JOHN SHOMAKER & ASSOCIATES, INC.
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# TECHNICAL MEMORANDUM

To: Ted J. Trujillo, Esq., Law Offices of Ted J. Trujillo, P.A.

From: Steven T. Finch, Jr., Senior Hydrogeologist-Geochemist

Date: June 17, 2008

Subject: Potential hydrologic impacts to surface- and ground-water resources within Rio Arriba County caused by the drilling of oil wells by Approach Operating, LLC.

This memorandum supports the basis for potential hydrologic impacts to surface- and ground-water resources within Rio Arriba County caused by the drilling of oil wells by Approach Operating, LLC. Four well drilling permits were granted by the New Mexico Oil Conservation Division (NMOCD) to Approach Operating, LLC. An additional six oil and gas well applications have been submitted to the NMOCD. A list of the well permits is provided as Table 1, and locations of proposed and permitted wells are shown on Figure 1. The Board of County Commissioners of Rio Arriba requested a hearing from the NMOCD to show that the drilling of the wells listed in Table 1 will cause waste, violate correlative rights and be injurious to human health and the environment.

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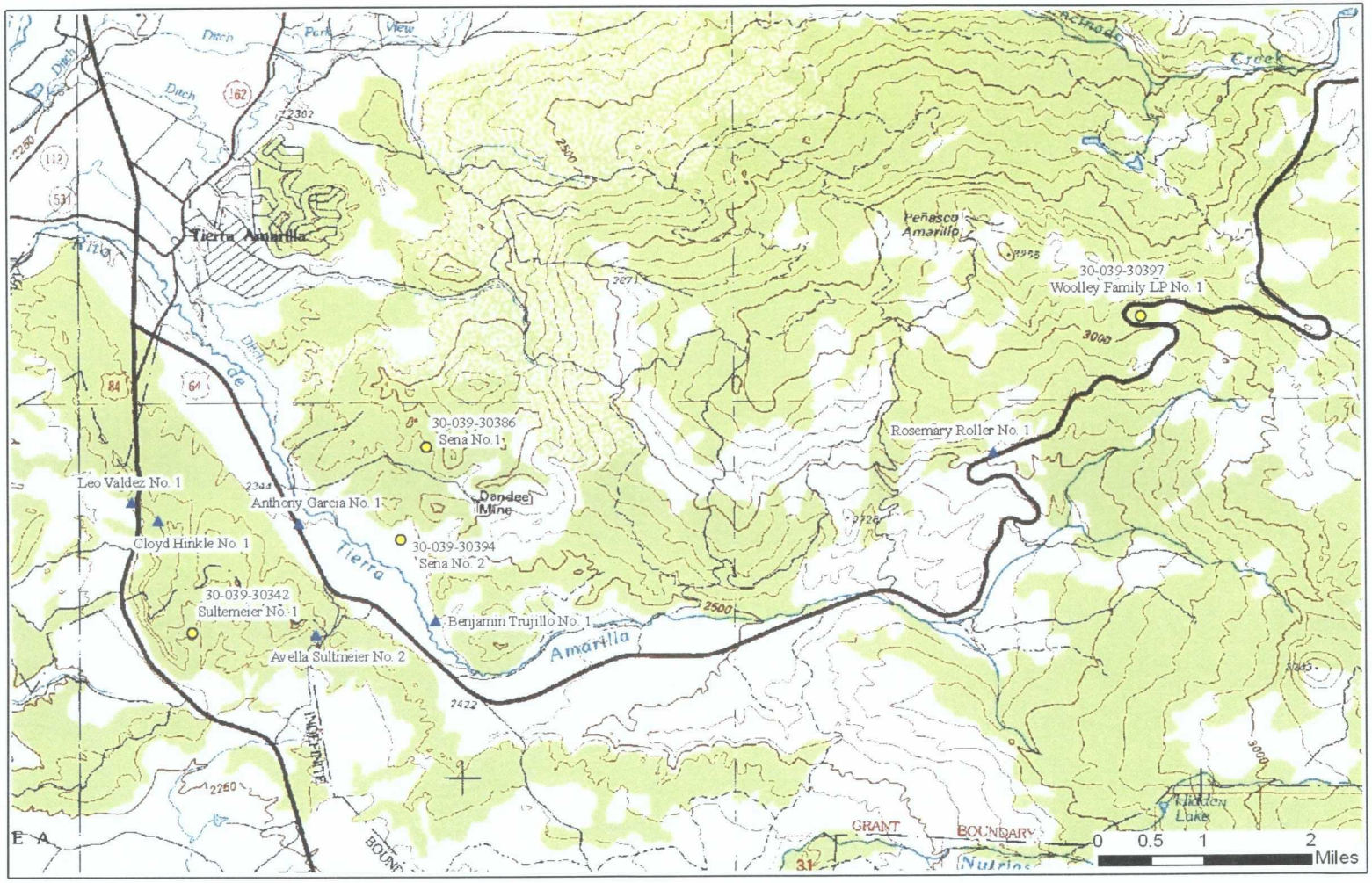


Figure 1. Topographic map showing the location of protested NMOCD well permits (yellow circles) and permit applications (triangles) in the Rio de Tierra Amarilla Watershed, Rio Arriba County.

