

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

Chapter 1 – General, planning and permitting BMPs

UMCES-AL	MDE and DNR
<p>1-A Pre-development environmental assessment should be conducted on a site-specific basis and include: (1) identification of all on-site drilling hazards such as underground mine workings, orphaned gas or oil wells, caves, caverns, Karst features, etc.; (2) identification of all ecological, recreational, historical, and cultural resources in the vicinity of a proposed site (includes well pad and all ancillary development such as cleared areas around a well pad, roads, bridges, culverts, compressor stations, pipelines, etc.); (3) identification of the appropriate setbacks and buffers for the proposed site; and (4) collection of two years of pre-development baseline data on underground drinking water, surface water, and both aquatic and terrestrial ecological resources.</p>	<p>Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation. Some of the data will be required for the CGDP; other data in applications for individual permits. This recommendation is also reflected in Sections V and VII.</p>
<p>1-B Maryland should require as part of its permit application at least two years of site specific data collection prior to any site development that would be used to characterize the resources at risk and provide a solid baseline dataset that would ultimately be used to understand process and feedback to the refinement of BMPs.</p>	<p>Section VII, Monitoring, Recordkeeping and Reporting adopts this recommendation and adds that characterization and monitoring data will be important to identify whether any impacts to the resources has occurred, and can be used as basis for mitigating damage.</p>
<p>1-C Comprehensive planning (a.k.a., comprehensive drilling plans) could potentially be used to effectively channel MSGD into areas that would be less sensitive to impacts while allowing for considerable and efficient exploitation of the gas resource. Spacing multiwall pads in clusters—as far apart as is technically feasible—makes maximum use of horizontal drilling technology and could be an important BMP in terms of minimizing development impacts. With careful and thoughtful planning (e.g., co-location of infrastructure wherever possible), it may be possible to develop much of the gas resource in a way that disturbs less than 1-2% of the land surface, even when accounting for the need for ancillary infrastructure such as access roads, pipelines, and compressor facilities. Comprehensive gas development plans could also moderate the rate</p>	<p>Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation; however, limiting the disturbance to 1-2% of the land appears as a planning principle for high value watershed and the Departments do not recommend using CGDPs to limit the pace of development.</p>

<p>at which the resource is developed in Maryland, thus allowing the regulatory enforcement arm of MDE (with little recent experience in gas well permitting and no experience in unconventional gas) to ramp up over time.</p>	
<p>1-D Maryland should consider legislation that would enable the state to implement “forced pooling” as a way of providing greater resource protection while allowing for efficient resource exploitation.</p>	<p>Section VIII. The Departments recommend that forced pooling not be considered at this time.</p>
<p>1-E Maryland should impose by regulation sensible setbacks (see Table 1.1) that are adequate to protect public safety, as well as ecological, recreational, historical, cultural, and aesthetic resources.</p>	<p>Section IV A. The Departments generally accept the proposed location restrictions and setbacks with the exceptions noted. The Departments reduced the suggested setback from limestone outcrops, increased the setback from private groundwater wells and recommend pre-drilling planning and use of pilot holes to evaluate subsurface hazards, such as deep coal mines.</p>
<p>1-F There is a definite need for an analysis of extant hydrogeological data from western Maryland that could be used to develop flow nets or models and infer groundwater flowpaths and other important features such as recharge areas, discharge areas, hydrologic residence times, and depth of the freshwater zone across the area.</p>	<p>The Departments, with the help of Garrett County, have begun to assemble the existing data on drinking water wells in Garrett County and undertaken additional groundwater sampling.</p>
<p>1-G Maryland might consider developing a standardized stakeholder process that could be implemented as part of comprehensive planning strategy; the goal of such a process while allowing the permit review process to be expedited.</p>	<p>Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.</p>
<p>1-H We recommend that Maryland follow guidance from New York’s experience with unconventional shale gas development and effectively not permit MSGD (or any other unconventional gas development) where the target formation occurs within 1,000 vertical feet of USDW or within 2,000 vertical feet of the ground surface. Since the freshwater/saltwater interface has not been mapped in Maryland, the prudent approach would be to rely on the 2,000 ft criterion to provide an adequate margin of safety.</p>	<p>This recommendation is accepted in Section IV.</p>
<p>1-I An obvious best practice would be to site</p>	<p>Section IV A. The Departments</p>

