

Mineral Resources

INTRODUCTION

Paleozoic sedimentary rocks underlie and outcrop within the Monongahela National Forest (MNF) area. These rocks represent the Ordovician to the Pennsylvanian periods, and have been folded and faulted by mountain building. Younger alluvial deposits (Quaternary age) occur along streams and rivers. This underlying geology provides the setting for the mineral resources present within the Forest. Mineral resources include commercial quantities of coal, natural gas and limestone; and limited amounts of iron, manganese, silica, gravel and stone. The mineral resource with the most production potential during the planning period is natural gas.

The desired condition for mineral management on the MNF is to provide for exploration, development, and production of mineral and energy resources in an environmentally sound manner. Mineral resource management on the Forest involves coordinating National Forest System (NFS) land and resource uses with exploration, development and production of federally owned or privately owned minerals. Federally owned minerals, primarily natural gas, can be leased for development, although not all areas on the Forest are available. Privately owned minerals may be developed anywhere they occur on the Forest, but activities must be consistent with the mineral deed terms and State law. The Forest strives to control effects from both types of mineral development by reviewing operating plans and approving with appropriate mitigation measures when approval authority rests with the Forest Service, or negotiating with private mineral operators for the implementation of mitigating measures. Operations are also bonded by the appropriate entity for the costs of anticipated site reclamation, to ensure that sites are returned to a condition consistent with the management emphasis of the area.

Need For Change

No significant issues directly related to mineral and geology resources were identified during scoping or the Need For Change analysis process. However, there have been changes to mineral conditions and direction, and in national direction and emphasis in forest planning, since the 1986 Forest Plan, and these changes necessitate the update of minerals information in Plan revision. The changes and needed updates include:

- Land Acquisition and Changes in Mineral Rights Ownership - Changes in coal ownership and prospects for coal development on the MNF in the last planning period indicate that allocating land to a Management Prescription (MP) dedicated to mineral development, such as MP 1.1, or identifying areas of economically recoverable bituminous coal and portals through which coal could be mined would be highly speculative and unreliable, thus not meaningful or beneficial to Plan revision. Therefore, the 1.1 MP in the 1986 Forest Plan was not carried forward into the 2006 Plan.
- Monongahela Forest Plan Amendment on Oil and Gas Leasing and Development - The 1992 Forest Plan Amendment #4 identified federally owned oil and gas available for lease, and

authorized the Bureau of Land Management (BLM) to lease such areas after the Forest Service identifies the lease notifications and stipulations that BLM must attach to the lease. In addition to direction on lease conditions, Amendment #4 provided direction on development of federally owned natural gas. This direction was reviewed and incorporated, as appropriate, into the Forest-wide and/or MP sections of the 2006 Plan.

- Forest Planning national direction and emphasis - As was the case for all management direction in the 1986 Forest Plan, there was a need to review, revise and update mineral resource management direction, and incorporate into the revised Plan. This has been done.

Issues and Indicators

Issue Statement

Forest Plan management strategies may affect mineral resources available for exploration and development.

Background

Forest Plan direction for the management of mineral resources has been revised during the revision process. Forest-wide desired conditions and goals were added, and a number of the standards and guidelines that were in the 1986 Forest Plan, as amended, were rewritten for clarity and integrated with other Plan resource direction. Some standards and guidelines were eliminated because they were repetitive, or they were better suited to an implementation guide, or they were already covered by law, regulation, or policy. Management Prescription direction was reviewed and updated in a similar manner. The overall result of these direction changes is that revised protection for and from mineral resource activities is much the same as in the 1986 Forest Plan, and desired conditions and goals for mineral management have improved.

The major effects to mineral management that this analysis will assess are related to Forest Plan MPs. The MPs contain management direction for mineral management that could potentially affect mineral exploration and development. In particular, there is a standard that prohibits surface occupancy on federal gas and oil leases in several MPs that would restrict lease operators from exploring and developing gas reserves in all but the outer portions of the prescription unit areas. Because the MP allocation changes by alternative, the potential effects from the MP prohibition of surface occupancy would change as well. This analysis will identify how much gas production may be affected by alternative due to these changes.

Indicators

The following indicators reflect the potential relative change by alternative based on management direction that could have substantial effects on the availability of mineral resources.

- Percent of federally owned natural gas acres available for exploration and development
- Billions of cubic feet of potential natural gas resources available for production from the MNF

Scope of the Analysis

The affected area for direct, indirect and cumulative effects to mineral resources includes the lands administered by the Forest, and lands of other ownership both within and adjacent to the Forest proclamation boundary. This represents the area in which the mineral resources could exist and the lands where mineral resources could be impacted by Forest Plan management strategies, particularly land allocation or standards for management or protection of various Forest resources. Although direct effects are focused on federally owned minerals, indirect and cumulative effects to mineral resources on land ownerships within and adjacent to the Forest proclamation boundary are addressed to lend a broader perspective to the importance of mineral resources within the Forest and to recognize the inter-relationships with those lands.

CURRENT CONDITIONS

Beneath some NFS land the mineral resources are owned by private entities. The amount of private mineral ownership beneath NFS land varies by mineral resource. For example, an estimated 38 percent of NFS land has privately owned oil and gas rights, while 27 percent of NFS land has privately owned coal.

Mineral resources such as iron and manganese, silica, high-calcium limestone, and limestone are either not known to occur in commercial quantities on the NFS land, or demand for them appears to be being met by sources off of NFS land.

