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Pre-Decisional Draft Environmental Assessment

Small-Scale Geothermal Power Plant and Direct-Use Geothermal Application at AmeriCulture Inc., Cotton City, NM

U.S. Department of Energy
National Renewable Energy Laboratory

June 2002

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LIST OF ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
BTU	British Thermal Unit
CFR	Code of Federal Regulations
DOE	Department of Energy
DOI	Department of Interior
EA	Environmental Assessment
EIS	Environmental Impact Statement
I-10	Interstate 10
KGRA	Known Geothermal Resource Area
NEPA	*National Environmental Policy Act*
NM	New Mexico
NMSLO	New Mexico State Land Office
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
OEC	Ormat Energy Converters
PW	Production Well
ROI	Region of Influence
SHPO	State Historic Preservation Office
TDS	Total Dissolved Solids
Tri-State	Tri-State Generation and Transmission Association, Inc.
UBC	Uniform Building Code
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
WSA	Wilderness Study Area

CHEMICALS AND ABBREVIATIONS

°C	degrees Celcius
°F	degrees Fahrenheit
ac-ft	acre-foot
cm	centimeter
dB	decibel
dBA	A-weighted sound levels
ft	foot
ft^2	square foot
ft/mi	feet per mile
ft^3/sec	cubic feet per second
gpd/ft	gallons per day per foot
gpm	gallons per minute
ha	hectare
hr	hour
kg	kilogram
km	kilometer
kW	kilowatt
L	liter
lbs	pound
lpd/m	liters per day per meter
lpm	liters per minute
m	meter
m^2	square meter
mg	milligram
mg/L	milligrams per liter
mi^2	square mile
m/km	meters per kilometer
MW	megawatt
MWt	megawatt thermal
ppm	parts per million
psi	pounds per square inch

1.0 PURPOSE AND NEED

1.1 INTRODUCTION

The U.S. Department of Energy (DOE) is preparing an Environmental Assessment (EA) for the construction and operation of a small-scale, approximately 1 megawatt (MW), geothermal power plant near Animas and Cotton City, New Mexico (NM), southwest of Lordsburg, NM within the Lightning Dock Known Geothermal Resource Area[1] (KGRA) (Figures 1-1, 1-2, 1-3). The Proposed Action includes the direct use of geothermal fluid exhausted from the geothermal power plant as a heating source for tilapia[2] production at an existing geothermally-heated fish hatchery. A total of 9.3 acres (3.8 hectares [ha]) would be disturbed by the construction of the power plant and associated wells and pipelines. Approximately 6.6 acres (2.7 ha) of this would occur on previously disturbed land. The remaining 2.7 acres (1.1 ha) acres of disturbance would take place on grazing land. The funding decision of the DOE is whether or not to partially fund the Proposed Action.

Through the Geothermal Energy Program, DOE is considering providing financial assistance to Exergy, Inc., of Hayward, California, for the development and field verification of a small-scale geothermal power plant, which would be located upstream of an existing geothermally-heated fish hatchery owned by AmeriCulture, Inc., of Cotton City, NM. AmeriCulture, Inc., leases the geothermal resource from the State of New Mexico (State of New Mexico Geothermal Lease No. GTR-304 Assignment 1).

DOE is also considering partially funding AmeriCulture, Inc., for a direct-use geothermal application using fluid discharged from the proposed power plant to heat water for the hatchery before being reinjected into a new well. Two system concepts would be investigated. The preferred concept involves cascading the spent geothermal fluid from the proposed geothermal power plant to various thermal processes used for fish production. In the second concept, the proposed power plant would not be built, and the fluid from the existing geothermal well would be used for all direct-use operations associated with the project. Partial funding for this portion of the project would be provided through a National Renewable Energy Laboratory (NREL) subcontract with AmeriCulture, Inc. The proposed power plant project would be administered and managed by the DOE Golden Field Office. The direct-use application would be managed by NREL.

Since the project would involve Federal funds, it is considered to be the result of a Federal action. As such, this action is subject to the requirements of the *National Environmental Policy Act* (NEPA). DOE has determined that an EA would be prepared to evaluate the potential environmental impacts that could result from the award of the grant/subcontract and

[1] A Known Geothermal Resource Area is a region identified by the U.S. Geological Survey as containing geothermal resources.

[2] Tilapia are a hardy, prolific, fast-growing tropical fish that traces its origins to the Nile River. Tilapia are one of the major groups of farm raised fish in the world. Large-scale commercial culture of tilapia is limited almost exclusively to the culture of three species: *Oreochromis niloticus*, *O. mossambicus* and *O. aureus*. Of the three tilapia species with recognized aquaculture potential, the Nile tilapia, *O. niloticus*, is by far the most commonly used species in fish farming. It has a mild, soft, white fish fillet, with a slightly sweet taste.

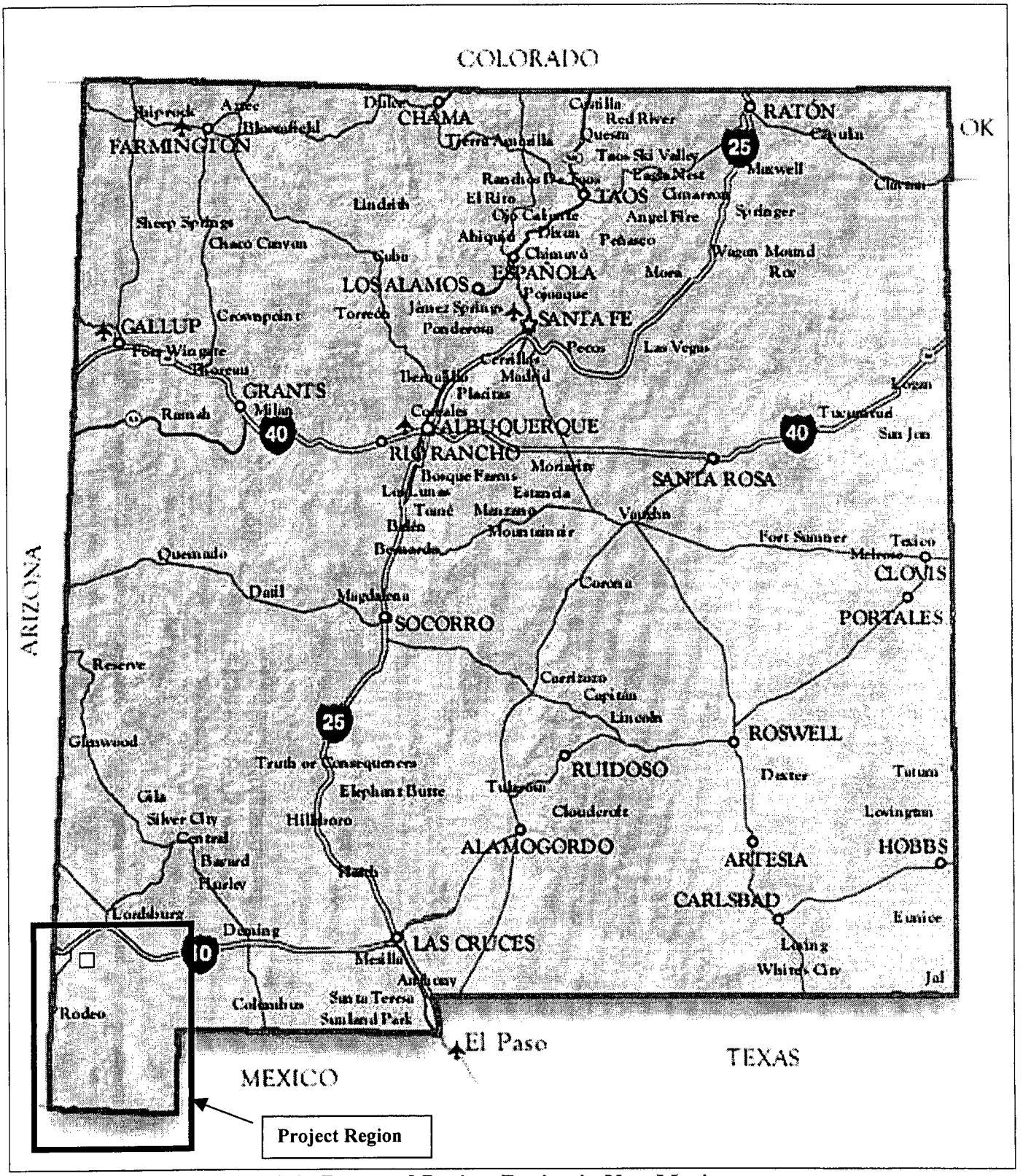


Figure 1-1. Proposed Project Region in New Mexico. (Proposed Site is Represented with White Square)

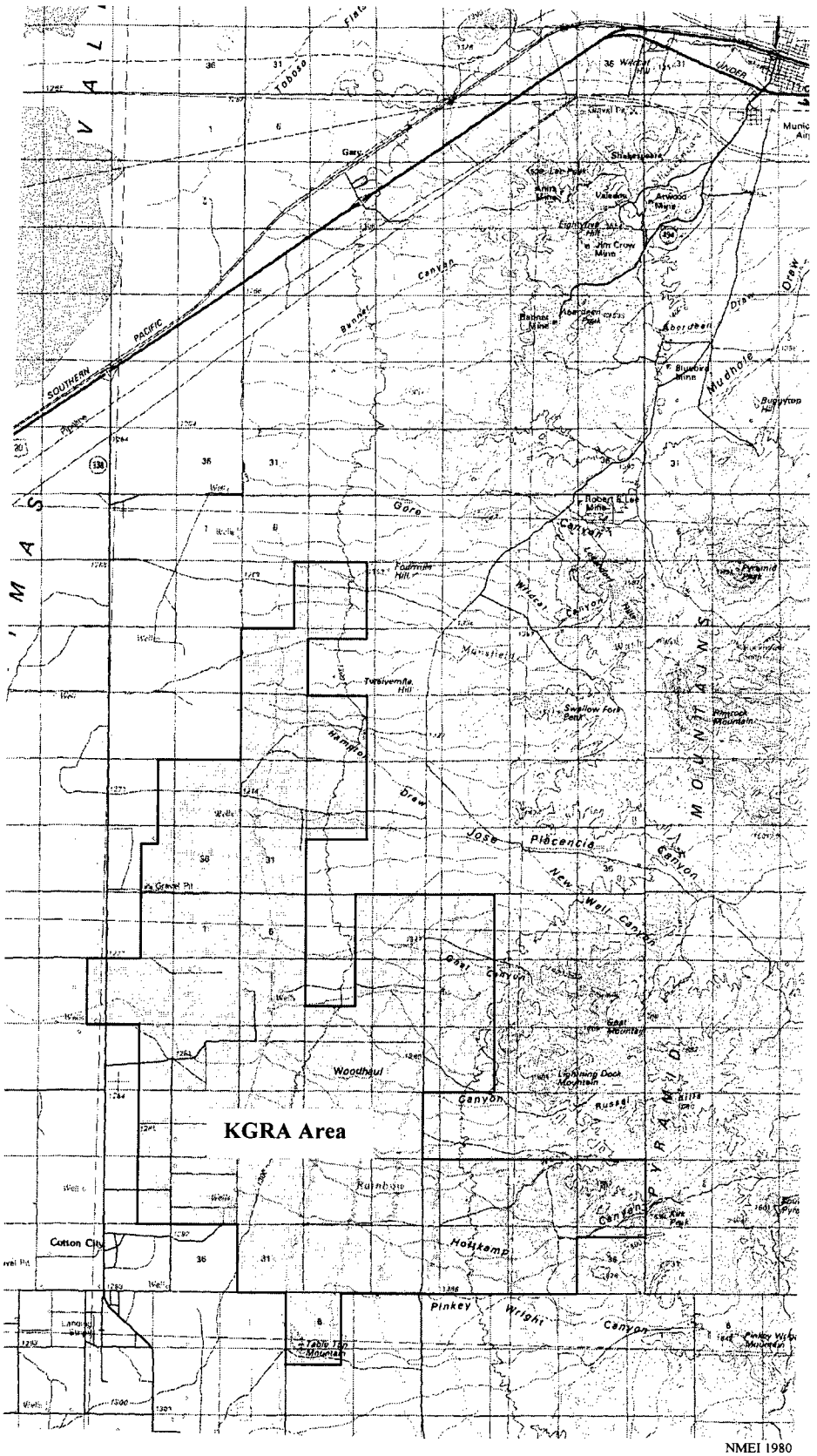


Figure 1-2. Location of Lightning Dock Known Geothermal Resource Area.

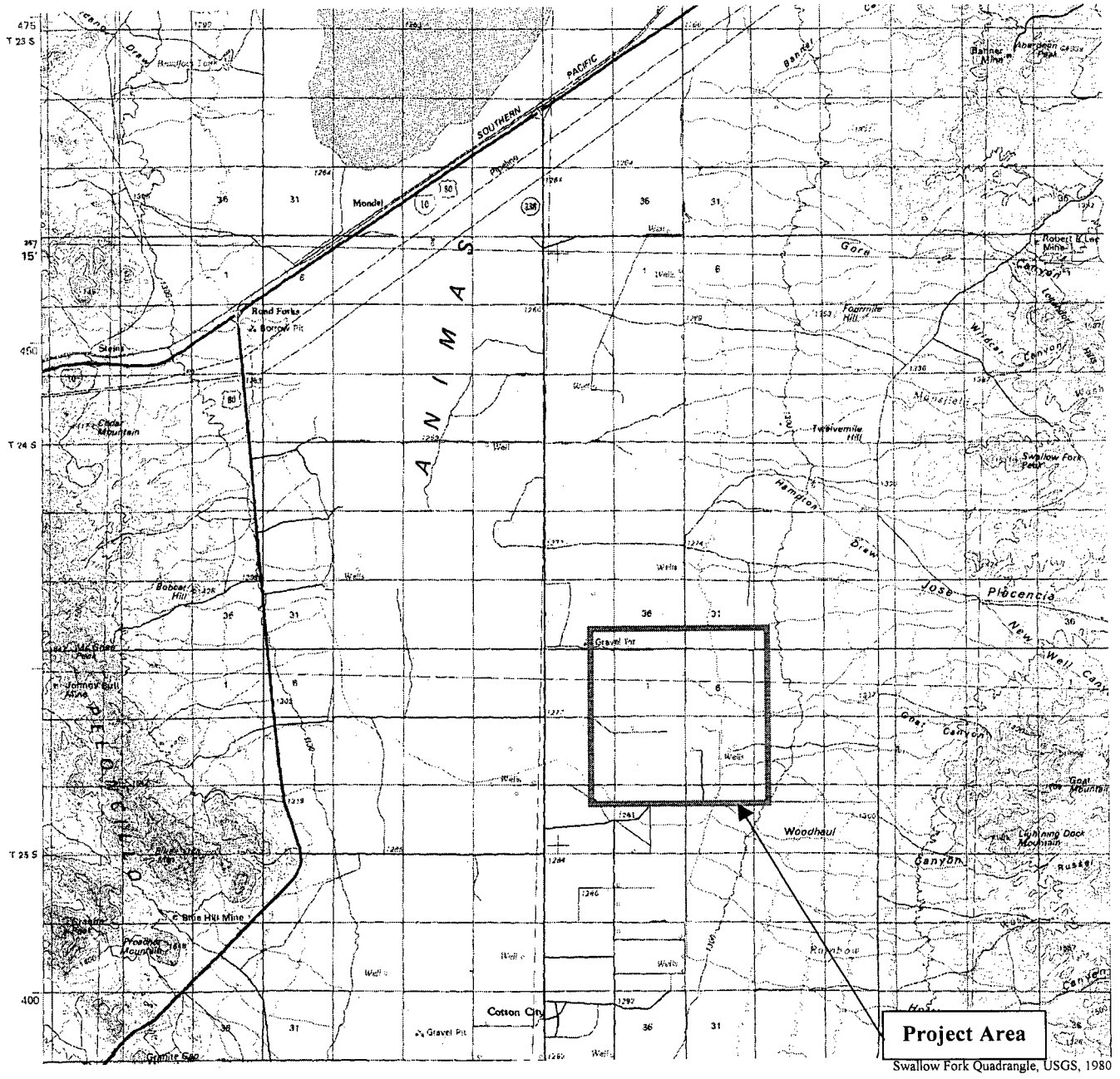


Figure 1-3. Topographic Map of the Vicinity of the Project Area.

any connected actions (i.e., the construction and operation of the geothermal power plant and direct use of the geothermal fluid prior to reinjection).

1.2 PURPOSE AND NEED FOR AGENCY ACTION

Geothermal power plants currently generate approximately 2,800 MW of electricity in the United States, most of which is provided by plants over 5 MW in size. Although worldwide there are approximately 50 geothermal power plants at or below 5 MW power generating capacity, only 6 plants in the United States are smaller than 1 MW. Small geothermal power plants have the potential for widespread application, but achieving cost-effectiveness in small plant sizes presents a number of challenges. To address these challenges, DOE is supporting the small-scale field verification projects to (1) determine and validate the economics, performance, and operational characteristics of small-scale geothermal electric power plants in different regions, and (2) determine their ability to provide distributed power in order to facilitate their increased use in the western United States.

DOE needs to decide whether to authorize the expenditure of Federal funds to Exergy, Inc., for partial funding of construction and field verification of a small-scale geothermal power plant south of Lordsburg, NM, at the AmeriCulture site. DOE also needs to decide whether to authorize the expenditure of Federal funds to AmeriCulture, Inc., for the direct use of geothermal fluid to determine, demonstrate, and validate the operational performance of a geothermal direct-use system.

DOE/NREL will take this opportunity to monitor and evaluate the technical and economic performance of the proposed power plant and the direct-use project. This information will be used to advance the design and use of small-scale geothermal technologies.

This EA was prepared in accordance with Section 102(2) of the NEPA of 1969, 42 U.S.C. 4332, Council of Environmental Quality regulations, and DOE NEPA Implementing Procedures (10 CFR 1021).

1.3 SCOPING

As part of the EA process, comments on the scope of the assessment were sought from the public, regulatory agencies, and other interested parties. A letter describing the scope of the project was sent out to all parties on the project's distribution list. Two responses were received. One response was to request a copy of the Pre-decisional Draft EA when it was issued. The other response raised the issue of the possible use of the cooled geothermal water for irrigation.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This chapter describes the Proposed Action and the No Action Alternative. The Proposed Action consists of DOE's decision to provide partial funding for two components of a geothermal system, a proposed power plant and a direct-use application. To present the reader and decisionmaker with a means of comparison, this EA discusses effects of the proposed power plant and direct-use application together and separately where appropriate. Since the Proposed Action consists of potentially adding a new small-scale geothermal power plant and a direct use application to an existing system that uses geothermal energy to heat water for the tilapia hatchery, the existing facilities are described in detail. The No Action Alternative is described in Section 2.4.

2.1 LOCATION

The proposed project would be located in the eastern half of Section 6 and in Section 7, Township 25S, Range 19W, Hidalgo County, NM, approximately 16 miles (26 km) southwest of Lordsburg, and just north of Animas and Cotton City (Figure 1-1). The project is within the Lightning Dock KGRA (Figure 1-2).

2.2 EXISTING FACILITIES

AmeriCulture currently operates a commercial tilapia fish hatchery. The hatchery facilities include 33,000 ft^2 (approximately 3,100 m^2) of converted greenhouse space on 15 acres (6 ha) of private land; large fish breeding tanks and tanks where mature fish are kept with a total volume of 170,000 gallons (640,000 l); a 1,200 ft^2 [110 m^2] small office/shop; and some small storage space (see Figures 2-1 and 2-2).

The fish require warm fresh water. The fresh water is supplied via an existing pipeline from an existing well approximately 8,500 ft (2,600 m) to the west (Figure 2-3 and 2-4). After circulating in the fish tanks, the water is filtered and recycled. The wastewater left over from the filtration is pumped through a pipe to a containment pond just west of the greenhouses where it evaporates. The amount of freshwater used varies according to the season. The average use is 50 gallons per minute (gpm) (190 liters per minute [lpm]). In a separate closed loop, water is circulated through a downhole heat exchanger in a geothermal well (AmeriCulture State 1) just to the southeast of the hatchery facilities. The water is heated in the exchanger and pumped to the hatchery and is used to maintain the required temperature for the fish tanks. The water is then recirculated back to the downhole heat exchanger. At this time, no geothermal fluids are pumped to the surface at AmeriCulture.

