# *Appendix F*

*Noise and Visual Risks*

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# Introduction

It is known that a person's well-being can be affected by noise through loss of sleep, speech interference, hearing impairment, and a variety of other psychological and physiological factors. Noise and light can impact domestic animals and wildlife. Visual perception is an important component of environmental quality. This quality can be adversely impacted if the views seen from recreational areas, publicly accessible trails, lakes and rivers, scenic highways, scenic vistas, and other publicly accessible sites are degraded.

This section of the risk assessment evaluates noise and visual impacts from unconventional gas well development (UGWD). This assessment will outline the duration and magnitude of these impacts at each step of the shale-gas extraction process. Where information is drawn from published sources, they are identified. For purposes of this analysis, it is assumed that the best practices detailed in the Interim Final Best Practices Report (MDE & DNR, 2014) are followed.

The scenarios considered for this risk assessment involve the installation of 150 wells, six on each of 25 well pads, over a ten year period and 450 wells drilled on 75 well pads over a ten year period. Visual impacts will be evaluated under these scenarios. Noise impacts are more localized and will likely be experienced at different times and at different locations. Noise impacts will be evaluated for a single 6-well pad, developed without any pause or interruption. If the wells on a single pad were drilled and fractured at different times, the noise levels would be similar, but would be intermittent and extend over a longer time. If two pads were to be developed simultaneously, it would still be reasonable to evaluate the noise associated with just one because the well pads are unlikely to be located close together, and noise dissipates with distance. Also, as explained below, humans do not perceive separate sounds as the sum of the two sounds.

# General Information on Noise

The scale for measuring noise intensity is the decibel scale, with a weighted scale (dBA) to account for relative loudness as perceived by the human ear... Natural nighttime environmental noise levels in rural areas is commonly estimated to be as low as 30 dBA, depending on weather conditions and natural noise levels. The noise scale is logarithmic, and an increase of 10 decibels represents a sound that is 10 times louder; however, humans do not perceive sound this way. A change of 3 decibels is at the threshold of what a person can detect; a 5 decibel change is readily noticeable; and the human ear perceives an increase of 10 dBA as a doubling of noise levels. (NYSDEC, 2011).

The combination of noises is not perceived as the sum of the noises. EPA explained the phenomenon as follows:

> *Another unusual property of the decibel scale is that the sound pressure levels of two separate sounds are not directly (that is, arithmetically) additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decible increase (to 73 dB), not a doubling to 140 dB. Furthermore, if two sounds are of different levels, the lower level adds less to the higher level. In other words, adding a 60 decibel sound to a 70 decibel sound only increases the total sound pressure level less than one-half decibel (EPA, 1978).*

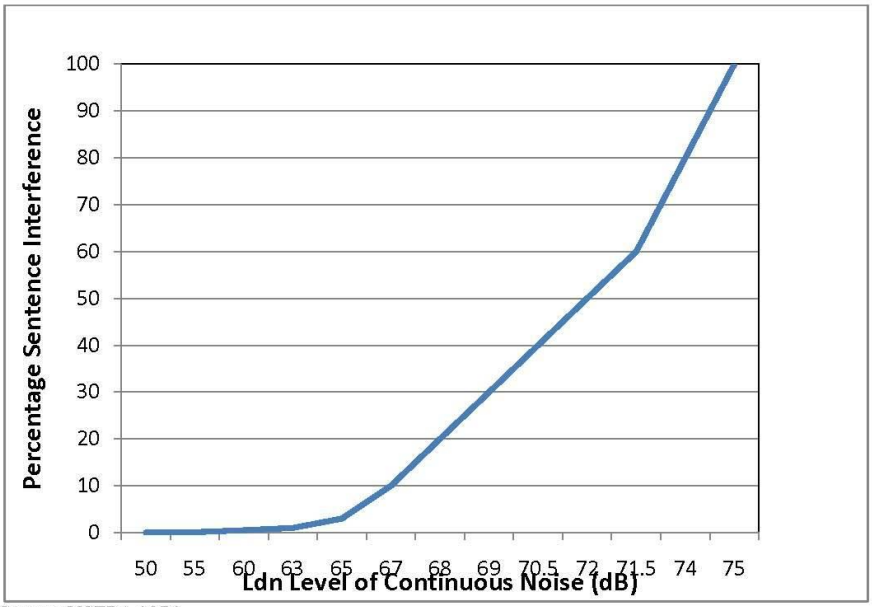
By application of the inverse square law and the logarithmic decibel scale, it can be demonstrated that a sound level drops 6 dBA for each doubling of distance from the source. (NYSDEC, 2011) The decrease in sound for a heavy truck passing at 25 miles per hour and 50 miles per hour is shown at various distances in Table 1.

