



# 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



Discussion Draft dated May 13, 2013

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EXECUTIVE SUMMARY .....	III
SECTION I – ORGANIZATION OF THE REPORT.....	1
SECTION II – OVERVIEW.....	2
A. MARCELLUS SHALE .....	2
B. DEVELOPMENTS IN MARYLAND .....	2
C. THE EXECUTIVE ORDER AND THE ADVISORY COMMISSION.....	3
D. THE WORK OF THE ADVISORY COMMISSION .....	4
SECTION III – COMPREHENSIVE GAS DEVELOPMENT PLANS.....	7
A. APPLICATION CRITERIA AND SCOPE .....	7
B. PLANNING PRINCIPLES .....	8
C. PROCEDURE AND APPROVAL PROCESS .....	8
D. REGULATORY AND NON-REGULATORY BENEFITS.....	9
SECTION IV – LOCATION RESTRICTIONS AND SETBACKS.....	10
A. LOCATION RESTRICTIONS AND SETBACKS .....	10
B. SITING BEST PRACTICES.....	13
SECTION V – PLAN FOR EACH WELL.....	14
SECTION VI – ENGINEERING, DESIGN AND ENVIRONMENTAL CONTROLS AND STANDARDS.....	16
A. SITE CONSTRUCTION AND SEDIMENT AND EROSION CONTROL .....	16
1. The pad.....	16
2. Tanks and containers.....	17
3. Pits and Ponds .....	17
4. Pipelines.....	17
5. Road Construction .....	18
6. Ancillary equipment.....	19
A. TRANSPORTATION PLANNING .....	19
B. WATER.....	20
1. Storage .....	20
2. Water withdrawal.....	20
3. Water reuse .....	21
C. CHEMICAL DISCLOSURE.....	22
D. DRILLING .....	23
1. Use of electricity from the grid.....	23
2. Initiation of drilling.....	23
3. Pilot hole .....	23
4. Drilling fluids and cuttings .....	24
5. Open hole logging.....	25
E. CASING AND CEMENT .....	25
UMCES-AL REPORT RECOMMENDATIONS 3-C, 3-D, 3-E, 3-F, 5-D.1, 9-D.2... 25	
1. Requirements for casing and cement .....	25

2. Isolation.....	26
3. Cased-hole logging, Integrity testing and Pressure testing.....	26
F. BLOWOUT PREVENTION .....	27
G. FRACKING.....	27
H. FLOWBACK AND PRODUCED WATER .....	27
I. AIR EMISSIONS .....	27
1. Green Completion or Reduced Emissions Completion .....	28
2. Flaring .....	28
3. Electricity from the grid.....	28
4. Engines.....	28
5. Storage tanks.....	29
6. Natural Gas Star.....	29
J. WASTEWATER TREATMENT AND DISPOSAL .....	29
K. LEAK DETECTION .....	31
L. LIGHT .....	31
M. NOISE .....	31
UMCES-AL REPORT RECOMMENDATION 9-B, 9-D-3, 9-D-4, 9-D-5.....	31
N. INVASIVE SPECIES.....	33
O. SPILL PREVENTION, CONTROL AND COUNTERMEASURES AND EMERGENCY RESPONSE .....	33
P. SITE SECURITY .....	34
Q. CLOSURE AND RECLAMATION BOTH INTERIM AND FINAL .....	35
SECTION VII – MONITORING, RECORDKEEPING AND REPORTING.....	36
SECTION VIII – MISCELLANEOUS RECOMMENDATIONS.....	38
A. ZONING.....	38
B. FINANCIAL ASSURANCE.....	38
C. FORCED POOLING.....	38
SECTION IX – MODIFICATIONS TO PERMITTING PROCEDURES .....	39
SECTION X – IMPLEMENTING THE RECOMMENDATIONS.....	40
APPENDIX A – MEMBERS OF THE COMMISSION.....	1
APPENDIX B – CONSULTATION WITH THE ADVISORY COMMISSION...	1
APPENDIX C – UMCES-AL REPORT .....	1
APPENDIX D – MARCELLUS SHALE CONSTRAINT ANALYSIS .....	1
APPENDIX E – MARCELLUS SHALE AND RECREATIONAL AND AESTHETIC RESOURCES IN WESTERN MARYLAND .....	1

## **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 this report, MDE entered into a Memorandum of Understanding with the University of Maryland Center for Environmental Science, Appalachian Laboratory, to survey best practices from several states and other sources, and to recommend a suite of best practices appropriate for Maryland. That report was completed in February 2013. The Departments evaluated whether to add to, accept, reject, or modify the suggestions, based on a number of factors. A draft was made available for public comment on [REDACTED], 2013. After consideration of the comments, the Departments submit this report on Part II of the study, Best Practices.

[Add the remainder of the Executive Summary after the report is complete.]

## **Section I – Organization of the Report**

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 incorporation the recommendations into a regulatory and permitting program, however, we have chosen to organize this report differently.

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 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, monitoring during drilling and fracking<sup>1</sup>, and monitoring during the production phase 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 a summary of the position of the Advisory Commission on the draft recommendations and a response to comments on the draft report. and

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<sup>1</sup> The correct spelling is “fracing” but the alternate spelling “fracking” has become common and is used herein.



## **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 hydraulic fracturing 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 high-volume hydraulic fracturing began around 2005 in Pennsylvania and has accelerated rapidly.

The production of natural gas has the potential to benefit Maryland and the United States. By tapping domestic sources, it 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 hydraulic fracturing 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 hydraulic fracturing 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 high volume hydraulic fracturing was received in 2009.<sup>2</sup> 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 hydraulic fracturing in the Marcellus Shale.<sup>3</sup> 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:

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<sup>2</sup> 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.

<sup>3</sup> Although the Governor's Executive Order is directed specifically at the Marcellus Shale and hydraulic fracturing, there is a potential for gas extraction from other tight shale gas formations, including the Utica Shale, and by well stimulation techniques other than hydraulic fracturing. The findings and conclusions regarding gas exploration in the Marcellus Shale may also apply to other formations and techniques.

