Appendix F – Minerals

The Ouachita National Forest is located in Central Arkansas, within the Ouachita Mountains and the very southern portion of the Arkansas River Valley, and in southeastern Oklahoma in the Ouachita Mountains and the Red River Valley (Idabel, Oklahoma area). The geologic setting of the Forest provides a diversity of energy and non-energy mineral resources. Since approval of the 1986 Land Management Plan, minerals from the Forest, including natural gas, hardrock, and mineral materials, have been used to meet the basic needs of the public, such as providing natural gas fuel for energy sources and heating homes; stone for construction and functional home projects, and road surfacing/maintenance materials. Development of the federal and private minerals underlying the National Forest stimulates the local and national economies by making available the raw materials needed for continued economic development, resulting in increased jobs and spending.

The sustainability of the Forest depends on the continued use of mineral resources to meet the public's demand for such things as fuels and building materials. The role of mineral resources is fundamental to viability of human ecosystems. The goals for management of the Ouachita National Forest were developed in consideration of the other national forests within the Southern Region. Any decisions on projects to implement the Revised Forest Plan will be based on site-specific analysis in compliance with the National Environmental Policy Act (NEPA). These environmental analyses will be appropriately documented according to direction in the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR Parts 1500-1508) and the Environmental Policy and Procedures Handbook (FSH 1909.15).

Topics within this Appendix include:

- The geologic table and the descriptions for each of the geologic formations on the Ouachita National Forest
- Oil and Gas Reasonable Foreseeable Development Scenario provided by the USDI Bureau of Land Management (BLM) for the Ouachita National Forest
- Minerals Laws and Authorities
- Withdrawal Review
- Minerals Program procedures for managing Federal minerals on the Ouachita National Forest
- Oil and Gas Leasing Stipulations

Geology

General Ouachita Geology: The Ouachita National Forest is located in the heart of the Ouachita Mountains through the west central portion of Arkansas and the southeastern portion of Oklahoma. The Forest is principally within the physiographic province referred to as the "Ouachita Province." In Arkansas, the northern portions of the Poteau, Cold Springs, and Fourche Ranger Districts are within the "Arkansas Valley Province." The Ouachita Province is a mountainous, geologically complex area located between the Gulf Coastal Plain to the south and the Arkansas Valley to the north. These other physiographic provinces are also known for their oil and gas production and potential. The physiographic "Ouachita Province" is subdivided into the Fourche Mountains in the northern half of the Forest, and the Novaculite uplift in the southern half of the Forest. The Ti Valley/Winding Stair/Choctaw fault system is projected through the northern portion of the Forest in eastern Oklahoma and western Arkansas. Major structural and stratigraphic changes caused by this significant fault system occur between the Arkoma Basin to the north of the Forest and the Ouachita Mountains. Geologically, the area between the Choctaw and Winding Stair faults is referred to as the "frontal" part of the Ouachita

Mountains and represents the geologic transition zone between the Ouachitas and the Arkoma Basin. The rock sequence south of the Ti Valley fault is referred to as the "Ouachita Mountain facies" and may reflect a north-northwest thrust of approximately 20 miles. The "Broken Bow - Benton uplift" extending through the southern third of the Forest from Benton, Arkansas south-southwest to Broken Bow, Oklahoma, is the principal anticlinal fold of the Ouachita Mountains.

Table F.1 Geologic Column for the Ouachita National Forest

Era	Period	Formation	Occurs on Ranger District Number[1]
Cenozoic	*Quaternary*	**Qal** Alluvium	All RD's
		Qt Terrace Deposits	1,5,12
Mesozoic	*Cretaceous*: upper	**Kob** Ozan (**Ko**) and Brownstone (**Kbr**)	12
	upper	**Kt, Kto** Tokio	12
	upper	**Kw** Woodbine	12
	lower	**Kk** Kiamichi	12
	lower	**Kg, Kgw** Goodland	12
Paleozoic	*Pennsylvanian*: Des Moines	**Ps, Psv** Savanna	3,9
	Des Moines	**Pm, Pma, Pms** McAlester	1,3,6,9
	Des Moines	**Phs** Hartshorne	1,3,9
	Atoka	**Pa**: Pau,Pam,Pal Atoka Formation	1,3,4,5,6,7,8,9,11
	Morrow	**Pjv** Johns Valley Shale	1,4,5,6,7,8,9,11
	Morrow	**Pj** Jackfork Sandstone	1,2,4,5,6,7,8,9,11, 12
	Mississippian	**Ms, PMs, Mst** Stanley Shale	2,5,6,7,8,10,11,12
	Devonian	**MDa** Arkansas Novaculite (**MDSa**)	2,5,7,10,11,12
	Silurian	**Smb** Missouri Mtn. Shale (**Sm**) & Blaylock Sandstone (**Sb**)	2,5,7,8,10,12
	Ordovician upper	**Obf** Bigfork Chert	5,12
	upper	**Obp, Obfp** Bigfork Chert (**Obf**) & Polk Creek Shale (**Op**)	2,5,7,8,10,11,12
	middle	**Ow** Womble Shale	2,5,10,11,12
	middle	**Ob, Oby** Blakely Sandstone	2,5,10
	lower	**Om** Mazarn Shale	5,10
	lower	**Ocm** Crystal Mountain Sandstone	2,10
	Cambrian/Ordovician	**COc** Collier Shale	2,10,12

[1]Ranger Districts: (1) Choctaw, (2) Caddo, (3) Cold Springs, (4) Fourche, (5) Jessieville, (6) Kiamichi, (7) Mena, (8) Oden, (9) Poteau, (10) Womble, (11) Winona, (12) Tiak

Geology of the Arkansas and the Oklahoma Portions of the Ouachita National Forest

I. Stratigraphic Summary of the Arkansas Valley and Ouachita Mountains

Reprinted with permission from John David McFarland, Arkansas Geological Commission (AGC), Little Rock, Arkansas, from the AGC website at http://www.state.ar.us/agc/stratigr.htm.

The Arkansas Valley is dominated by Pennsylvanian clastic sediments deposited on the margin of a continental shelf primarily by deltas and reorganized in part by marginal marine processes. Structurally, the area is made up of broad synclines with relatively narrow intervening anticlines. The axes of these folds generally trend east-west. Most of the observed faulting is normal, but some thrusts faults are noted, associated with the anticlines in the southern part of the province. The synclines are often the most conspicuously present positive topographic features, formed from more rapid erosion of underlying shales, once capping sandstones were breached on the crests and flanks of the surrounding anticlines.

The Ouachita Mountains are made up of complexly folded and faulted Paleozoic age sedimentary rocks that were originally deposited in mostly deep marine environments. The continental collision during the late Paleozoic that pushed up this region produced a structural fabric that trends more or less east-west. The folding was intricate at all scale levels and several local sequences, both complete and partial, are overturned. Compressional faulting is commonly expressed in the sequence throughout the area. The Ouachita province, in a general sense, can be considered an anticlinorum with Late Cambrian and Ordovician deposits being exposed in the center and Mississippian and Pennsylvanian sedimentary units exposed around the margins. The area is cut off to the east by the Gulf Coastal Plain and Mississippi Embayment.

COLLIER SHALE/FORMATION [COc]
Age: Late Cambrian Period and Early Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains (principally Montgomery and Garland Counties); southeastern Oklahoma
Geology: The sequence is composed of gray to black, lustrous shale containing occasional thin beds of dense, black, and intensely fractured chert. An interval of bluish-gray, dense to spary, thin-bedded limestone may be present. Near its top, the limestone is conglomeratic and pelletoidal, in part, with pebbles and cobbles of limestone, chert, meta-arkose, and quartz. The entire unit displays intensive deformation and frequent small quartz veins. Fossils are rare, but include trilobites and conodonts. The base of the formation is not exposed, but the total thickness exposed exceeds 1000 feet.
Original reference: A. H. Purdue, 1909, Geological Society of America Bulletin v. 19, p. 557; A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 31.
Type locality: Named for Collier Creek, Montgomery County, Arkansas.

CRYSTAL MOUNTAIN SANDSTONE/FORMATION [Ocm]
Age: Early Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains (principally Montgomery and Garland Counties); southeastern Oklahoma
Geology: The formation is typically composed of massive, coarse-grained, well-rounded, light-gray sandstone. Lesser amounts of interbedded light-gray to gray shale, black chert, bluish-gray limestone, and gray calcareous conglomeratic sandstone (often containing clasts of meta-arkose) are usually present. Some large boulders of meta-arkose and other exotics occur in some slurried conglomerate intervals. The unit is often set with a network of quartz veins up to several inches thick. In some places the quartz veins are open (up to several feet wide) allowing clusters of quartz crystals to form. Conodonts are present in this formation. The contact with the

underlying Collier Shale is considered conformable. Typical thicknesses of the unit range from 500 to 850 feet, but some sites may have less than 50 feet.
Original reference: A. H. Purdue, 1909, Geological Society of America Bulletin v. 19, p. 557; A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 32.
Type locality: Named for the Crystal Mountains, Montgomery County, Arkansas.

MAZARN SHALE/FORMATION [Om]
Age: Early Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The formation is predominantly shale with small amounts of siltstone, silty to conglomeratic sandstone, limestone, and glossy black chert. The shale is mostly gray-black, but thin layers of olive-gray silty shale or siltstone are interbedded with the darker shales in some sequences. When the dark and greenish shales are cleaved at an angle to bedding, they yield a ribboned surface. In many places quartzose siltstone or very fine-grained sandstone is present. Dense, bluish-gray, thin-bedded limestones may be present throughout the interval. Thin to thick beds of gray sandstone are occasionally found at random horizons, notably in the upper and lower portions of the sequence. The cherts are usually found in the upper part of the unit. Milky quartz veins are common in some areas. Only conodonts and a few graptolites have been noted. The unit is conformable with the underlying Crystal Mountain Sandstone. The thickness of the Mazarn Shale ranges from 1,000 feet to over 2,500 feet.
Original reference: H. D. Miser, 1917, U. S. Geological Survey Bulletin, V. 660, p. 68.
Type locality: Named for Mazarn Creek (headwaters), eastern Montgomery County, northeastern Caddo Gap Quadrangle, Arkansas.

BLAKELY SANDSTONE/FORMATION [Ob]
Age: Middle Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The formation consists of black and green shale in alternating layers with hard, gray sandstone and some bluish-gray limestone. Although the shale may locally make up 50 to 75 percent of the sequence, the sandstones appear dominant due to their erosion resistance. The sandstones are light-gray to blue, medium-grained, well-cemented, and in thin to thick beds. Silica or calcite may be present as cement. Where the cement is silica the sandstone is quartzite and is quite resistant to weathering. Erratic meta-arkose boulders and pebbles occur in some conglomeratic sandstones. The shales of the Blakely are sometimes ribboned much like the Mazarn shales. Graptolites and conodonts are the fossils reported from the formation. The lower contact is considered conformable. The thickness ranges from a few feet to about 700 feet.
Original reference: E. O. Ulrich, 1911, Geological Society of America Bulletin, V. 22, p. 676.
Type locality: Named for Blakely Mountain, Garland County, Arkansas.

WOMBLE SHALE/ FORMATION [Ow]
Age: Middle Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains; southern Oklahoma
Geology: The Womble Formation is mostly black shale with thin layers of limestone, silty sandstone, and some chert. Some green shales are interbedded with the black shales, but less so than in the Mazarn Shale. Cleavage, at an angle to bedding, frequently displays ribboned cleavage surfaces. The sandstones are dark-gray, compact, fine-grained, occasionally conglomeratic, and may be phosphatic. These sandstones are generally present in the lower part of the formation. Dense, blue-gray limestones usually occur near the top of the formation in thin to medium beds. Black chert also is present as thin layers at the top of the formation. Large milky quartz veins often fill fractures in the formation. Graptolite and conodont fossils have been noted from the Womble Shale. The formation rests conformably on the underlying Blakely Sandstone and ranges from 500 to 1,200 feet in thickness.
Original reference: H. D. Miser, 1917, U. S. Geological Survey Bulletin 600, p. 67

Type locality: Named for the town of Womble (now called Norman) in Montgomery County, Arkansas.

BIGFORK CHERT/FORMATION [Obf]
Age: Middle and Late Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The Bigfork Chert consists of thin-bedded, dark-gray, cryptocrystalline chert interbedded with varying amounts of black siliceous shale, calcareous siltstone, and dense, bluish-gray limestone. The cherts normally occur in thin to medium beds and are usually highly fractured. The interbedded siliceous shales occur in thin to thick sequences and are often pyritic. Limestones occur mostly as interbeds in the chert and typically weather to soft brown layers. The limestones are more common in the northwestern exposures. Fossils are rare, but fragments of brachiopods, crinoids, sponges, conodonts, and graptolites have been reported. The contact between the Bigfork Chert and the underlying Womble Shale is conformable. The Bigfork in Arkansas ranges in thickness from about 450 feet in the northern Ouachitas to about 750 feet in the southern Ouachitas.
Original reference: A. H. Purdue, 1909, Geological Society of America Bulletin v. 19, p. 557; A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 35.
Type locality: Named for exposures near the Bigfork Post Office, Montgomery County, Arkansas.

POLK CREEK SHALE/FORMATION [Opc]
Age: Late Ordovician Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The Polk Creek rocks are black, sooty, fissile shale with minor black chert and traces of gray quartzite and limestone. Graptolites are common in most of the shales in the formation. The Polk Creek Shale rests conformably on the Bigfork Chert. Its thickness ranges from about 50 to 225 feet.
Original reference: A. H. Purdue, 1909, Geological Society of America Bulletin v. 19, p. 557; A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 36.
Type locality: Named for Polk Creek, Caddo Gap Quadrangle, Montgomery County, Arkansas.

BLAYLOCK SANDSTONE/FORMATION [Sb]
Age: Silurian Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The Blaylock Sandstone consists of fine- to medium-grained sandstone of tan, dark-gray, or greenish color, interbedded with dark-colored to black, fissile shale in the southern Ouachita Mountains. The sandstones are usually thin-bedded, but some intervals consist of fairly thick beds. The sandstones tend toward wackestones with small amounts of plagioclase, zircon, tourmaline, garnet, leucoxene, and mica. The shales, which may dominate thick sequences, are usually dark-gray and micaceous. Fossils are rare: only graptolites and a few trace fossils have been reported. The unit rests conformably on the Polk Creek Shale. The formation ranges from as much as 1,200 feet thick along the southwestern part of its outcrop area in Arkansas, but thins dramatically to the north where it is frequently represented by only 5 to 20 feet of olive-gray shale.
Original reference: A. H. Purdue, 1909, Geological Society of America Bulletin v. 19, p. 557; A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 37.
Type locality: Named for Blaylock Mountain, Montgomery County, Arkansas.

MISSOURI MOUNTAIN SHALE/FORMATION [Sm]
Age: Silurian Period
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma
Geology: The Missouri Mountain Formation is a shale interbedded with various amounts of conglomerate, novaculite, and sandstone. The shales are usually gray, green, black, or red and weather to buff, green, yellow, or reddish-brown. Conglomerate is normally present at or near the base of the unit and may be up to 4 feet thick. Thin beds of novaculite are present in the upper part of the unit. Thin quartzitic sandstones occur throughout the unit, but are more common in the upper and lower parts. Few identifiable fossils have been found in the Missouri Mountain Shale. The formation rests conformably on the Blaylock Sandstone to the south and on the Polk Creek Shale in the northern part of its outcrop range. It reaches a maximum of about 300 feet in thickness.
Original reference: A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 37.
Type locality: Named for exposures in the Missouri Mountain, Polk and Montgomery Counties, Arkansas.

