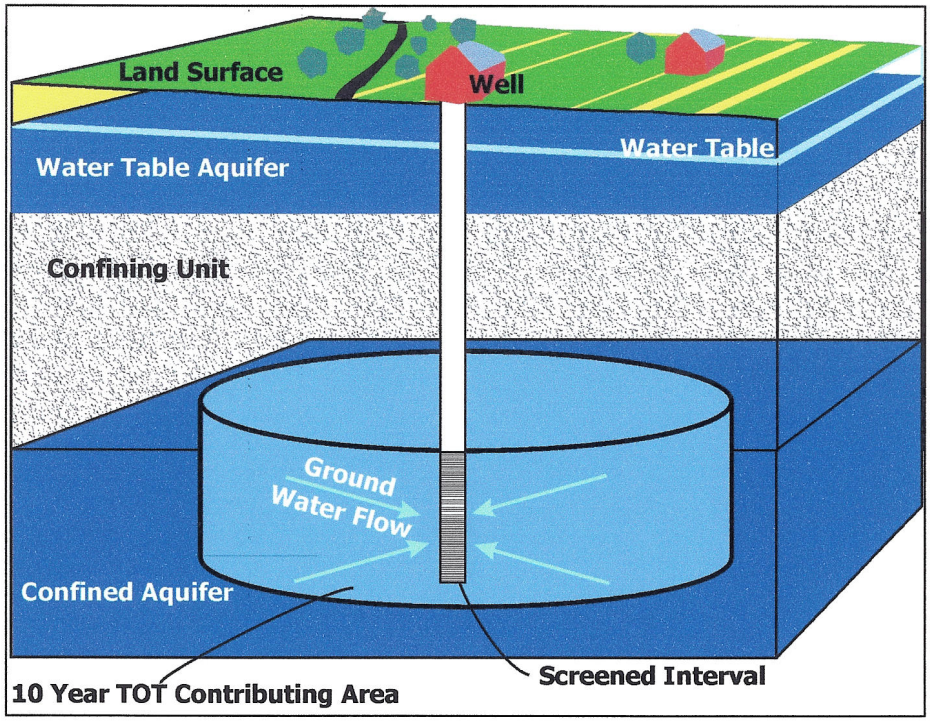
SOURCE WATER ASSESSMENT

FOR THE TOWN OF BETTERTON

KENT COUNTY, MD



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Maryland Department of the Environment
Water Management Administration
Water Supply Program
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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 Town of Betterton. The required 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 protecting the drinking water supply conclude this report.

The source of Betterton's water supply is an unconfined aquifer in the Coastal Plain known as the Magothy aquifer. The system uses two wells to obtain its drinking water. The Source Water Assessment Area was delineated by the Water Supply Program using an U.S. EPA approved method specifically designed for these sources.

Potential sources of contamination within the assessment area were identified based on MDE site visits, database reviews and land use maps. Well information and water quality data were also reviewed. Figures showing land uses and potential contaminant sources within the Source Water Assessment Area and an aerial photograph of the well locations are located at the end of the report.

The susceptibility analysis for Betterton's water supply is based on the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. It was determined that Betterton's water supply is not susceptible to contamination by inorganic compounds, volatile organic compounds, synthetic organic compounds, radionuclides or microbiological contaminants.

INTRODUCTION

The Town of Betterton is located about 10 miles north of Chestertown in Kent County. The Town's water supply system serves a population of 300 and has 270 connections. Currently, the water is supplied by two wells (Nos. 1 and 2) that are pumped alternately and their locations are shown in figure 1.

WELL INFORMATION

A review of the well completion report and sanitary surveys of the Betterton water system indicates that both Well Nos. 1 and 2 were drilled in 1969 prior to the implementation of the State's current well construction regulations. Well completion reports indicate that the Well No. was grouted with cement upto a depth of 80 feet. There is no information on grouting for Well No. 2. Pumping tests conducted after the wells were drilled indicated that Well Nos. 1 and 2 had yields of 75 and 134 gallons per minute (gpm), respectively. Table 1 contains a summary of the well construction data.

SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH	CASING DEPTH	AQUIFER
01	BETTERTON 1	KE690069	160'	115'	MAGOTHY FORMATION
02	BETTERTON 2	KE690070	120'	85'	MAGOTHY FORMATION

Table 1. Betterton Well Information.