Most of the demand for mineral materials—including gravel and stone used for construction, fills, landscaping or building stone—is apparently being met by commercial quarries or sources on private land. Small-scale removal of mineral materials is occurring on the MNF through issuance of personal use permits for less than 20 tons of mineral material.

Coal

Active coal mining on the MNF ceased in the early 1990s. In fact, the private coal estates that were being mined during the past 15 years are now federally owned. No coal mine permit applications on NFS land are pending or known to exist.

Although low in sulfur and high in British Thermal Unit (BTU) value, making them desirable for energy production and as metallurgical grade coals, the coal resources underlying NFS land are scattered and would be costly to develop due to the geologies involved. For the most part, demand for coal is being met from sources in other parts of the United States or world that have lower production costs. At current and foreseeable coal prices, the MNF does not expect to see major or extensive coal mine development and very probably no leasing and development of federally owned coal over the next 10-15 years. However, some underground coal mine development is possible. This development would be associated with the exercise of privately owned coal rights.

Natural Gas Storage

A 50,000-acre natural gas storage field exists beneath the MNF in the Middle Mountain-Glady area. This storage field is authorized by the “Glady Gas Storage Agreement”, effective from 1963 until 2013, with likelihood for re-issuance. The Agreement grants the gas storage operator the rights to use and occupy NFS land within the bounds of the storage field to construct, operate, maintain, replace, abandon and remove wells, pipelines and roads for the purposes of gas storage. These activities are expected to continue. Future expansion and clearing within the Glady Gas Storage Field is not foreseen at this time.

Although no proposals are known at this time, it is possible that the Forest could see a proposal to use larger depleted gas reservoirs for gas storage facilities during the 10-15 year planning period. Such proposals could be of particular interest in this region due to its proximity to large population centers, such as Washington, D.C. and Baltimore.

Oil and Natural Gas

Oil has never been found in commercial quantities on the MNF, and there is only a low probability for its occurrence. The natural gas that is produced from the Forest is generally pure methane, containing little water and no known production of hydrogen sulfide (sour) gas.

Natural gas exploration and development on the MNF began in earnest in the 1950s. Within the Forest proclamation boundary and purchase units, between 40 and 50 producing or capable-of-producing gas wells exist. Each gas well site has been between one and four acres of land that have been cleared of trees and maintained as herbaceous vegetation. Additionally, there are just over 100 miles of natural gas pipeline to transport gas produced from these wells, and about 12 miles of single purpose access roads used for well and pipeline maintenance. Total clearing for these facilities is about 620 acres (USDA Forest Service 1991 [EA Appendix C]; USDA Forest Service 1995). Twenty-five of these wells and their associated facilities are on NFS land.

The MNF may contain substantial quantities of natural gas. However, natural gas is not present everywhere underlying the Forest, but occurs associated with certain strata in locations where complex folding and faulting has resulted in a favorable setting for trapping natural gas. Gas exploration and development history demonstrates natural gas occurrence within the Forest. The Oriskany and associated geologic strata have the most likely potential to contain commercial quantities of natural gas. This strata, and in some cases the deeper Tuscarora Formation, are predicted to be the target of gas industry exploration and development within the Forest in the foreseeable future. When the natural gas resource potential based on the reasonably foreseeable gas development scenario is extrapolated, there is about a 19 percent chance of more than 860 billion cubic feet (Bcf) of natural gas underlying the area contained within the Forest proclamation boundary and purchase units. Considering the federally owned gas resource only, there is a similar chance for more than 280 Bcf of natural gas (USDI, Bureau of Land Management 1989; USDI, Bureau of Land Management May 1990; USDA Forest Service 1991 [EA, pages 3-48, 3-49]).

An estimated 24 percent of federally owned oil and gas are currently leased. When someone wants to obtain a federal oil and gas lease, they nominate the area they are interested in leasing to the Department of Interior, BLM. The BLM is responsible for issuing and administering oil and gas leases after the Forest Service consents to the lease issuance on NFS land on the MNF. Consent involves the Forest Service stipulating limits or conditions on the lease necessary for protection of national forest land and resources. Upon receipt of consent from the Forest Service, the BLM sells these leases to the highest bidder at an auction. Oil and gas leases typically terminate in 10 years, but may continue to be in effect as long as the lease is producing gas. An estimated 14 percent of the unleased federally owned oil and gas has been nominated for oil and gas leasing. The Forest continues to process the nominations by identifying applicable lease conditions according to the 1986 Forest Plan Amendment #4, and forwarding those conditions to the BLM for attaching to awarded leases.

Reasonably foreseeable gas development (RFD) has been projected and described for the Forest. The RFD is a projection of the likelihood of gas exploration, development, production and related activities within the MNF proclamation boundary and purchase units. The projections are speculative, but are based on credible geologic and mineral production information. The RFD included an analysis of gas resource potential, and factored in existing limits on gas exploration and development (such as existing Wilderness). The RFD's focus is on gas development potential in the MNF proclamation boundary and purchase units over the life of the Forest Plan. The Forest's RFD was prepared in May 1990 and updated and validated in Forest Plan revision.

The RFD describes typical operator activities associated with natural gas exploration and developments that are expected to continue over the planning period. These activities include:

- Obtaining an oil and gas lease,
- Conducting preliminary investigations, most commonly by geophysical exploration using seismic shot hole or vibroseis methods,
- Exploratory drilling,
- Development and production, and
- Plugging wells and decommissioning facilities that are not part of economical production (USDA Forest Service 1991 [EA], Appendix C: USDI, Bureau of Land Management May 1990, pp C-4 through C-11; Nolder Memo July 2003).

