MARYLAND

Department of the Environment

Groundwater Protection Program

Annual Report to the Maryland General Assembly 2012

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The Maryland General Assembly
Annapolis, MD

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MDE

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EXECUTIVE SUMMARY

Senate Joint Resolution No. 25 of 1985 requires the Maryland Department of the Environment (MDE) to provide an annual report on the implementation of a Comprehensive Groundwater Protection Strategy, and the coordinated efforts by State agencies to manage groundwater in the State. This document is the annual report of efforts to characterize, restore, allocate, conserve and protect groundwater through programs coordinated by MDE, the Maryland Department of Agriculture (MDA) and the Maryland Department of Natural Resources (MDNR) in State Fiscal Year (FY) 2012. The report reflects the evolution of State programs in response to advancing science and increasing public interest in the quality and quantity of groundwater, and the State's continuing emphasis on citizen education and assistance to reinforce regulatory programs.

Groundwater is a finite natural resource that sustains Maryland's natural ecosystems in addition to supporting significant and growing human water supply demands. Approximately one third of Maryland's population currently depends on groundwater for drinking water. As the population in Maryland continues to grow, the demand for groundwater for drinking, irrigation, industry, and other uses is increasing, while threats to groundwater quality related to that development also increase. Programs to better understand and manage this critical resource must be strengthened to ensure that an adequate supply of groundwater is available for existing and future generations.

Highlights of groundwater management initiatives coordinated by the State during FY 2012 (July 1, 2011 – June 30, 2012) include the following activities:

- Progress continued on Phase II of the regional Coastal Plain Assessment. Activities included further development of the regional groundwater flow model, incorporation of new data and refinements to the Coastal Plain Aquifer Information System, and an evaluation of the regional monitoring networks. Work also continued on the regional Fractured Rock Water Supply Study and focused on the development of the Fractured Rock Aquifer Information System, finalization of the Fractured Rock Science Plan, the development of a workplan for the compilation of water use data, and an evaluation of potential withdrawal impacts to the hydroecological integrity of fractured rock streams.
- A study evaluating groundwater-age in the upper Patapsco aquifer in Maryland's Coastal Plain demonstrated that groundwater-age ranges from modern to over 500,000 years old. The age of this water indicates that groundwater in this aquifer is essentially non-renewable.
- Maryland was granted primacy enforcement authority by EPA for regulation of two rules under the Safe Drinking Water Act, including The Long Term 2 Enhanced Surface Water Treatment Rule and The Groundwater Rule.
- MDE continued efforts to upgrade onsite sewage disposal systems through use of Bay Restoration Funds (BRF). As of June of 2012, Bay Restoration Fund grants had been used to fund upgrades for septic systems serving 3,732 equivalent dwelling units.

- The Marcellus Shale Safe Drilling Initiative Advisory Commission continued to study the potential effects of natural gas drilling in Maryland. The first part of the study will be issued in December, 2012. In addition, a study of methane in Garrett and Allegany Counties was initiated to provide baseline methane data prior to any drilling.

INTRODUCTION AND BACKGROUND

The Maryland General Assembly passed Senate Joint Resolution No. 25 mandating the development of a Comprehensive Groundwater Protection Strategy for the State in 1985. The Assembly charged the Department of the Environment (MDE), the Department of Agriculture (MDA) and the Department of Natural Resources (MDNR) with responsibility for groundwater protection in Maryland, designated MDE as the lead agency, and required MDE to provide an annual report on the coordinated efforts by State agencies to protect and manage groundwater.

A steering committee formed by MDE, MDA and MDNR produced Maryland's Comprehensive Groundwater Protection Strategy in 1986. The Strategy described the State's existing groundwater protection programs, established groundwater protection goals and recommended ways to improve groundwater protection. The Maryland Groundwater Protection Strategy, originally developed in 1986, is guided by the following goal:

> *The State of Maryland is committed to protect the physical, chemical and biological integrity of the groundwater resource, in order to protect human health and the environment, to ensure that in the future an adequate supply of the resource is available, and in all situations, to manage that resource for the greatest beneficial use of the citizens of the State.*

State, federal and local agencies continue to work cooperatively to achieve this goal with programs that educate business, industry, and the public about the importance of water protection and conservation, in concurrence with programs that enforce federal and State water protection laws. Maryland has become a leader in the implementation of land use practices that minimize the impacts of development on surface and groundwater with best management practices, sensitive area protection (forests, wetlands, groundwater recharge areas, etc.) and Smart Growth that promotes development in regional growth centers where transportation and other public infrastructure are already in place.

This report provides an overview of the condition of Maryland's groundwater resources and a description of efforts in FY 2012 to characterize, restore, allocate, conserve and protect groundwater through programs coordinated by MDE, MDA, and MDNR**.**

MDE Secretary, Robert Summers, participates in an elementary school education event for Groundwater Awareness Week, March 2012

MARYLAND'S GROUNDWATER RESOURCES

Groundwater is an abundant, but finite natural resource that sustains Maryland's natural ecosystems and growing population. Groundwater is the source of crucial, continuous base flows to Maryland's rivers, streams and wetlands. It is also a large source of the freshwater that flows to the Chesapeake Bay and to coastal bays. Groundwater also provides freshwater for residential, agricultural, industrial, energy production and other uses in Maryland. About twenty-six percent of Maryland citizens obtain their drinking water from groundwater sources. About half of these obtain water from a well that they own, while the other half obtain their drinking water from public water systems that use groundwater. In southern Maryland and the Eastern Shore, groundwater meets practically all water supply needs.

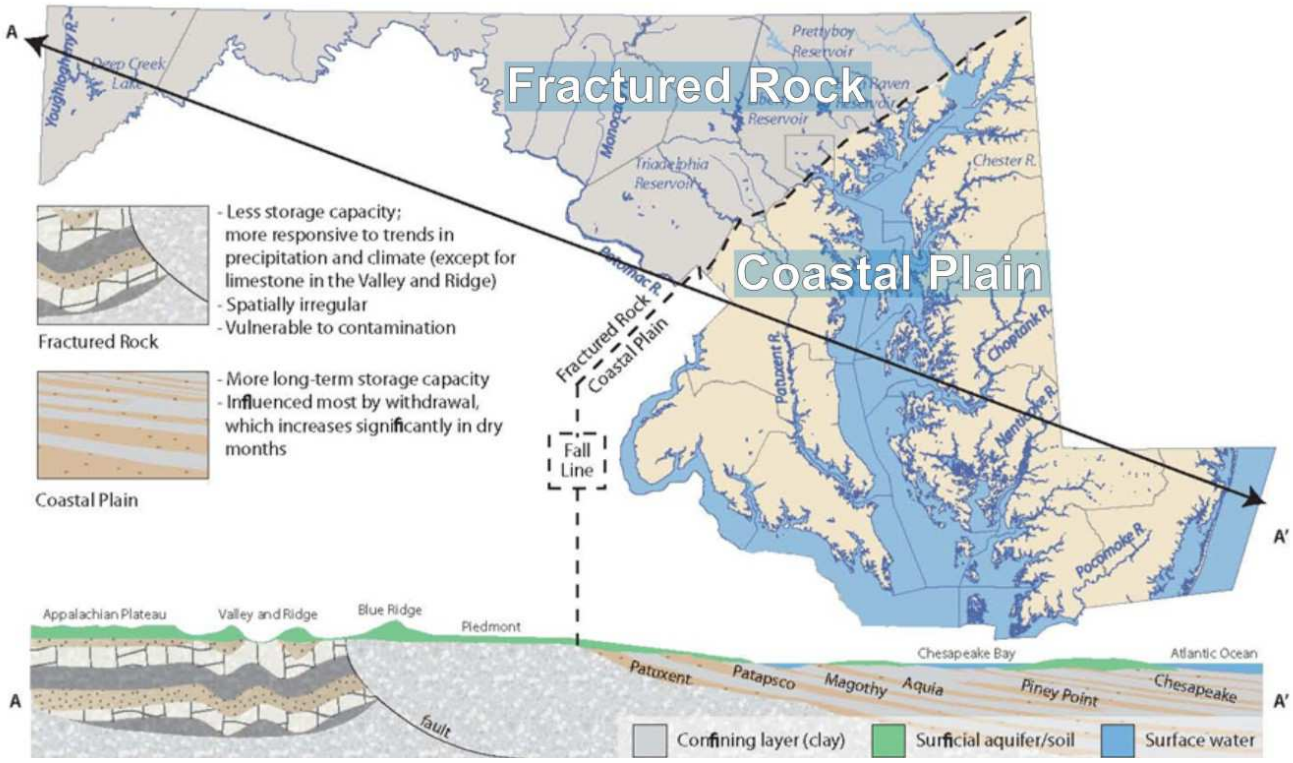
Geologic Conditions

Geologic conditions vary widely across the State, and produce significant variations in the quantity and quality of groundwater. Aquifers in Maryland fall into two major types: unconsolidated Coastal Plain aquifers found east of the Fall Line (a geologic divide that generally coincides with the Interstate 95 corridor), and hard rock aquifers found in the western part of the State. Coastal Plain aquifers composed primarily of sand and gravel layers separated by layers of silt and clay, are productive and generally of good quality. Hard rock aquifers are composed of consolidated sedimentary and crystalline rock, and provide generally low to moderate water yields.

Unconfined aquifers are found throughout the State, and are the primary source of groundwater in the western part of the State. Water levels in these aquifers undergo seasonal fluctuation and are principally recharged by precipitation during the fall and winter months. Confined aquifers, in contrast, are not as directly influenced by precipitation and climate changes because they are separated from the ground surface by relatively impervious layers such as silt, clay or rock. Such aquifers are the primary source of drinking water in southern Maryland and the Eastern Shore. The water levels in certain confined aquifers in southern Maryland and in the Aquia aquifer in Queen Anne's County show long-term steady declines in areas of high use. Increased water demands from a growing population place new stresses on these aquifers. More detailed monitoring and analysis of the State's groundwater resources is needed to assess the long-term viability of many of the State's aquifers in the face of existing and increasing demands for water.

In the Piedmont region, where aquifers consist largely of fractured, consolidated bedrock, successful groundwater production depends on the size and number of water-bearing fractures encountered at a particular well site. Consequently, some fractured-rock aquifers have the lowest yields in the State. Consolidated rocks of sedimentary origin, which can be found in parts of the Piedmont, Valley and Ridge, and Appalachian Plateau regions, can yield higher amounts of water than fractured rock aquifers. Carbonate aquifers have some of the highest yields of consolidated aquifers in Maryland due to the presence of potentially large solution cavities, a factor that also renders them susceptible to contamination from surface sources.

Declining water level trends in some areas of southern Maryland have raised questions about the long-term sustainability of current groundwater withdrawals. On the Eastern Shore, increases in agricultural irrigation and urban growth continue to place greater demands on groundwater supplies. The uncertain degree to which groundwater moves between different aquifers in the Coastal Plain is a major obstacle to reliable predictions of sustained aquifer yields in both Southern Maryland and the Eastern Shore. In hard rock aquifers in the western part of Maryland, the availability of groundwater to meet the increasing demands of growing communities is also uncertain, particularly where growth is concentrated.