<p>well pads so as to avoid vertical drilling (i.e., surface boreholes) in areas where shallow caves and caverns have been mapped or where there is a high probability that such systems might be present. Maryland should develop a GIS map system of both active and abandoned oil and gas wells (including gas storage wells) and active and abandoned coal mine workings prior to permitting any new Marcellus wells; all underground hazards with ¼ mile of any section of a proposed Marcellus well should be identified as part of the permit review process and avoided wherever possible.</p>	<p>generally accept the proposed location restrictions and setbacks recommendations and will develop a Shale Development Toolbox to provide a comprehensive set of GIS planning data, including known and mapped locations of the features listed in this recommendation.</p>
<p>1-J Maryland should require a 1,000 ft setback from all deep mine workings and ¼ mile setback from all historic gas wells. The gas well setback should be measured from any portion of the borehole (vertical or horizontal) to the historic well.</p>	<p>Section IV A. The Departments recommend reducing the 1,000 ft setback from deep mine workings as it is unnecessarily restrictive since Maryland’s deep coal mines may cover thousands of acres, are only several hundred feet deep, and can be safely cased through, particularly if pilot holes are drilled to identify these features and drilling processes are modified to address the known hazards.</p>
<p>1-K Maryland should develop regulations that force rapid partial reclamation (including revegetating disturbed areas surrounding wells pads, corridors, and ancillary infrastructure) of all land not needed for drilling and production as quickly as possible, while allowing the remaining portion to exist unreclaimed only until such time as drilling is completed, production ends, and final reclamation can be performed.</p>	<p>Section VI O and R adopt this recommendation</p>
<p>1-L We found that Maryland’s current oil and gas regulations governing permitting for conventional development require many of the elements that would be needed to properly address MSGD or unconventional development in general; however, the state should consider revising its oil and gas permitting regulations to explicitly address water withdrawal and storage issues, drilling waste and wastewater treatment and disposal issues, as well as transportation planning issues.</p>	<p>MDE considered the need to revise the oil and gas permitting regulations. Recommendations for changes can be found in specific sections.</p>
<p>1-M Local zoning ordinances for both counties should be amended to spell out in which zoning districts MSGD would be permitted as a way of</p>	<p>Section VIII. Zoning is a local matter over which the State has no control. The Counties are well aware of their authority</p>

minimizing some of the major conflicts and public safety issues that we addressed in this report.	to enact zoning regulations.
1-N Maryland’s requirements for performance bonding under current regulations (\$100,000 per well or \$500,000 blanket bond for all of an applicant’s wells) are relatively high compared to other states; thus, the state might be to avoid some of the problems associated with divestment of MSGD assets from primary to secondary firms that are predicted as gas production declines. Nonetheless, Maryland might want to consider alternate mechanisms of covering decommissioning and reclamation costs through a trust fund mechanism (i.e., investing revenue from pre-drilling fees and a five-year severance tax on production) as an alternative to performance bonding.	Section VIII C. Financial assurances and the concern about divestment were appropriately addressed in the 2013 legislative passage of SB854, sponsored by Senator Edwards, providing financial assurance for gas and oil drilling.

Chapter 2 – Protecting Air Quality

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

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

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

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

Chapter 4 – Protecting water resources

UMCES-AL	MDE and DNR
4-A A best practice for Maryland would be establishment in regulation of 500 ft. and 2,000 ft. setbacks (measured from the well pad, not from the individual wellbores) for private wells and public system intakes (both surface and groundwater), respectively.	Section IV A. The Departments accept the proposed 2,000 ft setback from public wells, and note that current regulations (COMAR 26.19.01.19G) already provide a 1,000 ft setback from all drinking water supplies, which includes private wells.
4-B We support Maryland Environmental Code § 14-110.1 (H.B. 1123) and recommend	Current Maryland regulations require that the applicant identify all water wells