HYDROGEOLOGY

Betterton's wells obtain water from the Magothy aquifer, which outcrops in the cliffs near Betterton. In the Betterton area the top of the Magothy is at sea level (about 85 feet below ground) and the bottom at around 50 feet below sea level (135 ft. below ground. The Magothy Formation comprises two lithofacies in Kent County, light-colored lignitic sand and a light-to dark-gray carboniferous silt-clay. The sand is white to yellowish brown, fine to coarse-grained quartz. The clay-silt occurs as thin horizontal layers which interfinger with the sandy layers, to massive layers (Drummond, 1998).

Based on a potentiometric surface map (Drummond, 1998), the predominate ground water flow direction was determined to be towards the north with a gradient of 0.0019. The transmissivity of the aquifer is 2000ft^2/day and a porosity of 25% was assumed for the aquifer.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. WHPAs were delineated for Betterton's supply wells using EPA's WHPA Code version 2.0, a user-friendly two-dimensional ground water flow model. The permitted daily average for Betterton is 50,000 gallons per day (6684ft^3/day). This was the quantity used for the model, with each well assigned half the permitted amount.

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 areas for each well are oval in shape and with a maximum diameter of 300 feet.

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 areas for the two wells were combined into a larger Zone 2 since the areas were influenced well pumpage. This area was then modified to take into account topography and uncertainty in ground water flow direction (figure 2). The delineated Zone 2 WHPA is triangular shaped and has an area of 52 acres.

POTENTIAL SOURCES OF CONTAMINATION

For this assessment, MDE Waste and Water Management databases were reviewed, staff consulted, and field inspections conducted, to identify potential sources of contamination in and around the Betterton WHPA. A follow up field survey of the WHPA was conducted in March 2001 and MDE staff also met Mr. Kippe Mathews, Assistant Operator of the system.

Potential sources of contamination that were identified in the WHPA were an underground storage tank (UST) and a sewer line (figure 2). The UST is a 550-gallon tank used for storing heating oil and currently in compliance with the State's UST regulations. The sewer line is a terra cotta line located about 100 feet from Well No. 2 and carries domestic wastes to the wastewater treatment plant.

Non point sources of contamination are usually related to land use activities. Based on the Maryland Office of Planning's 1997 Land Use map, three land uses were found in the Betterton WHPA. They are listed in table 2 below.

LAND USE CATEGORIES	TOTAL AREA (acres)	PERCENTAGE OF WHPA
Low Density Residential	20.03	38.4
Medium Density Residential	9.80	18.8
Forest	22.28	42.8

Table 2. Land Use Summary for WHPA Zone 2

Figure 3 shows the land use in and around the Betterton WHPA. 75% the land use in Zone 1 is residential with the rest being forest. A field visit indicates that a church, a post office and the Town's water treatment plant are in areas zoned residential within the WHPA. Nitrates and synthetic organic compounds could be potential sources of contaminants to the water supply due to application of fertilizers and pesticides for lawn maintenance and other landscaping activities in the residential properties.

A review of Maryland Office of Planning's Worcester County Sewer Map shows that 39 % of Zone 2 area has sewer service with no planned service for the rest of the area. In Zone 1, 75% of the area has sewer services that are the residential land use areas.

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 from the finished (treated) water unless otherwise noted. The treatment currently used at Betterton is disinfection, corrosion control and iron removal. Sodium hypochlorite is used for disinfection, calcium polyphosphate is used an inhibitor for corrosion control and iron removal, and calcite filters for corrosion control and sand filters for iron removal.

A review of the monitoring data since 1993 for Betterton's finished water indicates that the system's water supply currently meets the drinking water standards.

Inorganic Compounds (IOCs)

Table 3 lists all the IOCs that were detected in Betterton's water supply since 1993. No contaminants have been found to be at levels greater than one-half (50%) of the allowable maximum contaminant level (MCL). MCLs have not been established for sodium, iron or sulfate. The secondary standards for iron and sulfate are 0.3 ppm and 250 ppm, respectively. Secondary standards are levels established to indicate when taste, odor or color of the water may be offensive.

CONTAMINANT ID	CONTAMINANT NAME	MCL (ppm)	SAMPLE DATE	RESULT (ppm)
1040	NITRATE	10	23-Jun-93	1.4
1010	BARIUM	2	18-Sep-93	0.033
1040	NITRATE	10	16-Feb-94	1.5
1052	SODIUM	none	16-Feb-94	13.7
1040	NITRATE	10	18-Dec-94	1.4
1040	NITRATE	10	31-Oct-95	1.86
1055	SULFATE	none	18-Mar-97	4.6
1040	NITRATE	10	18-Mar-97	2.1
1052	SODIUM	none	18-Mar-97	48.7
1041	NITRITE	1	18-Mar-97	0.002
1040	NITRATE	10	16-Dec-98	2.8
1040	NITRATE	10	29-Dec-99	1.96
1040	NITRATE	10	25-Mar-00	2.6
1052	SODIUM	none	25-Mar-00	17.2
1028	IRON	none	25-Mar-00	0.12

Table 3. IOC results for the Betterton water supply

Volatile Organic Compounds (VOCs)

No VOCs have been found to be at or above 50% of the MCL from monitoring Betterton's water supply since 1991. Methylene chloride was the only VOC detected since VOC testing was initiated. Two (2) parts per billion (ppb) were reported from a sample collected on November 2, 1991. The MCL for methylene chloride is 5 ppb. This detection was attributed to a laboratory error, since this compound is used to clean laboratory equipment and was found in samples collected from other locations that day, and was never found in repeat samples.