ARKANSAS NOVACULITE FORMATION [MDa]
Age: Devonian and Early Mississippian Periods
Distribution: West-central Arkansas, Ouachita Mountains; southeastern Oklahoma; equivalent novaculite-bearing formation in Texas is the Caballos Novaculite
Geology: Three Divisions of the Arkansas Novaculite Formation are recognized (except in the northern exposures). The Lower Division is a white, massive-bedded novaculite with some interbedded gray shales near its base. The Middle Division consists of greenish to dark gray shales interbedded with many thin beds of dark novaculite. The Upper Division is a white, thick-bedded, often calcareous novaculite. Conodonts and other microfossils are sometimes common in the Arkansas Novaculite. The formation rests conformably on the Missouri Mountain Formation at most places, but the presence of conglomerates in a few places suggests a possible minor incipient submarine disconformity. The formation may attain a thickness of up to 900 feet in its southern outcrops, but thins rapidly to about 60 feet to the north.
Original reference: A. H. Purdue, 1909, Slates of Arkansas: Arkansas Geological Survey, p. 30, 39-40; (L. S. Griswold, 1892, Arkansas Geological Survey Annual Report 1890, V. 3, p. 57-61, 69, 85, 87-113).
Type locality: Named for quarries in Arkansas (especially near Hot Springs in Garland County) that produced this rock under the trade name of "Arkansas Novaculite."

STANLEY SHALE/FORMATION (GROUP) [Mst/Ms/PMs]
Age: Mississippian Period
Distribution: West-central Arkansas, Ouachita Mountains; central southern and southeastern Oklahoma
Geology: The Stanley Shale is composed of dark-gray shale interbedded with fine-grained sandstone. A thick sandstone member, the Hot Springs Sandstone, is found near the base of the sequence and an equivalent thin conglomerate/breccia occurs at the base of the unit in many other places. Stratigraphically minor amounts of tuff, chert, bedded and vein barite, and conglomerate have also been noted in various parts of the sequence. Silty sandstones outside the Hot Springs Sandstone Member are normally found in thin to massive beds separated by thick intervals of shale. The tuffs (Hatton Tuff Lentil and others) seem to be restricted to the lower part of the Stanley Shale. Cherts are sometimes present in the middle and upper parts of the formation. Both plant and invertebrate fossils occur in the Stanley Shale, but the preservation is usually poor. The Hot Springs Sandstone and conglomerate/breccia at the base of the formation possibly indicates a submarine disconformably between the Stanley Shale and the Arkansas Novaculite in Arkansas. The total thickness of the Stanley Formation varies from 3,500 feet to over 10,000 feet. The Hot Springs Sandstone may be as much as 200 feet thick in the area around Hot Springs, but is thinner elsewhere.

Original reference: J. A. Taff, 1902, U. S. Geological Survey Geological Atlas, Folio 79
Type locality: Named for Stanley, Pushmataha County, Oklahoma.

JACKFORK SANDSTONE/FORMATION (GROUP) [Pj]
Age: Pennsylvanian Period, Morrowan Series
Distribution: West-central Arkansas, Ouachita Mountains; southeastern and central southern Oklahoma
Geology: The Jackfork Sandstone is thin- to massive-bedded, fine- to coarse-grained, brown, tan, or bluish-gray quartzitic sandstones with subordinate brown, silty sandstones and gray-black shales. Toward the north of its outcrop area the shale units of the lower and middle Jackfork Sandstone take up more of the section and the sandstones are more lenticular, often occurring as chaotic masses in the shale. Minor conglomerates composed of quartz, chert, and metaquartzite occur notably in the southern exposures of the formation. A few poorly preserved invertebrate and plant fossils have been recovered from the Jackfork Formation. The Jackfork Sandstone rests conformably on the Stanley Shale and varies between 3,500 to 6,000 feet in thickness.
Original reference: J. A. Taff, 1902, U. S. Geological Survey Geological Atlas, Folio 79.
Type locality: Named for Jackfork Mountain, Pittsburg and Pushmataha Counties, Oklahoma.

JOHNS VALLEY SHALE/FORMATION [Pjv]
Age: Pennsylvanian Period, Morrowan Series
Distribution: West-central Arkansas, Ouachita Mountains, southern Arkansas River Valley; southeastern Oklahoma
Geology: The Johns Valley Shale is generally a gray-black clay shale with numerous intervals of silty, thin to massive, brownish-gray sandstone. Small amounts of gray-black siliceous shale and chert have also been noted. In the frontal Ouachita Mountains the unit contains large quantities of erratic rocks (limestones, dolostones, cherts, etc.) formed by submarine slumping of older stratigraphic units to the north. The Johns Valley Shale is conformable with the underlying Jackfork Sandstone. Due to the high degree of structural deformation, the total thickness of the unit is difficult to estimate, but it likely exceeds 1,500 feet in thickness.
Original reference: E. O. Ulrich, 1927, Oklahoma Geological Survey Bulletin 45, p. 6, 21-23, 30, 36-37.
Type locality: Named for Johns Valley, Pushmataha County, Oklahoma; exposures in the center of the Tuskahoma syncline (N 1/2, T1S, R16E).

ATOKA FORMATION [Pa: Pal Pam Pau]
Age: Pennsylvanian Period, Atokan Series
Distribution: In Arkansas the Boston Mountains, Arkansas River Valley, and Ouachita Mountains; eastern Oklahoma, eastern New Mexico, and central and western Texas
Geology: The Atoka Formation is a sequence of marine, mostly tan to gray silty sandstones and grayish-black shales. Some rare calcareous beds and siliceous shales are known. This unit has the largest areal extent of any of the Paleozoic formations in the state. It is the surface rock of the Boston Mountains and dominates the exposures in the Arkansas River Valley and the frontal Ouachita Mountains. It is also present in the southern part of the Ouachita Mountains. In the Arkansas River Valley and the frontal Ouachita Mountains, the Atoka Formation has been subdivided into upper, middle, and lower lithic members based on regionally mappable shale or sandstone intervals. The unit locally contains discontinuous streaks of coal and coaly shale in the Boston Mountains and Arkansas River Valley. Fossil plants, generally poorly preserved, are common throughout the section. Poorly preserved invertebrate fossils are much less common than plant fossils, but have been reported from several horizons. Trace fossils are relatively common in the Atoka Formation. The formation is conformable with the Bloyd Shale in the Boston Mountains and with the Johns Valley Shale in the Ouachita Mountains. The unit may be up to 25,000 feet in thickness in the Ouachita Mountains, although only large incomplete sections are known.

Original reference: J. A. Taff and G. I. Adams, 1900, U. S. Geol. Survey 21st Ann. Rept., pt. 2, p. 273.
Type locality: Named for Atoka, Atoka County, Oklahoma.

HARTSHORNE SANDSTONE/FORMATION [Phs]
Age: Pennsylvanian Period, Desmoinesian Series
Distribution: West-central Arkansas, Arkansas River Valley; eastern Oklahoma
Geology: The Hartshorne Sandstone is a brown to light-gray, massive, frequently cross-bedded, medium-grained sandstone. It is the first continuous sandstone underlying the Lower Hartshorne Coal. The formation is a prominent ledge-former under favorable structural conditions. A few fragmental plant fossils have been noted in the formation. The Hartshorne Sandstone rests with minor unconformity on the Atoka Formation. The unit's thickness ranges from about 10 to 300 feet.
Original reference: J. A. Taff, 1899, U. S. Geol. Survey 19th Ann. Rept., pt. 3, p. 436
Type locality: Named for exposures near Hartshorne, Pittsburg County, Oklahoma.

MCALESTER FORMATION [Pma]
Age: Pennsylvanian Period, Desmoinesian Series
Distribution: Western Arkansas River Valley, Arkansas coal fields; eastern Oklahoma
Geology: The McAlester Formation consists of (in ascending order): several hundred feet of shale with thin sandstone and coal (the Lower Hartshorne Coal is just above the base), several hundred feet of shale with a few sandstone beds and coal (Upper Hartshorne Coal), and capped by several hundred feet of shale with a few coal beds. Plant and a few invertebrate fossils have been reported from several horizons within the formation. The McAlester Formation rests conformably on the Hartshorne Sandstone. The unit ranges from about 500 to 2,300 feet in thickness.
Original reference: J. A. Taff, 1899, U. S. Geol. Survey 19th Ann. Rept., pt. 3, p. 437
Type locality: Named for exposures around McAlester, Pittsburg County, Oklahoma.

SAVANNA FORMATION [Psv]
Age: Pennsylvanian Period, Desmoinesian Series
Distribution: Western Arkansas River Valley; eastern and southern Oklahoma
Geology: The Savanna Formation consists mostly of dark-gray shale and silty shale. It contains minor amounts of light-gray siltstone and medium-gray, very fine- to fine-grained sandstone. On rare occasions, the sandstones may contain rounded, coarse-grained, quartz sand. The beds at the base and top of the section are normally the thickest. At least six coal beds are present in the formation. The unit caps isolated synclinal mountains in the western Arkansas River Valley. Fossils are few, but plant and marine invertebrate faunas have been recovered. The Savanna Formation is conformable with the underlying strata. The Savanna Formation is about 1,600 feet in thickness at its type section, but the top several hundred feet of the sequence is usually missing in Arkansas.
Original reference: J. A. Taff, 1899, U. S. Geol. Survey 19th Ann. Rept., pt. 3, p. 437
Type locality: Named for Savanna, Pittsburg County, Oklahoma.

BOGGY FORMATION
Age: Pennsylvanian Period, Desmoinesian Series
Distribution: Generally limited to isolated exposures in the Arkansas River Valley; fairly widespread in central southern and eastern Oklahoma
Geology: Only basal portions of the Boggy Formation are present in Arkansas. It is composed of light-gray, fine- to medium-grained, silty, micaceous sandstone. Typically the sandstones are cross-bedded, ripple-marked, and contain thin beds of light-gray siltstone and dark-gray shale. Plant fossils have been recovered, associated with some thin coal beds in the Boggy Formation of Oklahoma. The basal sandstone sequence fills channels cut into the underlying Savanna

Formation. About 225 feet of the lower Boggy Formation are present in Arkansas, but the unit may reach 1,100 feet in thickness in Oklahoma.
Original reference: J. A. Taff, 1899, U. S. Geol. Survey 19th Ann. Rept., pt. 3, p. 438.
Type locality: Named for exposures along North Boggy Creek, Pittsburg and Atoka County, Oklahoma.

TERRACE DEPOSITS [Qt]
Age: Quaternary Period, Pleistocene Epoch
Distribution: Arkansas River valley and significant tributaries
Geology: The terrace deposits include a complex sequence of unconsolidated gravels, sandy gravels, sands, silty sands, silts, clayey silts, and clays. The individual deposits are often lenticular and discontinuous. At least three terrace levels are recognized with the lowest being the youngest. Fossils are rare. The lower contact is unconformable and the thickness is variable.

ALLUVIUM [Qal}
Age: Quaternary Period, Holocene Epoch
Distribution: Flood plains of the Arkansas River and significant tributaries
Geology: The deposits indicated by this notation are alluvial deposits of present streams. Sediments will include gravels, sands, silts, clays, and mixtures of any and all of these clastic materials. The partition of this unit from other Holocene alluvial deposits was on the basis of geomorphic considerations rather than age or lithology. Fossils are rare and modern. The lower contact is unconformable and the thickness is variable.

II. Geologic descriptions of the Oklahoma portion of the Ouachita National Forest

Geologic descriptions Oklahoma portion of the Ouachita National Forest are similar to the Arkansas descriptions for the Arkansas side. Additional descriptive information taken primarily from the Oklahoma Geological Survey (website: http://www.ogs.ou.edu/) is listed here:

Stanley Group, Mst, Mississippian:
Lands in McCurtain County near Broken Bow Lake -- From: Marcher, Melvin V., and DeRoy L. Bergman, 1983, Reconnaissance of the Water Resources of the McAlester and Texarkana Quadrangles, Southeastern Oklahoma [Geologic Map]: Oklahoma Geological Survey Hydrologic Atlas #9 "Shale, olive-green to gray, illitic, chloritic, with many 5- to 30-foot-thick beds of poorly sorted, micaceours, quartzose sandstones and some thin siliceous cherty beds and black shales; several tuff beds occur in basal 1,000 feet and are indicated by red line [on the geology map] in Stanley exposures exposures as designated on [the geology] map; many asphaltite, lead, and quartz veins occur along fault zones; mostly Chesterian age; thickness, 7,500 to 14,000 feet or more."

Atoka Formation From: Suneson, Neil H., 1991, Geologic Map of Blackjack Ridge Quadrangle, LeFlore County, Oklahoma: Oklahoma Geological Survey.

Atoka Formation, Pa: Pal Pam Pau, Lower Middle Upper Atoka Pennsylvanian:
"Predominantly poorly exposed, olive -gray (5Y3/2) to olive-black (5Y2/1), slightly silty, noncalcareous, poorly laminated shale and mudstone. Stratification in some beds contorted. Some beds have sheared appearance, and shale fragments have well-developed "sheen." Locally fissile, weathers to "flaky" appearance. Contains rare sandstone and siderite pods or concretions elongate parallel to bedding. Some beds exhibit "pencil" structure. Contains many thin beds of laminated siltstone and very fine-grained sandstone and rare beds of dark-colored siliceous siltstone. Also contains less common, moderately well exposed sandstone beds as much as about 20 m thick. Sandstone typically is light-olive-gray (5Y5/2), yellowish-gray

(5Y7/2), to medium-light-gray (N6). Mostly very fine-grained to moderately fine-grained and silty, poorly to moderately sorted, and noncalcareous. In southern thrust sheets, the basal 1500 m (4800 ft) appears to be locally medium-grained or bimodal with medium-sized grains supported in a fine-grained matrix. Based on hand-specimen examination, sandstones generally composed of about 95% quartz, 2-5% feldspar and rock fragments, and conspicuous white mica parallel to laminations; quartz rarely less than 75% or greater than 98%. Individual beds mostly vary from several centimeters to several meters thick and average about 60 cm. Amalgamated beds common, forming resistant ridges and dip slopes easily identifiable on aerial photographs; these marker beds are mapped. Thicker beds are generally unstratified (corresponding to Ta of Bouma sequence) grading upwards to parallel-laminated (Tb); some beds exhibit low-angle, moderate- to long-wavelength, undulatory stratification similar to incipient dish-and-pillar or slump structures. Thinner beds commonly are ripple cross-laminated (Tc). Dish-and-pillar structures common. Sole marks (flute, groove, and load casts, trace fossils) at base of sandstone beds locally common. (Sole marks more common than in Jackfork Group sandstones.) Some beds have planar or slightly undulatory bases. Tops of sandstone beds typically grade upwards to siltstone; ripples or irregular tops caused by dewatering or slumping less common. Unfossiliferous except for local concentrations of plant debris on bedding planes throughout the formation and brachiopod and crinoid fossil fragments in rare beds in the lower part of the formation, particularly in the eastern part of the quadrangle. Porosity typically is very low except where medium-grained, fossiliferous, and/or moderately sorted. Sandstone beds typically weather to platy or blocky appearance; rarely vuggy; maximum exposed thickness approximately 2,100 m (7,000 ft); top not exposed." *Units Present North of Choctaw Fault*

Atoka Formation From: Mazengarb, C. and L.A.Hemish, 1993, Geologic Map of the Hontubby and Loving Quadrangles, LeFlore County, Oklahoma: Oklahoma Geological Survey Open File Map.