**Description of Water Resources near Proposed Wells**

The permitted wells are located in the Rio de Tierra Amarilla watershed, upstream of Tierra Amarilla, New Mexico (Fig. 1). The Rio de Tierra Amarilla is one of the major perennial tributaries to the Rio Chama. The New Mexico Water Quality Control Commission (NMWQCC, 20 NMAC 6.1 2116) has the following Designated Uses to the Rio de Tierra Amarilla:

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For Wildlife Habitat, 20 NMAC 6.1 3101 L states the following: "no discharge shall contain any substance, including, but not limited to selenium, DDT, PCB's and dioxin, at a level which, when added to background concentrations, can lead to bioaccumulation to toxic levels in any animal species."

**Proximity of NMOCD Permitted Wells to Water Resources**

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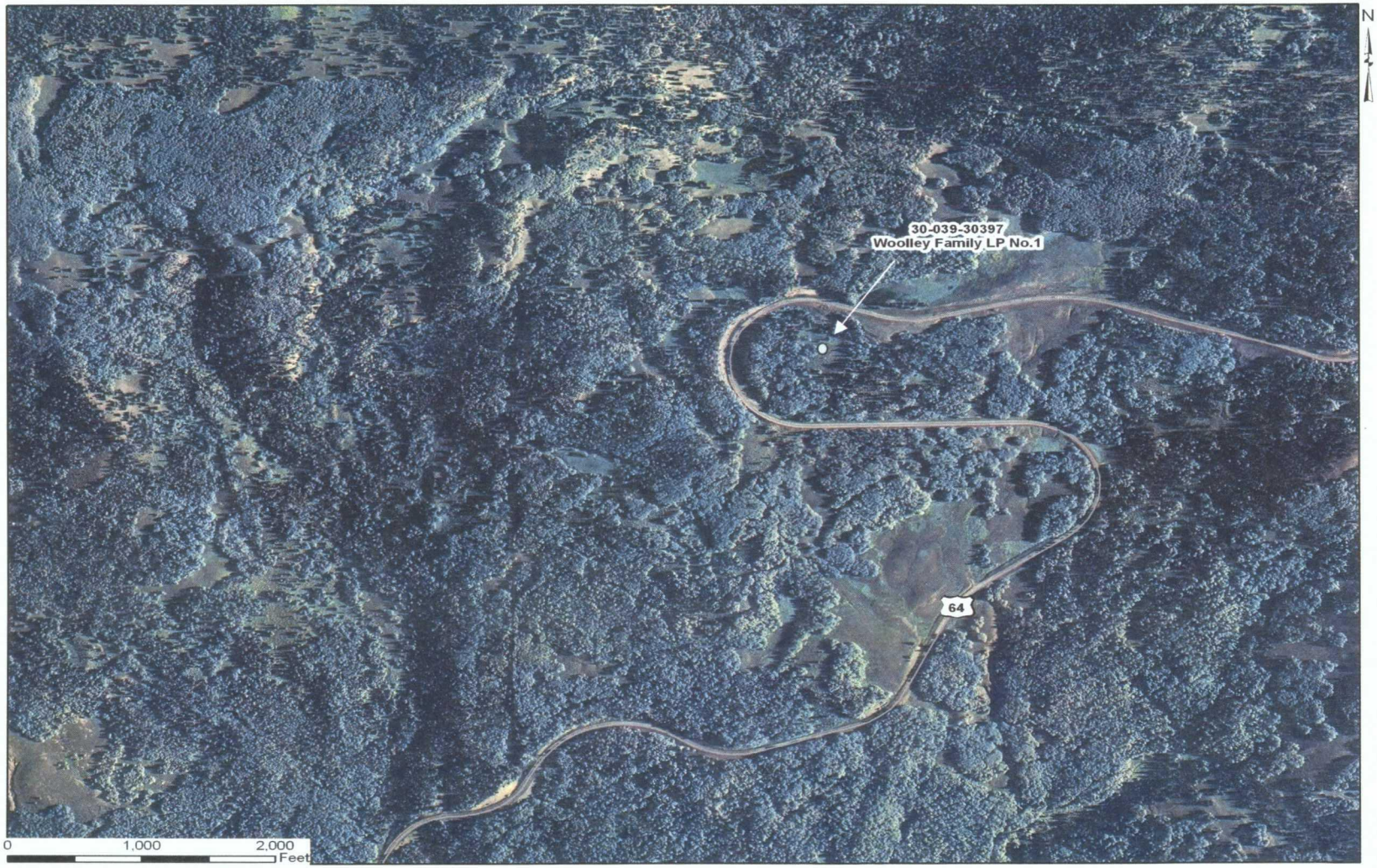


Figure 2. Aerial photograph showing Woolley Family LP No. 1 well permit location.