In the RFD Scenario, planned and potential gas developments were projected to involve the following per decade:

- Clearing about 130 acres for 66 gas well sites; each site about 2 acres,
- Clearing about 138 acres for an estimated 19 miles of new road to access projected well drilling, and
- Clearing about 473 acres for 78 miles of gas pipeline from an estimated 41 producing wells (out of the 66 drilled wells); rights-of-way may be up to 50 feet wide.

It is likely that some of the 66 wells will not yield gas. Consequently, an estimated 50 acres may begin reverting back to forested land shortly after drilling. Cleared areas from producing wells will remain open, supporting herbaceous vegetation, throughout gas production of probably up to

30 years. Due to the intermingled private and federal land and mineral ownership, one half to two thirds of this predicted surface disturbance could be a result of developing privately owned gas (USDA Forest Service 1991 [EA]).

Over the decade that the Forest has been implementing Forest Plan Amendment #4 for natural gas leasing and development, the amount of surface disturbance associated with developments has been substantially below predicted levels as shown in Table MI-1. The gas developments in the right-hand column represent those that have been approved in decisions. Only a portion have actually been implemented.

Table MI-1. Predicted and Actual Natural Gas Development on the MNF

Gas Developments on NFS Land	1990 MNF Oil and Gas Projections for 1991-2009 (new developments)	Amount of New Gas Developments 1991- June 2006
Number of wells drilled	136	27
Total acres of surface disturbance	1536	81
Miles of road	38	3
Miles of pipeline	164	48

The main reasons for these discrepancies are that: 1) the rate of natural gas exploration and development has been less than predicted, and 2) operators have chosen options for development that reduce the total amount of surface disturbance dedicated to gas wells and associated roads and pipelines. For example, operators have reduced surface disturbance by directionally drilling more than one gas well from one well site, which in turn reduces the amount of road and pipeline needed to support the gas wells. They have also co-located pipelines with roads to reduce the amount of new clearing and surface disturbance needed to support gas development. As long as such practices remain economically feasible, it is expected that these practices would continue where allowed.

Gas drilling to find new gas fields will likely continue. Areas containing gas discoveries will continue to be developed until the full field is delineated and producing. The gas exploration and development is expected to be within predicted amounts over the next 15 years, even with recent increased interests in MNF natural gas deposits as drilling for small gas pockets has become more economical (Nolder Memo 2003).

Current Area Available for Natural Gas Development

The Forest Plan was amended in 1992 to address where and subject to what standards federally owned oil and gas would be leased. The standards and guidelines identified in Forest Plan Amendment #4 were the basis for determining whether federally owned natural gas resource was available for exploration and development. The decision supporting Forest Plan Amendment #4 was that 388,000 acres out of 461,000 acres or 84 percent of federally owned oil and gas on the MNF are available for natural gas exploration and development (USDA Forest Service 1991 [DN/FONSI, p. 10-11]). The decision supporting Forest Plan Amendment #4 recognized that

some standards and guidelines to protect forest resources made small areas unavailable for surface occupancy by gas operations (roads, well sites and pipelines) (USDA Forest Service 1991 [EA pp. 2-27, 2-28]). It also recognized that avoiding small areas and directionally drilling for gas (drilling at an angle from the surface to a target rock unit that is not directly below the well surface location) may cost gas operators more, but as long as the areas in which surface occupancy was prohibited were no larger than about 640 acres (1 square mile), the natural gas could still be discovered and produced, and thus it would be available (USDA Forest Service 1991. [EA p. 3-50]).

The 1986 Forest Plan and wilderness designation had removed 99,000 acres of federally owned oil and gas acres from consideration for oil and gas leasing or surface occupancy (USDA Forest Service 1991 [DN/FONSI, p. 10-11]). In actuality, about 77,000 acres (76,000 acres in Wilderness and 1000 acres outside of wilderness) of the 99,000 acres are unavailable for gas exploration and development because the natural gas within 20,000 acres could be explored and extracted from adjacent areas. Therefore, out of 560,000 acres of federally owned oil and gas, 148,000 acres or 26 percent--including acres removed by Wilderness designation or made unavailable by Forest Plan standards that disallow surface occupancy in MP 6.2, large MP 8.0 areas, and within municipal watersheds--are unavailable; leaving 412,000 acres or roughly 74 percent of the federally owned gas available for exploration and development. The estimate of acres available and unavailable take into account that some federal gas within areas where surface occupancy is prohibited may be reached from adjacent areas by directional drilling.

Natural Gas Production Potential

A report prepared by the BLM notes that the MNF may contain significant quantities of natural gas. The report classified areas within the MNF on the basis of the natural gas potential from the Oriskany and associated formations. Areas classified as having inferred or hypothetical Oriskany gas resources were used to calculate reserve estimates because these areas are either within geologic blocks that are currently producing natural gas or contain similar geologic structures to those producing gas with a reasonable expectation for gas production. About 1,317,000 acres or 75 percent of the area within the Forest Proclamation boundary and purchase units are classified as having inferred or hypothetical Oriskany natural gas resources. Potential natural gas production from the Oriskany and associated formations was estimated for the MNF based on 1 Bcf per well ultimate recovery, or 1.56 million cubic feet (Mcf) (0.00156 Bcf) per acre on 25 to 50 percent of the acres within any individual geologic block in which gas is discovered. There is additional potential for gas from other formations, but reserve estimates have not been made due to insufficient data. Thus, reserve estimates contained herein represent only those from the Oriskany and associated formations, and not, for example, the Tuscarora Formation, which is currently being drilled and tested on the northern portion of the Forest (USDI Bureau of Land Management 1989, USDI Bureau of Land Management May 1990).