Synthetic Organic Compounds (SOCs)

No SOCs have been detected in Betterton's water supply since sampling began in 1993.

Radionuclides

Table 4 lists the radionuclides that have been detected at levels below 50% of the MCL. No radionuclides above 50% of the MCL have been detected in the Betterton water supply. Currently there is no MCL for radon-222; however, EPA proposed an MCL of 300 picoCuries per liter (pCi/L) and an alternate MCL of 4000 pCi/L, which could apply if the State has a program to address the more significant risk of radon from indoor air.

CONTAMINANT ID	CONTAMINANT NAME	MCL (pCi/L)	SAMPLE DATE	RESULT (pCi/L)
4100	GROSS BETA	50	18-Mar-97	2
40AS	GROSS ALPHA (SHORT TERM)	15	27-Aug-98	4.3
4004	RADON-222	300/4000 proposed	28-Mar-00	35

Table 5. Radionuclide results for the Betterton water supply.

Microbiological Contaminants

A composite raw water bacteriological sample was collected from Betterton's two supply wells on 12/16/98 to assist in determining whether these sources were Ground Water Under the Direct Influence of Surface Water (GWUDI). The results were negative for the presence of total and fecal coliform for the water supply.

SUSCEPTIBILITY ANALYSIS

Betterton'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 about interbedded clay layers between the surface and the well screen. The clay beds 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.

Inorganic Compounds (IOCs)

Nitrates have been detected in Betterton's 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. Fertilization of residential properties and onsite septic systems are non-point sources of nitrate in ground water. Nearly all the residential properties in the WHPA have public sewer. Barium, sulfate, and iron are naturally occurring minerals in the aquifer sediments.

Based on the above analysis, Betterton's water supply is **not** susceptible to nitrate or other inorganic compounds.

Volatile Organic Compounds

Methylene chloride, the only VOC detected, has been attributed to a laboratory error and does not represent the water quality. The one UST site is used to store heating oil which is not as mobile in ground water as gasoline fuel products.

Based on the above analysis, Betterton's water supply is **not** susceptible to VOCs.

Synthetic Organic Compounds (SOCs)

No SOCs have been detected in the Town's water supply since 1993. Improper application of pesticides for landscaping residential properties can become sources of SOCs for the water supply.

Based on the above analysis, Betterton's water supply is **not** susceptible to SOC contamination.

Radionuclides

Gross alpha and gross beta radiation were each detected one time at levels well below 50% of the MCL. Radon-222 was detected one time at a level well below the proposed MCLs. The presence of these contaminants is attributed to the decay of naturally occurring minerals like uranium in the aquifer sediments.

Based on the above analysis Betterton's water supply is **not** susceptible to radionuclides.

Microbiological Contaminants

Based on coliform sampling data, Betterton's water supply was determined **not** to be 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 water supplier, residents, the County Health and Planning Departments, local businesses, and farmers should work to reach a consensus on how to protect the water supply.

Increase Public Awareness

- Pamphlets, flyers or bill stuffers sent to local residents, businesses, schools, and farmers would help educate the general public about Wellhead Protection. A MDE pamphlet entitled "Gardening in a Wellhead Protection Area" is such an example (copy enclosed).
- Placing road 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 Safe Drinking Water Act.
- Annual sampling for microbiological contaminants of the 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 State's M*odel Wellhead Protection Ordinance* should be adopted with the cooperation of County Planning to minimize risks from new development to impact the Town's wells. A copy of the model ordinance can be obtained from County Planning or MDE's Water Supply Program.

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. Preservation of the forested land within the wellhead protection area will serve an excellent preventative measure to ensure the protection of the Town's 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 that Betterton contact the MDE Water Supply Program when an increase in pumpage is applied for or when new proposed wells are being considered.

