SOURCE WATER ASSESSMENT
FOR GROUNDWATER SUPPLIES
SERVING TRANSIENT NON-COMMUNITY SYSTEMS
IN WESTERN HOWARD COUNTY, MARYLAND

ALWI Project No. HO7S475

June 16, 2005

Prepared for

THE MARYLAND DEPARTMENT OF THE ENVIRONMENT

PURSUANT TO THE REQUIREMENTS OF THE

1996 AMENDMENTS OF THE SAFE DRINKING WATER ACT

ADVANCED Land and Water, Inc.
Global Environmental Solutions
7540 Main Street, Suite 7 • Sykesville, MD 21784
PHONE 410-795-4626 • FAX 410-795-4611 • www.alwi.com

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Reviewed and Approved By:

Mark W. Eisner, P.G.
President

Prepared and Submitted By:

David L. Pielmeier
GIS Analyst/Staff Scientist

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EXECUTIVE SUMMARY

Advanced Land and Water, Inc. (ALWI) was retained by the Maryland Department of the Environment (MDE) to prepare a source water assessment (SWA) for 37 groundwater wells serving 35 Transient Non-Community (TNC) public supplies located in western Howard County, Maryland. This SWA was prepared in accordance with the 1999 MDE Source Water Assessment Plan (SWAP).

Herein, ALWI delineates SWA areas that follow the 1999 MDE SWAP. Within SWA areas, we identify and map existing and potential contaminant hazards, assess the susceptibility of the subject wells to contamination, and formulate specific strategies to reduce the future risk of contamination.

ALWI found that some of the wells are susceptible to bacteriologic contaminants, and by extension, possibly viral and protozoan contaminants as well. Many wells also are susceptible to nitrate-nitrogen contaminants. Other conditions of susceptibility may also be present; with few exceptions, only bacteriologic and nitrate sampling results were available for review because of limits on TNC water quality monitoring requirements.

We identified several instances of seemingly incompatible land uses proximal to one or more of the wells, where changed or relocated operations could mitigate the future risk of contamination. To the degree that they seem practical to implement, appropriate suggestions have been offered on a hazard-specific basis. Generally, our recommendations for improved wellhead protection include hazard reduction measures, wellhead integrity maintenance, contingency planning, customized water quality sampling protocols, contaminant release response protocols and public awareness in the form of focused outreach to the well owners.

1.0 INTRODUCTION

Advanced Land and Water, Inc. (ALWI) was retained by the Maryland Department of the Environment (MDE) to prepare source water assessments (SWAs) of Transient Non-Community (TNC) groundwater supplies located in Frederick and Howard Counties, Maryland. The work was funded and prepared for the Water Supply Program of MDE.

ALWI Proposal Nos. FR7S575 and HO7S475 were authorized by MDE on February 12, 2004. This source water assessment and wellhead protection plan then was developed pursuant to our contract with MDE, with references to the 1999 MDE Source Water Assessment Plan (SWAP).

1.1 REGULATORY FRAMEWORK

The Safe Drinking Water Act (SDWA) of 1974 required the U.S. Environmental Protection Agency (EPA) to develop enforceable drinking water quality standards to protect public health. In 1986, amendments made to the SDWA strengthened provisions for the protection of underground sources of drinking water. These amendments included provisions for establishing Wellhead Protection Programs by individual states under "umbrella" EPA oversight.

The EPA approved MDE's Wellhead Protection Program in June 1991. The 1996 Amendments to the SDWA required Maryland (and other states) to develop SWAs. On an individual system basis, the SDWA provides guidance for an approvable system-specific SWA. Wellhead protection programs and system-specific SWAs, therefore, are related in design and purpose.

As aforementioned, ALWI's work was designed and executed following the 1999 MDE SWAP. Authorized tasks included SWA area delineations, contaminant hazard identification, susceptibility analyses, and recommendations regarding the implementation and management of the SWA areas.

1.2 BACKGROUND INFORMATION

Before or shortly after the outset of our work, MDE provided baseline information from which ALWI gleaned the following background information to aid the development of this plan:

1. **Number and Type of Systems** - ALWI's overall SWAP work covered 157 TNC groundwater supply systems in Frederick County, and 56 TNC groundwater supply systems in Howard County. Community systems, non-transient systems and unclassified systems that serve very small populations were excluded from consideration herein.

2. **Number of Sources Per System** - Most systems subject to this SWA withdraw groundwater from a single on-site well. Some of the systems use more than one well, manifolded together. The source water assessments for TNC surface water intakes, if any exist were excluded from our contract.

3. **Regional Distribution of SWA Data** - Because a singular report covering all subject systems would be voluminous and unwieldy, ALWI judged it beneficial to subdivide the

system list geographically and geologically. This approach resulted in a relatively even distribution of systems across three regions in Frederick County and two in Howard County. The focus of this report is the western Howard region (Figure 1), which geologically is dominated by metasedimentary and igneous rocks (see Section 2.2). In total, there exist 37 wells serving 35 individual systems in this region (Table 1).

4. **Groundwater Withdrawal Rates** - The subject systems withdraw varying quantities of water. The approximate amount of water being used is known for systems permitted through the MDE Water Appropriation Program. MDE estimates groundwater withdrawal amounts, based on applicant and permittee interviews and submitted site plan data. Systems without permits generally are un-metered and water use is not known. MDE knew that getting accurate pumping information from these types of systems would be nearly impossible. A generic SWA area was developed by MDE to be used for all transient water systems pumping less than 10,000 gallons per day (gpd) from fractured rock aquifers. The delineation methodology is specified in the 1999 MDE SWAP. The generic SWA area directs a circle centered on the well with a 1,000 foot radius (see section 3.0). The generic SWA area errs on the side of conservatism to help ensure that the SWA area is large enough for all small systems where the groundwater withdrawal is unknown.

2.0 HYDROGEOLOGIC FRAMEWORK

A scientifically sound and well-reasoned SWA area delineation is key to effective wellhead protection. For this reason, ALWI began its technical work by evaluating the hydrogeologic framework underlying the groundwater recharge areas contributing to the subject production wells. We used published information from the United States Geological Survey (USGS), and the Maryland Geological Survey to identify and describe the characteristics of the local hydrogeologic setting. As aforementioned, we also obtained records from MDE and the Howard County Health Department (HCHD) to help confirm specific information regarding the wells that are the subject of this SWA.

2.1 SITE TOPOGRAPHY

According to the USGS 7.5-minute series topographic quadrangle maps for western Howard County, regional elevations generally range from approximately 400 feet above mean sea level, near the Patuxent River, to approximately 800 feet above mean sea level near the western edge of Howard County. Otherwise in the study area, the land surface is typified by flat to gently sloping terrain. Regionally, most broad hills and subtle valleys appear to trend northeast/southwest, parallel to geologic strike.

2.2 GEOLOGY/HYDROGEOLOGY

Western Howard County is almost entirely within the Piedmont province. The eastern boundary for this region is the northeast-southwest trending Plummers Island fault, and the western boundary is the Howard County line. Rock formations found within western Howard County are a combination of metasedimentary rocks, with a few intrusive igneous dikes. The major geologic formations within western Howard County, from youngest to oldest, are described as follows (all

geologic descriptions from Edwards, 1993):

- Pleasant Grove Formation - This Permian aged formation represents a tectonic zone where an older rock unit was thrust onto the Prettyboy Schist. It is composed of medium gray to green-gray, chlorite-quartz-muscovite schist or phyllite and metagraywacke, and is found in a narrow belt that is one to three miles wide.

- Sykesville Formation - The Sykesville Formation is characterized by light to medium gray, muscovite-biotite-plagioclase-quartz gneiss or fels. It can contain cobble –to granular size clasts, slabs of schist and vein quartz. There is a biotite-plagioclase-quartz-muscovite schist member associated with this formation that is medium gray to brownish-gray in color. This formation along with the Morgan Run Formation and the Gillis Group make up the Ordovician aged Liberty Complex.

- Morgan Run Formation - This formation is composed of fine-to medium-grained, silvery gray to greenish-gray, garnetiferous quartz-chlorite/biotite-muscovite schist. Interlayered zones of metagraywacke with quartz granuals occur within this formation. There are discontinuous lenses of gray to dark-green to black chlorite-amphibole schist and fels, chlorite-talc schist, serpentinite and other ultramafic and mafic rock units found within the Morgan Run Formation.

- Gillis Group - The Gillis Group is characterized by dark to light silvery gray-tan, and greenish-gray quartz-chlorite-muscovite phyllite with silty laminae. Zones of reddish purple to pale purplish-gray muscovite phyllite and bluish-green muscovite-chlorite phyllite can occur, with thin quartzites and quartzitic phyllites occurring locally.

- Prettyboy Schist - The Cambrian aged Prettyboy Schist is greenish gray-tan to medium gray, fine-grained quartz-muscovite-chlorite schist. Albite and magnetite crystals are common, and lenses of vein quartz occur in lenses and pods throughout this formation.

Jurassic aged intrusive igneous rocks are found in small quantities in the western portion of this region in the form of dark greenish-gray to black basalt and diabase dikes.

2.3 Aquifer Recharge

Precipitation infiltrating through the soil, particularly near and up-gradient of the subject wells, is the primary source of aquifer recharge. Generally, overlying soil horizons act to absorb and then slowly release infiltrating precipitation. A portion of the precipitation percolates downward through the soil mantle and then may migrate through narrow, interconnected joints, fractures, faults and cleavage planes in the bedrock.

2.4 Water Quality and Contamination Risk

Groundwater within western Howard County generally is considered suitable for consumption. Nitrate concentrations tend to be elevated as a consequence of historic agricultural activities atop underlying geology regimes subject to this assessment, but generally remain below the drinking

water standard. Regionally, the groundwater generally has favorable secondary (aesthetic) characteristics. A discussion of the quantitative susceptibility of the groundwater to contamination, as indicated from the available water quality records, is provided in Chapter 5 herein.

Certain wells in western Howard County could be particularly vulnerable to contamination hazards in areas where major fracture zones occur. A majority of the wells in western Howard County are completed within metasedimentary and igneous rocks, which can contain bedrock fracture zones (where present) that can function as both downward and lateral water conduits. As a result, fracture zones receive and transmit water at a rate higher than would otherwise be available in unfractured areas. Recharge features and wide flow paths may limit natural filtration processes.

3.0 SWA AREA DELINEATIONS

In accordance with the 1999 MDE SWAP, ALWI delineated the areas surrounding the subject wells using the fixed radius method. The 1999 MDE SWAP specifies a 1,000 foot radius, based on an assumed drought-year recharge rate of 400 gpd per acre and an assumed withdrawal rate as high as 10,000 gpd. As discussed in Section 1.2, for most of the systems the withdrawal rate is far less than 10,000 gpd. This creates an adequate safety factor. The resultant delineations are summarized in detailed maps presented in Appendix A.

4.0 CONTAMINANT THREATS ASSESSMENT

ALWI identified existing and potential contaminant sources within each SWA area. The techniques used for identifying a hazard included spatially indexed database reports, regulatory inquiries, field observations and personal interviews. The SWAP suggests that the following potential contamination point sources be inventoried and mapped, for groundwater sources:

- Sites/facilities that hold groundwater discharge permits;
- Land disposal sites, such as landfills, certain less formal refuse disposal areas, and trenched sludge disposal sites;
- Underground storage tanks (USTs), including release sites and fuel lines;
- Coal mining areas (none exist in western Howard County); and
- Areas prone to salt water intrusion (none exist in western Howard County).