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**Proposed Drilling Methods**

All four permits state that the wells will be drilled using air-rotary methods. Lined pits are listed on the drilling permits, using 6 to 12 millimeter thick synthetic liner material. The pit volume is to be 4,000 barrels (bbls), which is equivalent to 168,000 gallons. A pit 5 ft in depth would require approximately 5,500 $ft^2$ of area (75 ft by 75 ft), and a pit 10 ft in depth would require approximately 2,500 $ft^2$ of area (50 ft by 50 ft).

The first 350 ft of each hole is proposed to be 12-1/4-inch diameter, with 9-5/8-inch casing to be installed and cemented. This will allow for a 1.3 inch annulus for the cement seal. The remainder of the drill holes will be 8-3/4-inch diameter with 4-1/2-inch casing cemented in place. The 4-1/2-inch casing will have a 2.1-inch annulus for cement seal.

**Potential Sources of Waste and Contaminants**

Typically air-rotary drilling methods do not involve the use of drilling fluids, and the hole can be drilled and cleaned by use of air. Drilling fluids are generated when the formation contains ground water, and sometimes water and additives are used to stabilize the formation or assist with borehole cleaning while drilling. The water-well drilling industry uses drilling fluid additives that are protective of ground-water quality and approved by the American Water Works Association (AWWA), where the Oil and Gas drilling industry typically does not use AWWA approved products. Drilling additives for air-rotary drilling may include foaming agents or other products for increasing the viscosity of the fluid.

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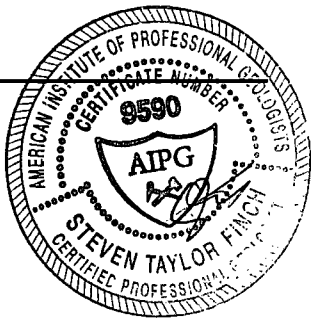


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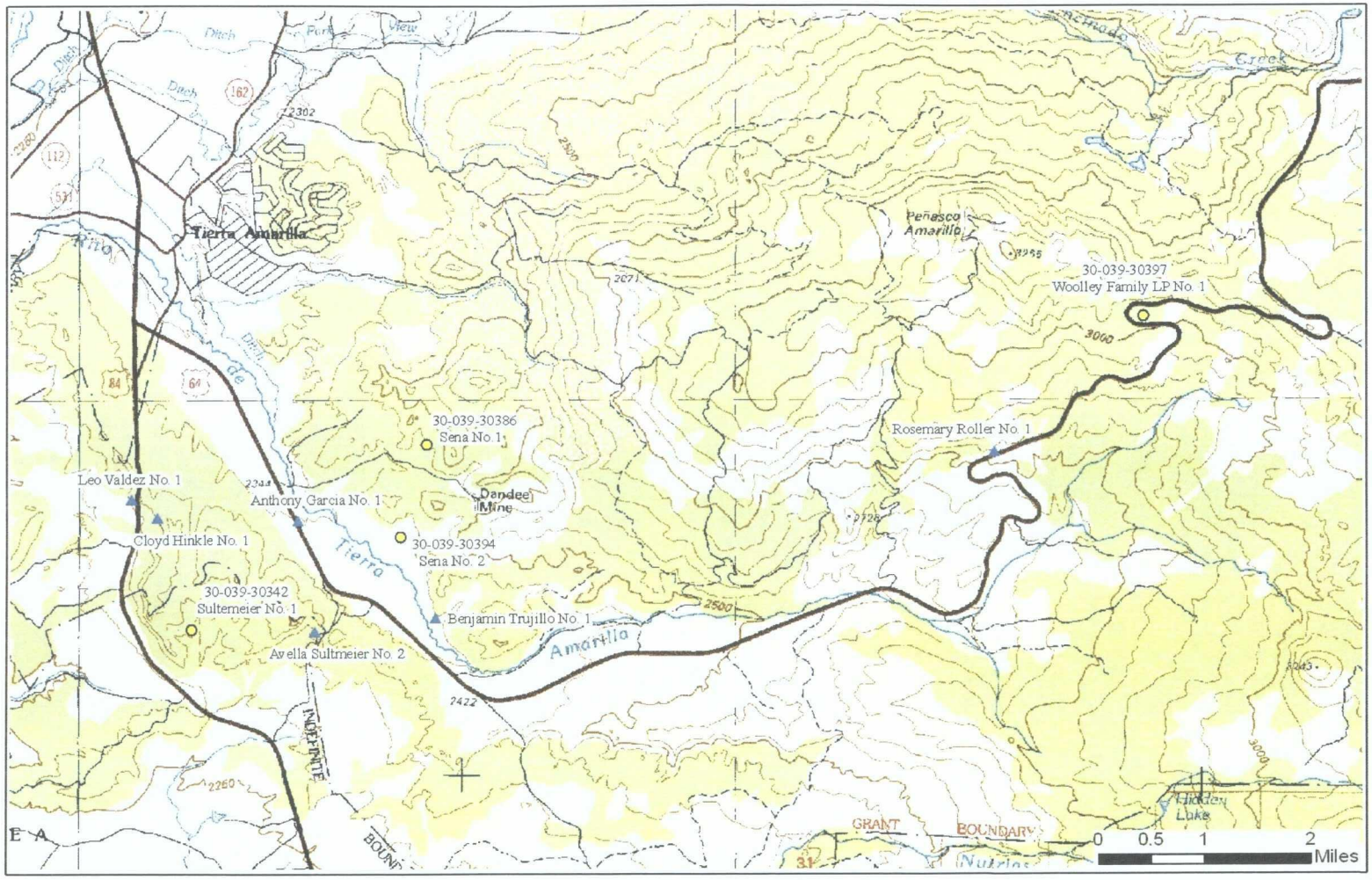


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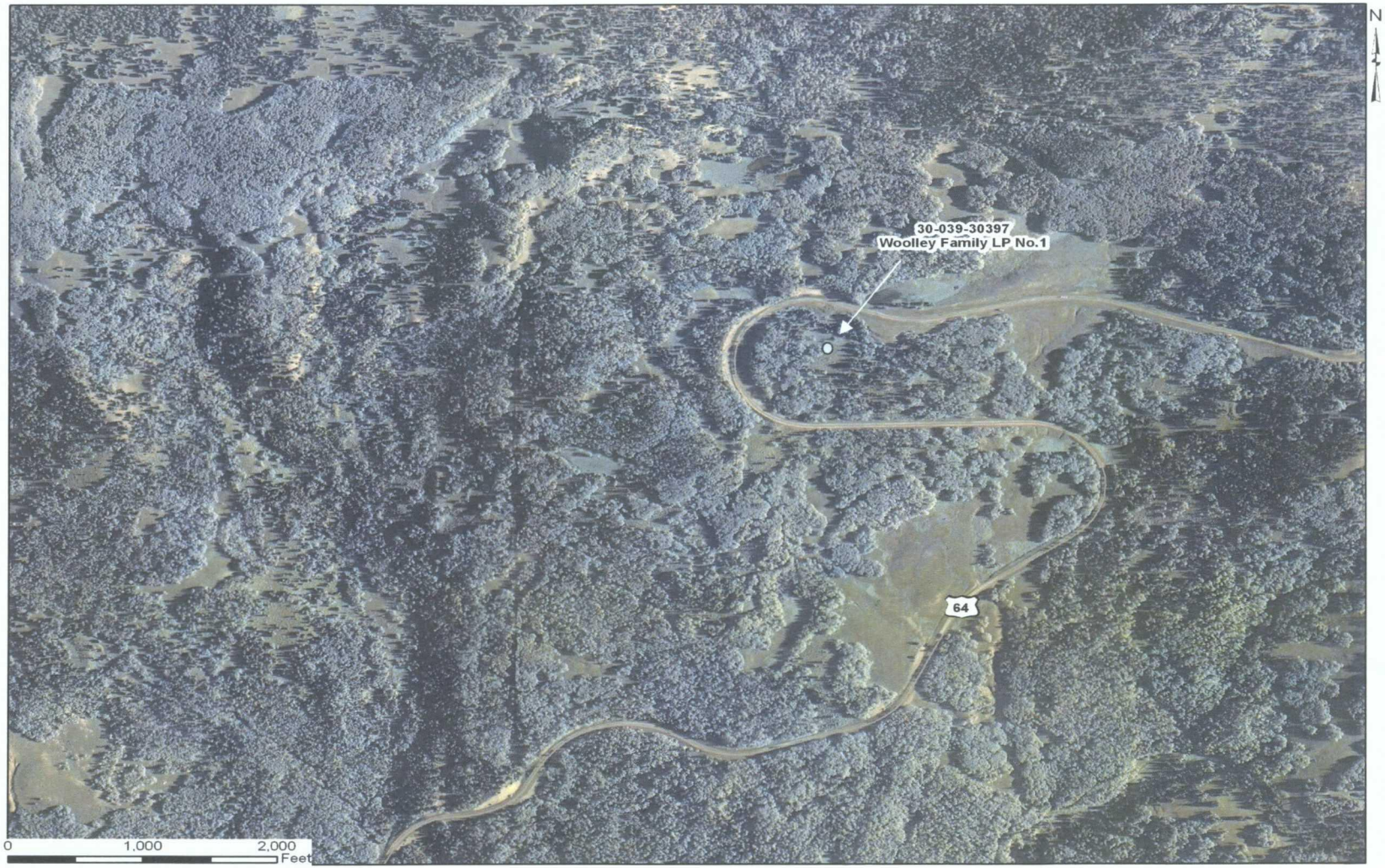


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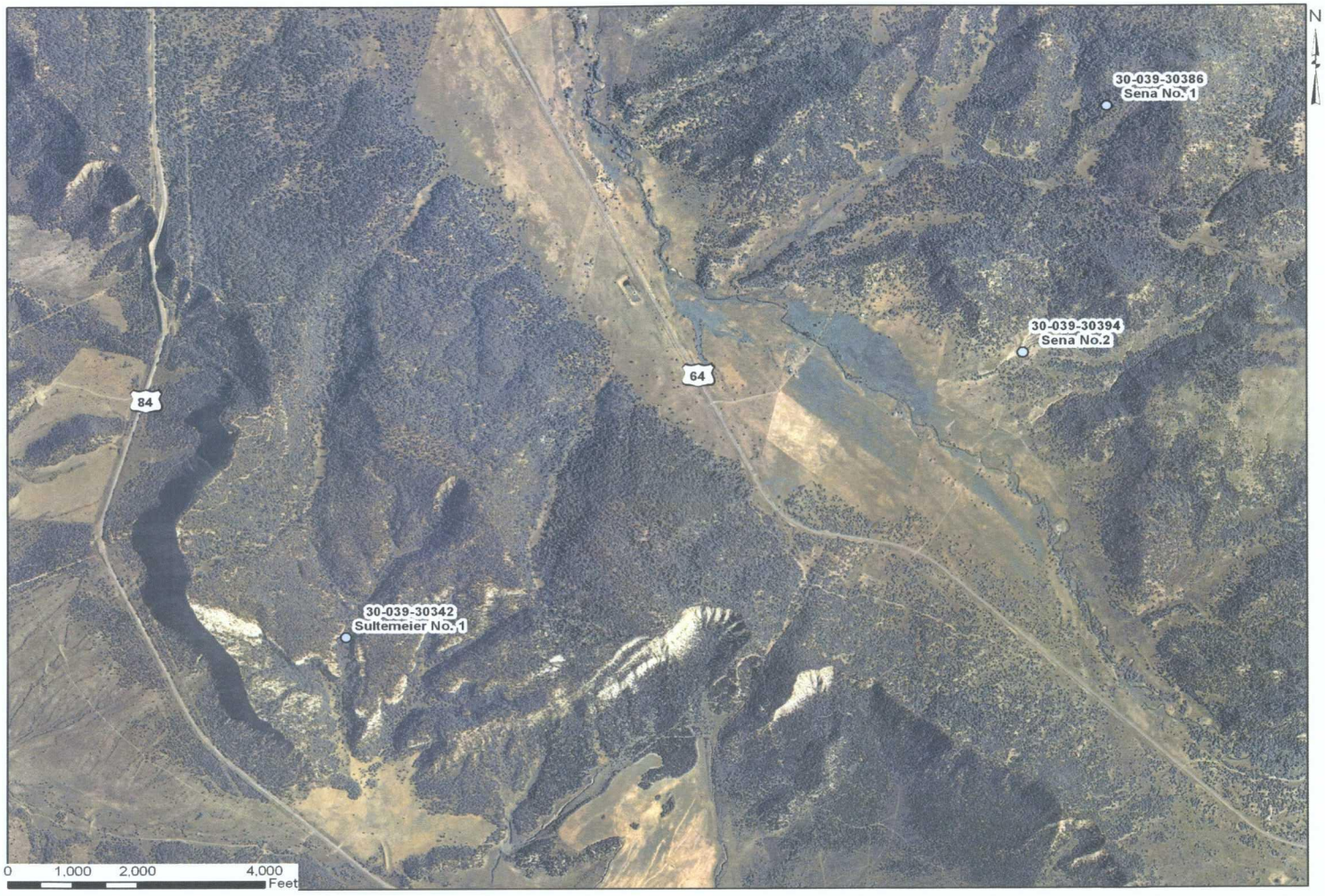


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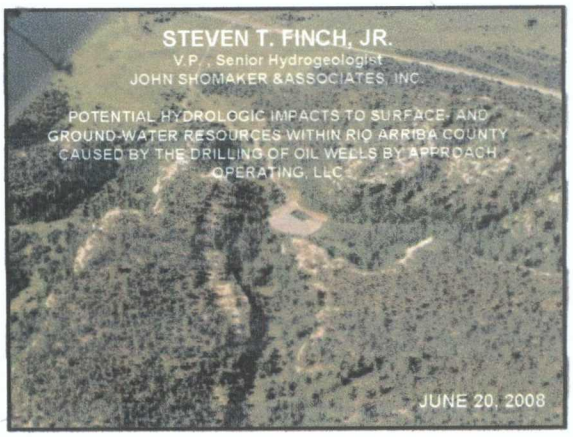
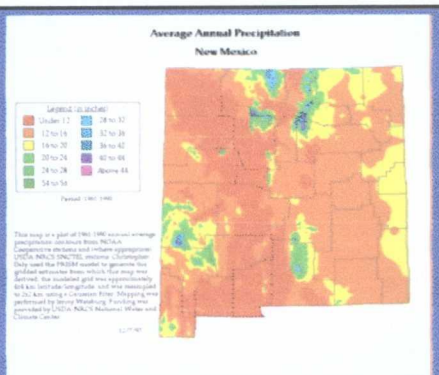



## OUTLINE OF PRESENTATION

- Surface-water resources of region
- Location of proposed and permitted wells to surface water features
- Ground-water resource of region
- Proposed oil well drilling methods and construction
- Rio Chama Regional Water Plan
- Conclusions




Localized precipitation in mountains accounts for most of stream flow generated in New Mexico

Area of proposed oil well drilling is located in the head waters of the Rio Chama

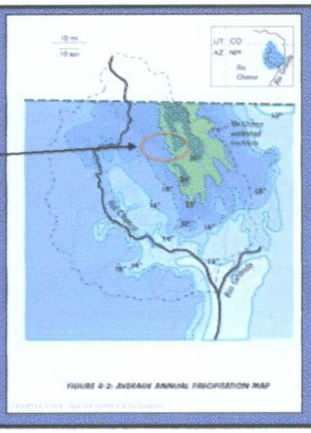



FIGURE 0-2: AVERAGE ANNUAL PRECIPITATION MAP

## NEW MEXICO WATER QUALITY CONTROL COMMISSION STREAM STANDARDS FOR RIO CHAMA AND TRIBUTARIES ABOVE EL VADO RESERVOIR

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| domestic water supply | dissolved nitrate | mg/L | 10 |
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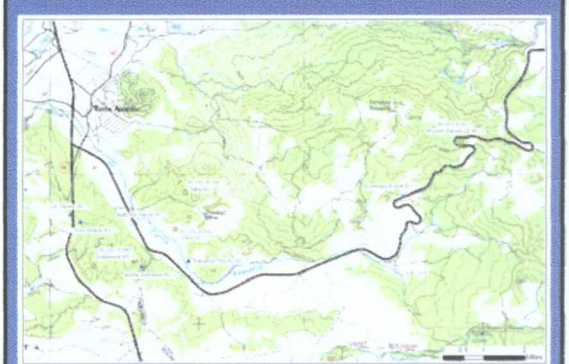
## LOCATION OF PERMITTED AND PROPOSED OIL WELLS



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SITING EVALUATION

- Most locations are in bottom of water course areas or in wetlands
- No provisions for limiting impact to watershed and foot print
- Depth to water has not been determine at these sites, and it is likely less than 25 ft

Figure 2. Aerial photograph showing Woolley Family LP No. 1 well permit location

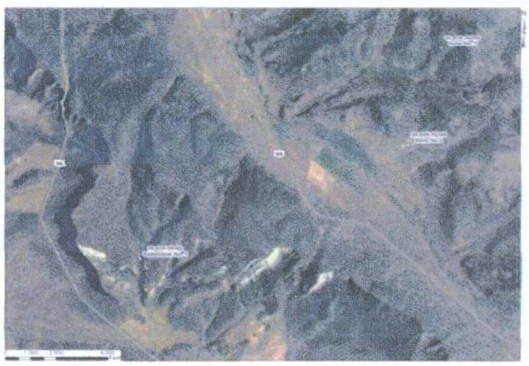
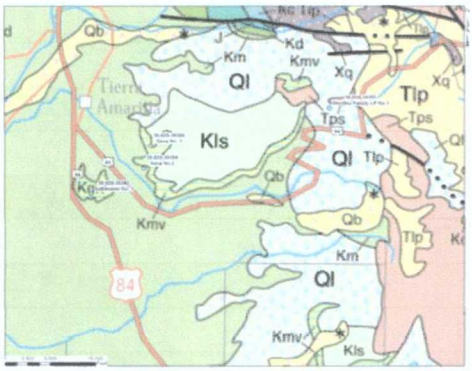


Figure 3. Aerial photograph showing Sultemeier No. 1, Sena No. 1, and Sena No. 2 permit locations.

## GROUND-WATER RESOURCES



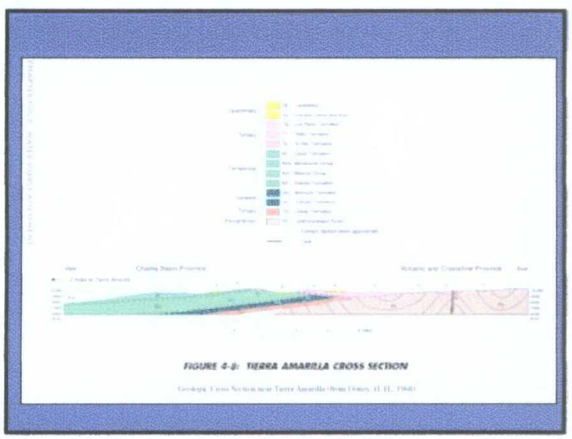



FIGURE 4-8: TIERRA AMARILLA CROSS SECTION

Geologic Cross Section near Tierra Amarilla (from Dinwiddie, 1968)

