



MARCELLUS SHALE SAFE DRILLING INITIATIVE STUDY

PART II

BEST PRACTICES

AUGUST 2013

Prepared By:

Maryland Department of the Environment
Maryland Department of Natural Resources

Prepared For:

Martin O’Malley, Governor
State of Maryland

Thomas V. Mike Miller, Jr., Senate President
Maryland General Assembly

Michael E. Busch, House Speaker
Maryland General Assembly

Prepared pursuant to Executive Order 01.01.2011.11



Draft for Public Comment

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EXECUTIVE SUMMARY

Governor O’Malley’s Executive Order 01.01.2011.11 established the Marcellus Shale Safe Drilling Initiative. An Advisory Commission was established to assist State policymakers and regulators in determining whether and how gas production from the Marcellus Shale in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment, and natural resources. The State has not yet determined whether gas production can be accomplished without unacceptable risk and nothing in this report should be interpreted to imply otherwise.

The Executive Order tasks the Maryland Department of the Environment (MDE) and the Department of Natural Resources (DNR), in consultation with the Advisory Commission, with conducting a three-part study and reporting findings and recommendations. The completed study will include:

- i. findings and related recommendations regarding sources of revenue and standards of liability for damages caused by gas exploration and production;
- ii. recommendations for best practices for all aspects of natural gas exploration and production in the Marcellus Shale in Maryland; and
- iii. findings and recommendations regarding the potential impact of Marcellus Shale drilling in Maryland.

Part I of the study, a report on findings and recommendations regarding sources of revenue and standards of liability, in anticipation of gas production from the Marcellus Shale that may occur in Maryland, was completed in December 2011. The schedule was extended by one year for the second report, which is Part II of the study.

In preparation for the Part II report, MDE entered into a Memorandum of Understanding with the University of Maryland Center for Environmental Science, Appalachian Laboratory (UMCES-AL), to survey best practices from several states and other sources, and to recommend a suite of best practices appropriate for Maryland. The UMCES-AL recommendations were completed in February 2013 and made available to the Advisory Commission and the public. Those recommendations and drafts of this report were considered by the Advisory Commission at several meetings.

The Departments evaluated whether to add to, accept, reject, or modify the suggestions, based on a number of factors, including comments from the Advisory Commission. A draft of the Departments’ report was made available for public comment on June 25, 2013. After consideration of the comments, the Departments submit this report on Part II of the study, Best Practices. The Departments’ Best Practices recommendations are very similar to those in the UMCES-AL report. Where a UMCES-AL recommendation was rejected or modified, an explanation is provided.

The most innovative recommendation in the UMCES-AL report is to use comprehensive planning for foreseeable gas development activities in an area rather than considering each well individually. By considering the placement of well pads, roads, pipelines and other ancillary equipment for a large area, the efficiency of the operation could be maximized while the impacts on local communities, ecosystems, and other natural

resources could be avoided or minimized. The UMCES-AL report recommended that a comprehensive plan be voluntary.

The Departments agree that a Comprehensive Gas Development Plan (CGDP) designed to address the larger, landscape-level issues and cumulative effects offers significant benefits to both the industry and the public. The Departments propose to make a CGDP mandatory in Maryland and a prerequisite to an application for a well permit. The CGDP would be developed by the company through a process that allows public participation and then submitted to the State for approval. Once the CGDP is approved, applications for individual wells consistent with the approved plan could be made.

Whereas the CGDP establishes the locations for well pads, roads, pipelines and other ancillary equipment, the application for an individual well permit will require detailed plans for all activities, from construction of the access road through closure and restoration of the site. The elements of the plan must meet or exceed standards for engineering, design and environmental controls that are recommended in this report. These standards address activities from the initial construction of the access road and pad through closure and restoration of the site. They address sediment and erosion control, stormwater management, transportation planning, water acquisition, storage and reuse, disclosure of chemicals, drilling, casing and cement, blowout prevention, hydraulic fracturing, flowback and produced water, air emissions, wastewater treatment and disposal, leak detection, light, noise, invasive species, spill prevention control and emergency response, site security and closure and reclamation. These standards do not preclude the use of new and innovative technologies that provide greater protection of public health, the environmental and natural resources.

The report also makes recommendations relating to monitoring, recordkeeping and reporting. Appendices provide additional information on specific subjects and include comments of the Advisory Commission and a summary of and response to public comments.

Section I – Organization of the Report

The Maryland Departments of the Environment and Natural resources acknowledge the excellent work of the University of Maryland Center for Environmental Science – Appalachian Laboratory (UMCES-AL), and in particular Keith N. Eshleman, Ph.D. and Andrew Elmore, Ph.D., for their work in preparing *Recommended Best Management Practices for Marcellus Shale Gas Development in Maryland*. The UMCES-AL Report is organized into ten chapters, each devoted to protecting one aspect of the environment, natural resources, public health and safety. In order to facilitate the incorporation the recommendations into a regulatory and permitting program, however, we have chosen to organize this report differently. Within each section, the relevant UMCES-AL recommendations are listed by their alphanumeric designation as it appears in the UMCES-AL report. The same UMCES-AL recommendations may be referenced in multiple sections. The remainder of the section reflects the Departments evaluation.

Section II provides background information and an overview of activities in Maryland related to the Marcellus Shale. In addition, it summarizes the work of the Advisory Commission.

Section III focuses on comprehensive planning, particularly the concept of planning for the extraction of gas in a large area in order to avoid adverse impacts and minimize those that cannot be avoided. This comprehensive planning would occur before the issuance of a permit to drill any well.

Section IV addresses restrictions on the locations of well pads, pipelines, access roads, compressor stations, and other ancillary facilities. Some ecologically important areas, recreational areas and sources of drinking water may be fully protected only if certain activities are precluded there. In other cases, set back requirements may be sufficient. This section also describes siting best practices.

Section V establishes requirements for planning documents for individual wells.

Section VI deals with engineering, design, and environmental controls and standards. This includes, among other things, pad and access road design, the use of tanks rather than ponds for storing wastewater, air pollution controls, casing and cementing standards, integrity testing, emergency plans, waste disposal, and closure.

Section VII describes best practices for monitoring, recordkeeping and reporting. Pre-application monitoring and monitoring during drilling, well completion, and production are addressed. The response to monitoring results that suggest impacts is also discussed. Inspections and enforcement are included in this section.

Section VIII includes miscellaneous recommendations.

Section IX discusses modifications to the permitting process.

Section X is a roadmap for implementing the recommendations.

Included as Appendices are: the names of the Advisory Commission members, comments of the Advisory Commission, the response to public comments, a constraint analysis, a discussion of Marcellus shale and recreational and aesthetic resources in western

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Maryland, the UMCES-AL report, and a comparison of the UMCES-AL recommendations with those of the Departments.

Section II – Overview

A. Marcellus Shale

Geologists have long known about the gas-bearing underground formation known as the Marcellus Shale, which lies deep beneath portions of the Appalachian Basin, including parts of Western Maryland. Until advances in horizontal drilling and high volume hydraulic fracturing (HVHF) and the combination of these two technologies, few thought that significant amounts of natural gas could be recovered from the Marcellus Shale. Drilling in the Marcellus Shale using horizontal drilling and HVHF began around 2005 in Pennsylvania and has accelerated rapidly.

The production of natural gas has the potential to benefit Maryland and the United States. Tapping domestic sources could advance energy security for the United States. When burned to generate electricity, natural gas produces lower greenhouse gas emissions than oil and coal, which could help to reduce the impact of energy usage as we transition to more renewable energy sources. The exploration for and production of natural gas could boost economic development in Maryland, particularly in Garrett and Allegany Counties.

As gas production from deep shale and the use of HVHF has increased, however, so have concerns about its potential impact on public health, safety, the environment and natural resources. Although accidents are relatively rare, exploration for and production of natural gas from the Marcellus Shale in nearby states have resulted in injuries, well blowouts, releases of fracturing fluids, releases of methane, spills, fires, forest fragmentation, damage to roads, and allegations of contamination of ground water and surface water. Other states have revised or are in the process of reevaluating their regulatory programs for gas production or assessing the environmental impacts of gas development from the Marcellus Shale. A significant amount of research has been completed on HVHF and gas production from the Marcellus Shale, but additional research by governmental entities, academic organizations, environmental groups and industry is currently underway focused on drinking water, natural resources, wildlife, community and economic implications, production technologies and best practices.

B. Developments in Maryland

The Maryland General Assembly has entrusted the permitting and regulation of oil and gas exploration and development in Maryland to the Department of the Environment. With a few notable exceptions, the statutory language is general and MDE is authorized to promulgate rules and regulations and to place in permits conditions it deems reasonable and appropriate to assure that the operations are carried out in compliance with the law and provide for public safety and the protection of the State's natural resources. Md. Env. Code Ann., §§ 14-103 and 14-110. The Department's regulations on oil and gas wells have not been revised since 1993 and thus were written before recent advances in technology and without the benefit of more recent research.

The Maryland Departments of the Environment (MDE) and Natural Resources (DNR) have roles in the evaluation of natural gas projects. Each would be involved in any future permitting decisions for drilling in the Marcellus Shale.

The mission of the Maryland Department of the Environment is to protect and restore the quality of Maryland's air, water, and land resources, while fostering smart growth, economic development, healthy and safe communities, and quality environmental education for the benefit of the environment, public health, and future generations. In addition, MDE is specifically authorized by statute to issue permits for gas exploration and production. The Department of the Environment is required to coordinate with the Department of Natural Resources in its evaluation of the environmental assessment of any proposed oil or gas well.

The Department of Natural Resources leads Maryland in securing a sustainable future for our environment, society, and economy by preserving, protecting, restoring, and enhancing the State's natural resources. In addition, DNR owns or has conservation easements on substantial acreage in the State, including western Maryland.

The first application for a permit to produce gas from the Marcellus Shale in Maryland using horizontal drilling and HVHF was received in 2009.¹ To address the need for information to evaluate these permit applications properly, the Governor issued the Marcellus Shale Safe Drilling Initiative in Executive Order 01.01.2011.11 on June 6, 2011.

C. The Executive Order and the Advisory Commission

Executive Order 01.01.2011.11 directs MDE and DNR to assemble and consult with an Advisory Commission in the study of specific topics related to horizontal drilling and HVHF in the Marcellus Shale.² The Advisory Commission is to assist State policymakers and regulators in determining whether and how gas production from the Marcellus Shale in Maryland can be accomplished without unacceptable risks of adverse impacts to public health, safety, the environment, and natural resources. The Advisory Commission includes a broad range of stakeholders. Members include elected officials from Allegany and Garrett Counties, two members of the General Assembly, representatives of the scientific community, the gas industry, business, agriculture, environmental organizations, citizens, and a State agency. A representative of the public health community was added in 2013. Appendix A is a list of the Commissioners.

The Executive Order tasks MDE and DNR, in consultation with the Advisory Commission, with conducting a three-part study and reporting findings and recommendations. The Commission is staffed by DNR and MDE. The completed study will include:

- (i) By December 31, 2011, a presentation of findings and related recommendations regarding the desirability of legislation to establish revenue sources, such as a State-level severance tax, and the desirability of legislation to establish standards of liability for damages caused by gas exploration and production;

¹ Additional applications were received in 2011. Applications for a total of seven wells were received by MDE, but all have been withdrawn. In general, drilling has migrated to areas where not only natural gas, but also natural gas liquids that are more valuable, can be produced from formations.

² Although the Governor's Executive Order is directed specifically at the Marcellus Shale and HVHF, there is a potential for gas extraction from other tight shale gas formations, including the Utica Shale, and by well stimulation techniques other than HVHF. The findings and conclusions regarding gas exploration in the Marcellus Shale may also apply to other formations and techniques.

- (ii) By August 1, 2012, recommendations for best practices for all aspects of natural gas exploration and production in the Marcellus Shale in Maryland; and
- (iii) No later than August 1, 2014, a final report with findings and recommendations relating to the impact of Marcellus Shale drilling including possible contamination of ground water, handling and disposal of wastewater, environmental and natural resources impacts, impacts to forests and important habitats, greenhouse gas emissions, and economic impact.

Part I of the [study](#)³, a report on findings and recommendations regarding sources of revenue and standards of liability, in anticipation of gas production from the Marcellus Shale that may occur in Maryland, was completed in December 2011. The schedule was extended by one year for the second report.

D. The Work of the Advisory Commission

The Governor announced the membership of the Advisory Commission in July, 2011, and the Commission has met 18 times through June 10, 2013. Most meetings were in Allegany or Garrett Counties, but two were held in Hagerstown and two in Annapolis. The Departments have provided written information and briefings to the Advisory Commission on issues relating to HVHF. Speakers representing scientific organizations, industry and agencies from Maryland and other states have presented information to the Advisory Commission and the Departments. The Commissioners were able to visit active drilling sites. The Departments have consulted with the federal government and neighboring states regarding policy, programmatic issues and enforcement experiences. The Commissioners themselves, a well-informed and diverse assemblage, shared information and brought their expertise to bear.

The Commission recognized the importance of obtaining background data on air and water quality in advance of any drilling. DNR has begun collecting data to establish pre-drilling baseline conditions. Limited by existing funding and staff, DNR and MDE were not able to implement the comprehensive baseline monitoring program recommended by the Departments and the Advisory Commission in its Part I report. DNR has, however, expanded and modified its monitoring program to include 12 continuous water monitoring sites chosen for their relevance to potential gas development. DNR also began a volunteer partnership with Garrett County watershed associations, Trout Unlimited and other citizens where volunteer stream waders are collecting baseline water and biological data from over 70 stream segments. More information on [stream monitoring in the Marcellus shale region](#)⁴ can be found online.

DNR conducted a natural resource assessment of Garrett County to identify high quality streams known for biodiversity and brook trout resources, landscape values, ecological resources, forest interior dwelling species habitats, areas supporting rare, threatened and endangered plants and animals, community water supplies, State lands, trail networks, recreational assets, and areas of particular scenic value that could be impacted, directly or indirectly, by drill pads, pipeline/road construction and use. The findings, [Marcellus](#)

³ http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Meetings/Marcellus_Shale_Report_Part_I_Dec_2011.pdf

⁴ <http://www.dnr.state.md.us/streams/marcellus.asp>

Shale Gas Development in Maryland: A Natural Resource Analysis,⁵ were presented to the Commission on February 27, 2012.

MDE funded the Maryland Geological Survey to perform a limited study of methane levels in drinking water wells in Garrett County. Approximately 50 wells were sampled and a report, Dissolved-Methane Concentrations in Well Water in the Appalachian Plateau Physiographic Province of Maryland, was issued on November 1, 2012.

The Departments, in consultation with the Advisory Commission, convened a committee to evaluate necessary revisions to existing statutes and the need for new legislation to address liability, revenue, leases and surface owner's rights. The Departments and the Advisory Commission coordinated with representatives of the House Environmental Matters Committee and the Senate Education, Health and Environment Committee. This effort is ongoing.

In the 2013 session of the General Assembly, three bills were introduced based on the recommendations of the Commission: Business Occupations – Oil and Gas Land Professionals (SB766, HB828); Environment – Gas and Oil Drilling – Financial Assurance (SB854); and Natural Gas Severance Tax and Impact Account (SB879). Of these, the first two passed. Landmen will now have to register with the Department of Labor, Licensing, & Regulation. The financial assurance bill lifts the cap on the closure and reclamation bond and requires a minimum level of environmental impairment insurance in addition to general comprehensive liability insurance. Senator George Edwards, a member of the Commission, sponsored all three bills.

At the same time, the Governor proposed and the legislature approved a supplemental Fiscal Year 2013 appropriation that provides MDE with \$1 million and DNR with \$500,000 to complete the studies required under the Executive Order. The Departments are using this money, among other things, to expand the pre-drilling monitoring of air and water, and undertake an economic study and a public health study.

In furtherance of developing Best Practices recommendations, MDE contracted with the University of Maryland Center for Environmental Science, Appalachian Laboratory (UMCES-AL), to survey best practices from several states and other sources, and to recommend a suite of best practices appropriate for Maryland. The principal investigators, Keith N. Eshleman, Ph.D. and Andrew Elmore, Ph.D., compiled best practices from five states (Colorado, New York, Ohio, Pennsylvania, and West Virginia), as well as the recommendations of expert panels and organizations. The survey was completed and made available to the Commission. The report, Recommended Best Management Practices for Marcellus Shale Development in Maryland⁶ (the UMCES-AL Report), was made available to the Commission and the public in February 2013 and is included as Appendix F. The Departments also charted a comparison of the recommendations of UMCES-AL and the Departments; it is included in Appendix F.

⁵ http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Eshleman_Elmore_Final_BMP_Report_22113_Red.pdf

⁶ http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Meetings/MAC_NaturalResourcesAnalysis.pdf

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As the Departments reviewed that report and consulted with the Advisory Commission, all of the recommendations in the UMCES-AL report were considered. The Departments evaluated whether to add to, accept, reject, or modify the recommendations based on a number of factors, including the opinions of the Advisory Commission, the expertise of Departmental staff, and judgments about environmental protection, technical practicability, and administrative feasibility.

For the draft report

This document is the Departments' draft of the report on recommended best practices. The draft will be open for public comment for 30 days, after which the Departments will consider the comments and issue a final report on recommended best practices in August 2013. This draft report contains the Departments' recommendations. Following a public comment period, the report will be issued in final form.

For the final report

A draft was made available for public comment on June 25, 2013. Having considered all of the comments, including those of the Advisory Commission, the Departments submit this final report on Part II of the study, Best Practices. The State has not yet determined whether gas production can be accomplished without unacceptable risk and nothing in this report should be interpreted to imply otherwise.

Section III – Comprehensive Gas Development Plans

UMCES-AL Report recommendation 1-A, 1-C, 1-G, 5-A, 5-A.1, 5-A.3, 5-F, 5-F.1, 6-A, 6-C, 6-D, 6-E, 6-F, 6-J, 7-A, 7-A.1, 7-D, 7-D.1, 8-A, 8-B, 8-E, 9-A, 9-A.1, 9-A.2, 9-A.3, 9-E, 9-E.1, 9-G, 10-B

The authors of the UMCES-AL Report suggest that the single most important recommendation in their report is the comprehensive drilling plan. They recommend that the State should institute a voluntary program whereby a company holding gas interests could prepare and submit for State approval a comprehensive drilling plan for a large geographic area before applying for any specific permit to drill a well. Incentives could be offered, such as expedited processing of permits for individual wells included in the comprehensive drilling plan.

The Departments agree that a comprehensive plan offers great advantages, but we recommend that the program be mandatory rather than voluntary. We propose that Maryland require, as a prerequisite to the issuance of any permit to drill a gas exploration⁷, extension, or production well, that the prospective applicant first submit a Comprehensive Gas Development Plan (CGDP). A CGDP should be required even for exploration and extension wells, because of the likelihood that an exploration well will become a production well. The siting of the exploration well therefore is potentially as important as the siting of a production well. We believe that the program can be structured so that obtaining a CGDP is not unduly burdensome to the applicant, allows industry the flexibility to respond to changing conditions, and still achieves its purpose of reducing adverse and cumulative effects. The CGDP will address the locations for activities, but not the well-specific requirements of an individual permit. The processes, therefore, will not be duplicative.

The CGDP should address, at a minimum, all land on or under which the applicant expects to conduct exploration or production activities over a period of at least the next five years. The CGDP could be submitted by a single company or by more than one entity for an assemblage of land in which multiple entities hold mineral rights. The CGDP must address the locations of well pads, roads, pipelines and ancillary facilities related to exploration or production activities from the identified land, but the CGDP is not a commitment on the part of the applicant to install any of the facilities, or to proceed in a particular sequence.

CGDPs provide an opportunity to address multiple aspects of shale gas development from a holistic, broad-scale planning perspective rather than on a piecemeal, site-by-site basis. By considering the entire project scope of a single company, or multiple companies simultaneously, responsible energy development could proceed while minimizing

⁷ Current Maryland law allows an applicant to apply for a permit for an exploratory well; however, production may not commence until the environmental assessment has been completed and approved by MDE and MDE has issued a permit for production. Md. Env. Code 14-106. Thus, a permit for an exploratory well does not guarantee that a production permit will be granted. If the CGDP were to exclude exploratory wells, minimum setbacks and other siting restrictions would still apply, but the opportunity for larger, landscape-level planning would be compromised. For this reason, the Departments recommend that a CGDP be required even for an exploratory well

conflicts and addressing the concerns associated with maintaining the rural character of western Maryland, and protecting high value natural resources and resource-based economies. To cite just one example, land disturbance could be minimized if infrastructure were shared or located within the same right of way. Proactive, upfront planning at a landscape scale provides the framework for evaluating and minimizing cumulative impacts to the environmental, social and economic fabric of western Maryland. The Departments agree that a CGDP process will be beneficial and recommend that this be a mandatory prerequisite before any individual well permits would be issued. The associated recommendations, as listed as above, are generally accepted by the Departments for planning guidelines. The outline below provides a conceptual framework.