Manage Potential Contamination Sources and Wells

- Betterton should conduct its own detailed survey to ensure that there are no other potential sources of contamination within or adjacent to the WHPA.
- Water operation personnel should have a regular inspection and maintenance program for each supply well to ensure its integrity and to protect the aquifer from surficial contamination.
- The Town should also conduct a detailed inspection of the sewer line near Well No. 2 to ensure its integrity and protect the well from leaks in the sewer line.

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 1979G002
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 Quads: Betterton NE and NW 3-25-95
USGS Topographic 7.5Minute Betterton Quadrangle
Maryland Office of Planning 1997 Kent County Land Use Map
Maryland Office of Planning 1995 Kent County Sewer Map

FIGURES

Figure 2. Betterton Wellhead Protection Area with Potential Contaminant Sites

LEGEND

Wellhead Protection Area
- Zone 1
- Zone 2

- Supply Well
- Underground Storage Tank
- Sewer line

1000 0 1000 Feet

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Base Map: USGS Topographic 7.5 minute Betterton Quadrangle

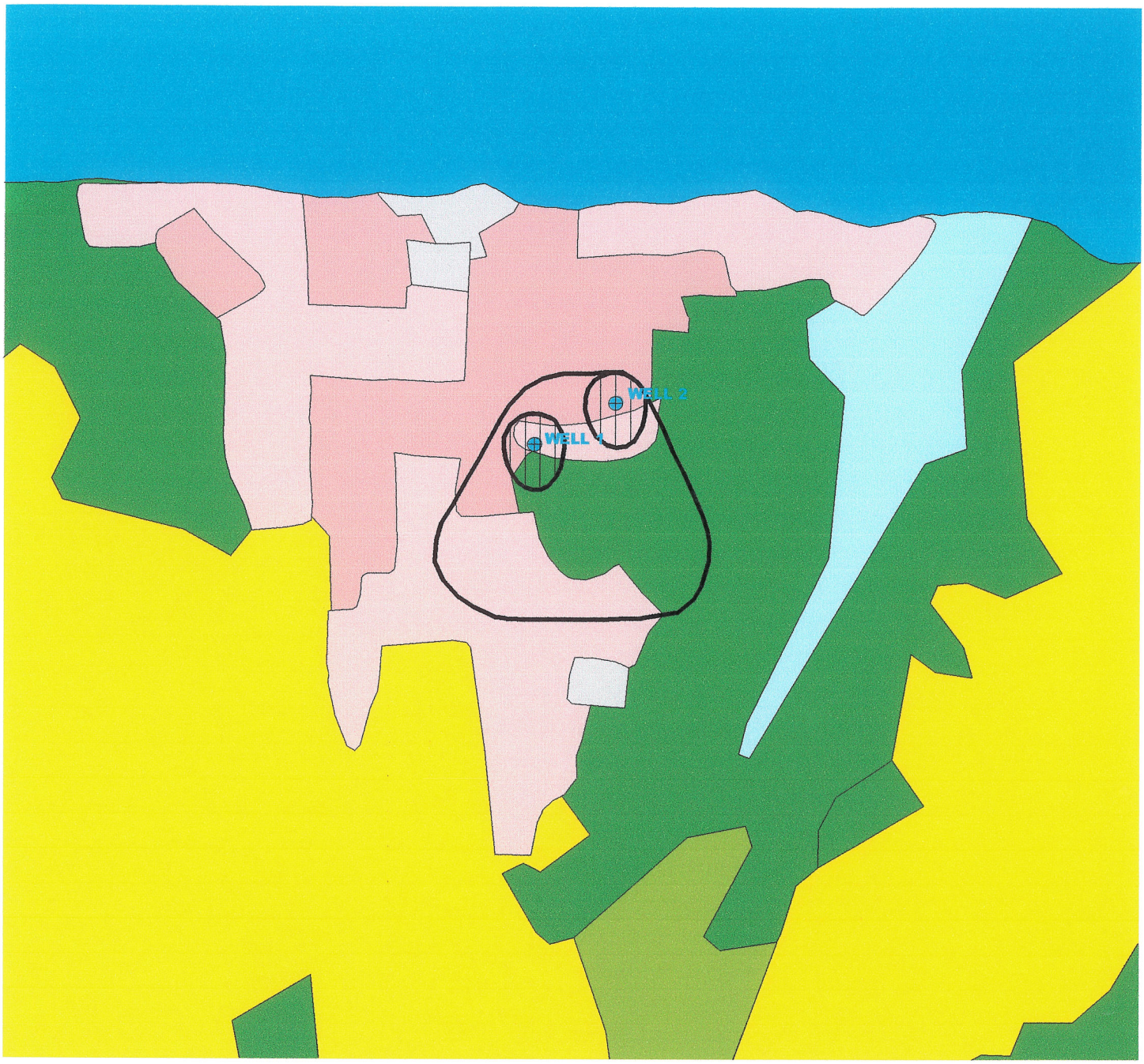

Figure 3. Land Use Map of the Betterton Wellhead Protection Area

LEGEND

Land Use Categories

- Low Density Residential
- Medium Density Residential
- Commercial
- Cropland
- Pasture
- Forest