| Distance from source | dBA at 25 mph | dBA at 50 mph |
|---|---|---|
| 50 feet | 75 | 83 |
| 100 feet | 69 | 77 |
| 200 feet | 63 | 71 |
| 400 feet | 57 | 65 |
| 800 feet | 51 | 59 |

***Table 1: Decrease in noise levels with distance, based on NYSDEC text at 6-299 and Figure 6.20***

## The Effects of Noise on People and the Environment

Elevated noise levels can adversely affect people. Noise can interfere with the ability to understand speech beginning at a continuous level of approximately 60 dB, as shown in Figure 1.



Source: USEPA 1974.

***Figure 1: Level of continuous noise causing speech interference reproduced from Figure 2.15 (NYSDEC, 2011)***

The World Health Organization notes that noise can interfere with sleep by making it more difficult to fall asleep, causing awakening, altering sleep stages and depth, as well as physiological effects. It recommends that sound levels should not exceed 30 dBA indoors for continuous noise and 45 dBA for intermittent noise. (WHO, 2000).

Noise can be annoying, although people differ in their tolerance for noise. A summary of community reaction to noise is reproduced in Table 2.

| Ldn (dBA) | Percent Annoyance | Average Community Reaction | General Community Attitude Towards Area |
|---|---|---|---|
| ≥75 | 37 | Very Severe | Noise is likely to be the most important of all adverse aspects of the community environment. |
| 70 | 22 | Severe | Noise is one of the most important adverse aspects of the community environment. |
| 65 | 7 | Significant | Noise is one of the important adverse aspects of the community environment. |
| 60 | 3 | Moderate | Noise may be considered an adverse aspect of the community environment. |
| ≤55 | | Slight | Noise is considered no more important than various other environmental factors. |

***Table 2: Community reaction to noise***

*Source: Table 2.102 (NYSDEC, 2011) original data, Cowan, James P. 1994. Handbook of Environmental Acoustics. New York: Van Nostrand Reinhold.*

The noise and other disturbances from seismic testing and drilling operations could cause adverse impacts to recreational activities in state parks and forests. The recreational experience of anglers, hunters, and others enjoying outdoor recreation would be adversely affected by noise and light particularly if it occurs in close proximity to prime fishing locations and during hunting season.

There are large gaps in the existing knowledge and little previous study on the impact of noise on certain species (FHWA, 2004). Noise can have a significant effect on birds but the impact differs among species. A study found that noise from a compressor station can impact both the pairing success and age structure of ovenbirds (Habib, 2007).

## Regulation of Noise Levels

The Department of the Environment has promulgated standards for environmental noise; they can be found in the Code of Maryland Regulations (COMAR) 26.02.03. The standards are goals expressed in terms of equivalent A-weighted sound levels which are protective of the public health and welfare. With certain exceptions, a person may not cause or permit noise levels which exceed those specified in Table 3.

| Maximum Allowable Noise Levels (dBA) for Receiving Land Use Categories | | | |
|---|---|---|---|
| Day/Night | Industrial | Commercial | Residential |
| Day | 75 | 67 | 65 |
| Night | 75 | 62 | 55 |

***Table 3: Maximum allowable noise levels***

The regulations permit more noise for construction and demolition site activities: 90 dBA during the daytime hours, and the levels in the table, above, during nighttime hours. In addition, a person may not cause a prominent discrete tone[1] or periodic noise[2] which exceeds a level which is 5 dBA lower than the applicable level listed in the table. The noise standards do not apply to on-road vehicles.