<p>predevelopment notification should be made to public and private drinking water well owners.</p>	<p>within 2,650 feet of the proposed well location. The Department must mail written notice of the decision to grant or deny the permit to all landowners within 1,000 feet of the proposed well. Section IX adopts the recommendation that notice be provided to well owners within 2,500 feet.</p>
<p>4-C Pre-drilling groundwater testing should be required to be conducted by the operator and the results provided to MDE and to the well owner. Post-drilling testing is often at the discretion of the well owner, but a best management practice that would enable improved understanding of the potential for effects on groundwater would be to require postdrilling and completion testing by the operator for all wells within a pre-determined potentially affected region for a specified time period after completion of well construction activities.</p>	<p>Section VII accepts this recommendation.</p>
<p>4-D Maryland might wish to consider ways of strengthening its anti-degradation policy to take account of the impacts of non-point source pollution that are a major threat to its high quality waters. One way that this might be accomplished would be by revising the WQS rules to require that any land development practices (e.g., forest management, MSGD, etc.) conducted in Tier II watersheds meet an anti-degradation standard.</p>	<p>Section IV B defers consideration of special anti-degradation regulations for well drilling until it undertakes revisions to those regulations.</p>
<p>4-E Maryland needs to carefully review its stormwater regulations as they pertain to oil and gas extraction; we recommend oil and gas extraction sites be considered “hotspots.” Based on our review of stormwater management practices in other states, we recommend the use of both “active” and “passive” stormwater management: (1) the construction of properly bermed “zero-discharge” pads that effectively collect all water on a pad site and enable the reuse of this water during drilling and completion operations; and (2) construction of a below-grade lined pond adjacent to the bermed zero-discharge pad that could be used as a sump during active stormwater management phases and easily converted into a retention pond prior to a passive phase.</p>	<p>This recommendation is accepted with modifications in Section VI A. Zero-discharge from pads during drilling and completion are adopted in Section VI A. The collection of stormwater and other liquids may cease only when all potential pollutants have been removed from the pad and appropriate, approved stormwater management can be implemented.</p>

<p>4-F Post-construction inspections of stormwater structures should occur prior to well drilling and completion.</p>	<p>Such inspections are routinely carried out by the counties.</p>
<p>4-G There are very long gage records available from USGS for most of the major western Maryland rivers (Youghiogheny, Casselman, Savage, Potomac, Georges Creek) that could possibly be used to support MSGD; data for these and other gaged systems can be used to inform a quantitative analysis of acceptable water withdrawals for MSGD. This analysis is much more difficult for smaller streams and rivers due to data limitations, although we believe that such an analysis should be done. Our experience in Maryland watersheds as well as review of other areas that have completed such analysis, suggest that in western Maryland, water withdrawals for proposed MSGD would need to occur solely from the region's large rivers (and perhaps from one or more reservoirs). Small streams (1) have significant existing withdrawals for drinking water; (2) have small catchment areas and discharges under most conditions; (3) are very unlikely to have excess flow capacity for new permitted withdrawals; and (4) can be readily dewatered. Water may need to be temporarily stored in centralized freshwater impoundments specifically constructed for this purpose, but such impoundments should never be allowed to receive or store any wastewaters.</p>	<p>The State's existing program for water appropriation, which protects small streams, is described in Section VI C. the recommendation regarding storage of water and wastewater are accepted in Section VI C and VI A 2 and 3.</p>
<p>4-H To support preparations and training by first responders and well pad staff for any chemical emergencies, lists of chemicals to be used on site (plus appropriate toxicological data, chemical characterizations, MSDS, and spill clean-up procedures) should be included in permit applications.</p>	<p>These recommendations are accepted in Section VI D and VI P.</p>
<p>4-I Closed-loop drilling systems that sit within secondary (and perhaps tertiary) containment are preferable to open pit systems and should be considered a best practice for Maryland.</p>	<p>Section VI A adopts this recommendation.</p>
<p>4-J Maryland should include a very strong preference for on-site recycling of wastewaters in permitting of shale gas development. Under no circumstances should Maryland allow discharge of untreated brine, partially-treated brine, or residuals</p>	<p>These recommendations are accepted in Section VI K.</p>

from brine treatment facilities, into the waters of the state. Development of brine treatment plants that recycle water to drillers should be discouraged in favor of on-site treatment by mobile units and immediate reuse as this decreases truck transport and associated impacts.	
4-K Maryland should review the relevant regulations surrounding development and use of underground injection wells for produced water from shale gas development and, at the same time, evaluate the capacity of nearby states to accept produced water or residual brine from treatment of produced water before permitting any development in the state.	In Section VI K, the Departments recommend deferring consideration of underground injection wells because it is not likely that any will be located in Maryland. As part of the permit application, applicants will be required to plan for the storage, treatment and disposal of wastewater.

