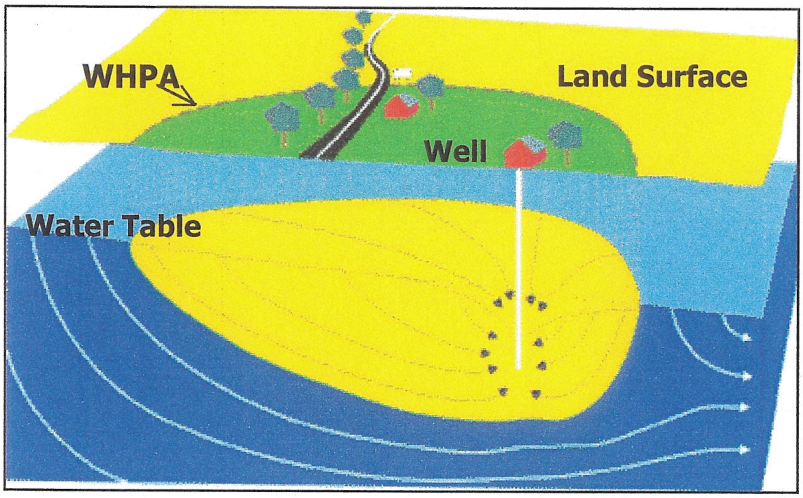
SOURCE WATER ASSESSMENT

FOR THE WORTON WATER SUPPLY

KENT COUNTY, MD



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Water Management Administration
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MDE

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SUMMARY

The Maryland Department of the Environment's (MDE) Water Supply Program has conducted a Source Water Assessment for the Worton Water System. The major components of this report as described in Maryland's Source Water Assessment Plan (SWAP) are: 1) delineation of an area that contributes water to the source, 2) identification of potential sources of contamination, and 3) determination of the susceptibility of the water supply to contamination. Recommendations for management of the assessment area conclude this report.

The source of the Worton water supply is an unconfined aquifer in the Coastal Plain. Three wells are currently being used to pump the water out of the aquifer. A fourth well is not in use. The source water assessment area was delineated by the Water Supply Program using a method approved by the U. S. EPA.

Potential sources of contamination within the assessment area were identified based on MDE site visits, a review of MDE's databases and land use maps. Well information and water quality data were also reviewed. Figures showing sites of potential contamination land uses and sewer service areas within the Source Water Assessment Area. An aerial photograph of the well locations is enclosed at the end of the report.

The susceptibility analysis for the Worton water supply is based on a review of the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. It was determined that the Worton water supply is susceptible to volatile organic compounds but not susceptible to inorganic compounds, synthetic organic compounds, radiological compounds or microbiological contaminants.

INTRODUCTION

The Worton Water System serves the communities of Worton and Butlertown in Kent County. The water treatment plant and the supply wells are located in Worton, which is approximately 4 miles north of Chestertown (figure 1). The Worton Water System is owned and operated by the Kent County Department of Water and Wastewater Services and serves a population of 805. Currently, the water is being supplied by three wells (Nos. 2, 3 and 4). Well No. 1 is not in service due to a drop in yield.

WELL INFORMATION

A review of the well data and sanitary surveys of the system indicates that Well Nos. 1, 2 and 3 were drilled in 1981and Well No. 4 in 1994 in accordance with the State's current well construction standards, which were implemented in 1973. Currently, the pumping rate for Well Nos. 3 and 4 is 27 gallons per minute (gpm) and 50 gpm for Well No. 2. Table 1 contains a summary of the well construction data.

SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH	CASING DEPTH	AQUIFER
01	Worton 1	KE731164	65'	40'	Aquia Formation
02	Worton 2	KE731165	65'	40'	Aquia Formation
03	Worton 3	KE731166	65'	40'	Aquia Formation
04	Worton 4	KE 920022	63'	40'	Aquia Formation

Table 1. Worton Well Information.

HYDROGEOLOGY

The Worton wells pump water from the sediments of the Aquia Formation of the Coastal Plain. In the Worton area, the Aquia is an unconfined aquifer with the top of the aquifer about 45 feet above sea level and bottom about 8 feet below sea level. The Aquia aquifer is a fine to coarse, glauconitic quartz sand, which locally contains clayey layers, shell beds, cemented zones, and highly weathered zones (Drummond, 1998).

