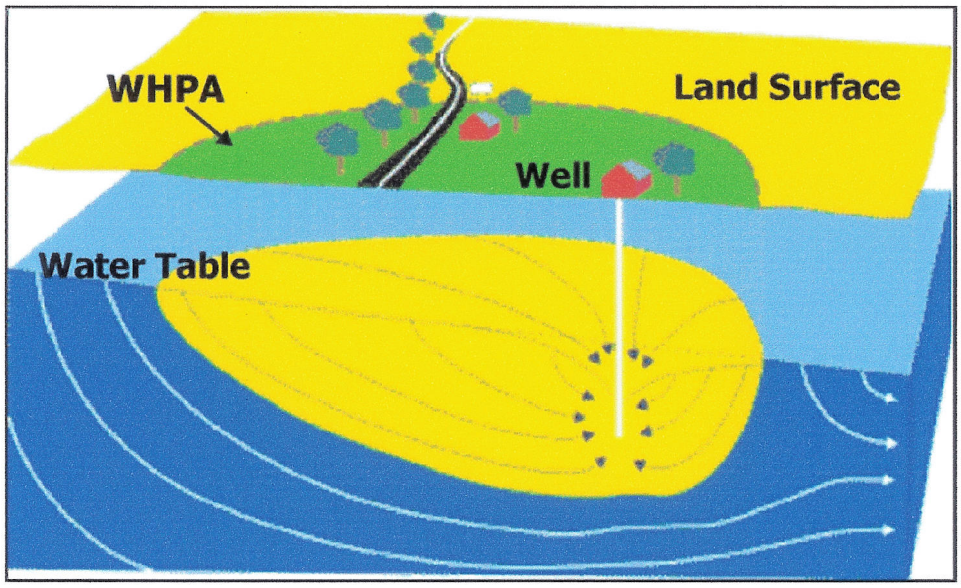
Source Water Assessment
for the Copperfield Water System
Frederick County, Maryland



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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 Copperfield 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 Copperfield's 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 Copperfield water supply is susceptible to some microbiological contaminants. This water supply is not susceptible to inorganic compounds, radiological contaminants, volatile organic compounds, synthetic organic compounds, and surface water microorganisms.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Copperfield water system in Frederick County. The Copperfield community is located approximately eight miles southwest of the City of Frederick. The system currently supplies water to the Copperfield subdivision and the Jefferson wastewater treatment plant on the north side of Route 340. The water system serves a total population of 335 and has 124 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 Copperfield system obtains it water supply from two wells (Table 1). The two production wells are located adjacent to residential properties (Fig. 1). A review of the well completion reports and sanitary surveys of Copperfield's 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	WELL NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	4678 NEWINGTON RD (WELL 1)	FR-81-5790	425	41	1988
02	COPPERFIELD PLANT (WELL 2)	FR-81-5789	425	55	1988

Table 1. Copperfield well information.

The Copperfield water system has an appropriation permit to draw water from the Catoctin Metabasalt formation for an average use of 28,300 gallons per day (gpd) and a maximum of 47,300 gpd in the month of maximum use. Based on the most recent pumpage reports, the average daily use was 26,366 gallons in 1999 and 23,926 gallons in 2000. The months of maximum use for the last two reported years were June 1999 and December 2000 with an average daily use of 37,027 and 26,513 gallons respectively.

HYDROGEOLOGY

Copperfield lies within the Blue Ridge physiographic province, which is bound by Catoctin and South Mountains. The Blue Ridge province is underlain by the oldest sequence of rocks in the County, which is composed of Precambrian gneiss, phyllite, and

metabasalt and forms the core of the South Mountain anticlinorium and is exposed in the Middletown Valley (Duigon and Dine, 1987). The Copperfield wells obtain water from the Catoctin Metabasalt formation, which is an important aquifer in the Middletown Valley due to its aerial extent. The Catoctin Metabasalt is an unconfined, fractured rock aquifer, composed of a dense green crystalline rock believed to be a series of metamorphosed lava flows (Meyer and Beall, 1958). The primary porosity and permeability of this aquifer are small due to the dense nature of the metabasalt. Ground water moves principally through secondary porosity, fractures and joint openings, and is recharged by precipitation percolating through soil and saprolite. Due to the low primary porosity, large production wells are not common in this formation unless significant, water-bearing fractures are encountered. A fracture trace analysis was completed in 1992 by R.E. Wright, Inc. in a well exploration project (Appendix A, Fig. 6). The wells were constructed based on this analysis.