Chapter 5 – Protecting terrestrial habitat and wildlife

UMCES-AL	MDE and DNR
5-A Minimize well pad size, cluster multiple well pads, and drill multiple wells from each pad to minimize the overall extent of disturbance and reduce fragmentation and associated edge effects.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-A.1 Concentrate operations including roads on disturbed and open lands, ideally in locations zoned for industrial activity and/or close proximity to major roads.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-A.2 Adopt a no-net-loss of forest policy requiring any activities that remove forest to be offset by plantings elsewhere in the region.	Section IV B. The Departments generally accept the proposed siting best practices recommendation and note that rules regarding acreage determination and temporary vs. permanent losses will need to be developed.
5-A.3 Implement comprehensive planning process to address the cumulative impact of multiple projects, to channel development into areas with greater amounts of existing disturbance, and to avoid areas with intact forests (especially forest interior habitat).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
5-B Allow for freshwater impoundments only. Impoundments should not be used for flowback or produced wastewater.	This recommendation is accepted in Section VI A 3.
5-B.1 Require watertight, closed metal tanks with secondary containment for all storage of	This recommendation is accepted in Section VI P and VI A.

chemicals and wastewater.	
5-B.2 Include runoff and spill prevention, response, and remediation plans as part of the permitting process	This recommendation is accepted in Section VI P and Section V.
5-C Establish and enforce setbacks to conserve terrestrial and aquatic biodiversity.	Section IV A. The Departments accept the proposed location restrictions and setbacks recommendation.
5-C.1 Enforce 300 ft minimum setbacks from all floodplains, wetlands, seeps, vernal pools, streams, or other surface water bodies.	Section IV A. The Departments accept the proposed location restrictions and setbacks recommendation.
5-C.2 Exclude all development activities from priority conservation areas (BioNet Tier I and Tier II sites and wildlands). Enforce a 600 ft setback from these areas.	Section IV A. The Departments accept the proposed location restrictions and setbacks recommendation.
5-C.3 Enforce 1,000 ft setback from any cave to reduce stress to bats and other obligate subterranean species.	Section IV A. The Departments accept the proposed location restrictions and setbacks recommendation.
5-D Review local noise ordinances to ensure they are sufficiently protective. Artificial sound barriers and mufflers should be considered where natural noise attenuation would be inadequate, especially in proximity to priority conservation areas.	Section IV B. The Departments accept the proposed siting best practices recommendation.
5-D.1 Avoid construction and drilling operations during sensitive migratory and mating seasons.	Section VI. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.
5-E Reduce the amount of light pollution at drill pad sites by restricting night lighting to only when necessary and to only the amount of lighting required, direct light downward, instead of horizontally, use fixtures that control light directionality well, minimize glare, and use low pressure sodium (LPS) light sources whenever possible.	Section VI accepts this recommendation.
5-E.1 When drill pads are located within 1,000ft of aquatic habitat, vegetative screens and additional lighting restrictions could be required to reduce light pollution into these sensitive areas.	Section VI accepts this recommendation.
5-F Co-locate linear infrastructure as practicable with current roads, pipelines and power	Section III, Comprehensive Gas Development Plans (CGDP) adopts this

lines to avoid new disturbance.	recommendation and also recognizes it as a Section IV B siting best practice.
5-F.1 Avoid stream crossings and any disturbances to wetlands and riparian habitat.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and also recognizes it as a Section IV B siting best practice.
5-G Submit an invasive species plan as part of permit application for preventing the introduction of invasive species and controlling any invasive that is introduced.	Section V and Section VI O accept this recommendation.
5-G.1 The invasive species management plan should emphasize early detection and rapid response and include baseline flora and fauna inventory surveys of site prior to operations and long-term monitoring plans for areas that could become problematic after gas development occurs.	Section VI O accepts this recommendation.
5-H Develop a two-phased reclamation strategy comprised of (1) interim reclamation following construction and drilling to reduce opportunities for invasion and (2) postactivity restoration using species native to the geographic range and seed that is certified free of noxious weeds.	Section VI R accepts this recommendation.