The existing geothermal well (AmeriCulture State 1) is located to the southeast of the hatchery. It is a 400 ft (122 m) deep 10.75 in (27.3 cm) diameter well that is cemented down to 282 ft (86 m). It is expected that the well can deliver more than 1000 gpm (approximately 3,800 lpm) at 232°F (111°C) (Witcher 2001). Depth to water is approximately 75 ft (23 m). The temperature in the well with the heat exchanger in place has been measured at 232°F (111°C). A 48-hour flow test was conducted in October 2000, which showed a

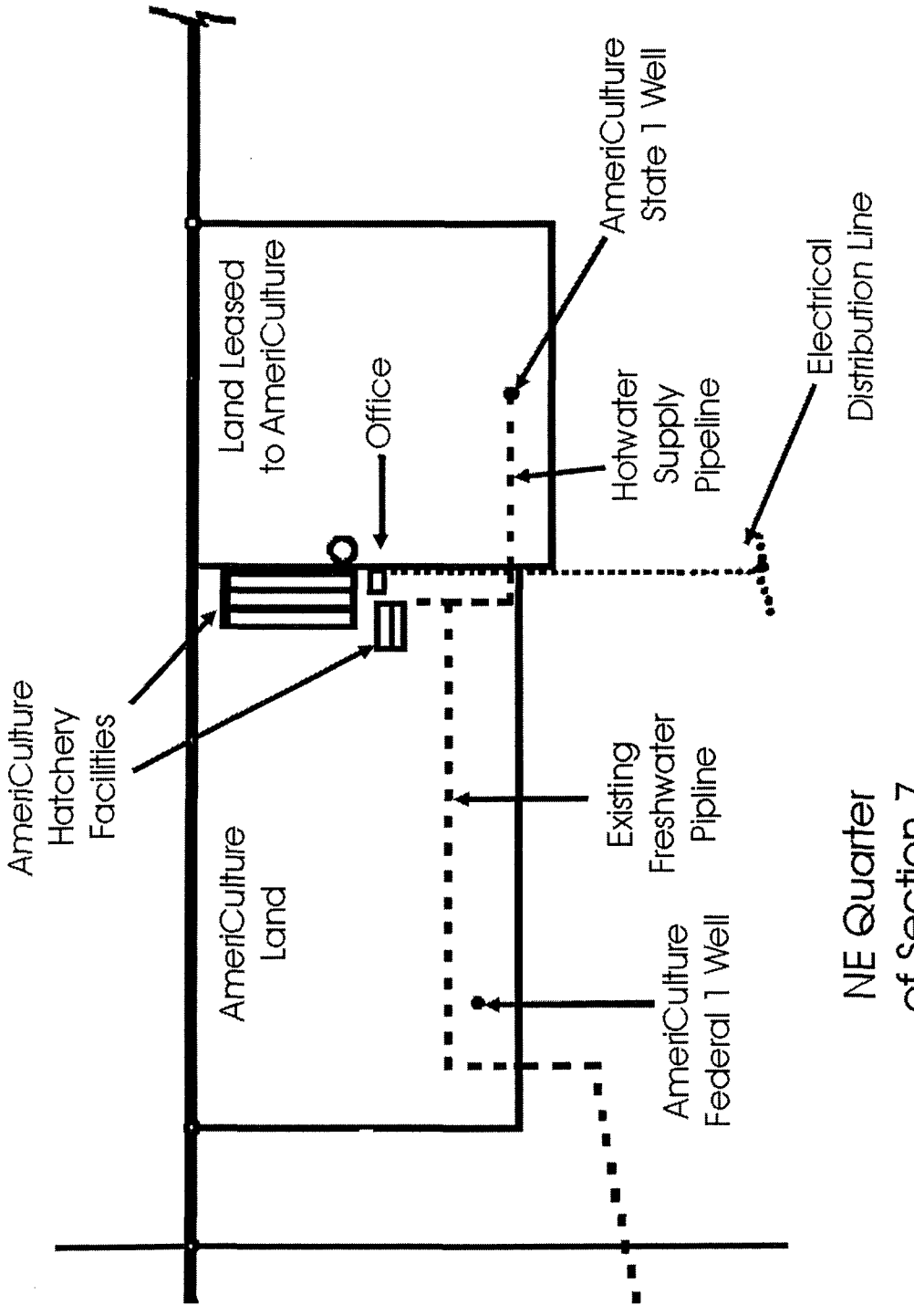
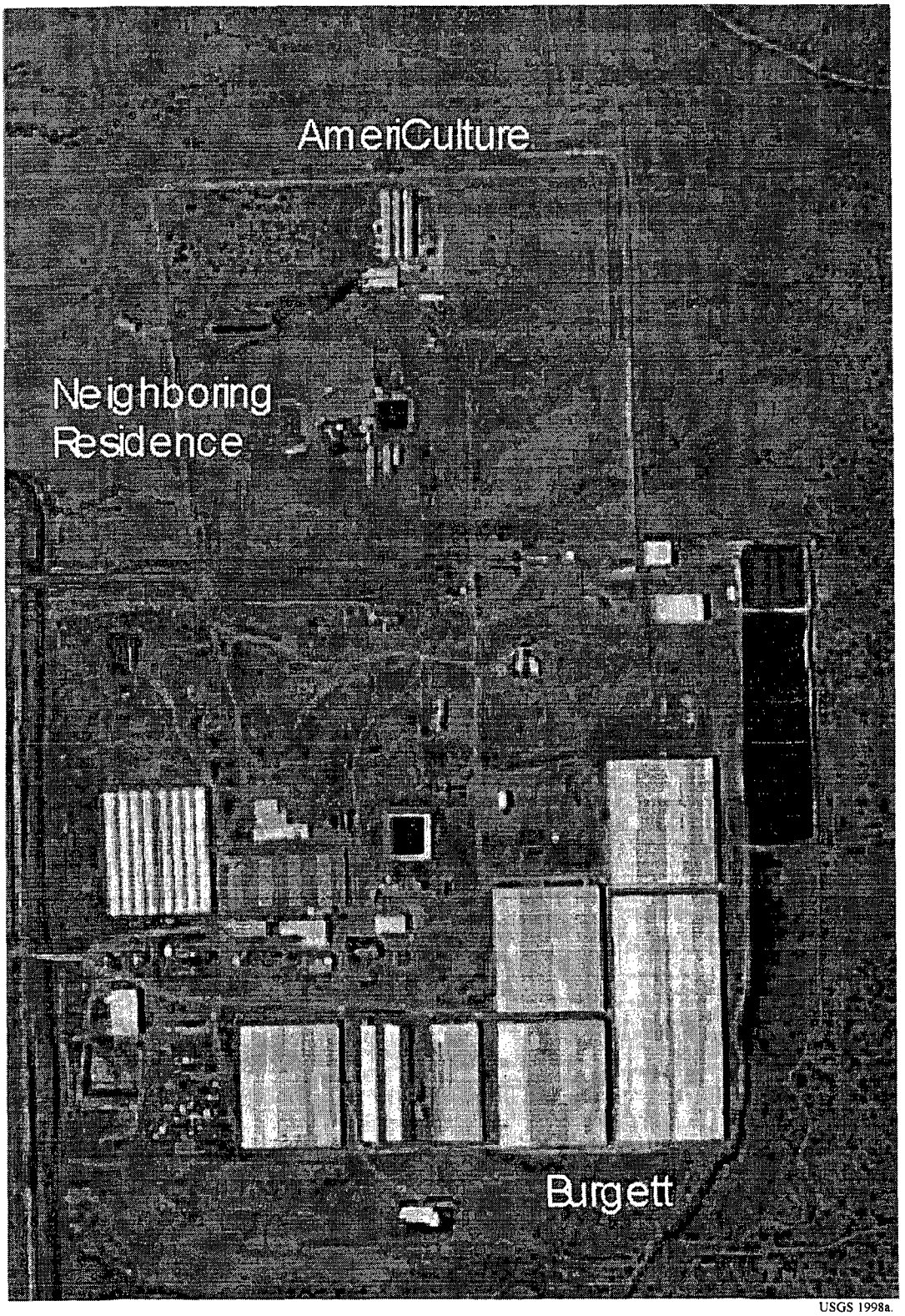


Figure 2-1. AmeriCulture's Existing Facilities.



USGS 1998a.

Figure 2-2. Aerial Photograph of Location of Proposed Action.

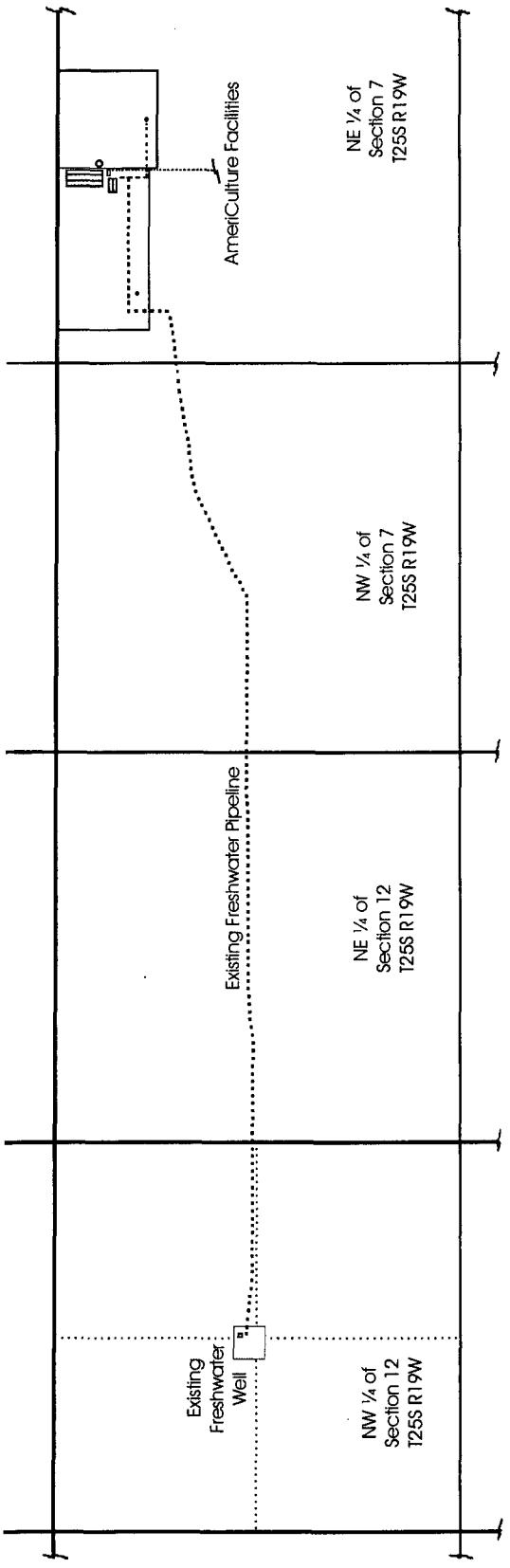
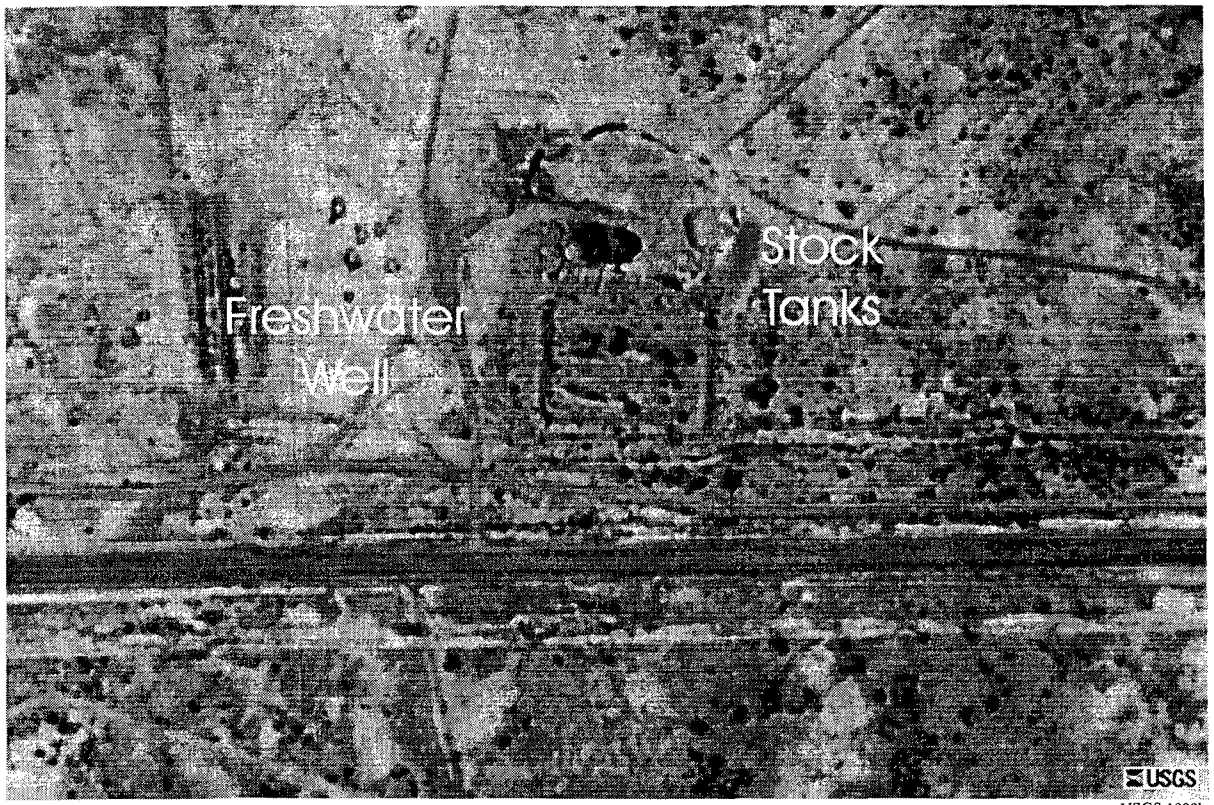


Figure 2-3. Existing Freshwater Well and Pipeline to AmeriCulture Facilities.



USGS 1998b.

Figure 2-4. Aerial Photograph of Existing Freshwater Well Site.

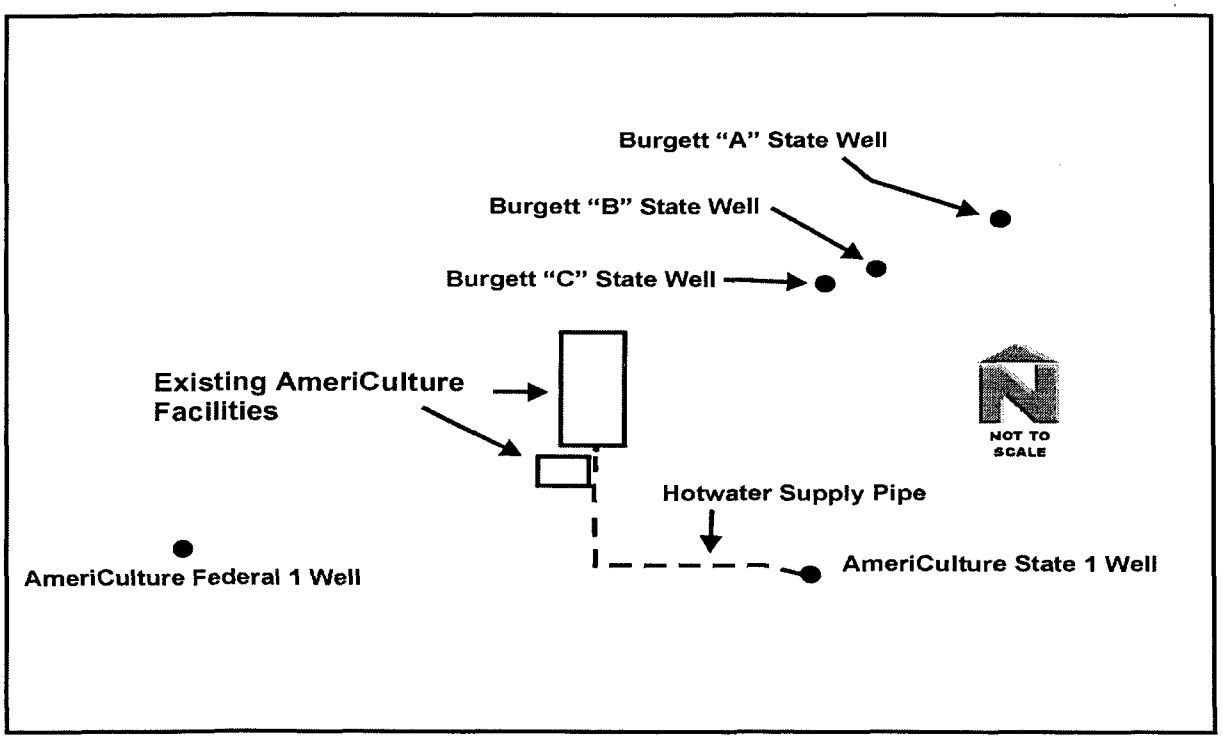


Figure 2-5. Pump Test Wells.

sustained rate of 1,050 gpm (approximately 4,000 lpm) or greater. The stable production temperature was 232°F (111°C). The heat exchanger was removed prior to the flow test. The water quality of the geothermal fluid is considered good with a total dissolved solid (TDS) of approximately 1,050 parts per million (ppm).

Other wells in the immediate vicinity include an AmeriCulture geothermal well (AmeriCulture Federal 1) to the west of the hatchery, which is unused, and the Burgett wells (Burgett "A," Burgett "B," and Burgett "C") to the east (Figure 2-5), which supply geothermal fluid used to heat the Burgett greenhouses and produce power in Burgett's turbine/generator.

The Columbus Electric Cooperative, Inc., a member of the Tri-State Generation and Transmission Association, Inc. (Tri-State), currently supplies electrical power at AmeriCulture. Columbus Electric interconnects with Tri-State at Deming and Playas, NM (see the discussion of infrastructure in Section 3.6).

2.3 PROPOSED ACTION

The Proposed Action is for Exergy, Inc., in association with AmeriCulture, Inc., to develop two components of an integrated geothermal system. The first component (see Section 2.3.1 below) is an average 1,280 kW gross (1,000 kW net) Kalina Cycle geothermal power plant at the AmeriCulture facilities. This power plant would utilize geothermal fluid from the existing geothermal well (AmeriCulture State 1) to generate power. The power would be used by AmeriCulture or neighboring industry. The second component of the Proposed Action (see Section 2.3.4 below) is a direct-use application would be constructed. to utilize the geothermal fluid exiting the proposed power plant to heat the water for the fish tanks. If for any reason the power plant (first component) was not constructed the direct-use application (second component) could still be built. In this case the direct-use applications would use the geothermal fluid straight from the existing geothermal well (AmeriCulture State 1). The spent geothermal fluid would be reinjected in a new well that would be drilled north-northeast of the AmeriCulture site (Figures 2-6 and 2-7).

2.3.1 Proposed Power Plant

The proposed power plant would be constructed within a 0.6 acre (approximately 0.2 ha) area approximately 80 ft by 300 ft (24 m by 91 m) on the AmeriCulture site just south of the existing hatchery facilities (see Figure 2-2). The proposed power plant would be constructed along the pathway of the existing heated water pipeline between the AmeriCulture State 1 geothermal well and the hatchery. The geothermal fluid for the power plant would be pumped from the existing well (AmeriCulture State 1). The production from the well is expected to be about 1,000 to 1,200 gpm (3,800 to 4,500 lpm) at 232°F (111°C). A new pipeline for the geothermal fluid would be installed along the existing heated water pipeline. The geothermal fluid exiting from the proposed power plant is expected to be thermally depleted to a temperature of approximately 140°F (60°C). This depleted geothermal fluid would used to heat the fish tanks. Once the new geothermal fluid heating system is installed the old heated water pipeline would be removed.

