

APPENDIX 3

PRACTICES FOR OIL AND GAS DRILLING AND OPERATIONS IN CAVE AND KARST AREAS

This appendix describes practices for detecting and avoiding significant caves and significant karst features with respect to oil and gas drilling, and for mitigating impacts to significant caves and karst when they cannot be avoided. These mitigations are predicated on the BLM's responsibilities for resource management and protection derived from the Federal Land Policy and Management Act, the Federal Cave Resources Protection Act, and the National Environmental Policy Act. The practices described here supersede those of the Draft "Interim Guide for Oil and Gas Drilling and Operations in Cave and Karst Areas" (February 1993).

POTENTIAL FOR CAVES OR KARST

A map of cave or karst potential will be maintained to provide the public with current information about the likelihood of the presence of cave or karst resources. The map will serve as an indicator of the potential for encountering caves or karst for which special practices could be required, following NEPA analysis, to mitigate drilling impacts. The primary use of the map is as a source of information for individuals or companies contemplating the leasing of federal minerals.

Three zones of cave or karst occurrence have been identified and categorized: high potential; medium potential; and low potential. Areas that contain known cave or karst features are in the high potential zone. Areas containing known soluble rock formations with the potential for cave or karst development are in the medium potential zone. These zones were identified using geologic maps and existing information on caves and karst. All other lands fall into the low potential zone. These zones may be increased or decreased in size as new information from drilling, cave exploration or other sources becomes available.

The cave or karst occurrence zones have been

further divided into smaller geographic areas to provide an additional means of identification of a specific area (See Table A3-1 and Map A3-1). An estimate has been made for each of these areas as to the lowest likely depth at which caves might be expected. Again, this is simply a source of information for individuals or companies contemplating the leasing of federal minerals.

The lease notice "Potential Cave or Karst Occurrence Area" (Roswell 46), will be applied to leases when all or part of the lease is located in a high or medium potential cave or karst occurrence area. Refer to Figure A3-1 for an example of the lease notice. The purpose of the lease notice, as with maps of cave or karst potential, is to provide information to the purchasers of federal oil and gas leases.

Because the identification of cave or karst potential zones is only informational, the mitigations described below will be applied, when and where appropriate, irrespective of any identified zone of cave or karst potential. However, the emphasis of management will be on caves presently designated significant or on those designated in the future as significant, and on significant karst features.

**TABLE A3-1
CAVE OR KARST OCCURRENCE AREAS
ROSWELL RESOURCE AREA**

Area ^{1/}	Area Name	Depth ^{2/}	Potential ^{3/}
1	Malpais	500	High
2	Fort Stanton	400	Medium
3	Carrizozo	None	Low
4	Corona	400	Medium
5	Cibola	None	Low
6	Cibola 2	None	Low
7	Border Hill	500	Medium
8	Salt Creek	400	High
9	Artesia	None	Low
10	Buffalo Hills	350	High
11	Chaves-DeBaca	400	Medium
12	East RRA	None	Low

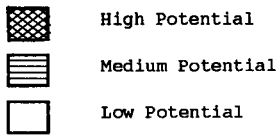
^{1/} Refers to areas on the "Cave or Karst Occurrence Areas" map for the Roswell Resource Area.

^{2/} Lowest likely depth, in feet, at which caves might be expected, measured from the surface. No cave depths are estimated for low potential areas.

^{3/} Potential for cave or karst occurrence.

Source: BLM files, 1994.

Cave or Karst Occurrence Areas



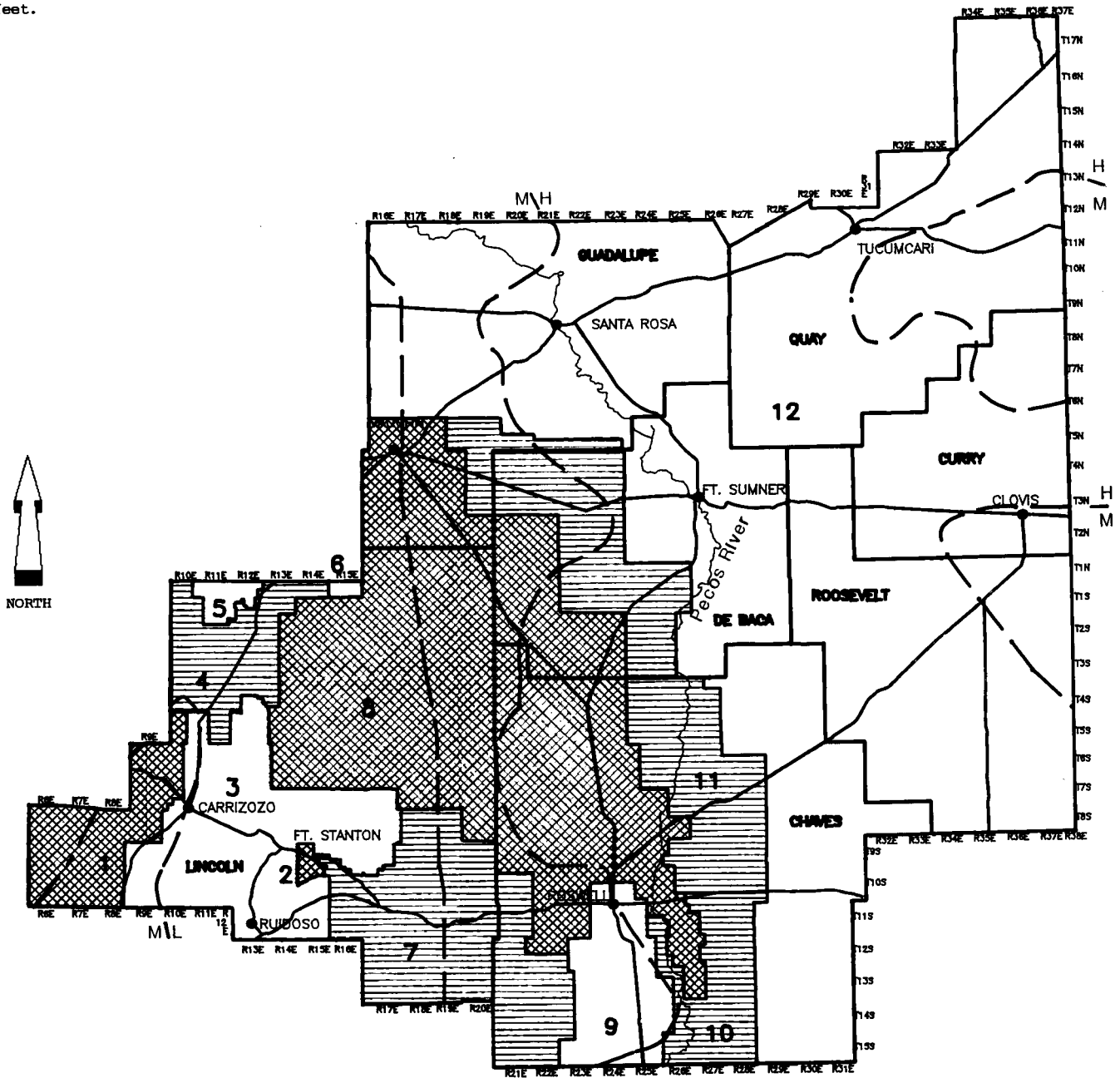
Oil & Gas Potential
Occurrence Boundaries

H = High Potential

M = Moderate Potential

L = Low Potential

NOTE - The table associated with this map shows the relative depth of each area shown on this map. For example, area number 1 is the Malpais Area which has a high potential for the occurrence of caves/karst features to a depth of 500 feet.



SCALE
1/2" = 13.5 Miles
BLM-Roswell District, 1994

FIGURE A3-1

LEASE NOTICE

Potential Cave or Karst Occurrence Area

All or portions of the lease are located in a potential cave or karst occurrence area. Within this area, caves or karst features such as sinkholes, passages, and large rooms may be encountered from the surface to a depth of as much as 2,500 feet, within surface areas ranging from a few acres to hundreds of acres. Due to the sensitive nature of the cave or karst systems of this area, special protective measures may be developed during environmental analyses and be required as part of approvals for drilling or other operations on this lease. These measures could include: relocation of the proposed well; changes in drilling operations; special casing and cementing programs; modifications to surface facilities; or other reasonable measures to mitigate impacts to cave or karst values. These measures may be imposed in accordance with 43 CFR 3101.1-2; 43 CFR 3162.5-1; Onshore Oil and Gas Order No. 1; and Section 6 of the lease terms.

Roswell 46
February 1991

MITIGATION OF DRILLING IMPACTS

The need to relocate drilling locations to avoid caves or karst, and any special drilling or production practices employed to mitigate impacts to caves or karst, will be determined during the NEPA analysis of APDs or other applications. The practices described below will be applied where needed, and to the extent necessary, to ensure that the potential impacts of drilling oil or gas wells, or of constructing other facilities, in cave or karst areas would be minimized according to the following process:

- (1) Detect potential cave or karst resources and determine their significance.
- (2) Avoid cave or karst resources where possible.
- (3) Mitigate impacts to caves or karst that cannot be avoided.

The results of any detection efforts will be ad-

dressed in the NEPA analysis and appropriate mitigations will be developed, if needed, as part of the analysis.

Depending on the results of detection, avoidance will be considered as a means of mitigating potential impacts. In most cases, avoidance will be accomplished by relocation of the proposed well location, which is often done in consultation with the operator at the time of a field examination. Moving a proposed location up to 200 meters is a commonly employed avoidance measure. The need to move a location more than 200 meters will be addressed in the NEPA analysis of an APD. If the construction of a pipeline, road, power line or other facility is proposed, rerouting or relocation will be required to accomplish avoidance.

The management of oil and gas operations in cave or karst areas, including approvals for drilling oil or gas wells, will be guided by procedures described below, Surface Use and Occupancy Requirements (Appendix 1), and Conditions of Approval (Appendix 2). These practices will be

modified as new and cost effective technologies for cave and karst protection become available.

Detection Methods

The primary detection method will be the review of BLM or other records on the presence of caves or karst features in the area of interest, in conjunction with a field exam by a BLM employee or cave inventory contractor to determine the presence of unrecorded cave or karst features. Depending on the results of initial detection efforts and a determination of potential significance by the BLM, cave exploration could be employed to gain additional information. As various geophysical techniques are proven useful for cave detection and become generally available for use, they may be considered on a case-by-case basis as a means of locating unrecorded cave or karst features.

Surface Mitigation

Whether or not a proposed activity has been relocated to reduce potential impacts on caves or karst, surface mitigations will be applied, when needed, to minimize the risk of impacts during construction, drilling or production. Appropriate surface mitigations will be developed during the NEPA analysis of a proposal and could include one or more of the following practices, most of which have long been employed to mitigate impacts.

Practices to minimize potential impacts from reserve pit spills or leakage:

- The use of a closed system or steel tanks;
- Reorientation of the rig and related pit location, while giving consideration to human safety;

Practices to minimize potential impacts from leaking tanks or pipelines:

- The construction of berms around storage tanks sufficient to contain spills, in accordance with Roswell District Conditions of

Approval (Appendix 2);

- The installation of leak detection systems for pipelines or tanks;
- The use of permanent liners in storage tank areas;
- The use of differential pressure shut-off valves;
- The use of corrosion-inhibiting coatings and cathodic protection.

Practices to minimize the potential impacts of vented or escaping gases settling in caves:

- The flaring or venting of gas to protect human safety and to better disperse the gases and eliminate possible gas ignitions;
- The use of stock tank vapor recovery systems.

Subsurface Mitigation

Applicable and reasonable subsurface mitigations will be applied where the presence of caves or karst is obvious or expected, based on the results of detection efforts, and in lost circulation zones. The options could include, but are not limited to, the following practices.

Drilling:

- Cable tool drilling techniques will be used when possible in areas where encounters of caves or karst are expected at depths not greater than 350 feet.
- Rotary drilling techniques in cave or karst areas will include the use of either fresh water mud, foam, or compressed air as a circulating medium in zones where caves or karst are expected. Below those zones, the operator may use whatever drilling fluid is appropriate.

Casing and Cementing:

- All casing will meet or exceed National Association of Corrosion Engineers specifications pertaining to the geology of the location and be run according to American Petroleum Institute and BLM standards.
- A “cave protection” casing could be required in instances when a designated significant cave would be jeopardized. The cave-protection casing string would be set at least 100 feet below the deepest known cave-bearing zone as determined by drilling or other pertinent methods.
- Regardless of the type of drilling machinery used, if bit drops of four feet or more and circulation losses greater than 75 percent occur simultaneously while drilling in any cave-bearing zone, drilling operations will immediately stop and the BLM will be notified by the Operator. The BLM will assess the consequences of the situation and work with the Operator on corrective actions to resolve the problem. If corrective actions fail, the well will be plugged.
- The casing will be cemented in place using one or a combination of any of the following methods that are environmentally sound, as determined by the BLM and the Operator:
 1. If a large void or severe lost circulation zone is encountered, isolation from above and below rather than complete cement coverage of these zones could be employed. This would be accomplished by using stage cementing equipment, external casing packers, cement baskets, and one-inch remedial cementing techniques.
 2. For a less severe lost circulation zone encountered while drilling, the operator would attempt to circulate cement to the surface using a single or multistage cementing job composed of a “lead” and “tail” slurry for each stage.

3. Foam cementing techniques may be used.

Any corrective actions proposed to resolve problems related to bit drops or lost circulation will require BLM concurrence before implementation. A decision on how to proceed will be reached within 24 hours of notification.

MONITORING DRILLING OPERATIONS

Where the presence of significant caves or significant karst features are obvious or expected based on the results of detection efforts, and in lost circulation zones, constant monitoring of drilling operations by the BLM could be required.

MONITORING PRODUCTION OPERATIONS

On wells within one-half mile of significant caves, annual pressure tests will be performed by the Operator on all casing annuli. If the test results indicated a casing failure, remedial actions approved by the BLM will be undertaken to correct the problem.

PLUGGING AND ABANDONMENT

The BLM standards for plugging and abandonment in Onshore Oil and Gas Order No. 2 will be applied to protect or isolate all useable water zones, potentially productive zones, lost circulation zones, abnormally pressured zones, caves, and any prospectively valuable deposits of minerals. This includes any zones encountered during drilling that contain fluids with a potential to migrate.

RECORD KEEPING

The Operator will track the customary drilling activities, including the rate of penetration, pump pressure, weight on bit, bit drops, percent of mud returns, and presence or absence of cuttings returning to the surface. As part of customary record keeping, each detectable void or sudden increase in the rate of penetration not attributable to a change in the formation type should be documented and evaluated as it is encountered.

The BLM may review data held by companies on wells drilled in cave or karst areas, to gain information about impacts to caves and karst. This information will be used to categorize lost-circulation zones on the basis of depth, relative volume, and severity, and to evaluate and compare the relative success or failure of different remedies attempted to combat lost-circulation problems while drilling and cementing casing in these zones. This information also will be used to update information about the occurrence of cave and karst features. Information concerning cave resources gathered during drilling will be submitted, as well, to be retained by the BLM in accordance with the Roswell District Cave Management Plan and the regulations implementing the Federal Cave Resources Protection Act.