In the Worton area, the transmissivity of the Aquia aquifer is 700 ft^2/day, the ground water flow direction is towards the southeast and the gradient is 0.0003.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered to be the source water assessment area for the system. The WHPA was delineated using the methodology described in Maryland's Source Water Assessment Plan (MDE, 1999). Since the Worton Water System uses an unconfined Coastal Plain aquifer and the average pumpage >10,000 gallons per day, the WHPA was delineated using EPA's WHPA Code

ground water model. The permitted daily average withdrawal for Worton is 67,000 gallons per day (8957 ft^3/day). This permitted quantity was divided equally among the four Worton wells for the modeling.

Delineation Zones

Zone 1: Zone 1 is the WHPA delineated using a 1-year time-of-travel (TOT) criterion. Zone 1 serves as the first zone of protection. The one-year criterion was selected base on the maximum known survival times of microbial organisms in ground water. The delineated Zone 1 WHPA is an oval shaped area with a maximum diameter of 600 feet. It is the combination of the Zone 1 areas for the four wells.

Zone 2: Zone 2 is the WHPA delineated using a 10-year TOT criterion. It would take any chemical contaminant present at the Zone 2 boundary 10 years to reach the well (if it moves at the same rate as the ground water). Zone 2 provides adequate time for facilities outside the WHPA to address chemical contamination before it could reach the well. The Zone 2 WHPA is also an oval shaped area with a maximum diameter of 1400 feet. It is the combination of the Zone 2 areas for the four wells.

POTENTIAL SOURCES OF CONTAMINATION

For this assessment, MDE Waste and Water Management databases were reviewed and a field inspection conducted to identify potential for any direct injection of contaminants into the aquifer in and around the Worton WHPA. The only potential point source of contamination that was identified is a welding shop adjacent to the well field and located at the boundary of Zone 1. Inspection of this facility by MDE Ground Water Permits Division staff indicated that there were no unpermitted discharges into ground water. Mr. Robert Sipes, Chief Operator for the Worton Water System, has talked to the owner of the facility about pollution prevention, and informally observes activities for potential risks to the supply wells.

Non-point sources of contamination are usually associated with land use activities in the area. Based on the Maryland Office of Planning 1997 Land Use Map, five land use categories were identified in the WHPA (table 2). Figure 3 shows the land use in and around the Worton WHPA. In Zone 1 the land use is approximately 55% commercial and 45% residential, respectively. Cropland makes up the largest portion of the WHPA (45.3%). Use of fertilizers and pesticides for crop production could result in migration of nitrate and synthetic organic compounds to the wells. The wells are located adjacent to Worton Road (MD 297) and railroad tracks and may be vulnerable contamination from accidental spills along these transportation corridors.

LAND USE CATEGORIES	TOTAL AREA (acres)	PERCENTAGE OF WHPA
Low Density Residential	2.98	13.6
Medium Density Residential	1.16	5.3
Commercial	4.04	18.3
Cropland	9.94	45.3
Open Urban	3.86	17.5

Table 2. Land Use Summary for the Worton WHPA (Zone 2).

A review of the 1995 Kent County Sewer Map shows that 58 % of the WHPA has sewer service with no planned service for the rest of the area (figure 4).

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database and system files for Safe Drinking Water Act contaminants. The data described is for finished (treated) water unless otherwise noted. The treatment currently used at Worton is disinfection, pH adjustment for corrosion control, and aeration, coagulation, flocculation, sedimentation and filtration for iron removal.

MDE personnel discussed water quality issues and concerns with Mr. Robert Sipes. Mr. Sipes indicated that the only water quality concern that he had was the presence of iron in the raw water. A review of the monitoring or data since 1993 for Worton's finished water indicates that the system's water supply currently meets the drinking water standards.

Inorganic Compounds (IOCs)

No IOCs above 50% of the MCL have been detected in the Worton water supply since 1993. Table 3 lists the IOCs that have been detected in the water supply since 1993.

CONTAMINANT ID	CONTAMINANT NAME	MCL (ppm)	SAMPLE DATE	RESULT (ppm)
1040	NITRATE	10	19-Jan-93	2.3
1040	NITRATE	10	25-Jan-94	1.43
1010	BARIUM	2	15-Aug-94	0.107
1025	FLUORIDE	4	15-Aug-94	0.28
1055	SULFATE	none	15-Aug-94	21
1025	FLUORIDE	4	17-Jan-96	0.14
1055	SULFATE	none	17-Jan-96	39.4
1040	NITRATE	10	17-Jan-96	0.4
1040	NITRATE	10	3-Jun-97	4
1040	NITRATE	10	6-Jan-98	1
1025	FLUORIDE	4	9-Mar-99	0.14
1052	SODIUM	none	9-Mar-99	62.5
1025	FLUORIDE	4	18-Jan-00	0.22

Table 3. IOC results for the Worton water supply.