Division and characteristics of fractured-rock and Coastal Plain geology in Maryland (from MDNR)

Groundwater Quality and Quantity

Except in some urban and industrial areas, Maryland's groundwaters are generally of good quality and meet drinking water standards. Incidents of serious contamination are usually localized near specific contamination sources. However, geologic conditions in some areas of the State make groundwater more vulnerable to anthropogenic influences. Areas most susceptible to groundwater contamination from local land use are the carbonate rock areas of Allegany, Washington, Fredrick, Carroll and Baltimore Counties; the unconfined Coastal Plain aquifers; the outcrop areas of major confined aquifers along the Baltimore-Washington corridor; and the hard rock aquifers of central and western Maryland. Potential contaminant sources

include point sources such as landfills, underground storage tanks, spills, improper discharge of wastes containing solvents (such as dry cleaning fluids) and improper storage of salt, fertilizer, or other materials on bare ground. Military installations often present unique risks such as contamination from perchlorate, an ingredient of solid rocket propellant.

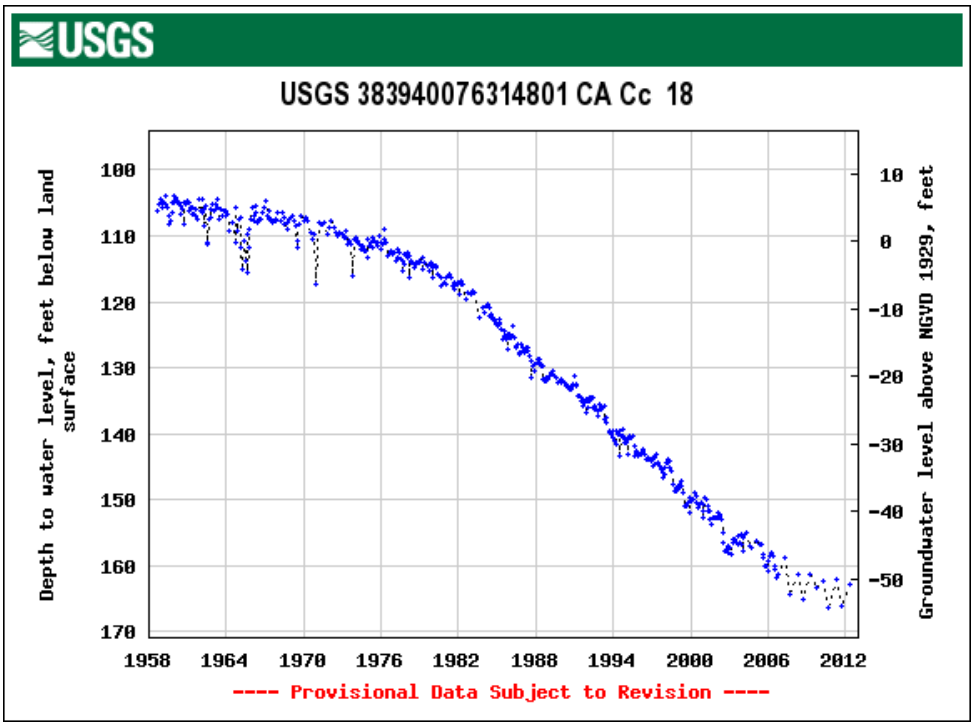
Nonpoint sources of groundwater contamination include livestock waste, onsite sewage disposal, application of fertilizers and pesticides, infiltration of urban runoff and road salt application. Nonpoint sources usually do not cause excessive contamination at specific well locations but often represent the largest loadings of pollutants to groundwater over large areas. Because groundwater contributes a significant percentage of water to surface water flow, delivery and reduction of nutrients via groundwater is a significant issue for Maryland's streams and reservoirs, and has a major impact on water quality in the Chesapeake Bay.

Local natural conditions affect both the availability and the quality of groundwater. While natural groundwater quality is generally good, some areas may have hard water and locally high iron levels. Surveys of naturally occurring radionuclides in groundwater have shown that portions of the Magothy and Potomac Group aquifers in the Coastal Plain, primarily in Anne Arundel County, are subject to high levels of radium. The Piedmont Aquifers of central Maryland often have elevated radon levels. Levels of naturally occurring arsenic above the federal drinking water standard are not uncommon in the Aquia and Piney Point aquifers in southern Maryland and the central Eastern Shore, and in Garrett County. In portions of the carbonate rock aquifers of Central and Western Maryland, groundwater may be directly influenced by surface water, presenting the risk of pathogen contamination.

In the past, Maryland's water resources were generally sufficient to meet all needs. Drought related water restrictions in 2002 and increasing building moratoriums due to localized water shortages however, provide evidence that water supplies are finite and are insufficient in some circumstances to meet current demands. Maryland's population is expected to increase by about 1.1 million over the next 25 years. The additional pressures of a growing population will further tax the State's water resources.

As water demand increases with population growth, communities find it increasingly difficult to find sufficient quantities of water without reaching beyond the boundary where they have a clear right to withdraw groundwater. The need to preserve some groundwater as base flow discharge to local streams and wetlands also affects its availability for withdrawals. In some areas, water quality concerns can limit the quantity of water available for withdrawal. For example, the threat of brackish water intrusion into the Aquia aquifer beneath Kent Island has precluded its full development as a drinking water supply source. In other instances, groundwater contamination due to a variety of human activities has affected water withdrawals at numerous sites.

Reliable assessments of water availability cannot be made without additional monitoring and modeling of groundwater movement within and between aquifers. Such information is needed to better predict the movement of groundwater contaminants as well. Estimating the sustainable yield of the State's aquifers will be an essential step in assessing the adequacy of Maryland's groundwater to meet the needs of current and future generations and their environment.



Water-level decline in a well in the Aquia aquifer, Calvert County (from USGS)

Water levels in Pretty Boy Reservoir, northern Baltimore County, during the drought of 2002 (from USGS)

GROUNDWATER RESOURCES PROTECTION

The following summary of State groundwater protection programs and actions in FY 2012 reflects a response to increasing public interest in the quantity and quality of groundwater and advances in hydrogeology and other groundwater related sciences. These interrelated programs are presented in this report in the following categories: Coordination of Groundwater Protection, Management of Groundwater Resources, Monitoring and Assessment of Groundwater, Planning for Changing Conditions, and Oversight of Public Water Systems. Additional activities related directly to water quality are considered separately in the following chapter of this report.

Coordination of Groundwater Protection

Agency Coordination

A number of State agencies are involved with the protection of Maryland's groundwater resources, including the MDE, the Maryland Department of Agriculture (MDA), and the Maryland Department of Natural Resources (MDNR). Many programs within MDE regulate specific types of potential pollution sources to the State's water resources and address compliance with applicable regulations. These programs' activities related to groundwater are described in subsequent sections. In addition to protecting water quality, MDE's Water Supply Program manages water withdrawals to ensure against unreasonable impacts on the water resource and other users.

MDA coordinates with MDE on issues related to pesticide usage and nutrient management. Development of regulatory controls and best management practices for storage and application of pesticides helps to minimize groundwater contamination. Nutrient management plans protect the health of waterways by establishing both short and long-term strategies for reducing nutrient levels in groundwater, streams, rivers and the Chesapeake Bay. MDE also works with the Maryland Geological Survey (MGS) of the MDNR on projects related to the assessment of water supplies and groundwater resources. Ongoing projects include state-wide groundwater quality and groundwater level monitoring.

In addition to coordinating with other State agencies, MDE partners with federal agencies, such as the United States Geological Survey (USGS), to conduct technical projects on groundwater quality or resource availability. Currently, two studies, the Coastal Plain Groundwater Study and the Fractured-Rock Water Resources Study are ongoing. Partnership with the U.S. Environmental Protection Agency (EPA) is essential for implementation of the Safe Drinking Water Act.

EPA provides funding through §106 of the Clean Water Act to assist in the coordination of groundwater protection activities. Maryland's annual funding for this program is approximately $385,000. These funds are used to support the coordination of activities around the State, including groundwater assessment projects, wellhead protection efforts and educational outreach activities.

Data Management

MDE currently uses an Enterprise System that incorporates and links information throughout the Department, allowing transparent access to accurate, up-to-date information among various business Programs. This system known as "Tools for Environmental Management and Protection Organizations" (TEMPO) provides access to permit application forms, permit renewals, inspection and enforcement data. MDE benefits from this centralized data source by providing interaction between the regulated community and MDE.

MDE's Water Supply Program has initiated development of a new data management system for managing water appropriation permits, to replace the existing legacy RAMS/WAN system. This new data management system will facilitate the issuance, management, and enforcement of water appropriation permits through a geographically-based system that is web-accessible. The system will allow permittees to electronically report water use data and supporting documentation for permit applications and will allow the MDE to analyze usage patterns in order to better plan for and manage water withdrawals throughout the State. Completion of the new database is expected by Fall 2013.

MDE's Water Supply Program is also reviewing options for the replacement of the Public Drinking Water Information System (PDWIS) with the EPA's Safe Drinking Water Information System (SDWIS-State) database. SDWIS contains information about public water systems and their violations of EPA's drinking water regulations. Conversion to SDWIS will increase program efficiency by automating the entry of water quality monitoring data and allowing direct interface between MDE and EPA programs.

Outreach

Each September, the Water Supply Program sponsors the Maryland Groundwater Symposium. This event has continued to evolve as a key source of topical information on the most current issues affecting groundwater management in the State. In September 2011, the twentieth annual symposium attracted more than 430 sanitarians and other groundwater professionals from local governments, State and federal agencies, and private sector organizations. More than thirty presenters addressed a variety of topics related to groundwater, including, but not limited to, groundwater hydrogeology, drinking water protection, stormwater management, onsite sewage disposal systems, and planning efforts related to water supply. Presenters included participants from State and federal organizations, including MDE, MDNR (including MGS), EPA, USGS, Maryland Conference of Local Environmental Health Directors, Maryland State Builder's Association, Anne Arundel County Department of Public Works, New Jersey Department of Environmental Protection, Maryland State Water Quality Advisory Committee, and several consulting companies.

The Governor of the State of Maryland proclaimed the week of March 11-17, 2012, as Groundwater Awareness Week. Secretary Robert Summers, PhD of MDE participated in outreach events at Col. Richardson Middle School in Federalsburg, Caroline County and Eastport Elementary School, Annapolis, Anne Arundel County to promote the importance of groundwater to school aged children.

Management of Groundwater Resources

The Maryland Coastal Plain region, including southern Maryland and the Eastern Shore, is largely dependent upon groundwater for its water supply. Decades of increased pumping has caused water-levels to decrease by as much as two feet per year in parts of the Eastern Shore. Steadily declining water levels can result in the inability of some homeowners to continue to withdraw water from their existing wells. While sufficient water is available, the homeowners are not able to tap it because their wells are not deep enough, or their pumps cannot be lowered to reach new drawdown levels.

Communities in the Piedmont region sometimes do not have sufficient water supplies to support projected growth. One problem can be that the available yield from wells often does not provide the amount of water that the system was permitted to withdraw, or that the original pump tests indicated that the wells would achieve. The economic downturn has resulted in less rapid growth in these areas; however, it is anticipated that these communities could experience water supply deficiencies when economic conditions change.

The conditions described above highlight the importance of managing water resources, including the management of both use and demand. MDE's Water Supply Program's Source Protection and Appropriation Division manages water use by ensuring that water uses are beneficial and do not have an unreasonable impact on the resource or other users. The State also assists with community development of plans to reduce demand, manage growth, and seek alternative water supplies.

Demand management is a means for extending water supplies and delaying or eliminating the need to develop new sources. Sound water use practices reduce the amount of stress that we place on our resources, both by limiting water withdrawals and by decreasing wastewater discharges. Managing demand is one important and relatively inexpensive alternative that water suppliers can use to meet their water supply needs.