Atoka Formation, Pa: Pal Pam Pau, Lower Middle Upper Atoka Pennsylvanian: "Predominantly poorly exposed, olive gray (5Y3/2) to grayish-olive (10Y4/2), slightly silty, noncalcareous shale (Pa) containing sideritic nodules. Includes numerous, continuous to discontinuous, ridge-forming moderate-yellowish-brown (10YR5/4) to dark-yellowish-orange (10YR6/6), very fine grained, silty, micaceous sandstones (Pass) containing plant fragments, sole markings, and trace fossils. Includes grayish-black (N2), fissile shale beds, and two unnamed coal beds in upper part. Sandstone units variable in thickness, generally thinly parallel-bedded with interstratified siltstones and shales; commonly ripple-marked; contacts usually gradational. Approximately 7,500 ft (2,300 m) exposed north of Choctaw fault." *Units Present South of Choctaw Fault*

Atoka Formation, Pa: Pal Pam Pau, Lower Middle Upper Atoka Pennsylvanian: "Predominantly alternating sandstone and shale (mudstone) sequence dominated by shale. Shale is olive-gray (5Y3/2) to grayish-olive (10Y4/2), slightly silty, noncalcareous, and poorly laminated. Single siliceous shale bed, 1.2 in. (3 cm) thick (marked on map). Sandstone is light-olive-gray (5Y5/2) and yellowish-gray (5Y7/2) where fresh, and grayish-orange (10YR7/4) where weathered. Mostly fine-grained, rarely medium grained, poorly to moderately sorted, noncalcareous, and composed predominantly of quartz, with minor feldspar, lithic fragments, and conspicuous white mica. Sandstone beds vary from several inches to several feet thick and average about 2 feet (60 cm). Amalgamated beds are common, forming resistant ridges and dip slopes, some of which are depicted (as marker beds) on the map. Sandstones, which are interpreted as turbidites, contain well developed sedimentary structures, including impressive sole structures (flute, groove and load casts, trace fossils), parallel and ripple cross lamination, and water expulsion (convolutions, dish and pillar) features. The formation is absent of macrofossils except for local concentrations of plant fragments on bedding planes. Thickness of the formation is uncertain, but a minimum 10,600 ft (3,200 m) is estimated. Maximum exposed thickness south of Choctaw fault approximately 11,000 ft (3,400 m); top not exposed."

Hartshorne Sandstone, Phs, Lower Des Moines Pennsylvanian: The Hartshorne Sandstone consists mostly of sandstone, with some siltstone, shale, and at least two economically important coal beds. The Lower portion consists of dense, massive, though usually thin bedded, gray sandstones, which are somewhat shaley. The interbedded shales are thin, silty, and gray. The middle portion of the unit consists of about 50 feet of gray platy shales. The Upper 75 feet of the unit consists of thick, generally massive, gray to brown sandstones. The total thickness of the unit varies from 100 to 400 feet in Arkansas and Oklahoma, but is usually about 225 feet thick in Oklahoma. The upper and lower Harshorne coal beds are among the most important in southeastern Oklahoma. These beds are mapped as part of the Hartshorne Sandstone Formation in Oklahoma and as part of the McAlester Shale Formation in Arkansas. In Oklahoma, the Hartshorne coal beds near Heavener, Oklahoma just north of the Choctaw Ranger District, together measure from 5 to 7 feet thick. These beds, along with beds from other formations, are part of the federal coal reserves identified by the Bureau of Land Management and the Oklahoma Geological Survey for the "Southeast Oklahoma Planning Unit."

From: Hemish, L.A. and Colin Mazengarb, 1992, Geologic Map of the Summerfield Quadrangle, LeFlore County, Oklahoma: Oklahoma Geological Survey Open File Geologic Map.

Savanna Formation, Psv, Upper Des Moines Pennsylvanian: "Predominantly pale-yellowish-brown (10YR 6/2) to olive-gray (5Y 3/2) to medium-dark-gray (N 4) shales (Psv) with several mappable moderate-brown (5YR 4/4) to grayish-orange (10YR 7/4) to moderate-reddish-brown (10R 4/6), fine to very fine-grained, noncalcareous sandstone units (Psv1, Psv2, Psv3, Psv4, Psv5, Psv6, Psv7). The sandstones are massive to thin bedded and shaly. They commonly are cross bedded and ripple marked and in places contain abundant soft-sediment deformation features. Sole marks (trace fossils; brush and prod marks; flute, groove, and load casts) at the base of some sandstone beds are locally common. Psv 1 is mappable only in the north-central part of the area. It forms a low ridge east of Little Caston Creek for a distance of about 1 mile, but then disappears under the alluvium of Caston Creek. Where exposed, the base of Psv1 marks the base of the Savanna Formation. Just west of Caston Creek, in the SW 1/4 sec. 30, T.6N R.23E., a thin (0.2 ft), fossiliferous, marine limestone is exposed in a shale interval below Psv2 in approximately the same position stratigraphically as the Spaniard Limestone Member of the shelf area of northeastern Oklahoma. The base of the Spaniard Limestone marks the base of the Savanna Formation in the shelf area. The marine limestone in sec. 30 is tentatively correlated with the Spaniard Limestone. In the absence of Psv1 in the area west of Caston Creek, it marks the base of the formation. A second marine limestone occurs in the stratigraphic interval between Psv2 and Psv3, approximately in the same position as the Sam Creek Limestone Member of the shelf area. It is predominantly olive-gray (5Y 4/1), to light-brownish-gray (5YR 6/1), to dark-yellowish-brown (10YR 4/2), impure, silty, fossiliferous, and about 1.2-1.6 ft thick. It is tentatively correlated with the Sam Creek Limestone of the shelf area. Psv2 thins markedly east of Caston Creek. Psv4 is thin and shaly and mappable for a distance of only about 2 miles. All Psv sandstone units locally contain shale beds. Most shales include thin, unmappable sandstone units. The Cavanal coal bed (20-22 in. thick) occurs in the shale interval just below Psv5. Thickness is 1,400-1,600 feet."

Goodland Limestone, Kg/Kgw, Lower Cretaceous Tiak RD: The Goodland Limestone (Kg), part of the Fredericksburg group, overlies the Antlers Sandstone (not exposed in this area) and is well exposed and readily identifiable, particularly along Little River. It consists of a thick, irregularly bedded, chalky white, fine-grained crystalline limestone, and erodes into a mappable escarpment. The lower limestone is white on fresh surfaces, and gray, pale orange, or pale blue on weathered surfaces. The dense upper limestone is oolitic in places. It is grayish white to pale orange where unweathered and sooty gray on weathered surfaces. The formation is abundantly fossiliferous, containing pelecypods, gastropods, echinoids, and ammonites. The Goodland

Limestone ranges in thickness from about 28 to 95 feet, and is about 50 feet thick near Idabel. Some argillaceous buff beds in the lower few feet may be "Walnut Clay" (Kw) equivalents. These units may be mapped together as the "Goodland Limestone and Walnut Clay" (Kgw). The Goodland Limestone apparently does not yield much water to wells, and the water is of poor quality.

Kiamichi Formation, Kk, Lower Cretaceous Tiak RD: The Kiamichi Formation, part of the Fredericksburg group but often mapped with the Washita group, overlies the Goodland Limestone. It is dark-gray to black shale with some brown fossilferous limestone. Thickness of exposed strata is as much as 28 to 36 ft. increasing to 80 ft. in the subsurface of McCurtain County. The upper boundary of the Kiamichi has not been delineated in Southern McCurtain County and the formation is included with the rocks mapped as "Washita." The Washita group including the Kiamichi formation consists of relatively thin beds of highly fossiliferous gray limestone alternating with thick beds of unconsolidated clay. The lower part of the limestone beds are compact, bluish gray to white, and highly fossiliferous. In the upper part, the limestones are softer, thicker bedded, gray or yellowish tan, and somewhat less fossiliferous than the lower part. Thin beds of clay separate some of the limestone beds and thicker beds of clay shale separate others. These beds of clay shale are mostly dark blue or black, weathering to light gray, yellow, and various other colors. The clays and clay shales are calcareous and commonly sandy. The thickness of the Washita ranges from 20 feet to about 200 feet in Southern McCurtain County. The unit contains relatively small amounts of water, primarily associated with the limestone, which is reportedly of poor quality.

Woodbine Formation, Kwbt Kwbs, Lower Upper Woodbine Upper Cretaceous Tiak RD: The surface exposures of the Woodbine form low, rolling hills that are covered with a thick mantle of red sand loam. The lower, tuffaceous, member of the Woodbine consists principally of highly cross-bedded coarse poorly consolidated dark green tuffaceous sand that weathers yellowish green to yellowish red and locally is cemented by calcite into balls or lenses. Interbedded with the sand is brownish-red clay. At the base in a few places is a white sand. Also included are a few gravel lentils, some of them rather extensive. The clays are lenticular and occur throughout the member, but are most abundant in the upper part. Typically the clays are brownish red, but at places they are red. The clays are almost entirely noncalcareous. The lack of calcium carbonate and the reddish color of the clays differentiates them from the clays in the underlying Washita. The upper member of the Woodbine formation is composed principally of gray to brown cross-bedded sand and sandy gravel with some brown or reddish-brown clay lenses. Field investigations over much of the exposure of the Woodbine on the Tiak district failed to show any evidence of gravel, probably because only the lower member is exposed. Thickness of the Formation ranges from 155 feet to about 455 feet increasing eastward. As a consequence of its thickness and southerly dip, the outcrop zone locally approaches 5 miles in width from north to south. The formation is not a productive aquifer and the water quality is reported to be poor, but capable of producing adequate supplies for stock animal uses.

Tokio Formation, Kt Kto, Upper Cretaceous Tiak RD: strata of the Tokio Formation crop out in a band as wide as 11 miles just south of the Woodbine, and are composed of gravel, light gray quartz sand, and clay shale. The sands are cross-bedded and poorly sorted, at many places are argillaceous, and weather to brown, red, or a mottled color. In some exposures small, hard plates cemented with iron weather out of the sand; in other exposures, the sand is massively bedded and weathers to a soft, sandy soil. The clay shales are generally gray and at many places have dark brown or black streaks caused by iron and manganese staining. The cross bedding, together with petrified wood, poor sorting and local, intraformational unconformities, indicates that the Tokio is a product of shallow, near shore environment. Thickness ranges from 88 to 380 feet thickening southeastward. Water yield from this formation is reported at less than 20 gallons per minute. A peculiar feature of the Tokio is the presence of cylindrical pipes or conical structures. These are erratically distributed, bunched at some places and widely

scattered at other, being most abundant about 3 miles south of Haworth. They reach a maximum length of more than six feet and are perpendicular to the bedding planes. They range in diameter from 0.1 foot to 0.7 foot. Some even have pipes within pipes. Their mineral composition is identical with that of the surrounding beds, but the pipe filling lacks stratification and is lighter in color. A hard, ironstone-like shell causes them to weather out as small knolls or humps.

Ozan and Brownstown Formations, Undifferentiated, Kob, Upper Cretaceous Tiak RD: The Brownstown Marl Formation (Kbr) is comprised of marl and clay, gray, calcaceous, micaceous, sandy, and fine-grained sand, with some interbedded chalky limestone, and has a total thickness of about 100 ft. The Brownstown Marl formation is exposed in the Pine Creek and McKinney Creek area in the extreme southeastern portion of the Tiak District, in conjunction with the overlying Ozan Formation. The Ozan Formation (Ko) is marl and clay, light- to dark- to brownish-gray, micaceous, clacareous, sandy and fine-grained sand, with interbedded chalky limestones. Clauconitic marl and sand are at the base of the Ozan Formation, and its total thickness is about 100 ft. Together, the strata of the Ozan and Brownstown Marl Formations (Kob) form an escarpment that rises as much as 30 feet above the Tokio Formation to the north and as much as 60 feet above the alluvial deposits to the west and south. The limestones and marls are light gray to white on both fresh and weathered surfaces. Small black particles, about the size of very fine sand, along with a few small pebbles, are sparsely scattered through the limestone. The limestone weathers into angular or nodular boulders and cobbles because of vertical and horizontal jointing. The joints are weathered brown at most outcrops. The clays are light gray to brownish gray and contain a few brown iron stains. Mica and sand in the clay cause it to be flaky. Thickness of the unit has not been determined, but it may be as much as 195 feet thick. Reportedly, only enough ground water is yielded from this unit for domestic use.

Terrace Deposits, Qt, Quaternary Pleistocene: Terrace deposits are described as containing gravel, sand, silt, clay, and some volcanic ash generally situated at several levels 20 to 160 feet or more above present flood plains, with each level containing deposits that average 20 to 30 feet in thickness. Some have windblown sand on top. The terrace deposits are positioned on the uplands between stream valleys. These deposits may also include colluvial wash on the sides of hills. Whereas there is little question about the origin of the alluvium deposits, that of the terrace deposits is not always clear. Situated as they are at several levels above present stream action, and containing materials such as volcanic ash, which is not obvious in the alluvium, they must have originated before the current alluvium deposits. The extent to which they are residual, transported or colluvial materials or a mixture thereof has not been determined. The terrace deposits in McCurtain County, Oklahoma, are reported to yield only enough water for domestic and stock use.

Alluvium, Qal, Quaternary Holocene: Alluvium is gravel, sand, silt, and clay, including low terraces generally about 30 feet above stream channels, associated directly with stream bottoms and floodplains as the obvious product of the regime of these streams. Alluvium deposits can vary widely in thickness. For example, on the Tiak Ranger District, the alluvium is about 50 feet thick along Little River and 110 feet thick along Red River. The alluvium deposits in McCurtain County, Oklahoma, are reportedly capable of yielding several hundred gallons of water per minute at some locations.

OGS Open-File Maps: Blackjack Ridge Quadrangle, LeFlore County, Oklahoma by Neil H. Suneson, 1991; Hodgen Quadrangle, LeFlore County, Oklahoma by Neil H. Suneson and Leroy A. Hemish, 1993; Hontubby and Loving Quadrangles, LeFlore County, Oklahoma by Colin Mazengarb and Leroy A. Hemish, 1993; LeFlore Quadrangle, Latimer and LeFlore Counties, Oklahoma by Leroy A. Hemish, 1991; LeFlore SE Quadrangle, LeFlore County, Oklahoma by Leroy A. Hemish and Neil H. Suneson, 1991; Red Oak Quadrangle, Latimer County, Oklahoma by Leroy A. Hemish, Neil H. Suneson and Charles A. Ferguson, 1990; Summerfield

Quadrangle, LeFlore County, Oklahoma by Leroy A. Hemish and Colin Mazengarb, 1992; Talihina Quadrangle, Latimer and LeFlore Counties, Oklahoma by Neil H. Suneson and Charles A. Ferguson, 1990; USDA, 1967, Geologic Map of LeFlore County Oklahoma: USDA, Soil Conservation Service, Stillwater, Oklahoma.