Ground water systems in crystalline rock tend to be localized and flow is within topographic divides towards the nearest perennial stream (Bolton, 1998). The water table is generally in the saprolite, which is characterized by high porosity and thus, the amount of storage often depends on the thickness of the saprolite. Stream valleys tend to follow fracture traces and as a result wells drilled in draws and stream valleys tend to have higher yields than those on hilltops and slopes.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. The source water assessment area for public water systems using wells in fractured-rock aquifers is the watershed drainage area that contributes to the well. The area should be modified to account for geological boundaries, ground water divides, and by annual average recharge needed to supply the well (MD SWAP, 1999).

Hydrogeologic mapping identifies the physical and hydrologic features that control ground water flow (EPA, 1991). Hydrogeologic mapping was used to identify drainage basin boundaries and hydrologic features that represent ground water divides. Fracture traces are surface expressions of vertical, closely spaced joints and fractures in the bedrock below. Highly developed fracture systems in bedrock aquifers readily transmit water; thus fracture trace analysis is commonly used to locate high yield wells in fractured bedrock aquifers. A well intercepting a fracture, or fracture zone, will demonstrate a drawdown pattern that is greatest along the trace of the fracture(s). As mentioned above, a fracture traces were mapped in and around the Copperfield property using aerial photographs. One major N-S oriented fracture trace was identified next to Well No. 1, and several other NW-SE fracture traces were identified. This analysis was later used to assess potential adverse effects of the Copperfield wells on neighboring users and it was determined through pump tests that the NW-SE traces were not hydraulically connected to the Copperfield wells (Greenhorne & O'Mara, 1994). The drawdown predictions conducted during this analysis showed that the N-S fracture trace

controlled transmissivity and predicted 5 feet of drawdown within 1000 feet of the pumping wells and along the N-S fracture trace. This information was used to delineate the WHPA. Since the watershed area upgradient of the wells is relatively small, the boundaries are drawn following topographic divides that contribute to the watershed of the predominant fracture trace in the immediate vicinity of the wells. The area is extended to the east to provide enough recharge area to supply the average appropriated amount of 28,300 gpd. The WHPA is approximately 160 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 two potential point sources of contamination within the WHPA (Fig.3). The Valley Elementary School has an underground storage tank (UST) for its heating oil, which is a potential source of volatile organic compounds in the WHPA. The Jefferson wastewater treatment plant is located within the Copperfield subdivision and its outfall discharges to Catoctin Creek a little under a mile away from the wells. Although the discharge is offsite, the proximity of the wastewater plant to the wells warrants mention of this facility for the sake of awareness in the event of an overflow, spill, or accident[1].

ID[2]	Type	Facility Name	Address	Comments
1	UST	Valley Elementary School	3519 Jefferson Pike	One 10,000 gallon heating oil tank in use. One old heating oil tank removed from ground.
2	NPDES	Jefferson WWTP[1]	Off Newington Rd	Discharge outside WHPA, plant inside WHPA. (See above paragraph)

Table 2. Potential Contaminant Sources in the Copperfield WHPA

[2]See Figure 3.

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. 4). The land use summary is given in Table 3. The majority of the WHPA is made up of agricultural land, with smaller proportions residential and commercial areas.

Land Use Type	Total Acres	Percent of WHPA
Medium Density Residential	38	23.6
Commercial	6	4.0
Cropland	116	72.4
Total	160	100

Table 3. Land Use Summary

Agricultural land may be associated with nitrate loading of ground water and also represents a potential source of SOCs depending on fertilizing practices and use of pesticides. Residential areas without sewer service may be a source of nitrate from septic systems. Additionally, residential areas may present a source nitrate and SOCs if fertilizers, pesticides, and herbicides are not used carefully in lawns and gardens. Commercial areas are generally associated with facilities that may have point sources of contamination as described above.

The Maryland Office of Planning's 1996 digital sewer map of Frederick County shows that most of the WHPA covers areas that have existing sewer service or are planned for sewer service (Fig. 5). Most of the agricultural areas to the north of the wells are planned for service. Table 4 summarizes the sewer service categories in the WHPA.