Water efficiency technologies, water reuse, and behavioral changes can reduce water demand by at least ten to 20 percent, effectively extending existing water supplies. Demand management strategies can include a variety of options. Potential approaches include reducing losses from leakage, implementing rate structures or rate surcharges that encourage customers to conserve, providing incentives for customers to install low-flow fixtures or appliances, working individually with large-volume users to identify potential water savings, and using public outreach and education to encourage consumers to modify their behavior.

Water Appropriation and Use Permitting

MDE's Water Supply Program (WSP) has the responsibility of controlling the impacts of groundwater withdrawal through the Water Appropriations and Use Permit process. Evaluation of Water Appropriations and Use Permits can include demand analysis, aquifer testing, fracture trace analysis, water level monitoring, evaluation of water balance, and other similar investigations. MGS and USGS groundwater data and modeling are also used in the evaluation. Review criteria are applied to determine whether the amount of water requested is reasonable for the proposed use, and whether the proposed use will adversely impact the resource or other users. Through the permit

review process, the WSP attempts to assure that groundwater withdrawals do not exceed the sustained yield of the State's aquifers.

The WSP has delineated Water Management Strategy Areas, which are areas that require special groundwater management consideration. Management options include limiting withdrawals in a certain aquifer, directing withdrawals to a different aquifer, or additional scrutiny and/or water level monitoring when permits are requested for these areas. For example, the Aquia aquifer on the Kent Island in Queen Anne's County is affected by salt water intrusion, which is exacerbated by pumping. To prevent further degradation of the Aquia aquifer, new appropriations for Kent Island are directed to deeper aquifers. Special management considerations are also taken into account when permitting withdrawals for the Aquia aquifer in the Annapolis Neck area of Anne Arundel County, the Magothy and upper and lower Patapsco aquifers in the Indian Head and Waldorf areas of Charles County, and the Columbia aquifer beneath the Ocean Pines area in Worcester County.

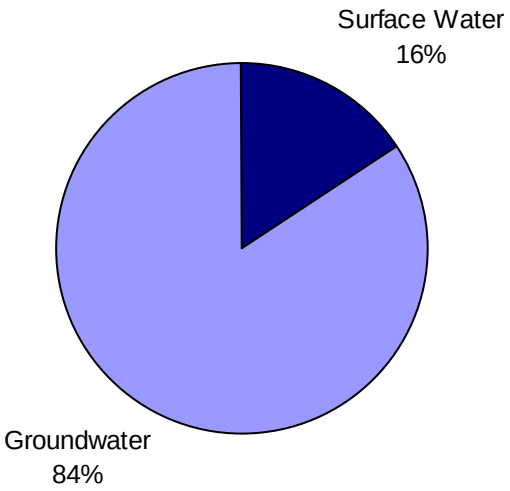
Agricultural water use has been growing steadily in recent years, particularly for irrigation on Maryland's Eastern Shore. In general, the WSP directs large irrigators to use the unconfined aquifers, reserving the more protected confined aquifers for individual potable and municipal uses. In some areas, however, the unconfined aquifer produces low yields, or is nonexistent, compelling an increasing number of farmers to seek water appropriation permits for confined aquifers or surface water.

Between March 2011 and March 2012, WSP issued approximately 662 Water Appropriations and Use Permits, including new and reissued permits. Of new permits issued, forty-two percent of these permits were issued for agricultural irrigation. However, approximately seventy-five percent of the permits issued for water use greater than 10,000 gallons per day (average use) were for agricultural purposes. About eighty-four percent of all permits issued were for groundwater withdrawals as opposed to withdrawals from surface water. In addition to processing permit applications, the program continued to evaluate requests for exemptions, per *Maryland Code Annotated*, Environment Article §5-502. The law exempts most groundwater withdrawals of 5,000 gallons per day (gpd) or less from the requirement to obtain a permit. Permits must still be obtained for community drinking water systems and withdrawals located in Water Management Strategy Areas. In FY 2012, 446 exemptions were granted.

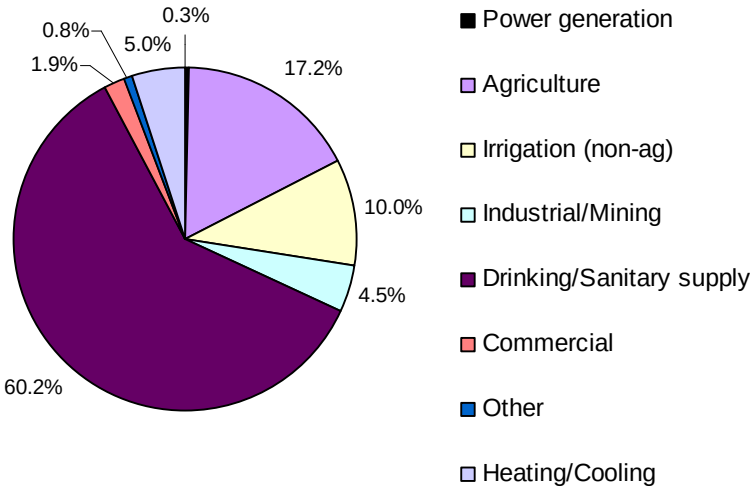
Environment Article §5-516 enacted civil penalties for violations of appropriation regulations, or failing to comply with a Water Appropriations and Use Permit. This allows the WSP to more effectively enforce permit conditions. In FY 2012, the WSP issued Notices of Violation for failure to renew a permit, failure to report water usage as required by the permit, and for withdrawing more water than is allocated under the permit. WSP also increased their focus on compliance with special permit conditions. In FY 2012, 93 enforcement actions were taken.

In April 2012, Senate Bill (SB) 117 was signed by Governor Martin O'Malley. Generally, prior to granting Water Appropriations and Use Permits for an annual average of more than 10,000 gallons per day (gpd), public notification (newspaper publication and public hearing) and service of notice to contiguous property owners is required. Dewatering associated with construction projects is typically short in duration and needs to begin with little notice. SB 117 authorizes MDE to waive the hearing requirements for a construction dewatering project.

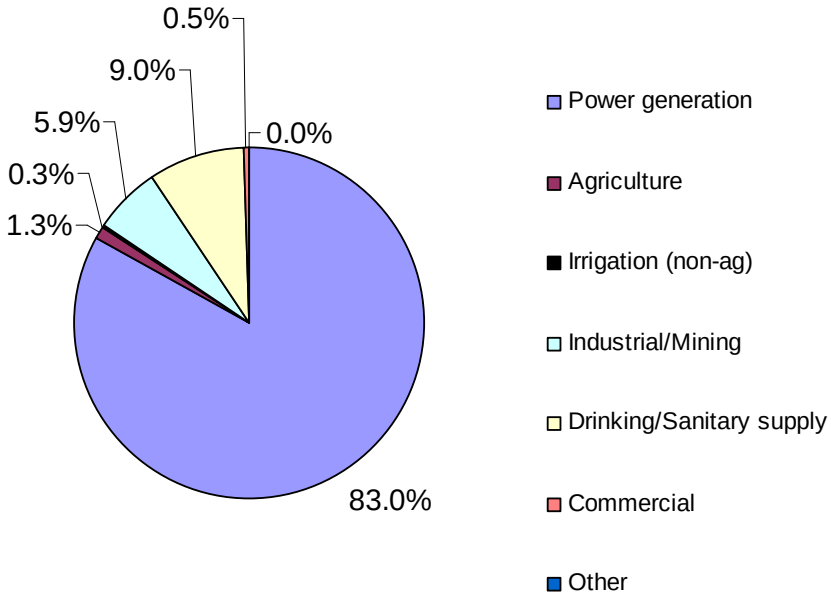
Notification will occur earlier in the permit evaluation process which will allow comments to be addressed prior to issuing the permit. When it takes effect in October, 2012, the law will reduce the permit processing time for construction dewatering projects.



Water source for permits issued from March 2011 to March 2012



Type of water use for all active permits as a percentage of the total number of permits issued (to March 2012)



Type of water use for all active permits as a percentage of total water appropriated (e.g. 83% of all water appropriated is for power generation; data to March 2012)

Demand Management, Water Conservation, and Water Reuse

Water demand management is the implementation of a strategy to influence water demand and useage, as opposed to making changes on the water supply side. Use of demand management technologies is not widespread in Maryland. Guidance issued by MDE and the Maryland Department of Planning (MDP) to assist local governments with meeting the requirements of House Bill 1141 (2006) encourages local governments to undertake demand management as one aspect of their strategies to meet future water needs. Currently, however, there is not a well-developed State-level program to assist local governments to implement demand management programs.

The 2008 Report of the Governor's Advisory Committee on the Management and Protection of the State's Water Resources recommended that State water policies encourage water suppliers, commercial and residential users, and industries to utilize incentives, water conservation, and water reuse technologies in order to reduce water demand.

The Maryland Water Conservation Act, passed during the 2002 legislative session, requires that as water appropriation permits for large water systems are renewed or expanded, that they be modified to require that these utilities consider certain conservation measures. The Maryland Water Conservation Act also required MDE to produce guidelines on water conservation best management practices for water utilities. This document was published in October 2003 and is available on MDE's website. MDE also requires water systems applying for loans and grants to include a water audit with their application, and if funds are awarded, to develop water conservation plans.

Revised guidelines for land treatment of municipal wastewater were finalized and adopted into regulation in April 2010. These new regulations allow high quality effluent to be used in public areas such as parks and athletic fields.

MDE is developing regulations to encourage the use of highly treated wastewater treatment plant effluent in a variety of commercial and residential settings including "purple pipe" systems to deliver reclaimed water for residential use as (non-potable) irrigation water. A stakeholder workgroup has reviewed similar regulations that have already been developed by other states, and is in the process of formulating new regulations. This has involved working with the Maryland Plumbing Board to ensure a coordinated approach. In addition, applicants seeking water appropriation permits for power generation and other non-potable uses are asked to evaluate alternative sources of water, including reclaimed water, prior to obtaining an appropriation permit for groundwater.

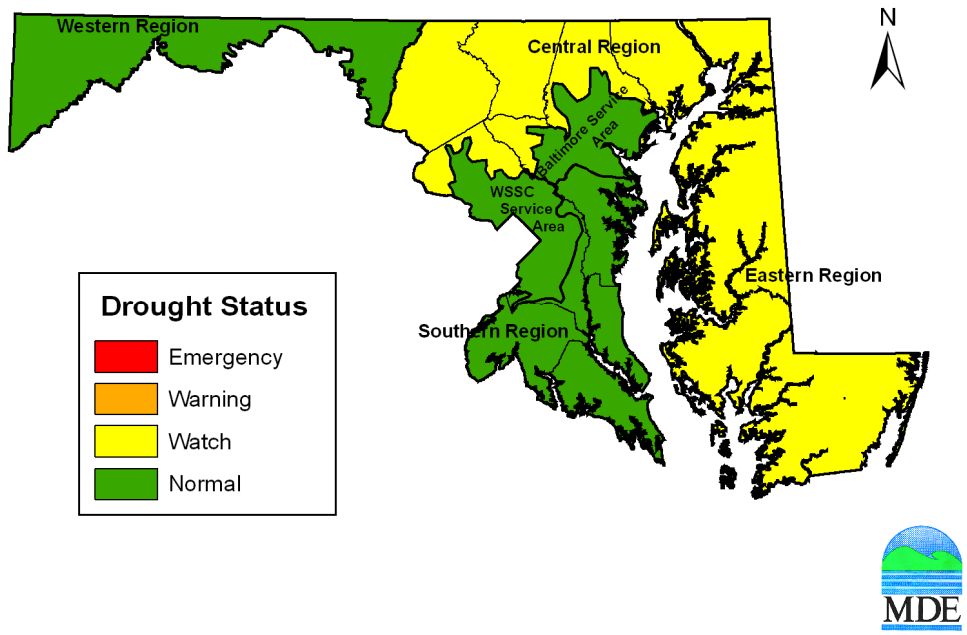
Drought Management

Drought conditions are evaluated on a regional basis, and drought status is assessed monthly during normal conditions and more frequently when drought conditions exist. During a period of drought emergency, MDE coordinates with local governments through a network of local drought coordinators and maintains continual contact with water suppliers to ensure that the detrimental impacts of a drought emergency are minimized. Each year, MDE works with the USGS to add "real-time" monitoring capability to additional wells that are monitored for drought. This improves data availability and allows the State to better assess drought conditions.