Oil and Gas Reasonably Foreseeable Development Scenario

From: USDA Forest Service and USDI Bureau of Land Management
(BLM Jackson, Mississippi and Tulsa, Oklahoma Field Offices)
(originally developed for 1990 Ouachita National Forest Plan, updated by the BLM in 2004)

Oil and Gas: Geophysical Exploration, General

Hydrocarbons occur in association with water in porous sedimentary rocks such as sandstone. Since petroleum and natural gas are less dense than water, they rise until trapped by a barrier, usually an impermeable rock layer. The likelihood of the presence of oil and gas is often determined by geological prospecting. Such prospecting can be done on the ground, where off-road vehicle travel may be necessary, or by aerial survey. Photographs from orbiting satellites have also been used to identify surface structure. Subsurface geology is not always accurately indicated by surface outcroppings. To verify surface indicators and to map the subsurface structures, geophysical exploration is used. An issued oil and gas lease is not required for geophysical exploration to occur; it may be permitted prior to or subsequent to leasing. Exploration activities may occur across the same area many times and continue over a period of years.

There are three types of geophysical exploration -- 1. gravitational field, 2. magnetic field, and 3. seismic characteristics. These are discussed as follows:

1. Gravitational prospecting detects variations in gravitational attraction caused by the differences in the density of various types of rock.
2. Magnetic prospecting often replaces or is used to supplement gravitational work. Magnetic methods reveal buried structures (likely to yield oil and gas) because such structures show a strong magnetic response. The only surface disturbance is that caused by the vehicle used to transport gravitational and magnetic prospecting equipment.
3. Seismic prospecting is the most popular geophysical method on the Ouachita National Forest since it gives the most reliable and reproducible results. Generally, geophysical seismic lines are run on wide spacing intervals and are narrowed and concentrated in smaller geographic areas as the target area is better defined. A separate permit is issued by the Forest for each geophysical request, and it will include specific mitigating measures for public safety warnings, wildlife concerns, property protection (fences, wells, buried utility lines, etc.), and site reclamation.

There are a number of geophysical exploration methods. The least impactive include gravity and magnetic surveys and consist of taking readings at regular intervals across the land from either hand held instruments, ground vehicles, or aircraft. No actual surface disturbance in involved unless off-road vehicle travel is used to reach survey points. These methods are used to get subsurface information over a large area. If promising structures are found, other exploration techniques are then used to further define and locate possible traps and structures containing hydrocarbons. One of these, "vibroseis," uses large trucks equipped with metal plates that are lowered from beneath each vehicle to the ground. With the entire weight of the truck resting on the plate, a hydraulic system vibrates the plate and transfers the energy into the ground to be picked up by the seismic detectors (geophones) arrayed along the line of survey. An instrument truck equipped with a seismograph records the seismic information. Two to eight trucks are used in tandem. Unless the topography is relatively flat and open, the trucks are

restricted to existing roads and trails. Little resource disturbance occurs with this type of geophysical exploration.

Another way to impart energy into the ground for the seismograph to record is the use of explosives. This can be accomplished by setting off charges in a hole or on the surface. Conventional seismic exploration drills 4-inch diameter holes to depths of 50-200 feet. An explosive is placed in each hole and detonated with the resulting shock waves recorded by geophones and passed on to the seismograph. The shot holes are made using a truck-mounted drill capable of driving across country. Although no roads are usually built to accommodate these vehicles, they can create trails that result in some soil compaction and movement and vegetation loss. All shot holes are required to be plugged on the Forest. Surface charge seismic involves placing explosive charges on the ground or above ground attached to wooden stakes some three feet high. Once the charges are detonated, geophones strung along the line of survey pick up the vibrations and channel them to the seismograph for recording. Most work is accomplished by hand labor with vehicle access needed only for the instrument truck.

Resource impacts include mowing grass and underbrush within the point of explosive effects. Usually, this is a 5-foot circle around the point of detonation, but it varies depending of the size of the charge. Leaves will also be stripped off of trees within this zone. The noise of the explosions will cause some wildlife displacement and can be heard by people in the area. In difficult terrain, both explosive methods may be done using helicopters to ferry people, materials, and instruments to the detonation points along the lines of survey. This eliminates surface impacts resulting from vehicles, but it adds to the noise factor. The shock waves, initiated by using a thumper/vibrator on the surface, or explosives in the bedrock, travel through or are reflected from various rock layers and are received by shock sensor equipment. The sensors are connected to a truck or portable station where the shock waves are recorded. The time required for shock waves to travel through the rock formations yields useful information. The most common seismic prospecting is surface detonations. Two-to-five pound explosive charges are detonated in clusters (generally 25 two-pound charges or 10 five-pound charges.) Geophones are used to "hear" the seismic reflections and are strung out in long lines extending over the survey area. Each geophone picks up the signals and they are recorded on sensitized paper and on magnetic tape.

Oil and Gas: Geophysical Exploration, Application

All individuals and organizations such as the lessee, a geophysical contractor, a geochemical contractor, or a government agency wishing to conduct exploration activities on National Forest System lands must submit an application for a permit to the appropriate District Ranger responsible for the Forest lands upon which the activity is to take place. This application may take several forms, but it must contain sufficient information relating to the location and nature of the proposed operations to allow the Forest Service issuing office to properly evaluate them.

Oil and Gas: Geophysical Exploration, Analysis and Decision Making

An environmental analysis is conducted on exploration proposals prior to permit approval and permit issuance in accordance with the provisions of Title 40 of the Code of Federal Regulations, Parts 1500 to 1508 (Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.) The appropriate level of analysis and type of NEPA documentation will be based on the nature and scope of individual proposals. Records compiled during the analysis must as a minimum be retained in the permit file(s) maintained at the Ranger District office administering the permit as delegated in FSM 2821.04. The analysis identifies the reasonable and necessary mitigation (stipulations) that, if approved, would be attached to the prospecting permit (Form FS-2800-1).

It is not a prerequisite to have an oil and gas lease to conduct exploration activities on the Federal mineral estate. The lease only provides the right to produce the minerals. On existing issued leases, the lessee, along with every other citizen of the U.S. who has the necessary bonding and permits, has the right to explore his leasehold. As most geophysical or geochemical survey methods constitute a temporary or casual use of the surface, any surface occupancy provisions of the lease terms do not directly apply to the terms and conditions of the prospecting permit. However, the surface resource or use concerns identified in the leasing analysis may, depending upon the nature of the exploration survey proposed, identify possible mitigation needs or management concerns. If the exploration proposal results in surface impacts requiring reclamation, clean up, shot-hole plugging, or other resource damage, an acceptable reclamation performance bond is required prior to permit issuance. The responsible Forest official ascertains if the applicant has an acceptable bond or cash deposit in lieu of bond for the proposed survey, or if the applicant has a Region-wide blanket bond on-file with the Regional Office in accordance with the provisions of FSM 6506.82.

Oil and Gas: Exploratory Drilling

When sufficient information is obtained by industry on the geologic resource, a "drill/no drill" decision is made. Geological and geophysical investigations provide valuable information on the potential for the occurrence of an oil and gas field. Based on this information, lands are leased or cooperative agreements are signed with adjacent lessees (on leased lands) to establish control over the lands within the potential field. Oil and gas operations are discussed for three phases: exploratory drilling, field development, and abandonment and reclamation. These phases are not clear-cut operational phases with distinct starting and ending points. This is especially true for distinguishing between exploration and field development. Frequently, a decision to develop a field cannot be made based on the results of a single, successful well. Additional exploratory wells may be needed for industry to make a decision on whether to develop the field. These additional wells can also provide meaningful information for land managers to help analyze potential impacts of field development and to make decisions based on more accurate information. In reality, few leases ever have geophysical exploration, much less drilling, occur on them. On average, about 90 percent of wells drilled are dry holes.

Before an exploratory (wildcat) well is drilled, the company organizing the drilling venture establishes a controlling interest in leases for all lands in and adjacent to the potential field area. Unitization is the uniting of all leases into a joint venture to operate under a cooperative or unit plan. Once the unit agreement is approved, all operations within the unit area are administered as if there were a single lease (43 CFR 3180).

Oil and gas leases are issued with stipulations to protect other resources. These stipulations authorize federal agencies to restrict oil and gas activities on the lease under certain conditions. The use of appropriate discretion, on a case-by-case basis, to enforce restrictions contained in the lease is the responsibility of the federal agencies. Exceptions to lease stipulations may be approved for a site-specific proposal based on an analysis of the proposal and the need for the lease stipulation to be enforced. If a stipulation is not needed to protect the resource for which it was designed, the stipulation may not be enforced because the restriction serves no purpose in and of itself. However, the inability of the leaseholder to conduct operations within the terms of the lease may be grounds for denial or delay of a particular proposal. The level of analysis and documentation associated with the approval of an exception to a lease stipulation varies. Generally, an exception would be approved if it can be demonstrated that the impacts of a proposed action can be acceptably mitigated or that the impacts to the resource protected by the stipulation would be similar whether or not the exception were approved.

Industry's decision on whether to develop the field is essentially an economic one. This decision depends, at least in part, on the type of hydrocarbon present, i.e., oil or gas, the size and

productivity of the geologic structure and formation, the price of oil or gas, and marketability. In some cases, a discovery may not be fully developed although production may take place to recoup some of the costs of exploration. The initial wildcat (exploratory) well is authorized under an Application for a Permit to Drill (APD). Procedures for submittal of an APD are contained in "Onshore Oil and Gas Order No. 1" issued under Title 43 of the Code of Federal Regulations, part 3164, by the USDI, Bureau of Land Management. After this well is completed, subsequent activities may include additional exploratory or confirmation wells to locate and confirm the presence of an oil and gas reservoir. Once the presence of such a reservoir is confirmed, industry may decide to pursue development of the reservoir (field) to fully extract the resource. When sufficient development wells are completed, the production phase to extract, collect, and transport the resource to the marketplace is initiated to get a return on the investment. Depending upon reservoir characteristics that affect the flow of oil and gas to the wellhead, additional development wells are drilled to extract the oil and gas.

Drilling for gas on the Ouachita National Forest:

- Up to 1989 – five wells drilled in T2N R32W Secs. 3&8, T3N R27W Sec. 1, T4S R25W Sec. 25, T5N R22W Sec. 32, all in Arkansas. Hydrocarbon discoveries reported from several of these wells. None were producers, and consequently all were plugged and reclaimed.
- 1990-1992 – five wells total: two wells drilled in Arkansas in T5N R22W Sec.33, T4N R26W Sec.18, and three wells drilled in Oklahoma in T4N R24E Sec.14, T5N R24E Sec.31, and T4N R23E Sec.10. Hydrocarbon discoveries reported from several of these wells. None were producers, and consequently all were plugged and reclaimed.
- 2000-2001 – two wells drilled in Oklahoma in T4N R23E, Secs.9 and 10. Both wells were plugged and reclaimed.
- 2002-2004 – Access to private mineral estate (Outstanding Mineral Rights) under Federal surface resulted in the drilling of one set of wells for coal bed methane and proposals at the time of this writing for an additional 6 more on the Poteau Ranger District in T4N R32W Sec.32 (Arkansas). The one coal bed methane well drilled in 2004 is a producer. Of the 6 more coal bed methane wells currently under consideration, at least one is anticipated to be drilled in 2005.

Oil and gas exploration on the Forest as specified in the approved APD may include road construction, clearing all vegetation from a one- to three-acre pad site for shallow wells and from four- to six-acre pad site for deeper wells, leveling and shaping of the drill pad site, and transportation and set up of the drilling equipment (drill rig, mud pumps, generators, pipe racks, tool house, and other facilities). Surface disturbance resulting from road and pad construction impacts soil, vegetation, and water resources. Topsoil is stripped and stockpiled for later use in site rehabilitation, but the associated vegetation and vegetative site productivity is lost until then. Some erosion of the exposed surface and sedimentation of streams may result. Wildlife and livestock will be displaced to some extent by the noise and activity at the well location. Air quality reduction from dust will occur locally along unsurfaced roads. If the well is drilled in a previously undeveloped area, this may change the opportunity for dispersed non-motorized recreation to motorized because of the new road.

Approximately 5,000 to 15,000 gallons of water a day may be needed for mixing drilling mud, cleaning equipment, and cooling engines. Water sources may be from wells or streams. Drilling depths on the Forest range from 3,000 feet to 17,000 feet. Transporting and setting up a drill rig capable of reaching the deepest zones requires an access road sufficient to handle the 30 to 40 semi-trucks and trailers of heavy equipment and a daily traffic of 20 to 30 vehicles. A level drill pad of, generally one- to four-acres in size, is needed to set up and operate the rig. Usually, the dimensions of a pad measure 380 by 250 feet (2 acres), but this may be modified based on the natural contours of the land and the other resource values involved. All of the pad must be placed on a "cut" rather than "fill" surface for reasons of safety and rig stability. Once the rig is

set up, drilling usually takes place on a 24-hours/day, seven-days/week basis. Additional standards are contained in "Surface Operating Standards for Oil and Gas Exploration and Development" prepared jointly by the Forest Service and the Bureau of Land Management.

Approximately 30 personnel are needed in drilling a typical well. Drilling may take from 1 to 18 months (typically no more than 3 months) to complete depending on the depth to be drilled. If no economic quantities of gas or oil are found it is considered a dry hole and the facilities are removed and the well pad is reclaimed as described under "Abandonment and Reclamation." The access road is also reclaimed unless it is needed for other purposes in conformance with the Forest Plan.

Oil and Gas: Field Development and Production

If a wildcat well is successful or the geologic information gained from the well log warrants additional exploration, additional exploratory wells may be authorized, on a case-by-case basis (prior to field development), to obtain sufficient information about the hydrocarbon reservoir to make plans to develop the field. After completion of these confirmation wells, there should be sufficient information available from the operator to predict the level of future activity. This appraisal includes information as to the extent of the field, initial and fill-in spacing of wells, need for tank batteries and/or pipelines, power lines, and scheduling of future operations. From this information, an environmental analysis is completed for the potential impacts of the field development and production activities, the need for a transportation plan and utility corridors, and adjustments in the Forest Plan. Before any actual drilling can commence, the operator must have an approved Application for Permit to Drill (APD), which must have gone through the NEPA process. As part of the federal approval process any mineral activity is subject to the environmental analysis requirements of NEPA and the implementing regulations of the Council on Environmental Quality.

Once an operating plan is submitted, BLM and the USFS would complete an environmental analysis on all aspects of the proposal. As required by NEPA, the environmental review would include a formal process for identifying public and agency concerns regarding a mineral proposal. The environmental analysis would specifically address the potential environmental impacts of the proposal and its alternatives. The environmental analysis would be documented in an EA or an EIS, depending on the scope of the proposal, which would be distributed for public and agency comment as part of the BLM and USFS decision making process. The procedures for drilling development wells are about the same as for exploratory drilling except that there is less subsurface sampling, testing, and evaluation. Field development locations are surveyed and a well spacing pattern is established by the State with the concurrence of the BLM and Forest Service. The spacing of the wells from one another depends on the State's regulations and the type of hydrocarbon sought. Gas wells are usually spaced one per section (640 acres), but can be drilled in some circumstances as dense as 4 wells per section (every 160 acres) with oil wells often one per quarter/quarter-section (40 acres). In developed petroleum fields, there are about two miles of roads per section.