Chapter 6 – Protecting aquatic habitat, wildlife, and biodiversity

UMCES-AL	MDE and DNR
6-A Direct disturbance of any aquatic habitat for shale gas development should not be permitted.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-B A minimum 300 ft aquatic habitat setback should be applied, with the distance measured from the edge of any land disturbance, not from the location of a particular wellbore, to the edge of a particular habitat.	Section IV A. The Departments accept the proposed location restrictions and setbacks recommendation.
6-C Data that describe the biological resources of western Maryland should be developed and made available to MSGD applicants. These data should be used to effectively channel development away from high-value biological resources and into industrial zones accessible via existing roads and highways.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-D The use of multi-well pads to access relatively large (~2 mi ²) resources of shale gas would enable the maintenance of reasonably low	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.

levels of surface development.	
6-E Cumulative surface development (including all well pads, access roads, public roads, etc.) could be maintained at less than 2% of the watershed area in high-value watersheds.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-F Initially, all MSGD could be excluded from areas of high-value assets (e.g., BioNet sites, stronghold watersheds, Tier II watersheds, etc.)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation as a planning principle for the applicant to consider when determining the sequence of well pad development.
6-G Closed drilling systems on zero-discharge drilling pads on which all drilling and hydraulic fracturing fluids, chemicals, and liquid wastes are collected and stored in steel tanks that provide superior primary containment to holding ponds are a best management practice. Vacuum trucks could be used to handle on-site runoff during drilling and well completion (see Chapter 4).	Section VI E 4 accepts this recommendation.
6-H Maryland should require an invasive species management plan of industry prior to any drilling operations. Such a plan should include, at the minimum:	Section VI O and Section III accept this recommendation.
6-H.1 A description of water sources to be used to fill any impoundment, including analysis of any invasive species that might be present at the withdrawal site but absent from the watershed where the impoundment will be located.	Section V, Section VI C 2 and Section VI O accept this recommendation.
6-H.2 Water withdrawal equipment should be power-washed and rinsed with clean water before leaving the withdrawal site.	Section V, Section VI C 2 and Section VI O accept this recommendation.
6-I Maryland should prohibit the discharging of any previously impounded water back into a natural water body, thus reducing the chance for the introduction of invasive species and short-term elevated thermal regimes in streams.	Section VI O accepts this recommendation.
6-J Wherever possible, existing roads should be used in MSGD. Where new roads are required, PA DCNR recommendations could be adopted:	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
6-J.1 Use materials and designs (e.g., crowning, elimination of ditches, etc.) that encourage sheet flow as the preferred drainage	This recommendation is addressed in Section VI A 5.

method for any new construction or upgrade of existing gravel roadways.	
6-J.2 Where stream crossings are unavoidable, use bridges or arched culverts to minimize disturbance of streambeds.	Section IV B. The Departments accept the proposed siting best practices recommendation.
6-J.3 Promote the use of geotextiles as a way of reducing rutting and maintaining subbase stability.	This recommendation is addressed in Section VI A 5.
6-J.4 Open trenches within streams should be avoided in favor of using directional boring techniques.	Section IV B. The Departments accept the proposed siting best practices recommendation and propose developing siting policies to guide pipeline planning and use of hydraulic directional drilling practices.
6-K In general, during road and pad construction a combination of BMPs should be used to reduce sediment and erosion, recognizing that additional protective measures might be necessary during wet times of the year (primarily late winter and early spring).	This recommendation is accepted in Section VI A.

Chapter 7 – Protecting public safety

UMCES-AL	MDE and DNR
7-A The first line of defense in protecting public safety is designing MSGD operations in a way that maintains separation between MSGD infrastructure (including transportation routes) and the public.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B.
7-A.1 Facilities should be sited as far away as possible from homes, businesses, public buildings, or places with high levels of recreational activity (e.g., hiking trails, parks, picnic areas, etc.) (see Chapter 9 also).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
7-A.2 Best management practices in well construction (e.g., casing and cementing) should be followed to ensure wellbore integrity and isolation (see Chapter 3).	This recommendation is accepted in Section VI E and F.
7-A.3 Proper monitoring and pre-development assessment are important steps to limit the migration of hydrocarbons, brines, or hydraulic fracturing fluids into groundwater, causing pollution of underground drinking water supplies and to enable rapid detection in the event	Section VII accepts this recommendation.