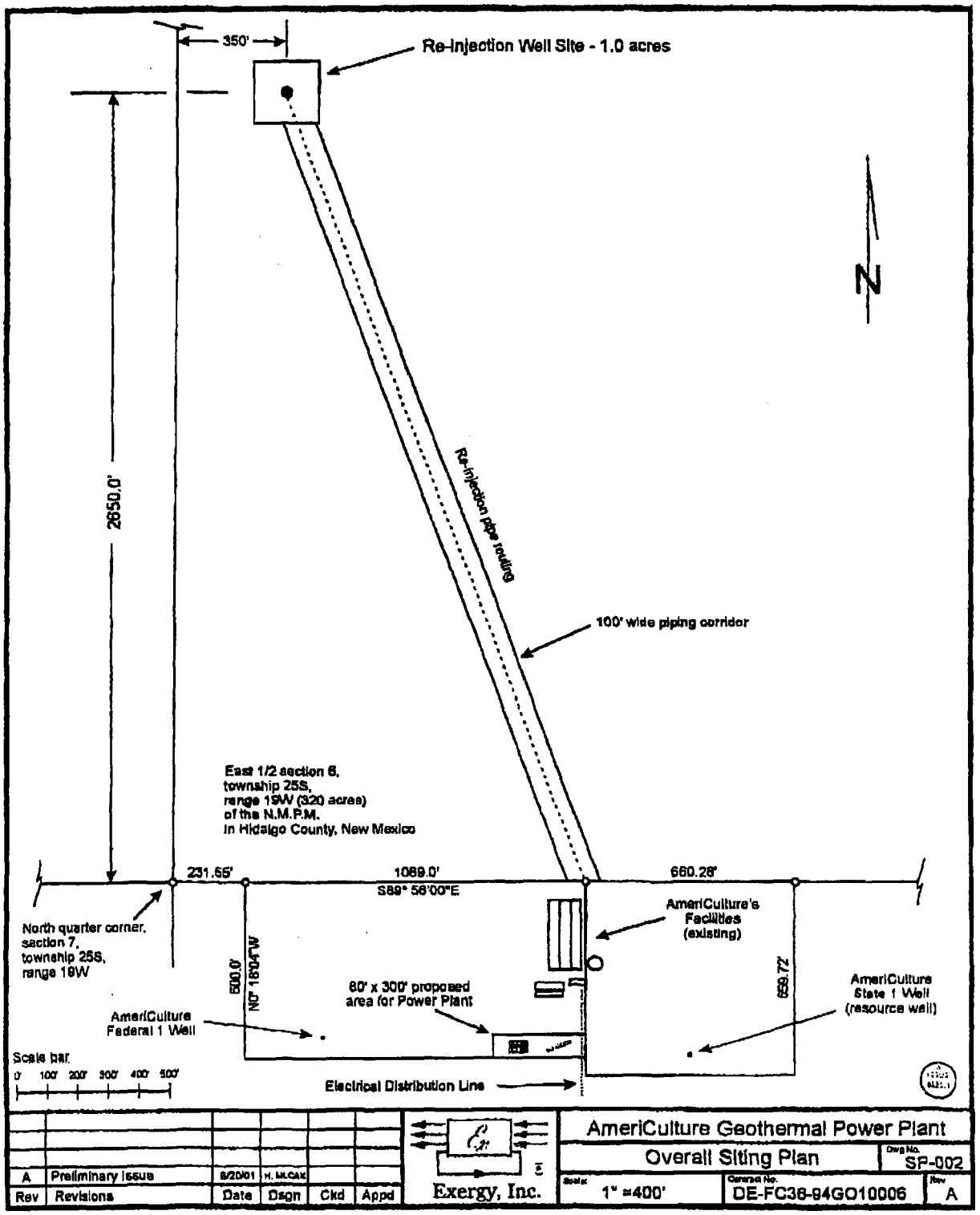


Figure 2-6. Location of Elements of Proposed Action at AmeriCulture.

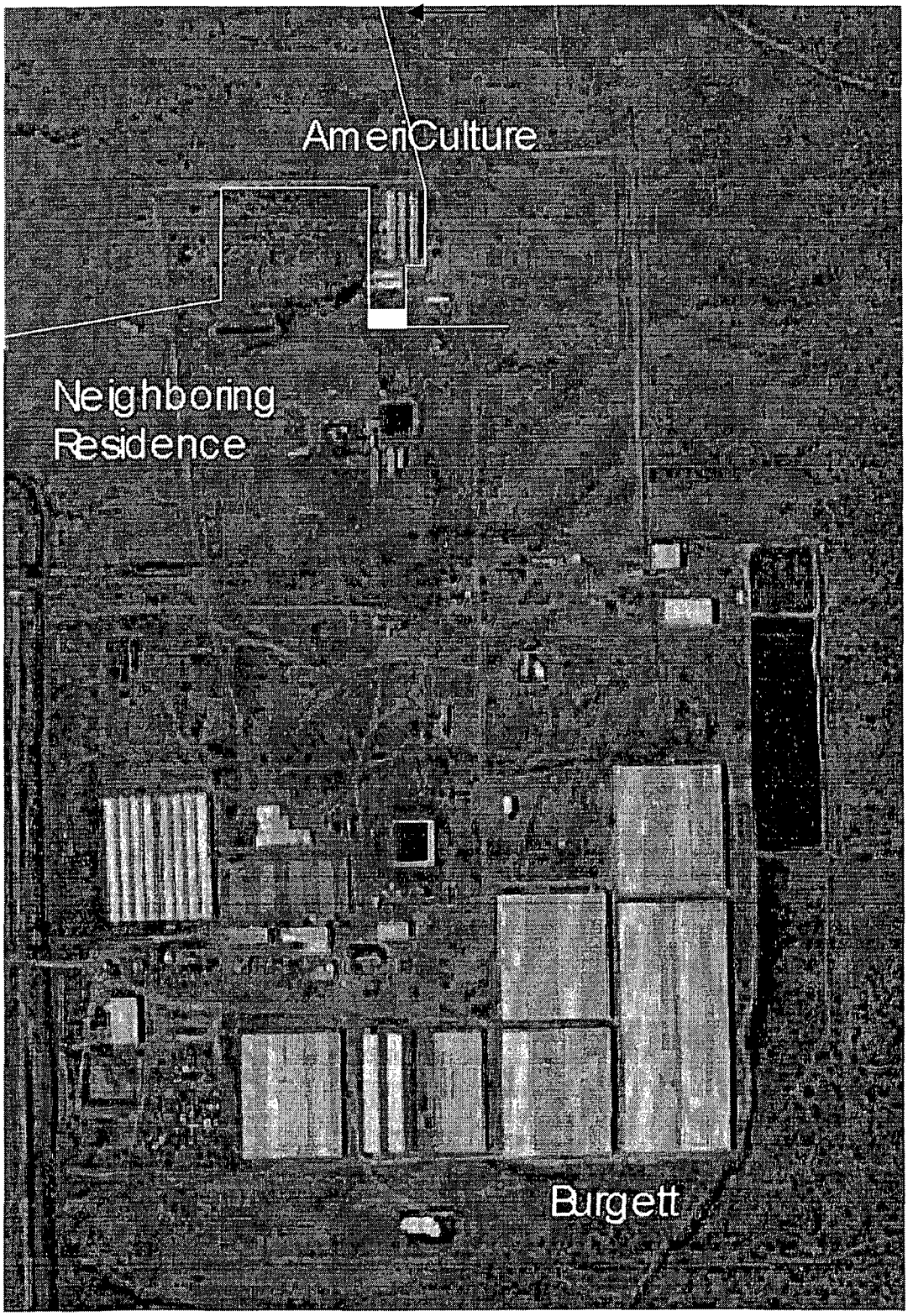


Figure 2-7. Location of Power Block and Pipelines on the Site Aerial Photograph.

The power plant would be designed to use the Kalina Cycle process. The Kalina Cycle process uses a working fluid of ammonia and water in a closed loop arrangement. The power plant would use the heat from the geothermal fluid to vaporize the ammonia-water working fluid in a heat exchanger. The vapor would drive a turbine generator. Figure 2-8 shows the layout of the power plant. The "power block" occupies an area of approximately 40 ft by 60 ft (12 m by 18 m). The power block includes the evaporator-condenser assembly, the turbine-generator skid, separator, feed pump, blowdown tank, water storage tank, ammonia storage tank, and the control building. The turbine would generate 85 dBA of noise at 3 to 5 ft (0.9 to 1.5 m). The ammonia storage capacity that is anticipated for this project would be a single tank that would have a volume of 2,000 gallons (approximately 7,600 liters) or less. The tank would be surrounded by a berm high enough to contain any spill.

The Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) require the reporting of hazardous chemical leaks. Reportable releases of ammonia usually have to be reported to three different governmental agencies: federal, state and local. All three must be notified immediately following a reportable spill or release. Any time ammonia is spilled or released to the outside in excess of its reportable quantity, 100 lbs per 24 hrs, immediate reports must be made to various government agencies.

Anhydrous ammonia is a "hazardous chemical" for purposes of OSHA, which prescribes handling and storage requirements. Employees must be trained in its safe handling methods, and have material safety data sheets readily available. Storage of over 500 lbs of anhydrous ammonia must be reported to the Local Emergency Planning Committee.

Anhydrous ammonia is a "hazardous chemical" for purposes of OSHA, which prescribes handling and storage requirements. Employees must be trained in its safe handling methods, and have material safety data sheets readily available. Storage of over 500 lbs of anhydrous ammonia must be reported to the Local Emergency Planning Committee. When the ammonia is mixed with water, the reportable quantity varies with the concentration of ammonia.

The mixture of two compounds with two different boiling points as the working fluid allows a better match to the temperature of the heat source and increased thermal efficiency. The relative concentrations of ammonia and water are varied throughout the process to also increase efficiency. The relative concentration can also be varied seasonally. Other geothermal power plants use a single compound working fluid such as isobutane, pentane, or ammonia. The higher efficiency of the Kalina Cycle would allow for greater plant capacity and energy output for the given heat source compared to other processes and lower capital cost.

The power plant would be designed to produce an average gross output of 1,280 kW. The power requirement for pumping the geothermal fluid from the well is expected to be approximately 75 kW. The power requirement for the cycle pumps, cooling water pumps, cooling tower fans, and other power plant equipment is expected to be approximately 205 kW. The remaining power (approximately 1,000 kW) from the proposed power plant would be available for use by AmeriCulture and/or a neighboring industry. This is enough power for approximately 860 homes (EIA 1997).

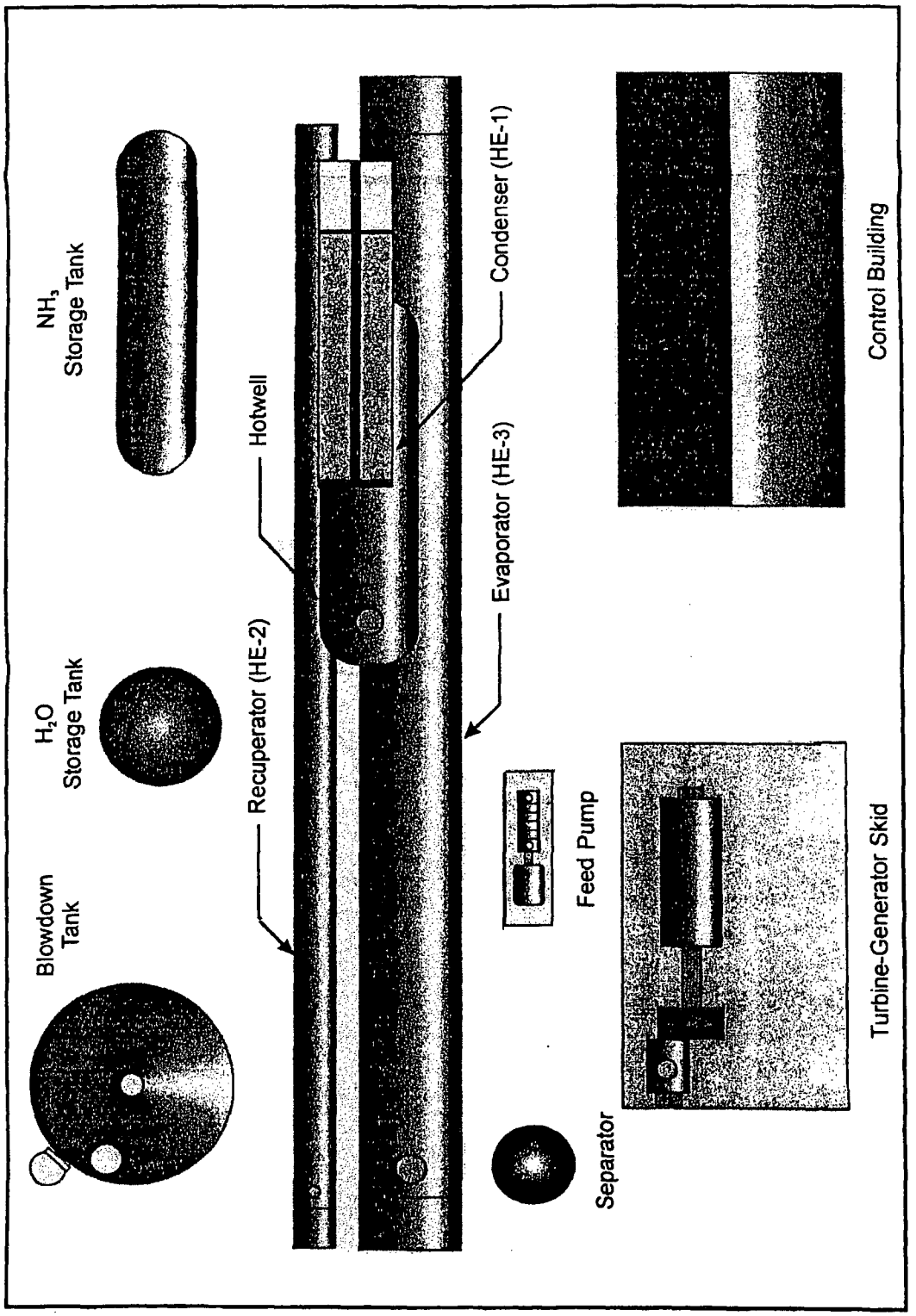


Figure 2-8. Proposed Turbine and Generator Layout

The power generated by the proposed power plant would be used by AmeriCulture, Inc. AmeriCulture anticipates that implementation of their current expansion plans would result in their power needs increasing to 1,000 kW within 2 to 3 years. At that point in time, AmeriCulture would be using all the power onsite that is produced by the power plant. Until that point in time, any excess power would be sold to Columbus Electric. Columbus Electric is a member of Tri-State. The details under which that power would be sold to Tri-State have not yet been worked out. Any safety, switching, transformer, or quality of service equipment that would be needed would have to be provided by the generating entity. While the types and specifications of the needed equipment have not been detailed, the equipment would be located next to the proposed power plant, just to the west of the turbines.

The power lines connected to the AmeriCulture site may not need any upgrades to accommodate the transmission of the generated power, should any be sold to Columbus Electric. The need for upgrades would be dependent on the amount of power that would be transmitted. The existing lines provide a moderate capacity for transmission. Potential upgrades to the existing power lines could include replacement of the existing lines or addition of a new line. Bearing the costs of the new lines would likely be the responsibility of the generating entity and would also affect the decision on whether to sell power to Columbus Electric. It is anticipated that the replacement line or additional line would be strung on the existing poles.

Exergy and AmeriCulture would monitor and report data to the NREL to document the facility's technical and economic performance. The data would include well physical and chemical data, plant process thermal, mechanical, and electrical performance, plant reliability, availability and load factor, plant energy generation, and plant operation and maintenance costs.

2.3.2 Cooling Towers

A cooling tower skid would occupy an area approximately 14 ft by 86 ft (4 m by 26 m), located just to the east of the proposed power plant (Figure 2-9). The cooling tower skid is oriented east-northeast along the prevailing wind direction. The cooling towers would be 25 ft (7.6 m) high. Similar cooling towers generate 85 dBA of noise at 3 to 5 feet. The cooling tower would use evaporative cooling to cool water circulated through a condenser that would condense the ammonia-water vapor exiting the turbine. The cooling tower would use fresh well water as makeup. The flow rate for this system is 100 gpm (approximately 380 lpm) into the cooling towers. After use in the cooling towers, the outflow rate of the blowdown water is 30 gpm (approximately 114 lpm). The blowdown water would have a temperature range of approximately 40°F to 75°F (4°C to 24°C) depending on the seasonal ambient air temperature. To supply the make-up water, a new second freshwater well would be drilled adjacent to the existing freshwater well. A new pipeline would be installed. The new pipeline would run next to the existing pipeline until it crossed into AmeriCulture property. At that point the new pipeline would continue north to the northern edge of the Americulture property and then turn east to the greenhouses. The new pipeline would bring the water for use in the proposed power plant for the cooling towers. The cooling tower blowdown would be mixed with the cooled geothermal fluid for reinjection.

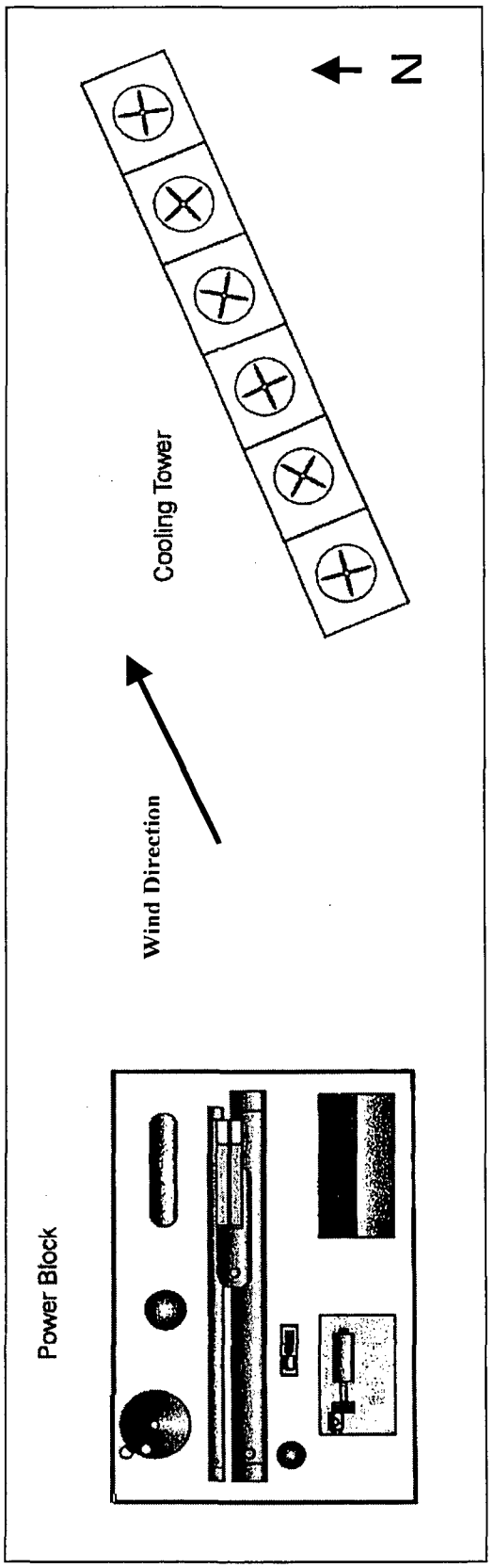


Figure 2-9. Proposed Power Block and Cooling Tower Layout

2.3.3 Changes to Existing Geothermal Well

The existing heat exchanger would be removed from AmeriCulture State 1 and a Centrilift, or similar, pump installed. A new pipeline for the geothermal fluid would be installed along the existing heated water pipeline. The measured temperature of the geothermal fluid in the well was 232°F (111°C). The production from the well is expected to be about 1,000 to 1,200 gpm (3,800 to 4,500 lpm). Existing data from a recent flow test and nearby production wells indicate that the existing well would be adequate for the proposed power plant (Witcher 2001). The neighboring greenhouse producer has used nearby wells for over 15 years. Pumping rates have occasionally reached 2,000 gpm when thermal demand is maximum and their power plant is operational.

2.3.4 Direct Use of Geothermal Fluid

While the Proposed Action is to develop the direct-use application in association with the proposed power plant, it could be implemented without the power plant. According to current plans, the direct-use application would use the 140°F (60°C) geothermal fluid exiting the power plant for heating the hatchery fish tanks. After use at the hatchery, the exiting geothermal fluid, cooled to approximately 100°F (approximately 38°C), would be mixed with the blowdown water and piped to the new injection well (detailed in Section 2.3.5) (Figure 10).

If the direct-use application were to be implemented without the proposed power plant, the 230°F (110°C) geothermal fluid from the AmeriCulture State 1 well would be used to directly heat the water for the fish tanks. In this case, the downhole heat exchanger in the AmeriCulture State 1 well would be removed and a pump would be installed to pump the geothermal fluid to the hatchery. This would allow for a greater amount of water to be heated to the required temperature. The geothermal fluid exiting the hatchery, cooled to approximately 130°F (54°C), would be piped away for reinjection in the same manner as described above (Figure 11).