Herein, we collectively term these "SWAP-classifiable point-source hazards." Other possible point-sources of groundwater contamination also may exist, of course. Only those deemed SWAP-classifiable required specific identification and mapping for compliance with the 1999 MDE SWAP. ALWI identified potential contamination hazards in stepwise fashion in the order of the report subsections within this Chapter.

4.1 Regulatory Database Reviews

ALWI began the process of identifying potential point-source contamination hazards by acquiring a spatially indexed list of SWAP-classifiable point source hazards from MDE. Among other regulatory information[1], the MDE listing provides spatially indexed information on regulated landfills, UST and leaking UST facilities, groundwater discharge permittees, petroleum release sites, trenched sludge disposal sites, pesticide dealers and regulated dumpsites.

4.2 Field Reconnaissance

Guided by the MDE databases, ALWI performed a visual reconnaissance of publicly accessible portions of each wellhead and surrounding SWA area to observe wellhead conditions, facilities or land use practices potentially constituting a SWAP-classifiable point-source contamination hazard. Pertinent information regarding existing and potential SWAP-classifiable point source contamination hazards (mapped within Appendix A) were noted (Table 2).

Wellhead locations and on-site, point-source contamination hazards were mapped using differentially-correcting Global Positioning Systems (GPS), capable of acquiring data with sub-meter precision (see Section 4.3). Off-site contamination hazard locations were mapped from the subject parcel(s) and public rights-of-way, resulting in mapping locations with a level of precision meeting or exceeding contract requirements[2], but without engendering trespass concerns.

ALWI observed each wellhead to the degree exposed and observable without excavation, confined-space entry, or other exposure to unusual personal hazards. Most of the subject wells appeared to possess good physical integrity at the wellheads (exceptions noted in Table 2), though no subsurface or invasive work of a confirmatory nature was performed. In nearly all cases, no visual evidence of existing, direct contamination to the wells was observed.

Subject wellheads generally were observed in outdoor locations, with casing stickup and pitless connections. Observations of potential concern at the wellheads and/or within the delineated SWA areas are summarized in Table 2; referenced photographs are contained within Appendix B.

4.3 Summary Classifications of Wellhead Hazards Observed

Design, construction and present condition are important factors in determining the contamination susceptibility of a well. Certain observations, warranting consideration, concern, and/or improved practices, were as follows:

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[1] MDE also provided other information (e.g., facilities where hazardous waste is generated and/or stored), not specifically germane to this SWA as set forth in the SWAP.

[2] ALWI used a handheld GPS unit, capable of acquiring data at a precision level of 3-15 meters, which satisfied contract specifications. Differential correction would have provided a false aura of accuracy, given that the GPS unit was operated at locations remote from the identified, private-property hazards.

1. **Wellheads in Frost Pits, Vaults and Other Manmade Enclosures** - ALWI was unable to observe a few subject wells (PWSID Nos. 1131082 and 1131088) because each were concealed in some fashion (e.g., vaults, locked bunkers, concrete enclosures, buried underground, etc). For these certain systems the top of the casing may terminate in a non-watertight subsurface vault, in apparent violation of several provisions[3] within COMAR 26.04.04.07F. If such a well were bacteriologically contaminated (No. 1101082 appears so, see Chapter 5.0), the bacteria and potentially associated pathogenic organisms could enter the well through open ports in its sanitary seal.

2. **No Well Tag** - Design, construction and present condition are important factors in determining a well's susceptibility to contamination. However, no well tag was visible for many of the subject wells. For those, ALWI could not assess the initial design or present condition of the casing or grout seal.

3. **Missing, Loose or Ajar Caps** - In several instances (PWSID Nos. 1131013, 1131058 (02) and 1131068), wells were equipped with a conventional pitless-style cap of the type that can sometimes allow insects or other potentially pathogenic organisms to enter the well. An upgrade to a more modern cap would provide greater protection against microbial contamination.

4. **Indoor Wellheads** - In a few instances (PWSID Nos.1131028, 1131085 and 1131103) the well was contained in a building. There was no observed hatch in the above ceiling or the roof that would allow easy access should the pump need to be serviced.

4.4 Summary Classifications of Point Source Hazards Observed

In addition to the wellhead reconnaissance and hazard identification, ALWI also performed a field reconnaissance from public rights-of-way within the SWAs. Readily-observable point-source contamination hazards, of a SWAP-classifiable nature, included the following:

1. **Underground Storage Tanks** - Several subject TNC systems had UST facilities within the corresponding SWA (see Table 2). Surficial and subsurface fuel spills from such USTs are possible, even if the facilities are within regulatory compliance standards. Based on comparable experience, ALWI has observed that UST sites may achieve compliance and pass leakage detection tests even with low to moderate degrees of subsurface petroleum contamination. Given the proximity of the UST field to the well, analytical testing to confirm the absence of gasoline and diesel fuel constituents (e.g., benzene, toluene, ethylbenzene, xylene, methyl-tertiary-butyl ether [MTBE], naphthalene), and totals for both gasoline- and

[3] This regulation prohibits frost pits, requires pitless adapters, and specifies that the finished height of well casings extend at least eight inches above natural grade.

diesel-range petroleum hydrocarbon compounds seems appropriate[4].

2. **Informal Refuse Disposal Areas** - ALWI observed an accumulation of informal refuse within the SWA areas associated with PWSID Nos. 1131005, 1131064, 1131074, and 1131096. There were numerous 55-gallon paint drums observed at PWSID No. 1131005. Two rusty 55-gallon drums associated with PWSID No. 1131064 were also observed. The informal refuse at the locations PWSID Nos. 1131074 and 1131096 is in the form of junked cars, which are associated with a nearby body shop. No definite hazardous materials, petroleum products or stressed vegetation were observed in this area, but regulated or unregulated liquid contaminants may nevertheless be present.

3. **Groundwater Discharge Facilities** - MDE generally regulates large groundwater discharges, exceeding 5,000 gpd. When near subject wells (e.g., PWSID Nos. 1131096 and 1131064), these have been mapped. Smaller wastewater discharges are ubiquitous, though not specifically mapped based on the 1999 MDE SWAP. Older septic tanks, if present, may have seams. Generally we believe that when a septic system needs replacement, or is newly installed within a SWA area, the tank should be a seamless model.

4. **Highway and Parking Area Deicing** - Highway and parking area deicing practices may increase a seasonal risk of sodium and chloride contamination. The State Highway Administration is unlikely to curtail or otherwise change deicing practices on nearby state and federal highways. However, consideration should be given to using non-chemical abrasives on the private parking lots for deicing to the degree possible.

Table 2 contains identified SWAP-classifiable hazards, sorted by the TNC system potentially affected. In many cases, the existence of a potential contamination hazard (i.e., its listing on a regulated facilities database) is an incidence of environmental compliance and does not itself indicate or imply an existing contaminant release.

4.5 Non-Point Source Contamination Hazards as Suggested by Land Use

The 1999 MDE SWAP suggests consideration and mapping of the following classifications of land use within the SWA areas: low, medium and high density residential, institutional, open urban land, industrial, commercial, crop land, pasture, deciduous forest, evergreen forest, mixed forest, brush, water, and agricultural building. Additionally, the 1999 MDE SWAP recommends that the extent of community sewer service areas be mapped, if within SWA areas.

ALWI obtained countywide land use and community sewer Geographic Information Systems data and maps from MDE and the Maryland State Office of Planning. Pertinent land use acreages and percentages, within the SWA areas, are listed in Figure 2. Dominant land uses within the

[4] Any finding of petroleum-contaminated groundwater must be reported to the MDE Oil Control Program. Such a report would open (or reopen) an Oil Control Program case file. MDE Oil Control Program representatives may order additional sampling, UST tightness testing, UST removal(s), monitoring well drilling, and/or other investigative and remedial measures. ALWI suggests that site ownership and HCHD interests consult legal counsel before taking any action that could have adverse financial or environmental liability consequences.

SWA areas are agricultural lands, forests, existing residential areas and public lands (Figure 2).

Figures A-1 through A-6 (Appendix A) also depict the approximate extent of public sewer service within and near affected SWA areas. No land within any SWA area in western Howard County existed in public sewer service areas. Property owners may discharge inappropriate liquid wastes, down the drain or onto the ground. In the former case and absent a public sewer system, the drain connects to a septic system and thus, to the local groundwater aquifer.

4.6 Resolution of Conflicting Data

In certain instances, the information that we received from various sources (i.e., the MDE databases, field observations, system owner interviews, etc.) appeared in internal conflict. For example, the MDE databases may indicate that two wells were on a single system, but during our reconnaissance the system owner verified that there was only one well serving the system. Some systems had additional wells that were not recorded in the MDE database. ALWI has included these additional wells in the updated database. Although these circumstances were few, they posed special challenges when they arose.

To help resolve these issues, ALWI contacted the HCHD for clarifications. HCHD sanitary surveys, along with information from the system owners, were reviewed for those systems where information otherwise appeared internally contradictory. Using the sanitary surveys and presuming them to be definitive, most ambiguities and inconsistencies were resolved.

Within western Howard County, there was one instance where a well listed in the MDE database, associated with that particular system, had recently been abandoned (PWSID No. 1131075). There was one additional well, not presently recorded in the MDE database (PWSID No. 1131068 (02)).

5.0 QUANTITATIVE ASSESSMENT OF CONTAMINANT SUSCEPTIBILITY

Building Consultants Incorporated (BCI), a woman-owned subconsultant working under ALWI's direct and continuous supervision, completed a review of available groundwater quality records to support an assessment of groundwater susceptibility as described in the 1999 MDE SWAP.

5.1 Procedures

The susceptibility assessment depended on electronic databases furnished by MDE (summarized in Appendix C), other water quality records furnished by MDE and reviewed in MDE files, our past overall experience in projects of this nature and in working as a hydrogeological consultant for public and private concerns within the subject area, and the results of the field reconnaissance described in Section 4.2 herein. Generally, the susceptibility assessment was completed in accordance with the following step-wise procedure:

1. **Obtain and Filter Electronic Records** - We reviewed available electronic databases of water quality analyses provided by MDE and extracted pertinent data (Appendix C). The raw databases first were filtered to isolate only TNCs subject of the presently authorized study

and within the geographical range of this specific report (i.e., western Howard County).

2. **Consider Chemical Classes** - Because the subject systems are TNCs, the furnished databases contained analytical records for bacteriologic and nitrate sampling results. Little, if any information was available for other contaminants.

3. **Identify "Exceedance" Instances** - We defined an "exceedance" as a singular test result indicating Maximum Contaminant Level (MCL). To identify such exceedances, we compared each specific analytical water quality result to published MCLs (in COMAR 26.04.01 as of the date of authorization of this work). Guided by MDE, we judged that a concentration of precisely 50% of a given MCL (i.e., 5 mg/L for nitrate) should be considered an exceedance. Procedurally, this was accomplished by sorting the database on a system-by-system basis by analyte and concentration.

4. **Assess Frequency and Relative Percentage of Exceedance Instances** - The number of times that a given analyte was detected in a concentration greater than 50% of its respective MCL was discerned in terms of overall frequency, percentage of total number of samples and date range of exceedance. Then, for conformance with the MDE SWAP, only those contaminants with 50% of the MCL equaled or exceeded were further evaluated. Certain results that seemed anomalous or otherwise surprising were flagged for a confirmatory file review.