## SUMMARY OF WATER SUPPLY WELL DEPTH AND WATER LEVELS

| DB File Nbr | Use | Owner | Location TRSqqq | Depth Well (ft) | Depth Water (ft) |
|---|---|---|---|---|---|
| RG 74579 | STK | DAVID R. MARTINEZ | 27N 04E.34 2 4 1 | 10 | 3 |
| RG 70941 | STK | ALEX SISNEROS | 27N 04E.26 2 4 2 | 12 | 6 |
| RG 29195 | DOM | ASELINO ORTIZ | 27N 04E.35 3 1 | 35 | 7 |
| RG 62904 | DOM | WENDELL WAYNE COWAN | 26N 04E.10 2 3 2 | 70 | 12 |
| RG 78780 | DOM | PAUL GORDY | 26N 04E.11 3 2 2 | 100 | 10 |
| RG 76187 | DOM | DEAN VANDOREN | 26N 04E.23 | 100 | 18 |
| RG 74957 | STK | DAVID ARCHULETA | 27N 04E.34 2 2 4 | 100 | 60 |
| RG 64926 | DOM | HAMID ISHAASH | 26N 04E.08 4 4 4 | 100 | 68 |
| RG 75041 | DOM | RONALD J. AND PATRICIA K. FUSS | 26N 05E.19 | 120 | 78 |
| RG 27785 | DOM | TOBIAS SANCHEZ | 27N 04E.13 2 | 143 | 83 |
| RG 70946 | DOM | LARRY ABRAHAM | 26N 04E.11 | 150 | 43 |
| RG 36927 | NOT | EMITT MUNDY | 26N 05E | 155 | 85 |
| RG 63675 | DOM | DIANA & DAVID S. MATTOON | 26N 05E.18 | 160 | 100 |
| RG 65518 | ISM | JOHNNY P. OTERO | 26N 04E.05 | 180 | 70 |
| RG 68739 | DOM | JOSEPH E BISH | 26N 05E.19 | 280 | 97 |
| RG 80929 | DOM | KENT R. AUGUSTINE | 26N 05E.19 | 300 | 200 |
| RG 24072 | MOW | BRAZOS MOVICA INC | 26N 05E.18 4 1 4 | 318 | 140 |
| RG 71349 | EXP | BRAZOS WATER COOPERATIVE AS | 26N 05E.18 4 1 4 | 1248 | 50 |
| RG 78107 | MUL | MUNDY RANCH | 26N 05E.19 | 340 | 220 |
| RG 82368 | DOM | RONALD HYDE | 26N 05E.18 | 350 | 200 |
| RG 71215 | DOM | KAREN EUDALY-ECKELS | 26N 05E.18 | 404 | 3 |
| RG 68417 | DOM | JENNIFER CAPELLI | 27N 04E.26 4 3 4 | 740 | 110 |
| RG 21554 | MOW | CEBOLLA MOVICA | 27N 04E.13 3 3 2 | 1167 | 619 |
| SP 03347 | MOW | CEBOLLA MOVICA | 27N 04E.13 3 3 2 | 1167 | 619 |
| | | | 27N 04E.13 2 3 3 | 2610 | 620 |

Water-bearing geologic units: alluvium, Mancos Shale, Dakota Sandstone

## PROPOSED WELL DRILLING METHODS AND CONSTRUCTION

**Table 1. Summary of well permits for Approach Operating, LLC**

| well API No. | name | location | elevation, ft amsl | proposed depth, ft bgl |
|---|---|---|---|---|
| 30-039-30342 | Subterniter Well No. 1 | T27N R4E 19 | 7,590 | 6,000 |
| 30-039-30386 | Sena Well No. 1 | T28N R4E 10 | 7,955 | 2,000 |
| 30-039-30394 | Sena Well No. 2 | T28N R4E 16 | 7,823 | 2,000 |
| 30-039-30397 | Woolley Family LP Well No. 1 | T28N R5E 3 | 9,922 | 2,000 |

ft amsl - feet above mean sea level ft bgl - feet below ground level

POTENTIAL SOURCES OF WASTE AND CONTAMINANTS

- Drilling fluids and additives
- Produced water
- Fuels and oils related to drilling rig and equipment
- Upward migration of fluids in annulus (artesian conditions)

## RIO CHAMA REGIONAL WATER PLAN

Recognizes the importance of water to the communities in the Rio Chama watershed

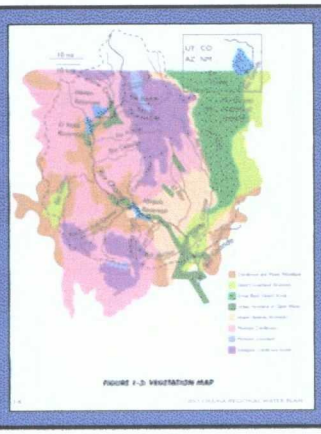



FIGURE 1-3: VEGETATION MAP

## RIO CHAMA REGIONAL WATER PLAN PLANNING ALTERNATIVES

- ***Preserve the acequia system and strengthen its role in community life***
- ***Enhance growing season streamflows (by increasing storage or other means) so that agriculture is less limited by low peak-season flows***
- ***Develop local agriculture with information, marketing, and financial support***
- ***Provide reliable water supplies to community water systems***
- ***Protect water quality***
- ***Conserve and reuse water resources where appropriate***
- ***Protect and restore upper watershed areas***

RIO CHAMA WATER PLAN

Provides the technical basis for prohibiting development in the upper reaches of the Rio Chama watershed in order to protect water quality and quantity.

**Strategy: Regulate and discourage development in upper watershed areas**

The upper reaches of the Rio Chama mainstem and tributary watersheds are sensitive areas and need to be carefully managed. Land practices in these upper reaches have large impacts on the quality and quantity of water that reaches the streams and acequias within the entire watershed. There is general agreement in the region to restrict (or even prohibit) development in these areas. If development is allowed, it is very important to stringently regulate road design, implement runoff catchment structures, require terrain management to prevent excessive runoff, and re-vegetate all disturbed areas. Revegetation and erosion control requirements should be stringently enforced in all instances of disturbance, including non- construction activities such as utility installation or logging. Adequate road construction standards are important here as everywhere. In most upper watershed areas we need to preserve the ability to use fire as a watershed management tool to maintain forest health and watershed productivity without fear of damaging inappropriately sited structures. This would tend to argue for prohibiting any development in these areas.

RIO CHAMA REGIONAL WATER PLAN

## *GOAL: PROTECT AND RESTORE OUR WATERSHEDS*

Managing watersheds to enhance both ecological health and hydrologic function will help achieve all our water planning goals. Good watershed management can help with acequia water supplies, enhance community and individual water security, protect water quality, make acequia maintenance easier, and even contribute to the long-term viability of the entire acequia system. At the same time, properly restored watersheds would offer environmental advantages in terms of wildlife habitat, forage, ecological diversity, rangeland productivity, and reduced danger of damaging large scale forest fires.

The strategies that will protect and restore our watersheds are the same ones that will enhance our water supplies and reduce water pollution. These are discussed and evaluated above in reference to these goals. It may seem redundant to give watershed protection and restoration the status of a separate water planning goal, but it deserves such recognition both because it unites many concerns and strategies for better managing water in our region, and because it was mentioned frequently and passionately by local residents in many water planning meetings.

There are opportunities for significant improvements in watershed management throughout the region. Higher altitude areas can benefit from improved fire management, forest thinning, beaver re-introduction, better grazing management in forest areas, and development restrictions in critical areas. At lower altitudes, erosion control structures and grass cover enhancement are needed almost everywhere, along with management of the timing and intensity of grazing so livestock can enhance soil cover. Better road construction and other kinds of runoff management offer advantages throughout the region. Specific techniques and opportunities are discussed in detail above. The unifying theme among many of the alternatives that would help us the most is enhancing and protecting our watersheds to store as much water as possible in the soil and shallow aquifers rather than letting it run off quickly and erosively.



RIO CHAMA REGIONAL WATER PLAN

Recommends Rio Arriba County as the agency to regulate land use and to protect sensitive upper watershed areas.

***Physical, hydrological, and environmental impacts***

One of the principal problems associated with homes sprinkled among lovely high-altitude forests is the resulting demand to protect these homes from forest fires. As we are increasingly coming to understand, fire is a natural part of the ecology of most of our forests, and requirements to suppress forest fires generally result in trading frequent small fires for infrequent large ones. Given the role of fire in maintaining forest health and also perhaps the desired hydrological properties of watersheds, it would be highly counterproductive if any substantial forested area were effectively required to be fire-free. It is also impossible for anyone or any agency to guarantee that forest fires can be prevented, even if that is desired, and the attempt is generally extremely expensive – imposing a major potential burden on taxpayers to subsidize forest homeowners.

The other major environmental or hydrological effects associated with development in forest areas (and exponentially more pronounced the greater the slope of the land) are increased concentration of runoff water caused by buildings, parking areas, driveways, and roads. While techniques exist to mitigate all these effects, they can be costly and in some instances it may well make more sense simply not to build in these areas, and more particularly not to build roads there.

***Implementation***

Implementation of land use restrictions generally falls to County administration in our region, since no other government entity has jurisdiction except in the Village of Chama, our only municipality, and the Jicarilla Apache Tribe. County staff would need to draw up an ordinance, to be enacted by the County Commission, and the County would need to assume responsibility and allocate funding for enforcement.

While Rio Arriba County has no authority to regulate land use and development within the Jicarilla Apache Reservation, it is hoped that the Tribe would similarly protect these sensitive upper watershed areas.

## CONCLUSIONS

- Prohibit development in upper watershed areas as recommended in the Rio Chama Regional Water Plan
- Implement hydrologic well siting evaluation before issuing drilling permits to ensure protection of surface water
- Use only closed loop systems in the Rio Chama watershed
- Require better annular seal to prevent upward migration of saline water or commingling of aquifers