The equipment would be the same for either direct-use possibility. The direct-use system must be capable of running on either the water discharged from the power plant (approximately 140°F [60 °C]) or directly from the ground (approximately 230°F [110°C]), because power plant downtime is inevitable and fish tanks must still be heated during power plant downtimes. Maintaining a pressure of between 30 to 50 pounds per square inch (psi) in the direct-use system prevents flashing. The control and variation of pressure is used across the geothermal industry to control the point in the system where the geothermal fluid would flash to steam.

Under either configuration, AmeriCulture would monitor and report data to the NREL to document the direct-use application's technical and economic performance. The data would include well physical and chemical data, thermal, performance, reliability, and maintenance costs.

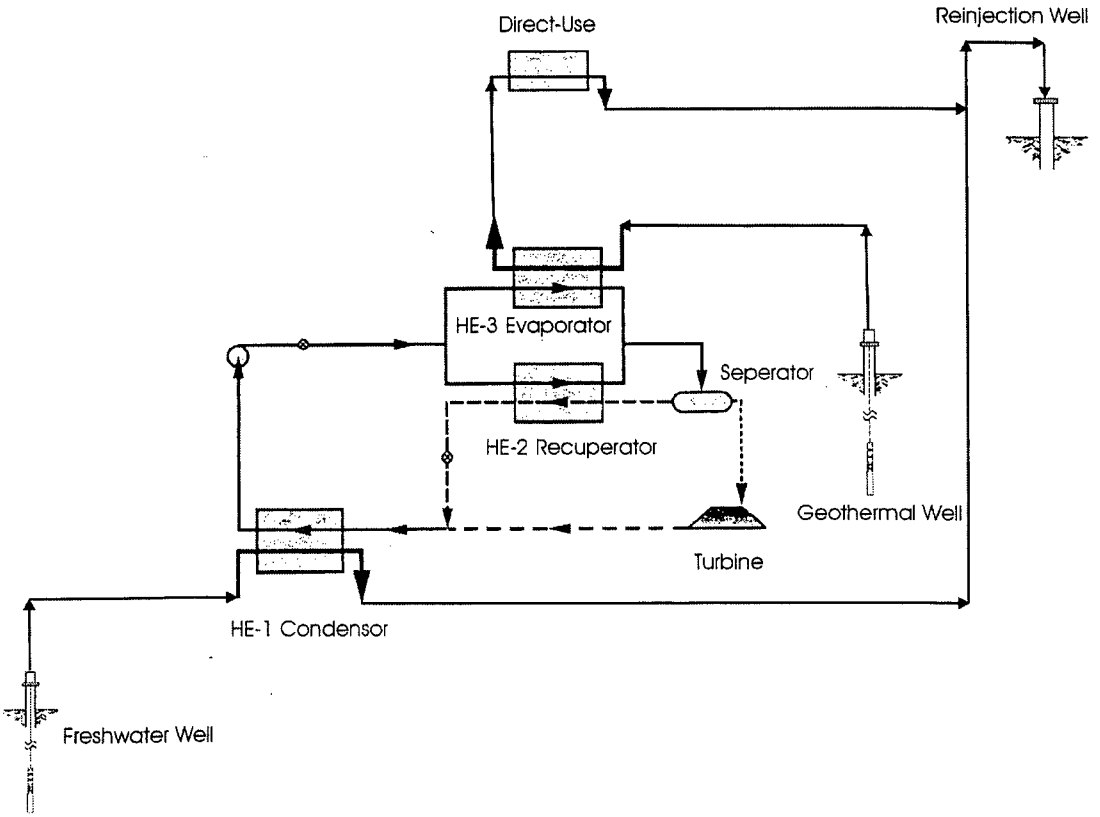


Figure 2-10. Flow Diagram for Both Components of Proposed Action.

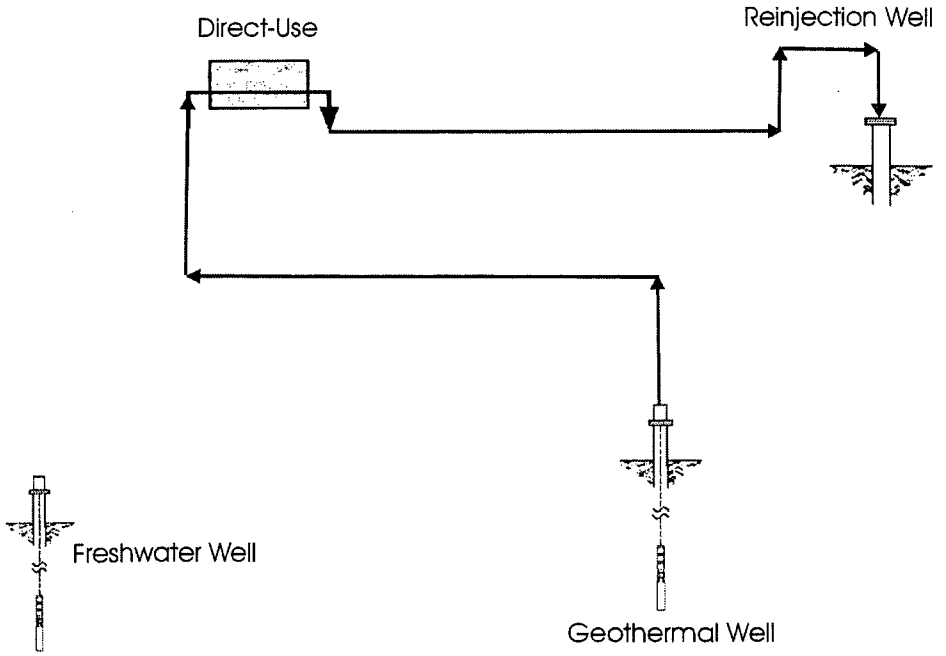


Figure 2-11. Flow Diagram for Direct Use Component of Proposed Action.

2.3.5 Reinjection of Cooled Geothermal Fluid

After use in the power plant and the direct-use application, the cooled geothermal fluid would be reinjected back into the geothermal resource. The temperature of the cooled geothermal fluid to be reinjected would depend on whether both components of the Proposed Action (power plant and direct-use application) are constructed, or only a single component is constructed (either the power plant or the direct-use application).

Reinjection from Both Power Plant and Direct-Use Application. The Proposed Action involves the construction of both the power plant and the direct-use application. The 140°F (60°C) geothermal fluid exiting the power plant would be used in the direct-use application to heat the water for the hatchery tanks. The temperature of the geothermal fluid exiting the direct-use application would be 100°F (38°C). This fluid would be mixed with the 40°F to 75°F (4°C to 24°C) blowdown water from the cooling tower. Since the flow rate of the blowdown water is 30 gpm (114 lpm), or less than 3% of the total mixed fluid flow rate, the temperature of the reinjected fluid would be essentially the same as the temperature of the cooled geothermal fluid (approximately 100°F (38°C)) (Seawright 2002).

The reinjection well would be sited at a distance to the north-northwest of the AmeriCulture site on leased land that is owned and controlled by the New Mexico State Land Office (NMSLO). The NMSLO also owns and controls the mineral rights for this land. The concern of the NMSLO is that the cooled geothermal fluid should not be reinjected into an area where the geothermal fluid in the ground is hotter. This would avoid any cooling of the resource. For the implementation of both components of the Proposed Action, the point where the temperature of the fluid to be reinjected equals the temperature of the geothermal fluid in the ground is currently calculated to be approximately 3,400 ft (1,000 m) north-northwest of the hatchery. An injection well would be drilled at this point; a new spent geothermal fluid pipeline built from the power plant to the reinjection well site, and an injection pump installed (as shown in Figure 2-6). The new spent geothermal fluid pipeline would be suspended aboveground on posts or blocks to allow the pipe room to expand and contract with the heat from the spent geothermal fluid.

Reinjection from Power Plant Alone. The cooled geothermal fluid from the power plant has a temperature of approximately 140°F (60°C) and a flow rate of approximately 1000 gpm (approximately 3,800 lpm). This fluid would be mixed with the 40°F to 75°F (4°C to 24°C) blowdown water from the cooling tower. Since the flow rate of the blowdown water is (30 gpm (114 lpm)) or less than 3% of the total mixed fluid flow rate, the temperature of the reinjected fluid would be essentially the same as the temperature of the cooled geothermal fluid (approximately 140°F (60°C)) (Seawright 2002).

For implementation of the proposed power plant alone, the temperature of the cooled geothermal fluid to be reinjected (140°F (60°C)) would be approximately 40°F (22°C) hotter than the fluid would be if both the power plant and the direct-use application (100°F (38°C)) were implemented. Therefore, the reinjected fluid would be hotter than the geothermal fluid in the ground at the planned location of the reinjection well. This plan would still satisfy NMSLO's concern over cooling the resources by injected fluid cooler that the geothermal

fluid in the ground at the point of injection. However, should NMSLO disagree, the reinjection well may have to be located closer to the AmeriCulture site along the path of the proposed reinjection pipeline. The exact location would depend on coordination with the NMSLO and the lease holder.

Reinjection from Direct-Use Application Alone. The geothermal fluid exiting the direct-use application at the hatchery would be cooled to approximately 130°F (54°C). Without the power plant there would be no cooling towers and no blowdown water. The temperature of the reinjected fluid would be approximately 130°F (54°C).

For implementation of only the direct-use application, the temperature of the cooled geothermal fluid (130°F (54°C)) would be 30°F (16°C) hotter than the fluid would be if both the power plant and the direct-use application (100°F (38°C)) were implemented. Therefore, the reinjected fluid would be hotter than the geothermal fluid in the ground at the planned location of the reinjection well. This plan would still satisfy NMSLO's concern over cooling the resources by injected fluid cooler that the geothermal fluid in the ground at the point of injection. However, should NMSLO disagree, the reinjection well may have to be located closer to the AmeriCulture site along the path of the proposed reinjection pipeline. The exact location would depend on coordination with the NMSLO and the lease holder.

Irrigation use of geothermal water is not being considered at this time. While it is possible to use cooled geothermal water for the irrigation of certain crops, the relatively high dissolved solids content (approximately 1,000 ppm) makes the water less suitable than water from the Animas Valley underground basin. Although the blowdown water originates from the Animas Valley underground basin, its TDS level would be enhanced through evaporation. Consequently, it would be well matched for reinjection along with the thermally depleted geothermal water.

2.4 NO ACTION ALTERNATIVE

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. The fish hatchery operations would continue current operations. The use of the geothermal resource would remain the same. No information pertinent to small-scale geothermal power plants or direct-use of heat from geothermal fluid for aquaculture would be developed from this location.

It is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway.

As with any business, AmeriCulture has plans and goals for growth of the business. Currently, the DOE grants play a role in AmeriCulture's plans. If the Proposed Action was not implemented and the partial funds not awarded, AmeriCulture's plans would change. Any planned expansions would be dependent on the demand for tilapia and economic factors, including the price of power and availability of water.

2.5 RELATED ACTIONS

The largest single greenhouse operation in the United States is a neighbor to the proposed project. Burgett Geothermal Greenhouses, Inc., grows cut roses using the heat and power generated from the Lightning Dock geothermal resource.

Other potential actions have been proposed in the Proposed Action area, including proposals for grants by DOE for other uses of the geothermal resource. One potential action involves drilling wells into the deep part of the geothermal resource where limited fluid is present. Water would be injected in one well and geothermal fluid would be collected at the nearby well. If this project proved successful, a power plant would be constructed to generate electricity from the resulting geothermal fluid. DOE also may consider providing future funding or partial funding for intermittent resource characterization studies in the area. These other actions are not evaluated in this EA. These actions would undergo their own review under the NEPA process if these proposals were further developed.

3.0 AFFECTED ENVIRONMENT

The following environmental resources are discussed to the level of detail commensurate with the potential for environmental impact to that resource.

3.1 GEOLOGY AND SOILS

The proposed project site is located with the Animas Valley, which is part of the Animas Basin system. The Animas Basin system is located in the Mexican Highland section of the Basin and Range physiographic province. The Mexican Highlands, part of the Basin and Range province, includes the deserts of southern and western Arizona, southwestern New Mexico, and northern Mexico. The Mexican Highlands consist of broad valleys or basins separated by steeply rising mountain ranges. Each basin is essentially an independent hydrologic system. Some of these basins (including the Animas Basin) have no drainage to the sea and are slowly filling up with sand, gravel, and soil washed down from the mountains.

The Animas Basin system is an interconnected group of four subbasins that cover a watershed area of about 2,448 mi^2 (3,940 km^2) (see Figure 3-1). The four subbasins are the Lower Animas, Upper Animas, Lordsburg, and Cloverdale (San Luis). The proposed project site is located in the southwestern part of the Lower Animas Subbasin. The Lower Animas Subbasin is bounded to the east by the Peloncillo Mountains, which form part of the Continental Divide. The Pyramid Mountains to the east separate parts of the Lordsburg and Lower Animas subbasins, which merge northwest of Lordsburg (NMWRRI 2000).

Sediments eroded from the mountains have formed broad fans filling the valley floor. The most extensive landforms of the Lower Animas Subbasin are broad slopes that fan out from the mountain fronts. The slopes of these fans flatten out away from the mountains to form the basin floor areas. The basin floor areas range from narrow alluvial flats along the north-south drainage ways to broad plains comprising both alluvial flats and playa-lake depressions (NMWRRI 2000).

The Lower Animas Subbasin with an area of about 847 mi^2 (1,360 km^2) is the deepest part of the Animas Basin system in the Cotton City-Alkali Flat area. The fill thickness probably does not exceed 2,000 ft (600 m) as indicated by oil and gas exploration drilling and geophysical (seismic and gravity) surveys done in the area (NMWRRI 2000).

The Lower Animas Subbasin includes an extensive (Middle Pleistocene) basalt flow and broad alluvial flats, with shallow braided channels of the Lower Animas fluvial system in the Animas-Cotton City area. A very large playa-lake complex north of Interstate 10 (I-10) is the ultimate sink for much of the storm runoff in the basin system (NMWRRI 2000).

Soils. Soils in the general vicinity of the AmeriCulture site belong to the Hondale-Playas Association, which are deep, moderately fine textured and fine textured, nearly level to gently sloping soils on alkali fats (USDA 1973). At the AmeriCulture site, soils are of the Hondale series, consisting of very deep, well-drained soils formed in alluvium, derived from mixed sediments. This series is extensively distributed throughout southern New Mexico and southeastern Arizona. Hondale soils are in mixed sediments on old alluvial plains and fans where

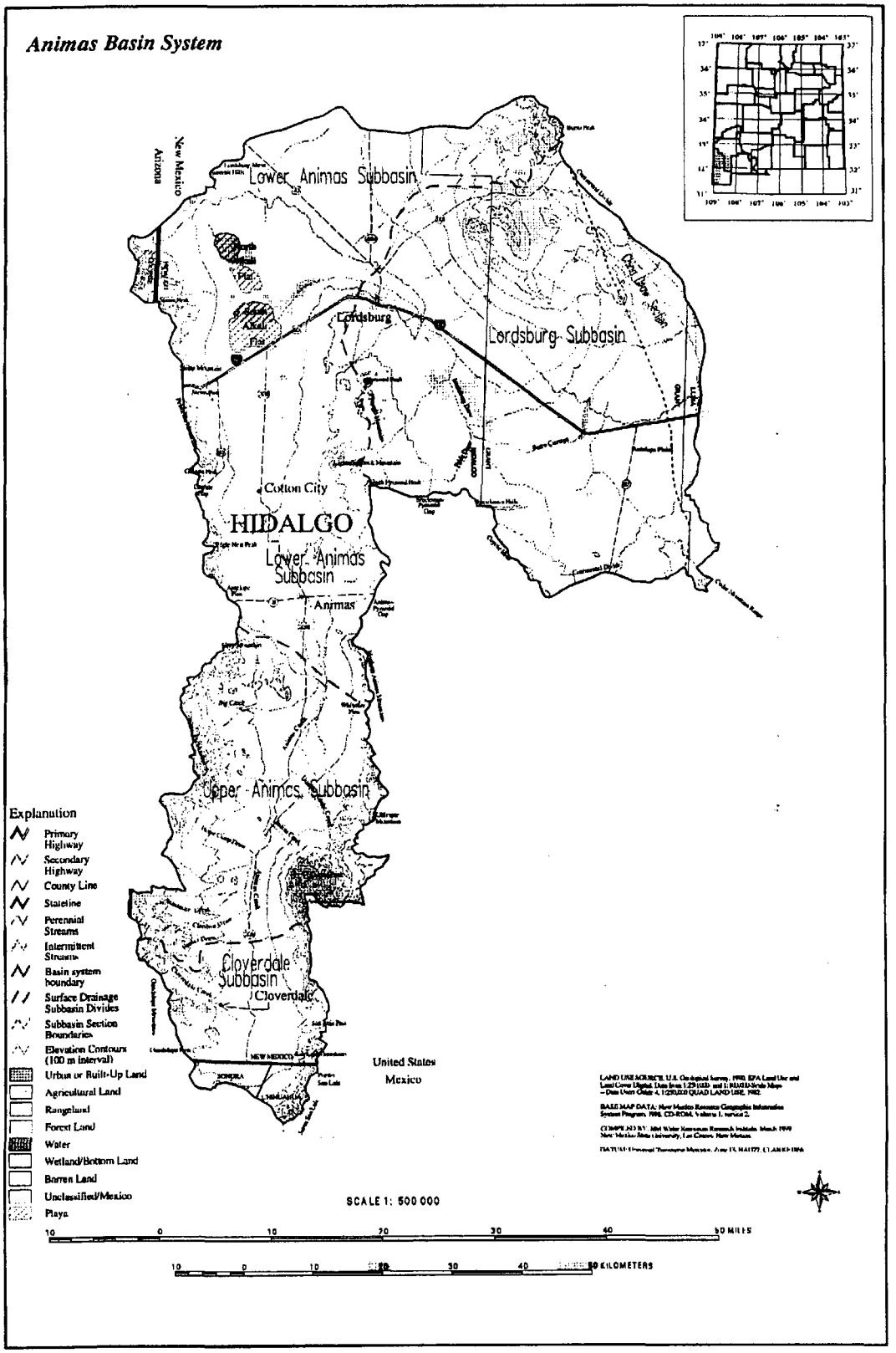


Figure 3-1. Animas Basin.

flooding is rare, and generally occur from 3,500 to 5,000 ft. Slopes range from 0 to 3 percent where Hondale soils are present (USDA 1994). Over the site area, the evaporation rate exceeds the permeability of the local soils.

In the area of the Proposed Action, there are areas that have been disturbed by past actions. The area immediately surrounding the AmeriCulture hatchery, the local roads, and the parking area to the southeast of the hatchery have all been previously disturbed. The area around the existing freshwater well was disturbed when the well was drilled. A water tank or stock tank exists just to the east of the freshwater well (see Figure 2-4). The pipeline that carries the water from the well to the AmeriCulture hatchery runs east paralleling the local road for most of the way then angles to the northeast to the hatchery.

Structural Geology. The structural history of southwestern New Mexico is dominated by three major tectonic episodes. The following paragraphs discuss these episodes, beginning with the oldest and ending with the most recent.
The Laramide Orogeny was a series of mountain-building events that affected much of western North America 35 to 75 million years ago. The deformation in the region included several north to northwest trending uplifts of 0.5 to 3 miles (0.8 to 5 km).

During the mid-Tertiary (approximately 20 to 40 million years ago), a large part of the area was covered with volcanic ash and sediments and minor volcanic flows. These flows were centered near volcanic centers. Some of these volcanic centers formed cauldron complexes where intense extension occurred along systems of faults.

In the late Tertiary (approximately 6 to 12 million years ago), basins and ranges were formed along widely spaced faults. The valleys or basins of the Mexican highlands were formed this way. These valleys and ranges are mostly horst and graben structures. The blocks that have been broken and slowly pushed up above the surrounding land to form steeply rising mountain ranges are called horsts. The blocks that are depressed relative to the mountain blocks (the valleys or basins) are called grabens. These structures are formed when blocks separated by faults have been lifted or depressed relative to each other.

Mineral Resources. There are extensive mineral resources to the north of the Animas Basin. In the Animas Basin area, Phelps-Dodge recently closed a copper smelter in Playas. There are old inactive mines in the area for gold, silver and copper ores. A small shallow gravel pit is present 2.5 mi (4 km) to the northwest.