5. **Data Quality Assurance Through File Review at MDE** - On December 13 and 14, 2004, BCI reviewed select hard copy water quality data at MDE offices in Baltimore, Maryland to assure that our findings accurately reflected the whole of the water quality records available at that time. These manually-collated data sources allowed us to verify the accuracy of the databases MDE had previously furnished[5].

6. **Integration** - ALWI then identified correlations between water quality exceedances and specific field observations suggestive of a condition of susceptibility.

5.2 RESULTS

The available data support an interpretation that many of the subject TNC wells are susceptible, in whole or in part to several compounds, summarized in Tables 3 and 4 and discussed below.

1. **Nitrate** - Many of the wells subject to this assessment were found to be susceptible to nitrate contamination. The wells generally record concentrations approaching the established MCL of 10 mg/L; amounts exceeding the susceptibility threshold of 5 mg/L were more common than not.

[5] Records predating 1998 were not observable during the time of the review and consequently, the accuracy of said records cannot be guaranteed. According to MDE, the records have been archived and are available for review for any data that may be questionable or inconsistent.

2. **Bacteria** - Total coliform bacteria may not themselves be pathogenic, but often are an indicator or screening tool for identifying possible bacteriologic, protozoan and viral contamination. As indicated in Table 3, the raw water within some of the subject wells appears susceptible to bacteria, and therefore also may be susceptible to protozoa and viruses. In some circumstances, however, experience has shown that a condition of apparent bacteriological contamination truly originates from a mere lack of appropriate disinfection prior to sampling.

5.3 LIMITATIONS OF SUSCEPTIBILITY ASSESSMENT

This susceptibility assessment was comprehensive insofar that all available chemical data were evaluated in comparison to 50% of the respective MCL, for each of the subject wells for which data were furnished. Nevertheless, certain limitations of this assessment potentially remain associated with the following:

1. **Treatment Plants vs. Individual Wells** - The databases contain information specific to treatment plants, not necessarily to individual wells. Each chemical class was considered separately for each treatment plant, since composite groundwater samples could not be separated. Where more than one well shares a treatment plant, well-specific information generally was not available on which to base a well-specific evaluation of susceptibility. Blending and other operational protocols may affect well-specific susceptibilities in a manner not discernable through this assessment.

2. **Reliance on Existing Data** - Water samples were not collected and analyzed as a component of this SWA. In addition, the water quality databases that were used to support this assessment revealed sometimes-irregular sampling intervals. MDE advises that the SDWA regulations are such that different contaminants are sampled at different intervals and provide MDE with the authority to reduce the frequency of sampling based on the occurrence of a contaminant in the water supply and geology.

6.0 WELLHEAD AND SWA PROTECTION RECOMMENDATIONS

Chapters 1 through 5 of this report constitute the Source Water Assessment for the western Howard County TNC systems, as required under the 1996 SDWA amendments. In concept, the system owners and their customers, tenants and guests benefit from a readily implemented plan for pro-active wellhead protection. Such protection efforts:

1. Provide measures to mitigate public health risks that may otherwise arise due to contamination of the groundwater supplies; and

2. Reduce the risk of future groundwater contamination of both natural and manmade origin.

6.1 WELLHEAD PROTECTION RECOMMENDATIONS; SYSTEM OWNERS AND OPERATORS

Bacteria (total coliform, *e. coli*) are the most common groundwater contaminant that is within the capability of individual system owners and operators to diagnose and correct. Many subject

systems had positive bacteria sampling results, at one time or another. Such corrective efforts, therefore, appear warranted.

Based on the generally recurrent positive bacteria results that probably eliminate sample error, ALWI presently believes the elevated bacteria concentrations to be a consequence of incomplete disinfection and/or pervasive anthropogenic bacteria sources. Groundwater under direct influence (GWUDI) determinations and other conclusions seem premature before aggressive shock-chlorination and additional sampling is performed. The causes of bacteriologic contamination may include casing perforations, leakage past the bottom of an incompletely seated casing, debris on the pump column, foreign matter in the well, insects and larvae within the well cap and other sources.

Chlorination and/or ultraviolet disinfection should be considered for those wells wherein bacteriologic contamination persists and wherein potability cannot be restored through redevelopment coupled with aggressive shock chlorination. In the event that GWUDI is confirmed the water system can (1) replace the GWUDI well with a new well, (2) reconstruct or rehabilitate the existing well to a non-GWUDI condition, and/or (3) install filtration that meets EPA/MDE requirements. We note that in some areas it may not be possible to drill a new well, or to rehabilitate a well, that would not still be GWUDI.

Focusing on wellhead maintenance and protection for sanitation and maintenance of a disinfected supply, ALWI offers the following additional recommendations to the individual system owners:

1. **Maintain Integrity of Well and Supply System** - A copy of the HCHD sanitary survey for the well(s) should be obtained and reviewed. Any defects in sanitation should be corrected, and the system should be disinfected following such work. Installing new two-piece well caps with insect-proof screens is a good way to reduce potential bacteriologic contamination from entering the well from its cap. Caulking the electrical conduit also helps to maintain a sanitary seal at the wellhead.

2. **Wells Near USTs** - Wells identified to be at risk from USTs should be sampled for volatile organic compounds annually if no UST releases are verified, or quarterly (or more often if directed by the MDE Oil Control Program) if a release in the SWA has been verified. Corrective action, as necessary, will help protect the health of regular consumers.

3. **Onsite Disconnected or Unused Wells** - At one location (PWSID No. 1131068 (02)), ALWI observed an unused, and/or disconnected well. Such a well potentially constitutes a short-circuit pathway for the downward migration of contamination into the aquifer. While it remains possible that the owner seeks to keep the well for emergency or backup uses, COMAR 26.04.04.11.D(2)a requires that unused and unneeded wells may need to be abandoned and sealed if they present a potential source of pollution. MDE and HCHD may wish to consider advising the owner of the potential contamination threat associated with disconnected wells, in an effort to encourage proper abandonment.

4. **Wellhead Vehicular and Tampering Hazard Reduction** - ALWI recommends continued protection of the wellheads from vehicular hazards. We also recommend grading to redirect storm water away from the wellheads. Water treatment chemicals should be stored in secondary containment devices to protect against leaks or spills. All outdoor wellheads not currently protected by locks, bunkers and/or fences should have these or other types of equally protective devices installed.

5. **Dry Cleaning Facilities** - Cleaning solvents associated with dry cleaning facilities can enter the groundwater through the cleaning, purification, and waste disposal stages. These solvents can enter the ground through spills, and leaky tanks, pipes and machines. Proper management of the wastewater or switching to "wetcleaning" can help reduce the potential of groundwater contamination near dry cleaning facilities.

6. **Roadway and Parking Lot Deicing** - The owners of subject TNC wells should be encouraged to use abrasives and calcium chloride formulations as roadway and parking lot deicer. If the data exist, restrictions in the use of conventional road salt should be predicated on existing sodium and chloride concentrations in the aquifer.

7. **Wells in Flood-Prone Areas** - Wells in areas subject to flooding, naturally or from stormwater, should be sampled for total coliform bacteria, *e. coli* and other contaminants following significant rain events (e.g., 0.5 inch in a 24 hour period) to verify the continued potability of the water. Corrective action may be necessary based on the results, including but not restricted to casing extensions, installation of disinfection systems, installation of filtration systems, redirection of floodwaters, and/or abandonment and replacement.

8. **Wells Serving Seasonal Facilities** - Water systems for seasonal facilities, such as campgrounds, should be disinfected and flushed prior to the opening of a new season.

9. **Be Cognizant of Land Use Changes; Participate in Public Processes** - System owners should keep track of potential changes in local zoning and land use within the individual SWA areas that might impact groundwater quality. Participation in public meetings and hearings, on issues such as planning, zoning and development, may help local officials be cognizant of groundwater quality issues and integrate such concerns in decision-making.

In summary, we recommend that tests for total coliform bacteria and *e. coli* be performed on a periodic basis as determined by MDE and HCHD. If treatment is provided, both pre- and post-treatment water should be sampled. Total coliform bacteria testing results are a good indication of the sanitary integrity of the system. *E. coli* analyses help diagnose the specific source and cause of a positive total coliform bacteria result because *e. coli* are present in the feces of warm-blooded animals. All positive results should be investigated, with the cause then corrected. Sources with chronic *e. coli* contamination should be rehabilitated, disinfected and filtered, or abandoned and replaced.

6.2 SWA Area Management Recommendations; MDE and HCHD

Many wellhead protection objectives are most commonly achieved via ordinance or restrictive covenant. However, ordinance-based wellhead protection is easier to implement at the municipal scale. ALWI believes that ordinances imposing greater land use restrictions than already within COMAR would be difficult to support, enact and enforce. Within this limitation, we recommend focus on wellhead integrity improvements, materials storage improvements, confirmatory sampling, treatment retrofits where necessary and/or use of bottled supplies in lieu of potentially costly repairs and rehabilitation measures.

6.2.1 Nitrate - Nitrogen Hazard Reduction Strategies

Nitrates are inorganic compounds that originate as non-point source contamination from the fertilization of farm fields and related practices of agricultural origin. Nitrates also can arise from point sources, such as sewage storage and disposal systems in the SWAs or in upgradient areas. It is possible that the elevated nitrate concentration recorded for many of the subject TNCs is a combination of both point- and non-point sources.

Specific recommendations to mitigate the nitrate hazard are provided below. The order of these recommendations reflects ALWI's judgment of their relative benefit:

1. **Enhanced Treatment for New Septic Systems** - Nitrate-nitrogen likely is of anthropogenic origin, suggesting that appropriately conceived and executed strategies may mitigate the hazard and/or reduce risk of contamination. ALWI recommends that the owners of new septic systems within the SWA areas be encouraged to have advanced pre-treatment systems or recirculating sand filter systems.

2. **Community Outreach to Agricultural Land Owners and Tenant Farmers** - MDE and/or HCHD may consider an area-wide community outreach and awareness program, concentrating on agricultural landowners. ALWI recommends that assistance be solicited from local agricultural extension officials in contacting and educating affected parties as to the benefits of adopting nutrient management practices. MDE and/or HCHD also should consider a mass mailing with pertinent information on source reduction and nutrient management, to owners of the subject TNCs, as a measure to educate them on contamination issues.

6.2.2 Household Hazardous Waste Collection Days; Dumping Mitigation

ALWI recommends that MDE and HCHD jointly establish and maintain a program for household hazardous waste collection days. We also recommend that existing informal refuse disposal practices in the SWA areas cease; letters to the affected PWSID owners may accomplish this goal. Any dumping areas or informal vehicle storage area should be cleaned up by the affected property owners to the degree financially feasible.

7.0 CONCLUSIONS

In preparing this SWA report and specifically the conclusions enumerated below, ALWI has utilized its best level of effort consistent with its professional standards, present scientific judgment and knowledge. We have upheld accepted industry practice and prepared this SWA report within the budgetary and work scope limitations set forth in its contract with MDE. Subject to this provision and the assumptions and exclusions specified and mutually agreed in the aforementioned contract and/or referenced herein, ALWI's conclusions follow:

1. **SWA Area Delineations** - In accordance with the 1999 MDE SWAP, ALWI delineated SWA areas around each subject TNC (Table 1) as having a fixed radius of 1,000 feet.