MCLs have not been established for sodium and sulfate. Sulfate has a secondary standard of 250 ppm. Secondary standards are levels established to indicate when taste, odor or color of the water may be offensive.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in the Worton water supply from 16 samples collected since 1993. The only VOC detected was carbon tetrachloride at 0.9 ppb in a sample collected on March 13, 1997. The MCL for carbon tetrachloride is 5 ppb.

Also detected in six samples taken between 1994 and 2001 were disinfection by-products know as trihalomethanes – bromodichloromethane, bromoform, chloroform, and dibromochloromethane. Trihalomethanes are currently regulated only for systems serving a population of over 10,000. New regulations will apply a MCL of 80 ppb for the total of the four above-mentioned VOCs for all community water systems. The total concentrations of the four trihalomethanes in the Worton water supply range from 0.6 ppb to 5.7 ppb. Disinfection by-products are the result of a reaction between chlorine used for disinfection and organic material in the water supply. The low levels indicate that little organic compounds are present in the water supply.

Synthetic Organic Compounds (SOCs)

The only SOC detected above 50% of the MCL from samples of the Worton water supply since 1993 was di (2-ethylhexyl) phthalate at 9.7 ppb in a sample collected on January 17, 1995. The MCL for phthlate is 6 ppb. Phthalate was found in laboratory blanks in samples collected that day and therefore these results do not represent water quality. 2, 4-D (dichlorophenoxy acetic acid) was detected at 4.9 ppb in a sample collected on February 3, 1994. The MCl for 2, 4-D is 70 ppb.

Radionuclides

No radionuclides above 50% of the MCL were detected in the Worton water supply since 1993. Table 4 lists the radionuclides detected in the Worton's water supply since 1993. Currently there is no MCL for radon-222, however EPA has proposed an MCL of 300 picoCuries per liter (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.

CONTAMINANT ID	CONTAMINANT NAME	MCL (pCi/L)	SAMPLE DATE	RESULT (pCi/L)
4100	GROSS BETA	50	13-Mar-97	4
4004	RADON-222	300 /4000 (proposed)	22-Feb-00	680
4000	GROSS ALPHA	15	26-Feb-01	1
4100	GROSS BETA	50	26-Feb-01	6

Table 4. Radionuclide results for the Worton water supply.

Microbiological Contaminants

Raw water samples were collected from each well for bacteriological testing to assist in determining whether these sources are Ground Water Under the Influence of Surface Water. No total or fecal coliform was detected in the water supply.

SUSCEPTIBILITY ANALYSIS

Worton's wells obtain water from an unconfined aquifer. In general, water supplies in unconfined aquifers are susceptible to contamination from land use activities in the wellhead protection area. Well completion reports indicate the presence of thin clay layers and lenses between the surface and the well screen. The clayey sediments may inhibit the infiltration of some of the surface contaminants into the aquifer. Continued routine monitoring of contaminants is essential in assuring a safe drinking water supply. The information that was used to conduct the susceptibility analysis is as follows: (1) available water quality data (2) presence of potential contaminant sources in the WHPA (3) aquifer characteristics (4) well integrity and (5) the likelihood of change to the natural conditions.

Inorganic Compound (IOCs)

Nitrates have been detected in the Worton water supply since 1993 at levels well below the MCL. There appears to be no increase in nitrate levels in the water supply. Sources of nitrate can be traced to land use. No IOCs above 50% of the MCL have been detected in the Worton water supply. Nitrate levels detected are probably background levels found in the aquifer. Barium, arsenic, sulfate and iron are naturally occurring minerals in the aquifer material. The sodium may be the result of the treatment process or road salt applications.

Based on the above analysis, the Worton water supply is **not** susceptible to IOC contamination.