Development of Federal oil and gas resources provides a domestic source of petroleum to help offset the import of foreign oil and gas. Foreign imports now make up some 60 percent of the total United States use. The Federal government also receives significant rentals and royalties from leasing and production. States are given 50 percent of these monies from Public Domain status lands and 25 percent from lands with acquired status.

Oil and Gas: Abandonment and Reclamation

If the well is a dry hole, the site is re-contoured, the topsoil spread over the disturbed area, and seeding with native plants and grasses accomplished. If the well is a producer, that portion of

the original pad needed to continue operations will remain unreclaimed for the life of the well (5 to 20 years). Well abandonment requires approval by both the BLM and the Forest Service. Although the approved APD includes a reclamation plan, this plan is reviewed to ensure that it conforms to both the current Forest Plan management direction for the area and the standards and guidelines. Abandonment will be approved when both agencies are satisfied with the reclamation. During the abandonment phase, the reclamation objective established during the approval process is reviewed to determine if reclamation needs have changed. Possibilities may exist for developing a well for fresh water purposes, utilizing improvements, or making wildlife habitat improvements. Reclamation criteria include the following: a) final configuration of the disturbed area, b) stabilization of the soil, c) management of the topsoil and addition of appropriate fertilizers, d) revegetation with prescribed seed mixtures, e) air, water, and visual quality standards, f) compliance inspection intervals and bond amounts, and g) conditions for bond release.

NOTE: A producing well will generate additional drilling to determine the size and extent of the field. With more producing wells there will be the need for facilities to produce, store, and transport the oil, gas, and water. Associated with this next phase are more roads (some upgraded to all weather travel), utility corridors for pipelines and power lines, and space for fluid storage tanks and oil/water separators.

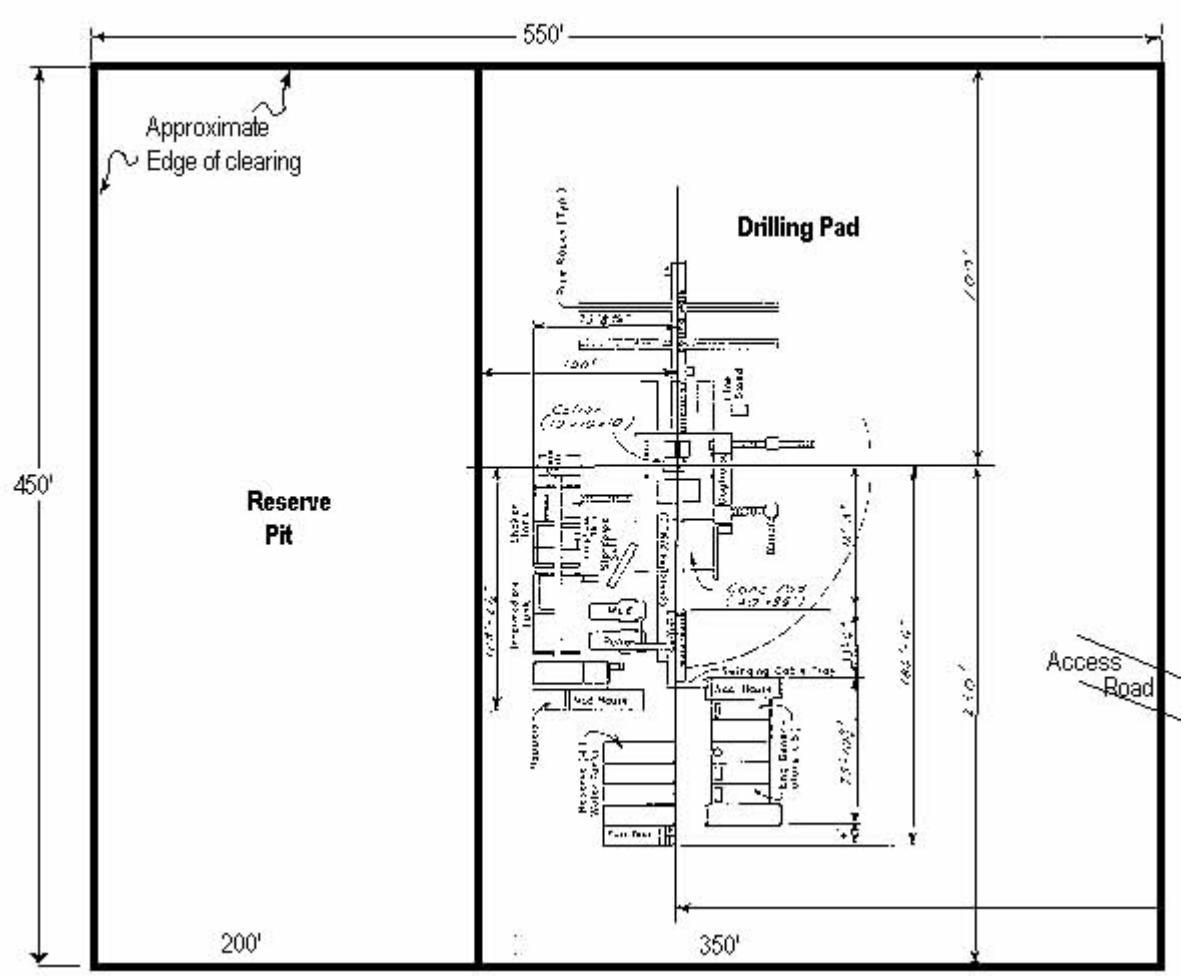

Figure F.1 Ground Plan Drawing of a Typical Well Site (Occupying 450'x550')
(from USDI Bureau of Land Management, Jackson District Office; 1989)

Reasonably Foreseeable Development Scenario for Gas and Oil

This section discusses the reasonably foreseeable development of potential gas and oil resources on the Ouachita National Forest. It has been developed by the USDI, Bureau of Land Management Jackson District Field Office of the Eastern States Office (Arkansas lands), and the Tulsa District Office of the New Mexico State Office (Oklahoma lands) for the Forest Plan. This information is divided into: 1) Development in the Reasonably Foreseeable Future; 2) Typical Drilling Scenario and Well Design *(Ground Plan Drawing of a Typical Well Site);* 3) Cumulative Impact of Projected Future Development *(a. Chart on "Approximate Area Disturbed from Drilling," b. Chart on "Approximate Area Disturbed from Production," Summaries of the net cumulative disturbance of Drilling and Production).*

1) Development in the Reasonably Foreseeable Future. This assessment of the development in the reasonably foreseeable future is based on projections over the next 10 to 15 years using available data and professional judgment. This scenario is a baseline scenario. As such, the scenario projects development based on the assumption that all areas are open to development under standard lease terms except those areas closed by statute. This scenario is consistent with the prescriptions contained in the Final Environmental Impact Statement for the Revised Forest Plan. Scenarios were considered for the alternatives. However, in relation to the availability of National Forest lands for oil and gas leasing and the associated lease terms, relatively minor differences were identified between the alternatives, a sufficient and applicable projection for all alternatives. The mineral potential assigned for the production of oil and gas from the federal mineral ownership (FMO) in the Ouachita National Forest conforms to the rating system outlined in the Draft BLM Fluid Minerals Handbook H-1624-1 (DD 9/7/88). This system is designed to remain dynamic. As new data is received it can be used to change the rating. The ratings used have four levels: high, moderate, low and no potential. These are defined as:

- *High Potential:* Geologic structures and formations highly favorable for the accumulation of oil and gas are known to exist, includes areas previously classified as Known Geological Structures (KGS).
- *Moderate Potential:* Many favorable non-producing geologic structures and formations are present, but not all potentially productive formations have been drilled and tested.
- *Low Potential:* Geologic structures and formations are well defined, and potentially productive formations have been drilled, tested, and failed to produce oil and gas.
- *No Potential:* Geologic structures and formations are present, but the potential for oil and gas accumulations does not exist. These areas contain geologic formations that do not meet the present criteria for oil and gas accumulations; that is, there are no source rocks, porosity and permeability have been developed (except for fractures), and no traps are thought to be present.

Little data is available to the federal agencies concerning the structures and reservoir characteristics of potential gas plays in the Ouachita National Forest. Petroleum companies hold most of the existing data confidentially. The timing of the drilling and the areas receiving the greatest attention is difficult to predict. This is dependent on the oil and natural gas market values; the success rate of wells being drilled and those that will be drilled in the near future; and the perceived impact of the lease stipulations by the petroleum industry.

The Ouachita National Forest has 12 Ranger Districts (RD): 3 in Oklahoma and 9 in Arkansas. The three Ranger Districts in Oklahoma are the Choctaw RD and the Kiamichi RD in LeFlore County and the Tiak RD in McCurtain County.

- <u>Choctaw RD, Oklahoma</u>: The Choctaw RD is on the north side of the forest. The possibility that this area will be explored and developed in the future is medium to moderately high. The reason for this is that the Choctaw RD is on a geological trend with

ongoing activity to the west. The Spiro/Wapanucka zone has been found to be productive south of the Choctaw Fault when it is encountered on the structurally high, hanging wall side of individual thrust fault wedge zones. Discoveries have been made which prove that the depositional trend of reservoir quality Spiro sandstone extended further south than previously thought. In addition to this, the Arbuckle Formation has been proven productive near Wilburton, Oklahoma. This zone lies below the thrust sheet and is a fractured porosity reservoir. Since this production was discovered in 1987, there have been 20 wells drilled to the Arbuckle in a 12-township area. This is somewhat more area than that of the Choctaw RD. Generally, these wells are targeted for the Spiro/Wapanucka zone as well as the Arbuckle. This play relies heavily on geophysical exploration techniques, and each well has to stand on its own merit. It is expected that this play will move east into the Ouachita National Forest. Due to the nature of geophysical exploration, such as time involved, expense, and permitting, this movement is expected to be slow. However, it is highly likely that commercial quantities of natural gas will be encountered in the Choctaw RD as it lies between the Choctaw Fault and the Winding Stair Fault traces. It is believed by some that the Winding Stair Fault is the limit of potential production to the south.

- Kiamichi RD, Oklahoma: The northern part of the Kiamichi RD is still to the north of the Winding Stair Fault and; therefore, due to the previously mentioned reasons, has a medium potential for future development. Also, it is very likely that the southern portion will receive some attention if production is found in the northern section. Development will probably be much slower paced than in the Choctaw RD.
- Tiak RD, Oklahoma: There is very little production in the vicinity of the Tiak RD. There are a great number of dry holes in the vicinity. For this reason, it is believed that the Tiak RD has medium to low potential for development in the foreseeable future. The fact that production is very shallow, less than 500 feet, indicates that there is a possibility that some exploration will take place. Approximately 100,000 acres of lands in the Broken Bow, Oklahoma area was obtained by the Ouachita National Forest in 1996 through an exchange with Weyerhaeuser Timber Company. These lands now make up the bulk of the Tiak Ranger District. The potential rating for these lands is medium to low potential for development in the foreseeable future as well.
- Arkansas Ranger Districts: The nine Ranger Districts in Arkansas on the Ouachita National Forest are the Caddo, Cold Springs, Fourche, Jessieville, Mena, Oden, Poteau, Womble, and Winona Ranger Districts.
    - The Caddo, Jessieville, Winona, Womble, Mena and Oden Ranger Districts are considered to have low potential for the production of oil and gas.
    - The Cold Springs, Fourche, and Poteau Districts were assigned moderate potential for the production of oil and gas.

  Geophysical data is not available to identify potential traps in the forest in Arkansas. However, an analysis of leasing activity, adjacent fields and conversations with oil and gas employees, both with industry and the State of Arkansas, indicates that three principal plays can be anticipated: the Atokan, Morrowan, and Arbuckle. After petroleum production is established in a field, additional wells will be stepped out. Drilling units contain 640 acres, and a fully developed field would have eight to twelve wells within its boundaries. Extending these plays from Oklahoma into Arkansas naturally increases the risk of dry holes. Several wildcats were drilled in southeast Oklahoma south of the basin fairway, but little has been done in Arkansas. In the late 1980s and early 1990s, interest increased in the overthrust belt (frontal thrust zone). The prospects during this last period of drilling were all located along the north edge of the Ouachita National Forest, north of the Choctaw Ross Creek Fault complex. These prospects were developed using seismic data with very little well control. None of the wells have penetrated the Arbuckle, and the data acquired, down to about 14,000 feet, was not encouraging. The ARCO Peeler Gap #1-32 drilled in Yell County, Arkansas, was plugged and abandoned at 13,919 feet in 1986, and the Oxy USA well drilled a mile from the ARCO well to a depth

of 23,000 feet from 1989 to 1991 (deepest well drilled in Arkansas) was also plugged and abandoned, both did not reassure those hoping for a discovery similar to the field found later at Wilburton Field. Porosity was low and no significant source rocks were noted.

- Coal Bed Methane on the Poteau Ranger District: Coal bed methane gas commonly associated with coal seams is present on that portion of the northwestern Poteau Ranger District partially underlain by a seam of coal. Production commenced on private lands immediately adjacent to the Forest in 2001 and on the Forest in 2004. At the end of 2004, one well on the Forest was completed and producing at the initial rate of 200,000 mcf (thousand cubic feet). Coal Bed Methane wells are typically short duration wells lasting 5 to 10 years when all the gas associated with a coal seam that can be recovered has been extracted. At the end of 2004, six more wells were being evaluated by the Forest. The mineral estate is all outstanding in third parties (non-Federal minerals).

2) Typical Drilling Scenario and Well Design in the Ouachita NF. To fully evaluate the impacts associated with projected oil and natural gas exploration and development on the forest, the types of activities typical of these actions must be identified and analyzed. Preparation for the drilling process includes construction of a drilling pad and reserve pit. Wells of 1,000 to 5,000 feet, typically associated with coal bed methane deposits and wells in the Arkoma Basin, will impact smaller acreage, with well pad sizes from one to three acres. Construction process for wells are essentially the same regardless of the wellpad size required for a typical operation. For a deep well (10,000 feet and deeper), pad sizes necessary to accommodate larger equipment will impact 3 to 6 acres.. Depending on the topography of the well site and access area, construction may require the creation of cut slopes and fill areas. An excavated reserve pit in this example is divided into two sections with total dimensions of 450 feet in length, 200 feet in width, and 10 feet deep and is lined with a plastic or butyl liner (or its equivalent) that meets minimum State standards for thickness and quality. Constructed access roads normally have a running surface (width) of approximately 15 feet and a right-of-way of 30 feet. The length is dependent upon the well site location in relation to existing roads or highways. The typical length of road construction will be about ½ of a mile or less. Because the cost of rig time in drilling a well is usually several thousand dollars a day, the drilling is conducted 24 hours a day when possible. The actual time to drill a well will depend on the depth of the hole, the number and degree of mechanical problems, if a well is a dry hole or a producer; etc. Material used in construction of the pads and access road (i.e., rock, shale, or gravel fill), when obtained from the Forest, is from sites that have been pre-approved by the District Ranger. Shale and/or gravel used in construction of the drilling pad shall be stockpiled or removed when restoring the area. For all surface-disturbing activities, the topsoil is removed and stockpiled for redistribution over the disturbed area prior to fertilizing and reseeding of the site. Restoration of the area normally includes reseeding of the area with natural vegetation, recontouring, and drainage control, as determined by the Forest Service. In the event production is established, pipelines and/or flow lines will be constructed in conjunction with the construction of the access roads whenever possible to minimize additional disturbance. Pipeline rights-of-way generally do not exceed 25 feet in width and will follow existing rights-of-way where possible. Exact right-of-way widths may be set by the surface management agency. Pipeline depth is usually at least 48 inches. When possible, a common point of collection shall be established to minimize the number of production sites. All pipeline designs, construction, operation, and maintenance comply with Federal Safety Standard for Gas Lines, Code of Federal Regulations, Part 192, Title 49, unless more stringent requirements are required by the surface management agency. Pipelines are immediately reclaimed once the pipe is placed in the pipeline trench.