During FY2012, real-time capabilities at three of eight wells converted to real-time in FY 2010 were discontinued due to lack of funding; continued funding for the remaining five wells is uncertain, and they may be discontinued in FY 2013.

MDE evaluates drought status for each region using appropriate regional indicators, which may include rainfall, streamflow, groundwater levels, and reservoir storage. Rainfall is evaluated as percent departure from average, from the start of the Water Year (October 1). Streamflow is evaluated by comparing the 30 day average to the historic record of 30 day averages ending the same day of the year. Groundwater levels are evaluated either by comparison with the historic record of measured values in the same month of the year, or, for a confined aquifer, as a departure from trend. Reservoir levels are evaluated using an estimate of days of storage remaining. Regional assessments, however, may not be adequate to predict water shortages at specific localities and/or water systems. Some local governments have developed individualized drought response plans to meet their specific communities' needs.

The Eastern and Central Regions of Maryland were in Drought Watch at the end of FY 2012. MDE's website (www.mde.state.md.us/programs/Water/DroughtInformation) is accessible by the public and shows current hydrologic conditions and drought assessment data. When regions are "Watch" status, drought evaluation is performed twice a month.



Drought Status in Maryland as of June 30, 2012

Monitoring and Assessment of Groundwater

Many of the initiatives described below are ongoing efforts that provide critical support to other State groundwater management programs. Although these programs provide crucial short term information, their primary value will be the comprehensive picture of groundwater

resources that they will provide over time. The future of these projects is uncertain, and sufficient funding has not been secured to complete the necessary work. It is essential that long-range funding is provided to assure the maximum benefit of the groundwater assessment efforts.

Coastal Plain Groundwater Study

In 2004, the Maryland Advisory Committee on the Management and Protection of the State's Water Resources identified the need for a comprehensive assessment of groundwater resources in the Maryland Coastal Plain, where the population is expected to grow by 44 percent between the years 2002 and 2030. Withdrawals from the confined aquifers of the Coastal Plain in southern Maryland and the Eastern Shore have caused water levels in some aquifers to decline by tens to hundreds of feet from their original levels, and the rate of decline is expected to increase as the population in these areas grows. A more comprehensive understanding of the confined aquifer systems and how much water is available in these systems is needed in order to make sound management decisions and appropriately evaluate water withdrawal requests. The first phase of a three-phase Regional Coastal Plain Aquifer Assessment began in 2006.

In FY 2012, MDE, U.S. Geological Survey (USGS), and Maryland Geological Survey (MGS) worked on Phase II of the Regional Coastal Plain Assessment. Geologic and aquifer test data and other refinements were made to the Maryland Coastal Plain Aquifer Information System (MCPAIS). The MCPAIS is a geospatially-referenced database that includes hydrologic, geologic, and water-use data. MDE uses MCPAIS to aid in decision making for the allocation of water withdrawals. Other activities in FY 2012 included the collection of synoptic water-level measurements in the spring for calibration of the groundwater flow model, quality assurance of historical and current groundwater use data for model input, and extensive compilation of water withdrawal data to aid in the determination of long-term aquifer sustainability. Work also continued on development of the hydrogeologic framework, resulting in a draft report. A comprehensive review of the monitoring networks was completed, and a report was drafted on the current status of Coastal Plain groundwater-level monitoring. The project website for the Coastal Plain Groundwater Supply can be accessed at http://md.water.usgs.gov/wss/.

Significant effort was placed on the continued development of the groundwater flow model. Its framework was expanded via the incorporation of twenty-five new layers, including thirteen aquifers and twelve confining unit layers. Land surface elevations were entered along with model boundary conditions. Furthermore, various arrays were generated and preliminary outputs were evaluated.

Planned future activities include conducting detailed studies of the regional groundwater flow system and water budget, improving documentation of patterns of water quality in the aquifers, enhancing groundwater level, stream flow, and water quality monitoring networks, and developing tools to facilitate scientifically sound management of the groundwater resources in the Maryland Coastal Plain. To date, Phase I and II activities have been supported by funds from MDE and in-kind services from MDE, MGS, and USGS. Additional Coastal Plain Study activities beyond FY 2012 will require significant additional investment from current and new funding partners.

Fractured-Rock Water Supply Study

The Final Report of the Maryland Advisory Committee on the Management and Protection of the State's Water Resources identified the need for a comprehensive assessment of water resources in the part of Maryland underlain by fractured-bedrock aquifers. This region covers the area of the State north and west of Interstate 95 and supplies water to approximately 4.4 million Maryland residents, or approximately 76 percent of the State's population. The fractured rock region is particularly susceptible to drought, because groundwater is mostly unconfined and responds directly to recharge (or the lack thereof). The Fractured Rock Water Supply Study was initiated in 2009. Information about the study can be found at the project website: http://md.water.usgs.gov/wss/.

In FY 2012, the MDE, MGS, USGS, and the MDNR Monitoring and Non-Tidal Assessment Division (MDNR-MANTA) completed several tasks including the preparation of three reports for publication: the Fractured Rock Science Plan, Factors Affecting Yields of Wells, and a report that documents the selection of Index gages in Maryland. Selected streamflow statistics were calculated, a workplan was developed for water use data compilation, and quality assurance was performed on water use data from selected counties. Furthermore, a literature review of studies assessing the impacts of water withdrawals on hydroecology was performed and twelve stream sites were sampled where impacts may have occurred.

The Fractured Rock Aquifer Information System was expanded to cover the entire fractured-rock study area, and is ready for use as version 1.0. Similar to the MCPAIS, the information system is a geospatially-referenced database that includes hydrologic, geologic, and water-use data. Enhancements to the system include the incorporation of additional data sets, such as geophysical logs from regional production wells and water quality data. The water quality data include available arsenic, iron, and manganese concentrations from more than 1,600 wells in western fractured rock counties. In addition, data from Garret County were compiled to create ArcGIS coverages illustrating the distribution of arsenic, iron, and manganese. The data will be used as the basis for future analyses to understand the factors that govern the distribution of these constituents.

The MGS in cooperation with MDE and USGS are currently finalizing a report on the factors related to well yield in the fractured rock terrane of Maryland. Data from 2,314 wells were analyzed to determine which factors most greatly affect yield. Factors that were considered include well construction, physiographic province, lithology, depth to bedrock, water-table position, topography, and distance from faults. The final report will be issued early in FY2013.

Future activities will include the completion of the Fractured Rock Aquifer Information System, publication of final reports well yield, and on the influence of withdrawals to stream hydroecology, and compilation of additional water quality information. Progress to date has been accomplished through funding from MDE and USGS and in-kind services from MDE, MGS, MDNR-MANTA, and USGS. Additional Fractured Rock Study activities beyond FY 2012 will require significant additional investment from current and new funding partners.

Age Dating of Groundwater

Preliminary results of a study from USGS, MGS, and MDE documenting the age of groundwater in an aquifer in the Maryland Coastal Plain were made available in May, 2012. Groundwater age is of interest because it shows how long groundwater has been in the aquifer since infiltration into the subsurface. This information is important to the issue of sustainability and aquifer management. The presence of very old groundwater indicates that it takes a long time for water to recharge the aquifer; therefore, the groundwater in that aquifer is non-renewable on human timescales. Age can also be used to determine groundwater flow paths and to calibrate groundwater models.

From analyses of isotopes, including ^{4}He, ^{14}C, and ^{36}Cl, in groundwater samples from 15 production wells in the upper Patapsco aquifer, it was determined that the age of groundwater in the aquifer ranges from a few years old to over one million years old. One water sample was dated at over 1 million years old. The age of the water, in conjunction with the temperature at the time of recharge, indicates that water was predominantly recharged during glacial periods. These results demonstrate that the water in this aquifer is essentially non-renewable, thereby highlighting the importance of sustainable pumping practices. Use of groundwater from the upper Patapsco aquifer has been increasing. Recently, water withdrawals have been directed to the upper Patapsco, due to concerns over salt water intrusion and arsenic concentrations in the Aquia aquifer. Groundwater levels in the Coastal Plain are declining at a rate of about two feet per year. The results of this study will provide insight into the rate of movement of groundwater, which will inform hydrogeologic models developed for the Coastal Plain Groundwater Study.

Evaluation of Salt-Water Intrusion into Maryland's Coastal Aquifers

Aquifers in several coastal areas of Maryland have experienced salt-water intrusion as a result of over-pumping of the aquifers. MGS has continued to monitor and assess the effects related to saltwater intrusion in FY 2012. Annual groundwater-quality monitoring continued on Kent Island, where salt water has intruded into the Aquia aquifer on the Eastern Shore of the Chesapeake Bay. In Ocean City, chloride concentrations from intruding seawater approach undesirable levels at some locations. USGS monitors groundwater levels and chloride levels in about 25 wells in the Ocean City area, and provides Ocean City with a summary report at the end of each year. The annual report also includes pumpage amounts from Ocean City's production wells.

Maryland Groundwater Quality Monitoring Network

The Maryland Groundwater Quality Monitoring Network is an ongoing monitoring effort intended to document the chemical quality of Maryland aquifers. In FY 2012, because of the interest in the potential development of natural gas reserves in the Marcellus Shale in western Maryland, MGS began a study of methane in groundwater in Garrett and Allegany Counties. Water samples were collected from wells in these counties to provide an overall assessment of ground-water methane concentrations in the region. This will also provide baseline data on methane (which has not been previously analyzed regionally) prior to any drilling for natural gas in the Marcellus Shale. This work is planned to continue into FY2013.

Groundwater Level Monitoring

Water-level data are collected on an ongoing basis by MGS and USGS from several statewide, regional, and county networks. Statewide, Maryland's groundwater network consists of approximately 150 wells that are monitored at intervals ranging from continuous recording (mostly in the unconfined aquifers) to biannually (in confined aquifers). Additionally, about 270 wells in the Maryland Coastal Plain are measured once a year to monitor effects of groundwater withdrawals by power plants and other users; these data are used to publish potentiometric-surface maps for major aquifers. In FY 2012, a report was prepared for publication that included updated water level maps of the major coastal plain aquifers. Several counties also support additional water-level groundwater monitoring by MGS and USGS. All data collected by MGS and USGS personnel are stored in the USGS-NWIS database and are published annually.