Areas classified as having inferred or hypothetical Oriskany natural gas resources have about a 19 percent chance for recovery of 1.56 Mcf of natural gas per acre on 25 to 50 percent of the acres (USDI, Bureau of Land Management 1989 and USDI, Bureau of Land Management May 1990). In 1991, the area within the MNF proclamation boundary and purchase units was estimated to contain proven gas reserves of 39 Bcf, with a 19 percent chance for an additional

867 Bcf of natural gas. Considering the federal gas resource only, there is a similar chance for the existence of an estimated 284 Bcf of natural gas (USDA Forest Service 1991 [EA]). After applying the existing Forest Plan standards, federally owned gas available for exploration and development could produce an estimated 232 Bcf of Oriskany gas (USDA Forest Service 1991 [DN/FONSI, p. 15]). The estimates represent the potential Oriskany gas production if 37.5 percent or the average of 25 to 50 percent, of the acres available for gas development produced natural gas.

Table MI-2 summarizes the estimates of Oriskany and associated strata natural gas production potential from the Forest, given the gas acres that are available for exploration, development, and production under the 1986 Forest Plan.

Table MI-2. Potential Oriskany and Associated Strata Natural Gas Production

Gas Production Potential	Forest Plan Amendment #4 with 37.5 percent of lands productive	Forest Plan Amendment # 4 with 25 to 50 percent of lands productive (as a range)
Potential (19 percent chance) for production from within the MNF proclamation boundary	867	474-948
Potential (19 percent chance) for Production from federally owned oil and gas within the MNF	232	131-261

ENVIRONMENTAL CONSEQUENCES

Resource Protection Methods

Laws, Regulations, and Policies

Federal laws and regulations guide the management of mineral resources on NFS lands. Mineral resources on the MNF are separated into three categories, whose exploration and development is guided by different statutes.

- 1) Privately owned minerals are subject to the terms of the mineral severance deed, state law, and various federal laws, most of which are not within Forest Service authority to administer or enforce. Some examples include:
 - Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201-1328) applies to all surface coal mining operations. It is administered and enforced by the USDI, Office of Surface Mining.
 - West Virginia Oil and Gas Laws and Administrative Regulations apply to gas development. The WV Division of Environmental Protection, Office of Oil and Gas administers and enforces these rules.

- 2) Leasable minerals include federally owned deposits of coal, gas, oil, oil shale, phosphate, sodium, potassium, and geothermal resources. The Mineral Leasing Act of 1920 and its amendments authorize the Secretary of the Interior to lease land for development of these minerals. The Mineral Leasing Act for Acquired Lands of August 7, 1947 extended provisions of the Mineral Leasing Act of 1920 to acquired lands which are present on the MNF. The Federal Onshore Oil and Gas Leasing Reform Act of December 22, 1987, which amended the Mineral Leasing Acts, specifies the Forest Service role in leasing, and analyzing and approving surface-disturbing activities with respect to oil and gas leases. The Forest Service reviews, approves, and administers the surface activities on the Forest, and the BLM manages the exploration and development program.
- 3) Mineral Materials, also called salable or common variety materials, are generally deposits of sand, gravel, or stone that are used for road surfacing or building materials. The Minerals Materials Act of 1947 states that these minerals on NFS lands are subject to disposal by the Secretary of Agriculture, and are not subject to mining and leasing laws.

National laws and regulations have also been interpreted for implementation in Forest Service Manuals, Handbooks, and Regional Guides. All management activities and facilities must comply with these laws, regulations, and policies, which are not only intended to provide general guidance for implementation, but also protection of resources.

Forest Plan Direction

Desired conditions, goals, objectives, standards, and guidelines provide guidance for mineral resources at both the Forest-wide and MP levels. Much of the mineral-related direction can be found in the Mineral Resources section of the Forest-wide Direction in Chapter II of the 2006 Forest Plan. However, additional mineral-related direction has been integrated and linked to and from other resource sections.

Effects on mineral management within the Forest, and natural gas development in particular, are primarily caused by the standards that restrict how, when, and where mineral development may occur in order to mitigate effects on the land and its resources, or by standards that control activities that may occur within MPs. These effects are described in the General Effects section below.

Forest Plan Implementation

There are several opportunities to mitigate effects of federal gas leasing and development on NFS land. The first occurs as part of the Forest Service consent to lease federally owned oil and gas. Forest Plan standards that have a substantial bearing on the ability or cost to develop the gas within a lease are forwarded to the BLM for incorporating into the lease. Examples include:

- Prohibitions on surface occupancy that apply to areas 640 acres or larger because this standard determines the parts of the lease area in which gas could not be extracted;
- Prohibitions on surface occupancy that affect areas between 20 and 640 acres in size because this standard would require directional drilling, which is more costly;

- Timing restrictions that result in delays of more than 60 days in order to operate on the lease, like seasonal restrictions on drilling or construction activities near developed recreation areas.

In addition, oil and gas leases issued since 1992 contain notification to the lessee that operations under the lease will be consistent with standards and guidelines in the MNF Forest Plan.