2. **Contamination Hazards** - ALWI identified and catalogued existing and potential contaminant hazards in each SWA area in accordance with the 1999 MDE SWAP. Not all hazards are equal in immediacy, proximity and condition. Hazards are mapped within Appendix A and summarized in Table 2.

3. **Quantitative Susceptibility Assessment** - For the most part, we found that many of the wells are susceptible to nitrate and/or bacteriologic contamination (Tables 3 and 4). Some of the reported bacteriologic concentrations of these contaminants already have risen to levels where proactive rehabilitation and/or treatment seem warranted. In most of the other wells, nitrate concentrations approach or exceed 50% of the respective maximum contaminant levels (MCL), wherein continued close monitoring is warranted but treatment seems premature and possibly unnecessary.

8.0 SELECTED REFERENCES

Edwards Jr., J., 1993, Geologic Map of Howard County, Maryland, Maryland Geological Survey, 1:62,500.

Maryland Department of Environment, 1999, Source Water Assessment Guidance Document.

United States Environmental Protection Agency, 1974, Safe Drinking Water Act, Amended 1986.

Table 1: Summary Table of Subject TNCs

System Name	PWSID	Source ID	Source Type	Tag Number	Wellhead Integrity	Hazards/Concerns [2]	Year Drilled	Aquifer Unit [3]
Circle D Farm Club House	1131005	1	GW	HO-94-0144	satisfactory	6 USTs and informal refuse observed nearby	1994	Morgan Run Formation
Glenelg UMC	1131013	1	GW	unknown	unsatisfactory [1]	loose cap; UST observed nearby	unknown	Morgan Run Formation
Lisbon VFD	1131021	1	GW	HO-81-1643	satisfactory	none at wellhead	1986	Pleasant Grove Formation
Morgan Station Inn	1131028	1	GW	unknown	satisfactory	none at wellhead	unknown	Morgan Run Formation
Lu & Joe's	1131029	1	GW	HO-94-3350	satisfactory	none at wellhead	unknown	Gillis Group/Liberty Complex
Country Kettle Cafe	1131032	1	GW	HO-94-3114	satisfactory	none at wellhead	unknown	Pretty Boy Schist
St. James UMC	1131036	1	GW	HO-67-0246	satisfactory	none at wellhead	1967	Morgan Run Formation
Woodbine Inn	1131041	1	GW	HO-88-1249	satisfactory	none at wellhead	1990	Pretty Boy Schist
Calvery Lutheran Church	1131046	1	GW	HO-81-0188	satisfactory	UST observed nearby	1983	Pretty Boy Schist
Howard County Fair (Office)	1131050	1	GW	unknown	satisfactory	none at wellhead	unknown	Sykesville Formation
Larriland Farms	1131052	1	GW	HO-94-1010	satisfactory	none at wellhead	unknown	Pleasant Grove Formation
West Howard Swim Club	1131058	1	GW	HO-81-0043	satisfactory	UST observed nearby	1983	Pretty Boy Schist
West Howard Swim Club	1131058	2	GW	HO-81-0030	unsatisfactory [1]	loose cap	1983	Pretty Boy Schist
Little George's Country Meat Market	1131064	1	GW	HO-81-1199	satisfactory	4 USTs, informal refuse and a dry cleaner observed nearby; gw discharge location in MDE database	1985	Morgan Run Formation
Willow Springs Golf Course	1131067	1	GW	HO-88-6466	satisfactory	none at wellhead	1989	Sykesville Formation
Cattail Creek CC Clubhouse	1131068	2	GW	HO-92-0305	satisfactory	disconnected well	unknown	Sykesville Formation
Cattail Creek CC Clubhouse	1131068	1	GW	HO-92-0304	unsatisfactory [1]	loose cap; disconnected well observed nearby	1993	Sykesville Formation
Glenwood Baptist Church	1131073	1	GW	HO-94-0114	satisfactory	UST observed nearby	1994	Sykesville Formation
Highs-Glenelg	1131074	1	GW	HO-81-1982	satisfactory	4 USTs, informal refuse and a dry cleaner observed nearby	1987	Morgan Run Formation
Howard County Fair (Wash Racks)	1131076	1	GW	HO-88-0702	satisfactory	none at wellhead	1989	Sykesville Formation
Howard County Fair (Exhibit Hall 1)	1131077	1	GW	HO-73-0765	satisfactory	none at wellhead	1974	Sykesville Formation
Howard County Fair (Main Exhibit Hall)	1131078	1	GW	HO-81-0423	satisfactory	none at wellhead	1984	Sykesville Formation
McDonald's/ Lisbon Plaza	1131080	1	GW	HO-94-0039	satisfactory	none at wellhead	1994	Pretty Boy Schist
Pizza Hut - Lisbon	1131082	1	GW	HO-81-1979	not visible	under manhole	1987	Pretty Boy Schist
St. Andrew's Episcopal Church - Chapel	1131084	1	GW	HO-88-0639	satisfactory	none at wellhead	1989	Sykesville Formation
Glenwood Center	1131085	1	GW	unknown	satisfactory	none at wellhead	unknown	Sykesville Formation
Howard County Fair (4-H Hall)	1131088	1	GW	HO-05-0428	not visible	underground	1963	Sykesville Formation
Highs-Cooksville	1131091	1	GW	HO-94-0809	satisfactory	2 USTs observed nearby	1996	Sykesville Formation
Circle D Farms Dowd House	1131093	1	GW	HO-73-1417	satisfactory	none at wellhead	1976	Morgan Run Formation
Howard County Fair (Poultry Building)	1131095	1	GW	HO-70-0008	satisfactory	none at wellhead	1969	Sykesville Formation
Royal Farms Store	1131096	1	GW	HO-94-1084	satisfactory	4 USTs, informal refuse and a dry cleaner observed nearby; 2 gw discharge locations in MDE database	1997	Morgan Run Formation
Therapeutic and Recreational Riding Ctr.	1131097	1	GW	HO-94-2656	satisfactory	none at wellhead	unknown	Sykesville Formation
Fox Valley Pool	1131100	1	GW	HO-94-1512	satisfactory	none at wellhead	1998	Morgan Run Formation
Citgo Gas Station	1131103	1	GW	unknown	not visible	enclosed; 3 USTs observed nearby	unknown	Pleasant Grove Formation
Bureau of Highways	1131105	1	GW	HO-73-1792	satisfactory	none at wellhead	1976	Sykesville Formation
Gethsemane Baptist Church	1131111	1	GW	HO-81-0720	satisfactory	none at wellhead	1984	Sykesville Formation
St. Andrew's Episcopal Church - Parish	1131112	1	GW	HO-94-2590	satisfactory	none at wellhead	2000	Sykesville Formation

[1] See report Section 4.3 for details.
[2] See Table 2 for a more detailed description of the hazards associated with each well.
[3] Aquifer unit determined through the use of *Geologic Map of Howard County* (Edwards, Jr. 1993).

Table 2: Point-Source Contamination Hazards

Associated System Name	Associated PWSID	Regulated Entity (Hazard) Name	Regulated Entity (Hazard) Address	Nature of Hazard [1]	Basis [2]	Chemical Class	Figure No.	Figure ID
Circle D Farm Club House	1131005	Bureau of Highways	14212 Frederick Road, Cooksville, MD 21723	UST (6)	Field Identified	VOC	A-5	A
Circle D Farm Club House	1131005	Bureau of Highways	14212 Frederick Road, Cooksville, MD 21723	informal refuse	Field Identified	various	A-5	B
Glenelg UMC	1131013	Glenelg UMC	13900 Burntwoods Road, Glenelg, MD 21737	UST (1)	MDE Database	VOC	A-6	A
Little George's Country Meat Store	1131064	Little George's Country Meat Store	3800 Ten Oaks Road, Glenelg, MD 21737	informal refuse	Field Identified	various	A-6	B
Glenwood Baptist Church	1131073	Glenwood Baptist Church	Rte. 97 & Roxbury Road, Cooksville, MD 21723	UST (1)	Field Identified	VOC	A-6	C
Highs-Cooksville	1131091	Highs-Cooksville	2101 Roxbury Mill Road, Cooksville, MD 21723	UST (2)	Field Identified	VOC	A-4	A
Royal Farms Store	1131096	Western Elementary School, No. 3	13500 Block, Triadelphia Road, Glenelg, MD 21042	gw discharge	MDE Database	IOC/nitrates	A-6	D
Citgo Gas Station	1131103	Citgo Gas Station	15943 Frederick Road, Lisbon, MD 21765	UST (3)	Field Identified	VOC	A-2	A
Various	1131046, 1131058	Calvery Lutheran Church	16161 Old Frederick Road, Woodbine, MD 21797	UST (1)	Field Identified	VOC	A-2	B
Various	1131064, 1131074, 1131096	Highs-Glenelg	13605 Triadelphia Road, Glenelg, MD 21737	UST (3)	Field Identified	VOC	A-6	E
Various	1131064, 1131074, 1131096	Royal Farms	3901 Ten Oaks Road, Glenelg, MD 21737	UST (1)	Field Identified	VOC	A-6	F
Various	1131064, 1131074, 1131096	Ten Oaks Cleaners	3900 Ten Oaks Road, Glenelg, MD 21737	dry cleaner	Field Identified	VOC	A-6	G
Various	1131064, 1131096	Eyre's Bus Service, Inc.	13600 Triadelphia Road, Glenelg, MD 21737	gw discharge	MDE Database	IOC/nitrates	A-6	H
Various	1131074, 1131096	Joe Bell's Body Shop	3932 Ten Oaks Road, Glenelg, MD 21737	informal refuse	Field Identified	various	A-6	I

[1] The number in parentheses indicates the number of underground storage tanks (USTs) that were observed within the Source Water Assessment area for that particular regulated entity.

[2] Basis explains which source the recorded hazard came from. In the case where "MDE Database" is listed, that particular hazard was not field identified but was included in this table for conservatism.