3) Cumulative Impact of Projected Future Development. Cumulative impacts are determined based on assumptions and analysis of the reasonable foreseeable fluid mineral development in the Forest. The scenario includes estimates of the number of wells that may be drilled and the size of areas disturbed. These were determined by analyzing the previous petroleum activity on or near the Ouachita National Forest in Oklahoma where production is from similar age rocks, sedimentary environments, and trapping mechanisms. These impacts are outlined in the following paragraphs. These assumptions are necessary for a meaningful and reasoned analysis of the cumulative impacts resulting from oil and gas leasing and development. Discussion of how these assumptions were derived can be found in the previous paragraphs. The assumptions are based on an analysis of historic development and conversations with State and industry employees.

The oil and gas potential on the Ouachita National Forest is highly speculative, as very little drilling activity has occurred. As a result, the projections of future development must be viewed as a range of potential development rather than a single scenario. For example, if a strike is made, it is estimated that as many as 132 wells could be drilled on the Forest over a 10 to 20 year period to define and fully develop the fields. On the other extreme, several dry holes could condemn the prospects. The projection of activity over a range is intended to establish the boundaries of minimum versus maximum field development. The projected number of wells to be drilled on each Ranger District of the Forest has been projected based on three levels of drilling activity; low, medium and high. These are shown in the following table titled "Approximate Area Disturbed from Drilling."

NOTE: This information was originally developed by the USDI Bureau Of Land Management in the late 1980s for the 1990 Amended Forest Plan. It projected possible scenarios that might occur if the minimal exploration interest at that time were to continue through the planning period ending in 2005, and if production actually occurred in that period as well. In reality, exploration interest was sporadic at best, with only 3 wells drilled between 1990 and 2003 (1 on the Fourche RD and 2 on the Choctaw RD). All 3 wells were dry and were subsequently plugged, reclaimed, and abandoned. A fourth well drilled in 2004 specifically for coal bed methane is producing that commodity. Additional coal bed methane wells are anticipated to be drilled in 2005 and 2006. The coal bed methane on the Ouachita National Forest is considered to be short term and duration interest for the gas community. Such wells typically produce for only 5 to 10 years, and are dependent on coal seams. The coal seam on the Ouachita National Forest is located in the very northwest corner of the Forest in Arkansas, on the Poteau Ranger District in Sebastian County. The bulk of the coal seam and coal bed methane production is on adjacent private lands bordering the Forest. The area directly affected by the coal bed methane interests embraces approximately 6,000 acres.

The following projections were reviewed by the USDI Bureau of Land Management for this Plan and the next 10 year planning period. Given that the history of drilling on the Forest has resulted in no production (outside of coal bed methane), this information is retained for consideration in the event that drilling interest should ever possibly increase beyond the coal bed methane area. Some acreage adjustments were made based on Forest Service observations of actual operations on the Forest and adjacent areas.

Approximate Area Disturbed from Drilling

These projections are used in conjunction with the typical well design to calculate the anticipated cumulative impacts associated with drilling under each scenario. The following are assumptions that were used in this analysis: maximum area cleared per well site is 1 to 6 acres [most wells are 1 to 2 acres in size – an average 3 acres is used here]; access road average length per well is ½ mile, maximum width 30 feet with approximately 2 acres disturbed. The well pad for the dry holes will be reclaimed, and the roads will either be reclaimed or used as determined by the Forest Service. The total amount of disturbances actually occurs over the

years of field development. Wells will be abandoned and restored during the years of field development. The amount of disturbance per item of activity is to a large extent controlled by the Forest Service and the Bureau of Land Management.

Table F.2 Drilling Projections

Ranger District	Scenario	O&G Drilling Activity Producers (P) + Dry Holes (D)		
		Low	**Medium**	**High**
Choctaw	Number of Wells	8 (2P+6D)	25 (17P+8D)	50 (40P+10D)
	Well Pad	24 Acres	75 Acres	150 Acres
	Access Road	16 Acres	50 Acres	100 Acres
	Total	40 Acres	125 Acres	250 Acres
Cold Springs (North of Hwy 80)	Number of Wells	1 (D)	8 (5P+3D)	17 (13P+4D)
	Well Pad	3 Acres	24 Acres	51 Acres
	Access Road	2 Acres	16 Acres	34 Acres
	Total	5 Acres	40 Acres	85 Acres
Fourche (North of Hwy 28)	Number of Wells	1 (D)	11 (8P+3D)	22 (18P+4D)
	Well Pad	3 Acres	33 Acres	66 Acres
	Access Road	2 Acres	22 Acres	44 Acres
	Total	5 Acres	55 Acres	110 Acres
Kiamichi	Number of Wells	4 (1P+3D)	12 (6P+6D)	23 (15P+8D)
	Well Pad	12 Acres	36 Acres	69 Acres
	Access Road	8 Acres	24 Acres	46 Acres
	Total	20 Acres	60 Acres	115 Acres
Poteau (North of Poteau River)	Number of Wells	0	5 (3P+2D)	10 (7P+3D)
	Well Pad	0	15 Acres	30 Acres
	Access Road	0	10 Acres	20 Acres
	Total	0	25 Acres	50 Acres
Tiak	Number of Wells	2 (D)	5 (2P+3D)	10 (4P+6D)
	Well Pad	6 Acres	15 Acres	30 Acres
	Access Road	4 Acres	10 Acres	20 Acres
	Total	10 Acres	25 Acres	50 Acres
The Following Ranger Districts (or District portions) are projected to have no wells: Caddo, Cold Springs south of Hwy 80, Fourche south of Hwy 28, Jessieville, Mena, Oden, Poteau south of Poteau River, Winona, Womble				
Total Wells Projected		16	66	132
Total Producers and Dry Holes		3(P)+13(D)	41(P)+25(D)	97(P)+35(D)
Total Area Disturbed Well Pads		48 Acres	198 Acres	396 Acres
Total Area Disturbed Roads		32 Acres	132 Acres	484 Acres
Total Area Disturbed:		80 Acres	330 Acres	880 Acres

Approximate Area Disturbed From Production

The estimated area disturbed from a production scenario, under a low, medium, and high scenario within each Ranger District, is shown in Table F.3. In the event that production is established, a portion of the original drilling pad will be used for production facilities, reduced to a maximum area of ½-acre. The access roads constructed for drilling are used for production operations as well. Consequently, the figures for well pads and access road represent acreage that was disturbed as a result of drilling, not new disturbance. Flowlines/pipelines are placed in existing road right-of-ways, but may cross unroaded lands in some cases. The assumptions for this analysis are as follows: maximum area needed on a producing well (once drilling is completed) is ¼ to ½ acre (½ acre is used as the average); average length of access road is ½

mile and width is 30 feet (approximately 2 acres); average length of a gas gathering line (flowline/pipeline) from a producing well is about one mile and a width of 25 feet. For an average, these will be placed in existing roads rights-of-ways for at least half the distance resulting in average new construction for the other half (1 ½ miles; 1 ½ acres). Pipelines are immediately reclaimed after the pipe is placed in the pipeline trench.

Table F.3 Production Projections

Ranger District	Scenario	O&G Drilling Activity		
		Low	Medium	High
Choctaw	Number of producing wells	2	17	40
	Well Pad Portion	1 Acres	8.5 Acres	20 Acres
	Access Road	4 Acres	34 Acres	80 Acres
	Flowlines	3 Acres	25.5 Acs	60 Acres
	Total	8 Acres	68 Acres	160 Acres
Cold Springs (North of Hwy 80)	Number of producing wells	0	5	13
	Well Pad Portion	0	2.5 Acres	6.5 Acres
	Access Road	0	10 Acres	26 Acres
	Flowlines	0	7.5 Acres	19.5 Acres
	Total	0	20 Acs	52 Acres
Fourche (North of Hwy 28)	Number of producing wells	0	8	18
	Well Pad Portion	0	4 Acres	9 Acres
	Access Road	0	16 Acres	36 Acres
	Flowlines	0	12 Acres	27 Acres
	Total	0	36 Acres	72 Acres
Kiamichi	Number of producing wells	1	6	15
	Well Pad Portion	½ Acres	3 Acres	7.5 Acres
	Access Road	2 Acres	12 Acres	30 Acres
	Flowlines	1.5 Acres	9 Acres	22.5 Acres
	Total	4 Acres	24 Acres	60 Acres
Poteau (North of Poteau River)	Number of producing wells	0	3	7
	Well Pad Portion	0	1.5 Acres	3.5 Acres
	Access Road	0	6 Acres	14 Acres
	Flowlines	0	4.5 Acres	10.5 Acres
	Total	0	12 Acres	28 Acres
Tiak	Number of producing wells	0	2	4
	Well Pad Portion	0	1 Acres	2 Acres
	Access Road	0	4 Acres	8 Acres
	Flowlines	0	3 Acres	6 Acres
	Total	0	8 Acres	16 Acres
Total Area Disturbed Well Pad Portion		1.5 Acres	20.5 Acs	48.5 Acres
Total Area Disturbed Roads		6 Acres	82 Acres	194 Acres
Total Area Disturbed Flowlines (Pipelines)		4.5 Acres	61.5 Acs	145.5 Acs
Total Area Disturbed		12 Acres	164 Acres	388 Acres

The following summarizes the net cumulative disturbance of drilling and production operations (well pads + new roads + pipelines/flowlines for producing wells).

	Low	Medium	High
Total Area Disturbed (Acres) Drilling	84.5	391.5	1025.5

The following area will be reclaimed. This includes the entire well pad for the dry holes, all but ½-acre for the producing wells and 100 percent of the roads for the dry holes.

	13 Dry Wells	25 Dry Wells	35 Dry Wells
Total Area Reclaimed (Acres)	72.5	227.5	417.5
	3 Producers	41 Producers	97 Producers
Total Area After Reclamation* (Acres)	7.5	102.5	242.5

*After Reclamation of dry wells. Producing wells will be reclaimed when production ceases.

Total Wells Projected	16	66	132

The following area will be added for flowlines (pipelines) on producing wells.

Total Area Flowlines (Acres)	4.5	61.5	145.5

Flowlines (pipelines) are reclaimed as soon as the pipeline is placed into the pipeline trench.

The net long term cumulative impact is calculated by adding the total area left disturbed after reclamation to the area needed for flowlines/pipelines. These areas will be maintained for production for the life of the well and subject to total reclamation after production ceases. During the production stage, all disturbed areas not used for equipment or traffic will be stabilized with grass and subject to conservation maintenance practices, as directed by the Forest Service. This includes the flowline/pipeline rights-of-way, slopes on the edge of well pads, road cuts, etc.

Total Area (Acres) Net Long Term Disturbance	12	164	388

Supplemental Minerals Program Procedures:

Projected Minerals Activity: Projected minerals activity in the planning period will be from coal bed methane exploration and possible development, possible natural gas exploration, existing hardrock minerals operations (quartz, novaculite, gravel and building stone), and with new proposed hardrock minerals operations. It is projected that there will be 7 to 16 gas wells drilled on the Forest, with 7 being commercially productive. The rest would be dry holes, and the sites would be reclaimed. For each of the producing well sites, the area needed for production would be less than was needed for the drilling phase. The size of the drill pad would decrease from two acres of disturbance to about ¼ acre, with the unneeded portion being reclaimed. In the next 10-year planning period, 5 new quartz operations are expected to occur. Most case sites are operated intermittently. The nature of hardrock mining operations on the Ouachita National Forest requires that they proceed at a slow and methodical pace. These are all surface operations.

New common variety mineral material operations are expected to occur at the rate of at least 40 to 60 per year. These are small tonnage short duration removals primarily from within the existing 22 pits and the primary building stone site on the Forest. Operations outside of existing pits are small tonnage (generally several pickup loads) hand removals of surface exposed building stone. Site-specific environmental analysis is conducted on all new sites. Gravel pits on the Forest are long-term impacts to allow controlled centralized access to essential pit-run aggregate resources. Pits are designed to prevent water runoff and consequent siltation from leaving the pit site and impacting adjacent Forest resources. All pits on the Ouachita National Forest are worked intermittently by Counties and Forest Service contractors removing material for public projects (roads, etc) as needed.

There are positive economic impacts resulting from oil and gas exploration and development activities. Lessees/operators usually contract locally for road and drill pad construction. They purchase food, fuel, lodging and other supplies from local sources and may subcontract certain parts of the operation to local well servicing companies. Most of the salaries paid to workers are spent in the local area. The estimated dollars that an average drill rig generates per day is over $200 per worker. A typical well drilling operation will have an average of 10 to 20 workers. This translates into about $2,000 to $4,000/day spent in the local area. Since the average gas well in this area takes 2 to 4 weeks to complete, $28,000 to $112,000 per well goes into the economy. There are 59 hardrock mining cases for quartz crystal, novaculite, wavellite, aggregate (gravel) and building stone, and one energy case for coal bed methane. The accumulated total existing surface impacts from these operations located across the Forest is approximately 120 acres. Average surface impact is less than 2 acres per case. This represents less than 1/10th of 1 percent of the total Forest land base.

Acquired Status: Acquired status refers to those Federal lands and minerals purchased, donated, or received in exchange for purchased or donated lands and minerals. The Weeks Act of March 1, 1911 (36 Stat.961, as amended) is the primary land acquisition authority for the Forest Service where Acquired status lands and minerals are involved. The USDI Bureau of Land Management is the lead Federal permitting agency for all energy and hardrock minerals permitting, leasing, and related operations on Federal Acquired status lands and minerals. They are referred to as “leaseable” minerals administered by the USDI Bureau of Land Management under Title 43 of the Code of Federal Regulations Part 3100 (Oil and Gas), Part 3400 (coal) and Part 3500 (hardrock). Where National Forest lands are involved, the Forest Service has consent authority and sets the stipulations and operating conditions (see “<u>Oil and Gas Lease Stipulations,</u>” below). In addition, the Forest Service works with the Bureau of Land Management to monitor approved minerals operations for compliance. Acquired minerals operations generate Federal revenue that is managed by the USDI Minerals Management Service.