Another opportunity to mitigate the effects of federal gas development occurs during project-level National Environmental Policy Act (NEPA) analysis. Surface use plans or operating plans for proposed activities within the lease must be reviewed and approved by the Forest Service before the proposed use of NFS land is authorized. NEPA compliance is part of the approval process. Through NEPA analysis and decision-making; site-specific mitigation measures, monitoring needs, or bonding requirements are identified and may be applied to the proposed surface use as appropriate. Operations are inspected for compliance with approved operating plans, which provides another opportunity to ensure effects are mitigated.

Effects Common to All Alternatives

Forest Plan direction does not preclude or interfere with a private mineral owners' rights to explore for and develop privately owned minerals. The exercise of these mineral rights is controlled by deed and State law. As such, direct effects on private mineral rights as a result of implementing the Forest Plan are not expected.

Effects on federally owned natural gas are caused by standards or guidelines that restrict gas leasing and development. Forest-wide standards mitigate effects of gas development on the land and its resources (See Management Direction for Mineral and Geology Resources) and can result in prohibitions on use of the land surface for gas exploration and development. This may make certain areas of federally owned gas unavailable for exploration and development.

Federally owned minerals, natural gas included, within congressionally designated wildernesses are withdrawn from leasing. Therefore, federally owned natural gas is unavailable for development on 76,000 acres of existing congressionally designated wildernesses under all alternatives.

Most Forest-wide standards, including ones that control timing of gas operations or mitigate potential effects to Forest resources, may increase federal gas exploration and development costs somewhat, but would not be sufficiently higher in cost such that industry would avoid leasing or developing federally owned gas. This is because most of these standards apply to small areas that can be avoided by gas developments without substantially compromising the ability to find and extract gas, or gas exploration and development can be scheduled to avoid the restricted season. A few examples of standards that have these effects include those pertaining to soil and water, developed recreation, and administrative sites.

Standards to protect soil and water require gas well sites to be located outside of 100-foot wide buffers of perennial channels and gas well drilling pits to be located outside of channel (stream) buffers (25 feet wide up to the riparian area width). Gas pipelines and access roads may cross channels as close to right angles as possible to minimize the disturbance to riparian habitat and the potential to degrade water quality. These standards notwithstanding, sufficient area and locations would still exist to explore for or extract gas.

Similarly, standards that require gas operations to avoid developed recreation sites, and to avoid drilling and construction in support of gas development within 500 feet of the recreation site during the recreation use season would still allow gas development to occur, albeit with extra cost or perhaps extra planning on the lessee's part. Standards that prohibit use of small areas of NFS land, such as administrative sites, for federal gas development, would still allow discovering and extracting gas by drilling from outside the protected area at an angle (directional drilling) into the gas-bearing strata below the protected area.

Forest-wide standards that prohibit surface occupancy of areas that are larger than 640 contiguous acres could result in gas unavailable for development. These areas include certain MPs (such as 5.1, 6.2, and some 8.0) and could also include specific resource-related areas. For example, surface occupancy is prohibited where certain threatened, endangered, and proposed (TEP) populations exist (Virginia big-eared bat, Indiana bat hibernacula and key areas, Cheat Mountain salamander, bald eagle nests, shale barren rock cress) or in municipal watersheds, but only where these areas attain a size of 640 or more contiguous federally owned gas acres do they become unavailable. Effects from these prohibitions are displayed and discussed in the Direct and Indirect Effects section below.

Direct and Indirect Effects by Alternative

Percent of Federally Owned Gas Acres Available For Exploration And Development

Forest Plan management strategies may affect mineral resources available for exploration and development. In particular, federally owned natural gas becomes unavailable for exploration and development when surface disturbance or surface occupancy required to drill for and extract gas is not allowed within areas that are larger than 640 contiguous acres. These areas are displayed in Table MI-3. Federally owned natural gas is present within 573,000 acres of MNF NFS land.

Alternative 1 - Table MI-3 shows that Forest Plan standards that prohibit surface occupancy within federal oil and gas leases result in 146,000 acres out of 573,000 acres, or 25 percent, of federally owned natural gas unavailable for exploration, development or production. The area unavailable includes MP 5.0, MP 6.2, some large MP 8.0 areas such as the Dolly Sods Scenic Area, and municipal watersheds. Portions of the periphery of these areas, except for Wilderness, were considered available when adjacent federal gas was available for leasing with surface occupancy. The acreages in Table MI-3 reflect the acres that are unavailable because they could not be reached by directionally drilling from federally owned gas outside of the boundary of the area in which surface occupancy is prohibited.

Table MI-3. Acres and Percent of Federally Owned Gas within MNF Unavailable for Gas Leasing and Development by Alternative

Affected Area	Alt. 1	Alt. 2	Alt. 2M	Alt. 3	Alt. 4
	Acres	Acres	Acres	Acres	Acres
MP 5.0	76,000	76,000	76,000	76,000	76,000
MP 5.1, 6.2, or SPNM portions of 8.1	66,000	57,000	71,000	127,000	38,000
MP 8 (excluding MP 8.1)	1,000	1,000	1,000	1,000	1,000
Municipal watersheds	3,000	0	0	0	0
Total acres affected	146,000	134,000	148,000	204,000	115,000
Percent of federally owned gas affected	25%	23%	26%	36%	20%

The rest of the federally owned natural gas, 427,000 acres or 75 percent, is considered available for exploration, development and production. Gas operations may be prohibited within small areas, and timing restrictions may dictate when certain operations may occur, all of which may increase the development costs. However, increases in the costs of operations are not expected to be sufficiently high to preclude exploration and development within these 427,000 acres.