Service Category	Total Acres	Percent of WHPA
Existing Service	92	57.7
7 to 20 Year Planned Service	53	33.0
Not Planned for Service	15	9.3
Total	160	100

Table 4. Sewer Service Area Summary

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database for Safe Drinking Water Act (SDWA) contaminants. The State's SWAP defines a threshold for reporting water quality data as 50% of the Maximum Contaminant Level (MCL). If a monitoring result is greater than 50% of 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 Copperfield water system has one point of entry or plant, which has chlorination for disinfection, polyphosphate addition for corrosion control, and manganese greensand filters for iron reduction as its treatment.

A review of the monitoring data for Copperfield water indicates that the water supply meets drinking water standards. No contaminants were detected above 50% of an MCL. The water quality sampling results are summarized in Table 5.

Contaminant Group	No. of Samples Collected	No. of Samples above 50% of an MCL
Inorganic Compounds (except Nitrate)	10	0
Nitrate	13	0
Radiological Contaminants	3	0
Volatile Organic Compounds	9	0
Synthetic Organic Compounds	8	0

Table 5. Summary of Water Quality Samples

Inorganic Compounds (IOCs)

A review of the data shows that inorganic compounds were not detected in the water supply with the exception of Barium, which had one sample reported at 0.176 ppm. The MCL for Barium is 2 ppm.

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. Only one Radon-222 result has been reported in Copperfield, but it was well below the lower proposed MCL.

Volatile Organic Compounds (VOCs)

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

Synthetic Organic Compounds (SOCs)

No SOC's have been detected above 50% of an MCL. The SOC's that have been detected at low levels are Di(2-Ethylhexyl)Phthalate for which the highest level reported was 2.17 ppb and Dalapon at 0.79 ppb. The phthalate contaminant is commonly found in laboratory blank samples and the method for analyzing this contaminant was just starting to be used in 1995 and had many false positive results. Dalapon is a herbicide used to control grasses in a wide variety of crops and is also registered for use in a number of non-crop applications such as lawns, drainage ditches, along railroad tracks, and in industrial areas. The MCL for Dalapon is 200 ppb.

Microbiological Contaminants

Raw water bacteriological data is available for each of the wells from evaluation for ground water under the direct influence of surface water (GWUDI). This data showed that the wells were not under the direct influence of surface water. The raw

water was free of fecal coliform, although some samples had total coliform present at low levels.

SUSCEPTIBILITY ANALYSIS

The wells serving the Copperfield water supply draw water from unconfined fractured-rock aquifers. Wells in unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the wellhead protection area. Therefore, continued monitoring of contaminants is essential in assuring a safe drinking water supply. The *susceptibility* of the source to contamination is determined for each group of contaminants based on the following criteria: 1) the presence of potential contaminant sources within the WHPA, 2) water quality data, 3) well integrity, and 4) the aquifer conditions. Table 6 summarizes the susceptibility of Copperfield's 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

The water supply is **not** susceptible to inorganic compounds based on water quality data and lack of potential contaminant sources within the WHPA. There is some agricultural land and non-sewer residential areas in the WHPA that could present a source of nitrate, but based on water quality data these potential sources are not impacting the water supply.

Radionuclides

The water supply is **not** susceptible to radionuclides. The source of radionuclides in ground water is the natural occurrence of uranium in rocks. Based on the low levels detected in the water supply, the aquifer is not a source of these contaminants in this area.

Volatile Organic Compounds

The water supply is **not** susceptible to contamination by VOC's. A potential source of VOC's to the water supply is an underground storage tank located at the Valley Elementary School. However, this is a new replacement tank that should meet current State construction standards for underground storage tanks. This, together with the UST's distance from the wells, presents a less significant risk and therefore the water supply is not considered susceptible to this group of contaminants.

Synthetic Organic Compounds

The water supply is **not** susceptible to synthetic organic compounds. SOCs have been detected in the water supply at low levels, but not above 50% of an MCL. A potential source of SOCs in the WHPA may be herbicide and pesticide use in

agricultural areas, but based on water quality data these potential sources are not impacting the water supply.

Microbiological Contaminants

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

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	NO	NO	YES	NO
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	NO	NO	NO	NO	NO
Volatile Organic Compounds	YES	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	YES[3]	NO	YES	YES – Total Coliform only

Table 6. Susceptibility Analysis Summary.

[3] There is no MCL for total coliform, presence is considered a violation in *finished* water samples.

