 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

- Woodsboro 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

- Woodsboro may wish to should conduct its 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 (and springs) will ensure their integrity and protect the aquifer from contamination..

Changes in Use

- Woodsboro is required to notify MDE if any 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

Grace, J., 2000, 010-0027, Corporation of Woodsboro, Surface Water Treatment Rule, letter dated May 22, 2000, Maryland Department of the Environment, Water Supply Program, 5 p.

Aukamp, D., 2000, 010-0027, Corporation of Woodsboro, SWTR Compliance, Well No. 1, letter dated October 19, 2001, ARRO Group, Inc., 1 p.

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

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 No. FR1979G010
Public Water Supply Inspection Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
USGS Topographic 7.5 Minute Emmitsburg Quadrangle
Maryland Office of Planning 2002 Frederick County Digital Land Use Map
Maryland Office of Planning 2002 Frederick County Digital Sewer Map

FIGURES

Woodsboro Wells/WHPA

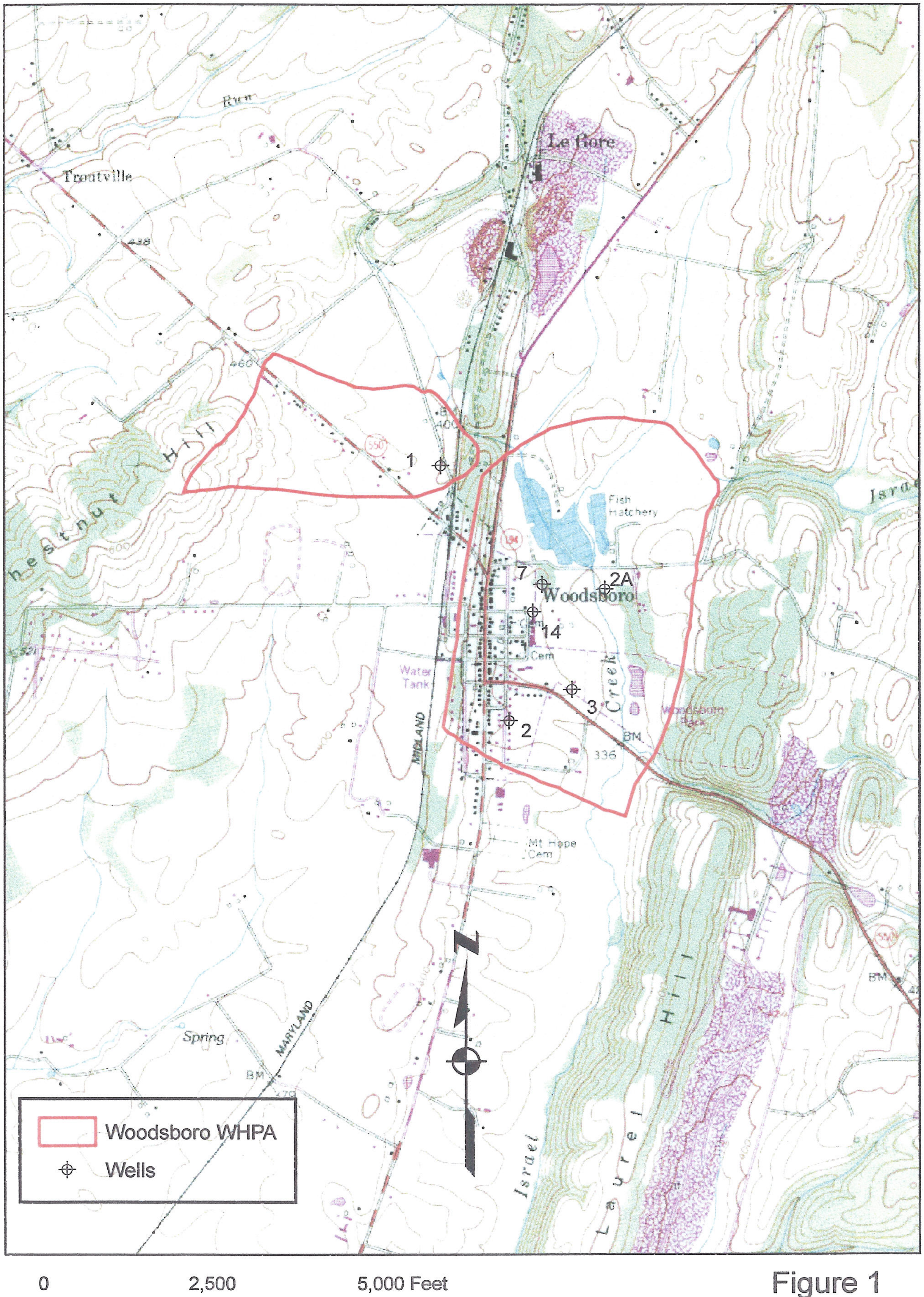

Figure 1

Woodsboro Area Geologic Map

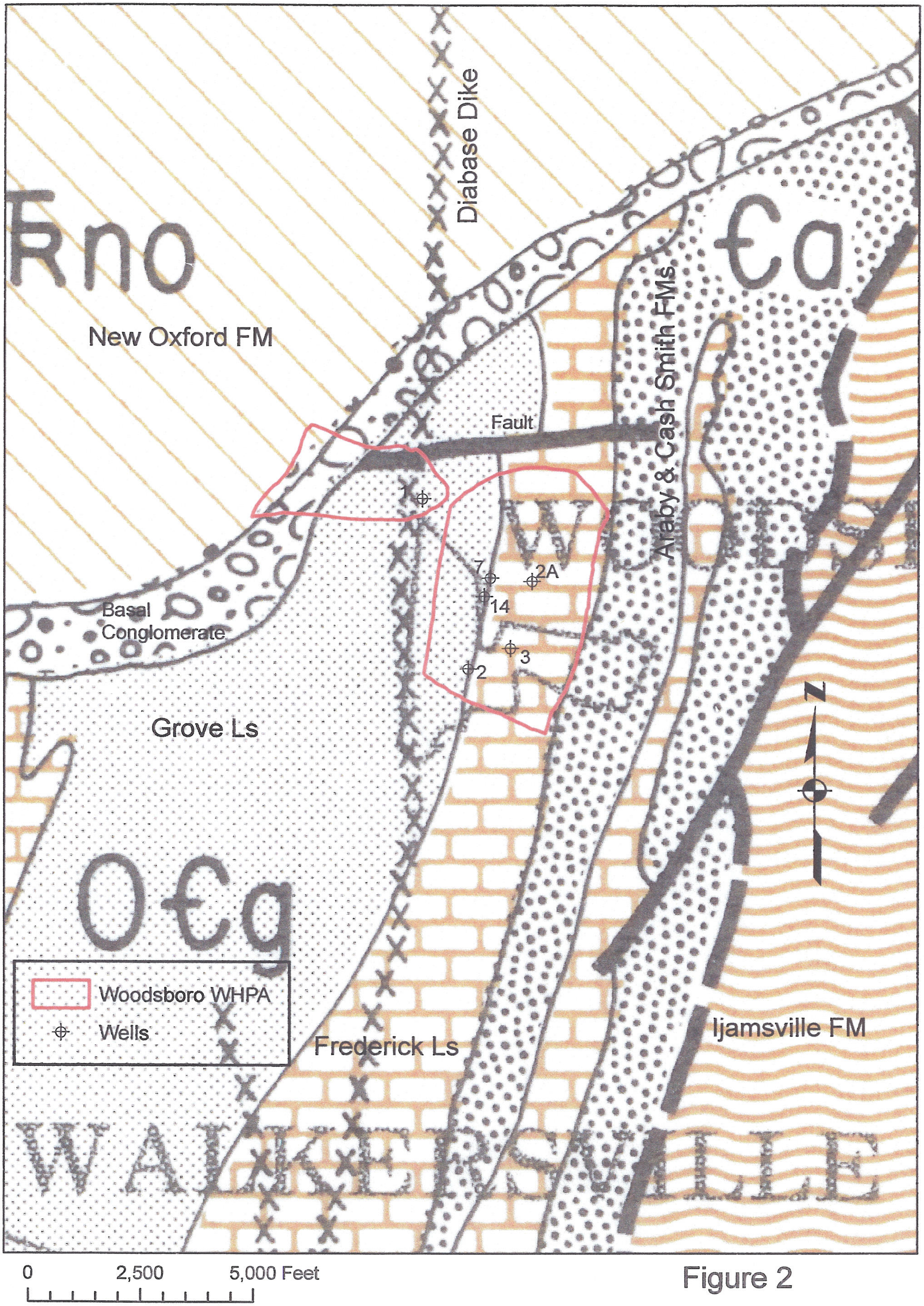

Figure 2

Woodsboro Map of Contaminants