Geothermal Resources. Many of the geothermal systems in New Mexico occur where the late Tertiary horsts intersect, older cauldron complexes, and Laramide uplifts. The Lightning Dock KGRA in the Animas Valley (Figure 1-2) occurs in an area where these three geologic features intersect (Witcher 1995). A KGRA is a region identified by the U.S. Geological Survey as containing geothermal resources.

In the region of the Lightning Dock KGRA, a major west-northwest trending structure is thought to exist. The fracture zone associated with a large mid-Tertiary caldera/cauldron is immediately

adjacent to or transverses the Lightning Dock Area. The Basin and Range faulting that created the Animas Basin system also runs through the Lightning Dock area (Witcher 2001).

The proposed power plant is located adjacent to Burgett Floral Greenhouses, the Nation's largest geothermally-heated greenhouse operation, in the northeast part of the Lightning Dock KGRA. In addition to the geologic features discussed above, a north-trending, late Pleistocene fault scarp, the southern end of which is in the Lightning Dock KGRA, which may provide a zone of open shallow fracture permeability in the KGRA local to the project area (Witcher 2001).

The source of water and heat found in the KGRA is likely background regional heat flow in deep bedrock, through which water flows on a regional scale and discharges upward in the Lightning Dock KGRA. Some regional aquitards (formations that impede or block water flow) that would prevent water from flowing upward are absent, possibly resulting from Cretaceous and Tertiary uplift. The intersection of the four tectonic elements discussed above provides the vertical fracture permeability that allows water to flow up in the Lightning Dock area (Witcher 2001). The capacity of the Lighting Dock KGRA to produce energy has not been fully characterized.

The direct-use geothermal plant at Burgett Floral Greenhouses, whose wells were included in aquifer testing at AmeriCulture, water at approximately 244°F (118°C) from three wells in the Lightning Dock KGRA. The capacity of the plant is approximately 32.8 megawatts thermal (MWt) (OIT 2001), from which approximately 1 MW of power is being generated.

The Lightning Dock KGRA is essentially elliptical in shape, with the long axis oriented north-south. It is approximately 1 mile wide and 2.5 miles long, and produces 95 to 250° F water from wells less than 500 feet deep (Fisher et al. 1990).

The characteristics of the Lightning Dock KGRA have been extensively described using a variety of methods, as reported in Callender 1985. A conservative estimate of the volume of the Lightning Dock KGRA is approximately 0.75 km^3. Porosity is estimated at 20 to 25 percent, and specific heat is assumed to range from 0.65 to 0.70 $cal/cm^3°C$. Temperature of the reservoir is estimated at 100° C, and mean annual temperature for the area is estimated at 17o C. The total heat content of the KGRA is estimated at approximately 2.1×10^{17} joules (Callender, 1985).

The capability of a geothermal resource area to produce sufficient energy on a sustainable basis is dependent on its hydrogeologic properties, which control the ability of subsurface materials to transmit the heated water contained within them to one or more wells. To assess the potential for sustainable energy production, a 48-hour pump test was conducted using an existing well (AmeriCulture State 1) at the proposed project location. This well is 399 ft (122 m) deep, producing from a fractured rhyolite reservoir in an open hole from a 282 to 399 ft (86 to 122 m) depth. The static water level is approximately 75 ft (23 m) below land surface. Water temperature during the last 40 hours of the test remained at 232° F (111°C), or slightly higher. A sample of the geothermal water was collected for analysis and found to be of good quality, with TDSs of 1,071 milligrams per liter (mg/L) and pH of 8.1.

Drawdown was measured at the AmeriCulture State 1 well. Drawdown was measured in the AmeriCulture Federal 1 monitoring well, located 1,170 ft (357 m) northeast of the AmeriCulture

State 1 well. This well is completed in Tertiary to Quaternary deposits from 60 to 223 ft (approximately 20 to 68 m) depth. A third well (Burgett "A" State well), associated with a neighboring greenhouse operation, was also involved in the test and monitored. This well, completed in the fractured rhyolite to a depth of 440 ft (approximately 130 m), is located 825 ft (251 m) to the north-northeast of the AmeriCulture State 1 well (Witcher 2001).

During the first 24 hours, only the AmeriCulture State 1 well was pumped at a rate of 1,050 gpm (approximately 4,000 lpm). During the second 24 hours, two other wells in the vicinity were pumped. The Burgett "C" State well, located 255 ft (77.7 m) southwest of Burgett "A" State well and 645 ft (197 m) north of the AmeriCulture State 1 well, was turned on first at a rate of 650 gpm (2,500 lpm). The Burgett "B" State well, located 345 ft (105 m) southwest of the Burgett "A" State well and 600 ft (approximately 200 m) north of the AmeriCulture State 1 well, was turned on second at a rate of 1,200 gpm (4,500 lpm). Both of these wells are similar in construction to the Burgett "A" State well. Pumping the wells simultaneously provided an opportunity to observe the impact of realistic operating scenarios.

An anomalously low drawdown in the AmeriCulture Federal 1 monitoring well appeared to indicate that there is a hydrogeologic boundary between the AmeriCulture State 1 well and the AmeriCulture Federal 1 well. Because the location and nature of this boundary is not well known, the data from the AmeriCulture Federal 1 well could not be used to calculate the hydrogeologic characteristics of the system. Data from the AmeriCulture State 1 and Burgett "A" State well were used to characterize the aquifer properties. Maximum drawdowns for the wells during the various pumping stages are summarized in Table 3-1.

Table 3-1. Drawdown Results of Pump Tests

Drawdown Measurement Point	First 24 Hours	Second 24 Hours
	Wells Pumped AmeriCulture State 1 Pumped at 1,000 gpm (approximately 4,000 lpm)	Wells Pumped AmeriCulture State 1 Pumped at 1,000 gpm (approximately 4,000 lpm) Burgett "B" State Pumped at 1,200 gpm (approximately 4,500 lpm) Burgett "C" State Pumped at 650 gpm (approximately 2,500 lpm)
AmeriCulture State 1	30 ft (9.1 meters)	32.29 ft (9.84 m)
Burgett "A" State Well	11.6 ft (3.54 meters)	23.4 ft (7.13 meters)

Using the 24-hour pump test data, transmissivity and storativity were calculated according to the Cooper and Jacob method to be 62,393 gpd/ft (775,310 lpd/m) and 1.17×10^{-4} (dimensionless), respectively. These values were used to project the long-term drawdown effects of pumping the well, which are discussed later in Section 4.1.1.

Drilling has commenced for the investigation and feasibility study phase for another potential use of the geothermal resource in the area of the Proposed Action. This potential use would

involve drilling wells into the deep part of the geothermal resource where limited fluid is present. Water would be injected in one well and geothermal fluid would be collected at the nearby well. If this project proved successful, a power plant would be constructed to generate electricity from the resulting geothermal fluid.

3.2 WATER RESOURCES

Surface Hydrology. The Lordsburg Subbasin to the northeast contributes flood runoff via Lordsburg Draw to the Lower Animas Subbasin (Figure 3-1). The Upper Animas Subbasin contributes surface runoff to the Lower Animas Subbasin via a north-flowing Animas Creek (Figure 3-1). The transitional boundary between the Upper and Lower Animas subbasins is located about 6 mi (approximately 10 km) south of Animas near the end of the entrenched Animas Creek (NMWRRI 2000).

There are no major perennial streams in the Animas Basin system with the exception of short perennial to intermittent reaches of Animas Creek and a few of its major headwater tributaries, all of which are located to the south of the project site. Upper Animas Creek occupies a well-defined valley to a point about 5 mi (8 km) south of Animas, and it contributes runoff and aquifer recharge to downstream areas in the Lower Animas Subbasin. The stream-channel system rapidly loses its identity in the Animas area. Some parts of the basin floor are occupied by a prominent (partly relict) pattern of shallow distributary channels, while other basin-floor surfaces appear to be mainly sites of sheet flooding during very high storm-runoff events. This ill-defined surface drainage pattern ultimately grades north to the (South Alkali Flat) playa-lake plain near and north of I-10 (NMWRRI 2000).

In the immediate vicinity of the project site the land has a gentle slope that grades to almost flat just to the northwest. Over the length of the site there is a slope of approximately 1.5 percent from the east to the west-northwest. Just to the west and northwest of the site the slope is less than 0.2 percent. The project sits between two very shallow dry washes. One wash approximately 1,550 ft (472 m) to the north of the site, trends northwest and becomes indistinguishable from sheetflow features about 3,960 ft (1,210 m) northwest of the site. The other wash, approximately 1,500 ft (approximately 460 m) to the south of the site, becomes indistinguishable from sheetflow features just south of the site and seems to flow into the drainage ditch cut along the north-south trending powerline and access road. This drainage ditch runs under the access road to the site and flows into the flat area 2,640 ft (805 m) west of the site.

The most prominent hydrologic feature on the site is a small marshy area of 0.5 to 1 acre (0.2 to 0.4 hectares) that lies just west of the greenhouses. This feature is formed by the discharge of water from the fish tanks at AmeriCulture.

Groundwater Hydrology. The primary aquifer system is formed by unconsolidated to partly indurated basin fill, which includes surficial deposits of ancestral Animas Creek, and basin-floor facies of Upper and Middle Gila Hydrostratigraphic Units. The aquifer system has unconfined, semiconfined and confined components. It is laterally extensive but quite variable in thickness (NMWRRI 2000).

Underlying basin fill comprises well-consolidated and partly indurated Middle and Lower Gila Hydrostratigraphic Units that have very low hydraulic conductivities. Storage coefficients reflect semiconfined and confined aquifer conditions. A very liberal estimate of available groundwater of good quality that is stored in the Animas Basin aquifer system is about 1.2×10^{10} m^3 (12 km^3, 9.5×10^6 ac-ft) (NMWRRI 2000).

Reported groundwater pumped for irrigation in 1995 was 2.5 x 106 m3 (2,040 ac-ft) and 17.9 x 106 m3 (14,542 ac-ft) for the Lordsburg and Animas areas, respectively. The Animas Valley underground basin was used to a greater extent in the 1940s when cotton farming occurred in the area and required significant amounts of groundwater. At the time, the water rights were adjudicated at a level that officials believed could be sustained with minimal impact. No new water rights have been added since the 1940s. Since then, agriculture in the area has declined. Some of the water rights associated with the declining agricultural activities have been sold to other operations. However, most are unused. As a result, the total water use in the area Animas Valley is below the level thought be sustained with minimal impact. The water use by AmeriCulture is provided in Section 3.6 (Infrastructure).

3.3 CLIMATE/AIR RESOURCES

Climate of the Animas Basin system is arid to semiarid except in the highest parts of the San Luis, Animas, Guadalupe, Peloncillo and Big Burro ranges. In the town of Animas, at an elevation of 4,415 ft (1,346 m), the average annual precipitation is 11.03 in (28.02 cm). The average total precipitation ranges from 0.20 in (0.5 cm) in April to 2.33 in (5.92 cm) in August. The average maximum temperature is 77.3°F (25.2°C). The average maximum temperature in summer is 93.6°F (34.2°C), with the hottest month being June (95.4°F [35.2°C]). The average minimum temperature in winter of 27.2°F (-2.67°C) with the coldest month being January with 26.2°F (-3.22°C) (WRCC 2000). Evaporation exceeds precipitation in the Animas Basin. Evaporation records at Animas indicate an annual evaporative rate of 99.7 in (253 cm). The prevailing wind direction at the site is to the east-northeast (Exergy 2001).

The eastern border of the Animas Basin system follows the Continental Divide. Crest elevations of the Continental Divide commonly exceed 6,600 ft (2,000 m) in the Sierra San Luis-Southern Animas Mountain area. This range is the northern extension of the Sierra Madre Occidental of northwestern Mexico, and the Guadalupe/Peloncillo range to the west. It is the first major highland area to intercept masses of moist air that seasonally move inland from the Gulf of Mexico and the eastern Pacific Ocean. Most of the large precipitation events are in the summer and early fall, but lower magnitude (but very effective) precipitation pulses occur during the winter and early spring in some years (NMWRRI 2000). Higher parts of the Cloverdale and Upper Animas subbasins are significantly cooler and wetter than the Animas-Cotton City, Lordsburg area. During the summer, precipitation occurs primarily as thundershowers, with the amount of rainfall from these storms being quite variable. Snowfall is the main precipitation during winter (NMWRRI 2000).

Except for the Southern Animas-San Luis range and the Guadalupe Mountains, the climate is arid with mostly clear skies and limited rainfall and low humidity. The air quality for southern rural New Mexico is normally very good. Gaseous emissions are limited. Ambient

concentrations of pollutants have traditionally been within state and Federal standards, although during periods of dry weather, particulate levels noticeably increase. No known quantitative data exist on the air quality of the area (NMWRRI 2000). The air emissions at the project site consist of vehicle exhaust, exhaust from the emergency generators, and from the propane heaters in the trailer used as living quarters at the site.

3.4 BIOLOGICAL RESOURCES

The AmeriCulture site is about 16 mi (approximately 26 km) southwest of Lordsburg, NM, at an elevation of approximately 4,200 ft (approximately 1,300 m). The project site is an area that has been previously disturbed by grazing, construction of roads and structures, and other activities. A diurnal and nocturnal pedestrian survey was performed at the AmeriCulture site in August 2001, with some supplemental information collected in January 2002. The following subsections address vegetation, wetlands, wildlife, and protected or sensitive species at or adjacent to this facility.

Vegetation. The Animas Basin system represents a moderate array of land cover ranging from Ponderosa Pine Forest in the higher parts of the Burro Mountains in the north and in the southern Animas, Peloncillo, and Guadalupe mountains adjacent to the Cloverdale and Upper Animas subbasins. Mixed Piñon-Juniper woodlands and grasslands on lower mountain slopes grade rapidly into semidesert-grass and desert-scrub vegetative cover in the rangelands on lower piedmont slopes and basin floors (McCraw 1985). A large playa-lake plain (Figure 3-1) including North and South Alkali Flats, dominates the floor of the Lower Animas Subbasin, and large areas are sparsely vegetated cover. Rangeland accounts for the majority of the land cover in the area.

The surveyed area consisted primarily of scrub vegetation characteristic of the Chihuahuan Desert scrub (Brown 1982). Some grassy areas at the site appear to be diminishing due to drought, historic heavy grazing and other land disturbances. Some of the more common plant species observed included creosotebush (*Larrea tridentata*), fourwing saltbush (*Atriplex canescens*), honey mesquite (*Prosopis glandulosa*), and purple prickly pear (*Opuntia violacea* var. *macrocentra*). One population of a nonnative and invasive plant species, Yellow starthistle (*Centaurea solstitialis*) or a related species, Malta starthistle (*C. melitensis*), was discovered in the disturbed area by the parking lot near the waste fish water containment pond.

Wetlands. An area where water has been discharged from the fish containment ponds was surveyed to determine if there were marshy areas present that are protected and regulated under the *Clean Water Act*. An artificially created marshy area less than one acre in size has been created on the edge of a containment pond by waste fish water discharges over a number of years. This area supports a small population of wetland vegetation that includes cattail (*Typha* sp.), willow (*Salix* sp.), and sedge (*Carex* sp). According to the owner, the cattail currently present represents growth from several years ago, because the pond no longer reaches the level required for their survival.

Wildlife. Only wildlife species representative and common to the area were sighted during the biological survey. During the August 2001 nocturnal survey, up to 100 individuals of a species of *Bufo* consistent with the Great Plains toad (*Bufo cognatus*), were observed along a section of

the paved road paralleling the fresh (non-geothermal) water pipeline. Power lines run parallel to the primary access road to the AmeriCulture site. These lines, and the transmission towers supporting the lines, were surveyed for the presence of raptors or other birds; however, none were observed.

Protected and Sensitive Species. The principal purpose of the biological survey was to characterize the habitat to determine the suitability for species that are federally-listed as endangered, threatened, or candidates for listing. Species listed by the State of New Mexico as endangered or threatened were also considered in this survey (NMDGF 2000). The New Mexico BISON-M database (http://www.fw.vt.edu/fishex/states/nm.htm) and the New Mexico Rare Plant Technical Council database (http://nmrareplants.unm.edu) were accessed to determine species of interest that may be present in Hidalgo County, NM, as was the U.S. Fish and Wildlife Service (USFWS) endangered species list (http://ifw2es.fws.gov/EndangeredSpecies/Lists/ListSpecies.cfm).

Available records indicate that 6 federally-listed endangered species, 7 federally-listed (or proposed) threatened species, 2 Federal candidate, 20 state-listed endangered species, and 32 state-listed threatened species have been reported in Hidalgo County where the project site is located (see Table 3-2). No federally- or state-listed plant or animal species were observed at the AmeriCulture site, and no suitable habitat is present for any federally-listed species. However, suitable habitat is present for certain state-listed species including the Common Ground Dove *(Columbina passerina pallescens*), Mexican Garter Snake (*Thamnophis eques megalops*), Colorado River Toad *(Bufo alvarius),* Costa's Hummingbird *(Calypte costae*), Arizona Grasshopper Sparrow *(Ammodramus savannarum ammolegus),* and Night Blooming Cereus *(Peniocereus greggii).* Additionally, no critical habitat for federally protected species occurs on the project site. Critical habitat is habitat that has been recognized by the USFWS as essential to the conservation and viability of the federally protected species.

Letters have been sent to the USFWS, the New Mexico Department of Game and Fish, and the New Mexico Department of Energy, Minerals, and Natural Resources, Forestry Division requesting a list of species those agencies are aware of in the project area.

On April 9, 2002, The USFWS responded to the faxed request with a list of federally-listed species including all endangered, threatened, proposed threatened, and candidate species for Hidalgo County, New Mexico. All of the species on the USFWS list have been included in the biological survey and analysis. All USFWS recommendations that pertain to the Proposed Action have been addressed and a copy of the letter can be referenced in Appendix B.