- (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;
- (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](#), 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. In preparation for this 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 principal investigators were Keith N. Eshleman, Ph.D. and Andrew Elmore, Ph.D. Their report, [Recommended Best Management Practices for Marcellus Shale Development in Maryland](#) (UMCES-AL Report), was completed in February 2013. It is attached as Appendix C. 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 suggestions, based on a number of factors, including the opinions of the Advisory Commission, the degree of environmental protection, technical feasibility, practicality, and the Departments' capacity to implement the recommendations and integrate them into their programs.

#### **D. The Work of the Advisory Commission**

The Governor announced the membership of the Advisory Commission in July, 2011, and the Commission has met on numerous occasions. Most meetings were in Allegany or Garrett Counties, but two were held in Hagerstown and   in Annapolis. The Departments have provided written information and briefings to the Advisory Commission on issues relating to hydraulic fracturing. 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.

DNR conducted an intensive environmental assessment of Garrett County to identify community water supplies, stronghold watersheds, high quality streams, State lands, trail networks, recreational assets, landscape values, ecological resources, forest interior dwelling species, threatened and endangered plants and animals and areas of particular scenic value that could be impacted, directly or indirectly, by drill pads, pipeline/road construction and use.

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. This effort is ongoing. The Departments and the Advisory Commission coordinated with representatives of the House Environmental Matters Committee and the Senate Education, Health and Environment Committee.

In the 2013 session of the General Assembly, [describe bills]

#### **Describe additional funding and plans for future work**

In furtherance of developing Best Practices recommendations, MDE contracted with the University of Maryland Center for Environmental Science, Appalachian Laboratory, to research best practices and recommend a suite of 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, (the UMCES-AL Report), was made available to the Commission and the public in February, 2013 and is included as Appendix C.

#### ***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 [REDACTED], 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 Departments decided 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. 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 modify its laws and regulations on gas exploration and development to institute a voluntary program whereby a company holding gas interests could prepare and submit for State approval a comprehensive drilling plan for all its holdings 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 recommend that Maryland should require, as a prerequisite to the issuance of any permit to drill a gas production well, that the prospective applicant first submit a Comprehensive Gas Development Plan (CGDP). This plan would include all land for which the prospective applicant has the right to extract natural gas, and cover a period of at least 10 years. More than one entity could prepare a CGDP for an assemblage of land in which multiple entities hold mineral rights.

Comprehensive Gas Development Plans (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, many of the concerns associated with maintaining the rural character of western Maryland, protecting high value natural resources and resource-based economies and minimizing public use conflicts can be resolved or minimized while allowing for responsible energy development. 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 entire area of the target formation for which the applicant holds gas rights and areas needed for additional supporting infrastructure (compressor stations, waste water treatment facilities, roads, pipelines, etc.).
2. The CGDP shall cover a period of at least five years of development.

3. Companies whose geographic planning units overlap are encouraged to develop integrated plans to improve use of existing and new infrastructure and to minimize cumulative impacts.
4. A company is not obligated to develop all the pads or wells identified in the plan.

## **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. Concentrate operations on disturbed, open lands or lands zoned for industrial activity
5. Co-locate linear infrastructure with existing roads, pipelines and power lines.
6. Reduce cumulative surface impacts that consider impacts from other gas development projects and land use conversion activities.
7. Avoid surface development beyond 2% of the watershed area in high value watersheds.
8. Minimize fragmentation of intact forest, with particular emphasis on interior forest habitat.
9. Additional planning elements include
  - a) Area wide transportation plan.
  - b) Water supply and waste management plans
  - c) Sequence of well drilling over the lifetime of the plan that places priority on locating early well pads in areas removed from sensitive natural resource values.
  - d) Consistency with local zoning ordinances and comprehensive planning elements.
  - e) Identification of all federal, state and local permits.

## **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 includes 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. Comprehensive planning GIS data will be provided through a Shale Gas Development Toolbox.
4. State agencies and local government agencies review the CDGP, 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 CDGP.

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 is 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.
8. Additional modifications to the plan are prepared based on alternatives analyses and public comment.
9. The State approves or disapproves the CDGP; upon approval, the applicant may file a permit application for one or more wells.
10. 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 of a modified CDGP application; however a change in the sequence of execution shall not require a modified application.

#### **D. Regulatory and Non-regulatory Benefits**

1. An approved, high quality CDGP 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:
  2. 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, erosion and sediment control, stormwater management, water appropriation and use, etc.
  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.



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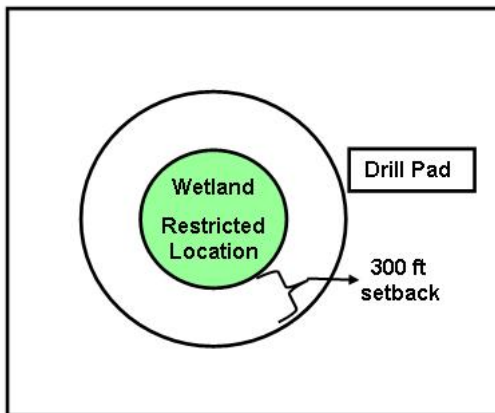
## Section IV – Location Restrictions and Setbacks

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

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.



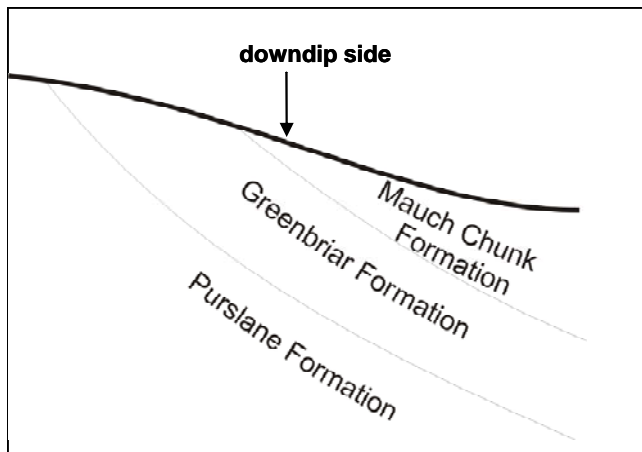
UMCES has recommended that the edge of drill pad disturbance should be 300 feet or greater from the wetland habitat. The drill pad must be located outside of the restricted resource and the required setback distance.