MANAGEMENT OF THE SOURCE WATER ASSESSMENT AREA

With the information contained in this report the Frederick County Division of Utilities and Solid Waste Management is in a position to protect the Copperfield 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 the facilities and the 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 and gasoline underground storage tanks (b) monitoring well installation near UST's, (c) appropriate use and application of fertilizers and pesticides, and (d) 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

- Copperfield's Contingency Plan was submitted to MDE and approved 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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Greenhorne & O'Mara, Inc., 1994, Copperfield Subdivision Hydrogeologic Report in support of Water Appropriation Permit FR87G034 (unpublished reports).

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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

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

U.S. Environmental Protection Agency, 1991, Delineation of Wellhead Protection Areas in Fractured Rocks: Office of Ground Water and Drinking Water, EPA/570/9-91-009, 144 pp.

OTHER SOURCES OF DATA

Water Appropriation and Use Permit FR1987G034
Public Water Supply Sanitary Survey Inspection Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
Department of Natural Resources Digital Orthophoto Quarter Quadrangles for Point of Rocks
USGS Topographic 7.5 Minute Quadrangles for Point of Rocks
Maryland Office of Planning 2000 Frederick County Digital Land Use Map
Maryland Office of Planning 1996 Frederick County Digital Sewer Map

FIGURES

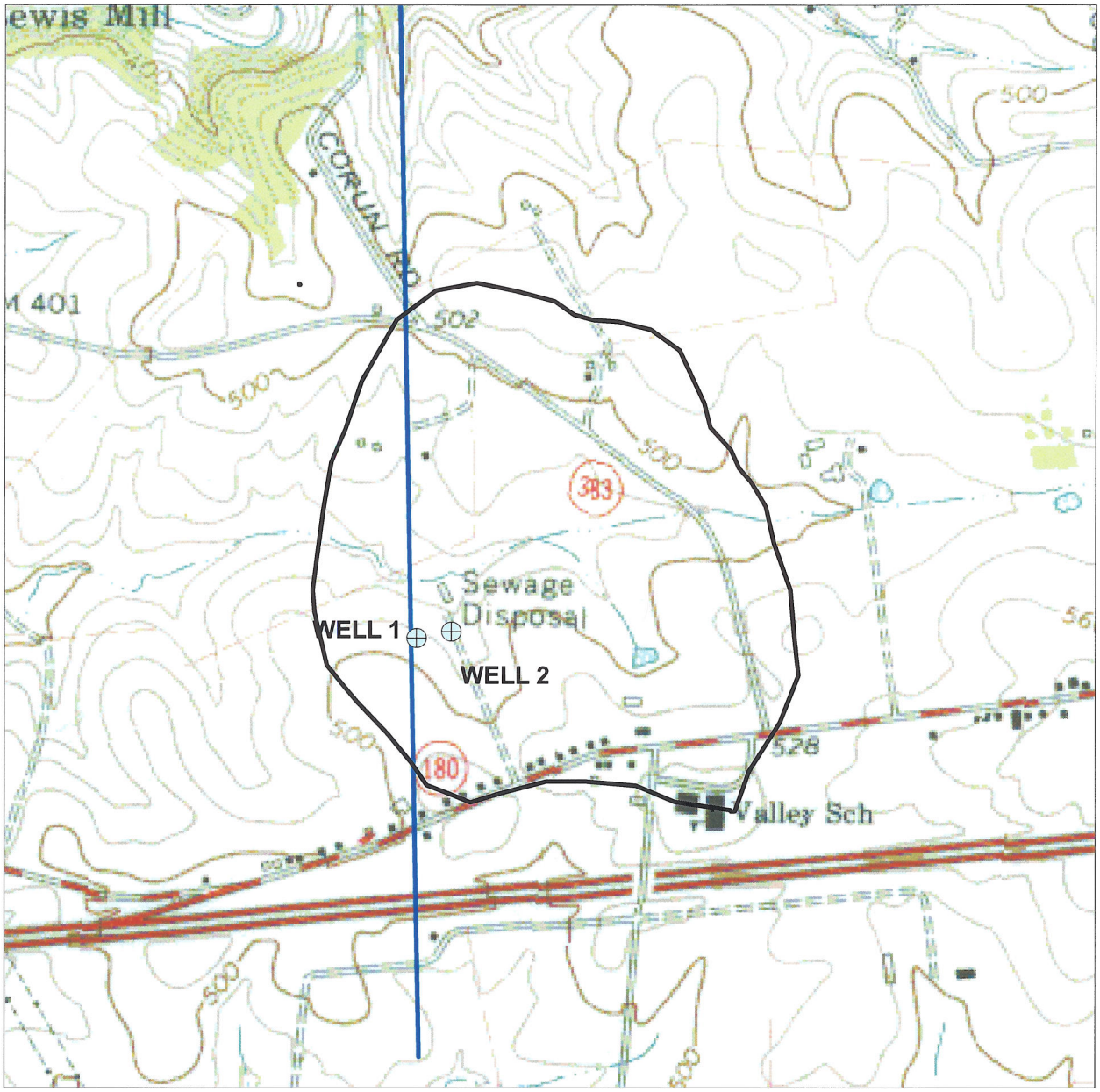

Figure 2. Copperfield Wellhead Protection Area (WHPA).

Legend

Wells

Fracture Trace

Wellhead Protection Area

N

500 0 500 1000 Feet

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

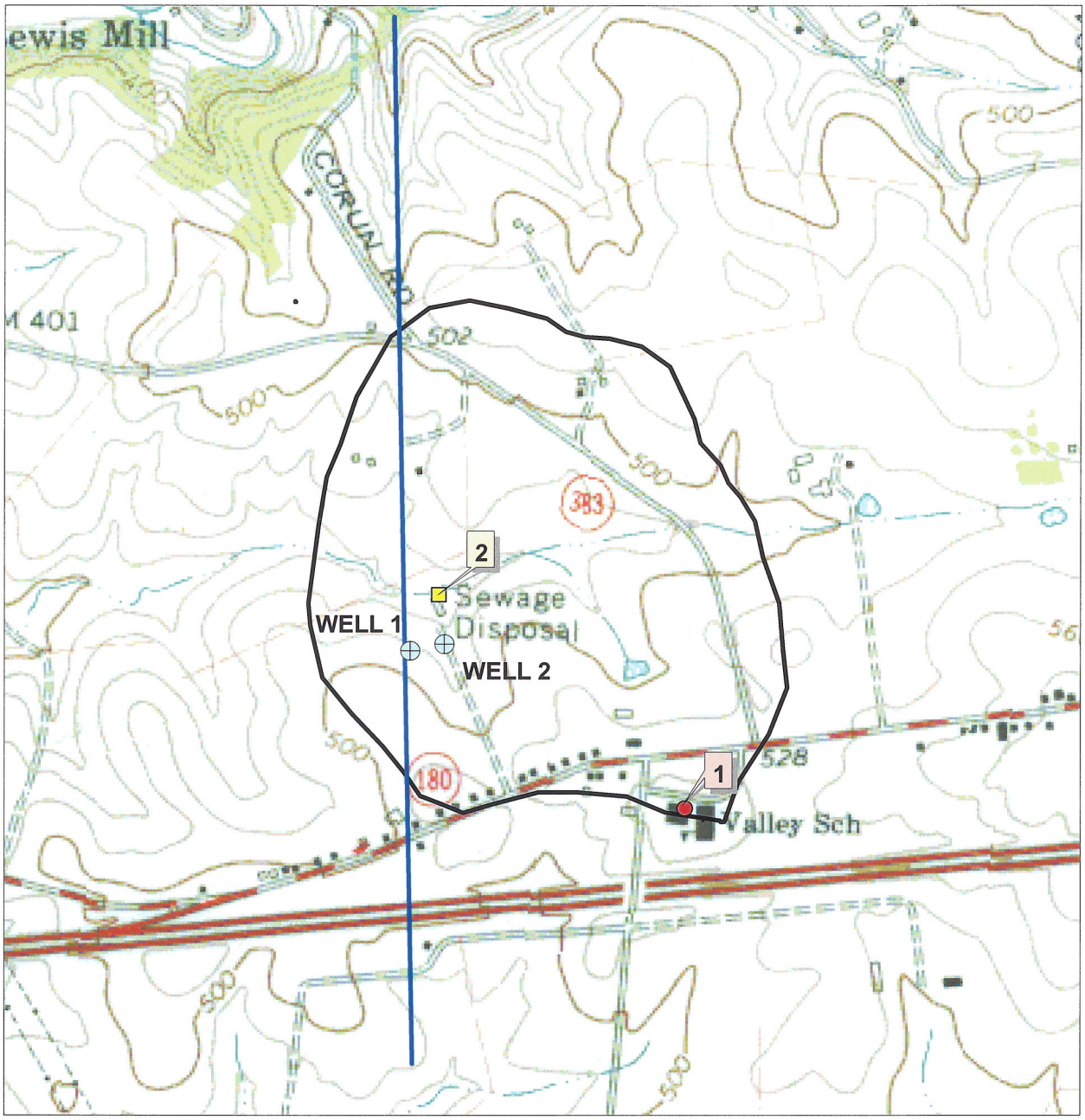

Figure 3. Copperfield WHPA with Potential Contaminant Sources.