Planning for Changing Conditions

Climate Change

MDE's Water Supply Program has been closely involved with both State and federal efforts to develop recommendations for adaptation approaches to address potential water resources impacts from changing climate conditions. In January 2011, The Maryland Commission on Climate Change published its "Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change – Phase II: Building societal, economic, and ecological resilience". This report evaluates vulnerability and recommends adaptation strategies in six important areas, including water resources.

The Greenhouse Gas Emissions Reduction Act of 2009 requires the State to develop and implement a plan to reduce greenhouse gas emissions 25 percent from a 2006 baseline by 2020. The MDE Air and Radiation Management Administration's Air Quality Planning Program, in cooperation with a number of agencies and organizations, published a draft plan, "Maryland's Plan to Reduce Greenhouse Gas Emissions", in December, 2011. Many strategies within the plan will also contribute to improving water quality through reduced emissions and deposition of mercury and other air pollutants. The final plan will be published in December 2012.

In 2012, the Water Supply Program published a brochure, "Climate Change Adaptation for Maryland Water Utilities", focused on educating water utilities in Maryland about the potential impacts of climate change and possible strategies to reduce vulnerabilities. Impacts to water resources from climate change could occur due to increased flooding, increased air and water temperatures, changes in precipitation and runoff, increased droughts, sea level rise, and more frequent and intense storms. Water utilities can incorporate climate change expectations into their planning to ensure the adequacy and safety of their supply. The brochure highlights measures that water utilities can take to adapt to water quality changes, changes in water availability, and to protect infrastructure.

Piedmont Water Supply and SB 674

Smart Growth development concentrates water use in high-density population areas. These areas do not always have sufficient local water sources available to meet concentrated demand. In particular, the towns that rely on groundwater from hard rock aquifers may exceed the sustained yield of their water supply aquifers as high-density population growth occurs in the area. Only towns using groundwater as their sole source struggle with the problem of needing sufficient land area to meet their water supply needs, as the water balance criteria is not applied to surface water withdrawals when issuing water appropriation permits. Towns relying on water from Coastal Plain Aquifers, however, such as those in southern Maryland and the Eastern Shore, generally rely on deeper confined aquifers, which are not subject to the water balance criteria.

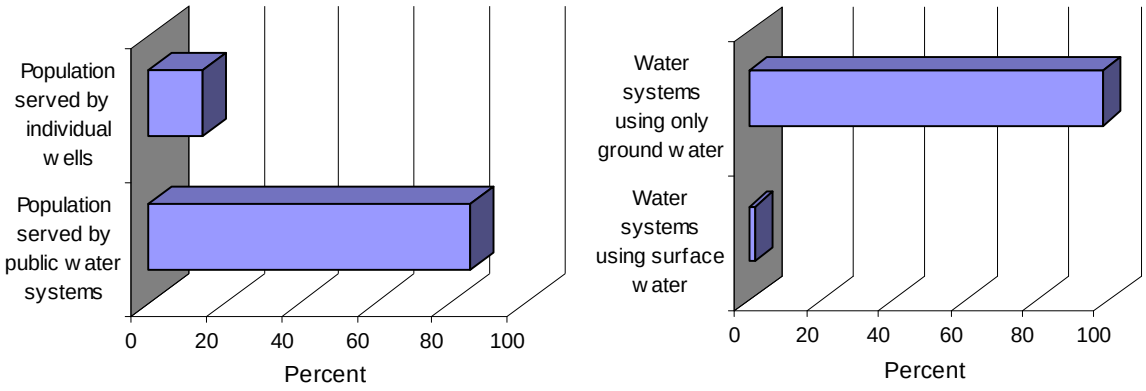
During the 2008 legislative session, the Maryland General Assembly passed SB 674, which authorizes MDE to give priority to public water systems that provide water to municipal corporations when allocating groundwater in Carroll, Frederick, or Washington counties. MDE has been meeting with a stakeholder's workgroup to develop regulations for implementing this law. The stakeholder workgroup, which began meeting in February 2009 to develop appropriate policies and draft regulations to implement the intent of SB674 has reached consensus on an approach for allocating water to municipalities in Carroll, Frederick, and Washington Counties. Regulations are expected to be finalized within the next year.

Water and Sewerage Planning

Counties are required by law to develop and maintain water and sewerage plans to provide for the orderly development and extension of community water supply and sewerage systems. MDE routinely reviews county water and sewerage plans to identify and address issues that pertain to source water protection, water supply capacity, and Safe Drinking Water Act requirements. MDE may disapprove a plan if it is not consistent with existing laws, regulations or policies.

Oversight of Public Water Systems

Groundwater continues to be a reliable and safe source of drinking water for thousands of Maryland residents. MDE's Water Supply Program is responsible for ensuring that public drinking water in Maryland is safe and adequate. Statewide, there are about 476 community public drinking water systems, of which about 424 use groundwater as their only water source. These groundwater systems serve more than 600,000 residents. Additionally there are about 549 Maryland facilities defined by the Safe Drinking Water Act as non-community non-transient public water systems that rely on groundwater. These small facilities include schools, day care centers, and office buildings. There are also about 2,397 transient non-community public systems such as restaurants, churches, community centers, and campgrounds that use their own groundwater wells.



Percentage of population served by public water systems or individual (private) wells and percentage of water systems using surface or groundwater (PDWIS, 2011).

New Regulatory Initiatives

The Long Term 2 Enhanced Surface Water Treatment Rule was adopted in Maryland in December 2009. Maryland was granted primacy enforcement authority by EPA on November 15, 2011. Under this regulation, surface water systems and groundwater systems under the influence of surface water are required to monitor for *Cryptosporidium* and *E. coli* in order to determine the vulnerability of the source water, and to determine what treatment improvements must be completed in the next ten years in order to provide up to 6.0 log removal of *Cryptosporidium*. The largest water systems that serve over 10,000 persons have completed their testing for *Escherichia coli* (E.coli) and *Cryptosporidium*; the smaller water systems that serve fewer than 10,000 persons will complete monitoring in Fall 2012. Based on the initial testing, two water systems will be required to improve operations or provide additional water treatment for *Cryptosporidium*.

As of March 7, 2011, the Groundwater Rule regulations were effective in Maryland. Maryland was granted primacy enforcement authority by EPA on November 15, 2011. The new rule provides the State additional authority for requiring water system improvement that will improve drinking water quality. Since its implementation, water systems with contaminated sources have been identified and corrective actions taken. One water system was re-evaluated and classified as groundwater under the influence of surface water based on the new data; the initial evaluation of the source was completed over 10 years ago. This regulation will ensure that groundwater sources are more closely evaluated on a regular basis.

Wellhead Protection

In order to protect public water supply wells from contamination the Water Supply Program implements the Wellhead Protection Program (WHPP) in wellhead protection areas

(WHPA) around each well. Existing and potential sources of contamination are identified, and management plans are developed to identify the best means for protecting the water supply source. EPA approved Maryland's Wellhead Protection Program in June of 1991. MDE's Water Supply Program coordinates wellhead protection activities among State agencies, public water suppliers, local governments and the public, assists local governments in delineating WHPAs and in developing management programs to protect water supplies. Participation at the local level is voluntary.

In FY 2012, MDE's Water Supply Program contracted with outside vendors to implement WHPPs for twenty vulnerable systems. Contractors are working closely with the selected communities to develop protection plans that can be readily implemented, and not just "sit on the shelf." It is expected that many of the systems will adopt land use ordinance to protect their water supplies. These projects are expected to be completed by 2013.

Well Siting

One priority for MDE's Water Supply Program is to ensure the safety of new public water supplies by reviewing and evaluating proposals for the siting of new wells. To ensure that wells are sited in the safest locations, staff review Departmental databases to identify existing or potential contamination sources, and use site investigations to verify this information and evaluate any additional factors that might influence the safety of the water supply. In FY 2012, the Water Supply Program reviewed proposals for the siting of approximately 20 new public water supply wells.

MDE staff member performing a well inspection on a golf course

WATER QUALITY PROTECTION AND RESTORATION

Groundwater supplies in Maryland are impacted by both natural influences and human-induced contamination. Population growth and development over the past 50 years has impacted water quality in both agricultural and urban areas in the State. Although Maryland has many programs in place to minimize and remediate existing groundwater contamination, threats to groundwater quality increase as new homes, new commercial development, and new roads are built to meet the needs of a growing population.

Drinking Water Quality Issues

Public drinking water systems are required by Federal law to monitor regularly to assure compliance with EPA standards, and in Maryland. Individual wells are typically tested only for limited contaminants (bacteria and nitrates) when the well is first drilled; any subsequent testing is at the discretion of the homeowner.

Arsenic

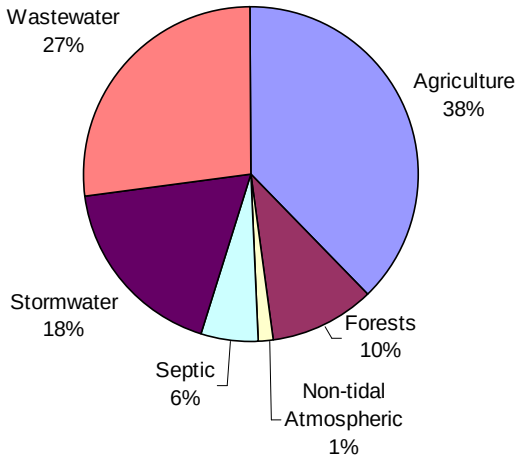
On the Eastern Shore and southern Maryland, arsenic in drinking water sources is from naturally occurring deposits in the underlying aquifers. Maryland has also identified arsenic contamination in western Maryland, but the source of the arsenic in the drinking water has not been specifically identified. Early evaluations of the groundwater in this part of the State indicate that Garrett County arsenic may be linked to coal in the hard rock aquifer, and that arsenic in the Carroll County aquifer may be linked to an external contamination source, such as pesticides.

Organic arsenic feed additives, such as Roxarsone and Histostat, are used in poultry production to increase weight gain, control parasites, and to improve pigmentation and feed efficiency. Arsenic compounds are then excreted by poultry, resulting in increased concentrations of arsenic in poultry manure. USGS studies indicate that land applications of this manure may result in the leaching of arsenic to the environment, including to groundwater. In response to human health and environmental concerns, in FY2012, the Maryland Legislature passed House Bill 167 which prohibits the sale of poultry feed with any arsenic additives, except Histostat, which is primarily used for the prevention of disease. This may help to limit the addition of arsenic to soils, potentially helping to protect groundwater.

MTBE

Since 1995, MDE has been periodically sampling community and non-transient community public water systems for MTBE. During the summer of 2006, MTBE was removed from the gasoline that is supplied to the State of Maryland. This change in formulation was a business decision by the gasoline suppliers, not a regulatory mandate. Soon after, MTBE was replaced with ethanol to meet EPA reformulated gasoline standards. Although removed from gasoline, MTBE still continues to be detected in groundwater. MDE predicts that there will be years of legacy cases related to MTBE. During CY2011, MTBE was detected at about 40 water

systems. The number of public water systems with detectable MTBE (less than 0.5 parts per billion) continues to decline.