A preliminary analysis was conducted by MDNR 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 4,000 foot horizontal drill length, resulting in about 94 % accessibility to the Marcellus shale formation. This assessment supports the UMCES 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.

<b>Setback Recommendations from UMCES-AL Report (Reference to Chapters omitted)</b>		
<b>From</b>	<b>To</b>	<b>Distance (ft)</b>
Aquatic habitat (defined as all streams, rivers, seeps, springs, wetlands, lakes, ponds, reservoirs, and floodplains)	Edge of drill pad disturbance	300
Special conservation areas (e.g., irreplaceable natural areas, wildlands)	Edge of drill pad disturbance	600
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	300
Mapped limestone outcrops or known caves	Borehole	1,000
Mapped underground coal mines	Borehole	1,000
Historic gas wells	Any portion of the borehole, including laterals	1,320
Any occupied building	Compressor stations	1,000
Any occupied building	Borehole	1,000
Private groundwater wells	Borehole	500
Public groundwater wells or surface water intakes	Borehole	2,000

The Departments generally accept the proposed location restrictions and setbacks with the following modifications and additions.

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. 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 updip side because the limestone formation – the Greenbrier – will not be encountered (see figure to left). This setback recommendation was established to avoid karst features. However, MGS 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.

3. Setbacks for known and discovered caves should remain at 1000 feet because of the biological resource sensitivity and the potential for groundwater contamination.
4. 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.
5. 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.

6. Reevaluate the setbacks associated with public drinking water reservoirs since current regulations impose setbacks from a drinking water intake but not the edge of the reservoir. Setbacks should be at least as protective as the recommended setback of 2,000 feet from public drinking water wells.
7. Expand drill pad location restrictions and setbacks listed in Table 1-1 to all gas development activities resulting in surface disturbance. This includes roads, pipelines, compressor stations, separator facilities and other infrastructure needs. This expansion specifically applies to aquatic habitat, special conservation areas, cultural and historical sites, State and federal parks and forests, trails, wildlife management areas, scenic and wild rivers and scenic byways.
8. MDNR will develop new maps of public outdoor recreational use areas to establish additional recreational setbacks and mitigation measures for minimizing public use conflicts. MDNR 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. MDNR 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.

## **B. Siting Best Practices**

UMCES-AL Report recommendations 3-B, 4-D, 5-A.2, 5-D, 5-F. 5-F.1, 6-J.2, 6-J.4, 8-C, 8-D, 8-H, 8-I, 9-G, 9-H, 10-A, 10-B, 10-C, 10-D

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

1. Determine if no-net-loss of forest should apply to temporary or permanent losses and define how the acreage should be determined.
2. 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.
3. MDNR will provide additional GIS conservation planning data layers and guidance for avoiding, minimizing and mitigating impact to aquatic and terrestrial high priority conservation areas.
4. Develop siting policies 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.
5. Stream crossings will avoid impact to brook trout spawning beds (mentioned in report, but not listed in key recommendations).
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, 5-B.2

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 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 adequate. The plan must address, at a minimum,

1. Updating the Environmental Assessment

This effort includes all environmental assessment baseline monitoring and site characterization required as a prerequisite for issuing individual well permits. The relevant UMCES recommendations are also reflected in Section VII – Monitoring, Recordkeeping and Reporting. 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. Acquisition of water
4. Evaluation of potential flow zones
5. Identification and evaluation of shallow and deep hazards
6. Pore pressure/fracture gradient/drilling fluid weight
7. Monitoring and maintaining wellbore stability
8. Addressing lost circulation
9. Casing
10. Cementing
11. Drilling fluids
12. Wellbore hydraulics
13. Barrier design
14. Integrity and pressure testing
15. Blow out protection
16. Contingency planning
17. Communications plan, including communication with contractors and subcontractors
18. Site security

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

## **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 are constantly evolving and improving. 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-I, 5-B, 5-B.1, 5-B.2, 6-G, 6-J.1, 6-J.3, 6-J, 6-K, 7-A.2, 9-D, 9-F

The proper construction of drilling pads, roads, pipelines, tanks, pits and ponds, 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.<sup>4</sup> 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.<sup>5</sup> 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 fracking. 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 fracking 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 impermeable berms 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 may cease only

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<sup>4</sup> COMAR 26.19.01.10 J through K.

<sup>5</sup> COMAR 26.19.01.06C (12) and (13).

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.

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 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 follow comply with 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.
- 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

UMCES-AL Report recommendations 6-J, 9-F

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 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 plan will provide assurance that erosion will be controlled..

The Departments are considering two options for construction standards for roads constructed by private parties to facilitate gas exploration and production:

- c. The recommendations of the Pennsylvania Department of Conservation and Natural Resources; or
  - d. Cornell University Transportation Center
6. Ancillary equipment

Ancillary equipment includes gathering and boosting station, 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 the air emissions section, below.

## **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 Garrett County have existing programs to allow for emergency transport of heavy or oversized equipment during off-hour periods. Allegany County may have a similar program. 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.

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

Ensure that local governments are adequately equipped for responsive and adequate transportation planning. This may require State agency technical and financial assistance.

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 1-L, 4-G, 9-A, 4-G

### 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. See 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

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

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. For the reasons explained below, the Departments do not see a need to incorporate water appropriation provisions in MDE's oil and gas regulations.

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 these are necessary practices.

The Maryland legislature had determined that it is necessary to control the appropriation or use of surface or ground water 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 the Department 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 (1,825,000 gallons per year) as an annual average of ground water. Appropriation requests for an annual average withdrawal of more than 10,000 gallons per day (gpd) (as a new request or increase) may be required to perform aquifer testing and other technical analysis. All applicants proposing a new use or 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.