3.5 CULTURAL RESOURCES

Cultural resources are those aspects of the physical environment that are the product of human or societal use, and those institutions that hold communities together and link them to their surroundings. Cultural resources include expressions of human society and history in the physical environment such as prehistoric or historic archaeological sites, buildings, structures, objects, districts, or other places including natural features and biota that are considered to be

Table 3-2. Federal and State Listed Species for Hidalgo County, New Mexico

Common Name	Scientific Name	Federal	State	Habitat	Site Findings
			PLANTS		
Night Blooming Cereus	*Peniocereus greggii*		E	Mostly sandy to silty gravelly soils. Typically growing up through and supported by shrubs especially *Prosopis glandulosa*	Habitat present, Species not observed
Orcutt Pincushion Cactus	*Escobaria orcuttii*		E	Rocky soils of broken mountainous terrain	Habitat not present, Species not observed
Parish's Alkali Grass	*Puccinellia parishii*		E	Alkaline spring seeps, seasonally wet areas. Can persist at springs highly impacted by grazing or trampling	Habitat present, Species not observed
			MOLLUSCA		
Hacheta Grande Woodland Snail	*Ashmunella hebardi*		T	Under loose stones under unusually large pinyon pine	Habitat not present, Species not observed
Shortneck Snaggletooth Snail	*Gastrocopta dalliana dalliana*		E	Only known NM pop. In Indian Creek Canyon	Habitat not present, Species not observed
			FISH		
Loach Minnow	*Rhinichthys cobitis*	T	T	Streams	Habitat not present, Species not observed
Roundtail Chub	*Gila robusta*		E	Mid elevation streams and rivers	Habitat not present, Species not observed
Spikedace	*Meda fulgida*	T	T	Riparian areas following fish maturation	Habitat not present, Species not observed
			AMPHIBIA		
Chiricahua Leopard Frog	*Rana chiricahuensis*	PT		Aquatic areas	Habitat not present, Species not observed
Colorado River Toad	*Bufo alvarius*		T	Typically found around 1500 m in Creosotebush and Mesquite vegetation	Habitat present, Species not observed
Lowland Leopard Frog	*Rana yavapaiensis*		E	Aquatic, deep pools below 1500 m	Habitat not present, Species not observed
			REPTILES		
Gray-checkered Whiptail	*Cnemidophorus dixoni*		E	Predominantly desert grassland and its derivatives	Habitat not present, Species not observed
Mexican Garter Snake	*Thamnophis eques megalops*		E	In NM, riparian areas 1300-1800 meters	Habitat present, Species not observed
NM Ridgenose Rattlesnake	*Crotalus wouldardi obscurus*	T	E	mountainous terrain	Habitat not present, Species not observed

Table 3-2. Federal and State Listed Species for Hidalgo County, New Mexico (continued)

Common Name	Scientific Name	Federal	State	Habitat	Site Findings
REPTILES (continued)					
Reticulate Gila Monster	*Heloderma suspectum suspectum*		E	Lower slopes in mountainous and outwash plains, especially in arroyos or canyons	Habitat not present, Species not observed
Bunch Grass Lizard	*Sceloporus scalaris slevini*		T	Montane grassland areas	Habitat not present, Species not observed
Giant Spotted Whiptail	*Cnemidophorus burti*		T	Canyon bottom areas in NM	Habitat not present, Species not observed
Mountain Skink	*Eumeces tetragrammus callicephalus*		T	Montane areas of Guadalupe Canyon	Habitat not present, Species not observed
Green Rat Snake	*Senticolus triaspis intermedia*		T	Montane and/or riparian areas	Habitat not present, Species not observed
Narrowhead Garter Snake	*Thamnophis rufipunctatus rufipunctatus*		T	Montane and adjacent areas	Habitat not present, Species not observed
BIRDS					
American Peregrine Falcon	*Falco peregrinus anatum*		T	Cliffy, wooded, forested slopes	Habitat not present, Species not observed
Bald Eagle	*Haliaeetus leucocephalus*	T	T	Riparian areas	Habitat not present, Species not observed
Common Black-Hawk	*Buteogallus anthracinus anthracunus*		T	Cottonwood stands near perennial streams	Habitat not present, Species not observed
Mexican Spotted Owl	*Strix occidentalis lucida*	T		Wooded, multicanopy areas	Habitat not present, Species not observed
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	E	E	Yucca Grassland and adjacent shrubbery	Habitat not present, Species not observed
Whiskered Screech Owl	*Otus trichopsis asperus*		T	Montane woodlands dominated by at least some Cottonwoods	Habitat not present, Species not observed
Common Ground Dove	*Columbina passerina pallescens*		E	Undeveloped areas below 1650 m	Habitat present, Species not observed
Buff-collared Nightjar	*Caprimulgus ridgwayi ridgwayi*		E	Arid shrublands and woodlands-generally in canyons and washes	Habitat not present, Species not observed

Table 3-2. Federal and State Listed Species for Hidalgo County, New Mexico (continued)

Common Name	Scientific Name	Federal	State	Habitat	Site Findings
			BIRDS (continued)		
Elegant Trogon	*Trogon elegans canescens*		E	Pine-Oak and Pinyon-Juniper vegetation	Habitat not present, Species not observed
N. Beardless Tyrannulet	*Camptostoma imberbe ridgwayi*		E	Lower elevations in dense stands of mesquite along stream courses	Habitat not present, Species not observed
SW Wouldow Flycatcher	*Empidonax traillii extimus*	E	E	Riparian areas consisting of upper story cottonwoods and lower story wouldows	Habitat not present, Species not observed
Thick-billed Kingbird	*Tyrannus crassirostris*		E	In NM, confined to riparian habitats	Habitat not present, Species not observed
Mountain Plover	*Charadrius montanus*	PT		Shortgrass prairies and dry playas	Habitat not present, Species not observed
Neotropic Cormorant	*Phalacrocorax brasilianus*		T	Large bodies of water	Habitat not present, Species not observed
Gould's Wild Turkey	*Meleagrus gallopavo mexicana*		T	Mountainous areas with live oaks	Habitat not present, Species not observed
Broad-billed Hummingbird	*Cynanthus latirostris magicus*		T	Riparian Woodlands	Habitat not present, Species not observed
White-eared Hummingbird	*Hylocharis leucotis borealis*		T	Montane areas	Habitat not present, Species not observed
Violet-crowned Hummingbird	*Amazilia violiceps ellioti*		T	Riparian Woodlands	Habitat not present, Species not observed
Lucifer Hummingbird	*Calothorax lucifer*		T	Slopes and adjacent canyons in montane areas	Habitat not present, Species not observed
Costa's Hummingbird	*Calypte costae*		T	Found in arid scrub terrain	Habitat present, Species not observed
Gila Woodpecker	*Melanerpes uropygialis uropygialis*		T	Lower elevation woodlands	Habitat not present, Species not observed
Bell's Vireo	*Vireo bellii*		T	Dense shrubland or woodland in riparian areas	Habitat not present, Species not observed
Gray Vireo	*Vireo vicinior*		T	Open woodlands and shrublands featuring evergreens	Habitat not present, Species not observed
Abert's Towhee	*Pipilo aberti aberti*		T	Thickets of seepwouldow in riparian areas	Habitat not present, Species not observed

Table 3-2. Federal and State Listed Species for Hidalgo County, New Mexico (continued)

Common Name	Scientific Name	Federal	State	Habitat	Site Findings
BIRDS (continued)					
Baird's Sparrow	*Ammodramus bairdii*		T	Grasslands	Habitat not present, Species not observed
AZ Grasshopper Sparrow	*Ammodramus savannarum ammolegus*		T	Open stand of creosote bush and succulents	Habitat present, Species not observed
Yellow-eyed Junco	*Junco phaeonotus palliatus*		T	Forested and riparian areas	Habitat not present, Species not observed
Varied Bunting	*Passerina versicolor*		T	Dense stands of Mesquite and associated growth in canyon bottoms	Habitat not present, Species not observed
Yellow-billed Cuckoo	Coccyzus americanus	C		Lowland deciduous thickets	Habitat not present, Species not observed
MAMMALS					
Arizona Shrew	*Sorex arizonae*		E	Higher elevation mesic forests	Habitat not present, Species not observed
Mexican Long-nosed Bat	*Leptonycteris nivalis*	E	E	In NM, upper desert scrub-pine/oak woodlands	Habitat not present, Species not observed
Desert Bighorn Sheep	*Ovis canadensis mexicana*		E	Arid, mountainous, rocky terrain	Habitat not present, Species not observed
Lesser Long-nosed Bat	*Leptonycteris curasoae yerbabuenae*	E	T	Desert scrub areas with little to no disturbance. Usually roost in caves	Habitat not present, Species not observed
Western Yellow Bat	*Lasiurus xanthinus*		T	Woodlands	Habitat not present, Species not observed
MAMMALS (continued)					
White-sided Jack Rabbit	*Lepus callotis gaillardi*		T	Grasslands	Habitat not present, Species not observed
Southern Pocket Gopher	*Thomomys umbrinus emotus*		T	Higher elevation riparian areas	Habitat not present, Species not observed
Jaguar	*Panthera onca arizonensis*	E		Lowland riparian terrain	Habitat not present, Species not observed
Mexican Gray Wolf	*Canis lupus baileyi*	E		Shortgrass plains, grassland, savanna, and montane areas	Habitat not present, Species not observed
Black-tailed Prairie Dog	Cynomys ludovicianus	C		Shortgrass plains	Habitat not present, Species not observed

Legend: **C** = Candidate for Protection; **E** = Endangered; **PT** = Proposed Threatened; **T** = Threatened

important to a culture, subculture, or community. Cultural resources also include traditional lifeways and practices, and community values and institutions.

The principal Federal law addressing cultural resources is the *National Historic Preservation Act* (NHPA) of 1966, as amended (16 *United States Code* [USC] Section 470), and implementing regulations (36 *Code of Federal Regulations* [CFR] 800), that describe the process for identification and evaluation of historic properties; assessment of the effects of Federal actions on historic properties; and consultation to avoid, reduce, or minimize adverse effects. The term "historic properties" refers to cultural resources that meet specific criteria for eligibility for listing on the National Register of Historic Places (NRHP). This Section 106 process does not require preservation of historic properties, but does ensure that the decisions of Federal agencies concerning the treatment of these places result from meaningful considerations of cultural and historic values and of the options available to protect the properties. The Proposed Action is an undertaking as defined by 36 CFR 800.3 and subject to the Section 106 process and other Federal requirements.

The human use of lands now encompassing Hidalgo County and the Animas Valley is believed to date back several thousand years. The prehistoric resources of the region are among the least surveyed and studied in New Mexico despite the presence of cave sites in the mountains with good preservation of artifacts and its designation in the archaeological literature as the focus of the Animas occupation. A universally accepted cultural chronology for the area has not been established, but some general trends have been noted. The Animas Phase (roughly AD 1150 to 1400) represents a distinct break in pottery style, site location, and architecture from the Classic Mimbres Phase, which preceded it. Around AD 1130, throughout the southwest, there appears to have been environmental instability and drought. Increased mortality, scrounging for foodstuffs, and social instability followed with a presumed outmigration from larger sites to smaller settlements at lower elevations near agricultural lands. Other researchers connect the Animas Phase as an outlier of the Casas Grandes culture of Northern Mexico. Environmental conditions in the lowlands prior to the extensive grazing of the more recent past would have provided broader range of food resources for prehistoric inhabitants than is apparent today (Stuart and Gauthier 1981). The region was not a major focus for Spanish occupation due to limited natural resources and Apache raiding, although it did provide a travel and trade corridor to what is now Mexico. Animas, south of the project area, was established in 1843 by Spanish settlers. The county seat and most important town, Lordsburg, was established in 1880 as a railroad stop. Silver and copper mining attracted other settlers around this time. Cotton City, the geographic place name nearest the project area was established later, centered around a cotton gin supported by local cotton farming (Julylan 1998).

A record search was conducted to determine whether any cultural resources have been recorded at or in the vicinity of the Proposed Action. The closest recorded archaeological site is LA 88047, which is located 1.5 mi (2.4 km) west of the AmeriCulture facility. It is southwest of the existing fresh water supply well across the paved road. LA 88047 is an artifact scatter containing lithics, ceramics, ground stone and six fire-affected rock concentrations. It has been attributed to the Mogollon Culture, San Luis Phase, dating to as early as AD 700, based on brownware sherds, although a similar pottery was in use up to AD 1400. There are no historic buildings and no known Native American or other cultural sites near any of the project areas (Ackerly 1992).

The Area of Potential Effect for cultural resources would be limited to those within the AmeriCulture project areas that could be physically disturbed by the construction of the proposed power plant, injection well, pipelines and related facilities. Cultural resource surveys were conducted for the proposed facilities in August 2001 and January 2002 by Ms. Katherine Roxlau and Mr. Kevin Doyle of Tetra Tech (Roxlau 2002). Much of the project area had been previously disturbed by prior activities. One isolated find was recorded in the area of potential effect, but no significant cultural resources exist within the entire development area. Consultation on this undertaking with the New Mexico State Historic Preservation Office (SHPO) is in progress.

3.6 INFRASTRUCTURE

Fresh water for the hatchery is supplied by an existing well located approximately 8,500 ft (2,600 m) to the west (Figure 2-2). The amount of water used at AmeriCulture is 50 gpm (190 lpm). Water used at the hatchery is filtered and recycled as much as possible. Discharge from the hatchery is pumped through a pipe to a containment pond just west of the greenhouses for evaporation. The land and water rights where the freshwater well is located are owned by the AmeriCulture owner's family. The water rights are leased to AmeriCulture. The pipeline to AmeriCulture from the freshwater well runs through an easement on private land.

Electrical power at AmeriCulture is currently supplied by power lines that connect to the site from the south. Power lines run parallel to the primary access road to the AmeriCulture site and enter the proposed project area from the south.

The local electric provider is Columbus Electric Cooperative, Inc., of Deming, NM. Columbus Electric serves approximately 2,500 members in Luna, Grant and Hidalgo Counties in New Mexico and Cochise County in Arizona. On June 30, 2000, the merger between Tri-State and Plains Electric Generating and Transmission of Albuquerque, NM was finalized. As a result, 12 New Mexico cooperatives including Columbia Electric became members of Tri-State.

Tri-State is owned by its 44-member rural electric systems (18 in Colorado, 12 in New Mexico, 8 in Wyoming and 6 in western Nebraska). The hub of the association's four-state network of transmission lines, substations and power plants is in Westminster, Colorado.

Tri-State's owned and contracted mix of electric energy is derived from coal, natural gas and oil-fired generation facilities located throughout its four-state member service territory. In addition, the association purchases Federal hydropower from the Western Area Power Administration, accounting for a substantial portion of the energy Tri-State sells to its 44-member systems. The association has exclusive wholesale power contracts with all of its members whereby each member is obligated to purchase all of its power requirements from Tri-State. Tri-State has contracted with several other utilities in the region to sell power that is not currently needed by its members.

Tri-State's 44 distribution systems directly supply electricity to rural residences, farms and ranches, cities, towns and suburban communities, as well as large and small commercial businesses and industries. Combined, they serve nearly 500,000 customers (based on electrical

metering devices) in a 250,000 mi^2 (650,000 km^2) area. Tri-State owns (wholly or jointly) or has maintenance responsibilities for over 5,300 mi (approximately 8,500 km) of transmission line ranging from 69 kV to 345 kV.

The Tri-State generating facility closest to the project site is the 250-MW Plains Escalante Generating Station, known as PEGS, located near Prewitt, NM, approximately, 220 mi (350 km) to the north.

There are no natural gas utilities at the proposed project site. Heating for the greenhouses and the office is provided by geothermal heat. The trailers at the site that provide temporary quarters for some employees use propane for heating and cooking. Sanitary wastes are discharged to a septic system.

Roads. The project site is accessed by a paved road running approximately 2.5 mi (4 km) east from New Mexico State Road 338 (NM 338). NM 338 provides north-south access to the area. United States Highway 80 (US 80) also provides north-south access to the area approximately 6.5 mi (approximately 11 km) west of the project site. I-10, the major east-west artery for southwestern New Mexico passes the project site approximately 10 mi (16 km) to the north. Other east-west access is provided by NM 9 approximately 15 mi (24 km) to the south.

3.7 NOISE

Noise is defined as sound that is undesirable because it interferes with speech, communication, or hearing; is intense enough to damage hearing; or is otherwise annoying. The physical unit most commonly used to establish a unit of measure that accurately compares sound levels is the decibel (dB). The decibel represents a relative measure or ratio to a reference pressure. The reference pressure is a sound approximating the weakest sound that a person with very good hearing can hear in an extremely quiet room. The reference pressure is 20 micropascals, which is equal to 0 (zero) dB.

A-weighted sound levels (dBA) are typically used to account for the response of the human ear. A-weighted sound levels represent adjusted sound levels that are made according to the frequency content of the sound. Therefore, the dBA is a good correlation to a human's subjective reaction to noise. Table 3-3 presents typical environmental noise on a scale from 0 to 110 dBA.

While the overall project region has the typical low noise level of many rural areas (around 30 to 40 dBA), the area immediately around the proposed project area has a higher level of noise. In the region, the background noise is primarily due to natural sources like wind, thunder, and animals. In the vicinity of the proposed project area, the man-made sources of noise in the area include the operational activity at the AmeriCulture fish hatchery and the Burgett's greenhouse (see Figure 2-2). These noise sources consist of the pumps and fans at the existing AmeriCulture operations, vehicles, and the Burgett turbine power generator. Workers at AmeriCulture experience an estimated noise level equivalent to a commercial/light industrial area, around 60 dBA.

Table 3-3. Comparative A-Weighted Sound Levels

Common Outdoor Sound Levels	Sound Level (dBA)	Common Indoor Sound Levels
	110	
Jet flyover at 1000 ft (300 m)		Rock band
	100	
Gas lawnmower at 3 ft (0.9 m)		Inside subway train
	90	
Diesel truck at 50 ft (approximately 15 m)		Food blender at 3 ft (0.9 m) Garbage disposal at 3 ft (0.9 m)
Noisy urban daytime	80	
		Shouting at 3 ft (0.9 m)
Gas lawnmower at 100 ft (30 m)	70	Vacuum cleaner at 10 ft (3 m)
Commercial area	60	
Heavy traffic at 300 ft (91 m)		Normal speech at 3 ft (0.9 m)
		Large business office
		Dishwasher in next room
	50	
		Small theater, Large conference room (background)
Quiet urban nighttime	45	
		Library (background)
Quiet suburban nighttime	40	
		Bedroom at night Concert hall (background)
Quiet rural nighttime	30	
		Broadcast and recording studio (background)
	10	
	0	Threshold of hearing

There are two nearby residences. One is the residence of the owner of AmeriCulture. The closest noise receptor not associated with these operations is the residence located about 375 ft (114 m) southwest of the proposed power plant site. With these sources of noise, the maximum background noise level experienced by the nearby receptor is estimated to be around 50 dBA.

3.8 VISUAL RESOURCES

Visibility in the area is generally high. High dust levels, which are typical of the Basin and Range Province, also reduce visibility when strong winds occur during dry weather. Occasionally there is blowing snow in the winter.

The visual foreground in the area of the proposed project is of flat scrubland where there are no structures. The structures in the area include the AmeriCulture greenhouses and office, the

Burgett greenhouses to the southeast, a residence to the southwest, and a pipe structure to the northeast that could be the exposed framework for a greenhouse or storage structure. There are also various pieces of old equipment, small tanks, pipelines, power poles and power lines in the foreground. Between the project site and the neighboring residence, a few old school buses are stored on the neighbor's land. The land is very flat so the foreground blends into the mid-ground views. In winter, steam plumes from the greenhouses to the south can be seen. The background view is of the mountains that border the basin to the east and west.

The primary viewpoints in the area are from the neighboring residence and NM 338. The view of the AmeriCulture facilities from the neighboring residence is obscured in the foreground by brush, fences, and the old school buses. In the midground, the tops of the AmeriCulture facilities can be seen. The residence also looks over the Burgett greenhouse operations. The largest number of viewers would be traveling along NM 338. From NM 338, both the AmeriCulture facilities and the larger Burgett facilities can be seen in the mid-ground. In winter, the steam plumes from the Burgett facilities are noticeable. The background views of the mountains are unimpeded along this stretch of NM 338.

3.9 LAND USE

A wide variety of land use/landcover categories are present in the Animas Basin system. Rangeland is the major land use category with forest areas exclusively located in the highest parts of the mountain ranges. Basin floors at the system's northern end include a mix of rangeland, sparsely vegetated to barren playas and dune lands, and the area's only sites of urbanization and irrigation agriculture. Lordsburg is the major urban center with the smaller communities of Animas and Cotton City located in the Lower Animas valley agricultural area. Irrigated crop acreages in 1995 were reported at 1,015 acres (411 ha) in the Lordsburg "Valley" and 7,322 acres (2,963 ha) in the Animas valley (NMWRRI 2000).

The area in the vicinity of the project site is primarily used for grazing. The grazing is not very intensive, as the suitable vegetation is sparse. There are two light "industrial" operations in the immediate area. These are the AmeriCulture fish hatchery and the Burgett greenhouses. Both of these operations lease geothermal resources. There are two nearby residences; one, approximately 1,500 ft (460 m) to the west of the AmeriCulture facilities is the residence of the owner of AmeriCulture. The other residence is closer, approximately 300 ft (90 m) to the southwest of the AmeriCulture facilities.

3.10 SOCIOECONOMIC RESOURCES

This section provides an overview of social and economic conditions present in Hidalgo County, NM. Hidalgo County is an appropriate socioeconomic region of influence (ROI) because any potential socioeconomic effects of the Proposed Action would likely occur within this geographic area and the current data is available for this area. Social and economic conditions include a baseline description of affected communities, population, ethnicity, social groups, economic indicators, and community services and facilities.

Hidalgo County shares borders with Arizona on the west, Mexico on the south and the east, and Grant and Luna Counties on the north and east. Hidalgo County includes 3,447 mi^2 (8,930 km^2)

of land with 86 linear miles (140 linear km) on the international border. Lordsburg is the county seat and the most populous city with 2,921 residents (Census 2001). The project area is located approximately 16 mi (26 km) southwest of Lordsburg. All project activities would be sited on lands in unincorporated parts of the county.

Population and Demographic Characteristics. Population and demographic information is presented for comparison purposes in Table 3-4. In the population category, Hidalgo County ranks 27 out of 33 counties in New Mexico with a population in 2000 of 5,932. It has declined in population since the 1990 census. Much of this decrease can be attributed to the closure in 1999 of the Phelps-Dodge copper smelter in Playas. The ethnicity and racial breakdown of the county population is more homogenous than the state overall with significantly lower percentages of Native Americans. A higher percentage of the county population reports as Hispanic/Latino origin than in the state or Nation (ADE 2001, Census 2001). While there has been an outmigration of both Hispanic/Latino and Anglos (non-Hispanic whites) from the county from 1980 to 2000, the percentage of persons reporting Hispanic/Latino origin has increased by 4 percent in the last 20 years (BBER 2000a, Census 2001). Over 90 percent of the Hispanic population of New Mexico is native-born; but there is some immigration, primarily from Mexico. Although Hidalgo County is on the border, the estimated net international migration (the difference between immigration and emigration) to Hidalgo County from 1990 to 1999 was only 155 persons (BBER 2000b). Given that annual Border Patrol apprehensions in the county numbered over 5,500 in 1999, Hidalgo County is not generally the final destination of choice for legal or undocumented immigration (UA 2001). Prior to the recent economic downturn, the population of the county was expected to increase to 6,823 by 2010 and 7,282 by 2030 (BBER 1997).