Alternative 1 meets the 2006 Forest Plan management direction objective for mineral and geology resources (MG06) of keeping 70 to 80 percent of federally owned oil and gas available for exploration, development, and production.

Indirect effects on adjacent landowners, owners of oil and gas beneath NFS land, and existing oil and gas lessees could occur depending on the availability of federal gas for exploration or development. Privately owned gas or gas adjacent to federally owned gas may remain undeveloped if the federal gas needed to make an operation economically feasible is unavailable for development. There have been no indications that substantial indirect effects, either adverse or beneficial, have occurred to adjacent landowners, oil and gas owners, or current oil and gas lessees since implementation of Forest Plan Amendment #4, and there is no expectation that these indirect effects will change substantially in the future.

It is noted that 2,000 fewer acres show as unavailable in this alternative compared to what is shown in the *Current Area Available for Natural Gas Development* discussion. This is due to differences in how the acreages were tallied in 1991 (manually using a dot grid) compared to today (electronically using geographic information system). There has been no change to the federally owned gas available as a result of Amendments 1, 2, 3, 5 or 6 to the Forest Plan.

Alternative 2 - Table MI-3 shows that Forest Plan standards that prohibit surface occupancy within federal oil and gas leases result in 134,000 acres out of 573,000 acres, or 23 percent, of federally owned natural gas unavailable for exploration, development or production. The area unavailable includes MP 5.0, MP 5.1, MP 6.2, semi-primitive non-motorized (SPNM) portions of MP 8.1 (National Recreation Area) and some large MP 8.0 areas such as the Dolly Sods Scenic Area. Portions of the periphery of these areas, except for Wilderness, were considered available when adjacent federal gas was available for leasing with surface occupancy. The acreages in Table MI-3 reflect the acres that are unavailable after subtracting acres that could be

reached by directionally drilling from federally owned gas outside of the boundary of the area in which surface occupancy is prohibited.

The balance of the federally owned natural gas, 439,000 acres or 77 percent, is considered available for exploration, development and production. Gas operations may be prohibited within small areas, and timing restrictions may dictate when certain operations may occur, all of which may increase the development costs. However, increases in operation costs are not expected to be sufficiently high to preclude exploration and development within the 439,000 acres.

Alternative 2 meets the 2006 Forest Plan management direction objective for mineral and geology resources (MG06) of keeping 70 to 80 percent of federally owned oil and gas available for exploration, development, and production.

Under Alternatives 2, 2M, 3, and 4, there is no standard that prohibits surface occupancy within municipal watersheds; instead, impacts to municipal watersheds would be evaluated during site-specific analysis of proposed gas development, and addressed through mitigation measures.

Alternative 2 includes about 4,400 fewer acres of NFS with MPs in which surface occupancy is prohibited than Alternative 1; 127,900 NFS in MP 6.2 versus 123,500 in MPs 5.1 and 6.2, respectively, yet 12,000 fewer acres of federally owned natural gas are unavailable in Alternative 2. This is because there are fewer acres of federally owned oil and gas in the MP 5.1, MP 6.2, and SPNM portions of MP 8.1 in Alternative 2 that are affected by the prohibition on surface occupancy than within the MP 6.2 areas in Alternative 1.

Indirect effects on adjacent landowners, owners of gas and oil beneath NFS land, and existing oil and gas lessees would be the same as those stated for Alternative 1, above.

Alternative 2M - Table MI-3 shows that Forest Plan standards that prohibit surface occupancy within federal oil and gas leases result in 148,000 acres out of 573,000 acres, or 26 percent, of federally owned natural gas unavailable for exploration, development or production. The area unavailable includes MP 5.0, MP 5.1, MP 6.2, semi-primitive non-motorized (SPNM) portions of MP 8.1 (National Recreation Area) and some large MP 8.0 areas such as the Dolly Sods Scenic Area. Portions of the periphery of these areas, except for Wilderness, were considered available when adjacent federal gas was available for leasing with surface occupancy. The acreages in Table MI-3 reflect the acres that are unavailable after subtracting acres that could be reached by directionally drilling from federally owned gas outside of the boundary of the area in which surface occupancy is prohibited.

The balance of the federally owned natural gas, 425,000 acres or 74 percent, is considered available for exploration, development and production. Gas operations may be prohibited within small areas, and timing restrictions may dictate when certain operations may occur, all of which may increase the development costs. However, increases in operation costs are not expected to be sufficiently high to preclude exploration and development within the 425,000 acres.

Alternative 2M meets the 2006 Forest Plan management direction objective for mineral and geology resources (MG06) of keeping 70 to 80 percent of federally owned oil and gas available for exploration, development, and production.

Alternative 2M includes about 2,000 more acres of NFS with MPs in which surface occupancy is prohibited than Alternative 1, which represents the current condition.

Indirect effects on adjacent landowners, owners of gas and oil beneath NFS land, and existing oil and gas lessees would be the same as those stated for Alternative 1, above.