Legend

Wells

Fracture Trace

WHPA

Potential Contaminant Sources
(See Table 2 in text)

UST

NPDES

N

500 0 500 1000 Feet

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

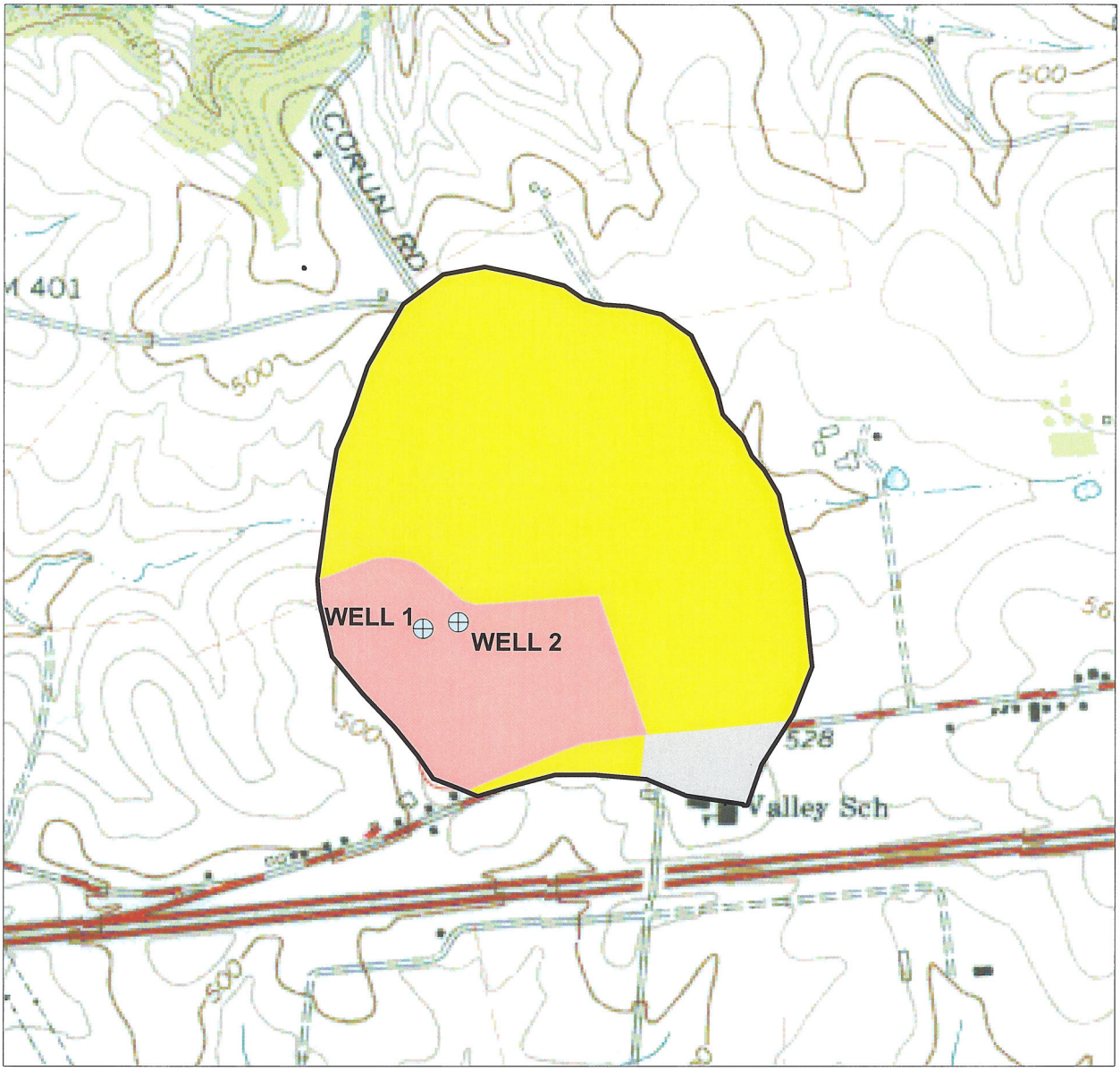

Figure 4. Land Use in the Copperfield WHPA.