Volatile Organic Compounds (VOCs)

Carbon tetrachloride and MTBE have been detected in the Worton water supply. Carbon tetrachloride is an organic solvent and has many applications. One possible source of this VOC may be the welding shop adjacent to the well field.
MTBE is an additive to gasoline. It promotes clean burning of the fuel. No underground storage tanks or known VOC contamination cases have been identified in the WHPA. The Worton wells are located adjacent to a major highway and an intersection. Spillage or highway runoff maybe the sources of the MTBE.

Based on the above analysis, the Worton water supply **is** susceptible to VOC contamination.

Synthetic Organic Compounds (SOCs)

2, 4-D, which is an herbicide, has been detected one time in the Worton water supply. The amount detected was less that 10% of the MCL. Improper application of

pesticides for crop production and landscaping of residential and commercial properties can become a source of SOCs for the water supply.

With no point sources present in the WHPA and a lack of significant levels of SOCs in the water supply, in spite of the significant percentage of land in crop production, it is apparent that the Worton water supply is **not** susceptible to SOC contamination. Clayey layers in the upper portion of the aquifer also serve to retard the migration of any organic chemicals used on the land surface.

Radionuclides

Gross alpha, gross beta and radon-222 have been detected in the Worton's water supply. Gross alpha and gross beta were detected well below the MCL, but there is no MCL for radon-222 at present. The presence of these contaminants is attributed to decay of naturally occurring minerals like uranium in the aquifer sediments.

Based on the above analysis the Worton water supply is **not** susceptible to the other radionuclides.

Microbiological Contaminants

Based on coliform sampling data and the aquifer characteristics, the Worton water supply is **not** susceptible to protozoans or bacteriological contaminants. The wells may be susceptible to viral contaminants, as these are much smaller, can survive longer, and may not be effectively filtered by the aquifer as protozoans and bacteria. Future monitoring will be needed to determine susceptibility to viruses.

MANAGEMENT OF THE WHPA

Form a Local Planning Team

- The team should represent all the interests in the community. The County Department of Water and Wastewater, the County Health Department, local planning agencies, local businesses, residents, developers and farmers within and near the WHPA should work to reach a consensus on how to protect the water supply.

Increase Public Awareness

- Pamphlets, flyers and bill stuffers sent to local residents, businesses, and farmers will help educate the general public about Wellhead Protection.
- Placing signs at the WHPA boundaries is a good way to make the public aware of protecting their source of water supply.

Conduct Monitoring

- Continue sampling as required by the Safer Drinking Water Act.
- Annual sampling for microbiological contaminants of untreated supply is a good check on well integrity.

Plan and Zone to Protect the Water Sources

- Ensure that any new development (residential and commercial) within the WHPA is sewered to protect the ground water against microbiological contaminants, excessive nitrates and chemicals from household wastes.
- The County Department of Water and Wastewater should work with the County Planning Department to consider countywide wellhead protection implementation. The State's *Model Wellhead Protection Ordinance* can be used to assist in this process. Grants are also available from MDE for wellhead protection projects.

Purchase Conservation Easements or Property

- Loans are available for the purchase of property or for the purchase of easements for the protection of the water supply. Eligible property must lie within the designated WHPA. Loans are currently offered at zero percent interest and zero points. Please contact the Water Supply Program for more information.

Prepare Contingency Plan

- Comar 26.04.01.22 regulations require all community water systems to prepare and submit for approval a plan for providing a safe and adequate drinking water supply under emergency conditions.

Changes in Sources

- Any increase in pumpage or the addition of new wells to the system will require revision of the WHPA since it is affected by pumpage. It is recommended the system contact the MDE Water Supply Program when an increase in pumpage is applied for or when new proposed wells are being considered.

Manage Potential Contaminant Sources and Wells

- Conduct a detailed survey to ensure that there are no other potential or historical sources of contamination within or adjacent to the WHPA.
- Water operation personnel should have a regular inspection and maintenance program for the wells to ensure their integrity and to protect the aquifer from surficial contamination.

REFERENCES

Drummond, D. D., 1998, Hydrogeology, Simulation of Ground-Water Flow, and Ground-Water Quality of the Upper Coastal Plain Aquifers in Kent County, Maryland: Maryland Geological Survey Report of Investigations No. 68, 76 p.

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

Tompkins, M. D., Cooper, B. F., and Drummond, D. D., 1994, Ground-Water and Surface-Water Data for Kent County, Maryland: Maryland Geological Survey Basic Data Report No. 20, 155 p.