The Susquehanna River Basin Commission (SRBC) issues water appropriation permits for withdrawals of surface or ground water in that basin. The SRBC has a regulatory threshold of 100,000 gpd as a 30-day average, and 20,000 gpd for 30 day consumptive uses; however, in 2008 it amended its regulations to require natural gas companies to seek approval from the SRBC before withdrawing or using any amount of water for unconventional natural gas development. The Departments believe that Maryland's current thresholds are adequately protective, but requests comments on whether it should adopt a threshold criterion for unconventional natural gas development to match that of the SRBC.

The Departments also believe that the substantive criteria for evaluating applications for water appropriation are adequate to address water withdrawals for Marcellus shale drilling and hydraulic fracturing. These criteria are set forth in COMAR 26.17.06.05. The Department of the Environment has the authority to include protective provisions in permits. COMAR 26.17.06.06.

### 3. Water reuse

UMCES-AL Report recommendations 4-J

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, which shall not be less than 90%, and on the pad site of generation to the extent feasible.

#### **D. Chemical Disclosure**

UMCES-AL Report recommendations 4-H, 7-B

The only recommendations made about disclosure of chemicals in the UMCES-AL report (4-H and 7-B) related 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 fracking 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) or propping agents for hydraulic fracturing. 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 Department 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 identification:

Safety Data Sheets (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 Abstract 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 fracking chemicals shall be the same as those of the OSHA Hazard Communication Standard, 29 CFR 1910.1200

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

The chemical name and Chemical Abstract Service number of all chemicals claimed to be trade secret must be provided to MDE with the permit application; MDE will release it 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.

A health care professional's need for the trade secret information need not relate to occupational exposure or employees.

In addition, the Departments encourage well operators to disclose the identity and amount of chemicals used on Frac Focus, 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, 9-D-1

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 Departments have not yet developed any criteria for deciding when electricity “could be made readily available” and solicits comments or suggestions for this determination.

The use of propane or natural gas to power motors and pumps should be encouraged if electricity from the grid is not available.

### 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 migratory or mating seasons.

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

### 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. They propose that a best practice be to conduct pre-drill planning in any area where underground mining is suspect which should require:

- e. Careful search for and geo-referencing of any mine maps for any mines within 500 feet of prospective drill holes.
- f. Selection of drill hole locations that avoid all mine voids and assures lateral support of drill holes during drilling and casings during well construction.
- g. If such locations cannot be found concrete mine voids to provide such locations and require double or triple casing through the mining zone.

- h. In all cases, a slim pilot hole should be drilled through any suspected mining zones to verify that suitable locations for production holes have been found or created by concreting mine voids.

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, 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.

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 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 may 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, returned drilling fluid and 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 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 think that they should also be tested for other contaminants, including sulfates and salinity before disposal and disposed of in compliance with the law. If the cuttings show no elevated levels of radioactivity, and meet other criteria established by MDE, however, 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 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, 3-F, 5-D.1, 9-D.2

### 1. Requirements for casing and cement

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 (ASTM) in “A500/A500M Standard Specification for Cold-Formed Welded and Seamless Carbon



Steel Structural Tubing in Rounds and Shapes” and has 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.”

Reconditioned casing may be permanently set in a well only if 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 the inspector 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 fracking 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.

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. Section V of this report requires the applicant for a drilling permit to provide a plan for integrity and pressure testing. In addition, the

Departments recommend that mechanical integrity tests shall be performed when refracturing an existing well.

### **G. Blowout Prevention**

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 (kick) 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. 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. Fracking**

Diesel fuel shall not be used in fracking fluids

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

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

A tilt meter or microseismic survey shall be performed by the permittee for the first well fracked on each pad to provide information on the extent, geometry and location of fracturing; the information shall be provided to MDE.

### **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:

- i. Inadequate water disposal capacity
- j. Undersized flowback equipment
- k. 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

Electrically-powered equipment must be used wherever line power is available (or could be made readily available) from the grid. The use of propane or natural gas to power motors and pumps should be encouraged if electricity from the grid is not available

4. Engines

- a. All on-road and non-road vehicles and equipment using diesel fuel must use Ultra-Low 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 NO<sub>x</sub> 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 IIII 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

In addition, on March 28, 2013, EPA proposed updates to the 2012 standards for storage tanks. EPA anticipates taking final action by July 31, 2013. Upon final adoption of these regulations, the Departments propose to require that facilities in Maryland meet these standards upon startup.

6. Natural Gas Star

UMCES-AL Report 2-A

The UMCES-AL report recommended that all operators in Maryland should voluntarily participate in USEPA's Natural Gas STAR program. This program is a voluntary 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 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. The Departments solicit comment on whether it should make any parts of the program mandatory for companies operating in Maryland.

## **K. Wastewater Treatment and Disposal**

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

After a well is fracked, some portion of the fracking 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, and 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 fracking. 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, as a best practice, flowback and produced water be recycled to the maximum extent practicable, which shall not be less than 90%, and on the pad site of generation to the extent feasible.

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. To evaluate this recommendation, it is necessary to understand the regulation of direct and indirect discharges of pollutants.

Direct and indirect discharge 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.<sup>6</sup> 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 fresh water streams, where they could kill or damage the aquatic

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<sup>6</sup> 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.

organisms. Where the discharges were above 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.

With regard to disposal in Class II injection wells, the 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.

## **L. Leak Detection**

UMCES-AL Report recommendations 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.

Require consideration of all feasible recommended strategies identified in EPA's Natural Gas STAR program as an element of 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 as discussed in the monitoring section is 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 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.

## **N. Noise**

UMCES-AL Report recommendation 9-B, 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; however, application of 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 district<sup>7</sup>, and may be conducted at 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 1**  
**Maximum Allowable Noise Levels (dBA)**  
**for Receiving Land Use Categories**

Day/Night <sup>8</sup>	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 Table 1 during nighttime hours. COMAR 26.02.03.02B. The noise regulations also address vibrations: “A person may not

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<sup>7</sup> “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

<sup>8</sup> “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

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 (i.e., especially 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.