Alternative 3 - Table MI-3 shows that Forest Plan standards that prohibit surface occupancy within federal oil and gas leases result in 204,000 acres out of 573,000 acres, or 36 percent, of federally owned natural gas unavailable for exploration, development or production. The area unavailable includes MP 5.0, MP 5.1, MP 6.2, SPNM portions of MP 8.1 (the NRA) and some large MP 8.0 areas such as the Dolly Sods Scenic Area. Portions of the periphery of these areas, except for Wilderness, were considered available when adjacent federal gas was available for leasing with surface occupancy. The acreages in Table MI-3 reflect the acres that are unavailable after subtracting acres that could be reached by directionally drilling from federally owned gas outside of the boundary of the area in which surface occupancy is prohibited.

The balance of the federally owned natural gas, 369,000 acres or 64 percent, is considered available for exploration, development and production. Gas operations may be prohibited within small areas and timing restrictions may dictate when certain operations may occur, all of which may increase the development costs. However, increases in the operation costs are not expected to be sufficiently high to preclude exploration and development within these 369,000 acres.

Alternative 3 does not meet the 2006 Forest Plan management direction objective for mineral and geology resources (MG06) of keeping 70 to 80 percent of federally owned oil and gas available for exploration, development, and production.

Alternative 3 includes about 195,250 more acres of NFS land with MPs in which surface occupancy is prohibited than Alternative 1; 127,900 NFS in MP 6.2 versus 323,150 in MP 5.1 and 6.2, respectively, yet only 58,000 more acres of federally owned natural gas are unavailable in Alternative 3. This is because not all of the acreage allocated to MP 5.1, MP 6.2 and SPNM portions of MP 8.1 in Alternative 3 contain federally owned oil and gas that are affected by the prohibition on surface occupancy.

Indirect effects on adjacent landowners, owners of oil and gas beneath NFS land, and existing oil and gas lessees could occur depending on the availability of federal gas for exploration or development. Privately owned gas or gas adjacent to federally owned gas may remain undeveloped if the federal gas needed to make an operation economically feasible is unavailable for development. Although, there have been no indications that substantial indirect effects, either adverse or beneficial, have occurred to adjacent landowners, oil and gas owners, or current oil and gas lessees since implementation of Forest Plan Amendment #4, this alternative makes substantially more acres of federally owned gas unavailable. With substantially fewer acres of federally owned gas available, there is increased risk compared to the other alternatives that

privately owned gas reserves within or adjacent to NFS land may remain undeveloped due to economics. For example, gas produced from private oil and gas estates alone may not contain the volume of gas needed to make the gas pipeline needed to transport the gas to market economically feasible.

Alternative 4 - Table MI-3 shows that Forest Plan standards that prohibit surface occupancy within federal oil and gas leases result in 115,000 acres out of 573,000 acres, or 20 percent, of federally owned natural gas unavailable for exploration, development or production. The area unavailable includes MP 5.0, MP 6.2, SPNM portions of MP 8.1 (the NRA) and some large MP 8.0 areas such as the Dolly Sods Scenic Area. Portions of the periphery of these areas, except for Wilderness, were considered available when adjacent federal gas was available for leasing with surface occupancy. The acreages in Table MI-3 reflect the acres that are unavailable after subtracting acres that could be reached by directionally drilling from federally owned gas outside of the boundary of the area in which surface occupancy is prohibited.

The balance of the federally owned natural gas, 458,000 acres or 80 percent, is considered available for exploration, development and production. Gas operations may be prohibited within small areas and timing restrictions may dictate when certain operations may occur, all of which may increase development costs. However, increases in the costs of operations are not expected to be sufficiently high to preclude exploration and development within these 458,000 acres.

Alternative 4 meets the 2006 Forest Plan management direction objective for mineral and geology resources (MG06) of keeping 70 to 80 percent of federally owned oil and gas available for exploration, development, and production.

Alternative 4 includes about 78,300 less acres of NFS land with MPs in which surface occupancy is prohibited than Alternative 1; 127,900 NFS in MP 6.2 verses 49,600 in MP 6.2, respectively, yet 31,000 less acres of federally owned natural gas are unavailable in Alternative 4. This is because the acres allocated to MP 6.2 under Alternative 4 are different than those allocated to MP 6.2 under Alternative 1, and the acres allocated to MP 6.2 and the SPNM portions of MP 8.1 in Alternative 4 contain proportionately fewer acres of federally owned oil and gas that are affected by the prohibition on surface occupancy.

Indirect effects on adjacent landowners, owners of oil and gas beneath NFS land, and existing oil and gas lessees would be the same as those stated for Alternative 1, above.

Potential Federally Owned Natural Gas Production from the MNF by Alternative

An indicator of the effect that Forest Plan management would have on potential gas production would be the amount of potential Oriskany natural gas available for production from federally owned oil and gas within the MNF. If the federally owned oil and gas were available everywhere except in congressionally designated wildernesses, estimated gas production potential is 151-303 Bcf. Using the same method as was used to generate the estimates shown in Table MI-4, Oriskany gas production potential would be 227 Bcf if federally owned gas was available everywhere except in Congressional designated wilderness.

Table MI-4. Potential Natural Gas Production from the MNF by Alternative in Bcf

Gas Production Potential	Alt. 1	Alt. 2	Alt. 2M	Alt. 3	Alt. 4
Potential (19 percent chance) for Production from federally owned oil and gas within the MNF (in billion cubic feet)	195	199	195	165	209
Percent of total potential federal gas production if only wilderness were unavailable	86%	88%	86%	73%	92%

Note that there is additional potential for gas from other formations, but reserves estimates have not been made due to insufficient data. Thus, reserve estimates discussed below represent only those from the Oriskany and associated formations, and not, for example, the Tuscarora Formation, which is currently being drilled and tested on the northern portion of the Forest (USDI, Bureau of Land Management 1989). The estimates represent the potential Oriskany gas production if 37.5 percent or the average of 25 to 50 percent, of the acres available for development within inferred and hypothetical gas resource areas produced natural gas.