of migration (see Chapters 1 and 4).	
7-B MSGD applicants should be required to develop site-specific, emergency response plans (ERP) that describes in detail how a particular operator will respond to different emergencies that may occur during each phase of shale gas development at sites, or transportation routes between sites, permitted for MSGD.	This recommendation is accepted in Sections V and VI P.
7-B.1 The ERP must include many types of standard information, including the names and contact information for first responders, and location (including GPS coordinates) of MSGD sites.	This recommendation is accepted in Sections V and VI P.
7-B.2 The ERP must include variations on standard responses demonstrating sensitivity to weather, time of day, time of year, and the particular geography of sites (e.g., topographic and soil conditions).	This recommendation is accepted in Sections V and VI P.
7-B.3 The ERP must also include a list of all chemicals or additives used, expected wastes generated by hydraulic fracturing, approximate quantities of each material, the method of storage on-site, MSDS for each substance, toxicological data, and waste chemical properties.	This recommendation is accepted in Sections V and VI P.
7-C Best management practices implemented to avoid emergencies should include:	Section VI accepts this site security recommendation.
7-C.1 Adequate perimeter fencing (at least a 6 ft high chained link or equivalent), gates (with keyed locks), and signage in place around drill rigs, engines, compressors, tanks, impoundments, and separators, to restrict public access.	Section VI Q accepts this site security recommendation.
7-C.2 Use of safety or security guards to further control access (particularly important during active drilling and completion phases of an operation).	Section VI accepts this site security recommendation.
7-C.3 Duplicate keys to all locks should be provided to the regulatory agency and to local emergency responders.	Section VI Q accepts this site security recommendation.
7-D Maryland's Department of Transportation should calculate, evaluate, and address the major impacts of additional truck traffic on the road and highway system prior to the state permitting	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B.

MSGD.	
7-D.1 Counties and municipalities should also undertake an inventory and structural evaluation of locally-owned bridges currently exempt from federally mandated inspections to ensure that these structures are capable of safely handling the additional traffic (and loads) associated with MSGD.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B.
7-D.2 The state should establish a protocol to allow for emergency transport of heavy or oversized equipment during off-hour periods (evenings, nights, and weekends).	Section VI B indicates that the State and Garrett County have existing protocols, but it is unknown whether one exists for Allegany County.

Chapter 8 – Protecting cultural, historical, and recreational resources

UMCES-AL	MDE and DNR
8-A Applicants for drilling permits should be required to consult with Maryland Historical Trust during the planning and permit application process to identify all eligible or existing cultural or historical sites in the vicinity of proposed MSGD activity (including all drill pad sites, gas pipelines, roads, and transportation routes to and from MSGD facilities).	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
8-B Regardless of whether or not a proposed operation would be located on state or federal land, best practice would require close consultation with local governments, state park and forest officials, national park managers, and wildlife managers who are familiar with the resources that could be impaired by shale gas development.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
8-C Applicants should be required to submit a visual resource mitigation plan as part of the permit application process based on site-specific assessment (i.e., viewshed analysis).	Section IV B. The Departments accept the proposed siting best practices recommendation.
8-D Site selection for drilling pads in Maryland should be locations that can provide natural vegetative or topographic screening.	Section IV B. The Departments accept the proposed siting best practices recommendation.
8-E Siting of well pads, or the routing of MSGD-related truck traffic, near high use recreation areas should be avoided if possible.	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is also included in Section VI B.
8-F Maryland should impose a minimum 300 ft	Section IV A. The Departments generally