Nitrogen Loading to the Chesapeake Bay from Maryland, 2010
(from: Maryland Phase II Watershed Implementation Plan For The Chesapeake Bay TMDL, MDE)

Nitrate

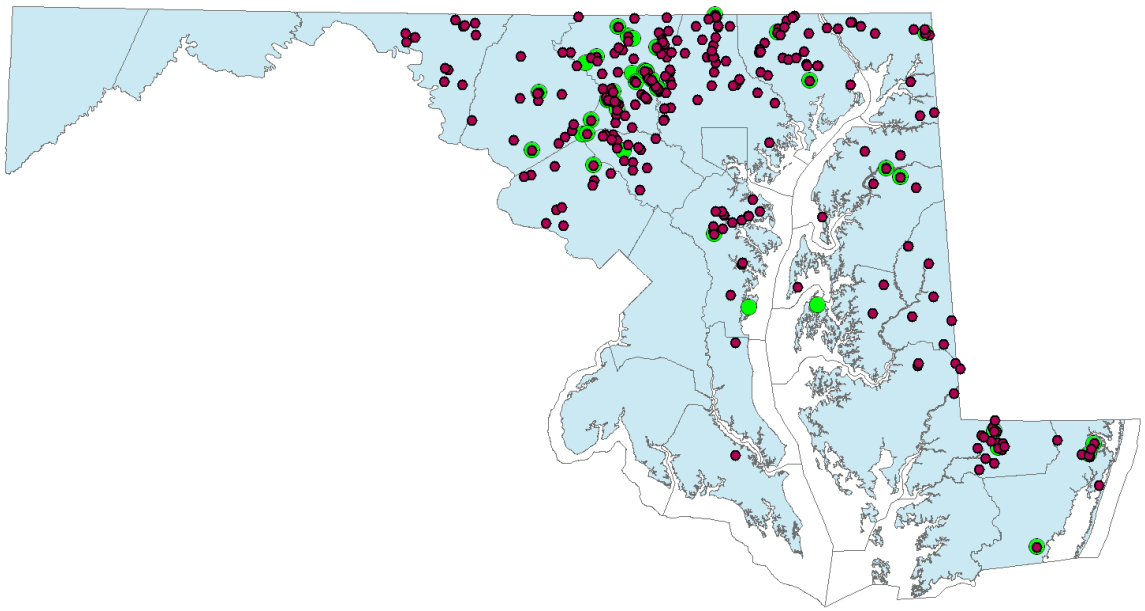
Nitrate pollution in groundwater is becoming increasingly problematic, especially in aquifers underlying agricultural areas. The primary sources of nitrate to groundwater are from agricultural land uses, including land application of commercial fertilizers and manure from animal feeding operations. Other major sources include wastewater treatment plants, onsite sewage (septic) systems, and atmospheric deposition of air pollutants.

Due to agricultural land use practices, nitrate concentrations in shallow waters of unconfined Coastal Plain aquifers on Maryland's Eastern Shore commonly exceed the Federal Drinking Water Standard of 10 mg/L. Concentrations greater than 10 mg/L can cause methemoglobinemia, a dangerous blood disorder, in infants. Shallow groundwater is generally used for irrigation and other non-potable uses, while water for public drinking is pumped from deeper in the unconfined aquifer or from confined aquifers. Private residential wells are not monitored regularly and many homeowners are not aware of potential contamination. In addition, over time, contaminated groundwater can move deeper into the unconfined aquifer or may affect water in confined aquifers if there is a hydrologic connection between geologic layers.

All public water systems are required to conduct monitoring for nitrate on at least an annual basis. In calendar year 2011, 19 water systems reported exceedance of the drinking water standard for nitrate. Currently, approximately 44 systems operate nitrate treatment systems to remove nitrate from drinking water via ion exchange and/or reverse osmosis.

As part of its source water protection activities, MDE's Water Supply Program, evaluates contaminants of concern, such as nitrate. Work is ongoing to assess the sources of nitrate in groundwater used by community water supplies. Identification of nitrate sources and concentration trends can assist watersheds in the development of management actions. In addition, MDE's Wastewater Permits Program administers The Bay Restoration Fund (BRF), which finances wastewater treatment plant and septic system upgrades, and implements cover crop programs to reduce nitrogen loading to the Bay from runoff and groundwater. Approximately 600 onsite sewage disposal systems per year are upgraded to remove nitrogen; totaling 13,920 pounds of nitrogen removed from discharges to groundwater.

MDA's Nutrient Management Program works to enforce the Water Quality Improvement Act of 1998, widely known as Maryland's Nutrient Management Law. These regulations require farmers to implement nutrient management plans which address nitrogen and phosphorus inputs to the environment. In May 2012, MDA finalized new rules for the use of manure, biosolids, and other organic nutrient sources on crop fields. The public comment period is open until August 13, 2012.



Map of Maryland showing public water systems with nitrate concentrations that have exceeded 10 mg/L in the past (red dots) and systems currently treating for nitrate (green dots) (data source: SDWIS, data to March, 2011)

Virus Studies

Finalized in October 2006, the Groundwater Rule aims to protect consumers from microbial pathogens in groundwater, particularly viruses. The regulation requires source water monitoring to identify vulnerable systems and requires treatments to inactivate or remove all viruses. A study conducted from 1998 to 2001 by MDE and USGS demonstrated that viruses are not commonly found in groundwater systems in either the Coastal Plain or Piedmont geologic settings.

In FY 2011, MDE completed sampling for a second study to evaluate unconfined aquifers in the Coastal Plain area for the groundwater indicators in the Groundwater Rule. The year-long study sampled 50 raw water sources on a quarterly basis. The sources were located in the Quaternary, Aquia, Patapsco, and Magothy aquifers. The raw water samples were analyzed for Escherichia coli (E. coli), Coliphage, Coliphage-Male, Enterococci, and nitrates as part of the study. The purpose of the study is to determine an appropriate indicator for vulnerability in the unconfined aquifers of the Coastal Plain. The report was finalized in June 2012.

Groundwater Remediation and Restoration

Contaminated Sites

The federal "Superfund" program, authorized by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), was established to identify, prioritize and cleanup hazardous waste sites. The Land Management Administration of MDE ensures that State requirements are met during investigation and cleanup of sites designated for the National Priority List (NPL) and federal facilities under the federal "Superfund" program. A key objective of the federal program is to obtain the data necessary to identify for cleanup the highest priority sites posing threats to human health and the environment.

A similar program under State law, the State Superfund Program, conducts investigations and oversees the remediation and cleanup of sites on the State Master List and Non-Master List that are not included on the NPL or are not owned by the federal government. The State Master List contains 234 sites that have been identified statewide with known or potential contamination and another 204 sites that have been archived and transferred to the State Master List - Formerly Investigated Sites. The Non-Master List contains 94 sites that have been identified statewide with known or potential contamination and another 163 sites that have been archived and transferred to the Non-Master List – Formerly Investigated Sites.

The Voluntary Cleanup Program provides a streamlined process for the remediation and redevelopment of former industrial or commercial properties that are contaminated or perceived to be contaminated with controlled hazardous substances. Upon successful completion of the program, participants are also provided limitations on liability for the eligible property. Since the inception of the Voluntary Cleanup Program in 1997, 720 applications for 622 properties representing approximately 7,182.77 acres have been received and 533 properties have been accepted into the program. Since 1997, the VCP has issued a Certificate of Completion (COC) for 118 properties and issued a No Further Requirements Determination (NFRD) for 264

properties. The majority of these sites were issued a prohibition on the use of groundwater beneath these areas for any purpose.

Underground Storage Tanks

Underground Storage Tanks (USTs) remain a major source of groundwater contamination. The Oil Control Program (OCP) within MDE has established stringent regulations and provides strict oversight of tank operations within Maryland. Releases from USTs are required to be investigated and those with groundwater impacts are required to define the vertical and horizontal extent of the contamination. Once defined, a Corrective Action Plan is implemented to mitigate the impact of the contamination. The effectiveness of remediation systems is normally evaluated through groundwater monitoring. The OCP has tracked reports of over 11,699 confirmed underground storage tank system releases from tanks other than heating oil tanks throughout Maryland. Of these releases, over 11,260 site cleanups have been completed. During FY 2012, OCP oversaw the investigation and cleanup of over 351 heating oil related cases. The OCP continues to provide oversight at both motor fuel and heating oil sites where cleanups have been initiated. A list of Oil Control Program UST's and remediation sites can be found at: www.mde.state.md.us/programs/land/oilcontrol

Emergency Response

MDE's Emergency Response conducts immediate removals of oil and hazardous materials that threaten both surface and ground water sources. Each year, Emergency Response responds to approximately 650 spills of hazardous materials and petroleum products occurring on land and water throughout the State. These spills are handled in a way that protects public health and safety and minimizes the contamination of water resources. If a spill occurs within a source water protection area, the appropriate public water system(s) will be notified so that monitoring of potential impacts to drinking water can begin. Water Supply Program engineers are on call 24-hours per day to provide technical assistance during any water supply emergency.

Onsite Sewage Disposal Systems

MDE has delegated the authority for administering on-site sewage disposal, land subdivision and well construction programs to either county health departments, which are part of the Maryland Department of Health and Mental Hygiene, or to a local county permitting agency. MDE personnel oversee the delegated programs, provide technical support, investigate potential public health threats and perform on-site evaluations of innovative and alternative sewage disposal system applications. A strong field presence and ongoing training are vital to the implementation of these important public health laws. Approximately 420,000 homes in Maryland use onsite sewage disposal systems.

MDE actively promotes the use of advanced onsite sewage disposal systems. As a rule, advanced onsite sewage disposal systems better protect groundwater resources than conventional systems. Advanced systems used in Maryland include: re-circulating sand filters, advanced

waste treatment units, sand mounds, waterless toilets and at-grade systems. Research on emerging on-site sewage disposal technologies continues, with emphasis on those technologies that reduce discharges of nitrogen.

Bay Restoration Fund

The Bay Restoration Fund (BRF) was signed into law on May 26, 2004 because the Chesapeake Bay had been experiencing a decline in water quality due to over-enrichment of nutrients (mainly phosphorus and nitrogen). The law established a dedicated fund for improving the water quality of the Chesapeake Bay. In addition to financing wastewater treatment plant upgrades, the BRF finances onsite disposal system (septic system) upgrades and implements cover crop programs to reduce nitrogen loading to the Bay from runoff and groundwater.

In FY 2012, the Maryland Legislature passed House Bill 446 which generally doubles the Bay Restoration Fee, beginning July, 2012. The fee increase was necessary to continue upgrading the State's major wastewater treatment plants with nutrient removal technologies. As a result of the BRF, more than 7.5 million pounds of nitrogen and more than 260 thousand pounds of phosphorus will be reduced each year, which will meet over one-third of Maryland's nutrient reduction commitment under the Chesapeake Bay 2000 Agreement. Approximately 600 onsite sewage disposal systems per year are upgraded to remove nitrogen; totaling 13,920 pounds of nitrogen that are removed each year, which would have otherwise been discharged into the groundwater.

The goal of the Onsite Sewage Disposal System (OSDS) portion of the Bay Restoration Fund is to curtail the amount of nitrogen discharged from OSDS into the State's water. This benefits the State by restoring the estuarine environment and by providing better protection of drinking water supplies. The BRF statute includes funding to provide grants for the incremental cost of upgrading OSDS to best available technology (BAT) for nitrogen removal. Through June of 2012, septic systems serving 3,732 equivalent dwelling units have been upgraded to remove nitrogen with BRF grants, reducing the load of nitrogen discharged to groundwater by 86,582 pounds per year.