Maryland's maximum allowable noise levels cannot legally be exceeded. If the applicant's plan for complying with the noise standards does not demonstrate that the noise standards will be met, the permit can mandate additional noise reduction measures. If compliance with the noise standards is not verified after operations begin, MDE could issue an administrative order requiring additional corrective action.

Compliance with this standard is considered protective of public health and welfare; therefore, the risk to be evaluated for human health is that the standards will be exceeded. The risks to non-human receptors will be evaluated based on the available literature.

[1] *"Prominent discrete tone" means any sound which can be distinctly heard as a single pitch or a set of single pitches. For the purposes of this regulation, a prominent discrete tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the sound pressure levels of the 2 contiguous one-third octave bands by 5 dB for center frequencies of 500 Hz and above and by 8 dB for center frequencies between 160 and 400 Hz and by 15 dB for center frequencies less than or equal to 125 Hz. COMAR 26.03.02.01.*

[2] *"Periodic noise" means noise possessing a repetitive on-and-off characteristic with a rapid rise to maximum and a short decay not exceeding 2 seconds. Id.*

# Noise Impacts related to UNGD

## Anticipated duration of noise-producing activity

| Operation | Estimated duration (days) for one event | Estimated duration for one 6-well pad |
|---|---|---|
| Access roads | 3 - 7 | 3 - 7 |
| Site preparation (well pad) | 7 - 14 | 7 - 14 |
| Well drilling[3] | 28 - 35 | 168 - 210 |
| Hydraulic fracturing | 2 - 5 | 12 - 30 |
| **Total** | **40 - 61** | **190 - 261** |

**Table 4: Anticipated duration of events**

Estimates for the duration for one event (NYSCED 2011,Table 6.59) were multiplied by 6 to reflect well drilling and hydraulic fracturing for a 6-well pad . Because only one access road and one well pad are required for a 6-well pad, the number of days does not increase for a multi-well pad.

Construction of an access road and site preparation would generally occur during daylight hours. The transportation of equipment, materials, sand, fuel, chemical additives, water and waste associated with well drilling and hydraulic fracturing could occur anytime of the day or night unless limited by regulations or permit provisions. Truck traffic is expected to be highest in the last five weeks of well development, due mainly to the transportation of fluids to the site. (NYSDEC, 2011). Well drilling and hydraulic fracturing typically continue 24/7 after initiation.

## Number of truck trips

Elsewhere in this risk assessment, the estimated number of loaded, one-way truck trips for a single well pad with six horizontal wells was estimated as follows in Table 5:

[3] *More efficient drilling has shortened this time. An industry group represents that drilling a Marcellus shale well can be accomplished in 15 to 30 days. Marcellus Shale Coalition.*

| Well Pad Activity | All water transported by trucks | |
|---|---|---|
| | Heavy trucks | Light trucks |
| Drill pad construction | 45 | 90 |
| Rig mobilization | 190 | 280 |
| Drilling fluids | 270 | 0 |
| Non-rig drilling equipment | 90 | 0 |
| Drilling (rig crew, etc.) | 300 | 840 |
| Completion chemicals | 120 | 1956 |
| Completion equipment | 10 | 0 |
| Hydraulic fracturing equipment (trucks & tanks) | 350 | 0 |
| Hydraulic fracturing water hauling | 6000 | 0 |
| Hydraulic fracturing sand | 138 | 0 |
| Produced water disposal | 1800 | 0 |
| Final pad prep | 45 | 50 |
| Miscellaneous | 0 | 400 |
| TOTAL truck trips per 6-well pad | 9358 | 3616 |

***Table 5: Number of truck trips***

These numbers assume that 5 million gallons of water are needed to hydraulically fracture each well, and that 30 percent of that returns to the surface as flowback, but assumes that all flowback is disposed of off-site. The total number of one-way trips, loaded and not loaded, would be approximately two times as many, or 18,716 heavy trucks and 7,232 light trucks for the development of one 6-well pad.