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

SOURCES OF DATA

Water Appropriation and Use Permit No. KE 1979G005
Public Water Supply Inspection Reports
Monthly Operating Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database
Department of Natural Resources Digital Orthophoto Quarter Betterton 3-25-95
USGS Topographic 7.5Minute Quadrangle – Betterton
Maryland Office of Planning 1997 Kent County Land Use Map
Maryland Office of Planning 1995 Kent County Sewer Map

FIGURES

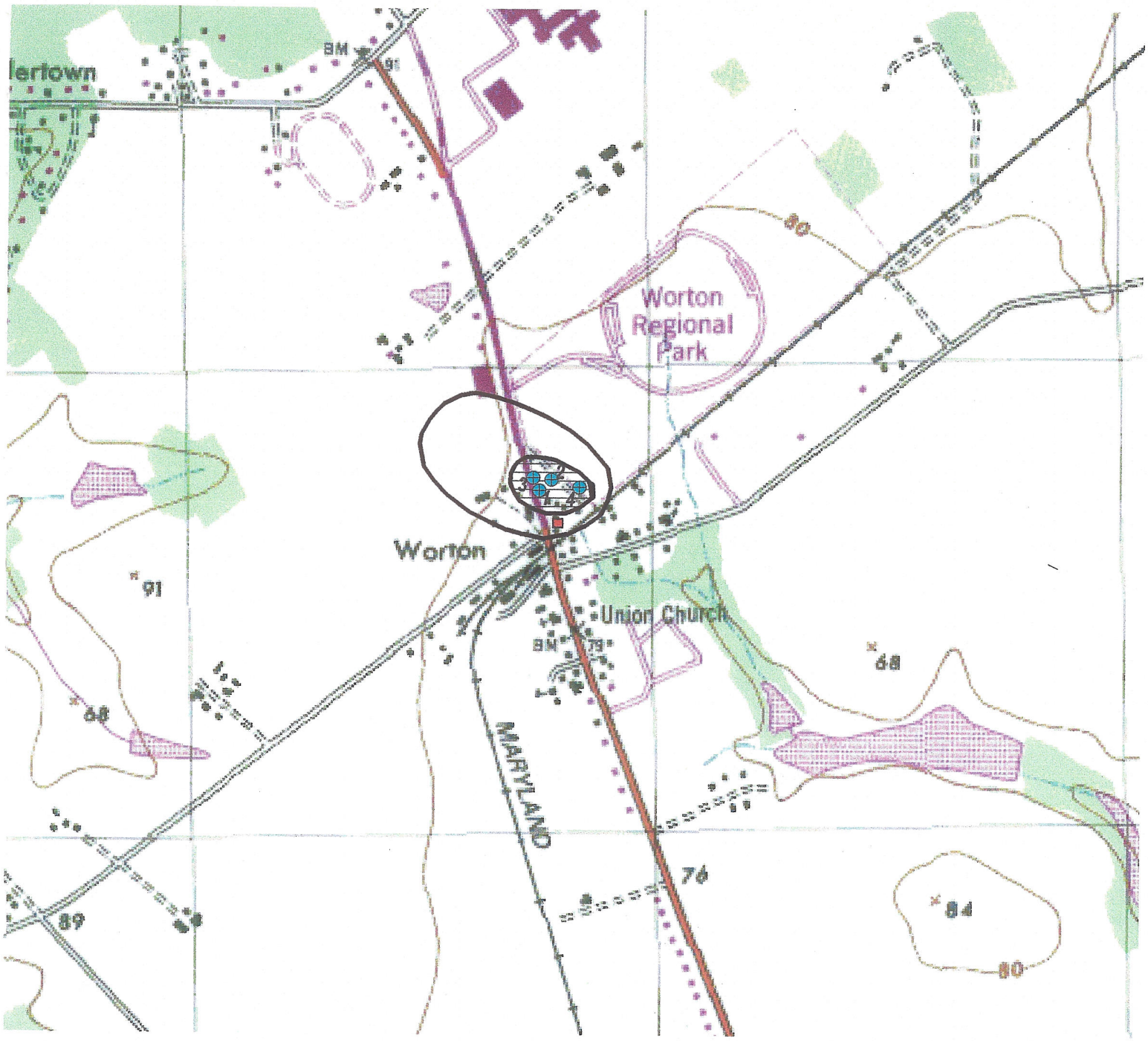

Figure 2. Worton Wellhead Protection Area with Potential Contaminant Sites

LEGEND

Wellhead Protection Area
- Zone 1
- Zone 2

Supply Wells

Commercial facility.shp

1000 0 1000 Feet

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Base Map: USGS Topographic 7.5 Minute Quadrangle - Betterton, MD

