4R - 003

GENERAL CORRESPONDENCE

YEAR(S):

1991-1990

AquaTerra Consulting, Ltd.
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Great Falls, Virginia 22066
(703) 444-3090
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May 27, 1991

Mr. L. D. Williamson
Operations Superintendent
Vermejo Minerals Corporation
Route 1, Box 68, Cimarron, NM 87714

Dear Mr. Williamson:

Enclosed are three copies of our evaluation of discharge water from Coal Bed Methane Pilot Program for Fishery Development at Vermejo Park, NM.

This work was done at the request and authorization of Robert F. Stephens, Fisheries Consultant.

Mr. William G. Gordon of our firm and Mr. William Berryhill of Genesis Aquaculture were the principal reviewers of the water quality data from the test wells and prepared the enclosed analysis.

We were very pleased to have the opportunity to participate in this project. If we can be of additional assistance as it develops further, we would like to do so.

Please contact me at the above address or telephone number if you have any questions concerning the report or the invoice.

Sincerely yours,

Robert A. Jantzen

Robert A. Jantzen, President

cc: Robert F. Stephens
Roy Johnson
Genesis Aquaculture

Evaluation Study of Discharge Water from Coal Bed Methane Pilot Program for Fishery Development at Vermejo Park

Prepared By

Aqua/Terra Consulting, Ltd
With Participation and Cooperation of
Genesis Aquaculture, Inc.

May 27, 1991

Evaluation Study of Discharge
Water from Coal Bed Methane Pilot
Program for Fishery Development
at Vermejo Park

Background:

Pennzoil Corporation owns large land areas in northern New Mexico where operations are aimed at recovery of methane gas underlying coal seams. These strata also produce water which cannot be readily disposed of within present economically and environmental practices. The area for development contain small lakes and spring fed streams, some of which could or do support populations of trout and other fish specie. Pennzoil management desires to utilize the by-product (water) of the methane recovery to augment the production of trout in support of a recreational trout fishery for clients of the firm. Recreational fishing is but one of many businesses conducted on the property including ranching, hunting, coal mining as well as oil and gas development. The underlying questions are the utility of the water to enhance such a fishery or to support a trout hatchery at the site.

In conducting our evaluation we relied upon analysis of water samples taken from test wells on the site by Pennzoil management. The analyses were preformed by an independent laboratory IML and state (New Mexico) SLD test facilities. We also reviewed trout water quality standards of the states of Pennsylvania and West Virginia (high coal producers), criteria published by the U.S. Environmental Protection Agency (EPA) and limits suggested by Piper et al (1982). The New Mexico standard, although currently under review, are similar to the Pennsylvania and West Virginia standards (New Mexico Water Quality Control Commission, personal communication). See Tables 1 and 2.

Water Quality

The laboratory reports show that water quality in wells Q, S, 90-1, 90-2, and 90-3 does not differ radically in most respects. Water taken from test wells 90-1, 90-2 and 90-3 (those nearest the lakes show high total dissolved solids and high total alkalinity {salinity}) but these were not excessive. Ph values of 8.08 to 8.77 are at the upper end of the range for trout. The high total dissolved solids could not cause problems unless these values also represent suspended materials with in the samples. Concentrations of some metals were a bit high. The worse case is shown in the SLD report for well Q, taken on 09/10/90 (one of the split samples) in which levels reported by Piper et al (1982) were exceeded by iron (>100X), lead (10X), magonese (23X), and zinc (7X). Aluminum exceeded the EPA proposed limit by 22X. The analysis of the same sample by IML gave significantly lower levels for these metals. Based upon the information available to us, we cannot reconcile the vast differences in the two analysis of the same sample. Since the water is well buffered as indicated by the high alkalinity values the presence of metals as reported probably will not be deleterious to adult trout.

Other toxic compounds such as hydrogen sulfide and cyanides were not detected or were not reported. Of the organics present the purgeable aromatics may be cause for concern. Of some concern are benzene, toluene, ethylbenzene, m/p xylene and o-xylene which exist at some levels in wells 90-1, 90-2 and 90-3. Since these are believed to be purgeable they can be dealt with prior to reaching fishing waters.

Water temperatures of 64 degrees to 69 degrees Fahrenheit are too warm for trout water. As the water from the wells mixes with lake water the temperature as well as the ph value will moderate depending on well pumping rates. Note that successful trout hatcheries operate at temperatures in the low 50's and survivability of fry diminishes greatly at higher levels. The warm water could be a useful factor during the winter by possibly preventing the lakes from freezing solid, thus allowing overwintering of the residual fish population. Three major species of trout could be considered for the project. Pennziol management may wish to seek out adfluvial races (trout that spawn in streams but feed and grow to maturity in lakes) for their project. Certain races have adapted well to life in sluggish water or to a lake existence. Under ideal lake conditions trout of all species may grow to trophy size.

Rainbow trout (Oncorhynchus mykiss) are native to the western slopes of the Rocky Mountains. They spawn at the head of riffles in gravel and nubble particles that vary between one-half and three inches diameter. For most rainbow trout spawning takes place in the spring during periods of rising water temperature and the period of embryonic development is short in comparison to fall spawners. Rainbows are considered fry from the time they hatch and emerge from the gavel until they lose their yolk sacs (frys self contained food supply). They are considered juveniles until reaching abut 8 inches.

Rainbows that migrate to an ocean or lake existence generally live one to three years in their natal stream before migration and there, spend one to three year before returning as adults to spawn. The majority of females are four year old before spawning and the males three. Mature fish can weigh between 6 to 17 pounds.

Brown Trout (Salmo trutta) are native to Europe, North Africa and Western Asia and were naturalized in North America since the Late 1800s. Brown trout are fall spawners when temperatures and daylight hours begin to decrease. Brown trout spawn in riffles and often adjacent to a spring or upwelling discharge area. The eggs incubate in gravel over the winter period, and depending upon water temperatures hatch in February to mid-March. The fry remain in the gravel several weeks until they fully absorb their yolk sacs.

The majority of a brown trout spawning population is composed of three-to-six year old fish. Although brown trout generally remain stream residents there are lake run races. Brown trout have adapted well to the sluggish somewhat warmer waters of rivers in their native lands.

Brook Trout (Salvelinus fontinalis) are the only native stream-dwelling trout in eastern North America and are members of the char genus as are lake trout and artic char. Brook trout require cooler water temperatures than the rainbow or brown trouts and they cannot survive in the deteriorated environmental conditions that the other species can withstand. Brook trout spawn in the fall usually initiated by decreasing daylight and temperature. Brook trout eggs incubate in the gravel until late February or early March and the fry remain there until the yolk sac is absorbed. Brook trout have a relatively short-life cycle as all are sexually mature by age three. Brook trout are considered a specie of small brooks but are also found in larger steams if environmental conditions are adequate. There are races that migrate in the Great Lakes where they reach considerably larger size than those which remain in the streams.

Although the rainbow trout evolved in the mountainous western United States where rapid-flowing streams are the norm, this trout more than any other has been adapted to a wide variety of environments and is most readily reared in enclosures of various size and under a wide range of environmental parameters. The rainbow in one form also migrates to the ocean or lake in which it is called the steelhead. Because of its great potential for adaptation it is recommended as the choice for the Pennzoil project.

Much depends on well pumping rates which appear unknown, especially regarding water quantity. How much water will be pumped into the lakes? How much water is available? We have heard that eventually 300 wells pumped at 1 to 2 million gallons per day might be installed. Will the wells eventually go dry? How much water is lost from the lakes by outflow i.e. evaporation, infiltration, or overland flow? How will pumping alter the present water budget in the lakes? If evaporation accounts for the major loss, the addition of significant amounts of well water with high total dissolved solids could increase salinity in the lakes. This may not be a problem as Piper et al (1982) reported that trout successfully acclimated to brackish water and grew to maturity at salinity of 30 parts per thousand. As young rainbow trout (steelhead) can grow in ocean water this species should be the trout of choice. Rapid changes in concentrations however will be stressful to fish, but a carefully monitored water budget should control such changes.

A more comprehensive assessment could be made of water quantity and quality if maps of the project area, knowledge of land use, mycological, and geology of the vicinity and well pumping rates were available. Once there data are available consideration would be given to pretreatment of water.

Recommendations:

We see no reason not to proceed to develop a fishery program utilizing pumped water to augment surface supply. As stated above there are many unknown factors which may impact water quality. Accordingly we make the following recommendations:

1. Establish a regular water quality monitoring program to include all the parameters reported in the analysis available to us as well as sulfides, cyanides and other toxic materials. Sampling should include lake water to establish a baseline and then to monitor changes as a result of influent waters. Monitoring should continue at test wells. Inflow rates from the wells should be established.

2. Oxygenate all well water. We suggest state-of-the-art oxygen technology rather that aeration as this will remove iron, volatile organic compounds, and reduce inorganic such as hydrogen sulfide. The system also raises dissolved oxygen levels without inducing the possibility of nitrogen gas bubble disease in fish. See appendix A.

We would be pleased to offer our services in the development of the recreational fishery program and the design and construction of a trout rearing facility at the project site.

Table 1. Suggested Water Quality Criteria for Optimum Health of Salmonid Fishes, Concentrations are in parts per million (ppm).[1]

Chemical	Upper Limits for Continuous Exposure
Ammonia (NH_3)	0.0125 (un-ionized form)
Cadmium[a]	0.0004 ppm (in solf water<100 ppm alkalinity)
Cadmium[b]	0.0003 ppm (in hard water>100 ppm alkalinity)
Chlorine	0.03 ppm
Copper[c]	0.006 ppm in solf water
Hydrogen Sulfide	0.002 ppm
Lead	0.03 ppm
Mercury (organic or inorganic)	0.002 ppm maximum, 0.00005 ppm average
Nitrogen	Maximum total gas pressure 110% of saturation
Nitrite (NO_2)	0.1 ppm in solf water, 0.2 ppm in hard water (0.03 and 0.06 ppm nitrate-nitrogen)
Ozone	0.005 ppm
Polychlornated biphenyls (PCBs)	0.002 ppm
Total suspended and settleable solids	80 ppm or less
Zinc	0.03 ppm

[a]To protect salmonid eggs and fry. For non-salmonids, 0.004 ppm acceptable.

[b]To protect salmonid eggs and fry. For non-salmonids, 0.03 ppm acceptable

[c]Copper at 0.005 ppm may suppress gill adenosine triphosphatose and compromise smoltification in anadromous salmonids

[1]From Piper et al 1982

Table 2. Suggested Chemical Values For Hatchery Water Supplies, Concentrations are in parts per million (ppm)[1]

Variable	Trout
Dissolved Oxygen	5 - saturation
Carbon Dioxide	0 - 10
Total Alkalinity (as $CaCO_3$)	10 - 400
% as phenolphthalein	0 - 25
% as methyl orange	75 -100
% as ppm hydroxide	0
% as ppm carbonate	0 - 25
% as ppm bicarbonate	75 - 100
PH	6.5 - 8.0
Total hardness (as $CaCO_3$)	10 - 400
Calcium	4 - 160
Magnesium	Needed for buffer system
Manganese	0 - 0.01
Iron (total)	0 - 0.15
Ferrous ion	0
Ferric ion	0.5
Phosphorous	0.01 - 3.0
Nitrate	0 - 3.0
Zinc	0 - 0.05
Hydrogen sulfide	0

[1]From Piper et al 1982

Appendix A.

Oxygen Supplementation in

Fish Culture

The Fish and Wildlife Service, Department of Interior has prepared an excellent compilation of information regarding oxygen injection in fish culture. A first volume of "Oxygen Supplementation-A New Technology in Fish Culture was published in 1987 and all copies have been distributed. A second volume, "Oxygen Supplementation-A New Technology in Fish Culture," Information Bulletin #2 is a compilation of new information from recent studies on oxygen injection, some important older papers, and a short section on new equipment. Data are included on performance form tests run with production size columns, mass transfer modelling and biological effects of rearing fish in an environment with high dissolved oxygen. The volume also includes information on new equipment for measuring dissolved oxygen and other technology necessary for surveillance where oxygen injection systems are installed. This report was completed in March 1990. Copies of the Report are available from:

U.S. Fish and Wildlife Service
Fisheries and Federal Aid
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225

References

Piper, R. G., McElwain, I. B., Orme, L. E., McCraren, J. P., Fowler, L. G., and Leonard, J. R. 1982. Fish and Wildlife Service, Washington, D. C.

Saums, G. 1991. Personal communication.

U. S. Environmental Protection Agency. 1990. Existing and Proposed USEPA Maximum Contaminant Levels in Drinking Water. Compiled by Robert A. Saar, Geraghty & Miller, Inc., Plainview, N. Y.

West Virginia Water Resources Board. 1990. Requirements Governing Water quality Standards, Charleston, W. Va.

OCD/Pennzoil Meeting on Vermejo Park 6/24/91
1345 hrs

participants

Ron Ostenhout } Pennzoil
Jim }
Dave Boyer
Bill Olson } OCD
Joy Johnson

R.O. Feel need NPDES permits

D.B. EPA classifies NPDES as
1) Major - Refineries, etc
2) Minor

EPA concentrates on major facilities, existing

Pennzoil in diff. position than SJB
In SJB sites located on fed. land and
discharge thru [illegible] to SJ River ultimately
EPA said unlikely to take enforcement action
if meeting general type permit conditions
But still public perception problem

In Vermejo - in private land
no impact to other landowners waters

options 1.) injection

2.) surface disposal

3.) NPDES, complying with state / stream requirement and federal

R.O. Not comfortable with non permit permit
Previous trouble with this circumstance in Pennsylvania

R.O.B. EPA will put back on state

R.O. what about individual pits

R.B. No specific rules for Vermejo
Need to work with Roy and the Rim
protection of G.W.

R.O. Plan of injection in SE Van Bremmer canyon

W.O. Could consider centralized pits

R.O. ~~[illegible]~~ Have to get permitted for dam thru SEO but have plenty of land to create lakes

D.B. Review & same State stream stds.
It not specific watercourse will fall under general stds.

R.O. Will consider 2 options

1.) Will attempt to deal with EPA on NPDES

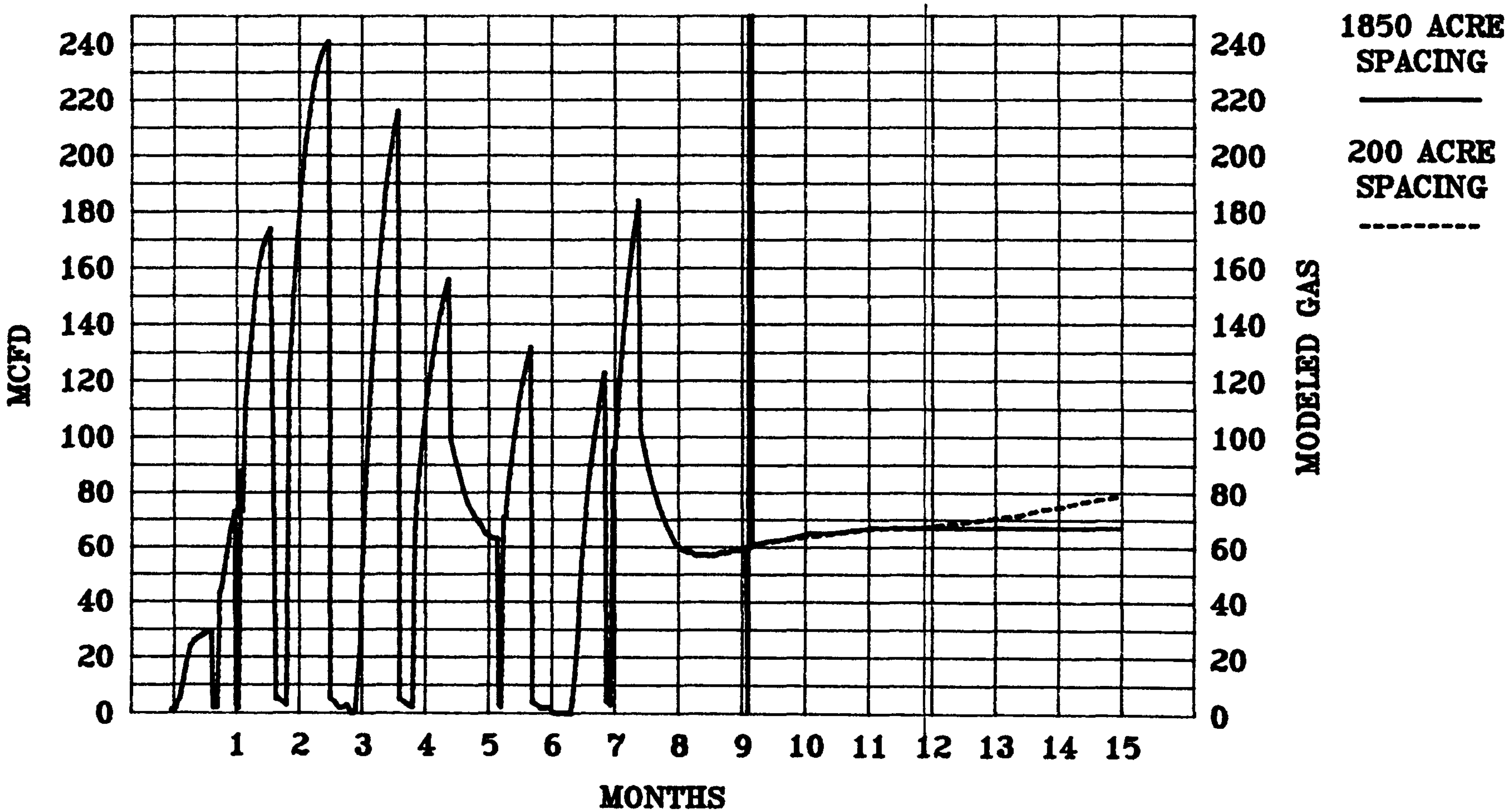
2.) If no NPDES will inject poor quality water and centralized for good quality for livestock

VERMEJO COAL BED METHANE
PRODUCTION
THROUGH
MAY 8, 1991

WELL	GAS MCF	WATER BW	DAYS PRODUCED
A	37,760	17,192	321
B	6,667	34,899	200
C	85	636	40
D	13,841	16,935	218
E	2,254	4,163	214
F	18,249	7,805	215
G	7,029	15,020	241
H	16,773	18,218	229
I	39,159	20,307	291
O	14,456	32,408	196
P	5,394	5,510	154
Q	15,506	11,556	77
R	21,581	30,303	331
S	853	233,875	322
T	32,200	10,365	162
U	6,684	5,704	154
V	1,400	7,844	162
901	848	111,636	288
902	~~13,339~~ 14,050	~~419,685~~ 437,827	~~291~~ 301
903	32,727	68,248	309
911	3,659	5,808	29
912	3,177	4,958	30
913	4,887	11,670	24
TOTAL	298,528 MCF	1,094,745 BBLS	4,498 WELL DAYS
AVERAGE/WELL	12,979 MCF/WELL	47,597 BBL/WELL	195.6 DAY/WELL

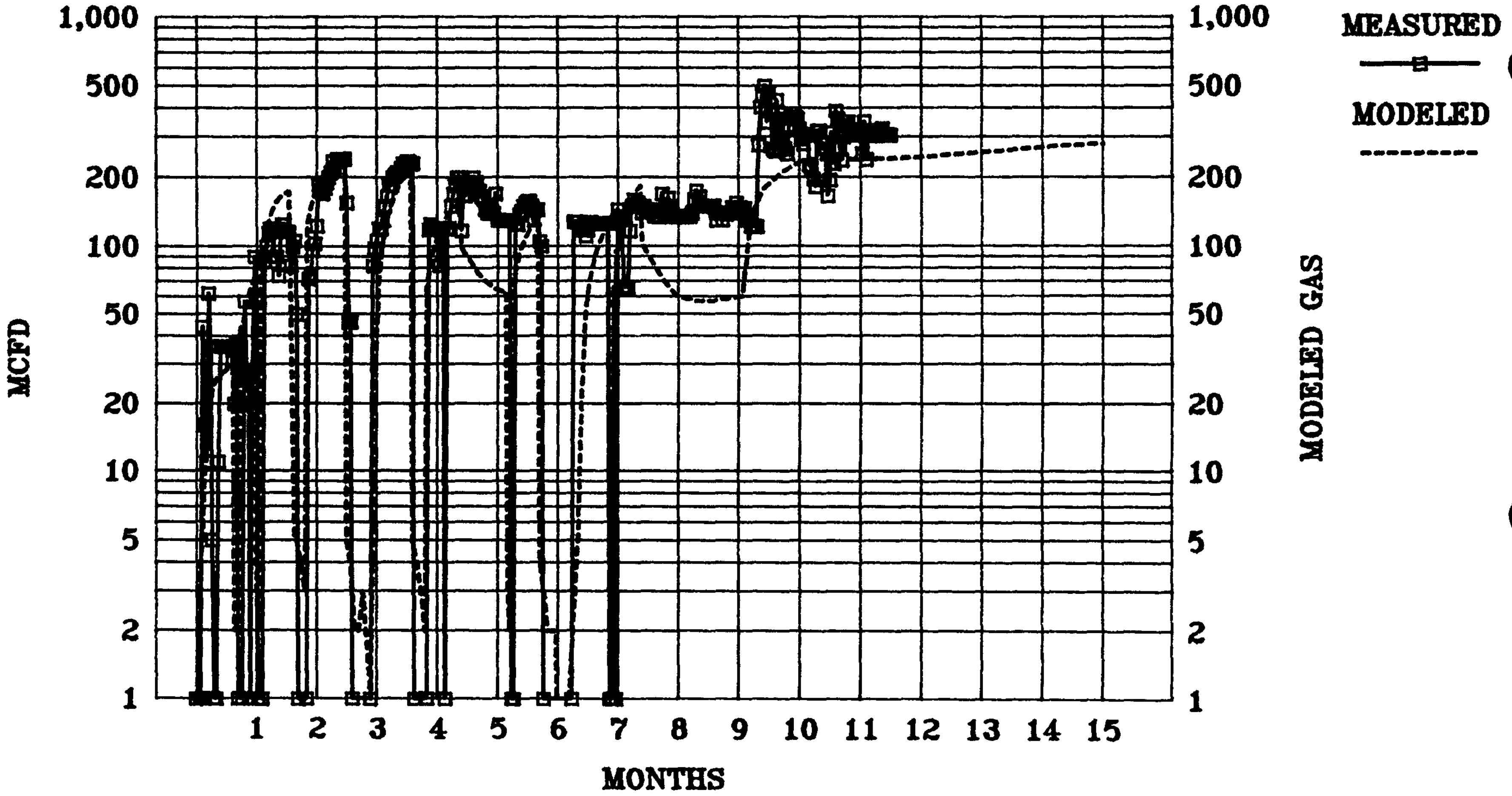
004/0509

WELL 903
1850 ACRE V 200 ACRE SPACING
MODELED PRODUCTION



OFFSET WELLS STARTED PRODUCTION IN MONTH 9.25

3 WELL CLUSTER
DAILY PRODUCTION



WELLS 903, 911, 912

WATER ANALYSIS
(MG/1)

WELL	DATE	pH	HCO3	CI	CA	Mg	K	Na	TDS
A	01/05/90	6.95	366	4162	261	19		2499	7307
B	01/05/90	7.00	1366	3779	12	9		2936	8102
D	01/05/90	7.79	1275	2237	28	28		1844	5412
E	01/05/90	7.66	1336	2322	34	28		1915	5635
F	02/05/90	8.64	732	1854	8	13		1504	4189
G	01/05/90	7.50	714	4396	132	36		2899	8177
H	01/05/90	7.91	1360	2634	24	30		2136	6184
I	01/05/90	7.97	1238	1085	12	18		1120	3473
	02/05/90	7.50	970	6774	104	382		3920	12150*
O*	01/05/90	7.28	702	6122	144	63		3950	10981*
	02/05/90	6.37	366	11961	653	92		6948	20056*
P*	01/05/90	6.16	134	10195	461	51		6039	16883*
R	01/08/90	8.55	824	57	4	4		356	1272
S	09/14/90	8.70	522	42	16	2	0.6	218	557
T*	01/05/90	6.26	464	9196	651	120		5134	15604*
	02/05/90	6.72	683	11014	854	216		5908	18816*
U*	01/05/90	6.52	409	7955	603	57		4513	13537*
V	02/05/90	7.25	665	9249	305	124		5656	16007*
301J	09/04/89	8.30	1331	2547	34	9.7	8.9	2166	5421
3-1	06/09/89	8.63	420	3	3	0	1	170	369
Eustace	09/04/89	8.26	1411	2606	79	29.5	837	1622	5874
DH3		7.80	245	13	51	15.6	1	28	262
90-1	09/14/90	8.12	553	44	16	5	1	218	573
90-2	09/14/90	8.36	763	139	12	5	1	369	912
90-3	09/14/90	8.44	1200	569	24	2	1.5	829	2050
Q(Coal)	09/14/90	8.56	824	369	16	5	2.6	589	1490
Q(Congl)	10/13/90	7.91	415	5707	399	98		3214	9836
91-1	05/10/91	8.41	1053	1125	8	0		1127	3325
91-2	05/13/91	8.32	1102	1199	28	6		1147	3482
91-3	05/10/91	8.32	798	2109	12	10		1645	4586

*Requires Reinjection

PROGRESS REPORT #1

Project: Fish Evaluation Study of Discharge Water From Coal Bed Methane Pilot Program. Vermejo Ranch, New Mexico.

Scope of Report: Initial familiarization with the geography and geology of the project area; comprehensive briefing of the purpose of the project including sensitive enviornmental considerations; view and do a cursory study of existing wells in place and producing water and methane and, become acquainted with project personnel as well as personnel from the State Oil and Gas Commission.

Date of Field Visit: September 17-19, 1990

This initial visit to the project area involved travel from Albuquerque, NM to Raton, Vermejo Park and Cimarron, NM and return to Albuquerque. The trip from Santa Fe, NM to Vermejo Park and return to Santa Fe was in company with Mr. Roy Johnson, Oil and Gas Geologist for the state of New Mexico in the State 4WD vehicle. Mr. Johnson explained the purpose and complexities of the Methane Pilot Program during our travel time and patiently answered questions concerning project details. He also conducted a comprehensive tour of the geographical area including visits to all operating wells, fishing lakes, potential water disposal sites, sensitive enviornmental areas (of which there were many) and areas which, at the moment, are being considered for methane development. During the tour many project employees as well as employees of Vermejo Park were met and interviewed to obtain as much on-site information as one could in short conversations. This included the initial face-to-face meeting with the Project Manager, Mr. Ron Osterhout.

The stated purpose of the project is to develop commercially profitable quantities of methane (natural) gas from deep underground coal beds on Vermejo Park property. Any development which may occur must be as inconspicuous as possible and leave an absolute minimum of visual impairment on the surface landscape. Preliminary drilling has revealed the presence of methane gas in nearly all coal seams penetrated. One or more test wells has encountered as many as three seams of coal, each of which appear to contain commercial deposits of methane. In all cases the methane is trapped within the coal beds under hydrostatic pressure. Removal of the contained water is necessary to release the flow of methane. Constant pumping of water for as long as two months from initial test wells has resulted in the development of methane deposits. When drilling reveals the presence of a coal bed the well casing is perforated to permit the passage of both water and methane. Pumping of water also brings methane to the surface. This water is passed through a separator to remove the methane before the water is discharged into pits dredged near the well site. These pits are as small as 50 feet square to four times this estimated size. Depth is three to four feet.

Pumping of water from test wells has varied from 900 to 2,000 barrels per day. This has not necessarilly represented the maximimum capacity of the well nor the pump. A fishery biologist must convert this flow rate to gallons per minute (gpm) to visualize what is happening at the end of the discharge pipe. As a standard of reference 1,000 barrels per day equals 58.3 gallons per minute (42 gals. per bbl.).

When, and if, this methane recovery field is fully developed there could be 100 or more producing wells each pumping water continuously for the life of the project. This could be as long as 10 or more years. The methane could be compressed and loaded on tank cars near Vermejo Park property. Disposal of the water is another problem--or opportunity. This is the reason for my involvement in the project planning process.

There are three logical choices for disposal of discharge water. (1) Channel it into free flowing streams. (2) Empty it into a deep (2,000 ft.) disposal well where it would mix with highly hot and saline waters and be lost forever as a resource or,(3) channel it into existing fishing lakes or large, closed basin depressions which exist adjacent to the development area. The State Enviornmental Improvement Division has ruled against option number 1 and all agree it was a good decision. The owners of Vermejo Park, Pennzoil Company, seriously want to avoid option number 2 if there is any possibility of making beneficial use of the well water. This possibility rests primarilly on the quality of the water being produced. The basic question is,"Is this water suitable for use in the existing fishing lakes or for the development of additional fishing lakes on the property." The additional lakes would result from the filling of the depression areas.

The "depression areas" are large (50 to 500 acres) closed basins created by wind erosion of surface sandstone layers over geologic time. Most of these hold water for part of the spring and summer months resulting from frequent rains and snow melt. Many remain dry lake beds during years of prolonged drought. All of their fishing lakes occupy depressions which have a long history of gathering and holding sufficient water to support fish life. Most of these fishing lakes suffer from partial to complete winter kill of resident fish due, primarilly, to a combination of dense rooted aquatic vegetation, filamentous algae and inadequate water depth. If the well water is of suitable quality for fish life the fishing recreational program of Vermejo Park could be expanded considerably plus there would be an opportunity for excellent beneficial use of the water.

The question of "chemical suitability" must await the results of water samples taken from test wells and other sources a few weeks ago. Analysis of these samples may necessitate additional samples or analysis for additional elements. We do have partial analyses of previous water samples to look at now. These include test wells "S" (a methane test well), Mary's Lake (an existing fishing lake) and Bubbling Springs (a free flowing well several years old). There are also analyses of other un-named wells which compare with well "S". Water from wells differ, in analysis, from surface waters in that they contain high levels of chlorides (90+) and sodium (27 to 250). Water was being pumped from well "S" during our visit as well as well (90-2). Water temperatures were 64 degrees F. in both wells. The water was perfectly clear and had no noticeable taste or odor. It certainly had no saline taste. One discharge pipe (90-2) was under water and a steady flow of bubbles was rising to the surface--probably methane which had escaped the separator. None of the wells and springs exhibited a sulphur dioxide odor. There was a hydrocarbon odor present but it was attributed to the use of propane fueled pumps. An examination was made among the rocks and detritis of the discharge pits at two wells which had been pumped the longest (2 to 3 months). No aquatic life was present and none was expected. There was a yellow tint on the surface of underwater rocks. Water analyses were negative for sulfates.

No field equipment was available for testing for dissolved oxygen or free carbon dioxide. It is assumed that oxygen is an or near zero but this may be a dangerous assumption. At any rate, D.O. must be measured on site. We must make sure that all samples require testing for B.O.D.

Conflicts will probably prevent a second visit to the site before winter sets in. At elevations of 8,000 to 9,000 feet all activities except elk hunting shut down. Existing roads are primitive by any standard. We must spend the winter working with what we have and plan for an early start in the spring of 1991. The "suitability" question may await our next visit or a way may be found to answer the dissolved oxygen question.

Respectfully submitted:

R. F. Stephens

Robert F. Stephens,
Fisheries Consultant

B// O.

STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

September 13, 1990

GARREY CARRUTHERS
GOVERNOR

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87504
(505) 827-5800

Pennzoil Exploration & Production
Company
P. O. Box 2967
Houston, Texas 77252

Attention: Ron Osterhout

Re: Vermejo Coal Bed Methane Gas Wells,
Water Analyses

Dear Ron:

As you are aware, on September 10 Larry Williamson, Bill Olson (O.C.D. Environmental Division) and myself obtained water samples on the five wells currently producing. These water samples will be delivered to Inter-Mountain Laboratories, Farmington, New Mexico on September 13. The analyses to be conducted are as follows:

1) General Chemistry - Cations and Anions
2) Aromatic and Halogenated Volatile Organics
3) Dissolved concentrations of Heavy Metals (ICAP Scan)

Sample splits were obtained on two of the wells and the New Mexico State Laboratory in Albuquerque will perform these analyses. This will provide us with the appropriate quality assurance of these analyses as prescribed by the U.S. Environmental Protection Agency. The two wells involved with these sample splits are 3118-311M and 3017-031F.

InterMountain Labs has been instructed to send original lab analyses and billing to Vermejo Minerals Corp., c/o Pennzoil Exploration and Production Co. at your Cimarron, New Mexico field office.

In the matter of surface disposal of produced water into existing lakes and dry lake beds, it would initially appear, depending on these water analyses, that this would be an acceptable method of disposal. As we have discussed, however, in certain potential disposal areas berms will have to be constructed and this will require permits from the State Engineer's office. Their regulations stipulate any berm over 10 feet in height and/or any impoundment greater than 10 acre feet will require their approval. Thus, I would recommend to you that Mr. Don Lopez, New Mexico State Engineer's Office, be in attendance when you present development plans to the OCD staff.

It is the intention of this district office to make this water disposal problem its number one priority. Subsequently, should you feel that for long range purposes that a NPDES permit will be necessary, I would suggest that we develop our future water sampling programs according to the guidelines for obtaining this permit.

Should you have any questions pertaining to this matter, or if I can be of any assistance, please feel free to contact me at this office.

Sincerely,

ROY E. JOHNSON,
Sr. Petroleum Geologist

REJ/dr

cc: Larry Williamson
Bill Olsen
Roger Anderson

STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

GARREY CARRUTHERS
GOVERNOR

June 20, 1990

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SANTA FE, NEW MEXICO 87504
(505) 827-5800

Pennzoil Exploration and
Production Co.
Rt. 1, Box 68
Cimarron, New Mex 87714

Attn: Larry Williamson

Re: Water Disposal Pits, Vermejo Park
Coal Gas Pilot Project

Dear Larry:

Subsequent to our meeting last week concerning fencing of disposal pits, I became aware of a memo pertaining to this matter. The memorandum basically states that the OCD has jurisdiction on water produced from oil and gas operations and the "beneficial" use thereof depending on the quality.

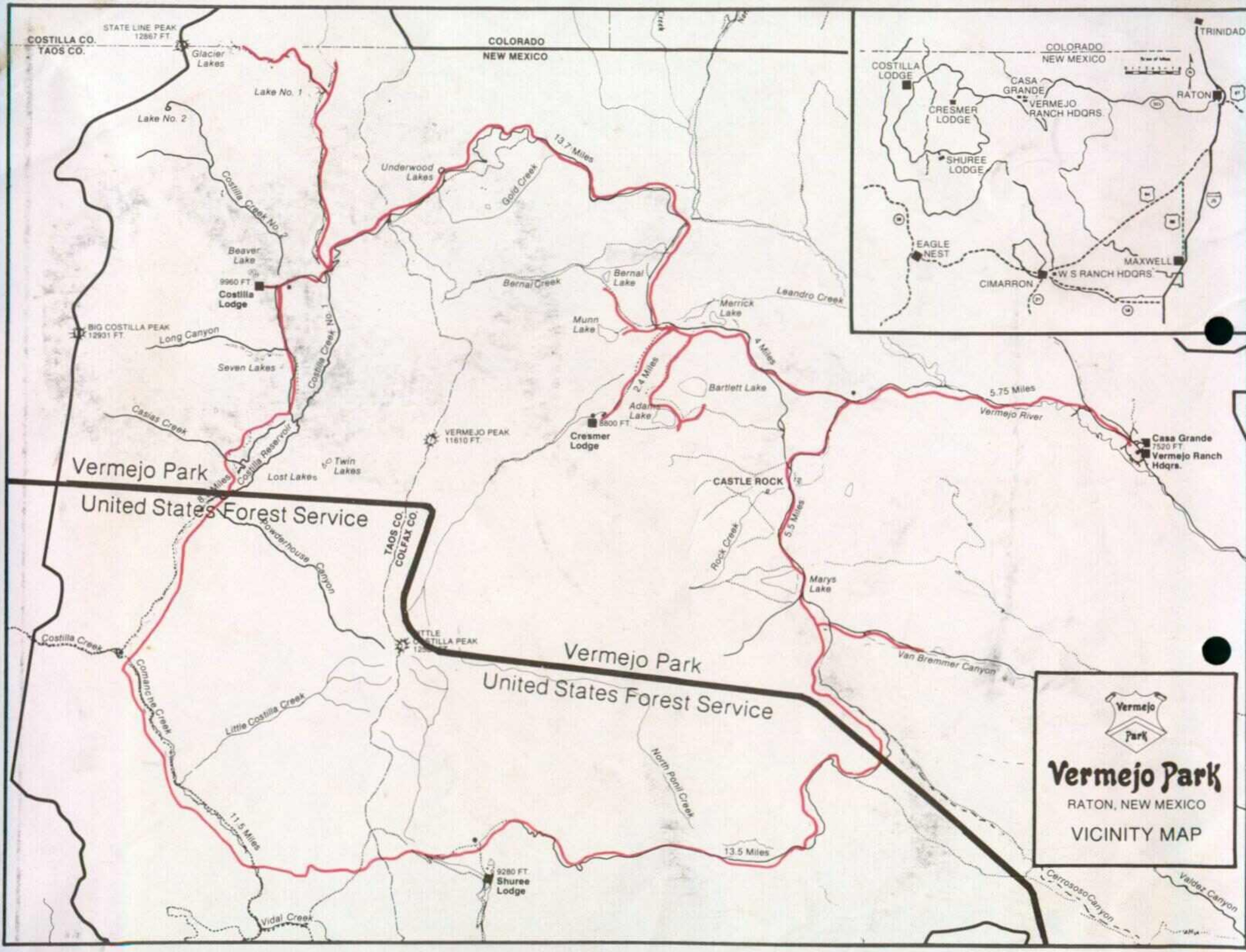
To establish a uniform policy for your Vermejo Park operations, this office will not require pits to be fenced provided that water quality does not exceed 10,000 ppm total dissolved solids. For those well with water quality exceeding 10,000 ppm T.D.S., I will require that these pits be fenced. I will also require fencing on any pit (Q location) that the testing of potential oil zones may occur until we can obtain water quality (i.e. organic compounds) in these formations. I have enclosed a copy of this memorandum for your reference.

Should you have any question pertaining to this matter, please contact me at this office.

Sincerely,

ROY E. JOHNSON
Sr. Petroleum Geologist

REJ/dr



COSTILLA CO.
TAOS CO.
STATE LINE PEAK 12867 FT.
Glacier Lakes
COLORADO
NEW MEXICO
Lake No. 1
Lake No. 2
Costilla Creek No. 2
Underwood Lakes
Gold Creek
13.7 Miles
Beaver Lake
9960 FT.
Costilla Lodge
Bernal Creek
Bernal Lake
Munn Lake
Merrick Lake
Leandro Creek
BIG COSTILLA PEAK 12931 FT.
Long Canyon
Seven Lakes
Costilla Creek No. 1
2.4 Miles
4 Miles
Bartlett Lake
5.75 Miles
Vermejo River
Adams Lake
8800 FT.
Cresmer Lodge
Casias Creek
Costilla Reservoir
VERMEJO PEAK 11610 FT.
Twin Lakes
Lost Lakes
Casa Grande
7520 FT.
Vermejo Ranch Hdqrs.
Vermejo Park
United States Forest Service
CASTLE ROCK
Powderhouse Canyon
TAOS CO.
COLFAX CO.
Rock Creek
5.5 Miles
Marys Lake
Costilla Creek
Van Bremmer Canyon
Vermejo Park
United States Forest Service
Comanche Creek
Little Costilla Creek
North Ponil Creek
11.5 Miles
13.5 Miles
9280 FT.
Shuree Lodge
Vidal Creek
Cerrososo Canyon
Valdez Canyon
COLORADO
NEW MEXICO
TRINIDAD
COSTILLA LODGE
CASA GRANDE
VERMEJO RANCH HDQRS.
CRESMER LODGE
RATON
SHUREE LODGE
EAGLE NEST
MAXWELL
CIMARRON
W S RANCH HDQRS.
Vermejo Park
Vermejo Park
RATON, NEW MEXICO
VICINITY MAP