Economic Characteristics. In 2000, Hidalgo County had an average labor force of approximately 1,974 workers (BBER 2001). Prior to 1999, the largest industries were durable goods manufacturing; state and local government; retail trade and services (BEA 2000c). Economic statistics, which include the full impact of the subsequent closure of the Phelps-Dodge copper smelter in 1999, have not been compiled but the loss of this employer is reflected in outmigration and the high unemployment rate. Phelps-Dodge and its employees also accounted for 40 percent of the tax base of Hidalgo County. In 2000, an average of 209 workers (10.6 percent of the workforce) were listed as unemployed; this number is over twice the national and state average (BBER 2001). The most recent monthly data from December 2001, however, shows an improvement to 7 percent (NMDL 2002). The current top three employers are the city of Lordsburg, Hidalgo County and the U.S. Border Patrol. Other major employers include various motels, service stations and restaurants on I-10, Hamilton James Construction, Burgett Geothermal Greenhouses, Saucedo's Supermarket, Phelps-Dodge, Western Bank and the two school districts (NMDL 2001, UA 2001). Table 3-4 compares the estimated median household incomes, personal income per capita, poverty rates, and unemployment rates for the Hidalgo County with the state and Federal government (Census 2001).

In 1996, approximately 396 people in Hidalgo County had wage or salary jobs in agriculture (NMDA 1996). Although relatively few people are employed in agriculture or raising livestock, the actual importance of ranching and agriculture to the economy of Hidalgo County is much larger because many self-employed proprietors depend on agriculture for their income, which

Table 3-4. Population, Demographics, Economic Characteristics, and Poverty Status[1]

POPULATION GROUP	HIDALGO COUNTY 2000	NEW MEXICO 2000	UNITED STATES 2000
Total Population	5,932	1,819,046	281,421,906
White	83.8%	66.8%	75.1%
Black	0.4%	1.9%	12.3%
American Indian, Eskimo, or Aleut	0.8%	9.5%	0.9%
Asian	0.3%	1.1%	3.6%
Native Hawaiian or Other Pacific Islander	0.0%	0.1%	0.1%
Other Race	11.9%	17%	5.5%
Two or More Races	2.9%	3.6%	2.4%
Hispanic/Latino Origin (any race)	56.0%	42.1%	12.5%
White, Non-Hispanic/Latino Origin	42.7%	44.7%	69.1%
Unemployment Rate	10.6%	4.9%	4.0%
Personal Income per Capita	$17,015 (1997)	$19,298 (1997)	$25,288 (1997)
Median Household Income	$28,400 (1997)	$30,836 (1997)	$38,885 (1997)
Living in Poverty	22.6% (1997)	19.3% (1997)	13.3% (1997)

[1]Original data is gathered from a variety of sources and may have been derived using different methodologies. Race and ethnic categories are based on self-reporting during the decennial census.
Source: Census 2001.

does not show up in employment statistics (ADE 2001). Hidalgo County ranks number 18 among the 33 counties in New Mexico in agricultural sales. The cash receipts for the agricultural sector in 2000 totaled over $27 million (NMDA 2001). Principal crops are chile, cotton, feed corn, hay, wheat and cut flowers. The sale of cattle has declined in importance since 1993 and 1998, as it has in most of the counties of southwest New Mexico. The dollar value of livestock declined during that period from $29.5 million to $10.6 million (ADE 2001).

Community Resources and Social Services. This section describes community resources such as housing, schools, health services, public safety, and fire protection. According to 2000 census figures, there were 2,848 occupied housing units in Hidalgo County, an increase of 18 percent from 1990. Homeownership rates are 67.9 percent, slightly less than the state average (Census 2001).

There are two school districts in Hidalgo County, the Lordsburg Municipal Schools and the Animas Public Schools. Public educational institutions in Lordsburg, NM include 3 elementary schools, 1 middle school and 1 high school with 874 students enrolled. Animas Public Schools, near the project area operate 1 elementary, 1 middle and 1 high school with a total enrollment of 457 students (NCES 2002). There is one private primary school in Lordsburg, but no public or private colleges or universities (NMDE 2002).

There are no hospitals in Hidalgo County. Hidalgo Medical Services in Lordsburg provides primary care and a variety of medical, mental health and dental services. The center employs a staff of 42 with 3 full time primary care providers and dentists. Those requiring extensive

treatment or major emergency care must be transported to hospitals in Arizona, Deming or Silver City, depending on the location and treatment needs. The county operates its own ambulance service, which is based in Lordsburg, NM (NMBJ 2002). Fire protection in Hidalgo County is provided by volunteer fire departments. The Hidalgo County Sheriff's Department consists of an elected sheriff and undersheriff, 10 patrol deputies, and detention personnel. The sheriff's department also oversees the central dispatch for the county, which averages 600 calls per month for police, fire, medical and animal control. Because of the large unpopulated border area, the costs of law enforcement, criminal justice, emergency and indigent health services to address illegal immigration and smuggling is a major burden to the limited public resources of Hidalgo County (UA 2001).

3.11 ENVIRONMENTAL JUSTICE

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. This Executive Order requires Federal agencies to identify and address disproportionately high or adverse human health and environmental effects of Federal programs, policies, and activities on minority and low-income populations. Consideration of environmental justice concerns includes race and ethnicity data and the poverty status of populations within the ROI (defined as Hidalgo County, see Section 3.10 above), as shown in Table 3-4.

Environmental justice impacts occur if there are any disproportionately high and adverse human health or environmental effects on minority or low-income populations. The 1997 median household income in Hidalgo County was $28,400 and 22.6 percent of the residents were classified by the U.S. Census Bureau as living in poverty, a higher percentage than in New Mexico or in the United States (Census 2001). There are no updated income and poverty data available, which would include the probable changes in these economic indicators due to the closure of the Phelps-Dodge smelter. Minority populations as defined by the U.S. Census Bureau are present in the ROI.

4.0 ENVIRONMENTAL CONSEQUENCES

The Proposed Action has two components, the power plant and the direct-use application. The impacts of implementing both components are discussed first for each environmental resource. Then the environmental impacts for implementing either component alone are discussed. Either component implemented alone would involve; the drilling of a new freshwater well, construction of a new freshwater pipeline, drilling a reinjection well, construction of a pipeline from the AmeriCulture site to the reinjection well, and removal of the existing heat exchanger and installation of a downhole pump in the AmeriCulture State 1 well. Therefore, the impacts from these actions are common to implementing both components together or implementing either component alone.

4.1 GEOLOGY AND SOILS

4.1.1 Proposed Action

Soils. The Proposed Action includes several activities that would result in the disturbance of 9.3 acres (3.8 ha) of land. The drilling of a new freshwater supply well, the construction of a second freshwater pipeline, the construction of the proposed power plant, the drilling of an injection well, and the construction of a new pipeline from the site to the injection well would all involve land disturbance.

The drilling of the new freshwater well would take place adjacent to the existing freshwater well. Approximately 1 acre (0.4 ha) of the area around the existing freshwater well was disturbed when the original well was drilled and has continued to be disturbed over the years from maintenance activities (see Figure 2-3). The well site covers an area of approximately 2 acres (0.8 ha), with a gated road and a water tank. Approximately 8,650 ft (2,640 m) of new freshwater pipeline would be buried alongside the existing freshwater pipeline. The approximately 5 acres (2 ha) of land that would be disturbed by trenching and other actions during the construction of the new pipeline was previously disturbed by the construction of the old pipeline, vehicle use, and powerline and fence installation. Therefore, the drilling of the new freshwater well and the construction of the new freshwater pipeline would not require the disturbance of additional land.

The proposed power plant and cooling towers would be located in an area that has been previously disturbed over time by the operations of AmeriCulture and the previous owner. The construction of the power plant and cooling towers would only involve the disturbance of 0.6 acres (approximately 0.2 ha) of disturbed land.

The drilling of the new injection well would disturb up to 1 acre (0.4 ha) of land around the new well site. The new pipeline from the proposed project to the new injection well is approximately 3,000 ft (approximately 900 m) long. With a conservative estimate of a 25-ft (7.6-m) wide area of disturbance along the pipeline, an area of approximately 1.7 acres (0.69 ha) of land would be disturbed. The land where the proposed injection well and pipeline would be constructed has only been disturbed to date by grazing activities and some vehicle use.

Implementing the proposed power plant component without the direct-use application component would result in disturbance of 9.3 acres (3.8 ha) of land as discussed above for implementing both components.

Implementing just the direct-use application would result in disturbance of 8.7 acres (3.2 ha) of land as discussed above for implementing both components. The 0.6 acres (approximately 0.2 ha) of previously disturbed land where the proposed power plant would have been located would not be disturbed for the direct-use application.

Geothermal Resources. As stated in Section 2.3, the Proposed Action would involve pumping hot (approximately 232°F [111°C]) water from the subsurface geothermal resource located at the AmeriCulture facility. This would require drawing approximately 1,000 to 1,200 gpm (approximately 3,800 to 4,500 lpm) of geothermal fluid from the AmeriCulture State 1 well.

As stated in Chapter 3, the total heat content of the Lightning Dock KGRA has been estimated at 2.1 x 1017 joules (Callender 1985). To assess the effect on the KGRA as a whole, it is necessary to compare the heat required to generate 1 MWe and compare it to the total heat content of the shallow reservoir.

The proposed power plant would use enough heat (13.7 MWt) to generate 1,280 kW gross electrical power per year (Exergy 2001). A watt is a unit of measure that is equal to 1 joule per second (J/s). The number of joules equivalent to 13.7 MWt is 4.32 x 1010^{14} J/yr. This represents only a very small fraction (approximately 0.2 percent) of the 2.1 x 10^{17} joule heat content estimated in Callender 1985. Therefore, it appears unlikely that the proposed withdrawal of geothermal waters at the AmeriCulture location would adversely affect the resource as a whole.

The capability of a "wet" geothermal resource is dependent upon its ability to deliver geothermally-heated water stored in the underlying formations to a well for extraction. Accordingly, pump tests and calculations, discussed in Section 3.1.2, were performed to assess whether the pumping that would be conducted under the Proposed Action could be expected to compromise the geothermally-heated aquifer's ability to deliver water to the proposed well and wells currently operating in the vicinity.

Section 3.1.2 provides an overview of the methods used to define the characteristics of the heated water aquifer that make up the geothermal resource to be utilized under the Proposed Action. Water temperature was found to be approximately 111°C (232°F), and transmissivity and storativity were estimated at 62,393 gpd/ft (775,309 lpd/m) and 1.17 x 10^{-4} (dimensionless), respectively (Witcher 2001).

The Theis Method was used to calculate potential long-term drawdowns resulting from continuous pumping of 1,200 gpm (4,500 lpm) at the AmeriCulture State 1 well for 20 years. No other production or injection wells were included in these calculations. The drawdown at the well was calculated to be approximately 60 ft (18 m) after 20 years of continuous pumping. Drawdowns at various distances from the pumped well after 20 years (Witcher 2001) are summarized in Table 4-1.

Table 4-1. Theis Method Drawdown Predictions Resulting from the Proposed Action

	Drawdown - ft (m)				
Distance	50 ft (15.2 m)	100 ft (30.5 m)	500 ft (152 m)	1,000 ft (305 m)	2,000 ft (610 m)
1 year	31.2 ft (9.51 m)	28.6 ft (8.72 m)	22.7 ft (6.92 m)	20.2 ft (6.16 m)	17.6 ft (5.36 m)
5 years	34.1 ft (10.4 m)	31.6 ft (9.63 m)	25.7 ft (7.83 m)	23.1 ft (7.04 m)	20.6 ft (6.28 m)
10 years	35.4 ft (10.8 m)	32.8 ft (10 m)	26.9 ft (8.2 m)	24.4 ft (7.44 m)	21.8 ft (6.64 m)
15 years	36.1 ft (11 m)	33.6 ft (10.2 m)	27.7 ft (8.44 m)	25.1 ft (7.65 m)	22.6 ft (6.89 m)
20 years	36.7 ft (11.2 m)	34.5 ft (10.5 m)	28.2 ft (8.6 m)	25.7 ft (7.83 m)	23.1 ft (7.04 m)

Calculations were also performed indicating that continuous pumping of Burgett "B" State well at 1,000 gpm (approximately 4,000 lpm) for 20 years could result in an additional 30 ft (approximately 9 m) drawdown at the AmeriCulture State 1 well. The construction of the AmeriCulture State 1 well is adequate to tolerate the additional drawdown. Similarly, the construction of the existing nearby production wells in the Lightning Dock KGRA appear adequate to tolerate the drawdowns that would result from withdrawal of geothermal waters at AmeriCulture. Therefore, it appears that the portion of the Lightning Dock KGRA in the vicinity of the AmeriCulture facility would likely be able to supply power to the AmeriCulture facility without substantially degrading the capacity of the resource in the long term.

As discussed in Section 2.3.2, cooling tower blowdown water would be mixed with the spent geothermal water and reinjected into the geothermal aquifer approximately 3,440 ft (1,050 m) north-northwest of the AmeriCulture State 1 well, where the groundwater temperature would match that of the 140°F (60°C) geothermal water/blowdown water mixture. The approximate well position was selected to avoid thermal breakthrough at any of the existing wells in the area.

Chemical additives to the cooling water would be minimal due to expected low corrosion, low bio-fouling, and low scaling potentials. This is due to the low average temperature of the water at this site, the near neutral pH level of the water, and the use of stainless steel plates in the condenser. Mixing cooling tower blowdown water with spent geothermal water is a typical design for geothermal power plants utilizing cooling towers. The cooling tower chemical treatment program would be developed and monitored by a specialty company. The treatment program would be custom tailored and adjusted, as required, for the specific conditions at the site. These programs are designed to protect the cooling tower and water system, and to meet all environmental regulations. Impacts to the temperature and quality of the water in the Lightning Dock KGRA resulting from injection are therefore anticipated to be negligible.

Implementing the proposed power plant component without the direct-use application component would result in the withdrawal of the same amount of heat and geothermal fluid as discussed above for implementing both components. Impacts to the temperature and quality of the water in the Lightning Dock KGRA resulting from injection are therefore anticipated to be negligible.

Implementing just the direct-use application would result in the withdrawal of less geothermal fluid than discussed above for implementing both components. The amount of geothermal water used would be dependent upon the future size of the operation, which has not been projected; however, it appears likely that future withdrawals would be less than or equal to those that would occur if the power plant were constructed. Therefore, the impact of implementing only the direct-use application component would be similar to that which would occur for the power plant component, and are anticipated to be negligible.

4.1.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. The disturbance of approximately 9.3 acres (3.8 ha) of previously disturbed land associated with the Proposed Action would not occur. There would be no changes anticipated and therefore no potential for impacts to the geology and soils.

Hatchery activities would be expected to continue as they do presently. The use of the geothermal resource would remain the same. AmeriCulture would continue to use the downhole heat exchanger. There would be no additional impacts to the geothermal resource.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. Future facility expansion could occur with the potential for impacts to geology and soils. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.2 WATER RESOURCES

4.2.1 Proposed Action

Surface Hydrology. The existing surface water hydrology at the site consists of mainly sheetwash (in a generally east-to-west direction) and man-made drainage ditches. The new freshwater well and new freshwater pipeline would be constructed alongside of the existing well and pipeline. The drainage patterns would not be changed from their current configuration. The proposed power plant and cooling tower would be constructed in a flat, previously disturbed area. The new pipeline to the new injection well would cross over the shallow dry wash to the north of the project site. The injection water pipeline would be built on blocks or post to allow for thermal expansion and contraction of the pipe. Therefore, no trenching would be required. Some vehicle crossing of the dry wash would occur during construction. After construction, maintenance activities could also require some vehicle crossing of the wash. Since the area is so flat and the wash becomes indistinguishable from sheetflow features just to the west, the small amount of temporary effects to the wash during vehicle crossings would be minor.

The containment pond west of the greenhouse would be unaffected by the Proposed Action. The path of the freshwater pipeline does not cross the containment pond and the Proposed Action

would not increase or decrease the amount of water pumped to the containment pond from the hatchery tanks.

Implementing the proposed power plant component without the direct-use application component would result in the same impacts to surface water as discussed above for implementing both components. Impacts to the surface water features and flows would be temporary and minor.

Implementing the direct-use application alone would result in the same impacts to surface water as discussed above for implementing both components. Impacts to the surface water features and flows would be temporary and minor.

Groundwater Hydrology. The AmeriCulture facilities currently use 50 gpm (190 lpm) of freshwater piped from a well located 8,500 ft (2,600 m) to the west (see Figure 2-2). The wastewater from the hatchery is discharged to a containment pond west of the hatchery buildings. The amount of freshwater flowing through the hatchery would not change under the Proposed Action.

The cooling towers for the proposed power plant would require up to 100 gpm (approximately 380 lpm) of fresh water to cool the working fluid for the turbine. The amount of water used would vary in accordance with seasonal temperatures. In order to supply this increased demand, a second freshwater well would be drilled just east of the existing freshwater well. A new pipeline would be constructed adjacent to the existing pipeline in the existing easement. The existing pipeline would remain in use. The total use of freshwater with the operation of the hatchery and the proposed power plant and cooling towers would be 150 gpm (570 lpm). Since the water rights in the Animas Valley were set at a level that would be sustainable with minimal impact to the aquifer, and since the water use in the valley has declined substantially since the water rights were set, the current withdrawal of groundwater in the region has a negligible effect on the aquifer. The Proposed Action is within AmeriCulture's water rights. The withdrawal of the amount of water planned for the Proposed Action would have negligible impact on the aquifer. The water used in the cooling towers would be blended with the spent geothermal fluid and piped northwest for reinjection.

Implementing the proposed power plant component without the direct-use application component would result in the same impacts to groundwater hydrology as discussed above for implementing both components. The new freshwater well would be constructed, and same amount of freshwater would be used. The withdrawal of the amount of water planned for the power plant component would have negligible impact on the aquifer.

Implementing the direct-use application alone would result in less impact to groundwater hydrology as discussed above for implementing both components. Since the cooling tower would not be built, there would be no increase in freshwater use. While the second freshwater well would still be drilled, it would be constructed more for reliability considerations. The level of freshwater use would remain the same as the current level.

4.2.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. The approximately 100 gpm (approximately 380 lpm) of additional freshwater required for the Proposed Action would not be used. There would be no changes in the surface and groundwater hydrology as a result of Federal funding. Hatchery activities would be expected to continue as they do presently. The water use at the AmeriCulture hatchery would remain at the current level of 50 gpm (190 lpm). AmeriCulture would continue to use the current freshwater well.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. Future facility expansion could occur with the potential for impacts to surface and groundwater hydrology. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.3 CLIMATE/AIR RESOURCES

4.3.1 Proposed Action

The air quality would be slightly affected by the Proposed Action. Exhaust emissions would increase temporarily during construction. The operations of the power plant would involve intermittent emissions of ammonia from the turbines. In addition, some ammonia emissions would occur during deliveries of ammonia to fill the holding tank.

The amount of ammonia to be emitted would be calculated during the preparation of the detailed design for the plant. The plant would be designed so that the emissions would be less than the thresholds above which an operating permit would be required. These thresholds are 1.20 lbs/hr (0.54 kg/hr) at 0 ft (0 m) to less than 32.8 ft (10 m) release height, or 6.00 lbs/hr (2.7 kg/hr) at 32.8 ft (10 m) to less than 65.6 ft (20 m) release height. If the design should reveal that more than 1.20 lbs/hr (0.54 kg/hr) would be released, the stack height would be increased to 32.8 ft (10 m).

It is possible that the reinjection well would have occasional minor releases of gasses associated with the geothermal fluid. These gasses could include sulfur dioxide or carbon dioxide. The small amounts of these emissions are not regarded by the State of New Mexico as requiring permits. Any releases would be downwind of any nearby receptors.