Public Domain: Public Domain Status lands are those Federal lands that were secured by the Federal Government through treaties and that have never left Federal ownership. Hardrock "locatable" minerals (i.e. precious metals and metallic minerals) under the authority of the 1872 Mining Law, are located as mining claim on Public Domain status lands that are open to mineral entry. Mining claim filings and adjudication are administered by the USDI Bureau of Land Management under Title 43 of the Code of Federal Regulations Parts 3800 through 3870. Field operations under the locatable minerals program is administered by the Forest Service under Title 36 of the Code of Federal Regulations Part 228 A. Mining claimants must provide operating plans or notices and reclamation plans to the Forest Service for approval to operate. An environmental analysis is conducted, and reclamation bond collected before operations can commence. The Forest Service monitors active operations for compliance. Energy minerals on Public Domain lands are managed by the USDI Bureau of Land Management in a manner similar to those on Acquired status lands.

Leasable Minerals – Energy, Typical Drilling Scenario: Historically, wells in Arkansas are drilled on a 640-acre spacing. The number of wells drilled is dependent on the oil and gas market values and the perceived impact of the lease stipulations by the oil and gas industry. In this geographic area, the standard approach is to drill vertical holes from a single drill pad down to the target formation. The deeper the suspected oil/gas bearing rock layer lies, the larger the drill rig must be and, consequently, the larger the drill pad must be to accommodate it. Since the known producing zones north of the Ouachita National Forest boundary, primarily in the Arkansas River Valley, lie relatively shallow with deeper plays to 6,000 feet, smaller drill rigs and pads are needed. Once the APD has been obtained from the BLM, the operator will construct an access road to the drill site and smooth out a pad to erect the derrick on. As stated in the RFD scenario, preparation for the drilling process includes construction of a drilling pad and reserve pit. Construction procedures must conform to the approved surface use plan of operations. Typically, one to two acres are cleared and graded level for construction of the well pad. However, depending on the topography of the well site and access area, this construction may require the creation of cut slopes and fill areas that may disturb additional area. The excavated reserve pit is usually about five feet deep and is lined with bentonite clay. Plastic or butyl liners (or its equivalent) that meet state standards for thickness and quality are used on occasions when soils are determined incapable of holding pit fluids. Constructed access roads normally have a running surface (width) of approximately 15 feet and a right-of-way of 30 feet; the length is dependent upon the well site location in relation to existing roads or highways. The average length of road construction will be about ½ of a mile or less (approximately 1 acre disturbance).

Because the cost of rig time in drilling a well is usually several thousand dollars a day, drilling is conducted 24 hours a day, 7 days per week when possible. Wells are usually drilled in 7 to 30 days depending on the depth of the hole, the number and degree of mechanical problems, or if a well is a dry hole or a producer. Wells are drilled by rotary drilling rig using mud as the circulating medium. Mud pumps would be used to force mud down the drill pipe, thereby forcing the rock cuttings out of the wellbore. Water used in the drilling process would normally be from a well drilled on the site; however, water could be pumped to the site from a local pond, stream, or lake through pipe laid on the surface. Water could also be hauled to the site by the use of tanker trucks. Shallower wells could be drilled with air instead of mud. Pad size and access would be the same. Approximately 500 barrels of drilling mud are kept on the location. Mud may also be needed for some down hole logging programs. Water production would be expected during the life of the field, separation, dehydration, and other production processing may be necessary. Construction of facilities off Federal lands may be needed to handle this processing. Some processing or temporary storage may be necessary on site, usually in the form of tanks.

Material used in construction of the pads and access road (i.e., rock, shale, or gravel fill) shall be obtained from pre-approved sources. Shale and/or gravel used in construction of the drilling pad shall be stockpiled when restoring the area. For all surface-disturbing activities, the topsoil to be removed will be stockpiled for redistribution over the disturbed area prior to fertilizing and reseeding of the site. Surface soil material stockpiles should be located to avoid mixing with other subsurface materials during construction and reclamation. Stockpile locations should be located so wind and water erosion are minimized and reclamation potential is maximized. In areas where excavation will be extensive or extreme, or where bedrock will be encountered, existing topsoil shall be replaced. Restoration of the area will include reseeding of the area with natural grasses as determined by the authorized Forest Officer. If drilling results in a producing well, the drilling pad must be reduced to a maximum area of 10,000 square feet (0.23 acres), and the remainder shall be restored to blend into the natural terrain. For a producing well, the operator will either install tanks on site to hold the oil and any produced water, or else a pipeline will be hooked up to the well head and the product transported off site. A producing gas well will have a pipeline connected to the wellhead or “Christmas tree,” and the gas will then be pumped off through these gathering lines. Either way, the amount of space required for these facilities is considerably less than the original pad size and will be reclaimed around the unneeded edges.

Gas pipelines and/or oil flow lines will be constructed in conjunction with the construction of the access roads whenever possible to minimize additional disturbance. Pipeline right-of-way shall not exceed 30 feet in width. Exact right-of way widths may be set by ground conditions. Whenever possible, pipeline when buried must be at a depth of at least 48 inches. Any deviation from the 48-inch depth must be approved by the appropriate Forest Service officer prior to any surface disturbing activity taking place. When possible, a common point of collection shall be established to minimize the number of production sites. All pipeline designs, construction, operation, and maintenance shall comply with Federal Safety Standard for Gas Lines, Code of Federal Regulations, Part 192, Title 49, unless more stringent requirements are required by the State of Arkansas. If the well is a dry hole, or cannot produce commercial quantities of oil/gas, then it will be closed off by plugging and capping the top of the pipe in the hole. All equipment will be removed from the site, and the drill pad area will be re-sloped and seeded with a mixture of native plants. There will be a positive economic effect on the local economy in areas close to drill sites. The drilling operation will rely on local merchants for food, fuel, and supplies (see Cumulative Impacts), and often housing as well. Pad and road construction is often subcontracted to local companies or companies employing local expertise.

Private Mineral Rights - Reserved and Outstanding Mineral Rights: Reserved or Outstanding mineral rights are those minerals owned by parties other than the Federal government under Forest Service administered lands. Reserved minerals are those “reserved” to the party who transferred the lands to the Forest Service. Outstanding minerals are those that are “outstanding” to a third party. The authority for the administration of mineral reservations is 36 CFR 251.15 or previously issued Secretary of Agriculture’s rules and regulations that govern the exercise of mineral rights reserved in conveyances to the United States. The appropriate rules and regulations in effect at the time of the mineral reservation were incorporated as part of the deed by which the United States acquired the surface. Forest Service direction for the administration of reserved and outstanding rights is found in Chapter 2830 of Forest Service Manual 2800.

Oil and Gas Lease Stipulations

Stipulations are applied by the Forest Service during the formal consent process to evaluate the National Forest System lands under lease consideration by the Bureau of Land Management. A uniform format for oil and gas lease stipulations was developed by the Rocky Mountain Regional Coordinating Committee (RMRCC) comprised of the USDI Bureau of Land Management (BLM), USDA Forest Service, and various representatives from the legal, industry, and environmental communities. The stipulations attached by the Forest Service are based on the management objectives established through the Forest Plan. Stipulations developed by the Committee and adopted by the BLM and Forest Service are as follows:

- No Surface Occupancy (NSO): Use or occupancy of the land surface for fluid mineral exploration or development is prohibited to protect identified resource values. The NSO stipulation includes stipulations which may have been worded as "No Surface Use/Occupancy," "No Surface Disturbance," "Conditional NSO" and "Surface Disturbance or Surface Occupancy Restriction (by location)."
- Controlled Surface Use (CSU): Use and occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may modify the lease rights. CSU is used for operating guidance, not as a substitute for the NSO or Timing stipulations.
- Timing Limitation (Seasonal Restriction): Prohibits surface use during specified time periods to protect identified resource values. This stipulation does not apply to the operation and maintenance of production facilities unless the findings of analysis demonstrate the continued need for such mitigation and that less stringent, project specific mitigation measures would be insufficient.
- Lease Notice: Provides more detailed information concerning limitations that already exist in law, lease terms, regulations, or operational orders. A Lease Notice also addresses special items that the lessee should consider when planning operations, but does not impose new or additional restrictions. Lease Notices attached to leases should not be confused with Notices to Lessees (re: 43 CFR 3160.0-5). Standard Lease Notices made part of all leases:
    - All or part of the leased lands may contain animal or plant species classified under the Endangered Species Act of 1973, as amended. Other species may have been identified as Sensitive in accordance with Forest Service Manual 2670 and be listed on the current Regional Forester's List of Sensitive Plant and Animal Species. Further information concerning the classification of these species may be obtained from the authorized Forest Officer. Exploration and development proposals may be limited or modifications required if activity is planned within the boundaries of a Proposed, Threatened, Endangered, or Sensitive plant or animal species location as it then exists. All activities within these areas must be conducted in accordance with existing laws, regulations, and Forest Plan guidelines.
    - All or part of the leased lands may be classified as wetlands in accordance with Executive Order 11990, "Protection of Wetlands" or a floodplain in accordance with Executive Order No. 11988, "Floodplain Management." Additional management requirements for the protection of riparian areas are contained in 36 CFR 219.27(e) and the National Forest Management Act of 1976. All activities within these areas may require special measures to mitigate adverse impacts to the resource values. They must comply with the above referenced executive orders, regulations, and laws and be in accordance with the Forest Plan guidelines. Further information concerning the classification and management of these lands may be obtained from the authorized Forest Officer.

Statutory and Regulatory Direction (Laws and Authorities) Affecting Minerals Activities on the Ouachita National Forest

The following section discusses the primary laws, regulations, and policies that regulate minerals activities on the Ouachita National Forest. Statutory and regulatory direction separates mineral resources in the publicly owned lands of the United States into three categories: locatable, leasable, and salable. Statutes, regulations, and Executive Orders guide Forest Service policy governing the exploration and development of mineral activities on National Forest System lands. Management direction for mineral resources on the Ouachita National Forest can be found in the following areas:

Public Law 100-446, Section 323, enacted September 27, 1988, directs the Forest Service to administer quartz minerals on the Ouachita National Forest in Arkansas as a "Salable" mineral by the Forest Service, under Title 36 of the Code of Federal Regulations, Part 228C. It further provides that one half of the revenues generated by the Forest Service are to be returned back to State of Arkansas specifically for use in county school and road programs.

The Federal Onshore Oil and Gas Leasing Reform Act of 1987 (PL 100-203) Provides additional authority for the Forest Service in regards to leasing and administration of surface operations during oil and gas development. The BLM may not issue any lease on National Forest public domain lands over the objection of the Secretary of Agriculture. Forest Service must approve and administer all surface disturbing activities on leases issued on National Forest System lands. The Act repealed the Known Geologic Structures (KGS) process and the Simultaneous leasing system (SIMO). The Act established a 2-level leasing process: 1) all tracts are offered competitively to the highest bidder, with a minimum bonus bid of not less than $2/acre, in addition to the annual rental; and 2) tracts offered for competitive sale which receive no bids, and for which no pre-sale applications were received, are then available non-competitively ("over-the-counter") for 2 years after the sale. The competitive lease sale notices must be posted in the appropriate Forest Service office for 45 days prior to the competitive lease sale. Prior to approval of applications for permits to drill (APDs) or lease modifications, a notice must be posted for 30 days prior to approval.

The National Materials and Minerals Policy Research and Development Act of 1980 (94 Stat. 2305; 30 USC 1601-1605) states the current policy of the Federal government regarding oil and gas exploration and development. This Act states that private enterprise is to be encouraged to develop domestic mineral resources and that Federal agencies are to facilitate availability and development of domestic resources. It also emphasizes prompt reclamation of disturbed lands.

The Energy Security Act of 1980, Section 262 (42 USC 8855) directs the Secretary of Agriculture to process applications for leases and permits to explore, drill, and develop resources on National Forest System lands, notwithstanding the current status of the Land and Resource Management Plan ("Forest Plan").

Surface Mining Control and Reclamation Act of 1977 prohibits surface (strip) mining of coal on federally administered lands located east of the 100th Meridian.

The Federal Land Policy and Management Act of 1976 (43 USC 1714) states public lands and their resources will be periodically and systematically inventoried, and their present and future use projected through a land use planning process. It also requires that the "public lands be managed in a manner which recognizes the Nation's need for domestic sources of minerals, food, timber and fiber from public lands, including implementation of the Mining and Minerals Policy Act of 1970." Sec. 314 requires the filing of mining claims and annual assessment work

with the USDI Bureau of Land Management (The Supreme Court has rendered a decision upholding the constitutionality of this section).

Mining and Minerals Policy Act of December 31, 1970 establishes a National Minerals Policy, and states in part: "Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in (1) the development of economically sound and stable domestic mining, minerals, metal and mineral reclamation industries; and 2) the orderly and economic development of domestic mineral resources, reserves, and reclamation of metals and minerals to help assure satisfaction of industrial, security and environmental needs."

Wild and Scenic Rivers Act of October 2, 1968: Under the Act, the minerals in federal lands which are part of the system and constitute the bed or bank, or are situated within one-quarter mile of the bank of any river segment which is designated a wild river under this Act, are withdrawn from all forms of appropriation under the mining laws and from operation of the mineral leasing laws. This restriction does not apply to those segments of a Wild and Scenic River that are designated as "scenic" or "recreational."

Mineral Leasing Act Revision of 1960 established a system of leasing public lands through either a competitive bidding process, utilized when BLM determined the lands to be within a known geological structure (KGS), or by one of two non-competitive leasing processes – an "over-the-counter" application process for non-KGS lands that had never been leased before and a simultaneous lottery type system (SIMO) for non-KGS lands that had been previously leased.

Multiple-Use Sustained-Yield Act of 1960 established the multiple use principles on which the National Forest Management Act of 1976 is based. The Multiple-Use Sustained-Yield Act specifically addresses the role of minerals in the management of the National Forests. The Act states, **"**Nothing herein shall be construed so as to affect the use or administration of the mineral resources of national forest system lands …"

Multiple Use Mining Act of 1955, Act of July 23, 1955 (Public Law 84-167) amended sections 1 and 2 of the Materials Act of 1947. This legislation defined "common varieties" of mineral materials, and distinguished them from rare varieties, that may be locatable in certain states under the Mining Laws of 1872.

Mineral Leasing Act for Acquired Lands Act of August 7, 1947 extends the provisions of the mineral leasing system to all acquired federal minerals, including those within the National Forests, unless excepted by the Act. It requires the consent of the Secretary of Agriculture prior to the BLM issuing a lease covering acquired lands administered by the Forest Service.

The Common Varieties of Mineral Materials Act of July 31, 1947 authorizes the disposal of mineral and vegetative materials through a sales system on public lands of the United States. The law also provides for free use of these materials by federal or state agencies, municipalities, or nonprofit associations, if not for commercial, industrial, or resale purposes. This Act authorizes the Secretaries of the Interior and Agriculture, under such rules and regulations as they may prescribe, to dispose of mineral materials, including but not limited to common varieties sand, stone, gravel, pumice, pumicite, or cinders.

The Mineral Lands Leasing Act of 1920 (40 Stat. 437; 30 USC 181-287) provides for leasing of energy minerals (coal, oil, gas, oil shale), sodium, phosphate, and potassium on all lands owned by the United States, except for those acquired under the Weeks Act of March 1, 1911. The USDI Bureau of Land Management (BLM) is the federal government's mineral leasing agency.