It is difficult to determine the number of truck trips per day or week, but if the assumption is made that all six wells will be drilled without pause and all six wells fractured immediately after drilling is complete, it is not unreasonable to assume that the heaviest volume of truck trips would occur as shown in Table 6:

| Delivery of | Assumed duration of delivery (days) for six wells on one pad | Number of truck trips per day (one loaded, one empty) |
|---|---|---|
| Rig mobilization | 5 | (190*2) ÷ 5=76 |
| Drilling fluids | 30 | (270*2) ÷ 30=18 |
| Drilling | 30 | (300*2) ÷ 30=20 |
| Hydraulic fracturing equipment | 5 | (350*2) ÷ 5=140 |
| Completion chemicals | 30 | (120*2) ÷ 30=8 |
| Hydraulic fracturing water | 30 | (6000*2) ÷ 30=400 |
| Hydraulic fracturing sand | 30 | (138*2) ÷ 30=9 |

***Table 6: Truck trips per day***

Rig mobilization would precede drilling; delivery of drilling fluids and drilling would occur simultaneously on an as needed basis; hydraulic fracturing equipment would not be delivered until the drilling was completed and the rig demobilized, and the delivery of completion chemicals, hydraulic fracturing water and the delivery of sand would follow the delivery of the hydraulic fracturing equipment and occur simultaneously on an as-needed basis.

The peak period of truck traffic would thus occur during the delivery of completion chemicals and water and sand for hydraulic fracturing, representing approximately 417 truck trips (one loaded, one empty) per day. If all the truck trips occurred between 7:00 am and 10:00 pm, the average would be about 28 truck trips per hour, or one every two minutes during this peak period.

## Anticipated noise levels

Information on the noise expected to be produced by the activities used in each phase of horizontal drilling and HVHF, and the evaluation of the noise at various distances from the source are shown in Table 7.

| | dBA at a Distance of (Feet) | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | 50 | 250 | 500 | 1,000 | 1,500 | 2,000 |
| Construction of access road | 89 | 75 | 69 | 63 | 59 | 57 |
| Well pad preparation | 84 | 70 | 64 | 58 | 55 | 52 |
| Rotary Air Drilling | 79 | 64 | 58 | 52 | 48 | 45 |
| Horizontal Drilling | 76 | 62 | 56 | 50 | 47 | 44 |
| HVHF (20 Pumper trucks operating at a sound level of 115 dBA) | 104 | 90 | 84 | 78 | 74 | 72 |

***Table 7: Noise levels at distances***

*Source: Tables 6.54 through 6.58 (NYSDEC, 2011)*

According to New York State Department Conservation, “the noise levels generated by vehicles depend on a number of variable conditions, including vehicle type, load and speed, nature of the roadway surface, road grade, distance from the road to the receptor, topography, ground condition, and atmospheric conditions” (2011). Figure 2 shows the noise levels at 50 feet on average pavement of various types of vehicles and speeds. As can be seen from the figure a heavy truck passing by at 50 miles an hour would contribute a noise level of approximately 83 dBA, while the same truck at 25 miles per hour would contribute about 75 dBA.

