Section VI – Engineering, Design and Environmental Controls and Standards

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

A. Site Construction and Sediment and Erosion Control

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

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

1. <u>The pad</u>

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

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

[11] COMAR 26.19.01.10 J through K.
[12] COMAR 26.19.01.06C (12) and (13).

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

2. Tanks and containers

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

3. Pits and Ponds

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

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

4. Pipelines

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

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

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

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

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

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

a. The owner and operator of any pipeline shall participate as an "owner-member" as that term is defined in the Maryland Public Utilities Code, Section 12-101, in a one-call system, which in Maryland is generally known as the "Miss Utility" program. Upon the request of someone planning to excavate in the area, the locations of these pipelines could be marked so that the digging could avoid them.

b. All pipelines and fittings appurtenant thereto used in the drilling, operating or producing of oil and/or natural gas well(s) shall be designed for at least the greatest anticipated operating pressure or the maximum regulated relief pressure in accordance with the current recognized design practices of the industry.

5. Road Construction

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

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

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

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

6. Ancillary equipment

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

B. Transportation Planning

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

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

[13] http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_004055.pdf
[14] http://www.dirtandgravel.psu.edu/

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

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

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

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

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

Encourage local jurisdictions to develop adequate transportation plans.

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

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

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

C. Water

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

1. Storage

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

2. Water withdrawal

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

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

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

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

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

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

3. Water reuse

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

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

D. Chemical Disclosure

UMCES-AL Report recommendations 4-H

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

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

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

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

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

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

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

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

E. Drilling

1. Use of electricity from the grid

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

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

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

2. Initiation of drilling

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

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

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

[15] http://fracfocus.org/

3. Pilot hole

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

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

a. Selection of drill hole locations that avoid all mine voids and assures lateral support of drill holes during drilling and casings during well construction.

b. If such locations cannot be found, voids must be filled or isolated with multiple concentric strings of casing and cement.

c. Unless seismic testing clearly indicates the absence of voids, a slim pilot hole should be drilled to verify that suitable locations for production holes have been found or could be addressed through multiple layers of casing and cement.

4. Drilling fluids and cuttings

UMCES-AL Report recommendation 6-G

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

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

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

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

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

5. Open hole logging

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

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

(a) Depth at which any fresh water inflow was encountered;

(b) Lithology of penetrated strata, including color;

(c) Total depth of the well;

(d) A record of all commercial and noncommercial oil and gas encountered, including depths, tests, and measurements;

(e) A record of all salt-water inflows;

(f) Generalized core descriptions, including:

(1) The type and depth of sample;

(2) Indications of oil, water, or gas;

(3) Estimates of porosity and permeability; and

(4) Percent recovery; and

(g) A copy of all electric, radiation, sonic, caliper, directional, and any other type of logs run in the well.
COMAR 26.19.01.10 V.

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

F. Casing and Cement

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

1. Requirements for casing and cement

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

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

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

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

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

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

2. Isolation

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

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

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

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

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

G. Blowout Prevention

UMCES-A: Report recommendation 3-F

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

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

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

H. Hydraulic Fracturing

UMCES-AL Report recommendation 3-G

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

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

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

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

I. Flowback and Produced Water

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

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

J. Air Emissions

UMCES-AL Report recommendations 2-B

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

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

1. Green Completion or Reduced Emissions Completion

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

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

2. Flaring

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

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

3. Electricity from the grid

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

4. Engines

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

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

e. For internal combustion engines that power equipment or electric generators and which do not stay on site for more than 12 months, the engines must comply with the requirements of either 40 CFR part 60 subpart 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

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

6. Natural Gas Star

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

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

K. Waste and Wastewater Treatment and Disposal

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

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

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

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

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

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

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

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

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

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

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

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

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

L. Leak Detection

UMCES-AL Report recommendation 2-A

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

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

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

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

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

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

M. Light

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

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

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

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

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

N. Noise

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

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

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

Pursuant to State law, MDE has adopted environmental noise standards. A local government may adopt its own noise control ordinance, rules or regulations, provided they are not less stringent than those the State adopts. Enforcement of the environmental noise standards, whether State or local, is the responsibility of the local government. Noise limits apply at the boundary of: (1) a property; or (2) a land use category, as determined by the responsible political subdivision. Md. Env. Code, Title 3. The measurement of noise levels shall be conducted at points on or within the property line of the receiving property or the boundary of a zoning district[17], and may be conducted at

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

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

Table VI-1

Maximum Allowable Noise Levels (dBA)

for Receiving Land Use Categories

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

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

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

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

O. Invasive species

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

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

[18] "Daytime hours" means 7 a.m. to 10 p.m., local time. "Nighttime hours" means 10 p.m. to 7 a.m., local time. COMAR 26.02.03.01

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

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

P. Spill Prevention, Control and Countermeasures and Emergency Response

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

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

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

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

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

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

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

Q. Site Security

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

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

R. Closure and Reclamation both Interim and Final

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

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

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

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

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