Mineral Resources on Weeks Law Lands Act of March 4, 1917 authorizes the Secretary of Agriculture to permit the prospecting, development, and utilization of mineral resources on lands acquired under the Weeks Act of 1911 (subject to section 402 of Reorganization Plan No. 3, of July 16, 1946 that transferred the function to the Secretary of Interior). The Functions Transfer Act of June 11, 1960 transferred the function back to the Secretary of Agriculture with respect to mineral materials only (sand and gravel).

The Organic Act of 1897 (16 USC 475), which provided for the administration of National Forests, and the Multiple Use-Sustained Yield Act of 1960 (16 USC 528), establishes the legal mandate that National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. The Multiple Use-Sustained Yield Act further states that management of National Forest System lands shall not affect the use or administration of the mineral resources in these lands.

The General Mining Law of May 10, 1872 authorizes locations of mining claims on public domain lands, sets the conditions for the dimensions of the claims, and establishes the procedures for holding mining claims. It applies to all mineral deposits in National Forest System lands reserved from the public domain, or which were acquired by exchange under the Act of March 20, 1922, and National Grasslands, or other Title III lands transferred from the public domain, except for oil, gas, oil shale, coal, and other “leasing act” minerals, and mineral materials, including, but not limited to, sand and gravel. Mining laws do not apply to lands situated in Minnesota, Michigan, Wisconsin, Alabama, Missouri, and Kansas; and certain lands in Oklahoma. It generally declares that all valuable locatable mineral deposits and public domain lands where they are found are free and open to exploration, occupation, and purchase under regulations prescribed by law.

Regulations:

Title 36 of the Code of Federal Regulations, Part 228 - Minerals sets forth the rules and procedures through which use of the surface of National Forest System lands, in connection with mining and mineral operations, shall be conducted so as to minimize adverse environmental impacts on National Forest System surface resources.

Onshore Oil and Gas Order #1 (Appendix A of 36 CFR 228E) states the necessary requirements for the approval of all proposed exploratory, development, and service wells. The Order requires the lessee/operator to submit a Surface Use Plan of Operation and a Drilling Plan as part of the Application for Permit to Drill (APD). Both the Forest Service and the BLM must approve the APD prior to drilling operations commencing on NF lands. The Forest Service adopted the section of BLM’s Onshore Oil and Gas Order #1 that dealt with Surface Use Plans of Operation, and incorporated it as Appendix A of 36 CFR 228E.

Title 36 of the Code of Federal Regulations, Part 251.15 – Reserved Mineral Rights sets forth the rules and procedures through which use of the surface of National Forest System lands, in connection with mining and mineral operations reserved in a deed, shall be conducted so as to minimize adverse environmental impacts on National Forest System surface resources.

Title 36 of the Code of Federal Regulations, part 219.22 (f) Specifically addresses minerals in Forest plans. The following shall be recognized to the extent practicable in forest planning: (f) the probable effect of renewable resource prescriptions and management direction on mineral resources and activities, including exploration and development. Lands Statutorily Withdrawn from Mineral Entry or Mineral Leasing:

- Subject to valid existing rights then existing effective January 1, 1984, the minerals in lands designated under the Wilderness Act of September 3, 1964, are withdrawn from all forms of appropriation under the mining laws and from disposition under all laws pertaining to mineral leasing.
- Subject to valid existing rights, the minerals in federal lands, which constitute the bed or bank, or are situated within ¼ mile of the bank of any river designated a "Wild River" under this Act, are withdrawn from all forms of appropriation under the mining laws and from operation of the mineral leasing laws. *Note*: This restriction does not apply to those segments of a Wild and Scenic River that are designated as "scenic" or "recreational." Elsewhere, the W&SR sections of the EIS and LMP should list the Wild & Scenic Rivers, their classification, the miles of river in each category, how many acres fall within ¼ mile of any wild segments, and the acreage within the various river category management area corridors. If the width of the management corridor for the wild segment of the river exceeds the ¼ mile area statutorily withdrawn, then a standard should be established for those acres outside the ¼ mile, but within the corridor (possibly leasing with no surface occupancy). For the corridor areas, which are managed as scenic or recreational, a controlled surface use stipulation could be adopted which precludes any long term surface disturbance which would alter the esthetics of the area which qualified it for inclusion in the W&SR system. By using this stipulation, short-term use, such as running a seismic line during the summer, could be authorized.

Policy:

Forest Service Manual (FSM) 2800 sets forth the policy and procedure the Forest Service will implement when working with the laws and regulations governing mining and minerals operations on the surface of National Forest lands.

Executive Order:

Executive Order 13212 (Actions to Expedite Energy-related Projects) of May 18, 2001 states that Executive departments and agencies shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy. For energy-related projects, agencies shall expedite their review of permits or take other actions as necessary to accelerate the completion of such projects, while maintaining safety, public health, and environment protections.

Other major acts affecting minerals activities:

The Clean Air Act (91 Stat. 685; 42 USC 7401 et. seq.) provides that each state is responsible for ensuring the achievement and maintenance of air quality standards within its borders.

The Federal Water Pollution Control Act, as amended by the Clean Water Act in 1977 (33 USC 1251 et. seq.) establishes national standards to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

The Endangered Species Act of 1973 (Public Law 93-205; 16 USC 1531, et.seq.) as amended, requires special protection and management for Threatened and Endangered species on Federal lands. The U.S. Fish and Wildlife Service (USFWS), U.S. Department of the Interior, is responsible for the administration of this Act. Federal agencies proposing an action or processing an action by a third party which "may affect" the existence of identified species must consult with USFWS to determine if the proposed action will jeopardize the continued existence of those species.

The Wilderness Act of 1964 (78 Stat. 890; 16 USC 1131-1136) establishes a National Wilderness Preservation System (NWPS) made up of lands administered by the Forest Service (Department of Agriculture) and the Department of the Interior. Section 2 (a) of the Act states that wilderness areas "...shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness..."

The Wild and Scenic Rivers Act of October 2, 1968 (82 Stat. 906, as amended;16 USC 1271-1287) declares it to be the "policy of the United States that certain selected rivers of the Nation...shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." In August of 1979, President Jimmy Carter issued a directive requiring each Federal Agency to "...take care to avoid or mitigate adverse effects on rivers identified in the Nationwide Inventory of Potential Wild and Scenic Rivers."

Withdrawal Review – Ouachita National Forest Minerals Withdrawals

Determination to recommend maintaining or revoking an existing mineral withdrawal, or initiate action to approve a new mineral withdrawal is based on the need to protect the resource or administrative values of the lands in question (Section 204 of the Federal Land Policy and Management Act of 1976). Where it is determined that full protection from the provisions of the 1872 mining law is necessary and that existing regulatory controls applied to a mining related activity would not be sufficient to secure this protection, then it is appropriate to recommend removing the lands from mineral entry. Where it is determined that existing regulatory controls would be sufficient then the lands should be made available for entry under the mining laws.

In order to protect valuable surface resources for special sites and areas like administration and recreation sites, some Public Domain status lands are withdrawn from locatable mineral entry for administrative purposes. A review of mineral withdrawals was conducted to determine if withdrawals on the Ouachita National Forest should remain in effect or recommended for removal. The USDI Bureau of Land Management is the lead Federal agency for monitoring and managing administrative mineral withdrawals. The withdrawals do not affect leasable energy and common variety disposals unless so stated in the withdrawal authority. Status of lands for mineral entry is discussed below.

1. LAKE OUACHITA
Public Land Order 628 (PLO 628) dated 2/13/50 withdrew 26,146.32 acres of public domain lands for use by the Department of the Army for flood control purposes. In 1987, lands around Lake Ouachita were formally interchanged between the Corps and the Forest Service. The lands around Lake Ouachita are chiefly valuable to maintain high water quality standard and recreation for the lake. The 16,795.74 acres of land around Lake Ouachita currently withdrawn from mineral entry are recommended to remain so withdrawn. An additional 2,000 acres of public domain lands within the Lake Ouachita Management Area, chiefly valuable for similar purposes, are recommended to be withdrawn from mineral entry and are identified as such:

T1N R22: Sec. 35 - 80 acres; T2S R21: Sec. 19 - 160 acres; T2S R22: Sec. 23 - 520 acres; Sec. 24 - 160 acres; Sec. 30 - 120 acres; Sec. 31 - 80 acres; Sec. 32 - 240 acres; Sec. 33 - 120 acres; T2S R23: Sec. 04 - 40 acres; Sec. 23 - 280 acres; Sec. 25 - 40 acs; Sec. 26 - 160 acs.

2. POTEAU MOUNTAIN

Because of its proximity to the Poteau Mountain Wilderness and Congress' stated intent to confer a special protective status to these lands, it is recommended that the following public domain lands within the Poteau Management Area be withdrawn from mineral entry: 3,400 acres:

T4N R30: Sections 19, 20, 21(SWSW), 28(SWNW, S2SW), 29, 30, partials 31&32
T4N R31: partial Sections 25, 36

3. LAKE WINONA

Lake Winona furnishes approximately 46 percent of the water needs for the 300,000 people in the city of Little Rock, the state capital of Arkansas. The Forest Service and the city of Little Rock have a cooperative agreement to establish a public use area and various management practices that will be followed to protect this valuable water source. Certain types of mining practices may be incompatible with the need to maintain high quality standards for the Lake Winona watershed. A withdrawal is necessary to prevent mining related activities that could adversely impact the watershed and affect the water quality of Lake Winona, and to prevent the potential loss of government control of surface resources that could result from a transfer of lands to the private sector as a result of key provisions of the general mining law. The following public domain lands around Lake Winona are recommended to be withdrawn from mineral entry: 1,120 acres:

T2N R17W: partial Sections 19 (SW, E2E2), 20 (W2W2), 30 (NW)
T2N R18W: partial Sections 15 (SW), 22(NW and S2), 23 (S, NE), 24 (S2), 25 (N2N2)

4. LOOKOUTS AND OTHER SITES

Twenty-four sites have been withdrawn from mineral entry as lookouts, guard stations, warden stations and warehouses, under authority of PLO 13358/27/56. The following 11 sites are no longer in use for specific administrative purposes. It is recommended that the withdrawals on these sites be lifted: 230 acres:

- Paul Mountain Lookout, Vanderslice Lookout, Allen Peak Lookout, Shady Warehouse, Muddy Mountain Lookout, Bear Knob Lookout, Eagle Gap Guard Station, Slatington Lookout, Cold Springs Guard Station, Pigeon Creek Warden Station, North Fork Pinnacle Lookout

The following 13 sites are still in use for specific administrative purposes. It is recommended that the withdrawals remain in effect on these sites: 220 acres:

- These nine sites originally were used as lookouts but are now needed for electronic sites: White Oak, Eagle Mountain, High Peak, Dutch Creek, Poteau Mountain, Tall Peak, Bee Mountain, Ouachita Pinnacle, Wolf Pinnacle
- These four sites remain in use for their original purpose: Jessieville Guard Station, Oden Ranger Station, Fiddlers Creek Game Warden Station, Hickory Nut Lookout

In addition, the following site is now in use as an electronic site. It is recommended that the site be withdrawn from mineral entry: 10 acres:

- Kingdoodle Knob Electronic Site (Union Hill Site) T4N, R27W Section 36

5. RECREATION AREAS
The following recreation areas have been withdrawn by the public land orders (PLO) as noted, and are currently being used for the purpose of the withdrawal. It is recommended that the withdrawals for these lands remain in effect: 566.60 acres:

- South Fourche (PLO725, 6/4/51); Crystal Campground (PLO725, 6/4/51); Shady Lake (PLO725, 6/4/51); Jack Creek (PLO 1335, 8/27/56 and PLO 1447, 7/18/57); Knoppers Ford (PLO 1335, 8/27/56 and PLO 2439, 7/18/61); Iron Springs (PLO 1335, 8/27/56); Charlton (PLO 1335, 8/27/56); Bard Springs (PLO 1335, 8/27/56 and PLO 1447, 7/18/57); Collier Springs (PLO 1335, 8/27/56); Queen Wilhelmina State Park (PLO 2597, 1/29/62)
- The Mine Creek site was withdrawn from mineral entry under authority of PLO 1560 on 12/6/57 and is no longer needed. It is recommended that the withdrawal for Mine Creek be removed: 504.22 acres

6. SCENIC AREAS
The following scenic areas have been withdrawn by the public land orders (PLO) as noted, and are currently being used for the purpose of the withdrawal. It is recommended that the withdrawals for these lands remain in effect: 1,926 acres:

Ouachita Lake Visitor Center (PLO 5053; 5/07/71) 920.0 acres, Womble RD, T2S R23W Sec 23-26
Dutch Creek Mtn Scenic Area (PLO 2436; 7/18/61) 320.5 acres, Fourche RD, T3N R26W Sec 1&2
Choctaw Trail (Skyline Drive) (PLO 4103; 9/29/66) 685.4 acres, Mena RD, T1S R30 thru 32W

The following scenic areas are to be managed in a manner to protect the scenic characteristics of the areas. This may be incompatible with minerals related activities. Further review of these areas is necessary to consider a recommendation of withdrawing them from mineral entry: 4,195 acres:

Blowout Mountain -- Oden RD; T1 S R26W Sec. 4, 5 (526 acres)
Dutch Creek -- Cold Springs & Fourche RD's; T3N R25&26W (624 acres)
Crystal Mountain -- Caddo & Womble RD's; T3S R24W Sec. 8 (100 acres)
Irons Fork -- Jessieville RD; T1 N R23W Sec. 5-9 (1,450 acres)
South Fourche -- Winona RD; T3N R19W Sec. 19, 20, 30 (1,495 acres)

7. RESEARCH NATURAL AREAS
Two research natural areas are identified on the Forest. The Roaring Branch Research Natural Area was withdrawn from mineral entry by PLO 5114 on 9/10/71. The Lake Winona Research Natural Area was designated as an RNA by the Chief on 11/7/77; however, the lands were not withdrawn from mineral entry. In addition, the Gap Creek watershed is proposed as an additional Research Natural Area in the Forest Plan. The need to protect the RNAs as unique research sites that will not be directly affected by man-caused impacts has led to the following recommendations:

Retain withdrawal - Roaring Branch RNA: Caddo RD, T4S, R28W- 330 acres
Withdraw Lake Winona RNA: Winona RD, T2N, R18W - 280 acres
Withdraw if Gap Creek RNA becomes established: Caddo RD T4S, R24W - 65 acres

8. EXPERIMENTAL FORESTS

The Alum Creek Experimental Forest was established by PLO 3647 on 4/15/65, and is currently being used for the purposes for which it was withdrawn. It is recommended that the withdrawal for Alum Creek be retained. 4,590 acres:

> Alum Creek Experimental Forest (Winona RD): T1 N, R19W: partial Sections 4 and 5; T2N, R19W: partial Sections 21-23,26-30,32-35

Note: the Irons Fork Experimental Forest (Mena RD, T1S R28W - PLO 1055, 1/18/55) is no longer in use. If it is still withdrawn from mineral entry, it is recommended that the withdrawal be removed.