Alternative Comparison - Table MI-4 shows how the amount of federally owned gas available for exploration and development affects the potential natural gas production from the federal oil and gas estate within the MNF. Under Alternatives 1, 2, and 2M, there is a 19 percent chance for discovery and production of 195 Bcf and 199 Bcf of natural gas, respectively, due to the minor difference (12,000 more acres in Alternative 2, 2,000 fewer acres in 2M) in federal gas acres available between these alternatives. The percent of the total federal gas potential under Alternatives 1 and 2 reflects this minor difference as well. Table MI-4 shows that under Alternative 3, the acres unavailable (204,000) have resulted in reduced gas production potential of 30 Bcf less than Alternative 1. Under Alternative 3, 73 percent of the total federal gas potential could be produced. Under Alternative 4, which has 31,000 acres more than Alternative 1 available, the most—209 Bcf or 92 percent of the total federal gas potential—gas production could occur as compared to the other alternatives.

The gas production potential figure is lower in Table MI-4 for Alternative 1 than what is shown in the *Current Area Available for Natural Gas Development* section of Table MI-2. This is because the figures used in Table MI-2 include potential gas production from areas that have less than a 19 percent chance of discovery of natural gas. In this analysis, only land that was classified as having a 19 percent chance for natural gas discovery, namely inferred and hypothetical classifications, was used to calculate estimated natural gas production. Areas classified as having speculative Oriskany gas resource potential were not included in estimates of gas production.

Cumulative Effects

Gas Resource

Gas could become unavailable for exploration and development when restrictions on federally owned gas development to protect other forest resources become so numerous that additional costs make gas economically unavailable for exploration and development.

Gas could become unavailable for exploration and development when restrictions on federally owned gas development to protect other forest resources produce many small areas which individually would not make gas unavailable, but could accumulate and form large blocks that would make gas unavailable for exploration and development.

Since federally owned gas is not the only source of gas produced from within the bounds of the MNF, gas could continue to be produced from non-federal minerals even if federally owned gas is unavailable. An indicator of the effect that Forest Plan management would have on potential gas production from the Forest area would be the amount of potential Oriskany natural gas available for production from within the proclamation boundary and purchase units of the MNF. Using the same method as was used to generate the estimates shown in Table MI-5, total Oriskany gas production potential within the MNF proclamation boundary and purchase units is estimated to be 742 Bcf, if only Congressionally designated wildernesses were unavailable.

Table MI-5. Potential Natural Gas Production from the MNF by Alternative in Bcf

Gas Production Potential	Alt. 1	Alt. 2	Alt. 2M	Alt. 3	Alt. 4
Potential (19 percent chance) for production from within the MNF proclamation boundary	711	714	711	681	725
Percent of total potential gas production from within the MNF proclamation boundary	96%	96%	96%	92%	98%

Table MI-5 indicates that most of the natural gas within the MNF proclamation boundary and purchase units could be produced even if some of federal oil and gas is unavailable due to Forest Plan management strategies. This assumes restrictions on federally owned gas development to protect other Forest resources do not become so numerous that: 1) the costs of gas development make gas economically unavailable for exploration and development; or 2) many small areas which individually would not make gas unavailable, accumulate and form large blocks that would make gas unavailable for exploration and development. It also assumes that federally owned gas that is unavailable for exploration and development will not result in economically infeasible private gas reserves. These assumptions are validated by observation of gas development within the MNF over the past one to two decades. There are no indications that unavailable federally owned gas has resulted in industry declining to explore for or develop privately owned gas.

A variety of factors affecting gas exploration and development within the MNF area suggest that most gas production within the MNF proclamation boundary and purchase units will continue as long as the amount of federally owned gas remains available at or near the levels at which it has been historically. Natural gas demand is strong and prices are high and expected to remain so

into the future, due in part to increasing use of natural gas for power generation. In addition, improvements in processing geophysical data collected on the subsurface will allow for more precise delineation of gas targets within the geologically complicated MNF (Nolder Memo 2003). Couple improvement in delineation of gas targets with improved economic and technical feasibility of directional drilling, and the circumstances for gas exploration and production remain favorable, even if some federal gas is unavailable or is available with higher production costs in order to protect MNF resources. It could also mean that federal gas may not always be needed to make gas fields economically feasible in certain areas, especially where there is intermingled federal and private gas ownership.

Gas Development

Increases in natural gas prices normally lead to increases in exploration and development. The complex geology and nature of the gas targets within MNF will act to limit exploration and development to levels described in the Current Condition section as the reasonable foreseeable gas development scenario for the MNF.

As exploration and development occurs, regardless of whether it occurs within federally or privately owned oil and gas estates, it will be subject to applicable West Virginia laws and a variety of federal laws. Development of federally owned gas is additionally conditioned by federal oil and gas lease terms and laws and regulations administered by the BLM. Laws and regulations administered by the Forest Service and the MNF Forest Plan also apply to gas development. In total, gas exploration and development within the MNF is subject to laws, regulations and management direction that conserve the gas resource and protect the environment.