## **O. Invasive species**

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

An invasive species plan must be submitted 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 the power washing of water withdrawal equipment 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 lease 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, 7-B, 7-B.1, 7-B.3

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 personnel must be capable of arriving at the site within 24 hours of the incident.

To support preparations and training by first responders and well pad staff for any chemical emergencies, the UMCES-AL report recommended that lists of chemicals to be used on site (including appropriate toxicological data, chemical characterizations, Material Safety Data Sheets, and spill clean-up procedures) should be provided in permit applications.

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 requirements for emergency response are sufficient to enable first responders and well pad staff to appropriately respond to emergencies involving chemicals. For this reason, the Departments do not agree that it is necessary for information on all chemicals used on the site be provided to MDE with the application for a permit to drill a well.

Operators shall prior to commencement of drilling, develop and implement an emergency response plan, ensure local responders have appropriate training in the event of an emergency, establish a way of informing local water companies promptly in the event of spills or releases, and work with the local governing body in which the well is located to verify that local responders have appropriate equipment 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 Departments accept the proposed site security recommendations intended to avoid emergencies and would include practices such as:

1. Perimeter fencing, gates, locks and duplicate keys available to emergency responders and regulatory personnel
2. Appropriate warning signs

3. Guarded access points, particularly during times of active operations

## **R. Closure and Reclamation both interim and final**

UNCES-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. Reclamation shall address all disturbed land, including the pad, access roads, ponds, pipelines and ancillary equipment. The reclamation plan shall address (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.

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 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. MDNR 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 has 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, fracking, 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.

## **Section VIII – Miscellaneous Recommendations**

### **A. Zoning**

UMCES-AL Report recommendations 1-M

Zoning is a local matter over which the State has 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 Edwards, providing financial assurance for gas and oil drilling.

### **C. Forced Pooling**

UMCES-AL Report recommendations 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.

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## **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.

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.

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## **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**

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### 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*

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

John Fritts, *president of the Savage River Watershed Association*

Jeffrey Kupfer, *senior advisor, Chevron Government Affairs*

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

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

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

Nick Weber, *chair of the Mid-Atlantic Council of Trout Unlimited*

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



## **APPENDIX B – CONSULTATION WITH THE ADVISORY COMMISSION**

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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.

## **APPENDIX C – UMCES-AL REPORT**

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[Insert without transmittal letter as pdf after report is complete]

## APPENDIX D – MARCELLUS SHALE CONSTRAINT ANALYSIS

### 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.

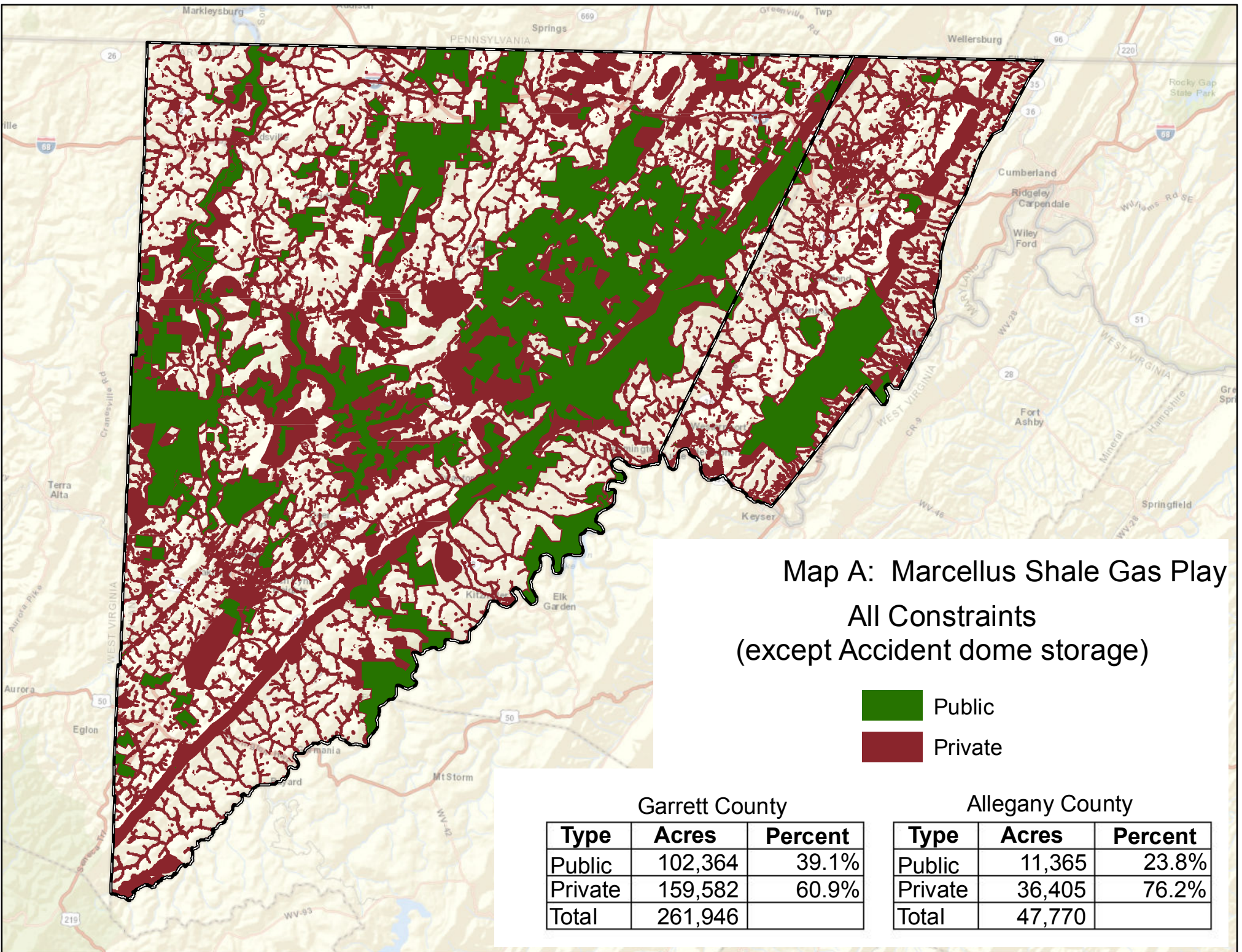
Off-Limit Areas	Setback/Buffers	Type	Source
Public lands, Trails, Scenic By-Ways	300 feet	Surface	UMCES
Irreplaceable Natural Areas (BioNet Tier 1 & 2), Wildlands	600 feet	Surface	UMCES
Wetlands, Vernal Pools, Streams and Rivers	300 feet	Surface	UMCES
Prime Agricultural Soils	0 feet	Surface	UMCES
Deep 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, leave 36.3% of the exploration area available for surface development.