To date, 16 proprietary technologies have been approved as grant eligible BATs for removing nitrogen. All these technologies must also undergo field verification of performance in Maryland. Twelve Maryland installations of each technology must be sampled on a quarterly basis for four quarters. The results of this sampling must indicate a minimum of 50 percent nitrogen removal to successfully complete field verification. Currently, six proprietary technologies have unconditional approval as BAT and an additional six technologies have conditional approval as additional performance data is collected for these systems.

Regulations

MDE proposed regulations that would require nitrogen-removal technology (BAT) for all septic systems serving new construction on land draining to the Chesapeake Bay, Atlantic Coastal Bays or in other areas where bodies of water are impaired by nitrogen. This includes most of the State. Existing regulations already require nitrogen-removal technology for all new and replacement septic systems in the Critical Area (1,000 feet from tidal waters). The Joint

Committee on Administrative, Executive and Legislative Review (AELR) published the proposed regulation in the Maryland Register on June 1, 2012.

In FY 2012, Senate Bill 236 passed the legislature and was signed by the Governor. This bill prohibits a jurisdiction from approving a major residential subdivision served by on-site sewage disposal systems, community sewerage systems, or shared systems unless it adopts the system of land use tiers established by the bill. Since nitrogen pollution from septic systems is greater than pollution from centralized treatment systems, the bill seeks to limit sprawling development and new septic systems; thereby protecting groundwater.

Permit Programs

MDE issues many types of permits for activities that can have a negative impact on groundwater quality. Permits can establish limits for specific chemicals or groups of pollutants, or can require best management practices that reduce releases to the environment.

Groundwater Discharge

Groundwater discharge permits are required for any discharges to groundwaters of the State. Sources of groundwater discharges include spray irrigation land treatment systems, overland flow systems, rapid infiltration systems (infiltration ponds), large on-site sewage disposal systems (greater than a daily average flow of 5,000 gpd), seepage pits, dry wells, septic systems, and injection wells. The Code of Maryland Regulations provides performance standards for location, design, installation, construction and maintenance of the permitted facilities. Issuing a permit involves the review of plans, specifications and hydrogeologic reports, and the evaluation of soil and site suitability. In many cases, groundwater monitoring is a condition of the permit, requiring that a facility maintain primary or secondary drinking water standards in the groundwater quality at the point of discharge or monitoring wells adjacent to the property boundary. In FY 2012, MDE issued sixteen municipal groundwater discharge permits and eighteen industrial groundwater discharge permits.

Underground Injection Control

EPA delegated authority for the Underground Injection Control (UIC) program to Maryland in 1984. There are six classes of UIC wells. Maryland has primacy for five classes of wells, but will be applying for primacy for Class VI wells. Class VI is a new class for carbon dioxide sequestration wells. In Maryland, UIC Wells are currently all Class V wells, which are essentially shallow subsurface treatment and disposal systems, such as septic systems.

Class V wells may receive treated industrial process wastewater or industrial wastewater commingled with domestic sewage. MDE's Groundwater Discharge Program issues permits for Class V wells. Large capacity septic systems, defined in the Code of Federal Regulations as serving greater than 20 persons, are also defined as Class V wells and are jointly permitted by the State's UIC Program and the county health departments. Disposal of hazardous waste by underground injection is not allowed in Maryland. Permitted Class V wells must meet primary and secondary drinking water standards.

The UIC Program maintains a data inventory of potential and known Class V wells. It also actively identifies unpermitted wells for regulation and inventory through unannounced site inspections by Program personnel that target un-permitted Class V wells. One inspector is dedicated to statewide inspections of facilities in unsewered areas, which may be using shallow disposal practices for industrial wastewater. A second inspector works in coordination with the Water Supply Program to investigate potential dischargers in wellhead protection areas (WHPAs). Notices of Corrective Action are issued for facilities not in compliance with UIC Class V regulations. Corrective action is required for these facilities. Approximately 400 inspections are conducted each year. In addition, MDE compliance inspectors visit approximately 125 permitted facilities to monitor compliance with the conditions of groundwater discharge permits. In FY 2012, 575 UIC inspections were conducted by the two MDE inspectors. The inspectors issued 36 Notices of Corrective Action. In FY 2012, 20 facilities were returned to compliance.

The UIC Program continues to provide information on best management practices and pollution prevention in all dealings with the regulated community, both during unannounced UIC, and permit related inspections. Outreach measures include distribution of brochures on *Management of Vehicle Washwater, Management of Photochemical Waste,* and *A Dry Cleaner's Guide to Wastewater Management.* The dry cleaner brochure provides information on percholoroethylene (PCE) and guidance on its disposal in septic and sewer systems.

There is a developing interest in producing natural gas from the Devonian Marcellus Shale in Western Maryland's Garrett County using the technology of hydraulic fracturing, also known as hydrofracking. This methodology uses tremendous quantities of fresh water for the fracturing process and then, as a byproduct of gas production, produces very large quantities of contaminated water for disposal. One disposal option is via a UIC Class II Well. Class II wells discharge wastewater beneath the lowermost underground source of drinking water. There are no pending applications for Class II disposal wells and no Class II wells currently operate in Maryland. The UIC Program works with MDE's Water Supply and Mining Programs to review permit applications for hydrofracking.

Inquiries have also been made to Maryland's UIC program regarding aquifer storage and recovery (ASR) wells. ASR wells are being considered in several locations in Maryland to store treated drinking water in an aquifer, for later withdrawal and use during periods of peak demand. These types of wells are regulated differently across the country. Since it was not named as a high risk well in the EPA's Phase I Class V Rule, this category of Class V wells are Rule authorized. Therefore, some UIC regulating authorities do exercise the regulatory option of Rule authorization for ASR wells, and some require permits. In Maryland, a UIC permit is required for ASR wells. To date, no applications have been received for ASR wells.

Class VI is a new UIC well designation for carbon dioxide sequestration, a process designed to address global climate change. Maryland is planning to apply for primacy for this new class of well.

Hazardous Waste

MDE's Land Management Administration (LMA) supervises hazardous waste generators and treatment, and storage and disposal facilities through both State regulations and a federally mandated permit program. LMA's Waste Diversion and Utilization Program (WDUP) manages the hazardous waste permit program and implements the requirements of the federal Resource Conservation and Recovery Act (RCRA) as well as the requirements of State law. In Maryland, there are approximately 10,500 facilities registered as generators of hazardous waste. There are twenty facilities that have been issued permits allowing treatment of hazardous waste, storage of hazardous waste for longer than 90 days, acceptance of hazardous waste from off-site, and/or management of hazardous waste in land disposal units. The permitted hazardous waste land disposal units have all gone through closure and are subject to post-closure care requirements.

LMA's Operational Services Program relies on record-keeping to maintain a "cradle-to-grave" tracking system for all hazardous waste generated. Proper management and pollution prevention techniques ensure against contamination of groundwater. LMA's Solid Waste Program oversees the enforcement of hazardous waste requirements. If there is improper management of hazardous waste, the program requires that actions be taken to remedy the situation and to restore, to the extent possible, the quality of the affected groundwater. A strong oversight and enforcement effort is maintained to provide high visibility as a deterrent against future violations.

Permitted hazardous waste treatment, storage, and disposal facilities whose operations would present a greater potential for groundwater contamination if an unforeseen incident occurs are placed under more stringent permit conditions. Permit conditions in this case would include the requirement that a groundwater monitoring system be deployed. The Solid Waste Program is charged with the responsibility of inspecting these systems and initiating enforcement action should the need arise. Permit requirements are tailored to address the potential for contamination presented by each facility using requirements for groundwater protection defined in State regulations. At a minimum, semi-annual reports are submitted by facilities required to monitor groundwater. Failure to meet permit requirements results in an enforcement action designed to both bring the facility into compliance and to remediate any contamination.

The Land Restoration Program maintains the Federal Installation Restoration Program (IRP) Support Section that is responsible for supporting cleanup at Federal Facilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or the federal "Superfund" program. MDE maintains a Department of Defense/State of Maryland Memorandum of Agreement, which provides federal funding to support the Section's activities. The focus of the Section's activities at Department of Defense sites is on groundwater contamination. Evaluation of the extent of contamination, remedial alternatives, and ultimate cleanup criteria is conducted through the CERCLA process. The Federal IRP Support Section directly supports EPA Region III in the CERCLA cleanups.

Solid Waste

Within MDE's Land Management Administration, the Solid Waste Program regulates the management and disposal of non-hazardous waste such as municipal solid waste, industrial waste, construction and demolition waste, land-clearing debris and natural wood waste, and

performs enforcement activities for scrap tires, sewage sludge and Controlled Hazardous Substances. The program's comprehensive permitting requirements for facilities accepting waste are directed at protecting ground and surface water, while assuring the safe management and disposal of waste.

Program activities include significant enforcement efforts to stop and clean up illegal dumps before they can significantly impact groundwater resources. Permitting requirements include liners and leachate collection/treatment systems for landfills (except land clearing debris or "stump dump" landfills), groundwater monitoring systems, and other environmental protection systems that serve to protect groundwater. The program regulates 24 municipal solid waste landfills, four industrial waste landfills, three sewage sludge storage or treatment facilities, and six construction and demolition waste landfills, and evaluates environmental monitoring data for approximately 60 closed landfills. The Solid Waste Program is also tasked with the permitting and enforcement of any new industrial landfill for the disposal of Coal Combustion Byproducts (CCB) such as coal flyash, and helps enforce MDE's CCB storage and transportation regulations.

Waste Diversion and Utilization

Within MDE's Land Management Administration, the Waste Diversion and Utilization Program regulates the utilization of sewage sludge that is applied as a soil amendment to farmland or used for the reclamation of land such as mined sites. Most of the sewage sludge generated in Maryland is applied to farmland here, or out of State. The beneficial use of this material is regulated by State statute and permit conditions that require buffers and nutrient management plans for farmland where sewage sludge is to be applied. By limiting the amount of nutrients applied to land to those actually required by crops, excess amounts of nutrients can be controlled and ground and surface water protected.

The Waste Diversion and Utilization Program also regulates the discharges from Animal Feeding Operations (AFO) in Maryland. Together, the regulations and General Discharge Permit are designed to control nutrients from Maryland's largest agricultural animal operations and are a significant step forward in protecting the Chesapeake Bay, local waterways, and our drinking water. The AFO regulations and General Discharge Permit are just one part of a comprehensive, statewide effort to address all sources of pollution that are impairing our waterways: wastewater treatment plants, industrial discharges, septic systems, urban/suburban stormwater runoff, and air emissions from power plants, vehicles, and trucks.

By eliminating unpermitted tire dumps and providing a regulatory program for the management, transportation, and recycling of scrap tires, the LMA's Waste Diversion Utilization Program prevents serious sources of pollution which are caused by "tire dump" fires, thus protecting both ground and surface water. See MDE's annual Scrap Tire Report for more information on these activities.

Oil Control

The Oil Control Program (OCP), within MDE's Land Management Administration, is the unit responsible for the implementation of the Underground Storage Tank (UST), Leaking Underground Storage Tank (LUST), and Aboveground Storage Tank (AST) programs. These

programs provide for preventive actions to minimize ground and surface water pollution from the storage of petroleum products. The Program has increased regulatory oversight of USTs with improvements in release detection, secondary containment, and tank monitoring.

OCP has enacted a specialized tank inspection program to ensure the protection of groundwater resources and public health from the release of chemicals stored in underground storage systems. An owner of an underground motor fuel storage system in Maryland is required, upon notification from OCP, to have the system inspected by a certified private inspector. The inspector must visit the storage tank facility and complete a detailed site inspection form provided by OCP. The inspector evaluates tank and piping release detection, overfill/spill prevention, system corrosion protection, as well as facility housekeeping and other compliance concerns. After the initial inspection, follow-up inspections must occur every three years to confirm continued compliance with Maryland regulations.