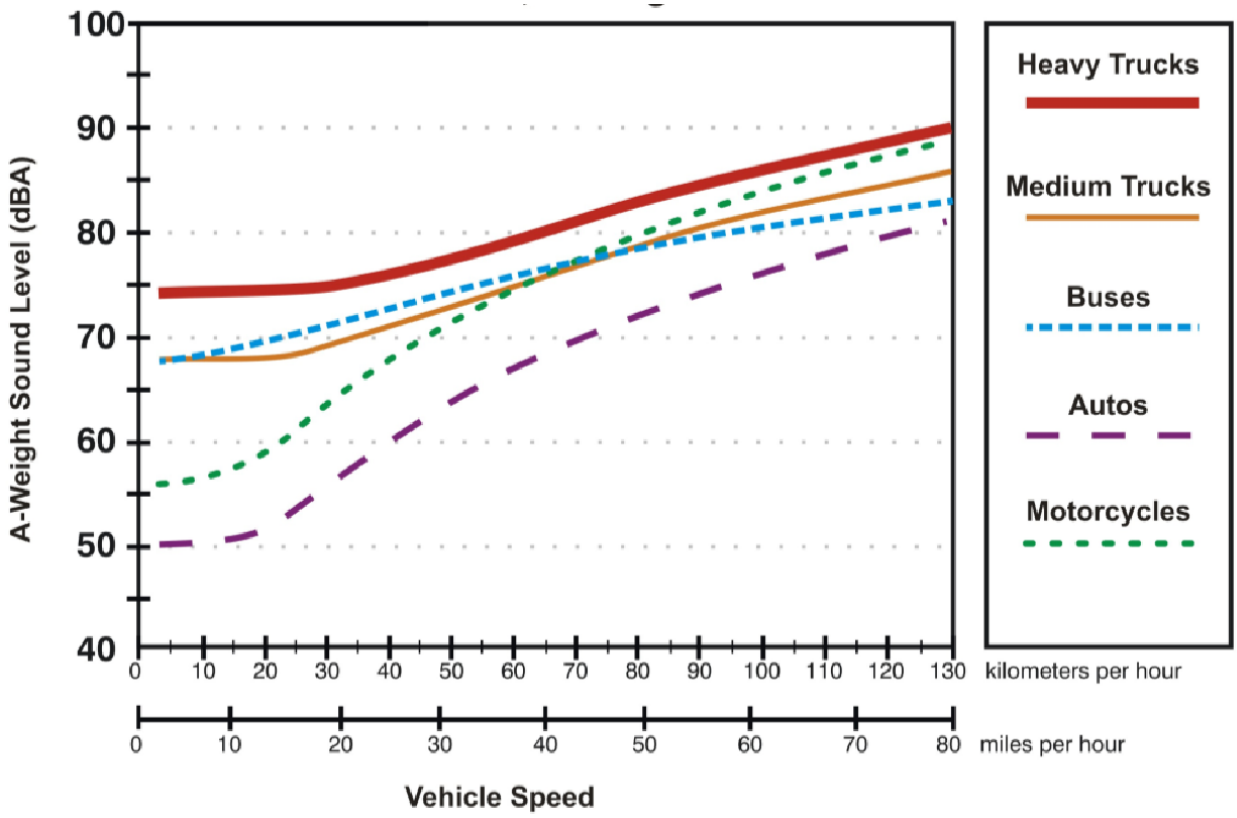



***Figure 2: Noise levels of vehicles at speed***

*Source: Figure 6.20 (NYSDEC, 2011) (original data from Federal Highway Administration)*

The sound from a single truck passing by would exist for a short time, but multiple truck trips along the same road would result in a higher equivalent continuous noise level (the total sound energy measured over an hour or other time period) and higher impacts on noise receptors close to main truck travel routes. (NYSDEC, 2011).

## Proposed Best Management Practices

The Best Practices identified in the Interim Final Best Practices report that affect noise are:

- The applicant for a permit must submit a plan for complying with the noise standards and for verifying compliance after operations begin.
- The Departments will incorporate the concept of "noise sensitive locations" into its review of the CGDP. If "noise sensitive locations" are potentially affected, additional noise controls may be incorporated into individual permits.
- The applicant for a permit must submit a transportation plan, including the identification of routes to be traveled in Maryland by heavy duty trucks and tractor trailers coming to or leaving the pad site.
- Setbacks from edge of disturbance for well pad

    - 1,000 feet from the boundary of the property on which the well will be drilled (a waiver can be granted if this is infeasible)
    - 450 feet from aquatic habitat
    - 600 feet from special conservation areas
    - 1,000 feet from a school, church, or other occupied building (Unless written permission of the owners is submitted with the application and approved by the Department)
- Setbacks of 300 feet from all permanent infrastructure to all cultural and historical sites, State and federal parks, trails, wildlife management areas, scenic and wild rivers, and scenic byways
- Setback of 1,000 feet from any compressor station to an occupied building
- A power plan that results in the lowest practicable impact from the choice of energy source (If electricity from the grid is available, this would almost certainly mandate the use of electricity in place of diesel-powered drill rigs, compressors, pumps, and generators)
- Site-specific noise provisions can be incorporated into individual permits.