Table 3: Bacteriologic Contaminant Susceptibility Table

Site Name	PWSID	Type of Bacteria	Units	Total Samples	Positive Samples	% Positive [1]	Time Period Positive	Max. Conc. Detected	Period of Record	Interpretive Susceptibility (yes/no)
Circle D Farm Club House	1131005	Total Coliform	col./100 mL	9	1	11%	2002	1	1996-2003	No
Glenelg UMC	1131013	Total Coliform	col./100 mL	19	5	26%	1997	66	1996-2003	Yes
Lisbon VFD	1131021	Total Coliform	col./100 mL	19	2	11%	1998	1	1996-2002	No
Morgan Station Inn	1131028	Total Coliform	col./100 mL	21	5	24%	2003-2004	16	1996-2004	Yes
Lu & Joe's	1131029	Total Coliform	col./100 mL	21	5	24%	1999-2001	40	1996-2004	No
Woodbine Inn	1131041	Total Coliform	col./100 mL	38	14	37%	1996-2003	201	1996-2004	Yes
Calvery Lutheran Church	1131046	Total Coliform	col./100 mL	12	1	8%	2002	1	1996-2003	No
Larriland Farms	1131052	Total Coliform	col./100 mL	10	1	10%	2000	5	1996-2003	No
West Howard Swim Club	1131058	Total Coliform	col./100 mL	34	10	29%	1996-2003	36	1996-2003	Yes
Little George's Country Meat Market	1131064	Total Coliform	col./100 mL	22	7	32%	1998	36	1996-2003	Yes
Willow Springs Golf Course	1131067	Total Coliform	col./100 mL	12	1	8%	2003	1	1996-2003	No
Howard County Fair (Wash Racks)	1131076	Total Coliform	col./100 mL	5	1	20%	1999	>0 [2]	1996-2002	No
McDonald's/Lisbon Plaza	1131080	Total Coliform	col./100 mL	27	6	22%	2000	2	1996-2003	No
Pizza Hut - Lisbon	1131082	Total Coliform	col./100 mL	33	9	27%	1997-2003	9	1996-2003	Yes
Circle D Farms Dowd House	1131093	Total Coliform	col./100 mL	6	2	33%	1998-2003	4	1998-2003	Yes
Therapeutic and Recreational Riding Ctr.	1131097	Total Coliform	col./100 mL	14	6	43%	1999-2002	145	1999-2003	Yes
		E. Coli	col./100 mL	14	1	7%	2000	1	1999-2003	
Citgo Gas Station	1131103	Total Coliform	col./100 mL	12	3	25%	2003	2	2001-2003	Yes
St. Andrew's Episcopal Church - Parish	1131112	Total Coliform	col./100 mL	5	2	40%	2003	1	2003	Yes

[1] Overall susceptibility to bacteria largely was guided on a 25% occurrence threshold. Those systems with positive results 25% of the time or more generally were deemed susceptible.

[2] In certain instances, laboratory reports indicated "presence" or "absence" of coliform bacteria, without quantitation.

Table 4: Chemical Contaminant Susceptibility Table

Site Name	PWSID	Compound > or = 50% of the MCL	Units	MCL (> or =)[1]	50% MCL (> or =)[2]	Total Samples	% Exc.	Time Period > or = 50% of the MCL	Max. Conc. Detected	Period of Record	Interpretive Susceptibility (yes/no)
Circle D Farm Club House	1131005	Nitrate	mg/L	**10 (3)**	5 (5)	8	100%	1997-2003	11	1997-2003	Yes
Glenelg UMC	1131013	Nitrate	mg/L	10 (0)	5 (1)	9	11%	2003	5.1	1996-2003	Yes
Lisbon VFD	1131021	Nitrate	mg/L	10 (0)	5 (8)	8	100%	1996-2003	9.4	1996-2003	Yes
Morgan Station Inn	1131028	Nitrate	mg/L	**10 (8)**	5 (3)	11	100%	1996-2003	13.2	1996-2003	Yes
Lu & Joe's	1131029	Nitrate	mg/L	10 (0)	5 (4)	8	50%	1999-2003	7.8	1996-2003	Yes
Country Kettle Café	1131032	Nitrate	mg/L	**10 (6)**	5 (1)	7	100%	1996-2003	19.5	1996-2003	Yes
Woodbine Inn	1131041	Nitrate	mg/L	10 (0)	5 (2)	8	25%	1996-2003	6.2	1996-2003	Yes
Calvery Lutheran Church	1131046	Nitrate	mg/L	10 (0)	5 (2)	8	25%	2001-2003	5.6	1996-2003	Yes
Howard County Fair (Office)	1131050	Nitrate	mg/L	10 (0)	5 (5)	5	100%	1998-2002	8	1998-2002	Yes
Larriland Farms	1131052	Nitrate	mg/L	10 (0)	5 (4)	9	44%	2000-2003	7.8	1996-2003	Yes
West Howard Swim Club	1131058	Nitrate	mg/L	10 (0)	5 (1)	8	13%	2002	5.1	1996-2003	No
Little George's Cntry. Meat Mark.	1131064	Nitrate	mg/L	10 (0)	5 (4)	6	67%	1998-2001	5.9	1996-2002	Yes
Willow Springs Golf Course	1131067	Nitrate	mg/L	10 (0)	5 (8)	8	100%	1996-2003	9.4	1996-2003	Yes
Cattail Creek CC Clubhouse	1131068	Nitrate	mg/L	10 (0)	5 (7)	10	70%	1997-2003	8.8	1996-2003	Yes
Highs - Glenelg	1131074	Nitrate	mg/L	10 (0)	5 (8)	8	100%	1996-2003	6.6	1996-2003	Yes
Howard County Fair (Wash Racks)	1131076	Nitrate	mg/L	10 (0)	5 (3)	5	60%	1999-2002	9.6	1998-2002	Yes
Ho. Co. Fair (Exhibit Hall 1)	1131077	Nitrate	mg/L	10 (0)	5 (4)	4	100%	1999-2002	9.7	1999-2002	Yes
Ho. Co. Fair (Main Exhibit Hall)	1131078	Nitrate	mg/L	10 (0)	5 (3)	6	50%	1998-2002	8.8	1998-2002	Yes
McDonald's/Lisbon Plaza	1131080	Nitrate	mg/L	10 (0)	5 (7)	8	88%	1996-2003	6.3	1996-2003	Yes
Pizza Hut - Lisbon	1131082	Nitrate	mg/L	10 (0)	5 (1)	8	13%	2003	5.2	1996-2003	Yes
St. Andrew's Epis. Chur.- Chapel	1131084	Nitrate	mg/L	10 (0)	5 (6)	6	100%	1996-2003	9.9	1996-2003	Yes
Howard County Fair (4-H Hall)	1131088	Nitrate	mg/L	**10 (4)**	5 (4)	12	67%	1997-2002	11	1997-2002	Yes
Circle D Farms Dowd House	1131093	Nitrate	mg/L	**10 (2)**	5 (4)	6	100%	1998-2003	12.2	1998-2003	Yes
Howard Co. Fair (Poultry Bldg.)	1131095	Nitrate	mg/L	10 (0)	5 (4)	4	100%	1998-2002	8.5	1998-2002	Yes
Therapeutic and Rec. Riding Ctr.	1131097	Nitrate	mg/L	10 (0)	5 (2)	4	50%	2000-2003	9.4	2000-2003	Yes
Citgo Gas Station	1131103	Nitrate	mg/L	**10 (2)**	5 (1)	3	100%	2001-2003	10.6	2001-2003	Yes
Bureau of Highways	1131105	Copper	mg/L	**1.3 (1)**	0.65 (0)	1	100%	2002	3.31	2002	Yes
		Lead	mg/L	**0.015 (1)**	0.0075 (0)	3	33%	2002	0.04	2002-2003	Yes
		Nitrate	mg/L	**10 (1)**	5 (1)	2	100%	2002-2003	12.5	2002-2003	Yes

[1] The number in parentheses indicates the number of times the measurements were detected at or above the MCL.

[2] The number in parentheses indicates the number of times the measurements were detected at or above 50% of the MCL and below the MCL.

Appendix C: Data Supporting Chemical Susceptibility Determinations

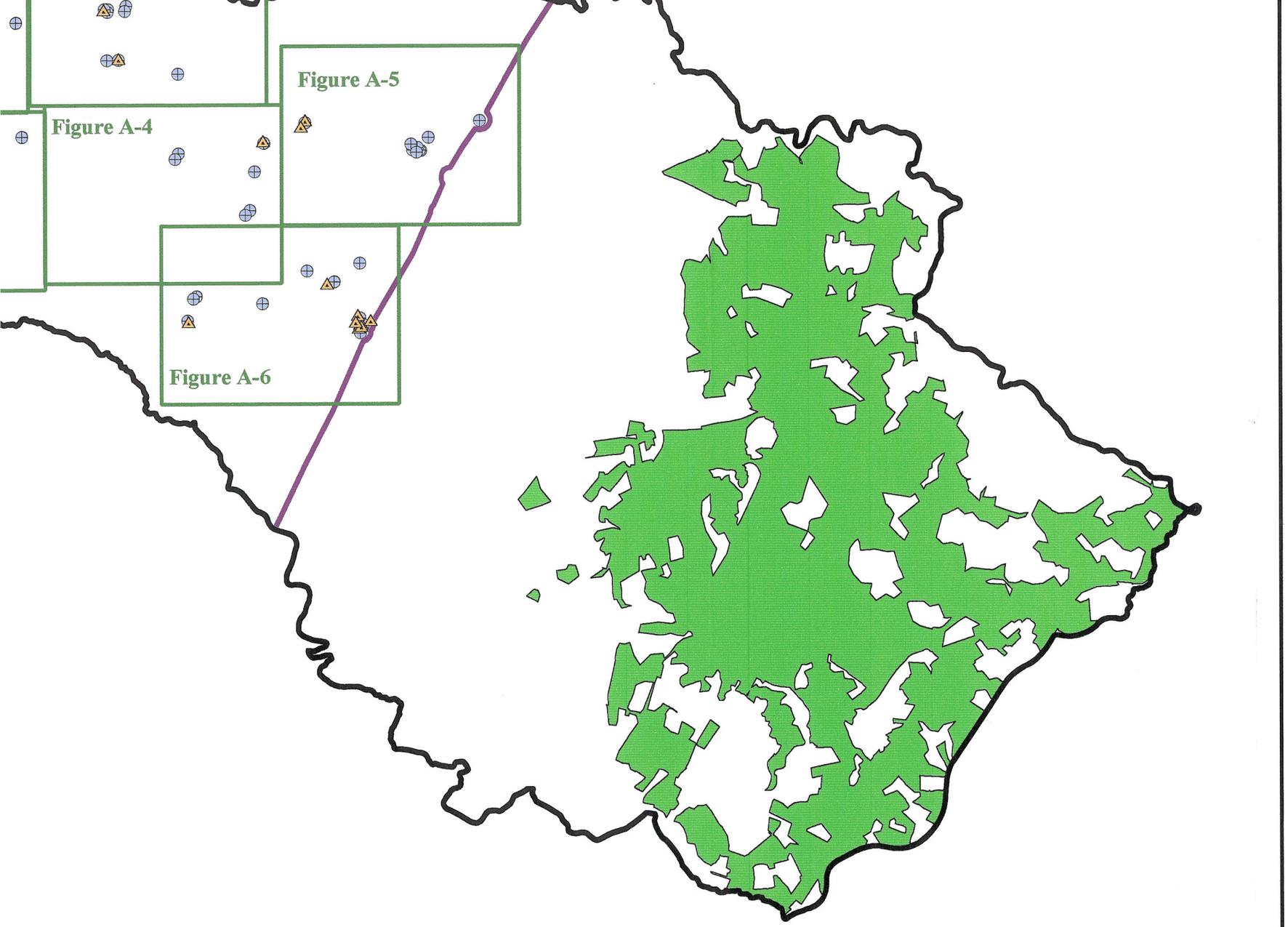
Site Name	PWSID	Compound	Units	MCL	Sample Date	Sample Result
Circle D Farm Club House	1131005	Nitrate	mg/L	10	May 19, 1997	8.6
					May 19, 1997	10.6
					May 11, 1998	9.1
					June 2, 1999	11
					June 7, 2000	9.2
					May 30, 2001	11
					June 10, 2002	8.8
					June 2, 2003	8.4
Glenelg UMC	1131013	Nitrate	mg/L	10	September 18, 2003	5.1
Lisbon VFD	1131021	Nitrate	mg/L	10	January 25, 1996	8
					February 25, 1997	7.7
					March 25, 1998	7.7
					March 18, 1999	8
					March 22, 2000	8.9
					March 26, 2001	8.9
					February 26, 2002	9.4
					March 24, 2003	8.4
Morgan Station Inn	1131028	Nitrate	mg/L	10	February 13, 1996	11
					March 6, 1996	11.2
					February 11, 1997	6.8
					August 25, 1997	9.1
					March 9, 1998	11.2
					October 7, 1998	10.6
					September 20, 1999	13.2
					September 28, 2000	10.4
					October 4, 2001	12.8
					October 4, 2001	12.8
					September 30, 2003	6.6
Lu & Joe's	1131029	Nitrate	mg/L	10	March 29, 1999	5.4
					March 26, 2001	5.4
					March 26, 2002	7.8
					March 24, 2003	7.2
Country Kettle Café	1131032	Nitrate	mg/L	10	February 20, 1996	13.8
					March 25, 1998	10.4
					February 3, 1999	10.4
					March 22, 2000	10.8
					January 18, 2001	10.2
					February 26, 2002	19.5
					March 27, 2003	6.1
Woodbine Inn	1131041	Nitrate	mg/L	10	September 25, 1996	5.3
					September 18, 2003	6.2
Calvery Lutheran Church	1131046	Nitrate	mg/L	10	December 18, 2001	5.6
					December 3, 2003	5.3