The OCP requires additional release detection methods for motor fuel facilities operating within the High Risk Groundwater Use and Well Head Protection Areas of Baltimore, Carroll, Cecil, Frederick and Harford County. Facilities within this area must sample the groundwater through at least three onsite monitoring wells. This sampling must be performed yearly and the results reported to OCP. The facility must also sample the site's water supply well and perform special release detection tests on any operational underground storage tank systems. Facilities that fail to perform these tests face MDE enforcement actions and the loss of their fuel supply.

Tank removal at an oil contaminated site

Mining: Marcellus Shale

Portions of both the gas-rich Marcellus and Utica shale formations underlie the western-most part of Maryland (mostly Garrett and Allegany counties). The advent and refinement of new technologies related to horizontal drilling and high-volume hydraulic fracturing have allowed for the economic recovery of hydrocarbon resources from these formations; a feat that was previously uneconomical. This process involves pumping large amounts of highly pressurized water mixed with chemicals and a proppant (usually sand) into the well in order to fracture the rock. These fractures, held open by the proppant, allow the gas to flow out of the formation and into the wellbore. However, concerns over issues like the possible environmental impacts, health risks and infrastructure strains have caused pause in many prudent communities.

Recognizing the many unknowns surrounding these technologies, in June 2011, a Governor's Executive Order in Maryland established the Marcellus Shale Safe Drilling Initiative Advisory Commission, to study and make recommendations to assist State policy makers and regulators in determining whether or how drilling can occur without unacceptable risks of adverse reactions to public health, safety, the environment, or natural resources. Pursuant to the executive order, the Commission released Part I (of III) of their study in December 2011. This report made recommendations focused on determining an appropriate revenue system to fund State activities related to deep shale gas production as well as recommendations towards establishing a "fair and equitable" liability system. The creation of a 'presumed area of liability' around a deep shale gas well was supported by the Commission and adopted by the Governor into statute in May 2012 (House Bill 1123). This area shifts the burden of proof from the landowner to the driller in case of any accidental contamination within 2500 feet and 365 days. It is also hoped that this will encourage drillers to collect their own baseline data.

The next installment of the Commission's study was originally due in August 2012, however, the bill that would have established the funding mechanism needed to complete the work failed in the General Assembly. As a result the Commission has requested an extension of the original deadline until December 31, 2012, with the final version of the second part of the study due August 1, 2013.

Additionally, in FY 2012, because of the interest in the potential development of natural gas reserves in the Marcellus Shale in western Maryland, MGS began a study of methane in groundwater in Garret and Allegany Counties. This will provide baseline data on methane prior to any drilling for natural gas in the Marcellus Shale.

To date, only seven applications for permits for drilling and production have been received by MDE. No permits have been issued. The permit process requires the applicant to identify the location from which they will obtain water for hydraulic fracturing as well as an approved disposal location. Permits will not be issued until the Commission's findings can be reviewed.

Stormwater Management

Urban development has a profound influence on the quality and quantity of Maryland waters by altering the hydrologic cycle. When vegetation is stripped, soil compacted and impervious surfaces added during the construction process, rain is deflected over these hard surfaces instead of filtering through the soil on site and recharging groundwater supplies. Stormwater from developed sites rushes overland, gaining volume, and picking up soil and its accumulated pollutants, which may include oil, grease, and fertilizer from streets, roofs, parking lots, lawns, and bare ground. This large quantity of contaminated water rushes into the closest surface water. This accumulated runoff causes flooding, stream channel erosion, sedimentation, wildlife habitat deterioration, water pollution, and lower stream base-flows.

The goal of MDE's Stormwater Management Program is to maintain pre-development runoff characteristics, during and after development. Currently, all new development projects are required to incorporate best management practices (BMP) to assist in achieving post

development hydrology that replicates the runoff conditions of woods in good condition. This will allow runoff to be filtered by infiltration through the soil and recharge groundwater supplies.

MDE's "2000 Maryland Stormwater Design Manual" provides guidelines for designing structural and nonstructural BMPs. Examples of structural BMPs include ponds, constructed wetlands, filters, and infiltration practices to address water quality, water recharge, and stream channel protection. Many nonstructural practices mimic natural hydrology and minimize the generation of excess stormwater after development, including disconnecting roof top downspouts, conserving natural vegetation, and providing stream buffers to maximize filtration and groundwater recharge.

Requirements to use environmental site design (ESD) to the maximum extent practicable to provide stormwater management went into effect in May 2010. All jurisdictions in Maryland have been implementing ESD for new development and redevelopment projects since changing local stormwater management ordinances two years ago. This completes the implementation mandate specified by the Maryland legislature in the Stormwater Management Act of 2007 and formalized by MDE is subsequent changes to the Code of Maryland Regulations (COMAR). ESD includes the use of better site planning, alternative surfaces, and small-scale runoff control practices on new development and redevelopment projects in an effort to replicate the runoff that would be expected from woods. Implementing ESD represents a significant change in the way development runoff is addressed in Maryland and marks another milestone in the evolution of a State program that has existed for nearly 30 years.

Water Well Construction

Responsibility for permitting well construction is delegated by MDE to local county health officers or other county environmental officials. MDE employees direct this delegated program and provide technical assistance to county personnel. Only drillers licensed by the Maryland Board of Well Drillers may drill wells in the State of Maryland. The driller must file a well completion report for each well; well completion reports are stored in a central computer database at MDE. The Department processes approximately 12,500 well permits each year. An estimated 400,000 households in Maryland rely on individual wells. MDE's On-Site Systems Division conducts well construction inspections in the field, trains well drillers and county personnel, and has been instrumental in developing enforcement cases for violations of well construction laws.

Maryland's Well Construction regulation, COMAR 26.04.04, is being updated. Previously, changes were proposed by MDE's Onsite Systems Division and reviewed by the Conference of Environmental Health Directors and the Maryland State Board of Well Drillers prior to their final promulgation in 2010. However, publication of the final regulation did not occur because MDE withdrew the regulations concomitant with concerns expressed by the AELR committee. The regulations that were not promulgated included the requirement that potable wells have a minimum casing diameter of four inches. The mandate of four inch wells was intended to address declining water levels in some Coastal Plain counties. In these areas, large withdrawals can cause the aquifer water levels in nearby wells to decline, making it impossible for some well owners to procure water from their two-inch diameter well casings. A four-inch

casing is necessary for installation of a submersible pump. The regulations also addressed geothermal well construction, well clusters, and variance provisions.

A new draft update of COMAR 26.04.04 includes the regulations that were previously not promulgated, in addition to other changes. These are currently undergoing stakeholder review. Due to various federal, State and county incentives, geothermal wells have gained popularity, so regulatory requirements have been added specific to geothermal wells. In order to protect drinking water aquifers, codifying the requirement for borehole grouting from the bottom to top of the well and defining setback distances from potential sources of contamination were necessary. Defining the types of wells that can be drilled under a single permit is very important to the permit cost of some environmental or large geothermal sites. A maximum number of wells that can be constructed of a non-potable nature was increased to 20 boreholes from the current maximum of 10. The current regulation does not include a variance provision. The State is proposing this in the regulation to deal with difficult construction or well siting criteria.

Pesticides Management

The Maryland Department of Agriculture (MDA) Pesticide Regulation Section, the State's lead agency for implementing the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), continues to implement, maintain and update, as needed, its generic Pesticide Management Plan (PMP). As an addendum to the PMP, the United States Environmental Protection Agency (EPA), in cooperation with the states, has developed a *State Pesticides of Interest* list. Pesticides of interest (including their degradates) are pesticides that have been identified by the states as having the *potential* to occur in ground or surface water at concentrations approaching or exceeding a human health or ecological reference points. These pesticides are to be periodically evaluated to determine whether a human health or environmental reference point is likely to be approached or exceeded. If an evaluated pesticide is found to pose a risk to water quality, then that pesticide must be actively managed. Management can include applicator training/public outreach, adoption of Best Management Practices (BMPs), targeted inspections and enforcement of existing water quality-related label restrictions, designation as a State "Restricted Use" pesticide due to water quality concerns, additional product label restrictions to reduce contamination or, ultimately, denial of State registration, of the pesticide, due to water quality concerns.

This is the twentieth year, of MDA's recycling program for empty pesticide containers. MDA, in cooperation with local government and private industry, inspects, stores, and chips clean, empty pesticide containers that have been offered for recycling. Collection centers are maintained in seven counties (Frederick, Harford, Kent, Talbot, Washington and Wicomico) with the assistance of county government agencies. A total of 24 collection days are held during June through September. In addition, fourteen pesticide dealers/custom applicators are participating in inspection and collection of containers at their own facilities. The program has been well received by different interest groups, including the agricultural community, EPA's Chesapeake Bay Program and environmental organizations. More than 700,000 empty pesticide containers have been collected and recycled since 1993, taking more than 300 tons of plastic out of Maryland's waste stream.

MDA offered an unusable/unwanted pesticide disposal program, for all agricultural producers, throughout Maryland. MDA collected nearly 18,000 pounds of unwanted or unusable pesticides from 54 participants. Since 1995, the program has collected more than 560 different pesticides producing more than 188,000 pounds.

CONCLUSION

In FY 2012, MDE, MDA and MDNR continued to coordinate activities to characterize, restore, allocate, conserve and protect the State's groundwater resources. This past year, studies progressed to provide a comprehensive understanding of Maryland's groundwater resources, including in the fractured rock and Coastal Plain regions of Maryland. When complete, this information will facilitate sound management of water resources in the State. The recently published study dating groundwater in the upper Patapsco aquifer shows groundwater in some confined aquifers to be very old, highlighting the importance of water conservation and demand management.

In FY 2012, MDE's Water Supply program continued to manage water withdrawals through the Water Appropriations and Use permitting process, and many different State programs contributed to the restoration and protection of water quality. Additionally, this year significant legislation was passed to enhance the protection of water quality by providing funding mechanisms for upgrades to septic systems, wastewater treatment plants, and stormwater management strategies.

State programs to protect groundwater must be strengthened to ensure that safe and adequate water supplies are available to meet growing demands. Increased data collection and management for better decision making and planning related to groundwater use are among the top priorities for funding. However, both the Coastal Plain Groundwater Study and Fractured-Rock Water Supply Study require significant additional investment from current and new funding partners for completion. In addition, funding limitations have negatively affected program staffing needs and the ability to implement new groundwater protection activities.

Funding to support voluntary groundwater protection programs (e.g., wellhead protection, cover crop planting and voluntary cleanup programs) is having a positive impact. However, improvements are needed in the depth and scope of regulations to address more contaminants, and improve protection measures to meet legal requirements, which will require additional funding. The costs associated with addressing the legacy of past contamination remain high.

The challenges to groundwater protection are daunting: water demand and the threats to groundwater quality and quantity will continue to increase for the foreseeable future. Maryland's varied hydrologic terrain works against a "one size fits all" solution for managing, protecting and restoring groundwater. While some areas of the State experience issues of quantity limitations, other areas experience problems due to naturally occurring and/or human induced contamination. In FY2013, the State's water protection programs will continue to integrate these water resource issues and work toward providing long-term protection and use of Maryland's groundwater resources.