A. Application Criteria and Scope

1. Companies intending to develop natural gas resources are required to submit a CGDP for the area where the applicant may conduct gas exploration or production activities and install supporting infrastructure (compressor stations, waste water treatment facilities, roads, pipelines, etc.) for a period of at least five years.
2. Companies whose geographic planning units overlap are encouraged to develop integrated plans to improve use of existing and new infrastructure, to share or co-locate infrastructure, and to minimize cumulative impacts.
3. A company is not obligated to develop all the pads, wells or supporting infrastructure identified in the plan.
4. An approved CGDP will remain in effect for ten years.

B. Planning principles

1. Use multi-well, clustered drilling pads to minimize surface disturbance.
2. Comply with location restrictions, setbacks and other environmental requirements of State and local law and regulations.
3. Avoid, minimize and mitigate impact on resources as discussed in Section IV.
4. Preferentially locate operations on disturbed, open lands or lands zoned for industrial activity.
5. Co-locate linear infrastructure with existing roads, pipelines and power lines.
6. Consider impacts from other gas development projects and land use conversion activities and plan to minimize cumulative surface impacts.
7. Avoid surface development beyond 2% of the watershed area in high value watersheds. This threshold is based on the ecological sensitivity of specific aquatic organisms within these high value watersheds. Other factors, as discussed in the location restriction and setbacks section will also limit the location and extent of surface development.
8. Minimize fragmentation of intact forest, with particular emphasis on interior forest habitat.

9. Adhere to Departmental siting policies (to be developed) to guide pipeline planning and direct where hydraulic directional drilling and additional specific best management practices are necessary for protecting sensitive aquatic resources when streams must be crossed.

10. Additional planning elements include

- a) Identification of travel routes.
- b) Sequence of well drilling over the lifetime of the plan that places priority on locating the first well pads in areas removed from sensitive natural resource values.
- c) Consistency with local zoning ordinances and comprehensive planning elements.
- d) Identification of all federal, state and local permits needed for the activities.

C. Procedure and Approval Process

1. An applicant with the right to extract natural gas prepares a preliminary CGDP that best avoids and then minimizes harm to natural, social, cultural, recreational and other resources, and mitigates unavoidable harm.

2. The CGDP shall include a map and accompanying narrative showing the proposed location of all wells, well pads, gathering and transmission lines, compressor stations, separator facilities, access roads, and other supporting infrastructure.

3. The State will develop a Shale Gas Development Toolbox that will include GIS data and provide it to companies that wish to prepare a CGDP. The applicant's preliminary Environmental Assessment shall be based on the data in the Toolbox, supplemented with other information as needed, including a rapid field assessment for unmapped streams, wetlands and other sensitive areas. A detailed description of the shale Gas Development Toolbox is provided in section E, below.

4. State agencies and local government agencies review the CGDP, evaluate opportunities for coordinated regulatory review and present comments to the applicant to direct any needed alternative analyses for review. This review will be completed within 45 days of submission by the applicant of the CGDP.

5. The public review and approval process will be initiated upon request of the applicant following receipt of agency comments.

6. A stakeholders group that includes the company, local government, resource managers, non-governmental organizations, and surface owners will be convened; in a facilitated process that shall not exceed 60 days, to discuss and improve the plan.

7. The plan is presented at a public meeting by the applicant and the public shall be allowed to comment on the plan.

8. The applicant may further modify the plan based on alternatives analyses and public comment before submitting it to the State for approval.

9. In evaluating the CGDP, the State shall determine whether the plan conforms to all regulatory requirements concerning location, and shall consider the plan and the comments of the stakeholders and public.

10. If the State determines that the CGDP conforms to regulatory requirements and, to the maximum extent practicable, avoids impacts to natural, social, cultural, recreational and other resources, minimizes unavoidable impacts, and mitigates remaining impacts, the State shall approve the CGDP.

11. Once the CGDP is approved, the entity may file a permit application for one or more wells that are consistent with the plan.

12. Significant modification to the original plan, such as a change in location of a drilling pad, or the addition of new drilling pads, will require the submission and approval of a modified CGDP application. Modifications that cause no surface impact, such as the installation of additional wells on an existing pad or a change in the sequence shall be approved by the State upon request of the applicant.

D. Benefits of a Comprehensive Gas Development Plan

An approved, high quality CGDP could result in numerous benefits for all parties. These benefits, particularly those related to improved coordination and expedited permit review, are still under discussion among the review agencies, but could include:

1. Better protection of natural, social, cultural, recreational and other resources, and reduced cumulative impact.
2. Fast track wetland and waterway permit approvals for multiple individual impacts, such as those associated with pipeline networks and road construction, contingent on a comprehensive alternatives analysis scenario.
3. Preliminary approval for drill pad locations, allowing the applicant to initiate baseline monitoring and begin application for individual well permits.
4. Expedited consideration of other environmental approvals and permits, such as air quality and water appropriation and use.
5. Opportunities to implement mitigation actions prior to permit approval or in advance of project development.
6. Reduced need for multiple public hearings.
7. Reduced expense and risk associated with leveraging existing infrastructure and centralizing various processing needs.
8. Reduced public use conflict and improved public good will.

E. The Shale Gas Development Toolbox

The toolbox will provide access to geospatial planning data necessary to address the Comprehensive Gas Development Plan (CGDP). The data will be available for download, and can be viewed through a publicly accessible interactive mapping application. The mapping application will be very similar to DNR's [MERLIN](#) online

tool⁸ but will be tailored to include the geospatial data needed for developing and evaluating the CGDP. Users of this data should be aware that actual site and landscape conditions may not be accurately reflected in the mapped information. Many fine scale environmental features, such as headwater streams or small wetlands, are often not mapped. In addition, the effects of recent land use change may not be reflected in the mapped datasets. For this reason, and to evaluate other site specific factors, additional site assessment data will need to be collected by the applicant to meet the requirements of the CGDP. The planning datasets that will be included in the toolbox include those related to the elements discussed in Section IV. A. Location Restrictions and Setbacks and in Section IV. B. Siting Best Practices. Additional datasets may be added to improve the CGDP process.

1. Planning objective: Leveraging existing infrastructure.
 - a. State and county roads
 - b. Existing right of ways for gas lines and transmission inks
 - c. Land use/land cover data for identifying industrial land uses
2. Planning element: Location restrictions and setbacks that indicate where certain gas development activities are restricted.
 - a. Streams, rivers and flood plains – stream maps will include designated use classifications
 - b. Wetlands
 - c. Reservoirs
 - d. Irreplaceable Natural Areas (BioNet Tier 1 and 2 areas)
 - e. Cultural and historic areas, including National Registry sites
 - f. Local, state and federal parks, including setback recommended through participatory GIS workshops
 - g. Wild and scenic rivers
 - h. Scenic byways
 - i. Mapped limestone outcrops and known caves
 - j. Historic gas wells
 - k. Private and public groundwater wells or surface water intakes
3. Planning element: Additional siting criteria to guide avoidance, minimization and mitigation of potential impacts.
 - a. Land use land cover for preferentially siting activities on open, disturbed land or areas in industrial use and avoiding forested areas.
 - b. High value watersheds (Tier II, Brook trout and Stronghold watersheds) where surface area impacts should not exceed the ecological threshold of 2 % of the watershed area.
 - c. Forest interior dependent species (FIDS) habitat - large contiguous forest patches important for supporting FIDS
 - d. Green Infrastructure Hub and Corridor network - a system of large habitat areas connected to each other through corridors that are important for allowing plant and animal migration.

⁸ <http://dnrweb.dnr.state.md.us/merlin/>

- e. Forests important for protecting water quality - forested areas that have exceptional value for maintaining clean and cool water quality for streams and rivers.
 - f. BioNet habitat areas - habitat important for wildlife and rare species. This dataset includes Irreplaceable Natural Areas (Tier 1 and 2 areas) and other important habitats (Tier 3, 4 and 5 areas).
 - g. GreenPrint Targeted Ecological Areas – high value lands and waters that are eligible for State conservation funding through Program Open Space.
 - h. Mapped underground coal mines
 - i. Aerial imagery – useful for evaluating actual ground conditions
4. Planning element: Identification of appropriate natural resource mitigation actions to address unavoidable impacts.
- a. The [Watershed Resources Registry Tool](#)⁹ can be used to identify potential mitigation options for restoration and conservation of stream buffers, wetlands and upland forests. This tool has been developed by a consortium of federal and state regulatory and non-regulatory agencies, including MDE and DNR.

⁹ watershedresourcesregistry.com

Section IV – Location Restrictions and Setbacks

This section addresses restrictions on the locations of well pads, pipelines, access roads, compressor stations, and other ancillary facilities. Certain ecologically important areas, recreational areas and sources of drinking water may only be fully protected if certain activities are precluded there. Similar reasoning can be applied to the protection of cultural and historic resources, where the presence of shale gas development infrastructure will detract from the interpretative value and visitor experience.

Minimizing conflict with residential and community based uses is also an important consideration in defining location restrictions. In addition to designating certain places or features “off limit”, many of these resources also require a minimum setback distance to provide an additional buffer between the development activity and the resource of concern. The setback distance will vary based on the resource of concern and the nature of the disturbance. This section also describes additional avoidance, minimization and mitigation criteria and siting best practices.

A. Location Restrictions and Setbacks

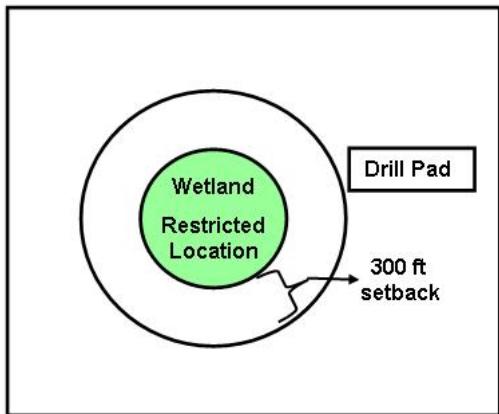
UMCES-AL Report recommendations 1-E, 1-H, 1-I, 1-J, 4-A, 5-C, 5-C.1, 5-C.2, 5-C.3, 6-B, 8-F, 8-G, 9-C

Certain location restrictions and setbacks exist in current law and regulation, and these will be continued. In addition to a statutory prohibition against drilling for gas or oil in the waters of the Chesapeake Bay, any of its tributaries, or in the Chesapeake Bay Critical Area (Md. Env. Code §14-107), these are:

Table I-1: Existing Setback Requirements				
Distance (feet)	From	To	Waivers	Cite
1,000	Well	The boundary of the property on which the well is to be drilled	Can be granted by the Department if a well location closer than 1,000 feet is necessary due to site constraints.	Md. Env. Code §14-112 and COMAR 26.19.01.09 C and D
2,000	Gas Well	Existing gas well in the same reservoir	Unless the Department is provided with geologic evidence of reservoir separation to warrant granting an exception	COMAR 26.19.01.09 E
1320	Oil Well	Exiting oil well in the same reservoir	Unless the Department is provided with geologic evidence of reservoir separation to warrant granting an exception	COMAR 26.19.01.09 F

1,000	Well	A school, church, drinking water supply, wellhead protection area, or an occupied dwelling	Unless written permission of the owners is submitted with the application and approved by the Department	COMAR 26.19.01.09 G
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The figure below illustrates the concept of location restrictions and setbacks that uses the UMCES-AL recommendation for aquatic habitat. The resource of concern is a wetland.



UMCES-AL has recommended that the edge of drill pad disturbance should be 300 feet or greater from the wetland habitat. The drill pad must be located outside of the restricted resource and the required setback distance.

A preliminary analysis was conducted by DNR to evaluate the effect of a subset of proposed location restrictions and setbacks on the ability to access Marcellus shale gas through horizontal drilling (Appendix D: Marcellus shale constraint analysis). The surface constraint factors selected

were those which were appropriate for a coarse, landscape scale analysis. Under a scenario that excluded drilling from the Accident gas storage dome and assumed an 8,000 foot horizontal drill length, approximately 98 % of the Marcellus shale would be accessible. In an effort to be conservative, the same analysis was run using a 4,000 foot horizontal drill length, resulting in about 94 % accessibility to the Marcellus shale formation. This assessment supports the UMCES-AL suggestion that it is reasonable to expect that shale gas resources can be broadly accessed while minimizing surface disturbance, particularly in areas with sensitive resources. Setback recommendations from the UMCES-AL report, with the Departments' comments, are provided in Table I-2 below.

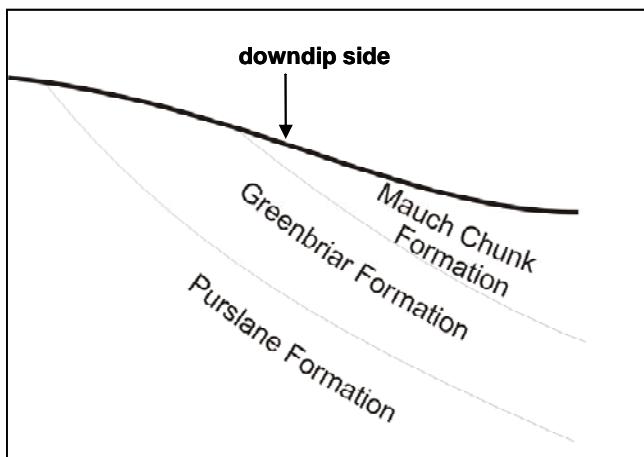
Table I-2: Setback Recommendations from UMCES-AL Report with Adjustments Recommended by the Departments			
Distance (feet)	From	To	MDE and DNR Adjustment
300 ¹⁰	Aquatic habitat (defined as all streams, rivers, seeps, springs, wetlands, lakes, ponds, reservoirs, and 100 year floodplains)	Edge of drill pad disturbance	Agree
600	Special conservation areas (<i>e.g.</i> , irreplaceable natural areas, wildlands)	Edge of drill pad disturbance	Agree; may be expanded on a case by case basis, after DNR conducts a participatory GIS workshop; apply not just to drill pad locations but to all permanent surface infrastructure
300	All cultural and historical sites, state and federal parks, trails, wildlife management areas, scenic and wild rivers, and scenic byways	Edge of drill pad disturbance	Apply not just to drill pad locations but to all permanent surface infrastructure
1,000	Mapped limestone outcrops or known caves	Borehole	Agree as to caves; for limestone outcrops, reduce to a setback of 500 feet on the downdip side
1,000	Mapped underground coal mines	Borehole	Unnecessarily restrictive; alternative approach recommended; see Section VI-D
1,320	Historic gas wells	Any portion of the borehole, including laterals	Agree
1,000	Any occupied building	Compressor stations	Agree
1,000	Any occupied building	Borehole	Agree

¹⁰ This distance shall be measured from the center of a perennial stream or from the ordinary high water mark of any river, natural or artificial lake, pond, reservoir, seep or spring, determined as conditions exist at the time of the approved CGDP.

500	Private groundwater wells	Borehole	Expand to 1,000 feet, as required by current regulations.
2,000	Public groundwater wells or surface water intakes	Borehole	Agree; drinking water reservoirs must also be protected

The Departments generally accept the proposed location restrictions and setbacks with the following modifications and additions that were based on the subject matter expertise of the agencies.

1. Well pads shall not be constructed on land with a slope > 15%. This was recommended in the report, but not included as a key recommendation.
2. Setback distances may be expanded on a case by case basis if the area includes steep slopes or highly erodible soils.
3. Modify restrictions for setbacks from limestone outcrops to the borehole; setback areas for mapped limestone outcrops apply only to 500 feet on the downdip side of the formation.



There is no need to adhere to setbacks on the up dip side because the limestone formation – the Greenbriar – will not be encountered (see figure to left). This setback recommendation was established to avoid karst features. However, the Maryland Geological Survey states that most limestone in Garrett County is not karst, but when these features do occur, they rarely penetrate below 100 – 200 feet from the surface. In Garrett

County, these formations generally dip at 20 degrees, while the beds in Allegany County dip at steeper angles. Using a 200 foot depth for potential karst development as a conservative estimate, a 500 foot setback on the downdip side of the limestone outcrop would be sufficiently protective.

4. Setbacks for known and discovered caves should remain at 1000 feet because of the biological resource sensitivity and the potential for groundwater contamination.
5. Modify restrictions for setbacks from mapped underground coal mines to the borehole. MDE's mining program notes that Maryland's deep coal mines may cover thousands of acres, are only several hundred feet deep, and can be safely cased through, particularly if pilot holes are drilled to identify these features and drilling processes are modified to address the known hazards. A setback of 1000 feet is unnecessarily restrictive. Instead the Departments recommend pre-drill planning as an alternative which

involves careful site evaluation and pilot hole investigations. See Section VI-D for a description on pre-drill planning.

6. Replace the recommended 500 foot setback from private groundwater wells to the borehole with a 1,000 foot setback.

Current regulations, COMAR 26.19.01.19G, are more protective and state that an oil and gas well cannot be closer than 1,000 feet to a drinking water supply. Private groundwater wells are considered a drinking water supply.

7. The setback requirement of 2,000 feet shall apply upstream of any surface water intake on a flowing stream, as a radius around any drinking water well, and from the edge of any drinking water reservoir.

8. Expand drill pad location restrictions and setbacks listed in Table 1-1 to all gas development activities resulting in permanent surface alteration that would negatively impact natural, cultural and historic resources. This includes permanent roads, compressor stations, separator facilities and other infrastructure needs. This expansion applies to aquatic habitat, special conservation areas, cultural and historical sites, State and federal parks and forests, trails, wildlife management areas, wild and scenic rivers and scenic byways.

9. DNR will develop new maps of public outdoor recreational use areas to establish additional recreational setbacks and mitigation measures for minimizing public use conflicts. DNR will initiate the first of a series of participatory GIS workshops to develop these new maps in the fall of 2013, focusing on the recreational amenities of Savage River State Forest. The results of this workshop will be weighed against the alternative option of expanding the setback to 600 feet.

Maryland has a number of well-developed and nationally-recognized networks of scenic and historic byways and hiking and water trails that provide opportunities for the public to experience nature, cultural and historical features and the outdoors through unique vistas and long-distance travel routes. The location and features that make these routes unique (*e.g.* vistas, through-trail hikes, canopy cover) should be considered during setback discussions. The proposed recreational setback from Marcellus shale gas infrastructure is a minimum of 300 feet with additional setback considerations for noise, visual impacts and public safety. Additional factors will include hunting and fishing activities, light, odor and other issues that would affect public use and enjoyment of these resources. A more detailed discussion of these issues and concerns is provided in Appendix E: Marcellus Shale and Recreational & Aesthetic Resources in Western Maryland. DNR will launch a formal process for developing new maps of use areas that would include participatory GIS workshops conducted with facility managers, friends groups, frequent visitors, and other stakeholders. The maps generated from these discussions and workshops could then be used to inform comprehensive gas development plans, setback considerations, mitigation measures and timing of shale gas development activities. This recommendation could be incorporated as an element of the public comment period of a CGDP process, or be developed independently of the CGDP and included in the Shale Gas Development Toolbox.

10. For good cause shown and with the consent of the landowner protected by the setback, MDE may approve exceptions to the setback requirements.

B. Siting Best Practices

UMCES-AL Report recommendations 3-B, 4-D, 5-A.2, 6-J.2, 6-J.4, 8-C, 8-D, 8-H, 9-G, 9-H, 10-A, 10-C, 10-D

This section also includes best practices recommended for siting pipelines, access roads and other supporting infrastructure. The Departments generally accept the proposed siting best practices with the following modifications and additions.

1. Forest mitigation that is required to meet a no-net-loss of forest standard will be evaluated differently based on whether the loss is temporary or permanent.
2. Site-specific viewshed analysis should be conducted (as recommended by UMCES-AL), but temporary and permanent impacts will be evaluated differently.
3. Conservation of high value forest land through easements or fee-simple acquisitions should be considered as an additional mitigation option for implementing the no-net-loss of forest recommendation, particularly since reforestation options in western Maryland locations may be limited. Conservation banking may also be an additional mechanism to meet forest conservation mitigation.
4. DNR will provide additional GIS conservation planning data layers and guidance for avoiding, minimizing and mitigating impact to aquatic and terrestrial high priority conservation areas. These data layers will be included in the Shale Gas Development Toolbox described in Section III-D.
5. Stream crossings will avoid impact to brook trout spawning beds.
6. Operations, water withdrawals and infrastructure siting should avoid thermal impacts to cold water streams.

The setback and other recommendations provide a high level of protection to Tier II waters from MSGD activities. MDE will consider whether additional anti-degradation protections are necessary for MSGD when it revises its anti-degradation regulations.

Section V – Plan for Each Well

UMCES-AL Report recommendations 1-A, 3-A, 4-B

For each well, the applicant for a drilling permit shall prepare and submit to MDE, as part of the application, a plan for construction and operation that meets or exceeds the standards and/or individual planning requirements for Engineering, Design and Environmental Controls set forth in Section VI. In preparing the plan, the applicant shall consider API Standards and Guidance Documents, and, if the plan fails to follow a normative element of a relevant API standard, the plan must explain why and demonstrate that the plan is at least as protective as the normative element. The plan must address, at a minimum,

1. Completing the Environmental Assessment

This effort includes all environmental assessment baseline monitoring and site characterization required as a prerequisite for issuing individual well permits. These are activities that would be initiated after the CGDP has been approved and require site-specific, field scale assessment and monitoring.