Legend

Frederick County 2000 Land Use

Wells

WHPA

Medium Density Residential

Commercial

Cropland

N

500 0 500 1000 Feet

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

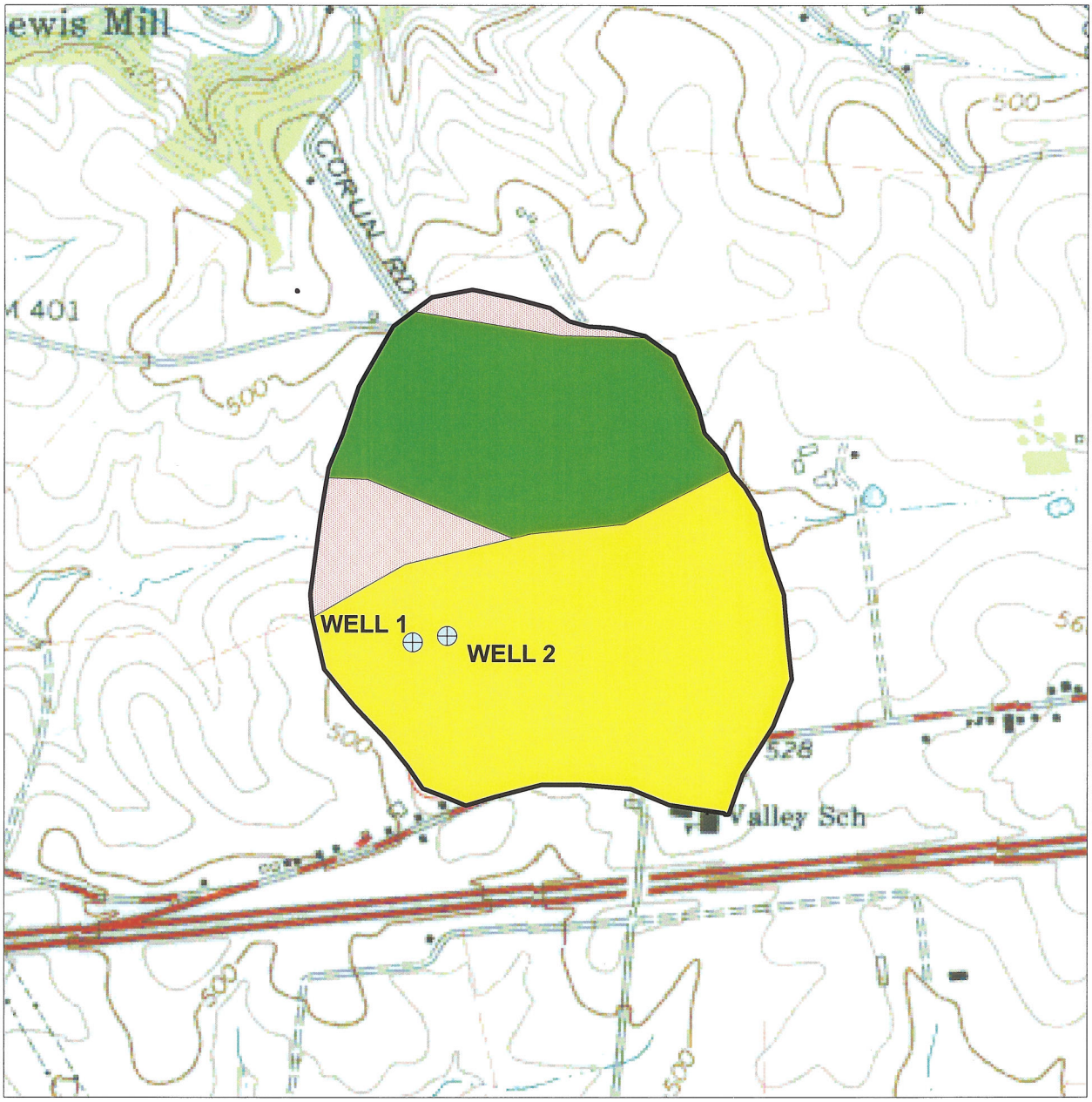

Figure 5. Sewer Service Areas in the Copperfield WHPA.