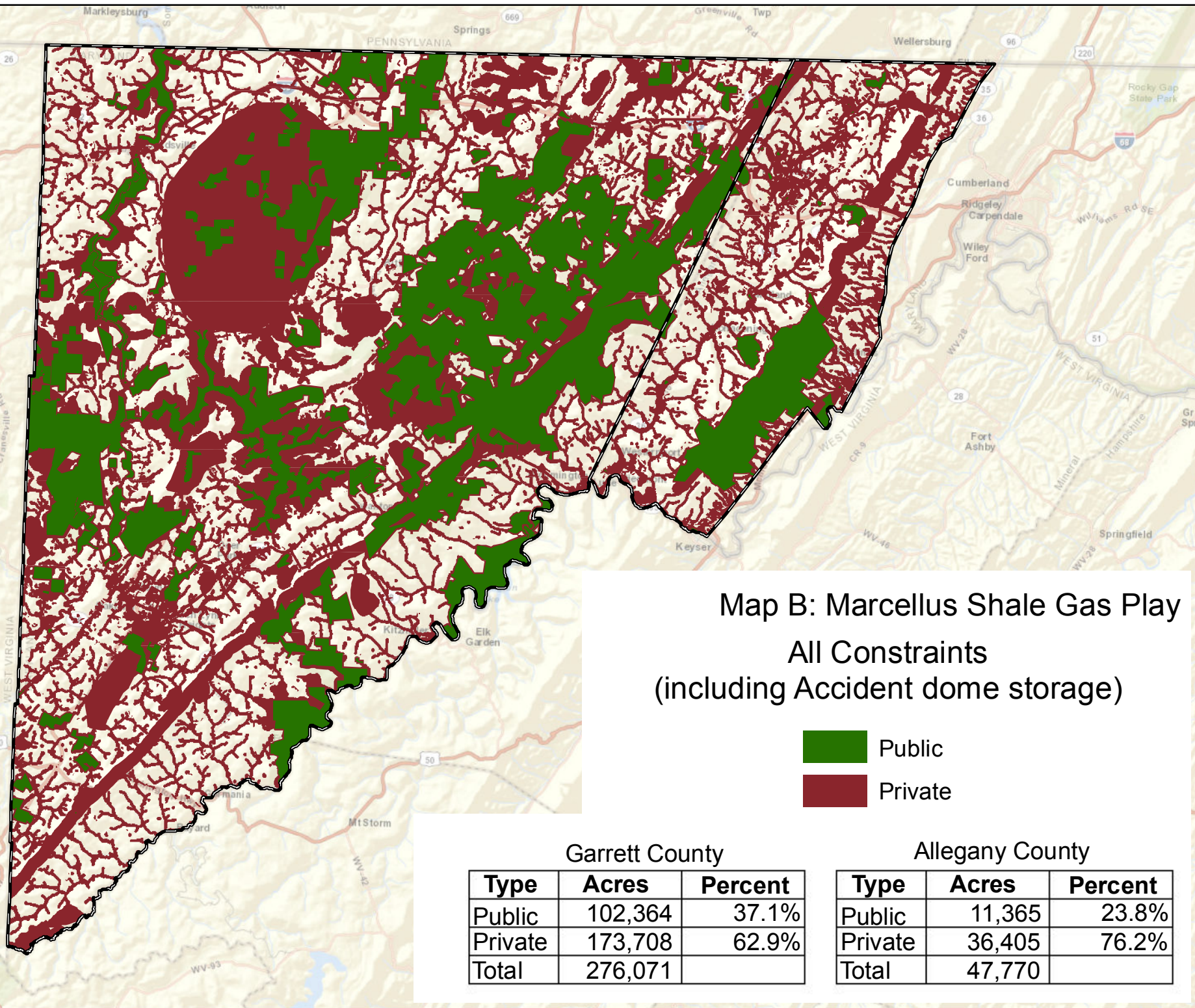
### **Subsurface Access Analysis**

Based on the constraints identified above, the ability to access Marcellus shale gas deposits through horizontal drilling was evaluated based on the UMCES 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).



**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%
<b>Constraint Area</b>	<b>261,946</b>	<b>62.0%</b>	<b>47,770</b>	<b>55.6%</b>	<b>309,716</b>	<b>60.9%</b>
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%
<b>Available for Operations</b>	<b>160,285</b>	<b>38.0%</b>	<b>38,169</b>	<b>44.4%</b>	<b>198,453</b>	<b>39.1%</b>
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%
<b>Total</b>	<b>276,071</b>	