The Interim Final Best Practices Report also identifies methods for mitigating noise from drilling and fracturing operations:

- Careful siting of facilities—distance, direction, timing, and topography are the primary considerations in mitigating noise impacts
- Placement of walls, artificial sound barriers, or evergreen buffers between sources and receptors (e.g., around well pads and compressor stations)
- Use of noise reducing equipment (e.g., mufflers) on flares, drill rig engines, compressor motors, and other equipment
- Use of electric motors in place of diesel-powered equipment
- Where the initiation of a drilling or fracturing operation or other activities that could be planned in advance or temporarily suspended, scheduling noisy activities to avoid times of peak outdoor recreational periods such as holiday weekends, first day of trout season, and during sensitive wildlife migratory or mating seasons.

# Visual Impacts Related to UNGD

## Impacts

Perceived visual impacts to scenery and landscape are very subjective: the degradation of the visual perception of the view. There are no uniform standards for evaluating the visual impact. Local jurisdiction zoning laws determine the land use allowed within that jurisdiction. The greatest visual impacts related to UGWD are temporary (roughly 190 to 261 days from construction of the access road to production). Lights and flares will be visible at night. If wells are being drilled and hydraulically fractured at different pads that are visible within the same viewshed, the effect will be more noticeable. The night sky may be less dark. Once the well is in production, however, the visual impact is less. The pad itself will have well heads and equipment, and pipeline rights of way may interrupt otherwise unbroken forest, but these impacts are similar to other developed sites and utility rights of way.

Landscape visibility has been demonstrated to be an important variable for wildlife. Elk changed their behavior in response to natural gas development in Wyoming to minimize their exposure to roads. (Buchanan, 2014)

## Proposed Best Management Practices for Visual Impacts

The Best Practices identified by the Maryland Department of the Environment and the Maryland Department of Natural Resources (2014) in the Interim Final Best Practices report that affect visual impact are:

- The CGDP will be approved if the State determines that the CGDP conforms to regulatory requirements and, to the maximum extent practicable, avoids impacts to natural, social, cultural, recreational and other resources, minimizes unavoidable impacts, and mitigates remaining impacts
- Once an exploratory well has been permitted, no other well, exploratory or production, can be permitted within a 2.5 mile radius around the exploratory well until a CGDP has been approved. Absent a determination by the Department that the exploratory well can be connected to a transmission line without any adverse impact on wetlands, forest, or nearby residents, the exploratory well cannot be converted to a production well until a CGDP for that area is approved.
- Location restrictions and setbacks
    - 1,000 ft setback from well to property boundary of the property on which the well is to be drilled; a waiver can be granted by the Department if a well location closer than 1,000 feet is necessary due to site constraints
    - 1,000 ft setback from edge of drill pad disturbance to a school, church, or other occupied building
    - All surface disturbance for pads, roads, pipelines, ponds and other ancillary infrastructure will be prohibited on State owned land, unless DNR grants permission.
    - Drill pad location restrictions and setbacks listed in Table 1-1 have been extended to all gas development activities resulting in permanent surface alteration that would negatively impact natural, cultural and historic resources. This includes permanent roads, compressor stations, separator facilities and other infrastructure needs. This expansion applies to aquatic habitat, special conservation areas, cultural and historical sites, State and federal parks and forests, trails, wildlife management areas, wild and scenic rivers and scenic byways
- Pre-development environmental assessment should be conducted on a site-specific basis and include, among other things, 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.); and identification of the appropriate setbacks and buffers for the proposed site; and.
- 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.
- 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.
- Night lighting must be used only when necessary for safety, directed downward, and use low pressure sodium light sources wherever possible. Screens or restrictions on the hours of operation shall be required to reduce light pollution further if necessary to minimize conflicts with recreational activities and minimize stress and disturbance to sensitive aquatic and terrestrial communities; provided, however, that hours will not be restricted for activities that are ordinarily carried on continuously once they begin.
- Two-stage reclamation will be required: (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. Pre-development and post-development photographic documentation will be required to ensure site closure conditions are satisfied.