setback from all cultural and historical sites, state and federal parks, trails, wildlife management areas, natural areas, wildlands, scenic and wild rivers, and scenic byways to protect the region’s most important cultural, historical, recreational, and ecological resources. Setback considerations should include high use areas, noise and visual impacts, and public safety concerns.	accept the proposed location restrictions and setbacks recommendation with the following modifications. A 300 ft setback may not adequate to protect the outdoor recreational visitors experience. DNR will develop new maps of public outdoor recreational use areas to guide additional recreational setbacks and mitigation measures for minimizing public use conflicts.
8-G The calculation of setback distances should consider prevailing winds, topography, and viewsheds, and repeatable formulas for calculating setbacks should be established.	Section IV A. The Departments generally accept the proposed location restrictions and setbacks recommendation. These factors are also considered in Section VI for lighting management.
8-H Mitigative techniques, such as the use of visual screens, sound barriers, camouflage, and landscaping near cultural and historical sites, as well as restricting the times of gas development operations, should be required to minimize disturbances and conflicts with recreational activities in areas adjacent to gas development zones.	Section IV B. The Departments accept the proposed siting best practices recommendation. These factors are also considered in Section VI for lighting management.
8-I Any permitted shale gas development activities in the vicinity of public recreational sites—including state forests—should be timed so as to avoid periods of peak recreational activity (e.g., holiday weekends, first day of trout season, spring and fall hunting seasons, whitewater release dates, etc.). Maryland DNR should collect and provide data to help inform peak activity times.	Section VI. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.

Chapter 9 – Protecting quality of life and aesthetic values

UMCES-AL	MDE and DNR
9-A Well-pad siting should consider the multiple factors that influence the quality of life and aesthetics of rural life in western Maryland (e.g., location of existing infrastructure, traffic loads on existing roads, etc.)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.1 Site well pads away from occupied buildings (e.g., dwellings, churches, businesses, schools, hospitals, and recreational facilities)	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.2 Site well pads and associated	Section III, Comprehensive Gas

facilities in industrial parks (either new or existing) designed and zoned for this type of industrial activity	Development Plans (CGDP) adopts this recommendation.
9-A.3 Site well pads in close proximity to major interstate highways and exit ramps designed to efficiently handle round-the-clock transportation	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation.
9-A.4 Reduce truck traffic associated with water hauling through use of temporary pipelines where possible.	Section VI B accepts this recommendation.
9-B Each of the counties in western Maryland should revisit noise regulations and enforcement policies and confirm they are appropriate for this industrial activity.	No State action is necessary.
9-C No drilling or compressor stations should be permitted within 1,000 ft of an occupied building.	Section IV A accepts this recommendation.
9-D Require electric motors (in place of diesel-powered equipment) for any operations within 3,000 ft. of any occupied building	Noise is addressed in Section VI N.
9-D.1 Encourage electric motors in place of diesel-powered equipment wherever possible.	This recommendation is accepted in Section VI J.
9-D.2 Restrict hours and times of operation to avoid or minimize the greatest conflicts between the public and MSGD.	Section VI. The Departments generally accept the recommendation, noting that once drilling and fracturing operations have been initiated it is not safe to halt operations except under an emergency.
9-D.3 Require ambient noise level determination prior to operations.	The Departments do not see a need for ambient noise measurements because the noise standards apply to noise during operations.
9-D.4 Require construction of artificial sound barriers where natural noise attenuation would be inadequate.	This recommendation is accepted in Section VI N.
9-D.5 Equip all motors and engines with appropriate mufflers.	Section VI N requires that noise be controlled, by mufflers if necessary.
9-E All permit applicants should develop and submit a detailed transportation plan for approval by the regulatory authority prior to conducting any site development, drilling, well work over, or well completion activities	Section III, Comprehensive Gas Development Plans (CGDP) adopts this recommendation and is included in Section VI B.
9-E.1 The approval process for the transportation plan should allow for adequate	Section III, Comprehensive Gas Development Plans (CGDP) adopts this

comment by the public, state transportation agencies, and county roads departments.	recommendation and is included in section VI B.
9-F It is recommended that new road construction follows PADCNR guidelines for construction of permanent non-paved roads to address potential environmental impacts, offset erosion, and avoid damage to environmentally sensitive areas.	This recommendation is addressed in Section VI A 4.
9-G We recommend the use of viewshed analysis to help determine the best location for MSGD-related infrastructure as well as to determine what mitigative techniques would be appropriate.	This recommendation is accepted in Section III and Section IV B.
9-H We recommend use of mitigative techniques (e.g., the use of visual screens, camouflages, paint schemes, evergreen buffers, and landscaping techniques) to minimize degradation of western Maryland viewsheds by MSGD.	This recommendation is accepted in Section IV B

Chapter 10 – Protecting agriculture and grazing

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

10-F Operators must fence livestock out of gas development areas.

This recommendation is accepted in Section VI Q.