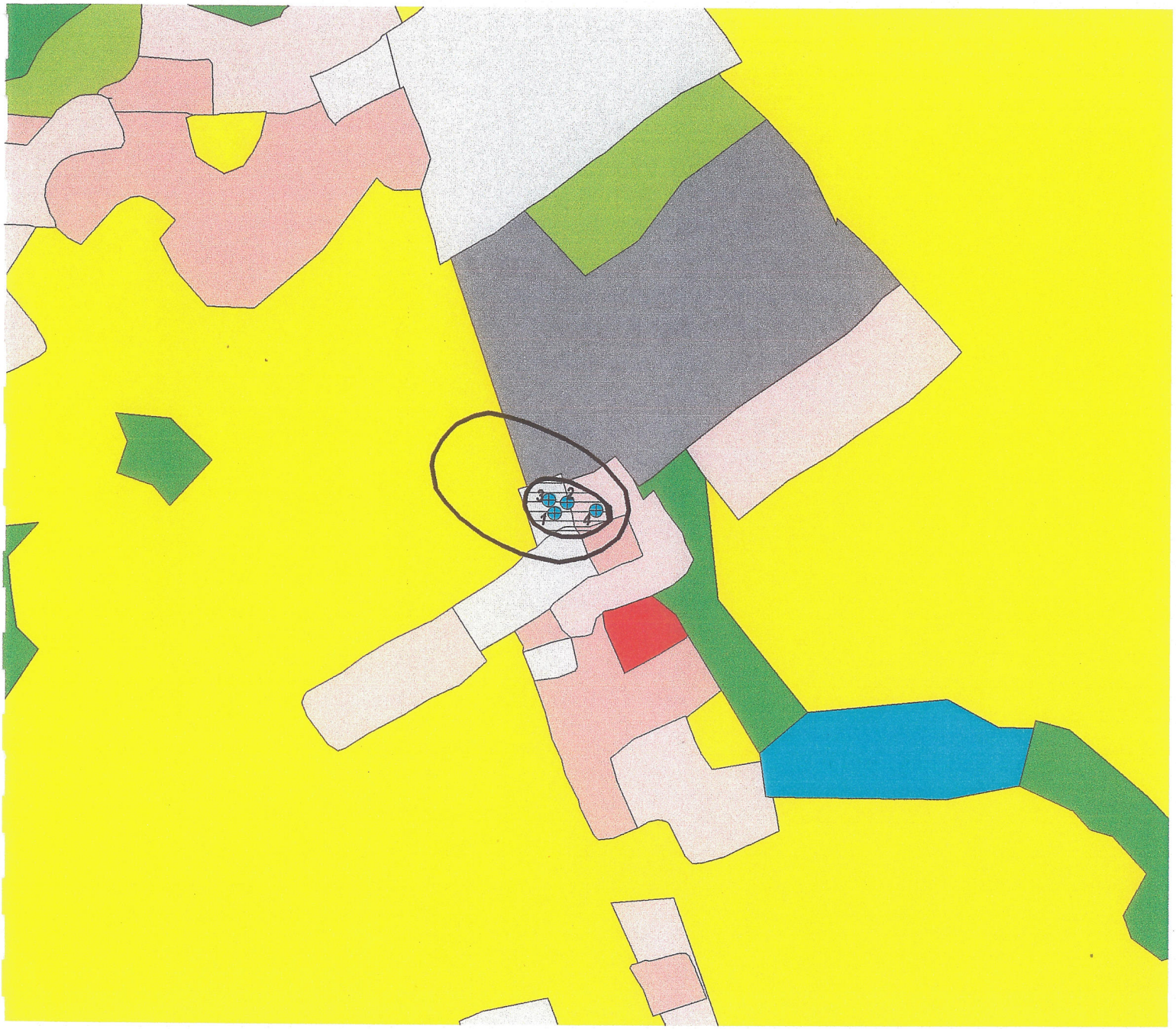

Figure 3. Land Use Map fo the Worton Wellhead Protection Area

LEGEND

Land Use Categories

- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Open Urban Land
- Cropland
- Pasture
- Forest
- Water