The Interim Final Best Practices Report also identifies methods for mitigating visual impacts from drilling and fracturing operations:

- Careful siting of facilities—topography is the primary considerations in mitigating visual impacts
- Placement of walls or evergreen buffers between sources and receptors (e.g., around well pads and compressor stations)
- Where the initiation of a drilling or fracturing operation or other activities that could be planned in advance or temporarily suspended, scheduling noisy activities to avoid times of peak outdoor recreational periods such as holiday weekends, first day of trout season, and during sensitive wildlife migratory or mating seasons.

# Risk Assessment

This section lists the phases of UGWD describes activities; and estimates the probability of excessive noise and visual impact, as well as the magnitude of the consequence. The probability is rated as low, medium or high, and the consequence is rated as minor, moderate, or serious. The overall risk ranking is also stated as Low, Medium, or High.

## Phase 1: Site Assessment

Seismic testing, geologic surveys/petro-physical assessments to characterize geologic formations may be conducted over several weeks, although significant noise is generated only during brief periods. The testing is done by "thumping" the ground with weight-drop vehicles or by the use of explosives to generate vibration. Instruments are deployed that register the seismic impact, which is generally too low to be detected by persons at the surface. Seismic testing requires a permit. Site assessment may occur in a large area.

The levels of noise and vibration are expected to be low but the noise may be appreciable at close range. The visual impact is expected to be negligible.

| Impact | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 8: Impacts and Assessment: vehicle traffic/thumping/vibration***

## Phase 2: Site Preparation

A well-pad site is prepared like other construction sites, and is typical of the scale of impacts associated with any comparable construction activity. It involves clearing and grading, road building, pit excavation, etc. all with the use of heavy machinery. It will last 7 to 14 days. Equipment will initially be staged at the site. The activity is more localized than during the Site Assessment phase. Construction noise is limited to 90 dBA during daytime hours and the setbacks from property

lines and occupied buildings should result in sound attenuation sufficient to achieve this standard. The noise may be appreciable, however.

There will be truck traffic during this phase of the project, with approximately 90 heavy truck trips. This amount of traffic is not expected to significantly increase noise levels in the community. The visual impact is expected to be negligible.

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |
| Ecological | Medium | Minor | Low |

**Table 9: Impacts and Assessment: trucks/traffic/construction noise**

## Phase 3: Drilling, Casing and Cementing

The drill rig itself may be over 100 feet tall and is lighted at night. Drilling entails vertical boring until the drill bit approaches the target formation, then turning the drill bit and drilling the lateral portion of the well. Casing and cementing occur during and after the drilling and integrity testing is also performed. After the casing and cement are in place, the drilling rig is replaced by a temporary wellhead. As indicated in Table 7, noise levels from drilling should be below 55 dBA at 1,000 feet. Therefore, the setbacks of the pad from property lines and occupied buildings should result in sound attenuation sufficient to achieve Maryland noise standards.

Trucks making deliveries to the site are not subject to the noise standards, and there will be approximately 1700 heavy truck trips during the drilling phase to mobilize the rig and deliver drilling fluids and other equipment.

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Low | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 10: Impacts and Assessment: drilling noise/vibration***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 11: Impacts and Assessment: visual***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Moderate | Medium |
| Ecological | Medium | Minor | Low |

***Table 12: Impacts and Assessment: traffic noise***

## Phase 4: Hydraulic Fracturing

The well is sometimes prepared for perforation by flushing with acid to remove cement and other debris. Perforating guns are then placed in the horizontal portion of the borehole, one stage at a time, beginning at the end of the borehole. The perforating guns fire an array of small explosive charges that perforate the casing and cement and extend a small distance into the target formation. Fracturing fluid is then forced down the well into the section under high pressure to create more fissures in the target formation. These fissures are held open by small particles in the fracturing fluid called proppant. After each stage is completed, a plug is set and the next stage is perforated and fractured. Once fracturing is completed the plugs are drilled out and the fracturing fluid begins to flowback to the wellhead. Water from the target formation, called produced water, also flows up the well. Flowback and produced water are collected in storage tanks.