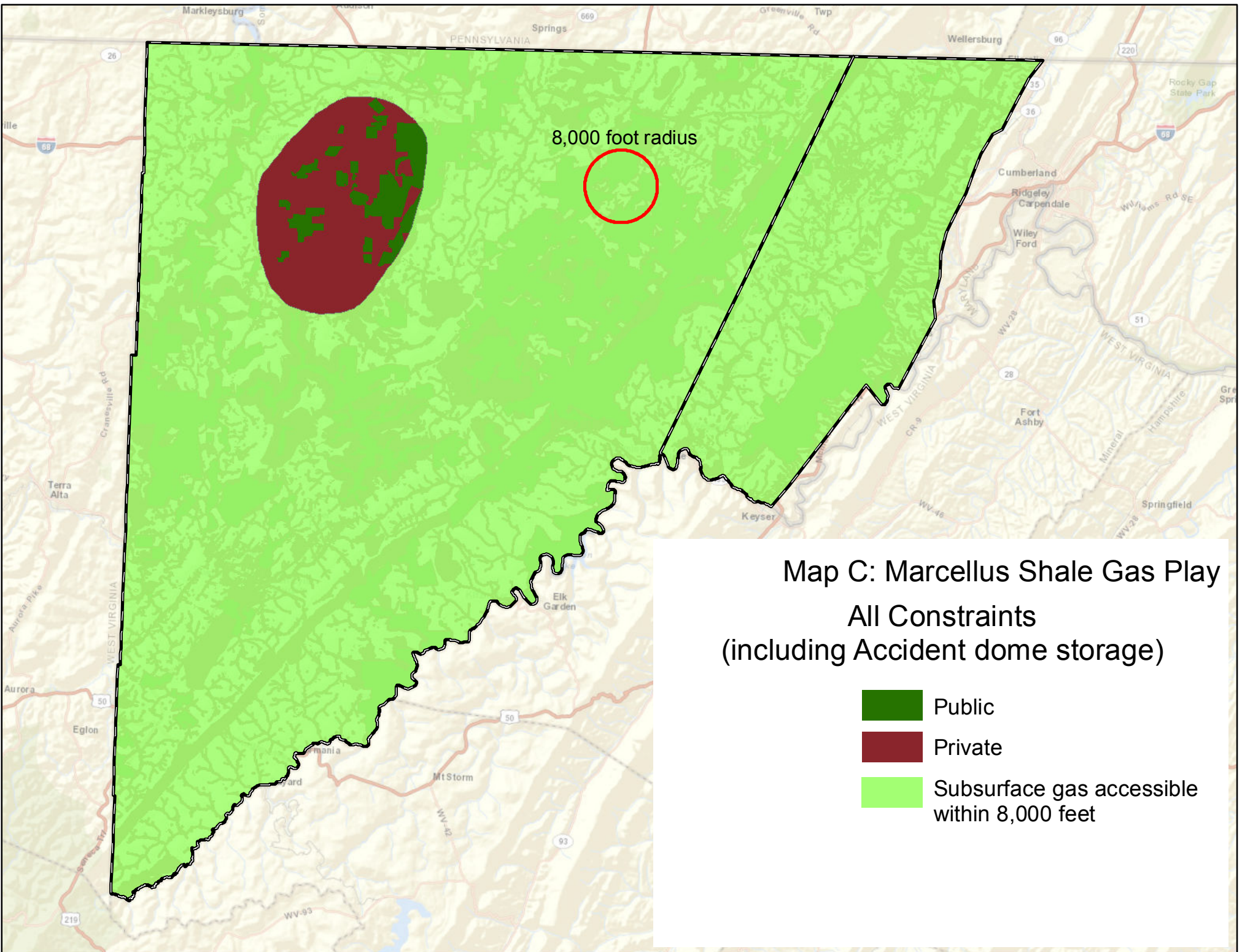
Allegheny County

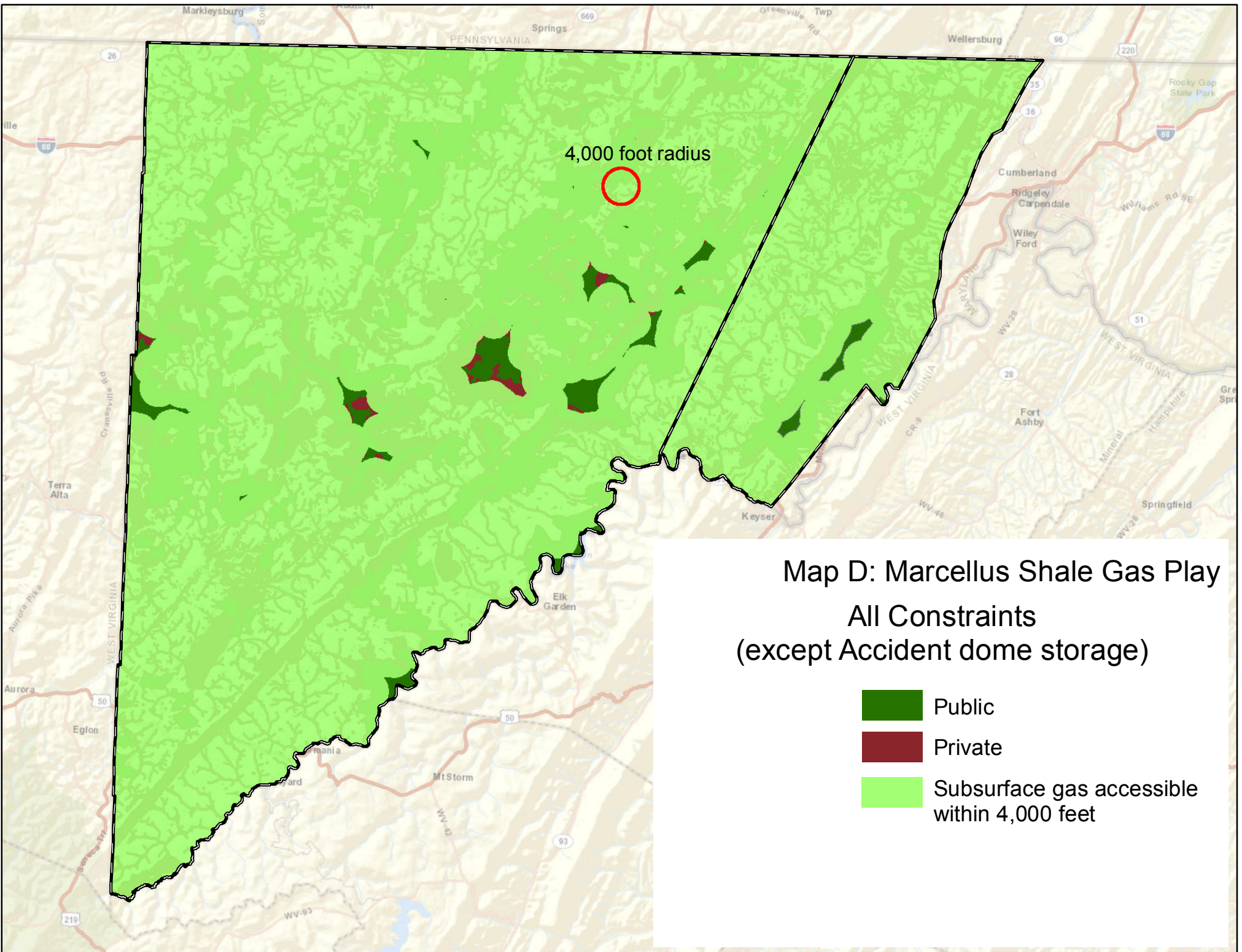
Type	Acres	Percent
Public	11,365	23.8%
Private	36,405	76.2%
<b>Total</b>	<b>47,770</b>	