Wellhead Protection Area

- Zone 1
- Zone 2
- Supply Wells

1000 0 1000 Feet

N

Source: MD Office of Planning 1997
Kent County Land Use Map

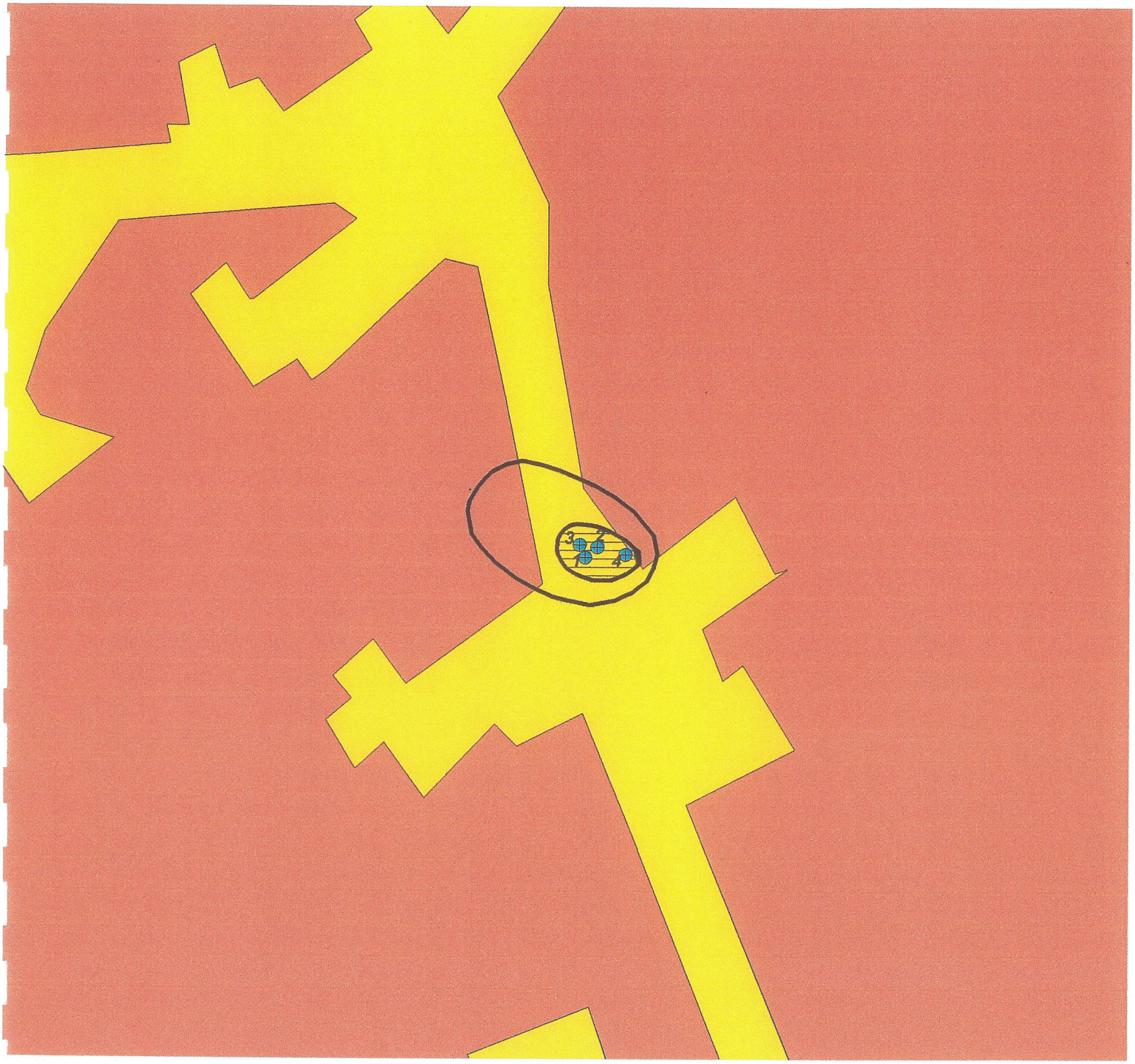

Figure 4. Sewer Service Map of the Worton Wellhead Protection Area

LEGEND

Sewer Service Categories

- No Planned Service
- Existing Service

Wellhead Protection Area

- Zone 1
- Zone 2
- Supply Well

1000 0 1000 Feet

N

Source: MD Office of Planning 1995 Kent County Sewer Map