2. Constructing the pad, containment structures, access roads and other ancillary facilities

3. Method of providing power to equipment

4. Acquisition of water

5. Evaluation of potential flow zones

6. Identification and evaluation of shallow and deep hazards

7. Pore pressure/fracture gradient/drilling fluid weight

8. Monitoring and maintaining wellbore stability

9. Addressing lost circulation

10. Casing

11. Cementing

12. Drilling fluids

13. Wellbore hydraulics

14. Barrier design

15. Integrity and pressure testing

16. Blow out protection

17. Contingency planning

18. Communications plan, including communication with contractors and subcontractors

19. Site security

20. Storage, treatment and disposal of water, wastewater, fuel and chemicals
21. Road construction and transportation planning
22. Spill prevention, control and countermeasures, and emergency response
23. Invasive species
24. Waste handling, treatment and disposal
25. Monitoring the well during production to detect well problems and failure of casing or cement
26. Reclamation

Consistent with UMCES-AL recommendation 4-B, the applicant will be required to notify the owners of any drinking water well within 2,500 feet that an application has been filed.

A suggestion has been made by some Commissioners that there be a formal process by which other State and local government agencies could review and comment on the application for an individual well permit. Because interagency issues will relate principally to the location of the well pad, access roads, pipelines and other infrastructure, review by other State and local government agencies would be more appropriate and effective at the time of the CGDP, not the individual well permit. The Departments recommend that the appropriate staff from specific agencies be invited to participate in the CGDP development. The Departments plan to address coordination with local government agencies on specific topics, such as transportation planning and emergency response, through the standards set out in Section VI.

Section VI – Engineering, Design and Environmental Controls and Standards

The standards in this section do not preclude the use of new and innovative technologies that provide greater protection of public health, the environmental and natural resources. Practices used in shale gas development continue to evolve and improve. Exceptions to these conditions will be considered if the new technology can be demonstrated to assure equal or greater protection.

A. Site Construction and Sediment and Erosion Control

UMCES-AL Report recommendations 4-E, 4-F, 4-G, 4-I, 5-B, 5-B.1, 6-G, 6-J, 6-J.1, 6-J, 6-K, 9-F

The proper construction of drilling pads, roads, pipelines, tanks, pits and ponds, roads, and ancillary equipment is critical for eliminating or minimizing the risk of release of pollutants to the environment from spills, accidents, and runoff of contaminated stormwater. Current Maryland statutes and regulations are nearly silent on design and construction requirements, except for pits and tanks.¹¹ The regulations require an approved stormwater management plan and sediment and erosion control plan, but do not establish any requirements specific to oil and gas operations.¹² As these plans are written to address the requirements of shale gas development, training of plan review and approval staff may be required.

1. The pad

The pad is the center of activity during drilling and HVHF. Not only are the drill rig and vertical borehole there, but the pad is also the site for storing fuel and chemicals, handling drilling mud and cuttings, mixing and pressurizing hydraulic fracturing fluid, and mixing and pumping the cement. Pollutants released on the pad could enter the environment by infiltrating through the pad, running off the pad, or being washed from the pad by precipitation. The UMCES-AL Report recommended closed loop drilling systems on “zero-discharge” pads, containment of stormwater from the pad, and storage of all liquids (except fresh water) in watertight, closed tanks inside secondary containment. The Departments agree.

No discharge of potentially contaminated stormwater or pollutants from the pad shall be allowed. Drill pads must be underlain with a synthetic liner with a maximum permeability of 10^{-7} centimeters per second and the liner must be protected by decking material. Spills on the pad must be cleaned up as soon as practicable and the waste material properly disposed of in accordance with law. The drill pad must be surrounded by an impermeable berm such that the pad can contain at least the volume of 2.7 inches of rainfall within a 24 hour period. The berm may be made impermeable by extension of the liner. In addition, the design must allow for the transfer of stormwater and other liquids that collect on the pad to storage tanks on the pad or to trucks that can safely transport the liquid for proper disposal. The collection of stormwater and other liquids

¹¹ COMAR 26.19.01.10 J through K.

¹² COMAR 26.19.01.06C (12) and (13).

may cease only when all potential pollutants have been removed from the pad and appropriate, approved stormwater management can be implemented.

2. Tanks and containers

Tanks shall be above ground, constructed of metal, and lined if necessary to protect the metal from corrosion from the contents. Except for tanks used in a closed loop system for managing drilling fluid and cuttings, which may be open to the atmosphere, tanks shall be closed and equipped with pollution control equipment specified in other sections of this report. Tanks and containers shall be surrounded with a continuous dike or wall capable of effectively holding the total volume of the largest storage container or tank located within the area enclosed by the dike or wall. The construction and composition of this emergency holding area shall prevent movement of any liquid from this area into the waters of the State.

3. Pits and Ponds

The UMCES-AL Report does not make recommendations for the construction of pits and ponds, but recommends that they should be used only to collect or store fresh water; all other material shall be stored in tanks. The Departments agree.

Current Maryland regulations require pits and ponds shall (a) have at least 2 feet of freeboard at all times; (b) be at least 1 foot above the ground water table; (c) be impermeable; (d) allow no liquid or solid discharge of any kind into the waters of the State; and (e) provide for diverting surface runoff away from the pit or pond. Dikes associated with pits must be constructed and maintained in accordance with standards and specifications for soil and erosion sediment control. In addition they must be constructed of compacted material, free of trees and other organic material, and essentially free of rocks or any other material which could affect their structural integrity; and the dikes must be maintained with a slope that will preserve their structural integrity; COMAR 26.19.01.10J and K. The Departments judge that the current regulations are sufficient for fresh water storage.

4. Pipelines

Gathering lines are pipelines that bring gas to a central facility or transmission line. Transmission lines are interstate lines that transport gas long distances. The federal and state governments share responsibility for gas pipelines. State and local laws address pipeline placement as a construction activity that must comply with erosion and sediment control plans and stormwater management. In addition, if pipelines cross wetlands or waterways, additional permits may be required.

The United States Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), Office of Pipeline Safety (OPS), has overall regulatory responsibility for hazardous liquid and gas pipelines in the United States that fall under its jurisdiction. OPS regulates and inspects hazardous liquid and gas interstate operators in Maryland. Through certification by OPS, the state of Maryland regulates and inspects the operators having intrastate gas and liquid pipelines. This work is performed by the Pipeline Safety Division of the Maryland Public Service Commission.

Onshore natural gas gathering lines are classified by the federal government based upon the number of buildings intended for human occupancy that lie within 220 yards on either

side of the centerline of any continuous one mile length of pipeline. If there are fewer than 10 such buildings, the gathering lines are not federally regulated. They are sometimes referred to as “rural gas gathering lines.” In Maryland, the Pipeline Safety Division of the Maryland Public Service Commission (PSC) regulates and inspects intrastate gas and liquid pipelines. It appears that the PSC has not established any standards for the location, materials, construction or testing of gathering lines, which should be addressed by the PSC.

In the past, gathering lines were generally small diameter and did not operate under high pressure. PHMSA has recognized that lines being put into service in shale plays like the Marcellus are generally of much larger diameter and operating at higher pressure than traditional rural gas gathering lines, increasing the concern for safety of the environment and people near operations. Because they are unregulated, the PHMSA had limited information about pipeline construction quality, maintenance practices, location and pipeline integrity management. It is in the process of collecting new information about gathering pipelines in an effort to better understand the risks they may now pose to people and the environment. If the data indicate a need, PHMSA may establish new, safety requirements for large-diameter, high-pressure gas gathering lines in rural locations.

In the absence of existing federal or Maryland regulation of rural gathering lines, the Departments recommend that, as a best practice, except for those oil and/or natural gas pipelines covered by the Hazardous Materials Transportation Act (49 U.S.C. sections 1802 *et seq.*) or the Natural Gas Pipeline Safety Act (49 U.S.C. sections 1671 *et seq.*), all pipelines utilized in the actual drilling or operation of oil and/or natural gas wells, the producing of oil and/or natural gas wells, and the transportation of oil and gas, shall comply with the following standards for material and construction:

- a. The owner and operator of any pipeline shall participate as an “owner-member” as that term is defined in the Maryland Public Utilities Code, Section 12-101, in a one-call system, which in Maryland is generally known as the “Miss Utility” program. Upon the request of someone planning to excavate in the area, the locations of these pipelines could be marked so that the digging could avoid them.
- b. All pipelines and fittings appurtenant thereto used in the drilling, operating or producing of oil and/or natural gas well(s) shall be designed for at least the greatest anticipated operating pressure or the maximum regulated relief pressure in accordance with the current recognized design practices of the industry.

5. Road Construction

The UMCES-AL report makes several recommendations about roads. Wherever possible, existing roads should be used. Where new road construction for Marcellus shale activities in Maryland is necessary, it should follow guidelines issued by the Pennsylvania Department of Conservation and Natural Resources. The guidelines: (1) recommend utilizing materials and designs (*e.g.*, crowning, elimination of ditches) that encourage sheet flow as the preferred drainage method for any new construction or upgrade of existing gravel roadways; (2) provide specific recommendations about aggregate depth,

type, and placement; and (3) promote the use of geotextiles as a way of reducing rutting and maintaining sub-base stability. Erosion should be controlled and damage to environmentally sensitive areas should be avoided. The authors opine that one of the best ways to minimize the risk of road failures is to selectively schedule hauling operations to avoid or minimize traffic during the spring thaw and other wet weather periods. They further recommend that where stream crossings are unavoidable, the design incorporate bridges or arched culverts to minimize disturbance of streambeds.

The Departments agree that roads constructed by private parties for access to gas exploration and production facilities should avoid adverse environmental impacts and minimize those that cannot be avoided. The location of roads will be evaluated during the review of the Comprehensive Development Plan. Sediment and erosion control plans and stormwater management plans will provide assurance that erosion will be controlled.

The UMCES-AL Report recommended the standards used by the Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry, for roads in leased state forest land. These standards are contained in [Guidelines for Administering Oil and Gas Activity on State Forest Lands](#).¹³ The Bureau of Forestry works closely with The Pennsylvania State University's [Center for Dirt and Gravel Road Studies](#)¹⁴ to identify and adopt best practices for road maintenance and construction. The Center makes a large amount of information about unpaved roads available on its website, including technical bulletins. The Departments recommend that the design, construction and maintenance of unpaved roads be at least as protective of the environment as the standards adopted by the Bureau of Forestry.

6. Ancillary equipment

Ancillary equipment includes gathering and boosting stations, glycol dehydrators and compressor stations. A gathering and boosting station collects gas from multiples wells and moves it toward the natural gas processing plant. Glycol dehydrators are used to remove water from natural gas to protect the systems from corrosion and hydrate formation. Compressor stations are placed along pipelines as necessary to increase pressure and keep the gas moving. The location of compressors will be addressed in the CGDP. Ancillary equipment is addressed in Section VI J and N (Air Emissions and Noise).

B. Transportation Planning

UMCES-AL Report recommendations 7-A, 7-D, 7-D.1, 7-D.2, 8-E, 9-A.4, 9-E, 9-E.1

In addition to road construction standards, timing of transportation activities and addressing road damage are necessary elements of transportation planning. The State and most counties have existing programs to allow for emergency transport of heavy or oversized equipment during off-hour periods. The Departments accept the proposed transportation planning recommendations with the following modifications and additions to minimize use conflicts and provide adequate mitigation for road damage.

¹³ http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_004055.pdf

¹⁴ <http://www.dirtandgravel.psu.edu/>

State public land managers should coordinate the timing of oil and gas activities with the operator to avoid public conflict and to minimize damage to roads on public lands. Public land managers should consider suspending activities requiring heavy trucking during:

1. Periods of heavy public use such as hunting season or trout season
2. Weather conditions that make the roads impassable
3. Traditionally wet periods when road damage is most probable
4. During the spring frost breakup

Note: Trucking should be closely monitored during high-use and wet periods if it is not possible to suspend activities.

Applicants must coordinate with county and/or municipal offices to avoid truck traffic under the following conditions:

1. During times of school bus transport of children to and from school locations.
2. During public events and festivals

Encourage local jurisdictions to develop adequate transportation plans.

Encourage maximum movement of heavy equipment by rail to protect road systems and prevent accidents.

Require that all trucks, tankers and dump trucks transporting liquid or solid wastes be fitted with GPS tracking systems to help adjust transportation plans and identify responsible parties in the case of accidents/spills.

Require the applicant to enter into agreements with the county and/or municipality to maintain the roads which it makes use of, in the same or better condition the roadways had prior to the commencement of the applicant's operations, and to maintain the roadways in a good state of repair during the applicant's operations.

C. Water

UMCES-AL Report recommendations 4-G, 4-J, 6-H.1, 6-H.2

1. Storage

The UMCES-AL Report recommended that the Maryland regulations should specifically address water storage, that impoundments may be used for storing freshwater, and that temporary pipelines should be considered instead of trucks for transporting water. The Departments agree that only freshwater should be stored in impoundments and would permit either centralized freshwater impoundments or impoundments serving a single well pad, provided the impoundment meets standards for safe construction (refer to Pits and Ponds, above). Applicants for permits are encouraged to propose using temporary pipelines for the transfer of fresh water to a drill site.

2. Water withdrawal

The UMCES-AL Report recommends that Maryland revise its oil and gas permitting regulations to explicitly address water withdrawal issues. In particular, they recommend a quantitative analysis of acceptable water withdrawals to ensure that all users of the

resource are protected and that water withdrawal should occur only from the region's large rivers and perhaps from some reservoirs. In addition, the authors recommend that precautions be taken to avoid the introduction of invasive species. For example, they recommend an analysis of any invasive species that may be present in the source water and power washing of the withdrawal equipment before it is removed from the withdrawal site.

The Departments agree that practices are necessary to control invasive species. They are addressed in Section VI O (Invasive Species). The Departments do not see a need to add water appropriation provisions in MDE's oil and gas regulations because current Maryland laws and regulations protect other users of the water resource and the resource itself.

The Maryland legislature has determined that the appropriation or use of surface or ground water must be controlled in order to conserve, protect, and use water resources of the State in the best interests of the people of Maryland. This control provides for the greatest possible use of waters in the State, while protecting the State's valuable water supply resources from mismanagement, abuse, or overuse. Private property owners have the right to make reasonable use of the waters of the State which cross or are adjacent to their land. For the benefit of the public, the Department acts as the State's trustee of its water resources. Maryland follows the reasonable use doctrine to determine a person's right to appropriate or use surface or ground water. A ground water appropriation or use permit or a surface water appropriation or use permit issued by MDE authorizes the permittee to make reasonable use of the waters of the State without unreasonable interference with other persons also attempting to make reasonable use of water. The permittee may not unreasonably harm the water resources of the State. COMAR 26.17.06.02.

Current Maryland statutes and regulations on water withdrawal, with certain exceptions not relevant here, require MDE approval and issuance of an appropriation permit before a person can withdraw any surface water, or more than 5,000 gallons per day (gpd) of ground water as an annual average. Appropriation requests for an annual average withdrawal of more than 10,000 gpd (as a new request or increase) may be required to perform aquifer testing and other technical analyses. All applicants proposing a new use of increase of 10,000 gpd are required to include certified notification of contiguous property owners and certification of compliance with the State plumbing code and requirements for water conservation technology. In addition, requests for an annual average withdrawal of more than 10,000 gpd as a new request or increase are advertised for a public information hearing.

Because the thresholds for requiring a permit are low, it is unlikely that anyone could obtain a sufficient amount of water for HVHF without first obtaining a water appropriation permit. The Departments believe that the substantive criteria for evaluating applications for water appropriation are adequate to address water withdrawals for Marcellus shale drilling and HVHF. These criteria are set forth in COMAR 26.17.06.05 and include impact on other users and the waters of the State, and the aggregate changes and cumulative impact that the particular request and future appropriations in an area may have on the waters of the State. The Department of the Environment has the authority to include protective provisions in permits. COMAR 26.17.06.06.

3. Water reuse

This topic is further discussed under Wastewater Treatment and Disposal, below. The UMCES-AL report recommended that Maryland should include “a very strong preference” for onsite recycling of wastewater over treatment at a centralized facility, because this would decrease truck transport and associated impacts. The Departments agree.

Flowback and produced water shall be recycled to the maximum extent practicable. Unless the applicant can demonstrate that it is not practicable, the permit shall require that not less than 90% of the flowback and produced water be recycled, and that the recycling be performed on the pad site of generation.

D. Chemical Disclosure

UMCES-AL Report recommendations 4-H

The recommendations about disclosure of chemicals in the UMCES-AL report related specifically to response to chemical emergencies, and are addressed under the heading of Spill Prevention, Control and Countermeasures, and Emergency Response.

The identity of chemical additives to drilling fluids and hydraulic fracturing fluids is of particular concern because these chemicals are used underground where, if appropriate precautions are not taken, the chemicals could enter underground sources of drinking water. At the federal level, the Safe Drinking Water Act (SDWA) allows EPA to regulate the subsurface emplacement of fluid; however, Congress excluded from regulation under the SDWA the underground injection of fluids (other than diesel fuels) and propping agents for HVHF. Many gas operators voluntarily disclose the chemicals they used, after the fact, although some chemicals are not specifically identified because they are claimed to be trade secrets. The Departments agree that it would be desirable for MDE to review the chemicals before they are used. The Departments therefore propose the following standards for chemical disclosure.

The permittee shall, before beginning operations, provide the local emergency response agency with a hazardous chemical inventory list and a copy of the Safety Data Sheets (SDS) for all hazardous chemicals that are expected to be on-site at any stage of the operation.

A copy of the SDS for all drilling and fracturing additives to be used shall be provided to MDE with the application for a permit to drill a well. If the SDS does not provide the chemical name and Chemical Abstracts Service number for each chemical in the additive, the permit applicant shall provide that information separately.

With the exceptions noted below, the provisions regarding claims of trade secret and disclosure of confidential information applied to drilling and hydraulic fracturing chemicals shall be the same as those of the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

1. No claim that the identity of any constituent is a trade secret shall be recognized by MDE until the applicant provides information demonstrating, to the satisfaction of MDE, that the claim is legitimate.

2. The chemical name and Chemical Abstract Service (CAS) number of all chemicals claimed to be trade secret must be provided to MDE with the permit application; MDE will release the chemical name and CAS number only to exposed persons or health care professions in accordance with the provisions of the OSHA Hazard Communication Standard governing disclosure by the chemical manufacturer, importer, or employer.
3. A health care professional's need for the trade secret information need not relate to occupational exposure or employees.

At the conclusion of well development, the permittee shall provide the Department with a list of the drilling and fracturing additives actually used, and the amount of each used. In addition, the Departments encourage well operators to disclose the identity and amount of chemicals used on FracFocus,¹⁵ a site managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission.

E. Drilling

1. Use of electricity from the grid

UMCES-AL Report recommendations 2-B, 9-D.-1. (Additional recommendations about the use of electricity are addressed below in section N., Noise.)

The UMCES-AL Report suggests that Maryland consider mandating electrically-powered equipment wherever line power is available (or could be made readily available) from the grid. The Departments agree that this practice would reduce air emissions. The use of propane or natural gas to power motors and pumps should be encouraged if electricity from the grid is not available.

There are multiple factors which would favor the use of one power source or fuel over another, including the land disturbance necessary to bring power to the site, the greenhouse gas footprint of electricity supplies and the loss of power resulting from running electrical transmission lines to the drill site. The Departments recommend that applicants provide a power plan that results in the lowest practicable impact from the choice of energy source.

2. Initiation of drilling

UMCES-AL Report recommendations 5-D.1, 8-I, 9-D.2

The UMCES-AL report recommended that drilling should avoid times of peak outdoor recreational periods such as holiday weekends, first day of trout season, and during sensitive wildlife migratory or mating seasons. In addition, the report recommended that hours and times of operation be restricted to avoid or minimize conflicts with the public.

The Departments agree that these recommendations would offer a high level of protection to these activities; however, the Departments acknowledge that once drilling and fracturing operations have begun, it is generally not safe to halt activities. For this reason, these restrictions can only be applied to the initiation of a drilling or fracturing operation or other activities that could be planned in advance or temporarily suspended. The specific restrictions should be included as a condition in the well permit.

¹⁵ <http://fracfocus.org/>

3. Pilot hole

The UMCES-AL Report notes the importance of avoiding drilling through large underground voids (*e.g.*, caverns, caves, mine workings, abandoned wells) because these voids increase the risk of losing fluid circulation during drilling and complicate the cementing process. The principal recommendations for avoiding these dangers involve setback requirements; in addition the authors suggest that Maryland also consider mandating the use of surface geophysical techniques (*e.g.*, seismic surveys) or “pilot hole” boring as part of an exploration/drilling hazard assessment program that is aimed at identifying other subsurface MSGD hazards that are not well mapped.