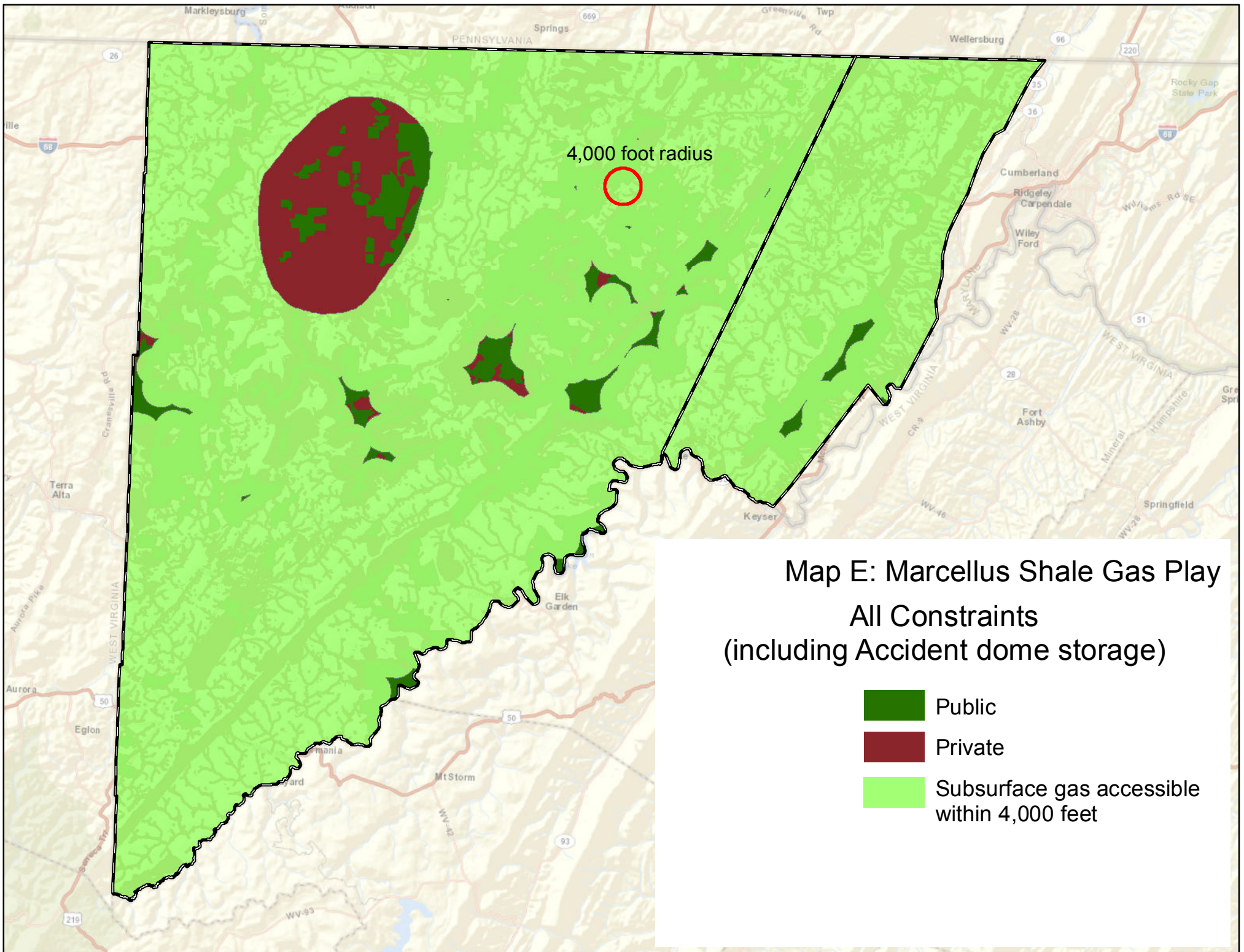
**Table 2 : Marcellus Shale Gas Play**  
(with Accident storage dome as a constraint)

	Garrett		Allegany		Total	
	(acres)	(percent)	(acres)	(percent)	(acres)	(percent)
Exploration Area	422,231	100.0%	85,939	100.0%	508,169	100.0%
<b>Constraint Area</b>	<b>276,071</b>	<b>65.4%</b>	<b>47,770</b>	<b>55.6%</b>	<b>323,841</b>	<b>63.7%</b>
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%
<b>Available for Operations</b>	<b>146,159</b>	<b>34.6%</b>	<b>38,169</b>	<b>44.4%</b>	<b>184,328</b>	<b>36.3%</b>
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%









## 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 undesignated 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

Total trip spending profile by region

Visitors to Maryland State Parks in each region spend more than \$567 million dollars in Maryland during their trips to State Parks.

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

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

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.

### Open Space Experience

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

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.

Maryland State Park experience for both day use and overnight

### 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 (MDNR) 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 UMCES' 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.