Legend

Sewer Service Areas

Wells

WHPA

Existing Service

7 to 20 Year Planned Service

Not Planned for Service

N

500 0 500 1000 Feet

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

APPENDIX

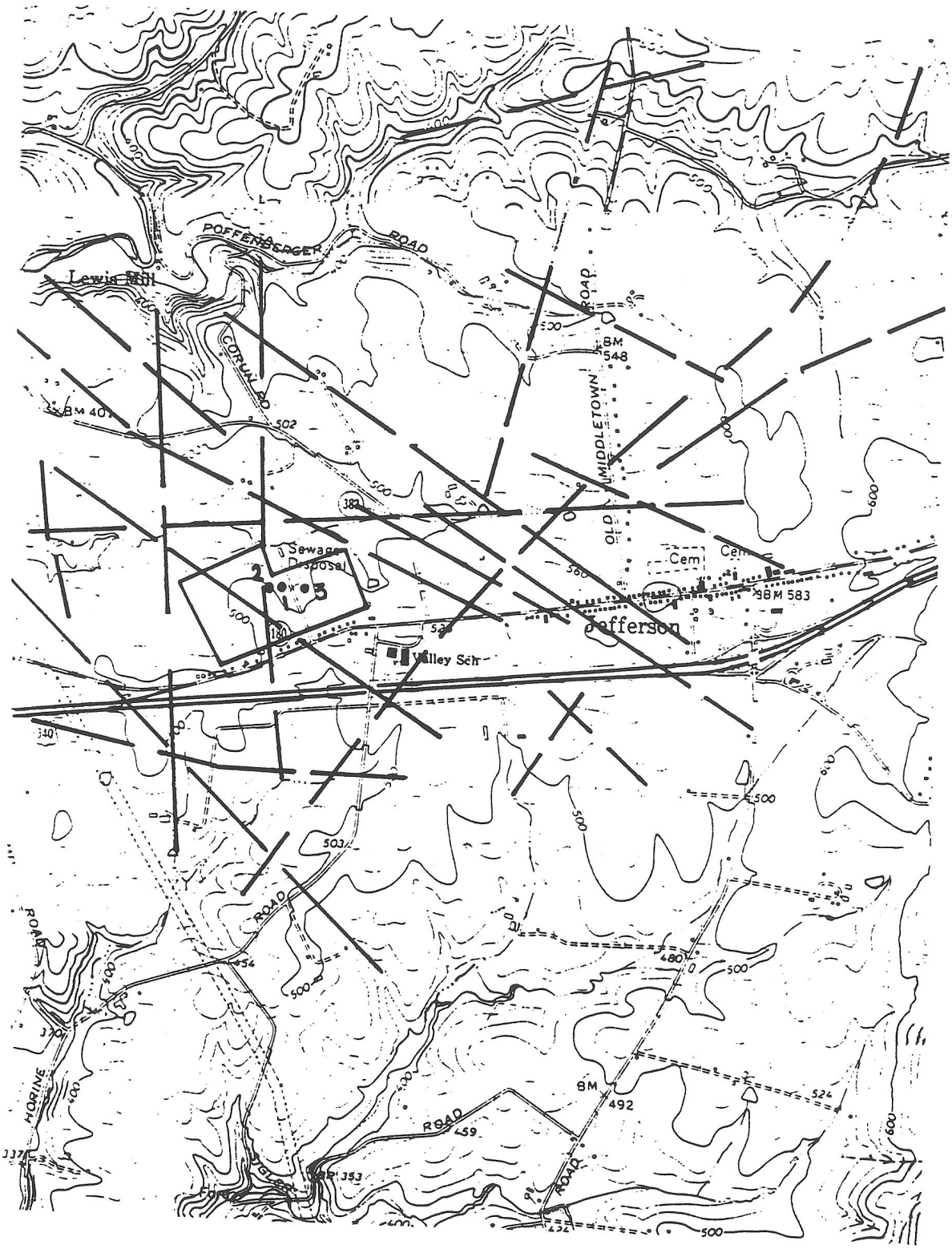

Figure 6. Fracture trace map for Copperfield site (Based on fracture trace analysis by R.E. Wright, 1992)

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