The Departments agree that drilling a pilot hole is an excellent way of identifying these underground voids in the immediate vicinity of the proposed bore hole, while seismic testing may be more practical for a larger area. The Departments propose that a best practice be to conduct pre-drill planning in any area where underground mining is suspected within 500 feet of the prospective borehole, based on a review of available records. The planning shall include:

- a. Selection of drill hole locations that avoid all mine voids and assures lateral support of drill holes during drilling and casings during well construction.
- b. If such locations cannot be found, voids must be filled or isolated with multiple concentric strings of casing and cement.
- c. Unless seismic testing clearly indicates the absence of voids, a slim pilot hole should be drilled to verify that suitable locations for production holes have been found or could be addressed through multiple layers of casing and cement.

4. Drilling fluids and cuttings

UMCES-AL Report recommendation 6-G

The UMCES-AL Report notes that high pressure air can be used rather than water as the “fluid” to bring rock fragments to the surface and cool the drill bit. When subsurface pressures are high, however, it is necessary to use drilling mud. Water-based drilling mud is a mixture of water, weighting agents, clay, polymers, surfactants and other chemicals. During horizontal drilling, mud powers and cools the downhole motor and bit, operates the navigational tools, provides stability to the borehole, and removes cuttings. The material returned to the surface is a mixture of drilling mud and native rock. The drilling mud can be reused. Open pit systems have been used in the past to manage the returned material, but the UMCES-AL Report recommends that closed-loop drilling systems be required. The Departments agree.

All intervals drilled prior to reaching the depth 100 feet below the deepest known stratum bearing fresh water, or the deepest known workable coal, whichever is deeper, shall be drilled with air, fresh water, a freshwater based drilling fluid, or a combination of the above. Only additives suitable for drilling through potable water supplies can be used while drilling these intervals. Below the cemented surface casing that isolates the deepest stratum bearing fresh water, additives other than those suitable for drilling through potable water can be used if approved by the Department.

A best practice for managing cuttings is to contain the drilling fluid, the returned drilling fluid and the cuttings in a closed loop system with secondary containment at the well pad. That means that separating the cuttings from the returned drilling fluid could only be done in tanks or containers, and that any storage of these materials would also have to be in tanks or containers. The secondary containment could be the zero-discharge well pad itself or another impermeable containment system, provided the secondary containment is capable of holding the total volume of the largest storage container or tank located within the area enclosed by the containment structure.

Due to the potential for cuttings from shale formations to contain Naturally Occurring Radioactive Material, the UMCES-AL Report recommends that onsite disposal be prohibited, that the cuttings be tested for radioactivity, and that they be disposed of in a landfill only if the testing indicates no significant elevation above background levels.

The Departments agree that the cuttings and drilling mud should be tested for radioactivity, but recommend that they also be tested for other contaminants, including sulfates and salinity, before disposal. If the cuttings show no elevated levels of radioactivity, and meet other criteria established by MDE, onsite disposal of the cuttings could be allowed.

5. Open hole logging

Open hole logging provides important information about the formations encountered and can be used to optimize the well design and drilling operations. Lithology can be determined from gamma ray logs, the presence of hydrocarbons by electrical resistivity logs, liquid-filled porosity by neutron porosity logs and bulk density by density logs. Borehole caliper logs assist in calculating the amount of cement needed. Mud logging can be used to determine the concentration of natural gas being brought to the surface with the drilling mud. The UMCES-AL report does not make a specific recommendation about open hole logging, but states that “The best practice would utilize modern open-hole well logging methods to help fine tune casing placement and characterize flow and hydrocarbon zones, [and] perhaps mud logging to determine levels of hydrocarbons in real-time during drilling....” (UMCES-AL at page 3-11)

Without specifying the methods to be used, current Maryland regulations require the submission of a well completion report that must include, among other things,

- (a) Depth at which any fresh water inflow was encountered;
- (b) Lithology of penetrated strata, including color;
- (c) Total depth of the well;
- (d) A record of all commercial and noncommercial oil and gas encountered, including depths, tests, and measurements;
- (e) A record of all salt-water inflows;
- (f) Generalized core descriptions, including:
 - (1) The type and depth of sample;
 - (2) Indications of oil, water, or gas;

- (3) Estimates of porosity and permeability; and
 - (4) Percent recovery; and
- (g) A copy of all electric, radiation, sonic, caliper, directional, and any other type of logs run in the well.
- COMAR 26.19.01.10 V.

To obtain this mandatory data, a driller would have to employ all of the techniques mentioned above with the exception of caliper logs and mud logging. The caliper logs would provide information to inform decisions about casing, centralizers, and cement. For this reason, we recommend that borehole caliper logs be performed.

F. Casing and Cement

UMCES-AL Report recommendations 3-C, 3-D, 3-E, 7-A.2

1. Requirements for casing and cement

Before drilling below the first casing string, the owner shall either crown the location around the wellbore to divert fluids, or construct a liquid-tight collar at least three feet in diameter to prevent surface infiltration of fluids adjacent to the wellbore.

All casing installed in a well shall be steel alloy casing that has been manufactured and tested consistent with standards established by the American Petroleum Institute (API) in “5 CT Specification for Casing and Tubing” or ASTM international in “A500/A500M Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes” and have a minimum internal yield pressure rating designed to withstand at least 1.2 times the maximum pressure to which the casing may be subjected during drilling, production or stimulation operations.

The minimum internal yield pressure rating shall be based upon engineering calculations listed in API “TR 5C-3 Technical Report on Equations and Calculations for Casing, Tubing and Line Pipe used as Casing and Tubing, and Performance Properties Tables for Casing and Tubing.”

Coupling threads should meet API standards, and casing strings should be assembled to the correct torque specifications to ensure leak-proof connections.

Operators must use a sufficient number of centralizers to properly center the casing in each borehole. The cement shall be allowed to set at static balance or under pressure for a minimum of 12 hours and must have reached a compressive strength of at least 500 psi before drilling the plug, or initiating any integrity testing

Reconditioned casing may be permanently set in a well only after it has passed a hydrostatic pressure test with an applied pressure at least 1.2 times the maximum internal pressure to which the casing may be subjected, based upon known or anticipated subsurface pressure, or pressure that may be applied during stimulation, whichever is greater, and assuming no external pressure. The casing shall be marked to verify the test status. All hydrostatic pressure tests shall be conducted pursuant to API “5 CT Specification for Casing and Tubing” or other method(s) approved by the Department. The owner shall provide a copy of the test results to MDE before the casing is installed in the well.

2. Isolation

The casing and cement provide zonal isolation between the well and all other subsurface formations. The surface casing shall be run and permanently cemented to a depth at least 100 feet below the deepest known stratum bearing fresh water, or the deepest known workable coal, whichever is deeper. All flow zones, including underground sources of drinking water, shall be fully protected through the use of cemented intermediate well casings, isolating the well and all drilling and produced fluids from surface waters and aquifers, to preserve the geological seal that separates fracture network development from aquifers, and prevent vertical movement of fluids in the annulus. The production casing provides for a continuous conduit for injecting the hydraulic fracturing fluid and for natural gas to flow up the well to the surface. The production casing shall be run the total depth and length of the well and cemented.

3. Cased-hole logging, Integrity testing and Pressure testing

Cased-hole logging occurs after the casing is cemented. The objectives are to determine the exact location of the casing, the casing collars, and the integrity of the cement job. Common methods of assessing the integrity of the cemented casing are cement bond logging and gamma ray logging. According to the UMCES-AL report, newer testing equipment can perform a segmented radial cement bond logging (SRCBL), which can determine the presence and locations of small channels in the cement that could indicate poor zonal isolation.

The UMCES-AL report recommended Maryland should consider amending its regulations to require SRCBL (or equivalent casing integrity testing) and other types of logging (*i.e.*, neutron logging) as part of a cased-hole program. The Departments agree and propose to require SRCBL.

Current Maryland regulations address pressure testing as follows. Each pressure test and mechanical test of casings must be recorded in a driller's log book. If strings of casing, in addition to surface casing, are run in the hole, they shall be properly pressure tested. COMAR 26.19.01.10 R and S. An applicant for a drilling permit will be required to provide a plan for integrity and pressure testing. In addition, the Departments recommend that mechanical integrity tests shall be performed when re-fracturing an existing well. These provisions shall be retained.

G. Blowout Prevention

UMCES-A: Report recommendation 3-F

A blowout preventer is a mechanical device that can close or seal a wellbore if pressure in the well cannot be contained. Without a blowout preventer, extreme erratic pressures and uncontrolled flow encountered during drilling could cause a blowout -- the uncontrolled release of liquid and gas from the well and the ejection of casing, tools and drilling equipment from the well. The blowout preventer is installed at the top of the surface casing. Depending on the design, a blowout preventer may close over an open wellbore, seal around tubular components, or shear through the casing to seal the well.

The UMCES-AL report recommended that Maryland require the use of blowout prevention equipment with two or more redundant mechanisms. The Departments agree

and will make this a requirement. Existing COMAR regulations already require the blowout prevention equipment must be tested to a pressure in excess of that which may be expected at the production casing point before drilling the plug on the surface casing; and penetrating the target formation. In addition it must be tested on a weekly basis.

H. Hydraulic Fracturing

UMCES-AL Report recommendation 3-G

The UMCES-AL report recommended that hydraulic fracturing should avoid times of peak outdoor recreational periods such as holiday weekends, first day of trout season, and during sensitive wildlife migratory or mating seasons.

The Departments accept the proposed timing on hydraulic fracturing recommendations; however, the State realizes that this could only apply to the initiation of fracturing operations that could be planned in advance or temporarily suspended. Once fracturing operations have begun, it is generally not safe to halt activities.

The UMCES-AL report recommended that tiltmeter or microseismic surveys be done to characterize the Marcellus shale across the region. The Departments will require that a tiltmeter or microseismic survey shall be performed by the permittee for the first well hydraulically fractured on each pad to provide information on the extent, geometry and location of fracturing. The permittee shall provide this information to MDE.

Diesel fuel shall not be used in hydraulic fracturing fluids. The Departments encourage companies to adopt innovative technology for well development that does not require large amounts of water or chemicals if the technology becomes practical. In all cases, companies should use additives with the least toxicity available.

I. Flowback and Produced Water

This topic is further discussed under Wastewater Treatment and Disposal, below.

Flowback and produced water shall be handled in a closed loop system of tanks and containers at the pad site.

J. Air Emissions

UMCES-AL Report recommendations 2-B

On August 16, 2012, EPA published a final rule in the Federal Register establishing New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAPs) for the oil and gas sector. EPA's final rule includes the first federal air standards for natural gas wells that are hydraulically fractured, along with requirements for several other sources of pollution in the oil and gas industry that had not previously been regulated at the federal level. These include requirements to reduce VOCs and air toxics from new and modified compressors, pneumatic controllers, storage vessels at gathering and boosting stations, and glycol dehydrators. In the federal rule, EPA is allowing a phased approach to comply with new requirements because of comments indicating that sufficient equipment would not be available by the proposed completion date. By January 1, 2015, however, all sources must conduct green completions.

The Departments propose to require that facilities in Maryland meet these federal standards upon startup. In addition, the Departments recommend additional measures for reducing air emission.

1. Green Completion or Reduced Emissions Completion

Green completion shall be achieved on all gas wells drilled in Maryland. In green completions, gas and hydrocarbon liquids are physically separated from other fluids and delivered directly into equipment that holds or transports the hydrocarbons for productive use. Flaring shall be allowed only if the content of flammable gas is very low, or when flaring is required for safety. The following circumstances shall not justify flaring:

- a. Inadequate water disposal capacity
- b. Undersized flowback equipment
- c. Except for wells drilled pursuant to a bifurcated permit for exploration only, lack of a pipeline connection

2. Flaring

When flaring is permitted during well completion, re-completions or workovers of any well, operators must adhere to the following requirements:

- a. Operators must either use raised/elevated flares or an engineered combustion device with a reliable continuous ignition source, which have at least a 98% destruction efficiency of methane. No pit flaring is permitted.
- b. Flaring may not be used for more than 30-days on any exploratory or extension wells (for the life of the well), including initial or recompletion production tests, unless operation requires an extension.
- c. Flares shall be designed for and operated with no visible emissions, except for periods not to exceed a total of five minutes during any two consecutive hours.

3. Electricity from the grid

Refer to Section VI.-E.1 on the use of electricity to support drilling operations.

4. Engines

- a. All on-road and non-road vehicles and equipment using diesel fuel must use Ultra-Low Sulfur Diesel fuel (maximum sulfur content of 15 ppm).
- b. All on-road vehicles and equipment must limit unnecessary idling to 5 minutes.
- c. All trucks used to transport fresh water or flowback or produced water must meet EPA Heavy Duty Engine Standards for 2004 to 2006 engine model years, which include a combined NOx and NMHC (non-methane hydrocarbon) emission standard of 2.5 g/bhp-hr.
- d. Except for engines necessarily kept in ready reserve, a diesel nonroad engine may not idle for more than 5 consecutive minutes. (A ready-reserve

state means an engine may not be performing work at all times, but must be ready to take over powering all or part of an operation at any time to ensure safe operation of a process.)

- e. For internal combustion engines that power equipment or electric generators and which do not stay on site for more than 12 months, the engines must comply with the requirements of either 40 CFR part 60 subpart III Standards of Performance for Stationary Compression Ignition Engines or 40 CFR part 60 subpart JJJJ Standards of Performance for Stationary Spark Ignition Internal Combustion Engines.

5. Storage tanks

EPA recently proposed updates to the 2012 standards for storage tanks. 78 Fed. Reg. 22126 (April 12, 2013). EPA anticipates taking final action by July 31, 2013. Upon final adoption of these regulations, the Departments propose to require that all new natural gas operations in Maryland meet these standards upon startup.

6. Natural Gas Star

The UMCES-AL report recommended that all operators in Maryland should voluntarily participate in USEPA's Natural Gas STAR program. This program is a partnership between EPA and industry that encourages oil and natural gas companies to adopt cost-effective technologies and practices that improve operational efficiency and reduce emissions of methane. It is up to each industry partner to determine which technologies and practices it will implement to reduce emissions. A company joins by signing a Memorandum of Understanding, then develops an implementation plan, executes the program, and submits annual progress reports.

No State action is necessary to allow operators to participate in the Natural Gas STAR program.

K. Waste and Wastewater Treatment and Disposal

UMCES-AL Report recommendations 4-J, 4-K

Wastes produced at well sites include cuttings, spent drilling muds, and other solid wastes. After a well is hydraulically fractured, some portion of the hydraulic fracturing fluid, called flow back, moves up the wellbore to the surface. Other water that is produced from the well after the initial flow back is termed produced water. These are the major types of wastewater generated at a drill site. Wastewater associated with shale gas extraction can contain high levels of total dissolved solids (TDS), fracturing fluid additives, metals, and naturally occurring radioactive materials. Typically, flow back contains significant concentrations of dissolved sodium, calcium, chloride, barium, magnesium, strontium, and potassium. It can also contain volatile organic compounds. There are a few options for managing this wastewater:

1. Underground injection in regulated Class II injection wells
2. Pretreatment, followed by further treatment by a sewage treatment plant
3. Evaporation/crystallization
4. Recycling

Operators have been moving toward recycling of gas development wastewaters, and reusing them for hydraulic fracturing. This is the most environmentally sound method, and the UMCES-AL report recommends that Maryland establish a goal of 100% recycling, with a preference for onsite recycling rather than shipment to a central treatment plant. The Departments recommend that, unless the permittee can demonstrate that it is not practicable, the permittee be required to recycle not less than 90% of the flowback and produced water and carry out that recycling on the pad site where the waste was generated.

The UMCES-AL report also recommends that Maryland should not allow the discharge of any untreated or partially-treated brine, or residuals from brine treatment facilities, into surface waters. The Departments agree, but note that MDE has taken appropriate steps to prevent such discharge. To understand this situation, it is necessary to explain the regulation of direct and indirect discharges of pollutants.

Direct and indirect discharges of pollutants to navigable waters are regulated under the Clean Water Act through the National Pollutant Discharge Elimination System (NPDES) permit program. Authority for issuing permits in Maryland has been delegated to MDE. Currently, federal regulations mandate that “there shall be no discharge of waste water pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment (*i.e.*, produced water, drilling muds, drill cuttings, and produced sand).” 40 CFR 435.32. Thus, the direct discharge of flow back or other brine is already prohibited.

Indirect discharge means the introduction of pollutants from a non-domestic source into a publicly owned wastewater treatment system, often called a Publicly Owned Treatment Works (POTW). Indirect discharges to POTWs are subject to General Pretreatment Regulations, which provide that a user of a POTW may not introduce into a POTW any pollutant(s) which cause a POTW to violate its own discharge limitations or which disrupts the POTW, its treatment processes or operations, or the processing, use or disposal of its sludge, and thereby cause the POTW to violate its permit.¹⁶ There are, however, no national standards specifically for the indirect discharge of gas exploration and development wastewaters. As a result, some shale gas wastewater has been transported to POTWs that are not equipped to treat this wastewater. Where POTWs discharged the inadequately treated wastewater to fresh water streams, the salts in the brine entered the streams, where they could kill or damage the aquatic organisms. Where the discharges were upstream of drinking water intakes, they impacted drinking water by contributing to high levels of disinfection by-products.

EPA has committed to develop standards to ensure that wastewaters from gas extraction receive proper treatment and can be properly handled by POTWs. EPA plans to propose a rule for shale gas wastewater in 2014. Until these regulations are in place, MDE has requested that POTWs not accept these wastewaters without prior consultation with MDE. MDE does not intend to authorize any POTW facility that discharges to fresh water to accept these wastewaters.

¹⁶ These and other pretreatment general prohibitions that are designed to protect the POTW from damage and its workers from harm can be found at 40 CFR 403.5.

With regard to disposal in Class II injection wells, the UMCES-AL report noted that establishing UIC Class II injection wells in Maryland would avoid long distance trucking of produced waters; however, it noted that locations in Maryland suitable for siting injection wells may be very limited. The Departments agree that it is not likely that Class II wells will be located in Maryland and therefore defers any consideration of the matter.

In order to assure that all wastes and wastewater are properly treated or disposed of, the Departments propose to require permittees to keep a record of the volumes of wastes and wastewater generated on-site, the amount treated or recycled on-site, and a record of each shipment off-site. The records may take the form of a log, invoice, manifest, bill of lading or other shipping documents. For shipments off-site, the record would have to include the following information:

1. The type of waste
2. The volume or weight of waste
3. The identity of the hauler
4. The name and address of the facility to which the waste was sent
5. The date of the shipment
6. Confirmation that the full shipment arrived at the facility

The records would be maintained by the permittee for at least three years, and MDE could audit them during site inspections or otherwise. The requirements would be included as a condition of the permit.

L. Leak Detection

UMCES-AL Report recommendation 2-A

The Departments accept the proposed recommendations (summarized below) and include additional comments.

A methane leak detection and repair program must be established from wellhead to transmission line.

Permittees shall consider all recommended strategies identified in EPA's Natural Gas STAR program for inclusion in a leak detection and repair program.

A statement must be submitted listing all equipment available for the detection, prevention, and containment of gas leaks and oil spills. COMAR 26.19.01.06C(17).

MDE may not issue a drilling and operating permit if drilling or operations would result in physical and preventable loss of oil and gas. COMAR 26.19.01.09J.

On site air pollution monitoring, discussed in the monitoring section, shall be included as an element of the leak detection program.

M. Light

UMCES-AL Report recommendations 5-E, 5-E.1, 8-G, 8-H

The UMCES-AL Report recommends that night lighting be used only when necessary, directed downward, and use low pressure sodium light sources wherever possible. If drill

pads are located within 1,000 feet of aquatic habitat, screens or restrictions on the hours of operation may be required to reduce light pollution further. The Departments accept the proposed recommendations for lighting at drill pad sites with the following modifications.

Light restrictions and management protocols must also minimize conflicts with recreational activities, in addition to minimizing stress and disturbance to sensitive aquatic and terrestrial communities.

The Departments agree that restrictions on hours of operation could reduce light pollution, but acknowledge that once drilling and fracturing operations have begun, it is generally not safe to halt activities. For this reason, these restrictions can only be applied to activities that could be planned in advance or temporarily suspended.

N. Noise

UMCES-AL Report recommendation 5-D, 9-B, 9-D, 9-D.3, 9-D.4, 9-D.5

The UMCES-AL report recommends that each of the counties in western Maryland should revisit noise regulations and enforcement policies and confirm they are appropriate for this industrial activity. Additionally, the report recommends that noise be reduced by: requiring electric motors (in place of diesel-powered equipment) for any operations within 3,000 ft. of any occupied building; encouraging the use of electric motors in place of diesel-powered equipment for operations not within 3,000 ft. of an occupied building; restricting hours and times of operation to avoid or minimize conflicts; require a measurement of ambient noise levels prior to operation; the construction of artificial sound barriers where natural noise attenuation would be inadequate; and requiring all motors and engines to be equipped with appropriate mufflers.

The Departments agree that noise must be controlled, and that compliance with the existing noise regulations should be sufficient. The Departments recommend that the applicant for a permit submit a plan for complying with the noise standards and for verifying compliance after operations begin.

Pursuant to State law, MDE has adopted environmental noise standards. A local government may adopt its own noise control ordinance, rules or regulations, provided they are not less stringent than those the State adopts. Enforcement of the environmental noise standards, whether State or local, is the responsibility of the local government. Noise limits apply at the boundary of: (1) a property; or (2) a land use category, as determined by the responsible political subdivision. Md. Env. Code, Title 3. The measurement of noise levels shall be conducted at points on or within the property line of the receiving property or the boundary of a zoning district¹⁷, and may be conducted at

¹⁷ “Zoning district” means a general land use category, defined according to local subdivision, the activities and uses for which are generally uniform throughout the subdivision. For the purposes of this regulation, property which is not zoned “industrial”, “commercial”, or “residential” shall be classified according to use as follows: (a) “Industrial” means property used for manufacturing and storing goods; (b) “Commercial” means property used for buying and selling goods and services; (c) “Residential” means property used for dwellings. COMAR 26.02.03.01

any point for the determination of identity in multiple source situations. COMAR 26.02.03.02D(2). The general standards for Environmental Noise are:

Table VI-1
Maximum Allowable Noise Levels (dBA)
for Receiving Land Use Categories

Day/Night ¹⁸	Industrial	Commercial	Residential
Day	75	67	65
Night	75	62	55

Special rules apply to construction and demolition sites: a person may not cause or permit noise levels emanating from construction or demolition site activities which exceed: (a) 90 dBA during daytime hours; (b) The levels specified in the table above during nighttime hours. COMAR 26.02.03.02B. The noise regulations also address vibrations: “A person may not cause or permit, beyond the property line of a source, vibration of sufficient intensity to cause another person to be aware of the vibration by such direct means as sensation of touch or visual observation of moving objects. The observer shall be located at or within the property line of the receiving property when vibration determinations are made.” *Id.*

Methods for minimizing noise impacts resulting from drilling and fracturing operations include: (1) careful siting of facilities—distance, direction, timing, and topography are the primary considerations in mitigating noise impacts; (2) placement of walls, artificial sound barriers, or evergreen buffers between sources and receptors (e.g., around well pads and compressor stations); (3) use of noise reducing equipment (e.g., mufflers) on flares, drill rig engines, compressor motors, and other equipment; and (4) use of electric motors in place of diesel-powered equipment. In the event sensitive species are identified in the Environmental Assessment, these additional measures may be necessary to protect adverse impacts.

Currently, county government bears the responsibility for monitoring and enforcing noise regulations. However, many counties do not have the capacity or the equipment to monitor. For this reason, the Departments may require the permittee to hire an independent contractor to conduct periodic noise monitoring and additional noise monitoring in response to a complaint.

O. Invasive species

UMCES-AL Report recommendations 5-G, 5-G.1, 5-H, 6-H, 6-H.1, 6-H.2, 6-I

The UMCES-AL recommended that the permittee submit an invasive species plan that emphasizes early detection and rapid response and meets certain criteria. The Departments agree.

¹⁸ “Daytime hours” means 7 a.m. to 10 p.m., local time. “Nighttime hours” means 10 p.m. to 7 a.m., local time. COMAR 26.02.03.01

The applicant must submit a plan with every well application for preventing the introduction of invasive species and controlling any invasive that is introduced. The invasive species management plan should emphasize avoidance, early detection and rapid response. The plan must include, at a minimum:

1. flora and fauna inventory surveys of sites prior to operations, including water withdrawal sites;
2. procedures for avoiding the transfer of species by clothing, boots, vehicles; and water transfers including assuring that the water withdrawal equipment is free from invasive species before use and before it is removed from the withdrawal site;
3. interim reclamation following construction and drilling to reduce opportunities for invasion;
4. annual monitoring and treatment of new invasive plant populations as long as the well is active; and
5. post-activity restoration to pre-treatment community structure and composition using seed that is certified free of noxious weeds.

P. Spill Prevention, Control and Countermeasures and Emergency Response

UMCES-AL Report recommendations 4-H, 5-B.1, 5-B.2, 7-B, 7-B.1, 7-B.2, 7-B.3

The UMCES-AL Report recommends that permit applicants should be required to develop site-specific emergency response plans, taking into account that the optimum response may differ depending on the season of the year and the topography of the site. Further, the report recommends that the plan must also include a list of all chemicals or additives used, expected wastes generated by hydraulic fracturing, approximate quantities of each material, the method of storage on-site, Material Safety Data Sheets for each substance, toxicological data, and waste chemical properties. The Departments agree that each permittee must prepare a site-specific emergency response plan and that the permittee must provide a list of chemicals and corresponding Safety Data Sheets to first responders before beginning operations; however, the Departments do not agree that all the detailed information described above needs to be in the plan or submitted to MDE with the permit application.

Spill Prevention, Control and Countermeasures Plans (SPCC Plans) are intended to prevent any discharge of oil. Spill cleanup and emergency response plans are intended to address spills or other releases after they occur. The Departments identify as a best practice that facilities develop plans for preventing the spills of oil and hazardous substances, using drip pans and secondary containment structures to contain spills, conducting periodic inspections, using signs and labels, having appropriate personal protective equipment and appropriate spill response equipment at the facility, training employees and contractors, and establishing a communications plan. In addition, the operator shall identify specially trained and equipped personnel who could respond to a well blowout, fire, or other incident that personnel at the site cannot manage. These

specially trained and equipped personnel must be capable of arriving at the site within 24 hours of the incident.

The federal Hazard Communication Program regulations, sometimes called Worker Right to Know, require that the chemical manufacturer, distributor or importer provide Safety Data Sheets (SDS), (formerly called Material Safety Data Sheets) for each hazardous chemical to downstream users as a way of communicating information on the hazards. Employers must ensure that SDSs are readily accessible to employees for all hazardous chemicals in their workplace.

Under new regulations, the SDS must be presented in a consistent 16 section format. Sections 1 through 8 contain general information about the identity of the chemical, hazards, composition and ingredients, first aid measures, fire-fighting measures, response to releases, handling and storage, and measures to minimize worker exposure. Sections 9 through 11 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information and toxicological information. Sections 12 through 15 contain ecological information, disposal considerations, transport information, and regulatory information. Section 16 must include the date the SDS was prepared or last revised and it may contain other useful information. Where the preparer is unable to find any applicable information, it must be stated on the SDS.

The Departments believe that the SDSs and the other requirements for emergency response are sufficient to enable first responders and well pad staff to appropriately respond to emergencies involving chemicals. In Section VI-D, we require operators to provide a list of chemicals on site and SDSs to the local emergency response agency. Operators shall, prior to commencement of drilling, develop and implement an emergency response plan, establish a way of informing local water companies promptly in the event of spills or releases, and work with the governing body of the local jurisdiction in which the well is located to verify that local responders have appropriate equipment and training to respond to an emergency at a well.

Q. Site Security

UMCES-AL Report recommendations 7-C, 7-C.1, 7-C.2, 7-C.3, 10-F

The UMCES-AL report recommends perimeter fencing, giving local emergency responders duplicate keys to locks, posting appropriate signage, and using security guards to control access. The Departments accept the proposed site security recommendations as best practices; however the decision whether to use security guards should be made by the permittee on a site-specific basis.

R. Closure and Reclamation both Interim and Final

UMCES-AL Report recommendation 1-K, 5-H, 10-E

The goal of reclamation should be to return the developed area to native vegetation (or pre-disturbance vegetation in the case of agricultural land returning to production) and restore the original hydrologic conditions to the maximum extent possible. The UMCES-AL Report recommended two-stage reclamation: (1) interim reclamation following construction and drilling to stabilize the ground and reduce opportunities for invasive

Draft for Public Comment

species and (2) post-activity restoration using species native to the geographic range and seed that is certified free of noxious weeds

The Departments agree. Reclamation shall address all disturbed land, including the pad, access roads, ponds, pipelines and locations of ancillary equipment.

As recommended by UMCES-AL, topsoil should be stockpiled during site development activities, covered during storage, redistributed back onto agricultural land as part of the land reclamation process. Soil compaction should be avoided at all times.

Section VII – Monitoring, Recordkeeping and Reporting

UMCES-AL Report recommendations 1-A, 1-B, 2-A, 2-C, 2-D, 2-E, 3-G, 4-C, 5.G-1, 7-A.3

The Departments accept the proposed monitoring, recordkeeping and reporting recommendations with the following modifications, additions and comments.

- A. DNR emphasizes that a minimum of 2 years of pre-development baseline data is necessary to evaluate the condition and characteristics of aquatic resources, particularly the living resources, since statewide monitoring experience demonstrates there is great variability on a seasonal and annual basis.
Characterization and baseline monitoring data will be important to identify whether any impacts to the resources have occurred as a result of drilling activities, and can be used as basis for mitigating damage.
- B. State agencies will develop standard protocols for baseline and environmental assessment monitoring, recordkeeping and reporting. In addition, the State agencies will develop standards for monitoring during operations at the site, including drilling, hydraulic fracturing, and production.
- C. All information collected at the site and within the study area must be reported according to the State developed guidelines. This is to include monitoring and assessment data for air and water quality, terrestrial and aquatic living resources, invasive species, well logs, other geophysical assessments, such shale fracturing characteristics and additional information as required by the State.
- D. State agencies will require more extensive testing of surface water and ground water parameters both randomly and in instances where elevated levels have been detected.
- E. Cuttings, flowback, residue from treatment of flowback and produced water, and any equipment where scaling or sludge is likely to occur shall be tested for radioactivity and disposed of in accordance with law.
- F. Personnel and time needed for inspections and compliance activities cannot be determined until we have a better sense of what the regulations will require. Nevertheless, the Department can assess fees adequate to cover the expenses of the program, including inspections.

Env. Code section 14-105 provides:

b) Fees. -- The Department shall establish and collect fees for:

- (1) The issuance of a permit to drill a well under § 14-104 of this subtitle;
- (2) The renewal of a permit to drill a well under § 14-104 of this subtitle; and
- (3) The production of oil and gas wells installed after October 1, 2010.

(c) Fees -- Rate. -- The fees imposed under subsection (b) of this section shall be set by the Department at the rate necessary to implement the purposes set forth in § 14-123 of this subtitle.

§ 14-123. Use of money

The Department shall use money in the Fund solely to administer and implement programs to oversee the drilling, development, production, and storage of oil and gas wells, and other requirements related to the drilling of oil and gas wells, including all costs incurred by the State to:

- (1) Review, inspect, and evaluate monitoring data, applications, licenses, permits, analyses, and reports;
- (2) Perform and oversee assessments, investigations, and research;
- (3) Conduct permitting, inspection, and compliance activities; and
- (4) Develop, adopt, and implement regulations, programs, or initiatives to address risks to public safety, human health, and the environment related to the drilling and development of oil and gas wells, including the method of hydrofracturing.

MDE will consider all of the costs to be incurred by the State in connection with its gas well program and propose an appropriate fee schedule by regulation.

Section VIII – Miscellaneous Recommendations

A. Zoning

UMCES-AL Report recommendation 1-M

The UMCES-AL report recommended that both counties amend their zoning ordinances to spell out in which zoning districts MSGD would be permitted. Zoning is an excellent way to separate incompatible land uses; however, authority to enact zoning rests with the local jurisdictions. Zoning has been controversial, especially in Garrett County. It is a local matter over which the Departments have no control.

B. Financial assurance

UMCES-AL Report recommendations 1-N, 3-H

This recommendation has been satisfied with the 2013 legislative passage of SB854, sponsored by Senator George Edwards, providing financial assurance for gas and oil drilling.

C. Forced Pooling

UMCES-AL Report recommendation 1-D

The Departments offer the following comments regarding the forced pooling recommendation.

At this point of time, consideration of this recommendation is premature. Once the requirements of the Executive Order have been fulfilled, this recommendation could receive additional consideration which would require further study, legal analysis and considerable public/private review.

Section IX – Modifications to Permitting Procedures

Following the public review and comment period for this report, recommendations for best practices for all aspects of natural gas exploration and production the Marcellus Shale in Maryland will be finalized. These recommendations will then be evaluated in light of existing permitting procedures in order to determine the necessary modifications.

Section X – Implementing the Recommendations

Following the public review and comment period for this report, recommendations for best practices for all aspects of natural gas exploration and production the Marcellus Shale in Maryland will be finalized. A roadmap for implementing these recommendations will then be developed.

APPENDIX A – MEMBERS OF THE COMMISSION

Chair

David A. Vanko, Ph.D., *geologist and Dean of The Jess and Mildred Fisher College of Science and Mathematics at Towson University*

Commissioners

George C. Edwards, *State Senator, District 1*

Heather Mizeur, *State Delegate, District 20*

James M. Raley, *Garrett County Commissioner*

William R. Valentine, *Allegany County Commissioner*

Peggy Jamison, *Mayor of Oakland*

Shawn Bender, *division manager at the Beitzel Corporation and president of the Garrett County Farm Bureau*

Stephen M. Bunker, *director of Conservation Programs, Maryland Office of the Nature Conservancy*

John Fritts, Ph.D., *president of the Savage River Watershed Association**

Jeffrey Kupfer, Esq., *senior advisor, Chevron Government Affairs*

Clifford S. Mitchell, M.D., *director, Environmental Health Bureau, DHMH*

Dominick E. Murray, *secretary of the Maryland Department of Business and Economic Development*

Paul Roberts, *Garrett County resident and co-owner of Deep Creek Cellars winery*

Nicholas Weber, Ph.D., *chair of the Mid-Atlantic Council of Trout Unlimited*

Harry Weiss, Esq., *partner at Ballard Spahr LLP*

* Dr. Fritts did not participate in the review of the best practices report.

APPENDIX B – COMMENTS OF THE ADVISORY COMMISSION

The purpose of the Marcellus Shale Safe Drilling Initiative Advisory Commission is to assist State policymakers and regulators in determining whether and how gas production from the Marcellus Shale (and, presumably, similar gas-bearing formations) can be carried out in Maryland without unacceptably and negatively impacting public health, safety, the environment and natural resources. The Advisory Commission's role, therefore, is to serve as a body with which representatives of the Department of Natural Resources and of the Department of the Environment may consult during the Departments' preparation of and production of the three reports called for in Executive Order 01.01.2011.11. The Advisory Commission helps identify and discusses issues surrounding shale gas development. It conducts its affairs openly and transparently and actively seeks and considers public commentary. Public comments are received through the Advisory Commission's web site and at Commission meetings.

Advisory Commission members include representatives from local and State government, the gas industry, environmental organizations, businesses, private citizens and landowners, a geology professor, and an environmental lawyer. The members have different perspectives and opinions, as well as a range of expertise and, consequently, achieving unanimity on all the issues discussed is difficult. From its inception, members of the Advisory Commission have agreed that if shale gas production is to proceed in Maryland, it needs to be done "right." Although the definition of "right" may vary to some extent among the Commissioners, all agree that safety is of paramount importance.

This Appendix summarizes the advice of the Advisory Commission on the Best Practices Report.

To be completed based on the comments of the Advisory Commission on the draft report.

APPENDIX C – RESPONSE TO PUBLIC COMMENTS

To be added after the public comments have been received and evaluated.

APPENDIX D – MARCELLUS SHALE CONSTRAINT ANALYSIS

This analysis was conducted by the Maryland Department of Natural Resources to estimate the potential effect that certain surface and subsurface constraint factors would have on the ability to access Marcellus shale gas deposits. The Department understands that there are many other additional factors that would also have an influence. This estimate is to be used only as a preliminary and draft assessment of certain constraints in order to illustrate the potential for avoiding sensitive surface resources and while accessing

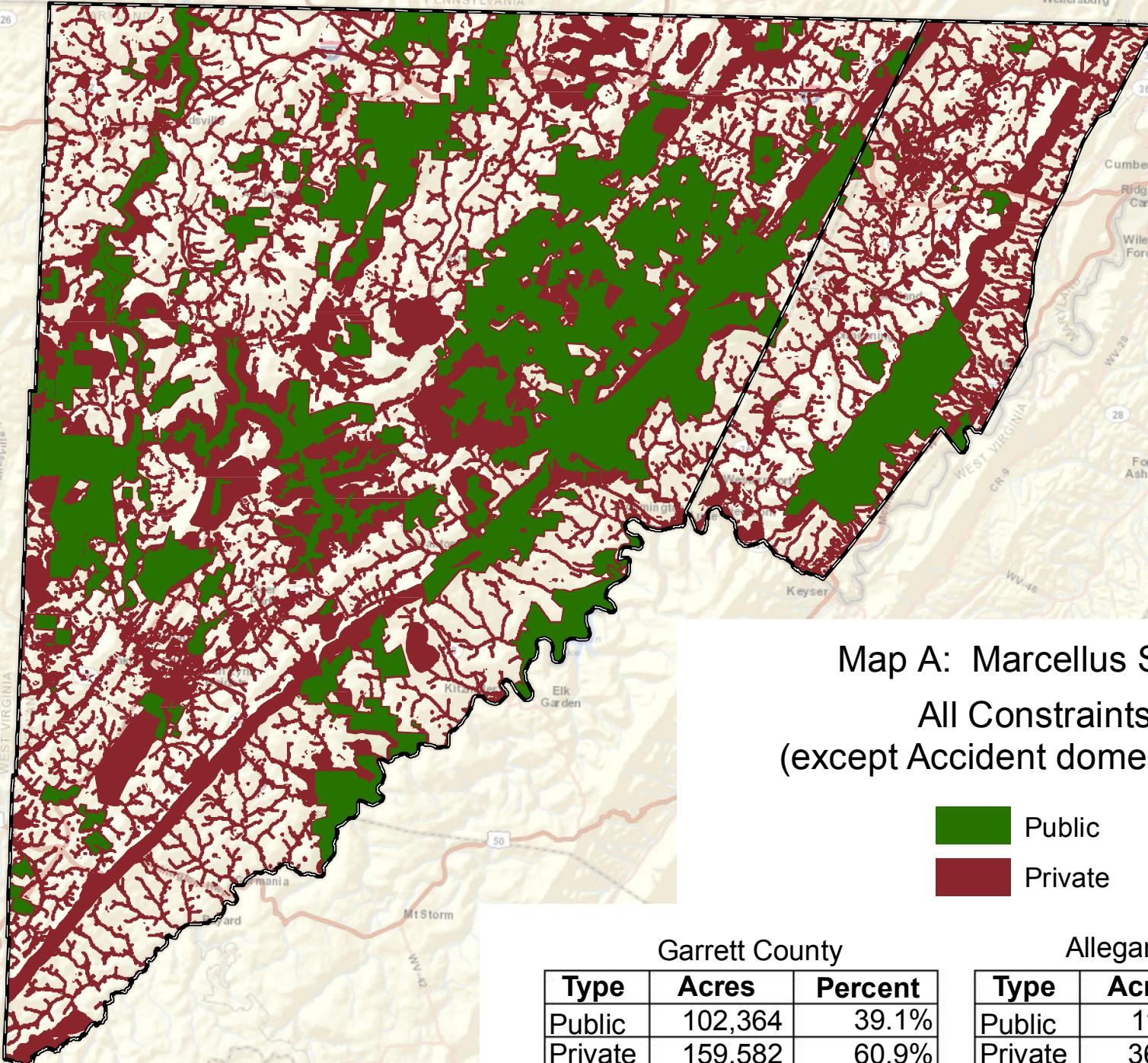
Surface and Subsurface Constraint Factors: Factors selected were those that support a landscape scale analysis and were determined to be reasonable based on joint DNR/MDE review of recommendations provided by UMCES. Fine-scale features, such as caves and drinking water wells, were not selected because complete data sets were not available. In addition, constraints associated with these factors will be most relevant at a field scale site assessment.

Off-Limit Areas	Setback/Buffers	Type	Source
Public lands, Trails, Scenic By-Ways	300 feet	Surface	UMCES
Irreplaceable Natural Areas (BioNet Tier 1 & 2), Wildlands	600 feet	Surface	UMCES
Wetlands, Vernal Pools, Streams and Rivers	300 feet	Surface	UMCES
Prime Agricultural Soils	0 feet	Surface	UMCES
Deep Creek Lake	2,000 feet	Surface	Local Ordinance
Low, Medium and High Density Residential and Institutional Uses	0 feet	Surface	DNR
Accident Dome Gas Storage Field	0 feet	Subsurface	DNR

Map A identifies the areas constrained from surface development and shows only the surface constraints. Table 1 shows that these constraints remove 60.9 % of the land surface within the Garret and Allegany county Marcellus Shale exploration area from surface development, leaving 39.1 % of the land area available. Map B shows the same information, but also includes the constraints resulting from the Accident Dome Gas Storage Field. Table 2, following the same logic as Table 1, but including constraints associated with the Accident Dome, leaves 36.3% of the exploration area available for surface development.

Subsurface Access Analysis

Based on the constraints identified above, the ability to access Marcellus shale gas deposits through horizontal drilling was evaluated based on the UM CES citation that each well could support an 8,000 foot horizontal drill length. Areas that remained suitable for surface development were buffered by 8,000 feet in order to determine the extent of Marcellus shale that was accessible. Table 1 (No Accident Dome) shows that 100% of the Marcellus shale can be accessed under this constraint analysis. Including the Accident Dome (Table 2) in the constraint analysis results in 97.7% subsurface shale accessibility (Map C). A more conservative analysis, using a 4,000 foot horizontal length was also conducted reducing subsurface accessibility to 98.2 % without considering the Accident Dome (Table 1, Map D)) and 94.0% including the Accident Dome (Table 2, Map E).



Map A: Marcellus Shale Gas Play
All Constraints
(except Accident dome storage)

Public
Private

Garrett County

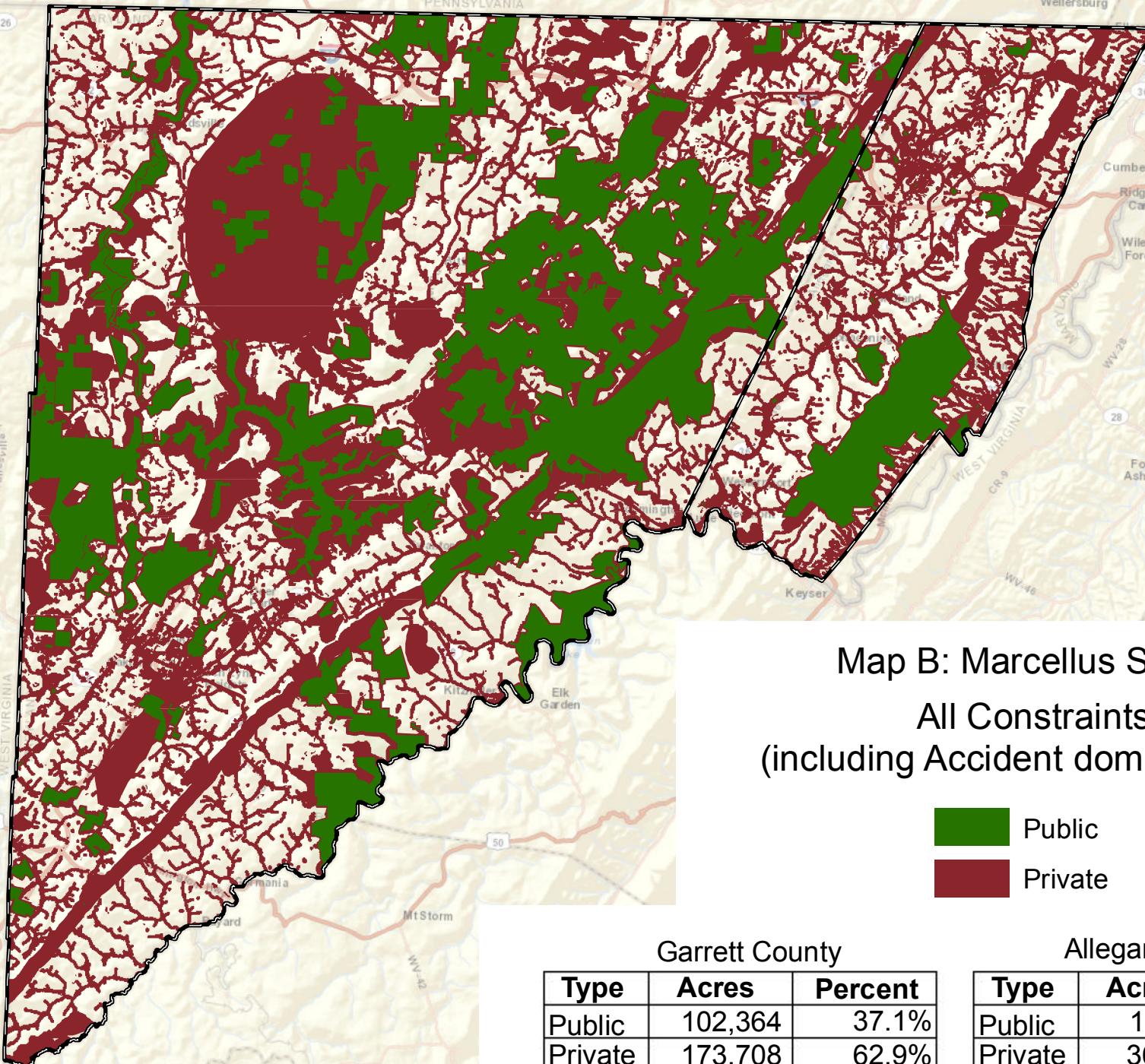
Type	Acres	Percent
Public	102,364	39.1%
Private	159,582	60.9%
Total	261,946	

Allegany County

Type	Acres	Percent
Public	11,365	23.8%
Private	36,405	76.2%
Total	47,770	

Table 1: Marcellus Shale Gas Play
 (no Accident storage dome constraint)

	Garrett		Allegany		Total	
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
Exploration Area	422,231	100.0%	85,939	100.0%	508,169	100.0%
Constraint Area	261,946	62.0%	47,770	55.6%	309,716	60.9%
Public	102,364	24.2%	11,365	13.2%	113,729	22.4%
Private	159,582	37.8%	36,405	42.4%	195,987	38.6%
Available for Operations	160,285	38.0%	38,169	44.4%	198,453	39.1%
Subsurface gas access - 8,000 feet	422,231	100.0%	85,939	100.0%	508,169	100.0%
Subsurface gas access - 4,000 feet	413,885	98.0%	84,903	98.8%	498,788	98.2%



Map B: Marcellus Shale Gas Play
All Constraints
(including Accident dome storage)

Public

Private

Garrett County

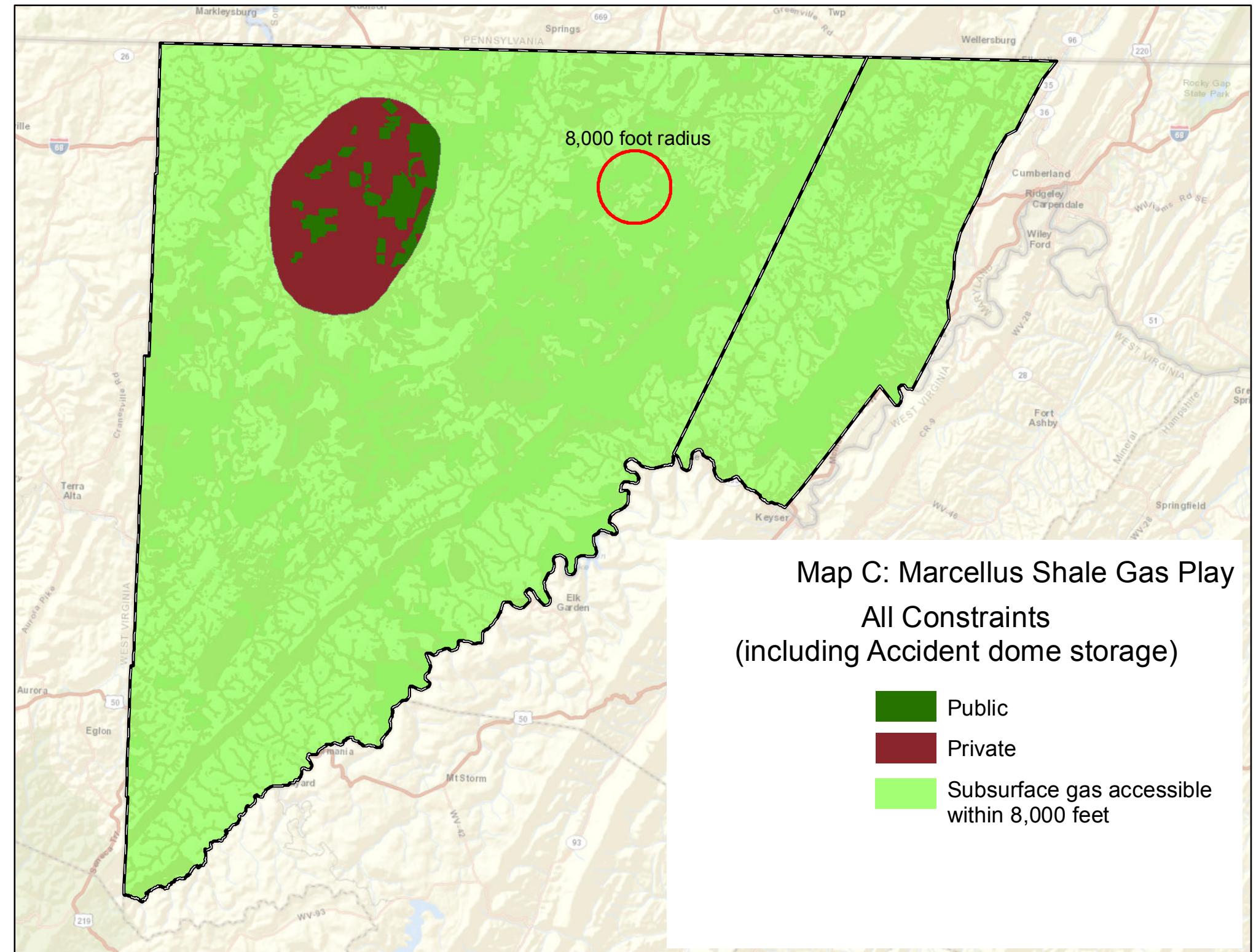
Type	Acres	Percent
Public	102,364	37.1%
Private	173,708	62.9%
Total	276,071	

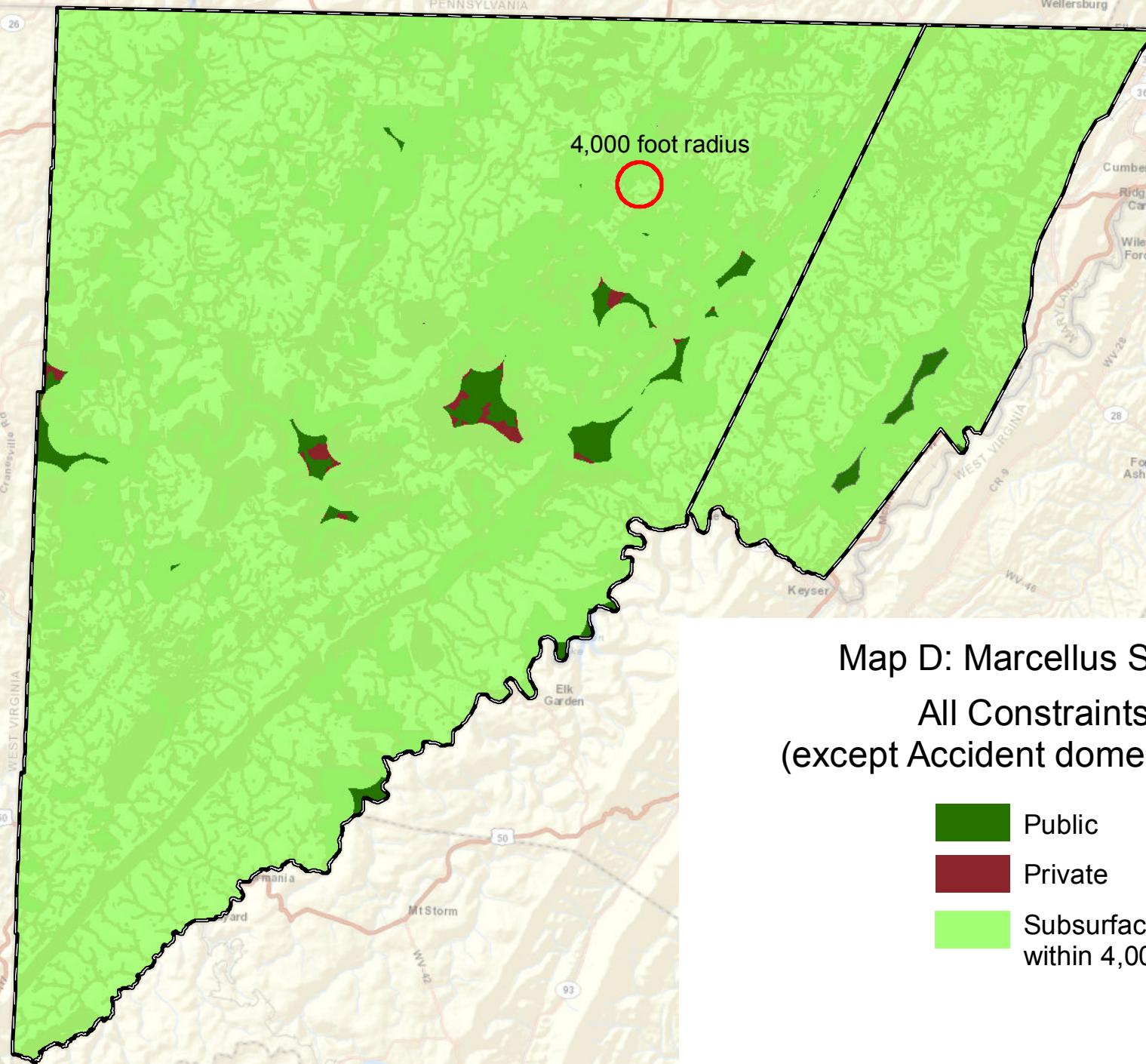
Allegany County

Type	Acres	Percent
Public	11,365	23.8%
Private	36,405	76.2%
Total	47,770	

Table 2 : Marcellus Shale Gas Play
 (with Accident storage dome as a constraint)

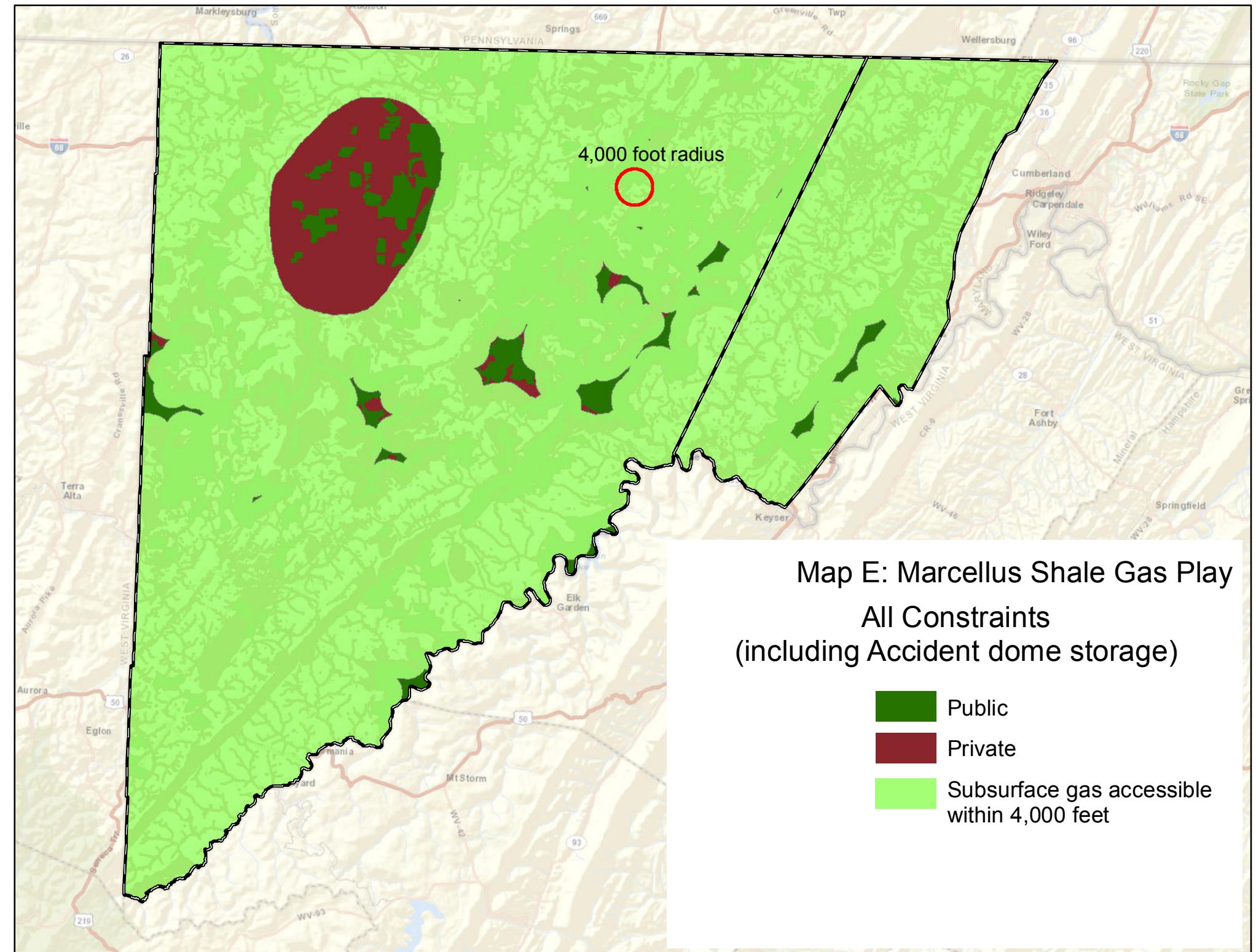
	Garrett		Allegany		Total	
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
Exploration Area	422,231	100.0%	85,939	100.0%	508,169	100.0%
Constraint Area	276,071	65.4%	47,770	55.6%	323,841	63.7%
Public	102,364	24.2%	11,365	13.2%	113,729	22.4%
Private	173,708	41.1%	36,405	42.4%	210,113	41.3%
Available for Operations	146,159	34.6%	38,169	44.4%	184,328	36.3%
Subsurface gas access - 8,000 feet	391,249	92.7%	85,939	100.0%	477,188	93.9%
Subsurface gas access - 4,000 feet	382,887	90.7%	84,903	98.8%	467,790	92.1%





Map D: Marcellus Shale Gas Play
All Constraints
(except Accident dome storage)

- Public
- Private
- Subsurface gas accessible within 4,000 feet



APPENDIX E – MARCELLUS SHALE AND RECREATIONAL AND AESTHETIC RESOURCES IN WESTERN MARYLAND

Marcellus Shale, State Lands and Economic Impacts of Parks

Maryland's Western Region is rich in recreational, cultural and aesthetic resources. Garrett and Allegany Counties are home to eight State Parks; one Natural Resources Management Area (NRMA); one Natural Environment Area (NEA) – the state's only designated wild river, four State Forests; four Wildlife Management Areas, three fish hatcheries/fish management areas, six Heritage Conservation Fund sites, one undesigned conservation area (MET), two scenic byways; miles of trails and a number of developed or developing water trails. Western Maryland has high public land visitation by both day use and overnight users. The development of a Marcellus shale gas industry in western Maryland has the potential to affect visitor's experiences, alter the recreational and aesthetic landscape of the region, negatively affect longstanding research and resource management sites and change the economic impact of park visitation in the future.

The Maryland State Parks are an economic driver for local communities and areas around the parks (Dougherty, 2011). Of the four park regions in the State, those in the Western region experience the highest overall economic benefit both in terms of direct spending and total economic impact that considers indirect and induced effects (Figure 1, below). State Park visitors in the Western region directly spend more than \$211 million annually

during their trips. The Western region also experiences the second-highest employment impact as a result of parks by supporting 2,775 direct jobs related to park visitation.

<u>Total trip spending profile by region</u>				
<u>Region visited</u>	<u>Direct Spending</u>		<u>Total Economic Impact</u> including indirect/induced effects	
	in MD	within a 20 minute drive	in MD	within a 20 minute drive
Western	\$211,407,422	\$152,722,509	\$239,273,592	\$169,903,045
Central	\$74,297,143	\$53,910,981	\$86,879,793	\$64,157,303
Southern	\$76,994,613	\$50,530,556	\$88,065,924	\$56,798,719
Eastern	\$204,743,180	\$140,054,190	\$236,445,765	\$159,830,604

Figure 1. Total trip spending profile by region (Dougherty, 2011).

Maryland State Park experience for both day use and overnight park visitors. The majority of activities that both of these user communities identified as activities that they participate in at parks include hiking/walking, general relaxation, swimming, picnicing/cookout, sightseeing and photography.

Open Space Experience

In the same Economic Impact Study (Dougherty, 2011), natural scenery was the most highly rated attribute of a

Byways, Hiking, Water Trails, Hunting and Fishing

Maryland has a number of well-developed and nationally-recognized networks of scenic and historic byways and hiking and water trails that provide opportunities for the public

to experience nature, cultural and historical features and the outdoors through unique vistas and long-distance travel routes. The location and features that make these routes unique (*e.g.* vistas, through-trail hikes, canopy cover) should be considered during setback discussions.

In addition to vast scenic values and hiking and water-based recreation, there are also many opportunities for citizens to enjoy hunting and fishing on public lands in Western Maryland. Especially for these groups, noise and other possible environmental effects from drilling and operations can impact the quality of or ability for these activities to be conducted. If wildlife is impacted or scared off from a particular area, the potential exists for the activity to be dislocated entirely.

Recommended Setbacks and Considerations

Currently, a proposed recreational setback from Marcellus shale gas infrastructure is a minimum of 300 feet with additional setback considerations for noise, visual impacts and public safety. In addition to these considerations odors, light and illumination from the same infrastructure can also affect the natural and recreational values of areas of Western Maryland.

Following discussions with Maryland Department of Natural Resource (DNR) staff related to these additional considerations, there are several factors that may influence where this minimum setback should be increased, in some cases significantly. For instance, additional consideration and thought should be given for whether this setback should be altered based on the following:

- whether the facilities at sites are concentrated or more spread out;
- locations of high-use where visitors, managers and community members identify as most heavily trafficked or utilized;
- the presence or absence of natural buffers that could buffer sound, light and odors, especially at night, and near campgrounds;
- areas where reduced-light recreation activities occur;
- areas where particular trails are most frequently identified as providing a peaceful experience and that may be most affected by shale gas operations noise;
- lands or aquatic areas where natural resources may be degraded to a point that park visitation for the purpose of enjoying those resources would no longer be attractive;
- hunting areas that could be affected by access or operations noise and/or locations where proximity to shale gas infrastructure would increase risk to site operators/operations;
- whether unique designations are in place (*e.g.* Wild and Scenic Rivers) that define an experience in a particular location or influence funding; and
- instances where public safety risks on or around state lands would be most likely to be increased on roads, day use or overnight accommodation areas or in surrounding areas as a result of close proximity of infrastructure and people.

To more thoroughly evaluate each of these and identify particular areas that may most need additional setback consideration, work could be conducted with facility managers, friends groups or small groups of frequent visitors to compile existing data and develop new maps of use areas. In addition, some of these considerations could be considered on a case-by-case basis during the siting process to determine their applicability and evaluate what recreational or aesthetic uses that might be affected in a given area.

Night Skies

In Pennsylvania, where the Marcellus shale gas industry is much more developed, efforts are underway to document the relationship between lighting on these industrial sites and changes in the darkness of night skies. Particularly, a group is working at Cherry Springs Park in Potter County to document the proximity of the lights and potential impacts on dark skies. In areas where there are dark night skies in western region state lands and where reduced-light recreation activities occur, work should focus on how to keep those night skies as dark as possible. Information and lessons learned can also be gleaned from efforts such as the one that is ongoing in Cherry Springs.

Outreach & Community Engagement

Over the past five years or more, property owners and communities in western region counties have become increasingly familiar with the development of the Marcellus shale gas energy industry. In some cases, property owners have entered into lease agreements with development companies for gas extraction. Since Maryland established its Marcellus Shale Advisory Commission the public has had a periodic forum to learn what the state is doing to plan for industry development; evaluate potential community, economic, infrastructure, and natural resource impacts; and, set up a regulatory framework to ensure safe and efficient development of the industry in Maryland.

State agencies and other partners have developed a number of resources to help citizens better understand Marcellus shale gas site development. With the recent completion of UM CES' report, there is now an opportunity to reach out to Marylanders and inform them about the state of the industry, plans for safe development of shale gas and provide opportunities for citizens to submit feedback and learn about work to date.

The Maryland Department of Natural Resources has extensive experience in public engagement on a variety of issues and can recommend forum structures, information format and organizational approaches for such events. As noted in previous sections, participatory mapping workshops could also be conducted to identify particular areas where recreational and aesthetic impacts would most likely intersect with the expansion of the shale gas industry.

APPENDIX F – UMCES-AL REPORT AND CROSS REFERENCES

The UMCES-AL Report can be found at
http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Eshleman_Elmore_Final_BMP_Report_22113_Red.pdf

Recommendations from the UMCES-AL Report with Analogous Provisions of Draft Agency BMP Report

Chapter 1 – General, planning and permitting BMPs

UMCES-AL	MDE and DNR
1-A Pre-development environmental assessment should be conducted on a site-specific basis and include: (1) identification of all on-site drilling hazards such as underground mine workings, orphaned gas or oil wells, caves, caverns, Karst features, etc.; (2) identification of all ecological, recreational, historical, and cultural resources in the vicinity of a proposed site (includes well pad and all ancillary development such as cleared areas around a well pad, roads, bridges, culverts, compressor stations, pipelines, etc.); (3) identification of the appropriate setbacks and buffers for the proposed site; and (4) collection of two years of pre-development baseline data on underground drinking water, surface water, and both aquatic and terrestrial ecological resources.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation. Some of the data will be required for the CGDP; other data in applications for individual permits. This recommendation is also reflected in Sections V, Plan For Each Well and VII, Monitoring, Recordkeeping and Reporting.
1-B Maryland should require as part of its permit application at least two years of site specific data collection prior to any site development that would be used to characterize the resources at risk and provide a solid baseline dataset that would ultimately be used to understand process and feedback to the refinement of BMPs.	Section VII, Monitoring, Recordkeeping and Reporting adopts this recommendation and adds that characterization and monitoring data will be important to identify whether any impacts to the resources has occurred, and can be used as basis for mitigating damage.
1-C Comprehensive planning (a.k.a., comprehensive drilling plans) could potentially be used to effectively channel MSGD into areas that would be less sensitive to impacts while allowing for considerable and efficient exploitation of the gas resource. Spacing	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation; however, limiting the disturbance to 1-2% of the land appears as a planning principle for high value watersheds and the

<p>multiwall pads in clusters—as far apart as is technically feasible—makes maximum use of horizontal drilling technology and could be an important BMP in terms of minimizing development impacts. With careful and thoughtful planning (<i>e.g.</i>, co-location of infrastructure wherever possible), it may be possible to develop much of the gas resource in a way that disturbs less than 1-2% of the land surface, even when accounting for the need for ancillary infrastructure such as access roads, pipelines, and compressor facilities.</p> <p>Comprehensive gas development plans could also moderate the rate at which the resource is developed in Maryland, thus allowing the regulatory enforcement arm of MDE (with little recent experience in gas well permitting and no experience in unconventional gas) to ramp up over time.</p>	<p>Departments do not recommend using CGDPs to limit the pace of development.</p>
<p>1-D Maryland should consider legislation that would enable the state to implement “forced pooling” as a way of providing greater resource protection while allowing for efficient resource exploitation.</p>	<p>Section VIII C, Miscellaneous Recommendations. The Departments recommend that forced pooling not be considered at this time.</p>
<p>1-E Maryland should impose by regulation sensible setbacks (see Table 1.1) that are adequate to protect public safety, as well as ecological, recreational, historical, cultural, and aesthetic resources.</p>	<p>Section IV A, Location Restrictions and Setbacks. The Departments generally accept the proposed location restrictions and setbacks with the exceptions noted. The Departments reduced the suggested setback from limestone outcrops, increased the setback from private groundwater wells and recommend pre-drilling planning and use of pilot holes to evaluate subsurface hazards, such as deep coal mines.</p>
<p>1-F There is a definite need for an analysis of extant hydrogeological data from western Maryland that could be used to develop flow nets or models and infer groundwater flowpaths and other important features such as recharge areas, discharge areas, hydrologic residence times, and depth of the freshwater zone across the area.</p>	<p>The Departments, with the help of Garrett County, have begun to assemble the existing data on drinking water wells in Garrett County and undertaken additional groundwater sampling.</p>

1-G Maryland might consider developing a standardized stakeholder process that could be implemented as part of comprehensive planning strategy; the goal of such a process while allowing the permit review process to be expedited.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
1-H We recommend that Maryland follow guidance from New York's experience with unconventional shale gas development and effectively not permit MSGD (or any other unconventional gas development) where the target formation occurs within 1,000 vertical feet of USDW or within 2,000 vertical feet of the ground surface. Since the freshwater/saltwater interface has not been mapped in Maryland, the prudent approach would be to rely on the 2,000 ft criterion to provide an adequate margin of safety.	This recommendation is accepted in Section IV A, Location Restrictions and Setbacks.
1-I An obvious best practice would be to site well pads so as to avoid vertical drilling (<i>i.e.</i> , surface boreholes) in areas where shallow caves and caverns have been mapped or where there is a high probability that such systems might be present. Maryland should develop a GIS map system of both active and abandoned oil and gas wells (including gas storage wells) and active and abandoned coal mine workings prior to permitting any new Marcellus wells; all underground hazards with $\frac{1}{4}$ mile of any section of a proposed Marcellus well should be identified as part of the permit review process and avoided wherever possible.	Section IV A, Location Restrictions and Setbacks. The Departments generally accept the proposed location restrictions and setbacks recommendations and will develop a Shale Development Toolbox to provide a comprehensive set of GIS planning data, including known and mapped locations of the features listed in this recommendation.
1-J Maryland should require a 1,000 ft setback from all deep mine workings and $\frac{1}{4}$ mile setback from all historic gas wells. The gas well setback should be measured from any portion of the borehole (vertical or horizontal) to the historic well.	Section IV A, Location Restrictions and Setbacks. The Departments recommend reducing the 1,000 ft setback from deep mine workings as it is unnecessarily restrictive since Maryland's deep coal mines may cover thousands of acres, are only several hundred feet deep, and can be safely cased through, particularly if pilot holes are drilled to identify these features and drilling processes are modified to address the known hazards.

<p>1-K Maryland should develop regulations that force rapid partial reclamation (including revegetating disturbed areas surrounding wells pads, corridors, and ancillary infrastructure) of all land not needed for drilling and production as quickly as possible, while allowing the remaining portion to exist unreclaimed only until such time as drilling is completed, production ends, and final reclamation can be performed.</p>	<p>Section VI R, Engineering, Design and Environmental Controls and Standards adopt this recommendation</p>
<p>1-L We found that Maryland's current oil and gas regulations governing permitting for conventional development require many of the elements that would be needed to properly address MSGD or unconventional development in general; however, the state should consider revising its oil and gas permitting regulations to explicitly address water withdrawal and storage issues, drilling waste and wastewater treatment and disposal issues, as well as transportation planning issues.</p>	<p>MDE considered the need to revise the oil and gas permitting regulations. Recommendations for changes can be found throughout Section VI, Engineering, Design and Environmental Controls and Standards.</p>
<p>1-M Local zoning ordinances for both counties should be amended to spell out in which zoning districts MSGD would be permitted as a way of minimizing some of the major conflicts and public safety issues that we addressed in this report.</p>	<p>Section VIII A, Miscellaneous Recommendations. Zoning is a local matter over which the State has no control. The Counties are well aware of their authority to enact zoning regulations.</p>
<p>1-N Maryland's requirements for performance bonding under current regulations (\$100,000 per well or \$500,000 blanket bond for all of an applicant's wells) are relatively high compared to other states; thus, the state might be to avoid some of the problems associated with divestment of MSGD assets from primary to secondary firms that are predicted as gas production declines. Nonetheless, Maryland might want to consider alternate mechanisms of covering decommissioning and reclamation costs through a trust fund mechanism (<i>i.e.</i>, investing revenue from pre-drilling fees and a five-year severance tax on production) as an alternative to performance bonding.</p>	<p>Section VIII B, Miscellaneous Recommendations. Financial assurances and the concern about divestment were appropriately addressed in the 2013 legislative passage of SB854, sponsored by Senator Edwards, providing financial assurance for gas and oil drilling.</p>

Chapter 2 – Protecting Air Quality

UMCES-AL	MDE and DNR
2-A Require that operators in Maryland establish a methane leak detection and repair program that governs operations from wellhead to the transmission line, regardless of whether processing plants are necessary. All operators in Maryland should voluntarily participate in USEPA's Natural Gas STAR program aimed at implementing cost-effective strategies for reducing methane emissions by the industry.	Leak Detection is required in Section VI L, Engineering, Design and Environmental Controls and Standards, and operators will need to meet monitoring, reporting and recordkeeping requirements as referenced in Section VII, Monitoring, Recordkeeping and Reporting. No State action is necessary to allow operators to voluntarily participate in EPA's Natural Gas STAR program.
2-B Encourage operators to either use newer internal combustion engines or convert from diesel internal combustion engines to electric motors for operating drilling rigs, pumps, and compressors wherever possible by implementing “fleet average” emission standards for NO _x , VOCs, and PM _{2.5} .	Section VI E and J, Engineering, Design and Environmental Controls and Standards accepts this recommendation.
2-C Require monitoring of hazardous air pollutants at well pad sites.	Section VII, Monitoring, Recordkeeping and Reporting. accepts this recommendation.
2-D Monitor gamma and alpha radiation of production brines.	Section VII, Monitoring, Recordkeeping and Reporting. accepts this recommendation.
2-E Implement an air emissions monitoring program throughout the region, focusing on sources and fugitive sources of pollutants (and pollutant precursors) at well pads and at other sources resulting from natural gas production.	Section VII, Monitoring, Recordkeeping and Reporting accepts this recommendation.

Chapter 3 – Well engineering and construction practices to ensure integrity and isolation

UMCES-AL	MDE and DNR
3-A A best practice for anyone proposing to operate in Maryland should be adoption of API's extensive guidelines for well planning—at least those elements that are clearly relevant to onshore development. Pre-permit site review should also be required.	Section V, Plan For Each Well accepts this recommendation.

<p>3-B Site selection is a critical aspect of well planning for multiple reasons discussed throughout the report. As discussed in Chapter 1, we are particularly concerned about drilling in areas where there is a high probability of encountering large underground voids (<i>e.g.</i>, caverns, caves, mine workings, abandoned wells, etc.) that have the potential to cause a loss of fluid circulation during drilling and impose additional risks during the cementing process. Such hazards are locally common in western Maryland and we recommend that sites with a high probability of encountering such hazards be avoided.</p>	<p>Section IV B, Location Restrictions and Setbacks. The Departments generally accept the proposed siting best practices recommendation and note that certain known hazards can be addressed through modified drilling processes.</p>
<p>3-C Surface casing must be fully cemented from the bottom to the surface to provide total protection of all USDW. There may be situations (<i>e.g.</i>, very deep wells) where fully cementing the intermediate casing to the surface may not be required, however. At a minimum, an absolute requirement should be that all flow zones (including USDW) must be fully protected through the use of cemented intermediate well casings. Where this cannot be accomplished feasibly with a single casing string, the use of multiple casing strings should be favored in the well design.</p>	<p>Section VI F, Engineering, Design and Environmental Controls and Standards accepts this recommendation.</p>
<p>3-D Maryland should consider amending its regulations to require SRCBL (or equivalent casing integrity testing) and other types of logging (<i>i.e.</i>, neutron logging) as part of a cased-hole program.</p>	<p>Section VI F, Engineering, Design and Environmental Controls and Standards accepts this recommendation.</p>
<p>3-E Best practice would clearly call for use of pressure testing of Marcellus shale gas wells in Maryland, with specific criteria and technical details governing the conduct of such tests likely established through consultation with industry. Maryland's current regulations with regard to pressure testing of cemented casings are even less specific than those established by neighboring states and appear to be in need of revision.</p>	<p>Section VI F, Engineering, Design and Environmental Controls and Standards makes recommendations for mechanical and pressure testing.</p>

3-F Use of BOPE with two or more redundant mechanisms should be considered a best practice for MSGD in Maryland.	Section VI G, Engineering, Design and Environmental Controls and Standards accepts this recommendation.
3-G We recommend that a sufficient number of tiltmeter or micro-seismic surveys be performed as part of any MSGD in Maryland, so that the extent, geometry, and location of Marcellus fracturing can be adequately characterized across the entire region. The principal goal of this effort would be to feed useful information back to the operators, so that subsequent hydraulic fracturing can be conducted more safely and effectively. Data from such surveys in Maryland (and other states) would also be deemed crucial in evaluating whether HVHF might eventually be safely conducted in locations where the target formation is located within 2,000 ft of the surface.	Section VI H, Engineering, Design and Environmental Controls and Standards and Section VII, Monitoring, Recordkeeping and Reporting accepts this recommendation.
3-H Maryland also has what appear to be excellent regulations that are consistent with API recommendation for plugging of wells. Given the long expected time lags (of the order of 30 years) between drilling and well decommissioning, the biggest problem that we anticipate with plugging of Marcellus wells in Maryland will be establishing liability and ensuring that liable parties can be held accountable for performing this critical task. The costs associated with plugging wells that were poorly constructed in the first place can be extremely high, which reinforces the need to ensure that any Marcellus shale gas wells in Maryland are constructed to the highest standards.	The report makes many recommendations for ensuring that any Marcellus shale gas wells in Maryland are constructed to the highest standards. In addition, financial responsibility for closure was appropriately addressed in the 2013 legislative passage of SB854, sponsored by Senator Edwards (Section VIII B, Miscellaneous Recommendations)

Chapter 4 – Protecting water resources

UMCES-AL	MDE and DNR
4-A A best practice for Maryland would be establishment in regulation of 500 ft. and 2,000 ft. setbacks (measured from the well pad, not from the individual wellbores) for private wells and public system intakes (both surface and groundwater), respectively.	Section IV A, Location Restrictions and Setbacks. The Departments accept the proposed 2,000 ft setback from public wells, and note that current regulations (COMAR 26.19.01.19G) already provide a 1,000 ft setback from all drinking water supplies, which

	includes private wells. The setback should apply from the edge of any drinking water reservoir and upstream of any drinking water intake on a free-flowing stream.
4-B We support Maryland Environmental Code § 14-110.1 (H.B. 1123) and recommend predevelopment notification should be made to public and private drinking water well owners.	Current Maryland regulations require that the applicant identify all water wells within 2,650 feet of the proposed well location. The Department must mail written notice of the decision to grant or deny the permit to all landowners within 1,000 feet of the proposed well. Section V, Plan for Each Well, adopts the recommendation that notice be provided to well owners within 2,500 feet.
4-C Pre-drilling groundwater testing should be required to be conducted by the operator and the results provided to MDE and to the well owner. Post-drilling testing is often at the discretion of the well owner, but a best management practice that would enable improved understanding of the potential for effects on groundwater would be to require postdrilling and completion testing by the operator for all wells within a pre-determined potentially affected region for a specified time period after completion of well construction activities.	Section VII, Monitoring, Recordkeeping and Reporting accepts this recommendation.
4-D Maryland might wish to consider ways of strengthening its anti-degradation policy to take account of the impacts of non-point source pollution that are a major threat to its high quality waters. One way that this might be accomplished would be by revising the WQS rules to require that any land development practices (<i>e.g.</i> , forest management, MSGD, etc.) conducted in Tier II watersheds meet an anti-degradation standard.	Section IV B, Location Restrictions and Setbacks defers consideration of special anti-degradation regulations for well drilling until it undertakes revisions to those regulations.
4-E Maryland needs to carefully review its stormwater regulations as they pertain to oil and gas extraction; we recommend oil and gas extraction sites be considered “hotspots.” Based on our review of stormwater management practices in other states, we recommend the use	This recommendation is accepted with modifications in Section VI A, Engineering, Design and Environmental Controls and Standards. Zero-discharge from pads during drilling and completion are adopted in

<p>of both “active” and “passive” stormwater management: (1) the construction of properly bermed “zero-discharge” pads that effectively collect all water on a pad site and enable the reuse of this water during drilling and completion operations; and (2) construction of a below-grade lined pond adjacent to the bermed zero-discharge pad that could be used as a sump during active stormwater management phases and easily converted into a retention pond prior to a passive phase.</p>	<p>Section VI A. The collection of stormwater and other liquids may cease only when all potential pollutants have been removed from the pad and appropriate, approved stormwater management can be implemented.</p>
<p>4-F Post-construction inspections of stormwater structures should occur prior to well drilling and completion.</p>	<p>Section VI A, Engineering, Design and Environmental Controls and Standards. Such inspections are routinely carried out by the counties.</p>
<p>4-G There are very long gage records available from USGS for most of the major western Maryland rivers (Youghiogheny, Casselman, Savage, Potomac, Georges Creek) that could possibly be used to support MSGD; data for these and other gaged systems can be used to inform a quantitative analysis of acceptable water withdrawals for MSGD. This analysis is much more difficult for smaller streams and rivers due to data limitations, although we believe that such an analysis should be done. Our experience in Maryland watersheds as well as review of other areas that have completed such analysis, suggest that in western Maryland, water withdrawals for proposed MSGD would need to occur solely from the region’s large rivers (and perhaps from one or more reservoirs). Small streams (1) have significant existing withdrawals for drinking water; (2) have small catchment areas and discharges under most conditions; (3) are very unlikely to have excess flow capacity for new permitted withdrawals; and (4) can be readily dewatered. Water may need to be temporarily stored in centralized freshwater impoundments specifically constructed for this purpose, but such impoundments should never be allowed to receive or store any wastewaters.</p>	<p>The State’s existing program for water appropriation, which protects small streams, is described in Section VI C, Engineering, Design and Environmental Controls and Standards. The recommendation regarding storage of water and wastewater are accepted in Section VI A and C, Engineering, Design and Environmental Controls and Standards.</p>

4-H To support preparations and training by first responders and well pad staff for any chemical emergencies, lists of chemicals to be used on site (plus appropriate toxicological data, chemical characterizations, MSDS, and spill clean-up procedures) should be included in permit applications.	These recommendations are accepted in Section VI D and P, Engineering, Design and Environmental Controls and Standards.
4-I Closed-loop drilling systems that sit within secondary (and perhaps tertiary) containment are preferable to open pit systems and should be considered a best practice for Maryland.	Section VI A, Engineering, Design and Environmental Controls and Standards adopts this recommendation.
4-J Maryland should include a very strong preference for on-site recycling of wastewaters in permitting of shale gas development. Under no circumstances should Maryland allow discharge of untreated brine, partially-treated brine, or residuals from brine treatment facilities, into the waters of the state. Development of brine treatment plants that recycle water to drillers should be discouraged in favor of on-site treatment by mobile units and immediate reuse as this decreases truck transport and associated impacts.	These recommendations are accepted in Section VI C and K, Engineering, Design and Environmental Controls and Standards.
4-K Maryland should review the relevant regulations surrounding development and use of underground injection wells for produced water from shale gas development and, at the same time, evaluate the capacity of nearby states to accept produced water or residual brine from treatment of produced water before permitting any development in the state.	In Section VI K, Engineering, Design and Environmental Controls and Standards, the Departments recommend deferring consideration of underground injection wells because it is not likely that any will be located in Maryland. As part of the permit application, applicants will be required to plan for the storage, treatment and disposal of wastewater.

Chapter 5 – Protecting terrestrial habitat and wildlife

UMCES-AL	MDE and DNR
5-A Minimize well pad size, cluster multiple well pads, and drill multiple wells from each pad to minimize the overall extent of disturbance and reduce fragmentation and associated edge effects.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.

5-A.1 Concentrate operations including roads on disturbed and open lands, ideally in locations zoned for industrial activity and/or close proximity to major roads.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-A.2 Adopt a no-net-loss of forest policy requiring any activities that remove forest to be offset by plantings elsewhere in the region.	Section IV B, Location Restrictions and Setbacks. The Departments generally accept the proposed siting best practices recommendation and note that rules regarding acreage determination and temporary vs. permanent losses will need to be developed.
5-A.3 Implement comprehensive planning process to address the cumulative impact of multiple projects, to channel development into areas with greater amounts of existing disturbance, and to avoid areas with intact forests (especially forest interior habitat).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-B Allow for freshwater impoundments only. Impoundments should not be used for flowback or produced wastewater.	This recommendation is accepted in Section VI A, Engineering, Design and Environmental Controls and Standards.
5-B.1 Require watertight, closed metal tanks with secondary containment for all storage of chemicals and wastewater.	This recommendation is accepted in Section VI A and P, Engineering, Design and Environmental Controls and Standards.
5-B.2 Include runoff and spill prevention, response, and remediation plans as part of the permitting process	This recommendation is accepted in Section VI P, Engineering, Design and Environmental Controls and Standards.
5-C Establish and enforce setbacks to conserve terrestrial and aquatic biodiversity.	Section IV A, Location Restrictions and Setbacks. The Departments accept the proposed location restrictions and setbacks recommendation.
5-C.1 Enforce 300 ft minimum setbacks from all floodplains, wetlands, seeps, vernal pools, streams, or other surface water bodies.	Section IV A, Location Restrictions and Setbacks. The Departments accept the proposed location restrictions and setbacks recommendation.
5-C.2 Exclude all development activities from priority conservation areas (BioNet Tier I and Tier II sites and wildlands). Enforce a 600 ft setback from these areas.	Section IV A, Location Restrictions and Setbacks. The Departments accept the proposed location restrictions and setbacks recommendation.

5-C.3 Enforce 1,000 ft setback from any cave to reduce stress to bats and other obligate subterranean species.	Section IV A, Location Restrictions and Setbacks. The Departments accept the proposed location restrictions and setbacks recommendation.
5-D Review local noise ordinances to ensure they are sufficiently protective. Artificial sound barriers and mufflers should be considered where natural noise attenuation would be inadequate, especially in proximity to priority conservation areas.	Section VI N, Engineering, Design and Environmental Controls and Standards. The Departments accept the proposed siting best practices recommendation.
5-D.1 Avoid construction and drilling operations during sensitive migratory and mating seasons.	Section VI E, Engineering, Design and Environmental Controls and Standards. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.
5-E Reduce the amount of light pollution at drill pad sites by restricting night lighting to only when necessary and to only the amount of lighting required, direct light downward, instead of horizontally, use fixtures that control light directionality well, minimize glare, and use low pressure sodium (LPS) light sources whenever possible.	Section VI M. Engineering, Design and Environmental Controls and Standards accepts this recommendation.
5-E.1 When drill pads are located within 1,000ft of aquatic habitat, vegetative screens and additional lighting restrictions could be required to reduce light pollution into these sensitive areas.	Section VI M, Engineering, Design and Environmental Controls and Standards accepts this recommendation.
5-F Co-locate linear infrastructure as practicable with current roads, pipelines and power lines to avoid new disturbance.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-F.1 Avoid stream crossings and any disturbances to wetlands and riparian habitat.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-G Submit an invasive species plan as part of permit application for preventing the introduction of invasive species and controlling any invasive that is introduced.	Section VI O, Engineering, Design and Environmental Controls and Standards accept this recommendation.

5-G.1 The invasive species management plan should emphasize early detection and rapid response and include baseline flora and fauna inventory surveys of site prior to operations and long-term monitoring plans for areas that could become problematic after gas development occurs.	Section VI O, Engineering, Design and Environmental Controls and Standards and Section VII, Monitoring, Recordkeeping and Recording accepts this recommendation.
5-H Develop a two-phased reclamation strategy comprised of (1) interim reclamation following construction and drilling to reduce opportunities for invasion and (2) postactivity restoration using species native to the geographic range and seed that is certified free of noxious weeds.	Section VI O and R, Engineering, Design and Environmental Controls and Standards accepts this recommendation.

Chapter 6 – Protecting aquatic habitat, wildlife, and biodiversity

UMCES-AL	MDE and DNR
6-A Direct disturbance of any aquatic habitat for shale gas development should not be permitted.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-B A minimum 300 ft aquatic habitat setback should be applied, with the distance measured from the edge of any land disturbance, not from the location of a particular wellbore, to the edge of a particular habitat.	Section IV A, Location Restrictions and Setbacks accepts this recommendation.
6-C Data that describe the biological resources of western Maryland should be developed and made available to MSGD applicants. These data should be used to effectively channel development away from high-value biological resources and into industrial zones accessible via existing roads and highways.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-D The use of multi-well pads to access relatively large (~2 mi ²) resources of shale gas would enable the maintenance of reasonably low levels of surface development.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-E Cumulative surface development (including all well pads, access roads, public roads, etc.) could be maintained at less than 2% of the watershed area in high-value watersheds.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation as a planning principle for minimizing cumulative surface impacts.

6-F Initially, all MSGD could be excluded from areas of high-value assets (<i>e.g.</i> , BioNet sites, stronghold watersheds, Tier II watersheds, etc.)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation as a planning principle for the applicant to consider when determining the sequence of well pad development.
6-G Closed drilling systems on zero-discharge drilling pads on which all drilling and hydraulic fracturing fluids, chemicals, and liquid wastes are collected and stored in steel tanks that provide superior primary containment to holding ponds are a best management practice. Vacuum trucks could be used to handle on-site runoff during drilling and well completion (see Chapter 4).	Section VI A and E, Engineering Design and Environmental Controls accepts this recommendation.
6-H Maryland should require an invasive species management plan of industry prior to any drilling operations. Such a plan should include, at the minimum:	Section VI O, Engineering Design and Environmental Controls accepts this recommendation.
6-H.1 A description of water sources to be used to fill any impoundment, including analysis of any invasive species that might be present at the withdrawal site but absent from the watershed where the impoundment will be located.	Section VI C and O, Engineering Design and Environmental Controls accepts this recommendation
6-H.2 Water withdrawal equipment should be power-washed and rinsed with clean water before leaving the withdrawal site.	Section VI C and O, Engineering Design and Environmental Controls accepts this recommendation.
6-I Maryland should prohibit the discharging of any previously impounded water back into a natural water body, thus reducing the chance for the introduction of invasive species and short-term elevated thermal regimes in streams.	Section VI O, Engineering Design and Environmental Controls accepts this recommendation.
6-J Wherever possible, existing roads should be used in MSGD. Where new roads are required, PA DCNR recommendations could be adopted:	Section III, Comprehensive Gas Development Plans (CGDP) and Section VI A, Engineering Design and Environmental Controls accepts this recommendation.

6-J.1 Use materials and designs (<i>e.g.</i> , crowning, elimination of ditches, etc.) that encourage sheet flow as the preferred drainage method for any new construction or upgrade of existing gravel roadways.	This recommendation is addressed in Section VI A, Engineering Design and Environmental Controls.
6-J.2 Where stream crossings are unavoidable, use bridges or arched culverts to minimize disturbance of streambeds.	Section IV B, Location Restrictions and Setbacks. The Departments accept the proposed siting best practices recommendation.
6-J.3 Promote the use of geotextiles as a way of reducing rutting and maintaining subbase stability.	This recommendation is addressed in Section VI A, Engineering Design and Environmental Controls.
6-J.4 Open trenches within streams should be avoided in favor of using directional boring techniques.	Section IV B, Location Restrictions and Setbacks. The Departments accept the proposed siting best practices recommendation and propose developing siting policies to guide pipeline planning and use of hydraulic directional drilling practices.
6-K In general, during road and pad construction a combination of BMPs should be used to reduce sediment and erosion, recognizing that additional protective measures might be necessary during wet times of the year (primarily late winter and early spring).	This recommendation is accepted in Section VI A, Engineering Design and Environmental Controls.

Chapter 7 – Protecting public safety

UMCES-AL	MDE and DNR
7-A The first line of defense in protecting public safety is designing MSGD operations in a way that maintains separation between MSGD infrastructure (including transportation routes) and the public.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B, Engineering Design and Environmental Controls.
7-A.1 Facilities should be sited as far away as possible from homes, businesses, public buildings, or places with high levels of recreational activity (<i>e.g.</i> , hiking trails, parks, picnic areas, etc.) (see Chapter 9 also).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
7-A.2 Best management practices in well construction (<i>e.g.</i> , casing and cementing) should be followed to ensure wellbore integrity and isolation (see Chapter 3).	This recommendation is accepted in Section VI F, Engineering Design and Environmental Controls.

7-A.3 Proper monitoring and pre-development assessment are important steps to limit the migration of hydrocarbons, brines, or hydraulic fracturing fluids into groundwater, causing pollution of underground drinking water supplies and to enable rapid detection in the event of migration (see Chapters 1 and 4).	Section VII, Monitoring, Recordkeeping and Reporting accepts this recommendation.
7-B MSGD applicants should be required to develop site-specific, emergency response plans (ERP) that describes in detail how a particular operator will respond to different emergencies that may occur during each phase of shale gas development at sites, or transportation routes between sites, permitted for MSGD.	This recommendation is accepted in Section VI P, Engineering Design and Environmental Controls.
7-B.1 The ERP must include many types of standard information, including the names and contact information for first responders, and location (including GPS coordinates) of MSGD sites.	This recommendation is accepted in Section VI P, Engineering Design and Environmental Controls.
7-B.2 The ERP must include variations on standard responses demonstrating sensitivity to weather, time of day, time of year, and the particular geography of sites (<i>e.g.</i> , topographic and soil conditions).	This recommendation is accepted in Section VI P, Engineering Design and Environmental Controls.
7-B.3 The ERP must also include a list of all chemicals or additives used, expected wastes generated by hydraulic fracturing, approximate quantities of each material, the method of storage on-site, MSDS for each substance, toxicological data, and waste chemical properties.	This recommendation is accepted in Section VI P, Engineering Design and Environmental Controls.
7-C Best management practices implemented to avoid emergencies should include:	This recommendation is accepted in Section VI Q, Engineering Design and Environmental Controls.
7-C.1 Adequate perimeter fencing (at least a 6 ft high chained link or equivalent), gates (with keyed locks), and signage in place around drill rigs, engines, compressors, tanks, impoundments, and separators, to restrict public access.	This recommendation is accepted in Section VI Q, Engineering Design and Environmental Controls.

7-C.2 Use of safety or security guards to further control access (particularly important during active drilling and completion phases of an operation).	This recommendation is accepted in Section VI Q, Engineering Design and Environmental Controls.
7-C.3 Duplicate keys to all locks should be provided to the regulatory agency and to local emergency responders.	This recommendation is accepted in Section VI Q, Engineering Design and Environmental Controls.
7-D Maryland's Department of Transportation should calculate, evaluate, and address the major impacts of additional truck traffic on the road and highway system prior to the state permitting MSGD.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B, Engineering Design and Environmental Controls.
7-D.1 Counties and municipalities should also undertake an inventory and structural evaluation of locally-owned bridges currently exempt from federally mandated inspections to ensure that these structures are capable of safely handling the additional traffic (and loads) associated with MSGD.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B, Engineering Design and Environmental Controls.
7-D.2 The state should establish a protocol to allow for emergency transport of heavy or oversized equipment during off-hour periods (evenings, nights, and weekends).	Section VI B, Engineering Design and Environmental Controls indicates that the State and Garrett County have existing protocols, but it is unknown whether one exists for Allegany County.

Chapter 8 – Protecting cultural, historical, and recreational resources

UMCES-AL	MDE and DNR
8-A Applicants for drilling permits should be required to consult with Maryland Historical Trust during the planning and permit application process to identify all eligible or existing cultural or historical sites in the vicinity of proposed MSGD activity (including all drill pad sites, gas pipelines, roads, and transportation routes to and from MSGD facilities).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
8-B Regardless of whether or not a proposed operation would be located on state or federal land, best practice would require close consultation with local governments, state park and forest officials, national park managers, and wildlife managers who are	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.

familiar with the resources that could be impaired by shale gas development.	
8-C Applicants should be required to submit a visual resource mitigation plan as part of the permit application process based on site-specific assessment (<i>i.e.</i> , viewshed analysis).	Section IV B, Location Restrictions and Setbacks. The Departments accept the proposed siting best practices recommendation, but note that a temporary impact and a permanent impact will be evaluated differently.
8-D Site selection for drilling pads in Maryland should be locations that can provide natural vegetative or topographic screening.	Section IV B, Location Restrictions and Setbacks. The Departments accept the proposed siting best practices recommendation.
8-E Siting of well pads, or the routing of MSGD-related truck traffic, near high use recreation areas should be avoided if possible.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B, Engineering, Design and Environmental Controls and Standards.
8-F Maryland should impose a minimum 300 ft setback from all cultural and historical sites, state and federal parks, trails, wildlife management areas, natural areas, wildlands, scenic and wild rivers, and scenic byways to protect the region's most important cultural, historical, recreational, and ecological resources. Setback considerations should include high use areas, noise and visual impacts, and public safety concerns.	Section IV A, Location Restrictions and Setbacks. The Departments generally accept the proposed location restrictions and setbacks recommendation with the following modifications. A 300 ft setback may not adequate to protect the outdoor recreational visitor's experience. DNR will develop new maps of public outdoor recreational use areas to guide additional recreational setbacks and mitigation measures for minimizing public use conflicts.
8-G The calculation of setback distances should consider prevailing winds, topography, and viewsheds, and repeatable formulas for calculating setbacks should be established.	Section IV A, Location Restrictions and Setbacks. The Departments generally accept the proposed location restrictions and setbacks recommendation. These factors are also considered in Section VI M, Engineering, Design and Environmental Controls for lighting management.
8-H Mitigative techniques, such as the use of visual screens, sound barriers, camouflage, and landscaping near cultural and historical sites, as well as restricting the times of gas development operations, should be required to minimize disturbances and conflicts with recreational activities in areas adjacent to gas	Section IV B, Location Restrictions and Setbacks. The Departments accept the proposed siting best practices recommendation. These factors are also considered in Section VI M, Engineering, Design and Environmental

development zones.	Controls for lighting
8-I Any permitted shale gas development activities in the vicinity of public recreational sites—including state forests—should be timed so as to avoid periods of peak recreational activity (<i>e.g.</i> , holiday weekends, first day of trout season, spring and fall hunting seasons, whitewater release dates, etc.). Maryland DNR should collect and provide data to help inform peak activity times.	Section VI E, Engineering, Design and Environmental Controls. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.

Chapter 9 – Protecting quality of life and aesthetic values

UMCES-AL	MDE and DNR
9-A Well-pad siting should consider the multiple factors that influence the quality of life and aesthetics of rural life in western Maryland (<i>e.g.</i> , location of existing infrastructure, traffic loads on existing roads, etc.)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.1 Site well pads away from occupied buildings (<i>e.g.</i> , dwellings, churches, businesses, schools, hospitals, and recreational facilities)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.2 Site well pads and associated facilities in industrial parks (either new or existing) designed and zoned for this type of industrial activity	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.3 Site well pads in close proximity to major interstate highways and exit ramps designed to efficiently handle round-the-clock transportation	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.4 Reduce truck traffic associated with water hauling through use of temporary pipelines where possible.	Section VI B, Engineering, Design and Environmental Controls accepts this recommendation.
9-B Each of the counties in western Maryland should revisit noise regulations and enforcement policies and confirm they are appropriate for this industrial activity.	Section VI N, Engineering, Design and Environmental Controls addresses noise regulations. No State action is necessary to address this recommendation.

9-C No drilling or compressor stations should be permitted within 1,000 ft of an occupied building.	Section IV A, Location Restrictions and Setbacks accepts this recommendation.
9-D Require electric motors (in place of diesel-powered equipment) for any operations within 3,000 ft. of any occupied building	Noise is addressed in Section VI N, Engineering, Design and Environmental Controls and Standards.
9-D.1 Encourage electric motors in place of diesel-powered equipment wherever possible.	This recommendation is accepted in Section VI E, Engineering, Design and Environmental Controls and Standards.
9-D.2 Restrict hours and times of operation to avoid or minimize the greatest conflicts between the public and MSGD.	VI E, Engineering, Design and Environmental Controls and Standards. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.
9-D.3 Require ambient noise level determination prior to operations.	Noise is addressed in Section VI N, Engineering, Design and Environmental Controls and Standards. The Departments do not see a need for ambient noise measurements because the noise standards apply to noise during operations.
9-D.4 Require construction of artificial sound barriers where natural noise attenuation would be inadequate.	This recommendation is accepted in Section VI N, Engineering, Design and Environmental Controls and Standards.
9-D.5 Equip all motors and engines with appropriate mufflers.	Section VI N, Engineering, Design and Environmental Controls and Standards requires that noise be controlled, by mufflers if necessary.
9-E All permit applicants should develop and submit a detailed transportation plan for approval by the regulatory authority prior to conducting any site development, drilling, well work over, or well completion activities	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is included in Section VI B, Engineering, Design and Environmental Controls and Standards.
9-E.1 The approval process for the transportation plan should allow for adequate comment by the public, state transportation agencies, and county roads departments.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is included in section VI B, Engineering, Design and Environmental Controls and Standards.

9-F It is recommended that new road construction follows PADNR guidelines for construction of permanent non-paved roads to address potential environmental impacts, offset erosion, and avoid damage to environmentally sensitive areas.	This recommendation is addressed in Section VI, A, Engineering, Design and Environmental Controls and Standards.
9-G We recommend the use of viewshed analysis to help determine the best location for MSGD-related infrastructure as well as to determine what mitigative techniques would be appropriate.	This recommendation is accepted in Section III, Comprehensive Gas Development Plans (CGDP) and Section IV B, Location Restrictions and Setbacks.
9-H We recommend use of mitigative techniques (<i>e.g.</i> , the use of visual screens, camouflages, paint schemes, evergreen buffers, and landscaping techniques) to minimize degradation of western Maryland viewsheds by MSGD.	This recommendation is accepted in Section IV B, Location Restrictions and Setbacks.

Chapter 10 – Protecting agriculture and grazing

UMES-AL	MDE and DNR
10-A Soil conditions at sites being considered for shale gas development should be evaluated as part of the planning process.	This recommendation is accepted in Section IV B, Location Restrictions and Setbacks.
10-B Prime agricultural soils and prime farmland protected by Maryland's existing land easement programs should not be disturbed for well pad siting, road construction, or any ancillary gas development activities.	This recommendation is accepted in Section III, Comprehensive Gas Development Plans (CGDP).
10-C Highly erodible soils should also be identified as part of the planning process and appropriate best practices employed to prevent erosion and sedimentation problems in developing these areas (see Chapter 4).	This recommendation is accepted in Section IV B, Location Restrictions and Setbacks.
10-D Well pads, infrastructure, roads, and utility corridors should generally be sited along field edges, thus avoiding bisection of fields.	This recommendation is accepted in Section IV B, Location Restrictions and Setbacks.
10-E Topsoil should be stockpiled during site development activities, covered during storage, redistributed back onto agricultural land as part of the land reclamation process, and soil compaction should be avoided at all	This recommendation is accepted in Section VI R, Engineering, Design and Environmental Controls and Standards.

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times.	
10-F Operators must fence livestock out of gas development areas.	This recommendation is accepted in Section VI Q, Engineering, Design and Environmental Controls and Standards.