Appendix C: Data Supporting Chemical Susceptibility Determinations

Site Name	PWSID	Compound	Units	MCL	Sample Date	Sample Result
Howard County Fair (Office)	1131050	Nitrate	mg/L	10	August 12, 1998	7.1
					April 16, 1999	7.8
					April 17, 2000	7.5
					April 26, 2001	8
					April 26, 2002	7.9
Larriland Farms	1131052	Nitrate	mg/L	10	September 28, 2000	6.8
					September 27, 2001	6.9
					September 24, 2002	6
					September 9, 2003	7.8
West Howard Swim Club	1131058	Nitrate	mg/L	10	April 29, 2002	5.1
Little George's Country Meat Market	1131064	Nitrate	mg/L	10	September 28, 1998	5.5
					September 15, 1999	5.4
					September 20, 2000	5.3
					September 27, 2001	5.9
Willow Springs Golf Course	1131067	Nitrate	mg/L	10	August 26, 1996	8.1
					July 2, 1997	8.3
					October 1, 1998	8.1
					September 29, 1999	8
					September 26, 2000	8.4
					October 11, 2001	9.1
					December 4, 2002	9.4
					September 24, 2003	9.1
Cattail Creek CC Clubhouse	1131068	Nitrate	mg/L	10	May 14, 1997	8.4
					May 20, 1997	8.4
					May 5, 1998	8.8
					May 20, 1999	8.8
					May 18, 2000	8.3
					May 18, 2000	8.5
					May 20, 2003	8.1
Highs - Glenelg	1131074	Nitrate	mg/L	10	January 22, 1996	6.6
					January 7, 1997	6.6
					February 2, 1998	6.5
					March 1, 1999	6.6
					February 15, 2000	6.5
					January 9, 2001	6.3
					March 28, 2002	6.1
					March 25, 2003	5.6
Howard County Fair (Wash Racks)	1131076	Nitrate	mg/L	10	April 16, 1999	9.6
					June 13, 2000	8.2
					April 26, 2002	8.3
Howard County Fair (Exhibit Hall 1)	1131077	Nitrate	mg/L	10	April 19, 1999	9.7
					June 13, 2000	9.4
					April 26, 2001	8.9
					April 26, 2002	8.9

Appendix C: Data Supporting Chemical Susceptibility Determinations

Site Name	PWSID	Compound	Units	MCL	Sample Date	Sample Result
Howard County Fair (Main Exhibit Hall)	1131078	Nitrate	mg/L	10	August 12, 1998	8.8
					April 16, 1999	5.1
					April 26, 2002	5.4
McDonald's/Lisbon Plaza	1131080	Nitrate	mg/L	10	September 24, 1996	5.3
					September 28, 1998	5.1
					September 29, 1999	5.6
					September 25, 2000	5.9
					September 27, 2001	6.3
					September 16, 2002	5.2
					September 9, 2003	5.6
Pizza Hut - Lisbon	1131082	Nitrate	mg/L	10	September 9, 2003	5.2
St. Andrew's Episcopal Church - Chapel	1131084	Nitrate	mg/L	10	December 10, 1996	6.9
					October 7, 1998	6.8
					September 22, 1999	6.4
					September 28, 2000	8.3
					October 11, 2001	7.1
					June 3, 2003	9.9
Howard County Fair (4-H Hall)	1131088	Nitrate	mg/L	10	April 14, 1997	7.9
					April 14, 1997	11
					April 14, 1997	5.3
					April 14, 1997	10.2
					April 14, 1997	10.7
					April 25, 1997	10.8
					April 26, 2001	5.8
					April 26, 2002	5.8
Circle D Farms Dowd House	1131093	Nitrate	mg/L	10	May 11, 1998	9.8
					June 2, 1999	9.5
					June 7, 2000	10.8
					May 30, 2001	12.2
					June 10, 2002	8.9
					June 2, 2003	9.9
Howard County Fair (Poultry Building)	1131095	Nitrate	mg/L	10	August 12, 1998	8.2
					April 17, 2000	8.3
					April 26, 2001	8.1
					April 26, 2002	8.5
Therapeutic and Recreational Riding Ctr.	1131097	Nitrate	mg/L	10	March 1, 2000	8.8
					March 10, 2003	9.4
Citgo Gas Station	1131103	Nitrate	mg/L	10	June 20, 2001	9.8
					September 16, 2002	10.6
					September 9, 2003	10.4
Bureau of Highways	1131105	Copper	mg/L	1.3	January 29, 2002	3.31
		Lead	mg/L	0.015	January 29, 2002	0.04
		Nitrate	mg/L	10	January 29, 2002	9.8
					March 31, 2003	12.5



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EXPLANATION:

- Source Wellhead
- Potential Contamination Hazard
- Detailed Figure Extents (see Appendix A)
- Report Regions
- Active Sewer Service Areas

Scale:

12500 0 12500 25000 Feet

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SOURCE WATER ASSESSMENT FOR GROUNDWATER SUPPLIES SERVING TRANSIENT NON-COMMUNITY SYSTEMS IN WESTERN HOWARD COUNTY

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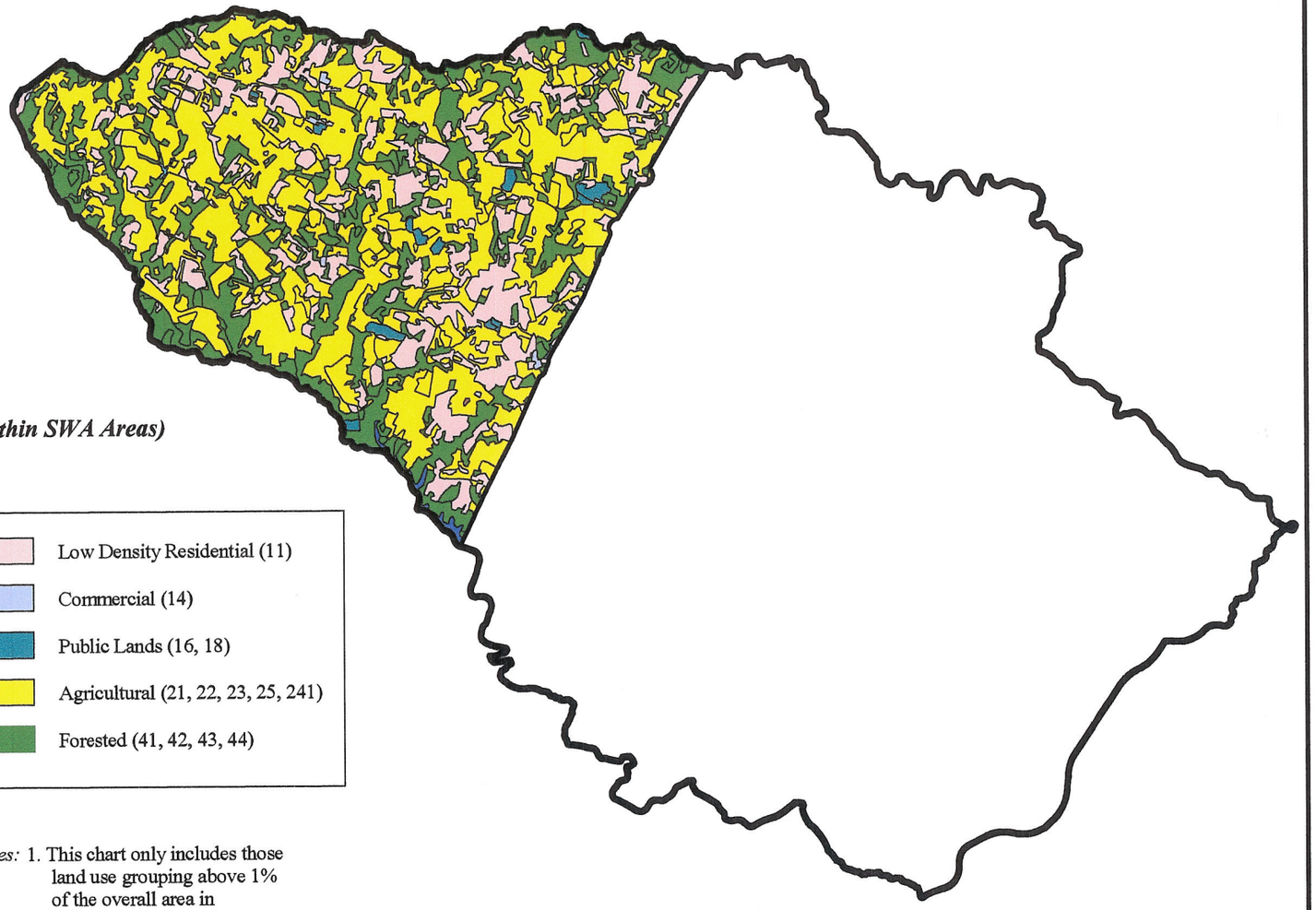
Figure 1:

Countywide Index of SWA Maps

n	Area (sq. meters)	Percentage of Total Area
	1,997,239	26.26
ıtial	7,663	0.10
	370,082	4.87
	314,056	4.13
	529,082	6.96
	2,311,494	30.39
	581,644	7.65
c.	212,838	2.80
	98,665	1.30
	834,101	10.97
	47,694	0.63
	143,881	1.89
	40,418	0.53
	116,991	1.54



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EXPLANATION:

Land Uses Within Western Howard County:

Residential:

- Low-density Residential
- Medium-density Residential
- High-density Residential

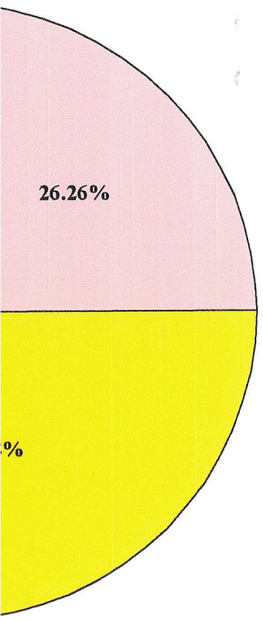
Other:

- Water Body
- Public Lands
- Forested
- Commercial
- Agricultural
- Industrial
- Wetlands
- Bare Ground

Scale:

17500 0 17500 35000 Feet

of Overall Area by Land Use (Within SWA Areas)



- Low Density Residential (11)
- Commercial (14)
- Public Lands (16, 18)
- Agricultural (21, 22, 23, 25, 241)
- Forested (41, 42, 43, 44)

Notes: 1. This chart only includes those land use grouping above 1% of the overall area in Western Howard County
2. Land use codes comprising each grouping in parentheses

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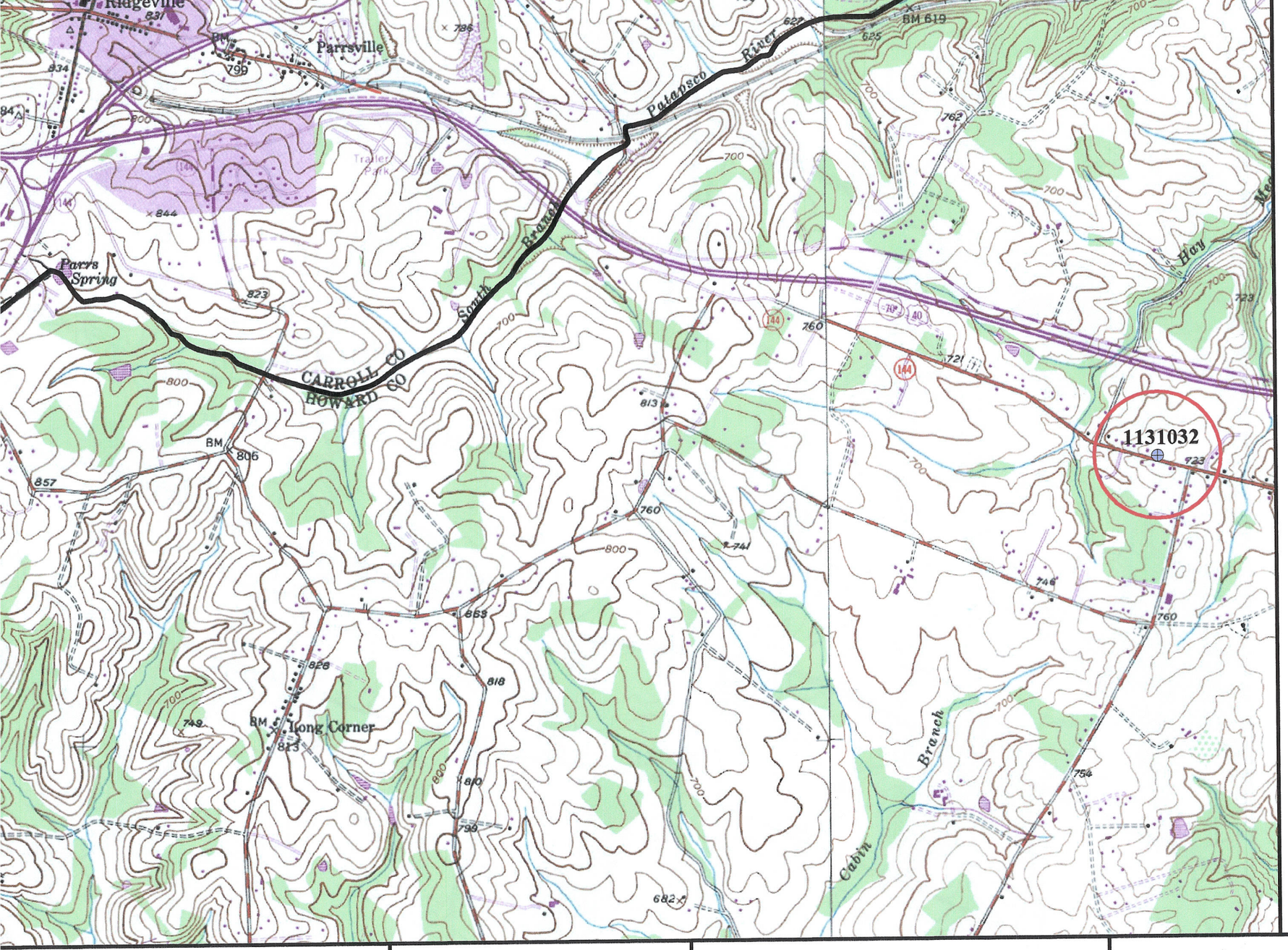
Figure 2:

Land Use Map



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EXPLANATION:

- Source Wellhead
- Source Water Assessment Area (1,000 ft radius)
- Howard County Boundary

Subject Sources:

PWSID	Source Name
1131029	Lu & Joe's
1131032	Country Kettle Cafe

Scale:

2000 0 2000 4000 Feet

GS topographic quadrangle map for
and Woodbine, MD (photorevised 1979);

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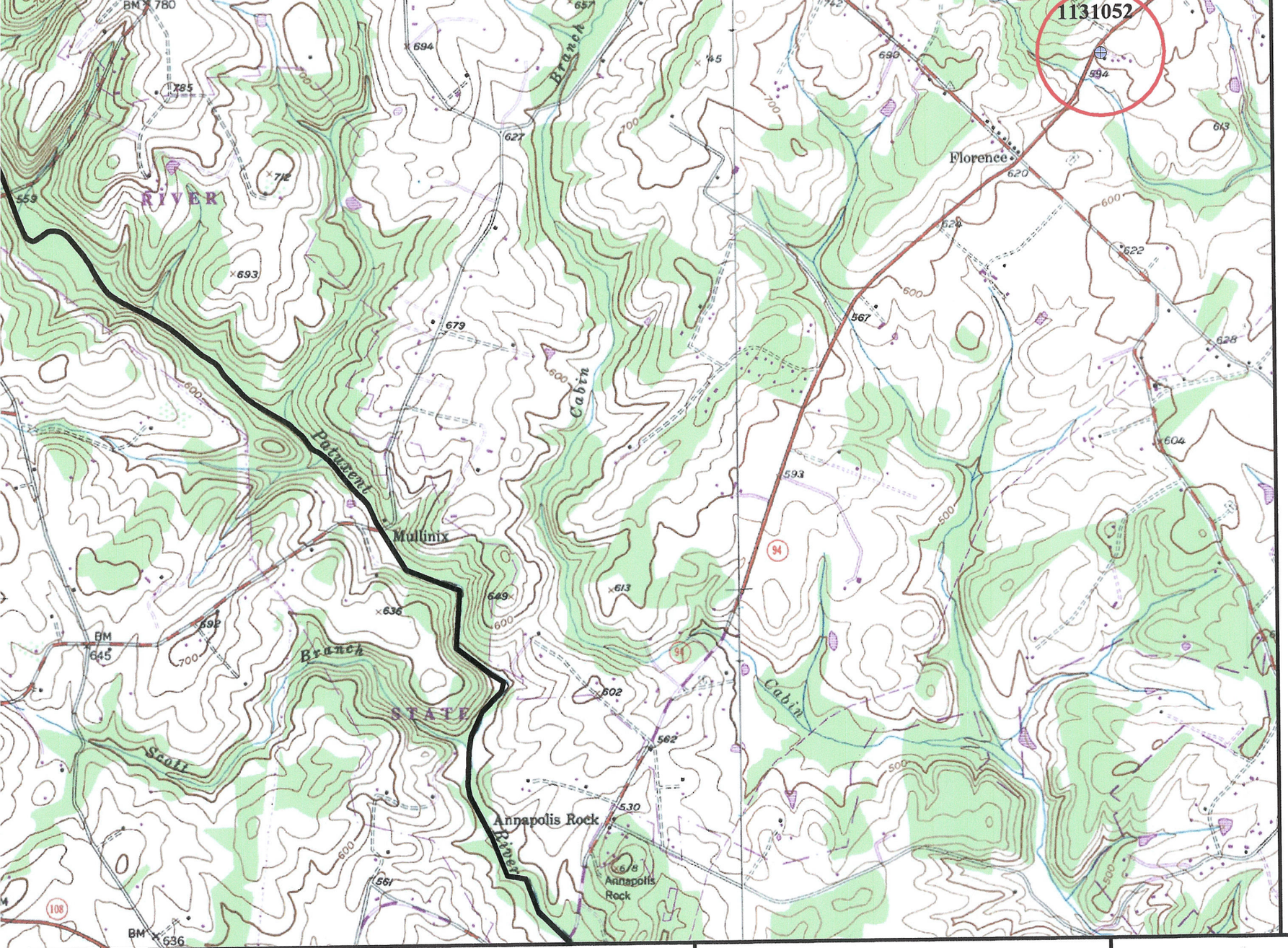
Figure A-1:



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EXPLANATION:

- Source Wellhead
- Source Water Assessment Area (1,000 ft radius)
- Howard County Boundary

Subject Sources:

PWSID	Source Name
1131052	Larriland Farms

Scale:

2000 0 2000 4000 Feet

GS topographic quadrangle maps for
) and Damascus, MD (photorevised 1993);

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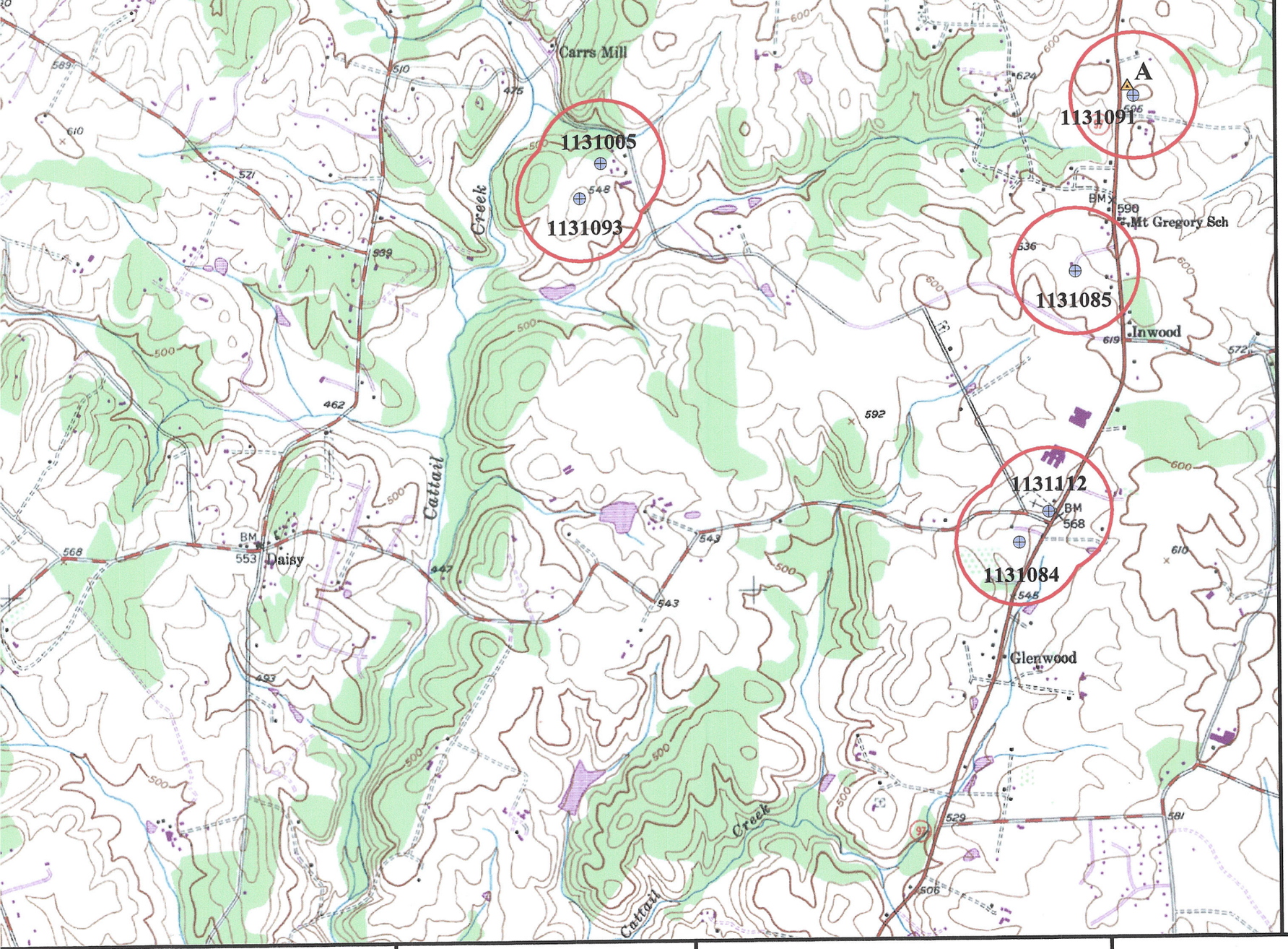
Figure A-3:



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EXPLANATION:

- Source Wellhead
- Potential Contamination Hazard
- Source Water Assessment Area (1,000 ft radius)

Subject Sources:

PWSID	Source Name
1131005	Circle D Farm Club House
1131084	St. Andrew's Episcopal Church - Chapel
1131085	Glenwood Center
1131091	Highs - Cooksville
1131093	Circle D Farm Dowd House
1131112	St. Andrew's Episcopal Church - Parish

Scale:

2000 0 2000 4000 Feet

USGS topographic quadrangle map for
); provided by MapTech, Inc.
2 of this report.
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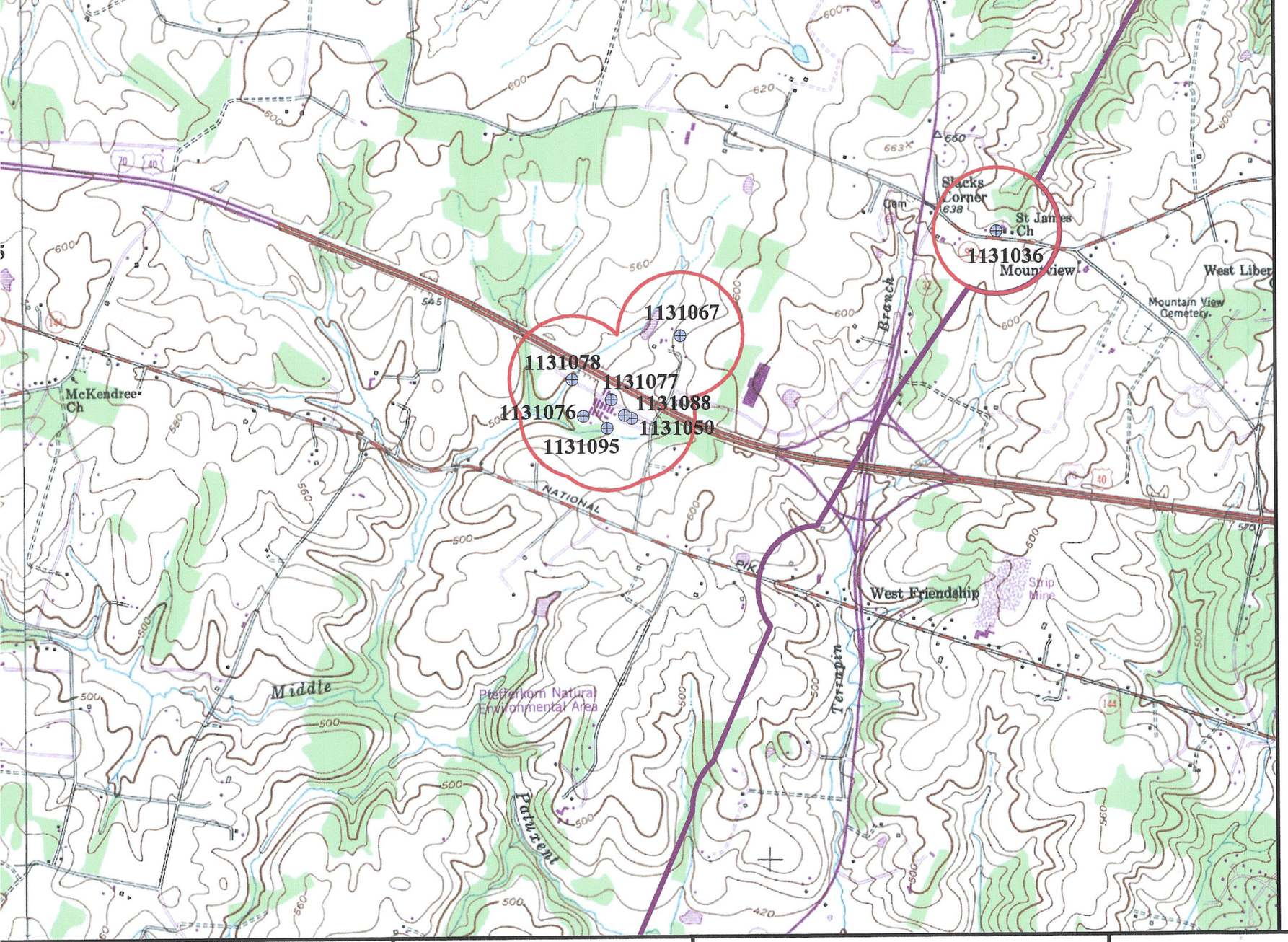
Figure A-4:



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EXPLANATION:

- Source Wellhead
- Potential Contamination Hazard
- Howard Report Area Boundary
- Source Water Assessment Area (1,000 ft radius)

Subject Sources:

PWSID	Source Name
1131036	St. James UMC
1131050	Howard County Fair (Office)
1131067	Willow Springs Golf Course
1131076	Howard County Fair (Wash Racks)
1131077	Howard County Fair (Exhibit Hall 1)
1131078	Howard County Fair (Main Exhibit Hall)
1131088	Howard County Fair (4-H Hall)
1131095	Howard County Fair (Poultry Building)
1131105	Bureau of Highways

Scale:

2000 0 2000 4000 Feet

SGS topographic quadrangle maps for
otorevised 1979); provided by MapTech, Inc.
e 2 of this report.
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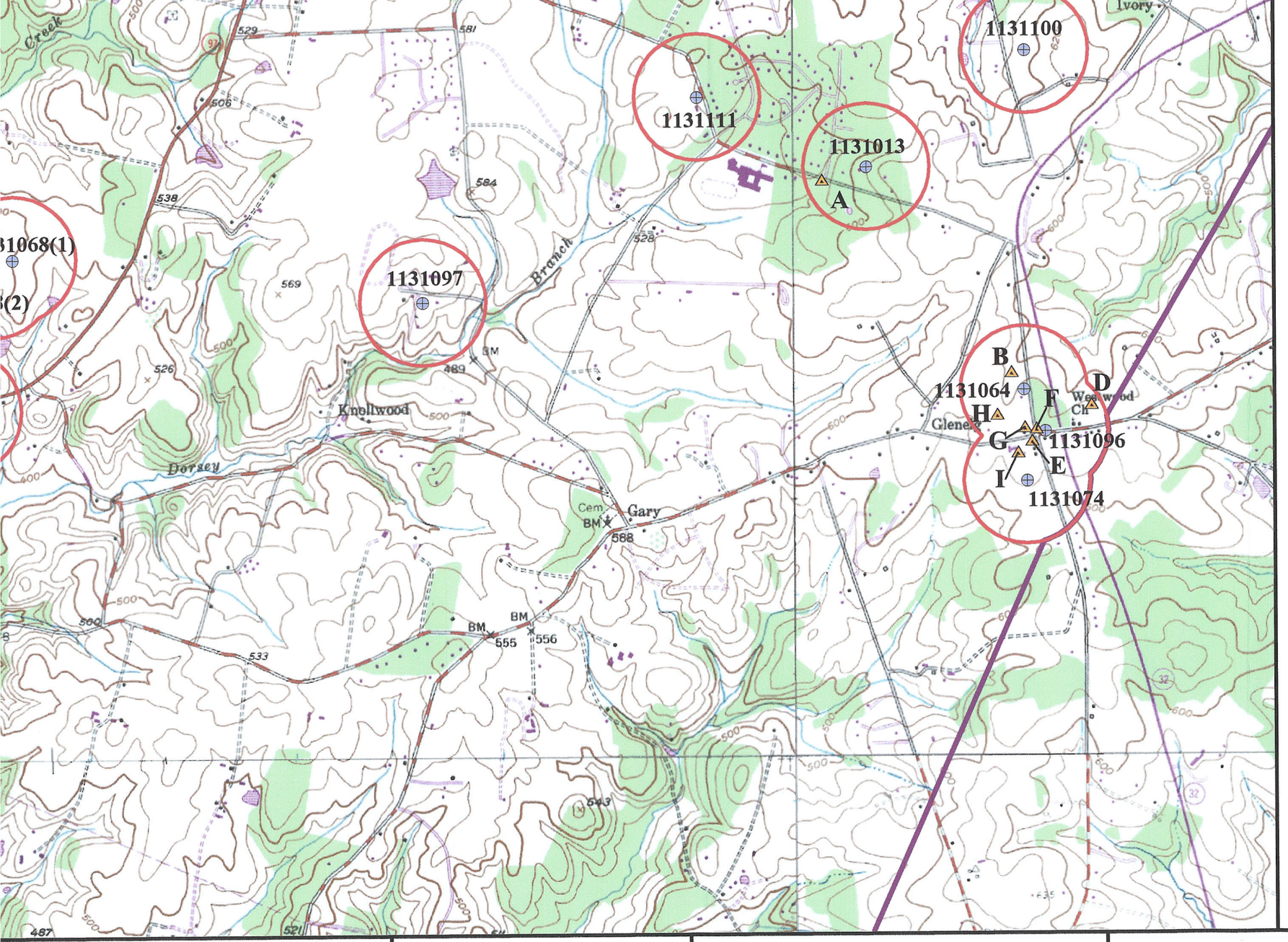
Figure A-5:



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EXPLANATION:

- Source Wellhead
- Potential Contamination Hazard
- Howard Report Area Boundary
- Source Water Assessment Area (1,000 ft radius)

Subject Sources:

PWSID	Source Name
1131013	Glenelg UMC
1131064	Little George's Country Meat Market
1131068(1)	Cattail Creek CC Clubhouse
1131068(2)	Cattail Creek CC Clubhouse
1131073	Glenwood Baptist Church
1131074	Highs - Glenelg
1131096	Royal Farms Store
1131097	Therapeutic and Recreational Riding Ctr.
1131100	Fox Valley Pool
1131111	Gethsemane Baptist Church

Scale:

2000 0 2000 4000 Feet

1 USGS topographic quadrangle map for
and Sandy Springs, MD (photorevised 1979);

e 2 of this report.
report and should only be used in that context.

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Figure A-6: