SAN LOUS VALLEY AND UPPER ARKANSAS
VALLEY, COLORADO E A R DRAFT GEOTHERMA
LEASING

IN REPLY REFER TO
3220.1

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

Canon City District Office
P. O. Box 311
3080 East Main St.
Canon City, Colorado 81212

February 4, 1975

Memorandum

To: Reid T. Stone, Area Geothermal Supervisor
U. S. Geologic Survey, Conservation Division
345 Middlefield Road, Menlo Park, CA 94025

From: District Manager,
Canon City District Office

Subject: Environmental Analysis for Geothermal Leasing in San Luis Valley and Upper Arkansas Valley, Colorado 520 —

Enclosed is a draft copy of the environmental analysis report this office is preparing for geothermal leasing in the San Luis Valley and Upper Arkansas Valley.

Your review and comments on this draft should be returned prior to February 18, 1975 in order for us to incorporate them into the final report. This short deadline for review is necessary in order for us to maintain a tight interagency schedule for offering the KGRA tracts at a lease sale scheduled later in F.Y. 75.

We will appreciate any assistance that you can offer.

R. McEldery

Enclosure 1
EAR draft

X 275-7494

Dick Anderson

ACTIVITY 1212

ENVIRONMENTAL REPORT FACE SHEET

OFFICE: Canon City District FY & REPORT # ______

IDENTIFY: Umbrella for Geothermal Leasing in SERIAL NO. C- N/A
(Project Name, Case Type, etc.)
San Luis Valley and Upper Arkansas Valley

REQUIRED BY 43 CFR 23: YES [X] NO [ ]

NEEDS "102 STATEMENT": YES [ ] NO [X]

TEAM SIGNATURES:	TITLE	RESOURCE VALUES ASSIGNED
	Outdoor Recreation Planner	Human Values
	Wildlife Management Biologist	Wildlife
	Natural Resource Specialist	Water
	Natural Resource Specialist	Vegetation,Livestock
	Geologist	Geology
	Geothermal Specialist	Geothermal
	Archaeologist	Archaeology
	Natural Resource Specialist	Team Leader

ENVIRONMENTAL COORDINATOR: __________ (Signature) __________ (Date)

"Property of Area Geothermal Supervisor's Office"

DISTRICT MANAGER: __________ (Signature)

__________ (Date)

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I. Introduction

The purpose of this environmental analysis report is to evaluate the potential effects of leasing geothermal resources on Federal lands in the San Luis and Upper Arkansas Valley as required by regulations 43 CFR 2300.06(b) and to develop special lease terms and conditions as needed to protect the environment and existing land uses. This report is written as a supplement to the Final Environmental Impact Statement, for the Geothermal Leasing Program prepared by the U. S. Department of Interior in 1973. Some appropriate sections of that report are summarized in this analysis.

With the exception of the four Known Geothermal Resource Areas (KGRA), individual lease areas will not be analyzed in this report. It will still be necessary to examine each lease proposal on a case by case basis to determine if potential environmental impacts have been adequately assessed in this umbrella report. In some instances the "exception analysis" may indicate a need for additional stipulations to assure adequate protection of resource values not forseen and described in this report. "Supplemental Reports" will be prepared as needed.

II. Description of the Proposed Action and Alternatives

A. Proposal

Please refer to the Final Environmental Statement on the Geothermal Leasing Program, Chapter II, Section C for a detailed description of the proposed action. That section is summarized in this report as a matter of convenience for the reader.

The proposed action involves the leasing of Federally-owned geothermal resources for exploration and development pursuant to the Geothermal Steam Act of 1970. The development of geothermal steam involves the harnessing of the natural heat of the earth's interior for the generation of electric power and the production of commercially valuable by-products such as water and/or minerals precipitated from the water.

A geothermal lease sale has been tentatively scheduled for late spring, 1975. The leasing is to take place on eight tracts of National Resource Lands (NRL), located in the San Luis Valley and the Upper Arkansas Valley in Southern Colorado. The KGRA's proposed for competitive leasing are listed as follows:

<u>Poncha Known Geothermal Resource Area - Chaffee County, Colorado</u>

Leasing Unit:

<u>T. 49 N., R. 8 E., N.M.P.M.</u>

Sec. 13: E½E½, SW¼NW¼, W½SE¼, SE¼SW¼, SW¼SE¼
Sec. 14: SW¼NE¼, S½NW¼, S½, exclusive of conflict with patented mining claim (M. S. 20752);
Sec. 15: SE¼NE¼, SW¼SW¼, SE¼, exclusive of conflict with patented mining claim (M. S. 20752);
Sec. 23: All, exclusive of conflict with patented mining claim (M. S. 20752).
Sec. 24: All

Approximately 2,119.15 acres.

<u>Valley View Known Geothermal Resource Area - Saguache County, Colorado</u>

Leasing Unit 1:

<u>T. 46 N., R. 10 E., N.M.P.M.</u>

Sec. 35: N½, N½S½, S½SW¼

<u>T. 45 N., R. 10 E., N.M.P.M.</u>

Sec. 1: Lots, 1,2,3, and 4, S½N½, SW¼, W½SE¼
Sec. 2: Lot 1, S½N½, S½

1,636.42 acres, more or less.

Valley View Known Geothermal Resource Area (continued)

Leasing unit 2:

T. 45 N., R. 10 E., N.M.P.M.

Sec. 3: SE¼
Sec. 4: Lots 2,3, and 4
Sec. 10: E½
Sec. 11: All
Sec. 15: E½, S½SW¼

1,634.45 acres, more or less.

Mineral Hot Springs Known Geothermal Resource Area, Saguache County, Colo.

Leasing unit 1:

T. 46 N., R. 9 E., N.M.P.M.
Sec. 22: W½NE¼, W½, NW¼SE¼, S½SE¼

520 acres,more or less

Leasing Unit 2:

T. 46 N., R. 9 E., N.M.P.M.
Sec. 25: W½NE¼, W½, NW¼SE¼, S½SE¼

520 acres, more or less.

Leasing Unit 3:

T. 46 N., R. 9 E., N.M.P.M.
Sec. 34:

T. 45 N., R. 9 E., N.M.P.M.
Sec. 2: Lots 2,3, and 4, S½NW¼, SW¼
Sec. 3: Lots 1, 2, 3, and 4, S½N½, S½
Sec. 10: N½, N½SW¼, NW¼SE¼
Sec. 11: N½
Sec. 12: W½NW¼

2,484.28 acres, more or less.

Alamosa County Geothermal Resource Area, Colorado

Leasing Unit 1:

T. 38 N., R. 12 E., N.M.P.M.
Sec. 23: All
Sec. 25: N½, SW¼
Sec. 26: All
Sec. 34: E½

2,080 acres, more or less.

Leasing Unit 2:

T. 38 N., R. 12 E., N.M.P.M.
Sec. 11: SE¼
Sec. 13: S½
Sec. 14: NE¼
Sec. 24: NW¼, S½

T. 38 N., R. 13 E., N.M.P.M.

Sec. 18: Lots 1, 2, 3, and 4
Sec. 19: Lots 1, 2, 3, and 4

1,480.03 acres, more or less.

After the competitive lease sale has been satifactorily completed, some "over the counter" leasing in the vicinity of the KGRA's and in areas that have been identified as potentially valuable for geothermal resources can be anticipated.

For the purpose of this analysis, the proposed action might occur on any of the federal lands in the area outlined on the attached maps. It is assumed that active exploration and some development will occur on the leased lands in a relatively short time after leases have been issued. It is further assumed that all geothermal operations will be conducted within the standard conditions that are a part of all geothermal leases.

1. Background Information

Today, geothermal energy is produced around the world in two forms. The vapor-dominated system is the more unusual type, and is found only in areas of very recent orogeny and/or volcanism. Here, dry, superheated steam is produced from the ground. The world's largest single geothermal plant, the Geysers in northern California with a 1974 capacity of 42- megawatts, is a dr steam system.

The more common type of geothermal system, and the type expected in Colorado, is the "Hot-water" system. Electricity is presently being produced from hot water resources in New Zealand; Japan; and Cerro Prieto, Baja California, Mexico. Hot-water systems are driven by convection: "normal" ground water percolates downward through sedimentary layers and is heated at depth. The warmer, less dense water rised to the surface, manifesting itself in hot springs and other thermal phenomena. Thermal energy is stored both in the hot rock and in the water and steam which fill the pore spaces in the rock. Tapping of the upwelling hot waters by wells results in a portion of the fluid flashing to steam due to pressure decrease. The steam fraction is separated from the hot water at the surface. Steam is directed through the turbines, and the hot water is discharged to the surface or reinjected into the ground.

Still in the experimental stage is the utilization of hot but dry rock masses by pumping water down boreholes to be heated, and then withdrawing this water and steam for use in a generating plant.

The Upper Arkansas and San Luis Valleys seem to be the most favorable areas in Colorado for geothermal potential.

2. Development of the Geothermal Resource

Development and production of geothermal resources involve six phases: exploration, test drilling, production testing, field development, power plant construction, and full scale operations. Each successive step is dependent upon successful results in the previous phases. Because of limited knowledge of the occurrence, location and properties of geothermal resources as related to both energy and by-product water and mineral materials, it is not

possible in this analysis to predict the success or failure of the leased areas, or to make a prediction about the program as a whole.

The following are general processes involved in the six phases of geothermal development:

A. Exploration: The exploration of geothermal areas is designed to locate commercial geothermal reservoirs and to evaluate the impact of possible geothermal development upon the environment. Principal exploration activities include geologic mapping and field examinations, ground and spring temperature surveys, geochemical studies, electric resistivity geophysical studies, and shallow drilling (500 feet) for the purpose of sampling surficial ground waters, temperature measurement and subsurface rock sampling. Generally these surveys are made by use of existing roads and trails.

B. Test Drilling: Locations for the drilling of test wells are selected on the basis of preliminary exploration work. Test wells provide subsurface geologic data, locate potential productive zones within the geothermal reservoir, help delineate the reservoir limits, and indicate the physical and chemical properties of the reservoir and its fluids.

Test wells may vary, depending on the geological conditions and the objectives, from boreholes with a diameter of about four inches to 24 inches, and in depth from a few hundred to several thousand feet, with the deepest in the 5,000 to 10,000 foot range. Where the principal objective is to outline prospective areas by collecting data on thermal gradients or geologic

structure, and steam producing zones will not be penetrated, small diameter boreholes may be put down by small or medium sized drill rigs to a depth of about 2,000 feet. For test wells intended to investigate the potential reservoirs with larger diameter and deeper boreholes, the drilling equipment, technology and methods are similar to those used in oil and gas operations.

Test drilling equipment used is often a truck-mounted drilling rig, and possibly a truck mounted air compressor if the drilling is done with air, or a water tank truck if the drilling is done with water. The drill site occupies an area of approximately 40 x 60 feet. In some cases a drilling rig with a conventional substructure is used. The drill site (or pad) generally involves an area of less than an acre which may be cleared of vegetation and graded to a flat surface. The drilling rig, mud pumps, mud tanks, generators, drill pipe rack and tool house usually are located on the drill pad. Other facilities, such as storage tanks for water and fuel, may or may not be on the drill pad; however, they will be nearby. A reserve pit of approximately 1,000 square feet and six to eight feet deep is sometimes dug to contain waste fluids during drilling operations. Where deeper holes are to be drilled, large equipment is required. It may be necessary to construct a heavy duty road that can support the drilling rig and other equipment that must be moved to the location. The larger drill rig and associated equipment will occupy a larger site, often 400 x 200 feet, and sumps may be as large as 3600 square feet.

C. Production Testing: Production testing is the transitional phase between exploration and development and production of a geothermal reservoir. A well that has penetrated a potentially productive geothermal zone is com-

pleted and tested over a period of time to clean out the well and to determine the flow rate, composition and temperature of fluids and gasses, recharge characteristics, pressures, and other physical properties of the reservoir fluids. Testing requires that the maximum production rate of the well be established over sufficient time to determine the hydrodynamic properties and/or boundary characteristics of the reservoir. This process involves venting of the well to the atmosphere with accompanying vapor release and noise. not true and

During production testing, considerable monitoring will be necessary to determine the quantity of potentially toxic substances present in the geothermal fluids, and to establish the control measures to be imposed to assure meeting environmental and public health and safety requirements.

In the event that exploratory drilling and production testing indicates that a geothermal field has economic potential for power development, a commitment must be obtained from a customer electric utility to warrant further development, if this agreement has not already been concluded. This would be a major decision in the development and production of the geothermal resource. Additional permits would be required for construction of industrial facilities and for road and powerline rights-of-way on Federal land off the lease site.

D. Field Development: Favorable exploration, test drilling, and production testing programs will probably lead to the drilling of a number of additional wells to develop a field. Access roads will be improved to give permanent service. Limited service and living quarters will be constructed if required, and adequate water sources and sewage facilities must be provided.

Development in a large field can continue for many years as new wells and additional power generating units are developed. The drilling for geothermal fluids will continue to include test wells and intensive production testing as the limits of the field are probed. In these wells, uncertainties as to the depth of the producing zone and type of fluids to be encountered will be less than in the initial prospecting stages. The bulk of this drilling will take place between proven wells under more predictable conditions.

If the geothermal production contains hazardous substances, the contaminants must be removed before surface disposal or reinjection,if the latter would be harmful to the subsurface. If no harmful materials are present, or if these components can be economically removed from the fluids, it is possible that fluids produced with the energy can be utilized as fresh water.

To the extent that wells produce geothermal fluids, it also may be necessary to carry out an injection well program. Deep well injection is the emplacement of wastes within the earth, far below the water table and beneath a confining stratum which serves to isolate the wastes from potable water supplies. The feasibility of reinjecting liquid wastes deep within the earth is suggested by the enormous volume of subsurface fluid storage space. The earth, however, contains little empty space, so waste fluids may have to be accommodated by compressing or displacing existing fluids (including injections into depleted reservoirs), or by compressing or deforming the surrounding strata.

E. Powerplant and Powerline Construction: Power generation and transmission facilities will be constructed in stages, paralleling the development of the associated geothermal reservoir. Under present technology, above-ground insulated pipes are used to transport the stream from the well to the power plant because of pronounced thermal pipeline expansion and construction. An under-ground pipe system is not economically feasible, owing to service and equipment requirements. Since geothermal fluids can be transported only about one mile due to pressure and temperature loss factors, powerplant installations will be relatively small, probably not exceeding 100 megawatts at individual sites. A typical power plant at the Geysers consists of two turbine generators housed in a single building, with an adjoining structure housing cooling towers.

F. Full Scale Operation : During the production period, activities will primarily consist of the operation and maintenance of the power plant and related facilities, and the drilling, redrilling, and workover of geothermal wells to maintain production capacity. Electrical energy generation during full scale operations may be expected to continue at approximately the peak level for many years. The overall activity, however, will be considerably reduced from that required during the field development and the construction of power generation and transmission facilities.

B. Alternatives:

The only alternative considered in this report is that of "no action". This is based on the premise that our only option is to lease or not lease. It is assumed that special conditions or mitigating measures will be attached to any lease that is issued.

If no action were taken, the Bureau of Land Management would simply not issue any geothermal leases and existing lease applications would be denied.

III. Description of the Existing Environment

A. Non-living Components

The affected environment is thoroughly described in the Unit Resource Analysis for the San Luis Valley Unit, Saguache Unit and Upper Arkansas Unit.

1. Physical Environment - The San Luis Valley and Upper Arkansas Valley are high mountain valleys located in south central Colorado, east of the Continental Divide. The area of this report extends approximately 140 miles from north to south and varies in width from 20 miles at the northern end to 50 miles or more throughout the southern part. The San Luis Valley includes the counties of Conejos, Alamosa, Rio Grande and takes in portions of Saguache County. Elevations of the valley floor range from 7,500 feet to 8.000 feet with an abrupt rise to 12,000 feet plus, in the surrounding mountains.

Geologically, the San Luis Valley is a roughly elliptical intermontaine basin bounded by the San Juan Mountains on the west, the Sangre de Cristo Range on the east, the Sawatch Range to the north, and the Taos Plateau which joins the San Luis Valley on the south.

The Upper Arkansas Valley is located in Chaffee County. This north-south valley lies immediately north of the San Luis Valley and between the Saguache Range on the west and the Mosquito range on the east. Elevations in the valley range from 7000 feet to 9400 feet.

The San Luis Valley appears quite flat except around its margins. The basin margins contain the coalescing alluvial fans formed principally by the San Luis, Saguache, Rio Grande, Alamosa and Conejos Rivers which drain the San Juan Mountains and a few lesser streams which flow from the western and southern slopes of the Sierra Blanca Massif of the Sangre de Cristo Range to the east. The northern portion of the valley is a closed basin. Rivers and streams in the southern portion are tributary to the Rio Grande River which is the major drainage of the valley.

The almost undissected basin represents a depositional surface consisting of many thin layers of alluvium separated by interstratified lavas and tuffs. These Tertiary (Miocene) aged deposits are overlain by younger Tertiary fresh water sands and clays.

In the Upper Arkansas Valley, streams originating in the adjacent mountains flow across the valley into the Arkansas River which provides the principle drainage. The valley is somewhat rolling in nature with a relatively small amount of flat land that lies adjacent to the river.

2. <u>Geology</u> - The Upper Arkansas and San Luis Valleys represent sidiment-filled rift valleys formed by late Tertiary tensional faulting overprinting the folded Laramide structures of the Sawatch and Sangre de Cristo ranges. In essence, the Basin and Range tectonic pattern of California and Nevada has made and "end run" around the southern margins of the Colorado Plateau, and has penetrated into Colorado as an extension of the Rio Grande rift system of New Mexico. The basin

of the San Luis Valley is a down-faulted block. Along a concealed fault, at the western foot of the Sangre de Cristo Range, the layered sedimentary rocks of the valley proper have moved downward relative to the rocks of the mountain range. Probably the displacement along this fault exceeds 10,000 feet. This displacement decreased northward. The sedimentary rocks of the valley dip to the east and into the mountain front. Structural features of these sedimentary rocks is somewhat obscured by recent and Tertiary alluvium and Tertiary volcanics to the west, but isolated exposures indicate a complicated structural topography. It is believed that the valley-fill may be as much as 30,000 feet deep and that water saturated sediments at the bottom of the valley fill, resting on presumed blocks of down thrown crystalline rocks which form the graben, are at sufficient temperatures and pressure to power a "hot water" system of the type operating at Cerro Prieto, Mexico. Somewhat sketchy data from a 1974 test well drilled about 10 miles northwest of the Alamosa County KGRA indicate a temperature of 300° F at about 10,000 feet, although this test well did not encounter basement rock.

3. <u>Soils</u> - Soils of the San Luis Valley were derived from volcanic or extrusive parent material. On the east side, along the western slopes of the Sangre de Cristo Range, are coalesced alluvial fans and torrential wash from the nearby mountains. These soils are thin and rocky and are situated on steep slopes. On the western side of the valley, near the San Juans, the soils are thick and rocky with numerous rock outcrops. Soils on the valley floor are for the most part, deep, light-textured soils. Heavy clay layers are located at different levels within this soil type. The soils common

to the salt flats vary from well drained to poorly drained and usually have excessive salts and alkali resulting from a fluctuating high water table. Old stream channels and lake beds in and adjacent to the Blanca area have poorly drained, fine textured soils. The soils in the vicinity of the Sand Dunes National Monument are coarse and very sandy. Some unstable sand dunes exist near the boundary of the National Monument.

Because of the sandy surface soils on the more level lands, and the shallow loose soils on the steeper land, most of the area is susceptible to erosion if the surface is disturbed. This hazard is severe with the very sandy soils found in the Blanca Unit.

The soils of the Northern portion of the Upper Arkansas Valley range from deep, moderately coarse textured soils to shallow soils overlying sand, gravel and cobbles that have outwashed from nearby mountains. The southern portion of the valley has soils composed of deep eroded sediments on moderately steep slopes and deep fine textured soils on alluvial and colluvial slopes. Erosion classes for soils are rated from slight to moderate over most of the valley.

4. Climate - The San Luis Valley and Upper Arkansas Valley experience considerable sunshine and an arid climate. Average precipitation ranges from about 7 inches at Alamosa to 10 inches in the foothills of the San Luis Valley and the Upper Arkansas Valley. Approximately one-third of the annual precipitation occurs as July and August thunderstorms. Snow fall contributes a substantial

amount of moisture to the northern portion of the San Luis Valley and the Upper Arkansas Valley. Evaporation will average from 4 to 5 feet per year throughout the valley. Relative humidity averages 76 percent in the early morning and 40 percent in the afternoons. Winters are very cold and summers are moderate. Strong winds occur during the spring months in the San Luis Valley.

In general, air flows up the valley during daylight hours and down the valley at night. The air quality is generally excellent due to a low population density in the area and a lack of industry.

The San Luis Valley has unusually low level air inversions which often trap emissions and concentrate particulates. There inversions have been measured as low as 50 to 100 feet above ground level at Alamosa. Average particulate measurements during the winter months usually range from 80 to 100 micrograms which exceeds the State and Federal standards. This situation is thought to be caused by the San Luis Hills blocking the slow flow of air out of the valley along the Rio Grande River south of Alamosa. This causes an air stagnation problem that allows very cold air to settle in the Alamosa area and that allows particulates and water vapor to concentrate, especially during the winter months. Temperatures ranging from 0° F to-20° F are common during most of the winter months.

5. <u>Ground Water</u>- The ground water regime in the San Luis Valley consists of water in both confine and unconfined aquifers.

amount of moisture to the northern portion of the San Luis Valley and the upper Rio Grande Basin. Precipitation will average less than 8 inches per year throughout the valley. Relative humidity averages 30 percent in the early morning and 20 percent in the afternoon. Winters are very cold and summers are moderate. Strong winds occur during the spring months in the San Luis Valley.

In general, air flows up the valley during daylight hours and down the valley at night. The air quality is generally excellent due to a low population density in the area and a lack of industry.

The San Luis Valley has occasionally low level air inversions which often trap pollutants and consequently particulates. These inversions have been measured as low as 50 to 100 feet above ground level at Alamosa. Average particulate measurements during the winter months usually range from 80 to 110 micrograms which exceeds the state and federal standards. This situation is thought to be caused by the San Luis Hills, blocking the free flow of air out of the valley along the Rio Grande River south of Alamosa. This results in its stagnation problem which allows very cold air to settle in the Alamosa area and thus higher particulates and water vapor to concentrate, especially during the winter months. Temperatures ranging from 25° F to -20° F are common during most of the winter months.

D. Ground Water - The ground water regime in the San Luis Valley consists of water in both confined and unconfined aquifers.

The unconfined aquifer is the uppermost aquifer and occurs almost everywhere in the valley and extends 50 to 200 feet below the land surface. The depth to water in the unconfined aquifer is generally less than 12 feet except along the edges of the valley (4-6 miles out from the mountain front) and in most of Costella County.

The composition of the unconfined aquifer is characterized by unconsolidated sand and gravel in the upper part of the Alamosa formation. The deposits that contain unconfined ground water were laid down primarily by streams carrying sediments into the valley from adjacent mountains; as a result, they are heterogeneous and discontinuous. Test holes drilled into the alluvial material of the unconfined aquifer reveal tha t the materials are not of uniform texture and that the soring action of streams resulted in the deposition of many distinct beds of sand, gravel, mixtures of sand and gravel, and lenticular beds of clay. The yield to wells drilled into the aquifer is a function of the size and degree of sorting of these materials, with small size and poorly sorted particles having the lowest permeability.

The confined aquifer lies below the unconfined aquifer and is separated by an impermeable clay layer up to 80 feet thick. This clay layer, as well as others existing at greater depths, restrict the vertical movement of ground water. Some communication does exist, however.

The confined zone consists of multipe aquifers, consisting of well sorted sand and gravel interbedded with impermeable beds of clay and silt, which also display very low porosity, usually approaching zero.

a. <u>Recharge:</u> Recharge to the unconfined aquifer is mainly by infiltration of irrigation water and leakage from canals and ditches. Some water percolates from the many streams flanking the valley and precipitation on the valley floor also recharges the unconfined aquifer.

The principal source of recharge to the confined aquifer is by seepage from mountain streams that flow across the alluvial fans flanking the mountain front. At the edge of the valley, the clay series is absent, permitting recharge to beds that gently dip basinward into the interbedded clay series, resulting in confined aquifers.

b. <u>Water Quality</u> - The quality of water is generally better in the confined aquifer than in the upper, or unconfined, aquifer. The concentration of dissolved solids in 41 samples from the confined aquifer ranged from 70 to 437 mg/l (milligrams per liter --- this measure very closely approximates the other commonly used measure, parts per million (ppm) if the concentration is low and the specific gravity of the water is nearly 1.0).

Water quality (dissolved solids) in 271 samples from the unconfined aquifer ranged from 52 mg/l to 13,800 mg/l. The lease mineralized water in the unconfined aquifer occurs on the west side of the valley. For comparison, the U. S. Public

Health Serive (1962) recommends a limit of 500 mg/l for drinking water. A much greater concentration (1500-2000 mg/l) can be used, but the water is not palatable, does not quench thirst, and may be laxative, but no permanent harmful physiological effects are known.

c. Supply: The two aquifers contain at least two billion acre feet of water in storage. The annual water supply to the San Luis Valley averages about 2.5 million acre feet. About 1.5 million acre feet is derived from snowmelt from the surrounding mountains. The remaining one million acre feet is contributed by precipitation on the valley floor.

Much water, perhaps as much as two million acre feet, is lost annually by evapotranspiration. Much of this is due to loss by phreatophytes (maybe as much as one million acre feet).

d. Use: Ground water withdrawals have averaged 750,000 acre feet annually in recent years. The stored water is sufficient to supply current consumptive use for 1,000 years.

Most domestic and stock supplies of ground water are obtained from the artesion or confined aquifer since quality is superior and most wells do not require pumps.

Shallow wells into the unconfined aquifer are used in a few rural areas. These wells are usually 10 to 40 feet deep

and 1¼ to 6 inches in diameter, finished with slotted casings or sand points. These wells generally discharge small quantities of water, usually on the order of 100 gpm or less. The large diameter wells (6 in.) may produce as much as 2,000 gpm.

The hydrology of the Upper Arkansas Valley is similar to the San Luis Valley with the exception that the confined aquifer is less well defined and the valley is narrower. Artesian wells are not common in this area as they are in the San Luis Valley. The lateral creeks and drainages do not "disappear" into the valley fill as quickly as in the San Luis Valley.

6. Surface Waters: The Rio Grande is the principle river flowing through the southern portion of the San Luis Valley. This river, fed by smaller tributaries such as the Conejos, Saguache and Alamosa Rivers, flows south into a deep volcanic gorge. At the New Mexico-Colorado State line, the river is designated as the Rio Grande Wild River. Much of the northern portion of the valley is thought to be in a closed basin. This area is characterized by poor drainage, old lake beds, and ancient river channels. Accumulated salts and alkali are common in this area.

The Arkansas River drains the Upper Arkansas Valley. It is fed by lateral streams that originate in the adjacent mountains and flows short distances into the Arkansas.

Both the Arkansas River and Rio Grande are classified as B1 streams which are noted as cold water fisheries. Algael blooms are common to both streams during low flow periods in late summer and fall. Excessive nutrients are added to these waters as runoff waters from agricultural areas enter the rivers. Both streams carry moderately heavy sediment loads during the spring runoff period;however, the sediment load is significantly reduced during periods of normal and low flow.

B. Living Components

1. Plants

Although the San Luis Valley and the Arkansas Valley are considered high mountain valleys, the vegetation is more typical of the lower, more arid lands. This is due mainly to the fact that these valleys are in the rain shadow of the San Juan Sangre de Cristo Ranges, Saguache and Mosquito Ranges and receive little precipitation. On the non-irrigated portions of the San Luis Valley floor, vegetation occurring on sandy sites is composed primarily of grasses such as: Indian ricegrass, spike dropseed, blue grama, needle and thread, and shrubs such as, rubber rabbit brush, greasewood and fourwing saltbush. On the alkali areas and salt flats, alkali sacaton and greasewood are the dominant plants. Wet areas characteristic of old lakebeds, and old stream channels support salt grass, western wheatgrass and salt tolerant rushes.

The valley is, for the most part, a treeless plain and appears almost flat. A good percent of this valley floor is land under cultivation. The primary crops grown are barley, potatoes, lettuce and alfalfa hay, all under irrigation.

The lower slopes around the valley are mostly covered with blue grama, needle and thread, ring muhley, western wheatgrass, Indian ricegrass, globemallow, cactus, yucca, low rabbitbrush, fourwing saltbush, winterfat and scattered pinon-juniper trees.

The upper slopes surrounding the valley support stands of pinon-juniper at the lower reaches and ponderosa pine, Douglas fir, Englemann spruce, white fir and aspen as the upper limits. These areas have an understory of shrubs such as currant bushes, mountain mahogany, snowberry, rabbitbrush and grasses such as Indian rice-grass, blue grama, western wheatgrass and numerous forbs. Gambel oak is found along the toe of the mountain slopes in the northern end of the San Luis Valley and the Upper Arkansas Valley.

The vegetation of the Upper Arkansas Valley is similar to that in the northern portion of the San Luis Valley. Foothills and woodland vegetation is more common than the broad flat San Luis Valley. The open grasslands and agricultural lands occur in the lower central portion of the valley while the more sloping and rolling foothills area around the edge of the valley support a pinon-juniper woodland type. Below 9000 feet, the major grasses are blue grama, Arizona fescue, Indian ricegrass, sand dropseed, western wheatgrass and needle and thread grass. Dominant grasses at elevations above 9000 are mountain muhly, June grass, Thurber fescue, and nodding brome.

Browse plants include big sagebrush, fringed sagebrush, mountain mahogany and ribes. Ponderosa pine, Douglas fir and lodgepole pine are found on north facing slopes or at higher elevations where ~~site~~ sites are cooler and have a greater amount of effective moisture.

2. Animals

The San Luis and Upper Arkansas Valleys are inhabited by a wide

variety of animals. Big game species include mule deer, elk, bighorn sheep, black bear, mountain lion and turkey. With the exception of antelope which spend a considerable amount of time in the flat lower portions of the valley, most of the big game animals are found in the more sloping foothills and mountainous areas that lie around the outer fringe of these valleys. This area identified on map____ normally provides critical winter range for deer, elk, and antelope. It is felt by some that big game populations may be limited by available winter range. Seasonal big game migration routes shown on map____ normally follow the outer edge and narrow places in the valleys.

The Arkansas River and irrigated portions of the San Luis Valley support large populations of ducks, geese and shore birds. Major water fowl concentration areas shown on map____ exist in National Wildlife Refuges near Del Norte and Alamosa. The Blanca Wildlife Area northeast of Alamosa provides considerable riparian vegetation and waterfowl use of this area is increasing dramatically. At least 500 species of verebrates, mostly rodents and small birds, inhabit the area. The more common species include morning doves, blue grouse, cottontail rabbits, prairie dogs, coyotes, bob cats and foxes. The large number prey species makes the area an important region for numerous mammal and raptorial predators. Large concentrations of wintering bald and golden eagles and several species of hawks are found in the valleys.

Trout, especially browns, are abundant in the Arkansas River, Rio Grande and their tributaries. Rough fish also occupy these waters and lakes and farm ponds throughout the area.

Black footed ferrets, peregrine falcons, Rio Grande cutthroat and wolverine, all on the U. S. Threatened List, are known to inhabit the area occasionally.

Domestic livestock, cattle, sheep and horses, are common in the valleys.

3. Human Values

The San Luis and Arkansas Valleys have a beautiful scenic background of towering mountain peaks. Distant views are excellent throughout both valleys however the valley floors are low in scenic appeal as they are dry monotonous and somewhat drab. Virtually everything in the San Luis Valley is visible from the majority of the rest of the valley due to its flat treeless nature. This is pronounced on the foothills of the San Juan range and the slopes of the Sangre de Cristo range. The Upper Arkansas Valley is largely composed of rolling hills and woodland which form topographic and vegetative screens for visual intrusions, however, the elevated lands around the outer edge of the valley are quite visable.

Major features of cultured and human value value include an extensive, yet important archaeologic area, natural hot springs, displays of fall colors, extensive open spaces with generally clear clean air and opportunities to view and hunt wildlife.

Sensitive areas are identified on map as proposed no occupancy zones.

The Upper Arkansas and portions of the San Luis Valley are potentially rich in archaeological materials, however the area suffers from a lack of information and data derivative from extensive professional surveys and examinations. Ongoing research in the San Luis Valley conducted by Dr. Herbert Dick of Adams State College in Alamosa has revealed a concentration of archaeologic sites in the Blanca Area and extending northward to the area around San Luis Lake.

The general area around Salida and Poncha Springs is rich in aspects of historical interest. Fremont and Pike expedition routes, among others pass through the area and there is record of Indian battles in 1855 in the Poncha Springs area. General research work by Denver Federal Center Archaeologists has indicated the Upper Arkansas region as potentially very rich in archaeological materials.

Major features of cultural value include Smelter towns (north of Salida), the proposed Brown's Canyon Primitive Area, the Chalk Cliffs, the Colorado State Boys Reformatory, the Arkansas River and ample open space.

A rural life style dominates both valleys as farms and ranches are common. Population centers in the Upper Arkansas include Salida and Buena Vista while the San Luis Valley has Antonito, Alamosa, Del Norte, Center and Saguache as its major population centers.

C. KGRA's

The environment associated with the four KGRA's is basically as described above. The highlights of each area are listed below.

1. Poncha KGRA

The Poncha KGRA lies roughly 3 miles southwest of Salida. Except for the NE¼ of Section 13 and the N½ of Section 14, this tract lies on steep, mountainous terrain that supports moderate stands of pinon-juniper woodland. The northeast portion of the tract lies at the foot of this steep country on gentle undulating topography. The tract includes Poncha Hot Springs, a small (15 gallon per minute) but hot (150°F.) spring eminating along the northern boundary fault of the Sangre de Cristo block. A fluorspar deposit, mined by Reynolds Aluminum Company in the 1950's is nearby. Because of the rough topography of this area, it does not seem as likely a target for early exploration drilling as the three flat lying KGRA's in the San Luis Valley.

2. Valley View KGRA

The Valley View KGRA lies just west of the Valley View Hot Spring which wells up about 6 miles ENE of Mineral Hot Springs in the northern part of the San Luis Valley. This spring flows out of the western boundary fault of the upthrown Sangre de Cristo block. Water temperatures are about 97°F and flows as much as 200 gallons per minute have been recorded. An abandoned hot springs resort exists on private land. The tumbled down facilities still receive a considerable amount of use. The eastern edge of the KGRA lies within an area identified as critical winter habitat for deer and antelope.

6. [illegible]

[illegible]

1. [illegible]

[illegible] of Dallas. [illegible]

2. [illegible]

[illegible]

The topography ranges from flat on the west to gently sloping on the east. Some oak brush occurs along the eastern edge, however, most of the KGRA supports a grassy cover. A ranch house is situated on the western boundary of the tract.

3. Mineral Hot Springs KGRA

The Mineral Hot Springs KGRA lies between Villa Grove and Mineral Hot Springs on both sides of Highway 285 and State Road 17, the major access routes through the north end of the San Luis Valley. That portion of the KGRA that lies east of Highway 285 slopes very gently to the southeast while slopes increase to the west. The western ¼ of the tract lies in a fairly rough foothill area. A small amount of this area supports woodland vegetation while the majority is covered with grasses and low shrubs. An existing powerline crosses the area and an old hot springs resort, currently in disuse, lies in the eastern part of the tract. There are several active and dormant springs, some with sinter mounds. Water temperatures range between 90°F and 131°F. The area west of Highway 285 lie within the Noland Gulch Allotment which has been planned for intensive management and development for cattle grazing and wildlife. Antelope frequent the area and the western portion is important as deer and elk winter range. Prairie dog towns have been known to exist in the eastern part of the KGRA. Any active prairie dog town may provide potential habitat for the black footed ferret (an endangered species) which is suspected to occupy the area.

D. Alamosa County KGRA

The Alamosa County KGRA lies about 17 miles ENE of Alamosa. Numerous warm artesian wells are found in this area. The topography is flat to gently rolling and vegetation consists of grasses and low shrubs. Alkali soil conditions are common. Drainage patterns are poorly defined and the soils are quite sandy. This KGRA lies immediately east of the Blanca Wildlife Area that is managed for waterfowl by the Bureau of Land Management. The area around the Blanca Wildlife Area and north to San Luis Lake contains a high concentration of archaeologic sites which may extend into the KGRA. Evidence of human occupancy as old as 10,000 years has been found in this part of the Valley. The access road to the Sand Dunes National Monument (10 miles north of the KGRA) passes through the KGRA.

A slow air movement pattern with air moving from the east over the KGRA in a westerly direction has been identified. This slow moving air stream might drift any water vapor or air pollutants from a geothermal development over Highway 160 and perhaps even Alamosa.

IV. Analysis of the Proposed Action

A. Environmental Impacts of the Proposal

1. Unmitigated Impacts

a. Non-Living

In order to evaluate the potential impacts on the environment, it will be assumed that exploration, drilling, and ultimately power plant and electrical facilities will be constructed on lands leased for geothermal development.

(1) Air

Pollution of the air could result during any of the stages of development. Dusty conditions will be created to a minor extent during exploration, testing, development of the lease areas, and construction of power lines. Dust will be blown into the air primarily as the result of ncreased traffic on unsurfaced roads however, this will probably be minimized during the production phase by surfacing roads that receive heavy use. Some noncondensable gases such as H_2S, NH_3, CH_4, N_2, H_2, and CO_2 may escape into the atmosphere as wells are vented during the production testing phase. It is also probable that during full scale production, a lesser amount of these gases may pass through scrubbers and be released into the air. It is anticipated that these gases may create a foul odor in the vicinity of the steam wells and generating plant. Under conditions, such as an inversion, that might allow these gases to concentrate, it is possible they could become irritating and a potential health hazard to workers in the area and to people living on the downwind side of the plant. Water vapor escaping from steam wells and cooling towers will create a plumes of fog. During inversions, this fog could reduce visability on nearby roads and airports and could cause local icing problems during cold weather. A geothermal development anywhere in the Alamosa County KGRA or the Alamosa potentially valuable area would

probably present fog and icing problems for Alamosa, the airport and roads in the area during low inversion conditions.

One of the principle impacts from a geothermal development will be the increased levels of noise from drilling activity and testing of wells. Very high noise levels will be experienced when steam is allowed to escape unrestricted from a well during cleaning and production testing. Other noise sources including the generating plant, traffic, construction activity and the high voltage hum common to powerlines are not expected to create major adverse impacts.

(2) Land

Soil erosion may be increased as vehicular traffic disturbs the surface and loosens dust that may be transported by wind or water to other areas. Discrete actions contributing to erosion include use and construction of roads, use of off road vehicles and construction of drill pads. Special problem areas are expected to develop with surface disturbances on slopes greater than 15 percent and in the vicinity of the Sand Dunes National Monument.

If geothermal waters are spilled or stored on the ground surface, a certain amount of soil pollution will occur. The degree of the impact will depend largely

on the quality of the geothermal fluids that are produced. A minor amount of localized soil pollution will occur as wells are "blown off" and the steam and geothermal fluids are vented to the atmosphere.

It is possible that minor amounts of subsidence could occur in the area, however, it is very unlikely that this would occur since the geothermal reservoir is very deep (perhaps 10,000 feet). Condensed and cooled geothermal fluids probably will be reinjected into the geothermal reservoir. Any subsidence could affect shallow fresh water acquifers, highways, wells and a number of factors not forseen at this time. It is possible that fault zones might be lubricated by reinjecting geothermal wastes, however, due to the geology of this sediment filled basin, this is not expected.

Reclamation of disturbed areas would seldom, if ever, return the site to its former productivity since this area is quite arid. In addition, disturbances on steep slopes that require cut and fill operations may never be returned to the original land form. These disturbed areas will be noticable for a considerable time. Some viewers will consider this as a dramatic negative impact while others will pass by without noticing the scar.

(3) Water

Geothermal waters generally carry more dissolved solids

than do non-geothermal waters because the higher temperatures have increased the dissolution of the more volatile chemicals of the hot rocks.

The potential for pollution of fresh water streams, lakes, rivers and acquifers with geothermal fluids is probably the most serious threat of all. Since regulations 43 CFR 3204.2 prohibit the unauthorized release of geothermal wastes into fresh water acquifers or surface waters, it is assumed that only accidental discharges should be considered. As an indication of the frequency of "blowout" accidents, more than 100 wells have been drilled in the Geysers field in California between 1957 and 1973 with only three blowouts. Two of the three blowouts occurred before 1960 early in the development program. Major negative impacts would be felt if geothermal fluids were allowed to escape and flow into the Arkansas River or the Rio Grande upstream from that portion designated as "Wild River". Thermal pollution and/or chemical pollution could destroy acquatic eco-systems in lakes or for a considerable distance downstream from the point of entry if geothermal fluids contained concentrations of pollutants.

Many of the unique values identified in the Rio Grande Wild River might be lost or modified as its water quality deteriorated. The vast acquifers in the San Luis and Arkansas Valley could become locally polluted if geothermal fluids were introduced into them. It is possible

that a geothermal well casing could rupture and leak contaminants into the fresh water acquifers without the operator being aware of the situation. This could cause agricultural losses as the water was used for irrigation or it could cause death or injury to people, livestock, wildlife and birds that rely on that water for subsistance. The possibility of this type of accident would be greatest during production testing, field development and during full production.

If geothermal wells tap hot water at or near the source of existing hot springs, the flow of the hot springs might be reduced or stopped as the well is put into production. This negative impact would be felt during production testing, field development and would be most likely to happen during full scale production.

If the geothermal reservoir contained high quality water, the waste waters could provide a supplement to surface water supplies in the area. The fresh water might be used for irrigation or to supplement surface waters for wildlife, waterfowl, fish, livestock which, indirectly, would be a positive impact on man's environment.

An operating geothermal plant will consume about 45 acre feet of water per megawatt of electricity generated. The water is lost to the atmosphere as water vapor through the cooling towers. Over a long period of time, there might be a decrease in available fresh water supplies

due to withdrawal. Although this is possible, it is not expected. This might cause reduced flow of existing wells.

b. Living Components

(1) Plants

A small amount of vegetation would be disturbed and destroyed as roads, drill pads, pipelines, powerlines, power plants, parking areas, etc. are constructed. On the relatively flat valley floor where grasses and low shrubs are dominant, these disturbances will be minor and reclamation will be possible. On steep slopes and in woodlands, the destruction of vegetation is obvious to passers by and the site is opened to accelerated erosion.

In the alkali low areas, clearings may tend to accumulate salts on the surface as the shallow water table fluctuates. This could have a sterilizing effect on the site. Under these conditions, it is difficult to reclaim the area and establish a vegetative cover.

Forage and browse important to wildlife and livestock is destroyed, however, the negative impact will not be significant. Vegetation around steam exhausts, wells and blow off points may be eliminated.

(2) Animals

If geothermal waters were to flow into the Rio Grande,

Arkansas River, Poncha Creek or any other cold water stream, thermal pollution would result in trout losses and possible disruption of the total cold water acquatic eco-system. The potential for accidental discharges of geothermal fluids into cold water streams is greater in the Upper Arkansas since the valley is narrow, all areas slope toward the river, and spilled fluids would have to travel only short distances before encountering the Arkansas River.

A geothermal development could place serious stresses on antelope, elk and deer that winter in the Upper Arkansas Valley, in the northern and peripheral areas of the San Luis Valley. The impact from exploration and drilling would probably be minimal regardless of location as only temporary dislocation would occur. Full scale development of geothermal resources in critical areas, i.e., critical winter ranges, reparian zones, ~~and~~ etc., would result in populations being proportionately reduced. Map_____ shows important big game ranges to exist over most of the Upper Arkansas Valley except the flat valley floor and ranges also around the outer edge of the San Luis Valley except for the flat valley floor. Migration routes shown on Map____ could be disrupted if geothermal development became intensive. Major causes of impacts would be the continued presence of and harassment by people. Any fences constructed during field development and surface pipelines that exceed

24 inches in total height would create barriers to normal movements and migrations. The periodic release of steam and the extreme noise levels associated with the release would disturb wildlife.

There are numerous prairie dog concentration areas in the two valleys (see map____). These dog towns provide habitat for the endangered black footed ferret. Major surface disturbances, excavations, etc., could destroy the prairie dog's homes.

Eagles, hawks and other raptors could be killed on improperly designed powerlines. If powerlines are properly designed, the poles may provide additional safe perches.

Waterfowl could be benefitted if high quality warm water were discharged to create open water in the winter. If polluted waters were discharged, waterfowl might be harmed. The Blanca Wildlife Area could be degraded substantially if a geothermal development were installed very close to it. Again the primary impacts would result from increased human presence and harassment and high intermittent noise levels. Mud pits used during drilling could pose a threat to waterfowl if they are not properly fenced or screened.

Livestock authorized to graze in the area would be affected similarly by noise, mud pits, contaminated

water, etc. During development of the geothermal resource, livestock management facilities may be destroyed or rendered ineffective. Surface steam pipes could alter utilization patterns of grazing animals which would affect the total forage available to livestock.

c. Ecological Interrelationships - Although the embryonic geothermal industry appears to be relatively pollution free, definite changes in ecologic interrelationships will occur as a result of the proposed action.

With full development, there will be some changes in the residential and service business distribution in the San Luis Valley. This would be the result of the best resource apparently being in the north end of the San Luis Valley, which is virtually unpopulated. Little change in the current distributions in the Upper Arkansas Valley is anticipated.

In the event of drilling close enough to the source of the natural hot springs to affect them, a reduction or cessation of their activity could be anticipated. This would have a dramatic effect upon the present ecosystem within the spheres of influence of the hot springs. Growing seasons would be shorter, aquatic plants and animals currently dependant upon the hot water would have smaller populations or die out, perishable archaeologic remains possibly located in the presently boggy drainage below the springs would lose their protective stable temperatures and wet condition, and the effect of a "winter oasis" on the wildlife and nearby terrestrial plants would be greatly reduced or lost.

d. Human Values - The physical manifestation of geothermal development and resulting electricity production will be readily visible in both the San Luis and Upper Arkansas Valleys. These manifestations are roads, pads, new transmission lines and substations, steam plumes, buildings, pipelines, and dust and noise from blowing out and venting the wells.

Generally, these features will be more noticeable on the steeper slopes (over 15 percent) than on the flat valley floors. Also, the closer the feature to

a well travelled road, the greater the visual impact. This is especially pronounced in the case of power transmission lines and substations. Visual impacts resulting from clearing for roads, pads, etc. will be greater in forested lands (including pinon-juniper) than in open lands. The features resulting from development will be an encroachment on the present open space values and scenic vistas of the two valleys.

Visual and audial impacts of the exploration and development will have marked detrimental effects upon the atmosphere of the Great Sand Dunes National Monument, the proposed Brown's Canyon Primitive Area, the proposed Arkansas River Scenic Corridor between Salida and Leadville, and the Blanca Wildlife Area.

The socio-cultural impacts can be significant. The processes of exploration and development can result in the destruction of historic and archaeologic sites. The impacts on the existing natural hot springs can be disasterous to those popular features.

Not all of the socio-cultural impacts appear to be detrimental. Geothermally generated electricity appears to be a virtually pollution free means of producing useable energy. Its development will produce needed electricy and a few new jobs in areas that are in need of increased employment opportunities. The finished plants will be of educational value and interest to the general public and knowledge of the geologic features and structure of the two valleys will be increased. The opportunity of using condensed steam and purified water for man-made "hot springs" resorts will also be available to enterprising businessmen.

e. <u>Specific Impacts in KGRAs</u>

1. Poncha KGRA

a. Any development on the steep slopes would be highly visible from Salida and the south end of the valley.

b. Roads, drill pads, etc. would create severe erosional problems on the steep slopes.

c. Important big game habitat would be modified:

1. Displace 10 DDU/A (deer days use per acre).

2. Displace 5 EDU/A (elk " " ").

d. Poncha Creek and/or the Arkansas River might become polluted.

2. Valley View KGRA

a. The flow of Valley View Hot Springs might be modified.

b. Critical winter habitat for deer and antelope may be lost.

1. Displace 5 to 50 DDU/A winter use (50 in critical area).

2. Displace 5 to 10 ADU/A (antelope).

3. Displace 5 EDU/A in E½, Sec. 36.

4. Disrupt or block migration route for 200 antelope.

c. Valley View Creek could become polluted.

3. Mineral Hot Springs

a. The flow of Mineral Hot Springs might be modified.

b. Winter habitat for antelope and deer might be lost.

1. Displace 15 DDU/A winter deer use in critical areas.

2. Displace 10 ADU/A antelope use in critical areas.

c. A prairie dog town and possibly black footed ferrets might be destroyed.

d. Development on steep terrain would be highly visible from U.S. 285.

e. Roads, drill pads, etc. would create erosional problems on steep slopes.

4. [illegible]

a. [illegible]
[illegible]

b. [illegible]
[illegible]

c. [illegible]

1. [illegible]

2. [illegible]

d. [illegible]

5. [illegible]

a. [illegible]

b. [illegible]

1. [illegible]

2. [illegible]

3. [illegible]

4. [illegible]

c. [illegible]

6. [illegible]

a. [illegible]

b. [illegible]

1. [illegible]

2. [illegible]

7. [illegible]
[illegible]

8. [illegible]

9. [illegible]
[illegible]

4. Alamosa County KGRA

   a. Winter habitat for antelope and deer might be lost.

      1. Displace 1-3 ADU/A antelope.

      2. Disrupt migration of 25 antelope.

   b. A prairie dog town and possibly black footed ferrets might be destroyed.

   c. Air pollutants and fog might be drifted over highway 160 and Alamosa. Serious problems could arise during low inversions.

   d. Destruction of archeologic sites is possible.

   e. Excessive good quality water could be used beneficially in the adjacent Blanca Wildlife Area.

2. Possible Mitigating or Enhancing Measures.

A. The measures set forth below are intended to represent the basis for special lease stipulations which could supplement standard lease requirements Form_______ and the general terms and conditions in the regulations 43 CFR 3204.0-8 and 30 CFR 270.34-47.

   1. The lessor reserves the right to require as part of an approved plan of operations specific measures to protect the surface and environment.

   The plan of operation must assure adequate protection of drainages, waterbodies, springs, or fish and wildlife habitat, steep slopes or fragile soil. The lessee agrees that during periods of adverse conditions due to climatic factors such as thawing, heavy rains, or flooding, all activities creating irreparable or extensive damage as determined by the surface managing agency, will be suspended or the plan of operation modified and agreed upon.

6. [illegible]

a. [illegible] and deer [illegible], et cetera.

1. [illegible] methods.

2. [illegible]

b. A [illegible] changed.

c. Air pollutants [illegible] and Alberta. [illegible]

d. Deterioration of [illegible]

e. [illegible]

7. Possible mitigation of adverse impacts

a. The [illegible]

b. The [illegible] specific measures to protect [illegible]

The [illegible]

2. Prior to undertaking any ground disturbing activities on lands covered under the provisions of this lease, the lessee shall:

   a. Engage the services of a qualified professional archeologist to conduct a thorough and complete survey of areas to be disturbed for evidences of archeological or historic sites or materials. Said archeologist shall work only under the authority of a current Antiquities Act permit, applicable to the area to be investigated.

   b. Provide the lessor sufficient time to review documentary evidence that a survey as required by (1) above, has been performed. This evidence shall be in the form of a report from the archeologist and shall cover, at a minimum: citation of permit authority, location of area(s) surveyed, methods employed, report of findings, conclusions/recommendations.

   c. Follow the requirements set forth by the lessor concerning protection, preservation, or disposition of any sites or material discovered. In cases where salvage excavation is necessary, the cost of such excavations shall be borne by the lessor.

After undertaking ground disturbing activities, the lessee shall insure compliance with those portions of Section 2(q) of the basic lease terms that require reporting and protection of materials of scientific or historic interests encountered during performance of the lease.

3. Air - Noise levels will at all times be kept to a minimum and will never exceed 60 decibels at a distance of 1,000 feet from its source.

   a. Mufflers will be used on hole when they are being tested.

4. Testing and cleaning of holes will be accomplished only during

normal working hours of 8:00 a.m. to 5:00 p.m.

5. Remove as much hydrogen sulphide and other toxic gases and vapors as possible from emissions into the atmosphere but in no case will emissions exceed a standard of .03 ppm. Any release of gases or vapors must be in accord with Federal and State ambient air quality standards.

6. Monitor all non-condensible gases released from gas ejector vents on power plant condensers and from cooling towers.

7. Apply dust binders or water to unimproved roads being used intensively to preclude dust from being visible to the travelling public.

<u>Water</u>

8. All production fluids exceeding State or Federal water quality standards will be reinjected in accordance with procedures approved by the U. S. Geological Survey.

9. Disposal of any condensate not recycled will be by reinjection unless surface disposal is found suitable.

10. No material which is toxic or otherwise deleterious to aquatic organisms will be discharged into any natural drainage, stream course, pond or lake.

11. No fluid shall be discharged which could percolate into ground unless it is of equal or better quality than the ground water it is discharged into.

12. A ground water monitoring system will be incorporated as geothermal wells are brought into production to monitor underground leakage of geothermal fluids and changes in water quality in fresh water acquifers.

Wildlife

13. Active prairie dog towns will not be physically disturbed.

14. Fence mud pits so as to prevent entry by livestock and large wildlife.

15. Screen over mud pits containing any additives known to be toxic to wildlife.

16. Design pipelines so they are not a barrier to livestock and wildlife movements.

Operations

17. Where possible, utilize existing roads in lieu of new road construction and refrain from blocking roads or trails commonly in public use.

18. Wherever possible, locate surface facilities so as to be hidden from major highways and populated areas.

19. Color-blend all surface facilities in harmony with the natural environment.

20. Maintain dirt berm at least one foot high around mud pits, test wells and producing wells.

21. Conduct initial drilling on sites where the surface is relatively flat in defilade position and where vegetative and soil disturbance can be kept to a minimum.

22. Line mud pits with bentonite, or some other non-toxic sealent.

23. No drill pads may be constructed on slopes that exceed 15 percent and road construction will be limited to slopes less than 40 percent.

24. Use blowout preventers during all drilling and well testing operations and install blowout preventers on all productive and abandoned wells.

25. Casing shall be run concurrently with all drilling activity to prevent contamination of ground waters with geothermal fluids.

26. Obtain all cooling water required from produced geothermal fluids.

27. Lessee shall take precautions to prevent and suppress forest, brush and grass fires.

28. Lessee shall install cattleguards on fence crossings wherever access routes are constructed on national resource land.

29. The lessee shall participate in all earthquake and land subsidence prevention and detection programs applicable to the leased area.

30. Access to mining claim location monuments shall be unrestricted and such monuments and corner markers shall not be disturbed.

31. At the conclusion of drilling operations, mud pits shall be cleaned, backfilled and replanted with native vegetation.

32. Scarify and reseed with native plants all temporary drilling sites and roads after grading to contour.

33. When there is no longer a need for the wells, power plants, pipelines, or any other facilities, or upon expiration of this lease, whichever first occurs, the lessee shall restore the surface to as near its original condition as possible after removing all surface improvements installed by the lessee. All holes and depressions shall be filled and packed with native earth and all waste material shall then be ripped or scarified and reseeded with native vegetation if, and to the extent, required by the land managing agency.

and

34. Any excess good quality water/abandoned wells that will produce good water on national resource lands will be deeded to the BLM for wildlife habitat development.

no

35. Power transmission lines shall not be constructed within one mile of any highway parallelling or acutely converging with the line. closer construction is allowable only if topographic camouflaging is employed or there are no other routes that are feasible.

36. Power transmission lines shall be grouped into corridors at every opportunity. The corridors shall not be stripped of vegetation, but shall only have clearings made that are large enough for tower installation.

no

37. Power substations and similar transmission developments shall not be constructed within one mile of any major highway.

38. Low profiles and subdued or greyed coloration shall be used on all structural improvements.

General Area Closures (not lease stipulations).

39. Allow no exploration or development that will damage the atmosphere of the Great Sand Dunes National Monument, the proposed Brown's Canyon Primitive Area, the proposed Arkansas River Scenic Corridor between Salida and Leadville, the Blanca Wildlife Habitat Management Area and the Rio Grande Wild River (see Map).

40. Allow no exploration or development within the area identified as "Critical Archaeologic Area" (see Map).

41. Exploration and development should be restricted to the lower, dry areas to prevent damage to big game winter range and migration routes. Map ___ identifies areas where surface occupancy should not be allowed.

42. No surface occupancy is permitted within one-half mile from any lake used by waterfowl for nesting or feeding, including the Dry Lakes (Blanca Wildlife Area).

43. Drilling and all other surface activity is precluded from occurring within one mile of existing hot springs.

44. No occupancy will be allowed within 300 feet of any live stream, lake, marsh or wet area.

B. In addition to the standard stipulations listed above, special stipulations are proposed for the KGRA's that will be subject to leasing first.

1. <u>Poncha KGRA</u>

   a. No surface occupancy will be allowed in Section 15: SW¼SW¼.

2. <u>Valley View KGRA</u>

   a. No surface occupancy will be allowed in Section 1: E½ to protect critical winter range for deer and antelope.

3. <u>Mineral Hot Springs KGRA</u>

   a. No surfance occupancy will be allowed in:

      Section 10: W½, NE¼

      Section 3: All

      Section 34: SW¼

      Section 22: N½SW¼, NW¼NE¼, NW¼

   b. Prior to any surface disturbance the operator will contact the BLM for a joint inspection of the lease area to determine if any active prairie dog towns are in the area. Active prairie dog towns will not be disturbed.

4. <u>Alamosa County KGRS</u>

   a. Prior to any surface disturbance the operator will contact the BLM for a joint inspection of the lease area to determine if any active prairie dog towns are in the area. Active prairie

dog towns will not be disturbed.

b. Activities that produce fog and air pollutants will be curtailed as necessary during periods of low inversions so that visibility on Highway 160 is not impared and so that air quality in Alamosa is not seriously degraded.

3. Adverse Impacts that Cannot Be Avoided

The adverse impacts of geothermal leasing and subsequent developments can be mitigated to a great extent, however, few if any of the impacts can be eliminated. Net environmental losses will occur to wildlife, vegetation, water, recreation and other activities. Residual negative impacts on vegetation will be minimal. Some erosion and degradation of the surface waters and acquifiers may occur although the probability of a major catastrophy is slight. The small amount of space taken up by plant facilities, roads, etc. would be lost to other uses. One of the more significant residual impacts is that of additional people in the area and their demands for housing, services, recreation, etc. Interference with movement patterns of livestock and wildlife will occur especially in the northern portion of the San Luis Valley and Upper Arkansas. Visual Impacts from drilling and production facilities will detract from the present unspoiled open space attitude of the area. Powerlines will be visible regardless of where they are installed.

From a regional standpoint, it appears that geothermal development in this area may be far less detrimental to the environment than a power producing facility of equal production capability that rely on fossil fuels for generating electricity.

B. Environmental Impacts of the "No Action" Alternative

If the Bureau took no positive action on the geothermal leasing program

and cancelled existing lease applications, the geothermal resources in both the San Luis Valley and the Upper Arkansas would probably be developed on private land rather than on Federal land. Since the land ownership pattern is predominately private, in both valleys, this action would cause only minor inconveniences to the industry. It is possible and quite likely that the environment in this area would be adversely affected to a greater degree under private control than Federal control as private land owners might be willing to "sell out" for monetary considerations. Geothermal development would then progress with fewer environmental restrictions.

The impacts described for the proposed action would apply to the alternative with the exception that they would probably be more adverse for the alternative than for the proposal.

From a regional viewpoint, geothermal power plant(s) in the San Luis and Upper Arkansas Valleys could lessen the potential for air pollution in the Rocky Mountain area whem compared with fossil fuel power plants of similar productive capacity. For example, a 1,000 Megawatt power plant fired by coal with one percent sulfur produces 140 tons of SO_2 per day while a geothermal power plant of similar size would produce only 34 tons of SO_2 per day.

In a similar comparison a geothermal plant would release about 860 tons per day of CO_2 compared to 20,000 tons per day of CO_2 from a coal fired power plant.

C. <u>Relationship between Short-term Use and Long-term Productivity</u>

If drilling and well testing fail to produce commercially valuable geothermal resources, this short-term use should have a negligible cumulative adverse impact upon present land uses and other environmental components. Temporary and geothermal electric power applications, the geothermal resources in both the Bear Lake Valley and the Upper Arkansas basin would probably be developed on private land rather than on Federal land. Since the land ownership patterns of geothermally favorable ground, in both valleys, are [illegible] private [illegible] than [illegible] of the Secretary. It is possible and quite likely that the environment of both areas would be adversely affected to a greater degree under private ownership than Federal control as private land owners might be willing to "sell out" for short-term considerations. Piecemeal development would then proceed with fewer environmental restrictions.

The impacts described for the proposed action would apply to the alternative with the exception that they would probably be more adverse for the alternative than for the proposal.

From a regional viewpoint, geothermal power generation in the Bear Lake and Upper Arkansas valleys would reduce the potential for air pollution in the [illegible] compared with that produced from fossil fuel-fired plants of similar generating capacity. For example, a 1,000 megawatt power plant fired by coal with low sulfur content produces [illegible] tons of SO_2 per day while a geothermal power plant of similar size would produce only [illegible] tons of SO_2 per day.

In a similar comparison a geothermal plant would release about [illegible] tons per day of CO_2 compared to [illegible] tons per day of CO_2 from a coal-fired power plant.

C. Relationship Between Short-Term Use and Long-Term Productivity

If drilling and well testing [illegible] is pursued conservatively (including restoration), this short-term use would have a negligible cumulative adverse impact upon present land uses and other environmental [illegible]. [illegible] roads and drilling locations can revegetate naturally or can be planted with native species to expedite the process. Thus, the value of the land for cattle grazing, outdoor recreation, and wildlife habitat can be restored to present productive capabilities within several years following unsuccessful activities. However, if temporary roads and drill sites are subjected to continued public use, such as access by recreationists, there would be long-term imparment of those values.

If development and full-scale geothermal operations take place, there would be a long-term loss of livestock forage, wildlife habitat and recreational values, plus continued soil disturbance, noise and air pollution during the life of the field. However, the land would still be capable of reduced productivity of its surface resources and of sustaining present uses even under such circumstances.

The consumptive use of water by a geothermal plant would deplete the geothermal reservoir at a rate of about 45 acre feet of water per kilowatt per year of electricity generated. This could deplete the geothermal reservoir and could affect the shallow acquifers however, this is not anticipated. Following cessation of geothermal operations on these lands, reclamation could be performed so as to establish conditions closely approximating those of the existing environment.

D. <u>Irreversible and Irretrievable Commitments of Resources</u>

1. Impairment of scenic values.
2. Consumptive use of geothermal water would result in a depletion of water stored in acquifers of the San Luis and Upper Arkansas Valleys.
3. Probable degradation of existing air and water quality.
4. Destruction of alteration of wildlife habitat values.

Roads and drilling locations can revegetate as early as 3-5 years or sooner with reclamation to expedite the process. Thus, the values of vegetation, wildlife habitat, dispersed recreation, and naturalness can be returned to pre-oil development capabilities within several years following abandonment of activities. However, if temporary roads and drill sites are subjected to continued public use, such as access by recreationists, there would be long-term impairment of these values.

4. If development and full-scale production commences [illegible], there would be a long-term loss of livestock forage, wildlife habitat and recreational values, plus continued soil disturbance, noise and air pollution during the life of the field. However, the land would still be capable of reduced production of its various resources and of maintaining present uses to some extent under such circumstances.

5. The consumptive use of water for geothermal plant would deplete the geothermal reservoir at a rate of about 63 acre-feet of water per [illegible] per year of electricity generated. This would deplete the geothermal reservoir and could affect the surface conditions; however, this is not anticipated. Following completion of geothermal operations on these lands, reinjection could be performed so as to re-establish conditions closely approximating those of the existing environment.

D. Irreversible and Irretrievable Commitments of Resources

1. Impairment of scenic values.
2. Consumptive use of geothermal water would result in a depletion of water stored in reservoirs of the [illegible] and [illegible] Valleys.
3. Probable degradation of existing air and water quality.
4. Destruction of a portion of existing wildlife values.

5. Loss of top soil during road construction and site development.

6. Loss of livestock forage in developed sites and access roads.

7. Destruction of any archaeological values which are not removed prior to site development and road construction.

8. Alteration of terrain in hilly areas where exact grading to contour may not be possible.

9. Changes in natural drainage patterns.

V. Persons, Groups and Government Agencies Consulted

A. Rio Grande Water Conservency District

B. Colorado Division of Wildlife

1. Stan Ogilvie and Walt Schuett

C. Dr. Herbert Dick, Adams State College, Alamosa

D. C. L. Edwards, New Mexico Institute of Mining and Technology

E. Albuquerque District BLM, Lloyd Eisenhauer

F. Sierra Club, John McComb, SW Representative, Phoenix,Ariz.

G. U. S. Forest Service, RioGrande N.F., Alamosa District

VI. Intensity of Public Interest or Controversy

The local public has shown little interest in the development of geothermal resources. Perhaps this is due to a lack of understanding of the impacts of a geothermal operation. Prior to this environmental analysis effort, a news release was sent to major newspapers in Denver, Colorado Springs, Canon City, Salida, and Alamosa explaining the process and inviting comments. Only one reply was received and is consisted of a request for additional information. Based on day to day contact the local sentiment seems to be favorable for a geothermal development.

VII. Participating Staff

Gary Sharpe, BLM, Canon City District

3. Loss of top soil during road construction and site development.

4. Loss of livestock forage in developed sites and access roads.

5. Interruption of any archaeological values which are not removed prior to site development and road construction.

6. Alteration of terrain in hilly areas where exact grading to contour may not be possible.

7. Changes in natural drainage patterns.

9. Persons, Groups and Government Agencies Consulted

A. Rio Grande Water Conservancy District

B. Colorado Division of Wildlife

1. Glen Ogilvie and Dale Schmidt

C. Dr. Herbert Dick, Adams State College, Alamosa

D. W. K. Summers, New Mexico Institute of Mining and Technology

E. Albuquerque District BLM, Lloyd Eisenhauer

F. Kenneth Kuhn, Dames Moore, NM Representative, Phoenix, Ariz.

G. U. S. Forest Service, Hinchcliff, D.F., Alamosa District

Intensity of Public Interest or Controversy

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Participating Staff

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VIII. Recommendations on Environmental Statement.

Based on the foregoing analysis of impacts and the lack of significant controversy we recommend that an environmental impact statement not be prepared, providing recommended mitigating measures be included as conditions of the geothermal lease.

IX. Interdiciplinary Team Recommendations.

A. It is recommended that the proposed action subject to modification by the recommended mitigating measures be pursued.

B. The possible mitigating measures identified in IV.A.2. of this report be made conditions of geothermal leases issued in the subject area.