- Water
- Wetlands

Wellhead Protection Area

- Zone 1
- Zone 2
- Supply Well

1000 0 1000 Feet

N

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

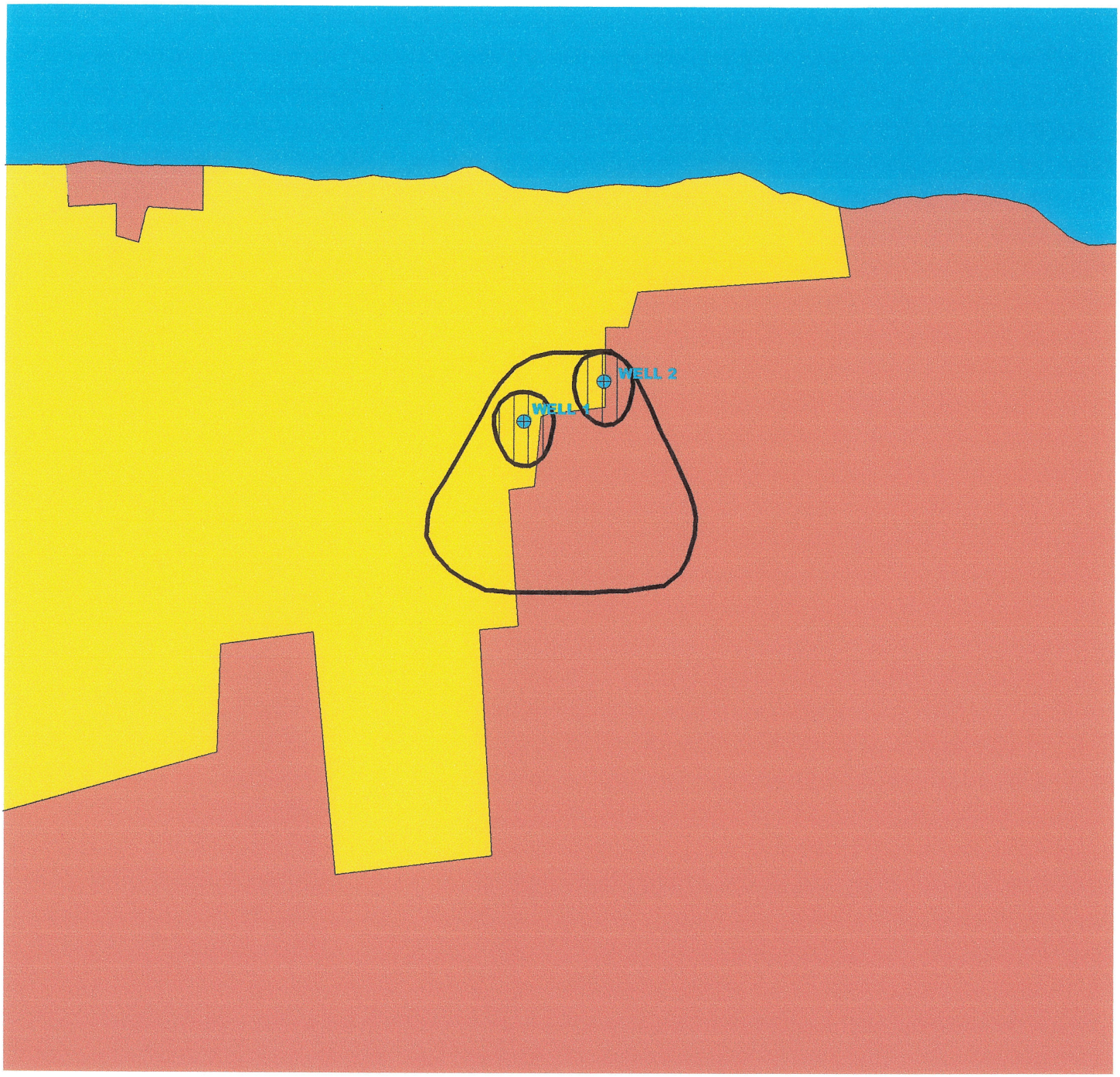

Figure 4. Sewer Service Area Map of the Betterton Wellhead Protection Area

LEGEND

Sewer Service Categories

- No Planned Service
- Exsiting 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