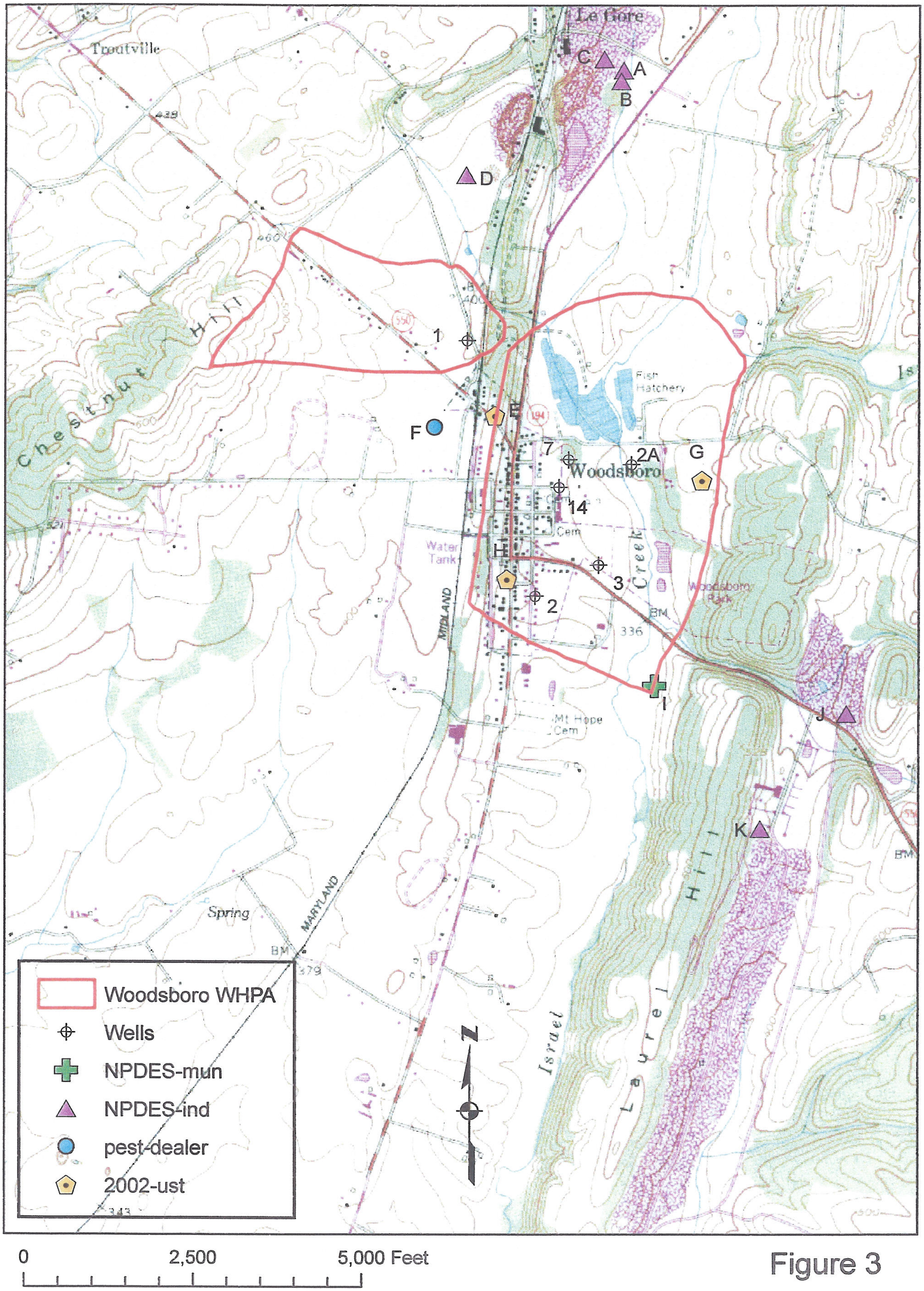

Figure 3

Woodsboro Land Use Map

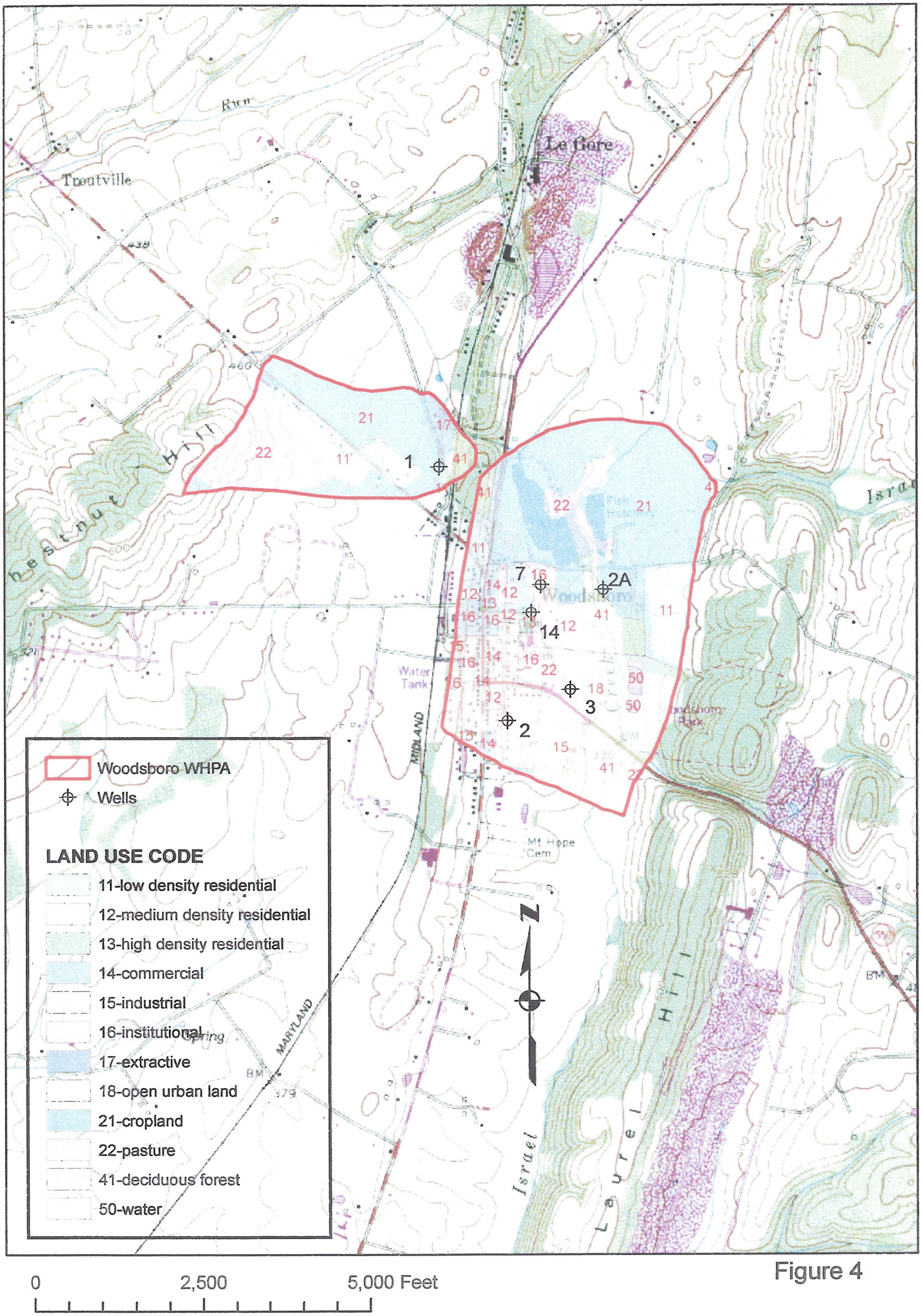

Figure 4

Woodsboro Sewer Service Map

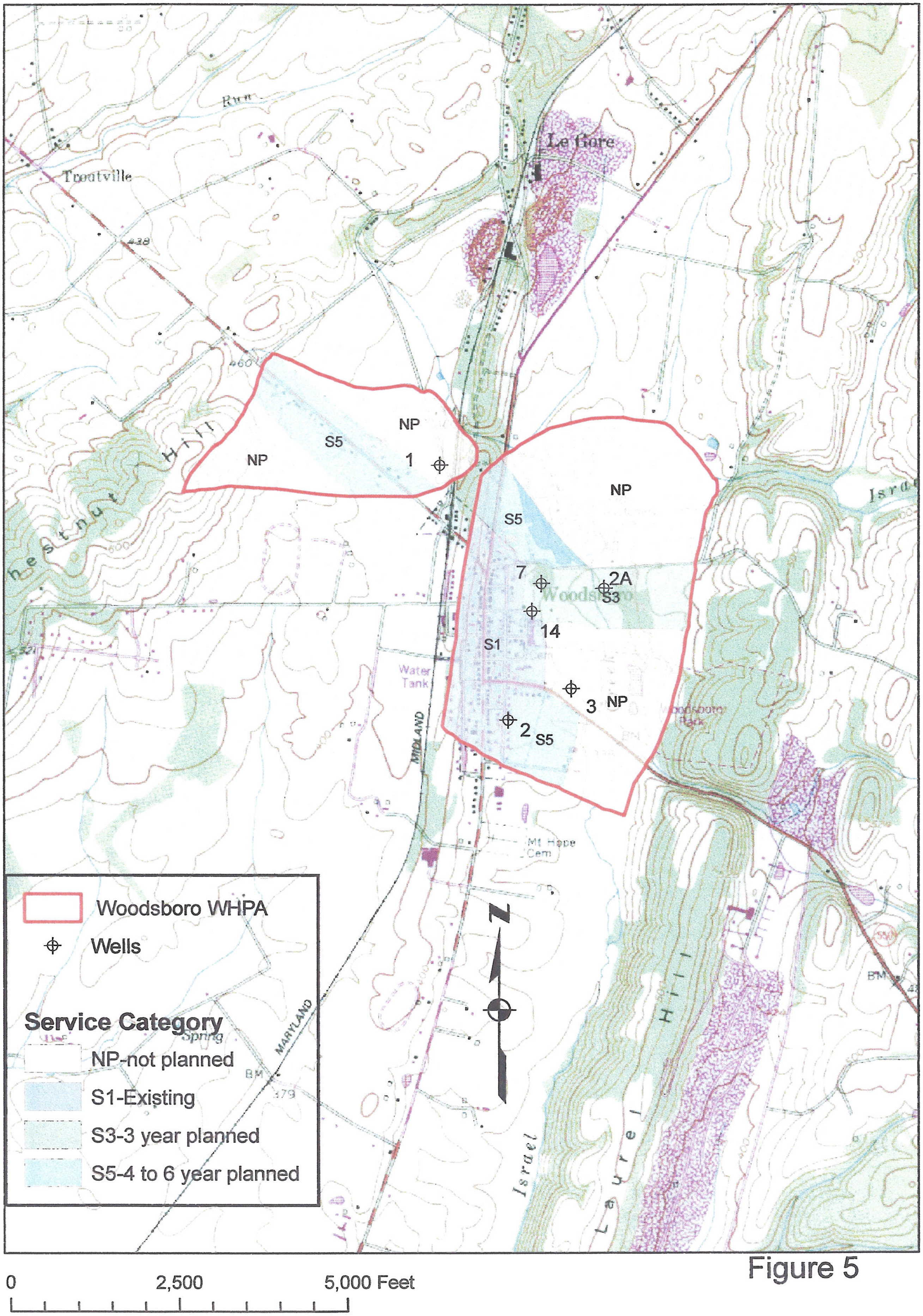

Figure 5

Woodsboro Dye Trace Map

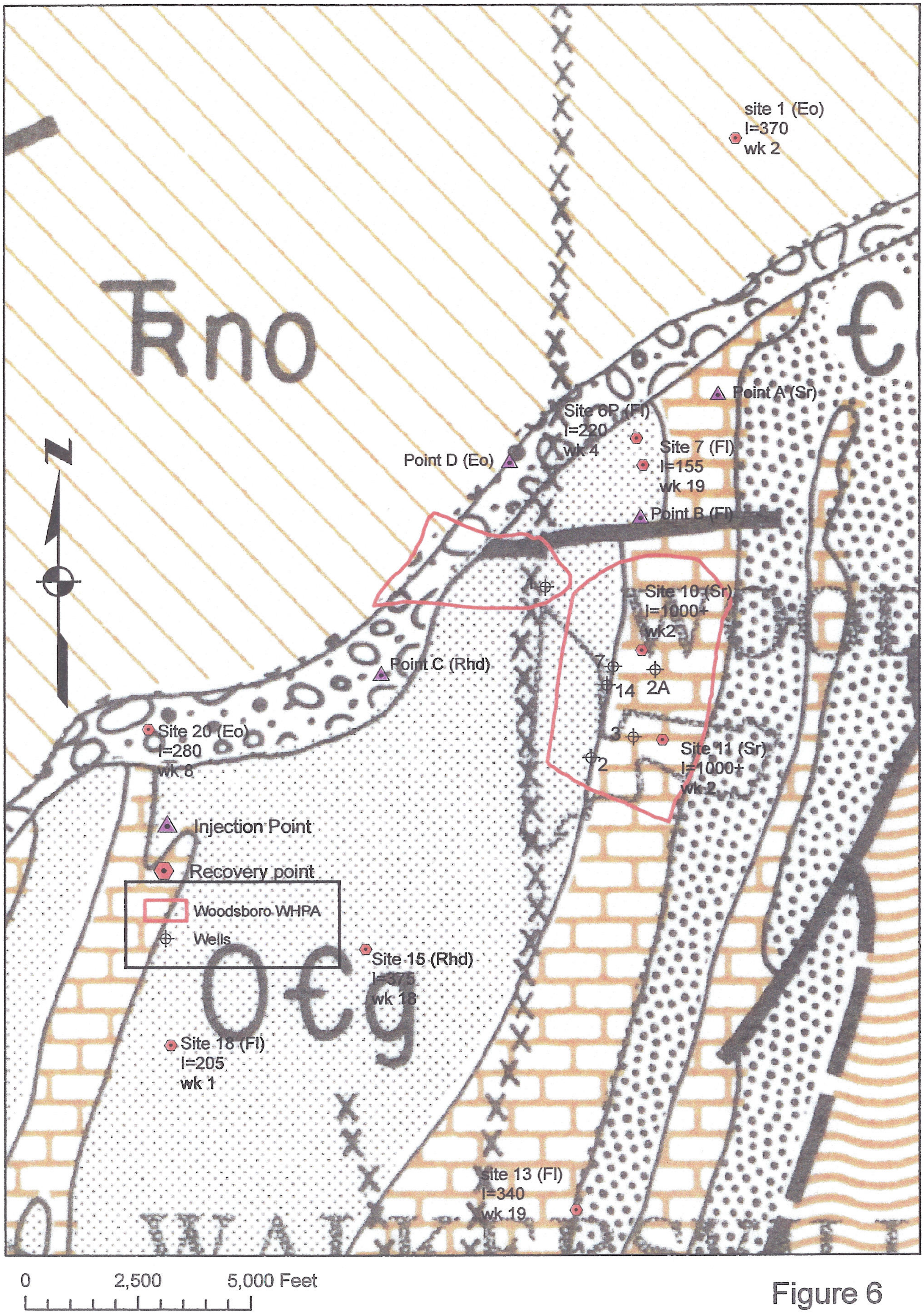

Figure 6