The pumps used to generate the pressure for hydraulic fracturing produce a significant amount of noise, making this stage the loudest. Without noise mitigation, the pumper trucks used in HVHF will exceed Maryland's noise standards even at a distance exceeding the mandatory minimum setbacks. It may therefore be necessary for noise mitigation steps, such as a sound barrier, to be erected at the pad in order to meet standards. The applicant for a permit must submit a plan for complying with the noise standards and for verifying compliance after operations begin.

Trucks are not subject to the noise standards, and there will be approximately 16,000 heavy truck trips during the hydraulic fracturing stage. The probability of harmful noise is high, and the consequence is considered moderate because it would be localized.

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Low | Moderate | Low |
| Ecological | Medium | Minor | Low |

***Table 13: Impacts and Assessment: noise from on-site activities***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 14: Impacts and Assessment: lights***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | High | Moderate | High |
| Ecological | Medium | Minor | Low |

***Table 15: Impacts and Assessment: noise from truck traffic***

## Phase 5: Well Production Operations

Well production begins following the completion of the hydraulic fracturing process. Equipment may be needed on site to remove water from the gas. Gas from the well is transported through gathering lines to a gas processing plant off-site or to a transmission line. A gathering and boosting station with a compressor may collect gas from multiple wells and convey it to the processing plant or transmission line. Compressor stations may also be necessary to pressurize the gas for transport.

Noise from compressors, either on or off the pad, but still within the control of the permittee, should be sufficiently attenuated by the setback requirements to meet Maryland's noise standards. Compressors off the pad that are not under the control of the permittee must meet Maryland noise standards, but the Federal Energy Regulatory Commission, rather than Maryland, may have jurisdiction over these compressors.

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Low | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 16: Impacts and Assessment: noise from compressors on the pad***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Moderate | Moderate |
| Ecological | Medium | Minor | Low |

***Table 17: Impacts and Assessment: noise from compressors off the pad***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |

***Table 18: Impacts and Assessment: visual impact from pad***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |

***Table 19: Impacts and Assessment: visual impact from gathering lines***

## Phase 6: Site Reclamation and Well Abandonment

A well is abandoned when it reaches the end of its useful life or is a dry hole. The casing and other equipment is removed and salvaged; sometimes casing is abandoned in place. Cement plugs are placed in the borehole to prevent migration of fluids between the different formations. The surface is reclaimed. The activity is similar to the site preparation stage.

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Medium | Minor | Low |
| Ecological | Medium | Minor | Low |

***Table 20: Impacts and Assessment: noise from trucks and construction equipment***

| Impact on | Probability | Consequence | Risk Ranking |
|---|---|---|---|
| Human | Low | Minor | Low |
| Ecological | Low | Minor | Low |

***Table 21: Impacts and Assessment: visual impact***

## Summary Assessment of Noise and Visual Impacts

Assuming that best practices are followed, only one risk ranks high for noise and visual impact: noise from the truck traffic associated with transporting the materials for hydraulic fracturing to the well pad. Regardless of the final number of well pads in Maryland, noise and visual impacts are expected to be localized and limited in duration for each site. The probability of impacts of noise due to truck and equipment traffic is high and will necessarily be more significant if more pads are developed concurrently and in close proximity.

## Suggestions for Additional Mitigation

For purposes of this risk assessment, we have assumed that Maryland's allowable noise levels are protective of public health and welfare. Sound at lower levels may nevertheless be perceived as annoying. For this reason, the State should consider a best practice that requires noise reduction devices on all equipment at the pad site, even if the levels are below the noise standards without them. For example, all engines and motors could be required to have mufflers. In addition, the permittee's plan for bringing water to the site should, to the extent practicable, spread the truck trips over a longer period of time to reduce the equivalent continuous noise level.

Noise modeling should be required for any drill site that is located within 1,000 feet of any occupied building to support and verify the permit applicant's plan for complying with noise standards. Commercially available software is capable of simulating the three-dimensional movement of sound, atmospheric and other noise absorption features, and attenuation due to topography. (NYSDEC, 2011).

Consideration should be given to the impact of successive drilling operations in specific areas over multiple breeding seasons or migration periods to provide long term protection to sensitive species.

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