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.

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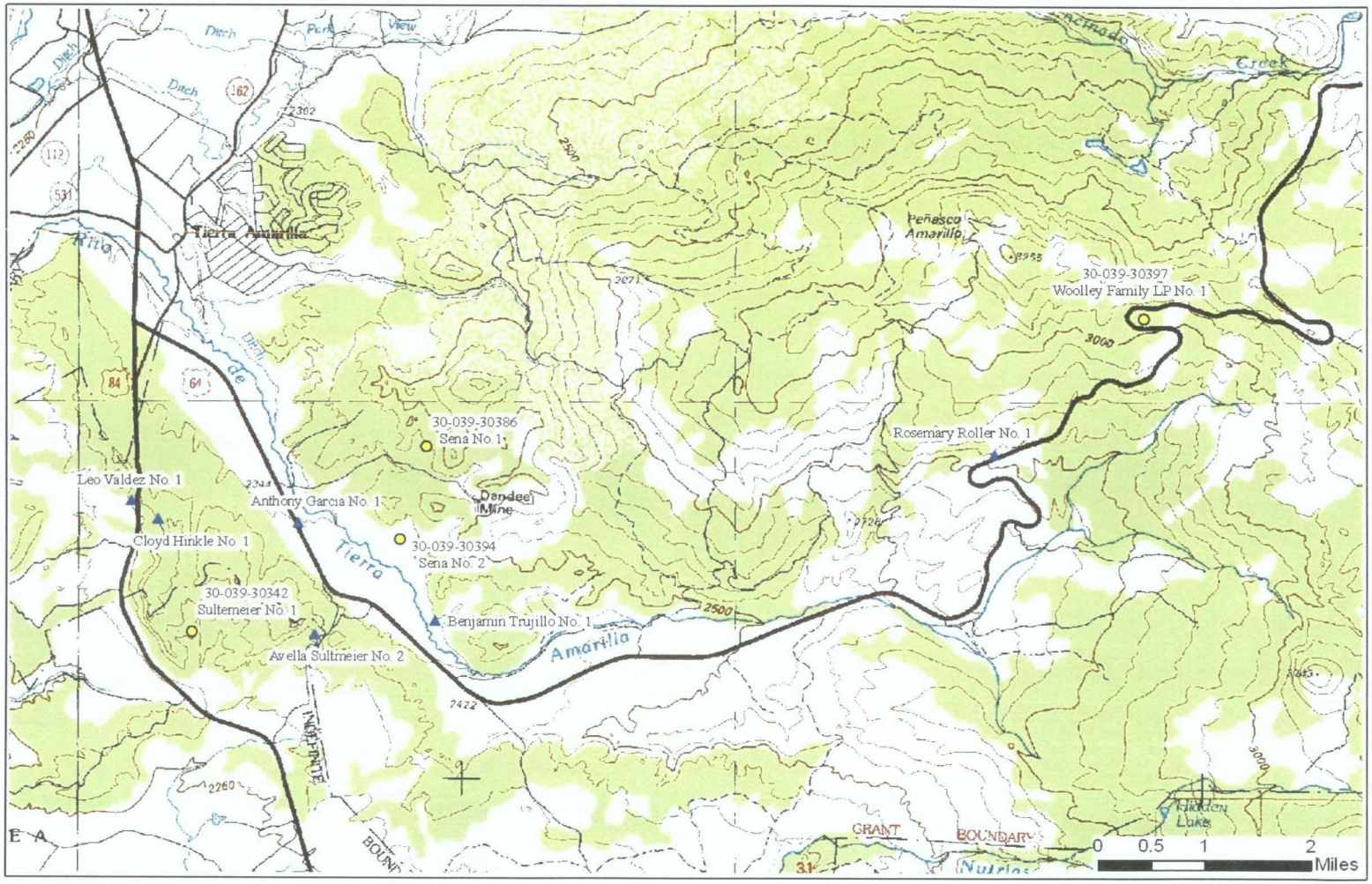

Figure 1. Topographic map showing the location of protested NMOCD well permits (yellow circles) and permit applications (triangles) in the Rio de Tierra Amarilla Watershed, Rio Arriba County.

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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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	dissolved uranium	mg/L	0.3
	gross alpha	pCi/L	15
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Proximity of NMOCD Permitted Wells to Water Resources

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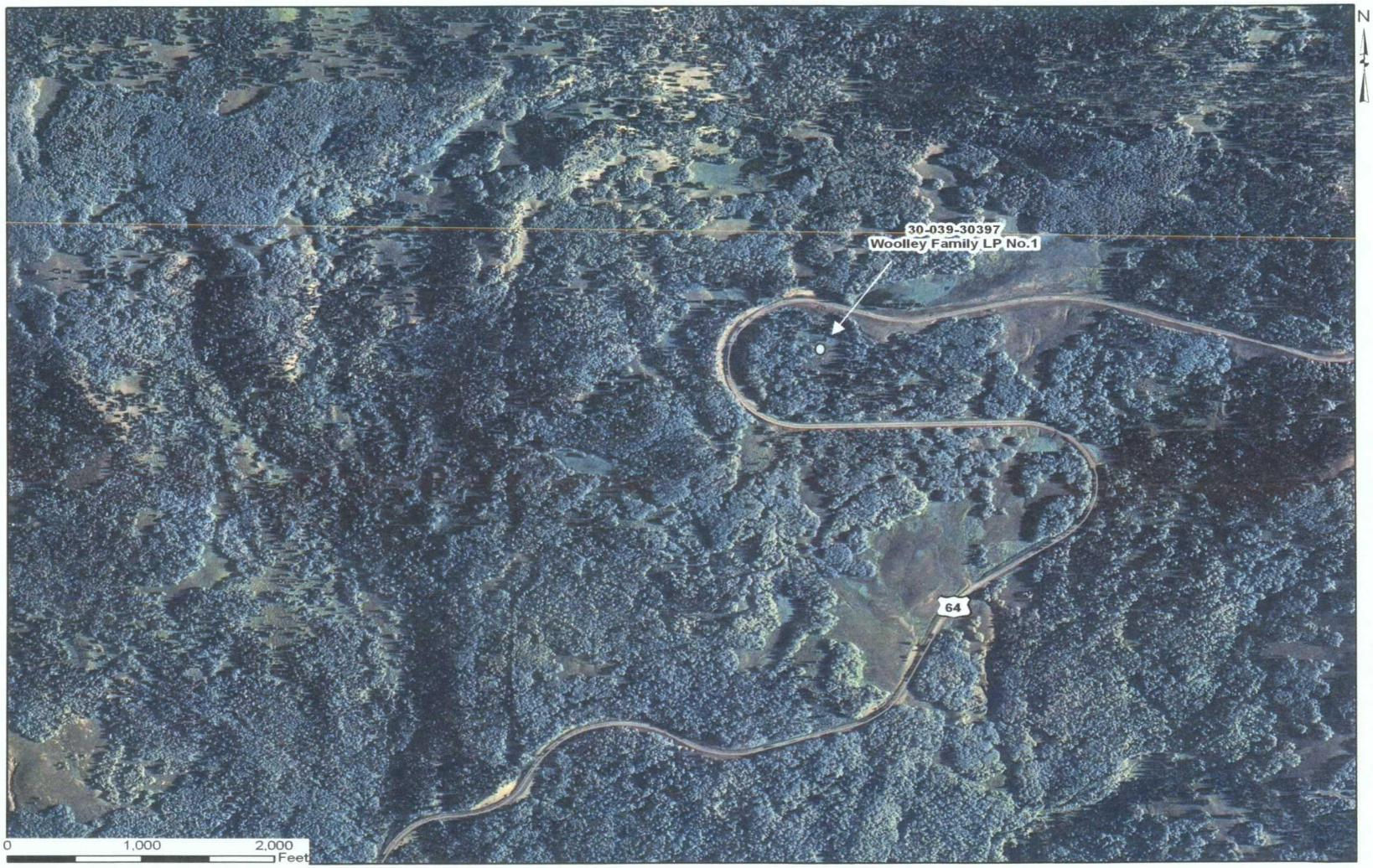

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Proposed Drilling Methods

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).

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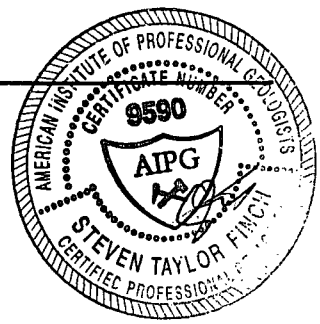

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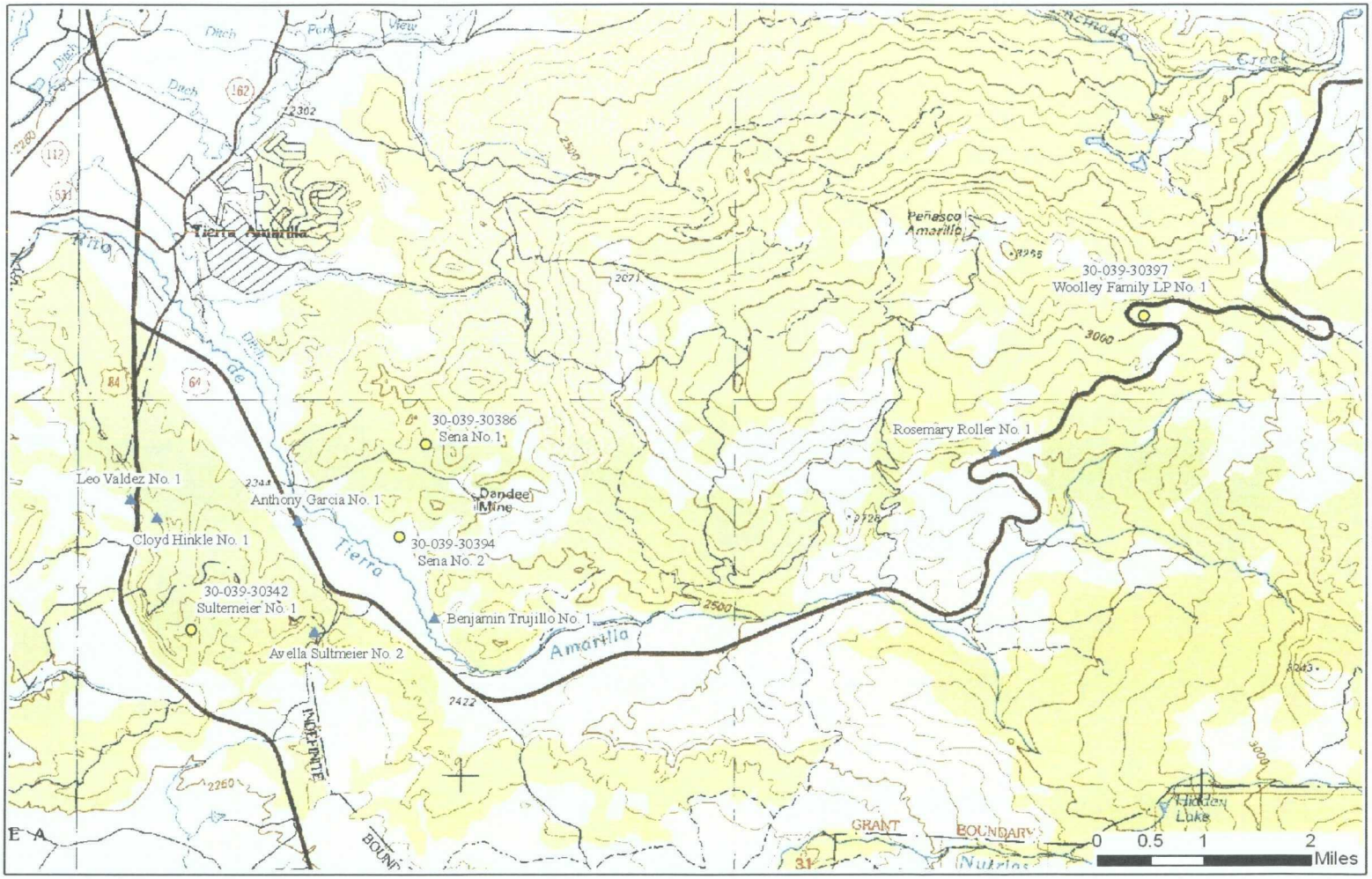

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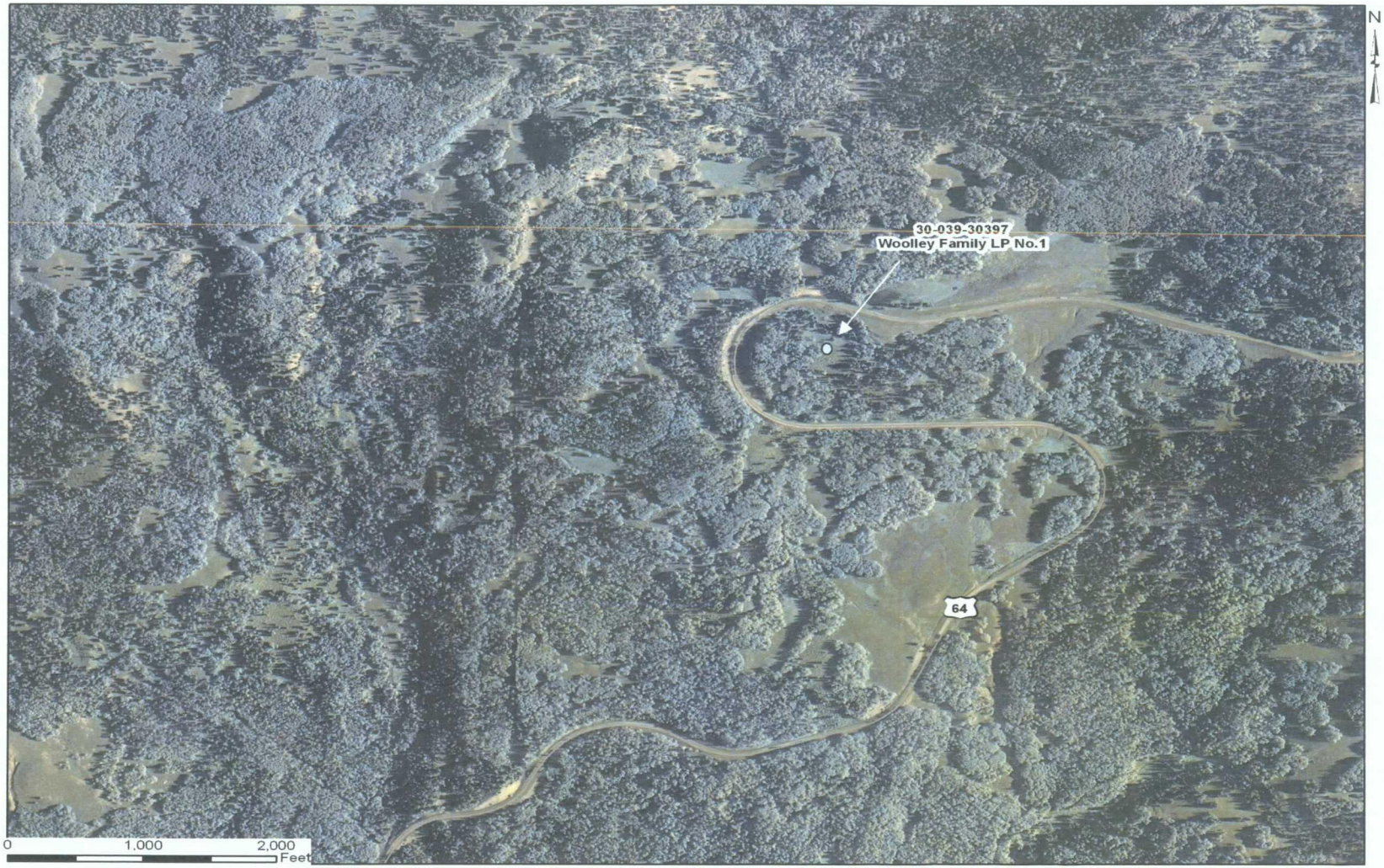

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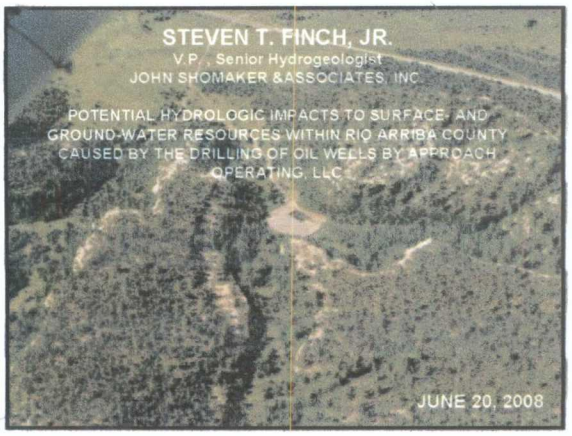
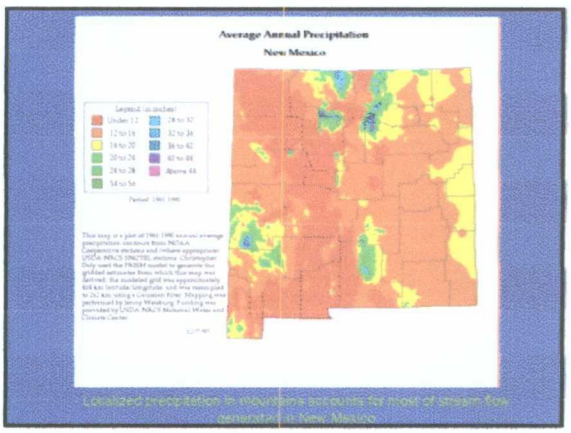


OUTLINE OF PRESENTATION

- 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 generation in New Mexico

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

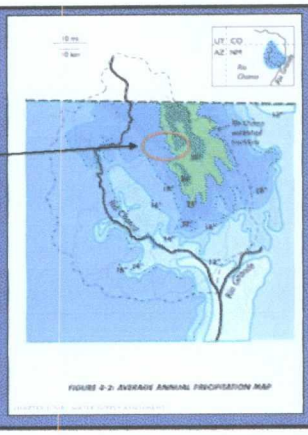


FIGURE 3-2: AVERAGE ANNUAL PRECIPITATION MAP

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

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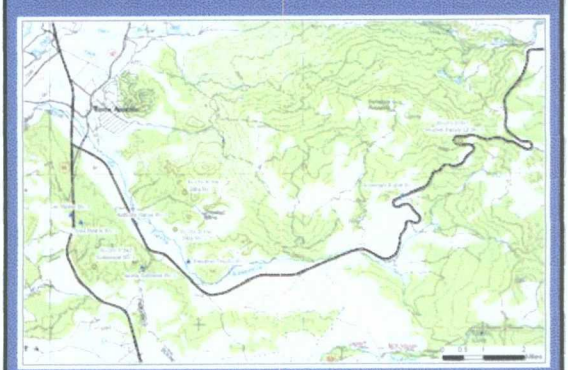
LOCATION OF PERMITTED AND PROPOSED OIL WELLS



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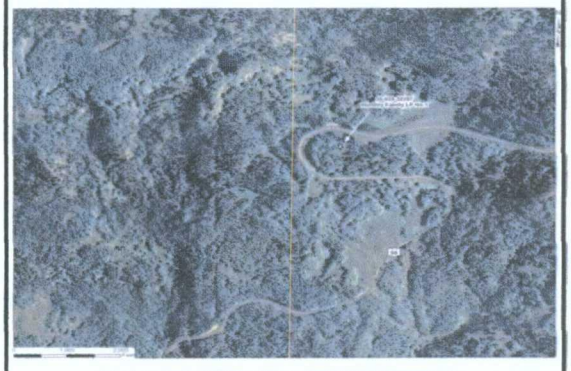
SITING EVALUATION

- 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



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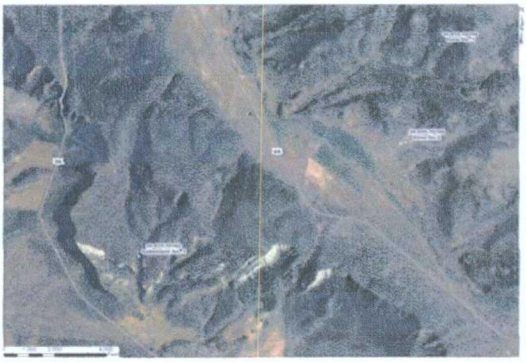
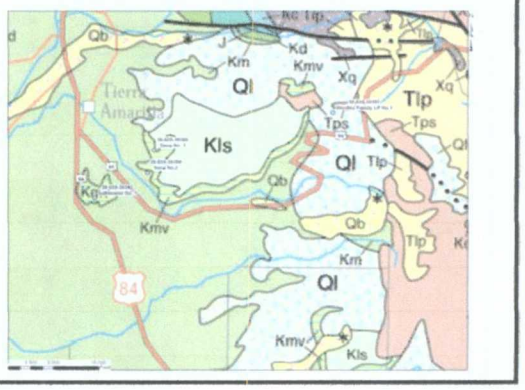


Figure 3. Aerial photograph showing Sultemeier No. 1, Sena No. 1, and Sena No. 2 permit locations.

GROUND-WATER RESOURCES



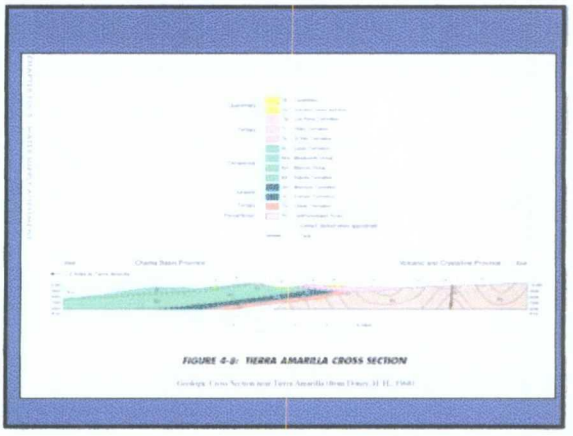


FIGURE 4-9: TIERRA AMARILLA CROSS SECTION

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 7 4 1	120	0
RG 70941	STK	ALEX SISNEROS	27N 04E 26 7 4 2	121	0
RG 79195	DOM	ABELINO ORTIZ	27N 04E 35 3 1	35	2
RG 69804	DOM	MINDELL WAYNE COWAN	26N 04E 10 4 3 2	72	0
RG 78783	DOM	PAUL GORDY	26N 04E 11 3 2 4	160	10
RG 76187	DOM	DEAN VANDOREN	26N 04E 22	150	10
RG 74967	STK	DAVID ARCHULETA	27N 04E 34 2 2 4	100	60
RG 64026	DOM	HAMID GHIASSI	26N 04E 08 4 4 4	130	60
RG 75041	DOM	RONALD J. AND PATRICIA K. FUSS	26N 05E 19	120	70
RG 77765	DOM	TOBIAS SANCHEZ	27N 04E 13 2	140	63
RG 70946	DOM	LARRY ABRAHAM	25N 04E 11	150	43
RG 36927	NDY	EMITT MUNDY	26N 05E	155	85
RG 63615	DOM	DIANA & DAVID S. MATTOON	26N 05E 18	162	100
RG 68516	SAN	JOHNNY P. RIVERO	26N 04E 05	180	70
RG 78709	DOM	JOSEPH E BISH	26N 05E 19	260	43
RG 80609	DOM	KENT R. AUGUSTINE	26N 05E 19	300	200
RG 24272	MDW	BRAZOS MOWCA INC	26N 05E 18 414	318	140
RG 74345	EXP	BRAZOS WATER COOPERATIVE AS	26N 05E 18 414	324	170
RG 78107	MUL	MUNDY RANCH	26N 05E 19	340	220
RG 82908	DOM	RONALD HYDE	26N 05E 18	350	200
RG 71215	DOM	KAREN LUDALY-ECKELS	26N 05E 18	404	3
RG 68412	DOM	JENNIFER CAPELLI	27N 04E 26 4 3 4	740	110
RG 71354	MDW	ICEBOLLA MOWCA	27N 04E 13 3 3 3	1167	610
EP 93347	MDW	ICEBOLLA MOWCA	27N 04E 13 3 3 3	1181	610
			27N 04E 13 2 3 3	2810	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	Subtmeter 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 (erosion conditions)

RIO CHAMA REGIONAL WATER PLAN

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

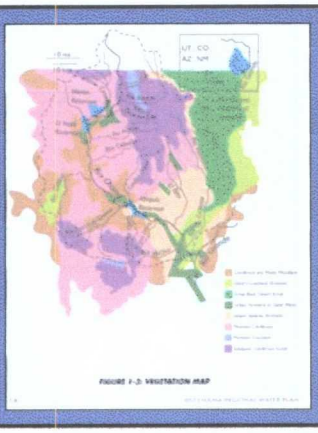


FIGURE 1-3: VEGETATION MAP

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