Implementing the proposed power plant component without the direct-use application component would result in the same level of impacts to climate and air resources as discussed above for implementing both components. The ammonia emissions and possible emissions from the reinjection well would be the same. The air quality would only be slightly affected by implementing the power plant component.

Implementing just the direct-use application would have less impact to air quality than implementing the power plant component. The direct-use application would not involve emissions of ammonia. However occasional minor releases of gasses at the reinjection well associated with the geothermal fluid could still occur. Due to the use of less geothermal fluid by the direct-use application, the amount of these reinjection well emissions would be less than that associated with the power plant component. The air quality would only be slightly affected by implementing the power plant component.

4.3.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Intermittent releases of small amounts of ammonia, sulfur dioxide, and carbon dioxide associated with the Proposed Action would not occur. There would be no changes in the impacts to air quality as a result of Federal funding. Hatchery activities would be expected to continue as they do presently.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. Future facility expansion could occur with the potential for impacts to air quality. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.4 BIOLOGICAL RESOURCES

4.4.1 Proposed Action

Based on the Proposed Action described in Chapter 2 and the conditions observed in Chapter 3, impacts to biological resources would be minor and not expected to adversely affect any plant or animal populations or communities. No impacts are projected for any individual or population of state- or federally-listed threatened or endangered plant or animal species.

Vegetation. Up to 9.3 acres (3.8 ha) of land at the site would be disturbed by Proposed Action-related tasks. The construction of the new freshwater well, the new freshwater pipeline, and the proposed power plant would all take place on approximately 6.6 acres (2.67 ha) of previously disturbed land. The new spent geothermal fluid pipeline and reinjection well would involve disturbing 2.7 acres (1.1 ha) of land that have been disturbed only by grazing activities. The new spent geothermal pipeline would not be buried. It would be supported on posts or blocks above ground to allow for expansion of the pipe. This would result in less intensive disturbance along the path of the pipeline than those associated with burial. Some loss of vegetation would result from construction related activities. All of the plant species observed (e.g., creosotebush, fourwing saltbush, purple prickly pear, and honey mesquite) are common throughout a wide geographic region and plant populations would not be adversely affected by the Proposed Action.

Implementing the proposed power plant component without the direct-use application component would result in the same impacts as those discussed above for the Proposed Action. Up to 9.3 acres (3.8 ha) of land would be disturbed, 2.7 acres (1.1 ha) of which is land that has only been previously disturbed by grazing activities. Some loss of vegetation would result from construction related activities. No impacts are projected for plant species.

Implementing just the direct-use application component would result in disturbance of 8.7 acres (3.2 ha) of land would be disturbed, 2.7 acres (1.1 ha) of which is land that has only been previously disturbed by grazing activities. The 0.6 acres (approximately 0.2 ha) of previously disturbed land where the proposed power plant would have been located would not be disturbed for the direct-use application. Some loss of vegetation would result from construction related activities. No impacts are projected for plant species.

Wetlands. A second freshwater pipeline would be required for the project. If constructed, it would avoid the marshy area on the periphery of the containment pond and thus eliminate adverse impacts to this area. The pond does not drain into waters of the United States and has not been designated a jurisdictional wetland. It does not appear to be under U.S. Army Corps of Engineers jurisdiction as a result of the U.S. Supreme Court findings in the case of *Solid Waste Agency of Northern Cook County* (SWANCC) *v. U.S. Army Corps of Engineers* (No. 99-1178) (http://originalintent.phc.edu/Library/99-1178_S.asp, (Pratt 2002)). In the SWANCC case, the U.S. Supreme Court determined that isolated wetlands are exempt from U.S. Army Corps of Engineers oversight. No impacts to the marshy area are anticipated.

Implementing the proposed power plant component alone would result in the same level of impacts to the marshy area as discussed above for implementing both components. No impacts to the marshy area are anticipated.

Implementing just the direct-use application would also result in the same level of impacts to the marshy area as discussed above for implementing both components. No impacts to the marshy area are anticipated.

Wildlife. It is anticipated that the Proposed Action would not have an adverse impact on wildlife populations. Individuals of small, or less mobile, animal species tend to hide rather than flee during threat situations. Although some individuals of a given animal species may be killed during the proposed construction activities, no adverse impacts on the population of that species is anticipated due to the presence of other members of the species that would avoid disturbance areas or be present in the abundant surrounding habitat. Most wildlife species would be expected to avoid adverse impacts by movement out of disturbance areas until construction activities have been completed. No impacts to wildlife are anticipated to result from operations from the Proposed Action.

Implementing the proposed power plant component without the direct-use application component would result in the same level of disturbance as discussed above for implementing both components. The 2.7 acres (1.1 ha) of land where the new spent geothermal fluid pipeline and reinjection well would be constructed would result in impacts to wildlife living in this area that are unable to flee as described above.

Implementing just the direct-use application would result in no disturbance of the 0.6 acres (approximately 0.2 ha) of previously disturbed land where the proposed power plant would have been located, therefore no wildlife would be affected in this area. The 2.7 acres (1.1 ha) of land where the new spent geothermal fluid pipeline and reinjection well would be constructed would result in impacts to wildlife living in this area that are unable to flee as described above.

Protected and Sensitive Species. Most of the construction activities (new freshwater well, new freshwater pipeline, and proposed power plant) would occur in previously disturbed areas characterized by parking lots, buildings, and bare ground. The reinjection well and associated pipeline construction would occur in habitat suitable for, although of marginal or low quality, for 1 state-listed plant, 2 state-listed amphibia, 1 state-listed snake, 3 state-listed birds. No state or federally protected species were observed during the pedestrian survey. Therefore, no impacts to these species are anticipated from the Proposed Action.

Implementing the proposed power plant component alone would result in the same level of disturbance to protected and sensitive species as discussed above for implementing both components. No impacts to protected or sensitive species are anticipated.

Implementing just the direct-use application would result in less disturbance than for the power plant component. The 0.6 acres (approximately 0.2 ha) of previously disturbed land where the proposed power plant would have been located would not be disturbed by the direct-use application component. No impacts to protected or sensitive species are anticipated.

4.4.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. The disturbance of approximately 9.3 acres (3.8 ha) of previously disturbed land associated with the Proposed Action would not occur. Hatchery activities would be expected to continue as they do presently. There would be no changes anticipated and therefore no potential for impacts to vegetation, wetlands, wildlife, or protected or sensitive species.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.5 CULTURAL RESOURCES

4.5.1 Proposed Action

Potential impacts to historic properties are assessed by applying the Criteria of Adverse Effect as defined in 36 CFR 800.5a. "An adverse effect is found when an action may alter the characteristics of a historic property that qualify it for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, workmanship, feeling, or association. Adverse effects may include reasonably foreseeable effects caused by the action

that may occur later in time, be farther removed in distance, or be cumulative." The Criteria of Adverse Effect provide a general framework for identifying and determining the context and intensity of potential impacts to other categories of cultural resources, as well, if these are present. Assessment of effects involving Native American or other traditional community, cultural or religious practices or resources requires focused consultation with the affected group.

The area of potential effect for the proposed power plant, injection well, pipelines and related facilities would be limited to the surveyed areas, much of which have been disturbed by prior activities. No historic properties or other significant cultural resources are present. The project would not disturb LA 88047; the nearest recorded archaeological site to the project area. There are no historic buildings and no known Native American or other cultural sites on or near the proposed project area which could be impacted directly or through an alteration of setting by the project. The Proposed Action would have no effect on any known cultural resources, although there does remain the remote possibility that subsurface archaeological resources could be encountered during construction excavations.

Implementing the proposed power plant component alone would result in the same level of disturbance as discussed above for implementing both components therefore, no effect on any known cultural resources are anticipated in the event that only the power plant is constructed. There does remain the remote possibility that subsurface archaeological resources could be encountered during construction excavations.

Implementing just the direct-use application would also result in slightly lesser amount of disturbance than discussed above for implementing both components, therefore, no effect on any known cultural resources are anticipated in the event that only the direct-use application is constructed. There does remain the remote possibility that subsurface archaeological resources could be encountered during construction excavations.

4.5.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. The disturbance of approximately 9.3 acres (3.8 ha) of previously disturbed land associated with the Proposed Action would not occur. Hatchery activities would be expected to continue as they do presently. There would be no effect on any known cultural resources.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.6 INFRASTRUCTURE

4.6.1 Proposed Action

The Proposed Action would involve a 200 percent increase in the use of freshwater by AmeriCulture. The current level of use for the hatchery operations and employee use is around 50 gpm (190 lpm). The cooling unit for the proposed power plant would require an additional 100 gpm (380 lpm) of freshwater. This increase would be supplied from an additional freshwater well drilled approximately 8,650 ft (2,640 m) to the west. This increase is within AmeriCulture's water rights. The water rights in the region have been set at a level that would result in minimal impact to the aquifer.

The wastewater from the AmeriCulture operations that is discharged to the containment pond would not change in quantity or character. Since the power plant would not require additional employees, the sanitary discharge would not change either. The wastewater from the power plant cooling tower skid would be blended with the spent geothermal fluid and piped to the reinjection well.

The inexpensive electrical power generated by the proposed power plant would be sold to AmeriCulture, Inc. by the generating entity (see Section 2.3.1). The use of the more expensive power from Columbus Electric (the local utility) consumed by AmeriCulture would be reduced to zero. While the power generated by the proposed power plant would be in excess of AmeriCulture's current power needs, AmeriCulture anticipates that implementation of their current expansion plans would result in their utilizing all of the power generated.

Until these plans are implemented, the generating entity could sell any excess power to Columbus Electric, if power surpluses, utility regulations, and economic considerations permit. The costs for any required safety, switching, transformer, or quality of service equipment and the amount of time between the capability to generate the power and the time AmeriCulture would need all of the generated power will affect the decision on whether to sell power to Columbus Electric. While the types and specifications of the needed equipment have not been detailed, any equipment that would be needed would be located next to the proposed power plant, just to the west of the turbines.

The power lines connected to the AmeriCulture site may not need any upgrades to accommodate the transmission of the generated power, should any be sold to Columbus Electric. Should upgrades to the existing power lines be needed, the upgrades could include replacement of the existing lines or addition of a new line. It is anticipated that the replacement line or additional line would be strung on the existing poles. The impacts of upgrading the lines on the exiting poles would be minor.

Implementing the proposed power plant component alone would result in the same level of impacts to infrastructure as discussed above for implementing both components. The additional 100 gpm (380 lpm) of freshwater would still be required for the cooling towers. The power generation and sale issues would be the same as discussed above.

Implementing just the direct-use application would result in no need for AmeriCulture to withdraw an additional 100 gpm (380 lpm) of freshwater. The withdrawal of freshwater would remain at 50 gpm (190 lpm). There would be no generation of electrical power. AmeriCulture would continue to use power from the local supplier. The potential upgrades for interconnection with Columbus Electric would not be necessary. Therefore, there would be no changes in infrastructure at AmeriCulture and no changes in infrastructure impacts.

4.6.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. AmeriCulture would continue to use power from the local supplier. There would be no changes in infrastructure at AmeriCulture and no changes in infrastructure impacts.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.7 NOISE

4.7.1 Proposed Action

The prediction of the noise effects of the Proposed Action includes those generated during construction and normal facility operation over the existing background noise. Other than workers at AmeriCulture, the primary receptor for noise would be the neighboring residence. There would be short-term noise from the construction activities. These would exceed the background noise levels in the area and would be noticeable at the residence. However, this noise would be temporary and the overall impact would be minor.

The turbine and cooling fans at the proposed power plant would be the largest source of long-term noise. The nearest offsite human receptor (person who would hear the noise) would be approximately 375 ft (114 m) from the turbines. Turbines and cooling tower fans can generate as much as 85 dB of noise at 3 to 5 ft (1 to 2 m) from the turbines (Exergy 2002). Workers at AmeriCulture would experience an increase in noise from around 60 dBA, to noise levels as high as 75 to 85 dBA, equivalent to the level of a noisy urban daytime environment. The neighboring residence could experience noise levels as high as 70 to 80 dBA. This receptor would also experience the rise in noise to an equivalent of a noisy urban daytime environment.

The determination as to whether an impact is significant with respect to noise is a qualitative assessment of the increase in noise level above background as experienced by those receptors near the source. A subjective response to changes in sound levels based upon judgements of sound presented within a short timespan indicate that a change of +/- 5 dBA may be quite noticeable, although changes that take place over a long period of time of this magnitude or greater may be "barely perceptible." Changes in sound levels of +/- 10 dBA within a short

timespan may be perceived as "dramatic" and changes in sound levels of +/- 20 dBA within a short timespan may be perceived as "striking". A qualitative assessment of dramatic and striking changes in sound level could be considered a significant impact.

While the noise from the turbine would not be short-term, and thus, the "noticeability" would be slightly reduced, the one nearby human receptor, which is at the residence that is approximately 375 ft (114 m) from the turbines, is likely to experience the increase in noise from around 50 dBA to around 75 dBA as "dramatic" or "striking". However, the noise would not be of a new type. The Burgett turbine power generator to the southeast already produces similar noise.

Implementing the proposed power plant component without the direct-use application component would result in the same level of noise impacts as discussed above for implementing both components. The neighboring residence could experience noise levels as high as 70 to 80 dBA.

If just the direct-use application were to be implemented, the turbine generator and cooling tower fans would not be built and would not be a source of noise. The direct-use application does not involve any large sources of noise. The noise level of current operations (around 60 dBA) would continue but would not increase. The noise level from AmeriCulture hatchery and Burgett greenhouse operations would remain at about 50 dBA at the nearby residence.

4.7.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. The current level of noise (around 60dBA) would continue. The noise level from AmeriCulture hatchery and Burgett greenhouse operations would remain at about 50 dBA at the nearby residence. There would be no changes in noise impacts from AmeriCulture operations.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.8 VISUAL RESOURCES

4.8.1 Proposed Action

The existing visual resources were discussed from two viewpoints, the neighboring residence and NM 338. The visual impacts of the proposed power plant facilities from the neighboring residence would include direct sight of the turbine generator and cooling tower skids in the foreground, as well as the steam plume in the foreground and midground. With a possible height of 33 ft (10 m) the stack would be the most visible equipment. The cooling towers at 25 ft (7.6 m) would also be visible. While there is an existing steam plume from the Burgett geothermal operations, the AmeriCulture steam plume would be closer, and therefore, more visible.

From the viewpoint of NM 338, the impacts to the mid-ground view of the proposed facilities would not be much of an addition to the impacts from the existing facilities. The addition of a second steam plume close to the first one would result in very minor impact to visual resources from this viewpoint.

Implementing the proposed power plant component alone would still include the turbine generator, stack, and cooling towers. The second steam plume would still be produced. The same level of impacts to visual resources would occur as discussed above for implementing both components.

Implementing just the direct-use application would not include the turbine generator, stack, or cooling towers. The second steam plume would not be produced. Also, the temporary visual resource impacts associated with construction dust would be reduced. The visual impacts would be the same as for current operations.

4.8.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. The power plant stack and cooling towers associated would not be built. There would be no additional facilities added to the visual foreground at AmeriCulture. There would be no second steam plume. Only the current steam plume from the Burgett greenhouse operations would be visible. There would be no changes in impacts to visual resources.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.9 LAND USE

4.9.1 Proposed Action

The current land use around the AmeriCulture site is a mix of grazing, commercial/light industrial, and residential. Regardless of whether both components of the Proposed Action (the power plant and direct-use application) are built, just the power plant component, or just the direct-use application component, the site would still be used for commercial/industrial purposes. The land use in the surrounding area would not change in any of these cases. Therefore, the construction of the power plant or the direct-use application would not affect land use in the AmeriCulture area.

4.9.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use

application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. No change in land use would occur

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects as discussed above would not involve a change in land use.

4.10 Socioeconomic Resources

4.10.1 Proposed Action

Potential impacts to socioeconomic resources are assessed by determining whether the action would substantially alter the location and distribution of populations, change populations at a rate that exceeds historic rates, decrease jobs so as to raise the regional unemployment rates or reduce income generation, substantially affect the local housing market, preclude the use of resources for other economically viable enterprises, result in the need to construct new schools or medical facilities or would affect the delivery of emergency and other community services.

The Federal involvement in partial funding of the proposed power plant, injection well, pipelines and related facilities would not result in any major socioeconomic changes. AmeriCulture is a family-run enterprise that currently has one regular outside employee, although additional temporary workers are sometimes used (Seawright 2002). Some temporary employment and additional goods and services from local vendors could be required during construction, but these minor inputs into the local economy would be temporary. Operation of the new facilities, as proposed, would not require permanent additions to the current workforce. The Proposed Action would therefore have little or no direct effect on population, demographics, employment, or availability of housing or community services. The geothermal resource in the area can support a limited amount of electrical generation or other uses near the source, but not a large-scale generation project. This action would not impact other viable uses of the resource in the area.

AmeriCulture has future plans to expand the aquaculture operations at the site. The timing and nature of any expansion would be dependent on permitting, the availability of water rights, the price of power, product markets, and other economic factors. To the extent that these factors can be projected, the Proposed Action may affect the timing and economic viability of these plans by, for example, lowering power costs or freeing other capital for the expansion. These expansion plans are not dependent on the Proposed Action. There could be substantial socioeconomic effects if a large expansion is undertaken, but these plans are not ripe for analysis here.

Implementing the proposed power plant component alone would result in the same level of impacts to socioeconomic resources as discussed above for implementing both components. Operation of the proposed power plant would not require permanent additions to the current workforce, and therefore, would have little or no direct effect on population, demographics, employment, or availability of housing or community services.

Implementing just the direct-use application would result in less temporary and minor involvement in the local economy for construction and materials than as described for the Proposed Action as a whole. Operation of the direct-use application would not require permanent additions to the current workforce, and therefore, would have little or no direct effect on population, demographics, employment, or availability of housing or community services.

4.10.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. No change in the current workforce, and therefore, no direct effect on population, demographics, employment, or availability of housing or community services would occur.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

4.11 ENVIRONMENTAL JUSTICE

4.11.1 Proposed Action

Environmental justice impacts occur if there are any disproportionately high and adverse human health or environmental effects on minority or low-income populations.

No significant impacts are expected from the Proposed Action or if either component were to be implemented alone. Therefore, no disproportionately high and adverse human health or environmental effects would be anticipated to the minority or low-income populations in the project study area.

4.11.2 No Action Alternative

Under the No Action Alternative, DOE would not provide funds for either the proposed power plant or the direct-use application. Neither the proposed power plant nor the direct-use application would be built as part of a Federal Action. No changes attributed to direct Federal financial assistance under this program would occur at the AmeriCulture site. Hatchery activities would be expected to continue as they do presently. There would be no changes anticipated and therefore no potential for disproportionately high and adverse human health or environmental effects to the minority or low-income populations in the project study area.

While the partial funding from DOE would not be granted, it is possible that other sources of funding, including private funds, could be obtained by AmeriCulture to build either, or both, of these projects. In that case, the projects and their impacts could occur anyway. The timing and nature of any expansion would be dependent on financial factors and the aquaculture market.

5.0 CUMULATIVE IMPACTS

Impacts from Proposed Action. The Proposed Action would add a new approximately 1 MW geothermal power plant and a direct-use application to heat water for fish tanks at the AmeriCulture fish hatchery. The AmeriCulture site currently uses a downhole heat exchanger in a geothermal well to heat freshwater for the hatchery operations. The addition of the proposed power plant and direct-use application would allow AmeriCulture to operate with less energy (electricity) costs.

The impacts of the Proposed Action include disturbance of 9.3 acres (3.8 ha) of land, 2.7 acres (1.1 ha) of which is land disturbed only by grazing activities. The new pipeline to the new injection well would cross over the shallow dry wash to the north of the project site. The injection water pipeline would be built on blocks or post to allow for thermal expansion and contraction of the pipe. Since the area is so flat and the wash becomes indistinguishable from sheetflow features just to the west, the small amount of temporary effects to the wash during vehicle crossings would be minor. The impacts to biological resources would be minor and not expected to adversely affect any plant or animal populations or communities. No historic properties or other significant cultural resources are present in the areas that would be disturbed. The current land use around the AmeriCulture site, a mix of grazing, commercial/light industrial, and residential, would not change.

The air quality would be slightly affected by the Proposed Action by exhaust emissions during construction; minor intermittent emissions of ammonia from the turbines and during deliveries; and small amounts of hydrogen sulfide and carbon dioxide released from the injection well. The turbine and cooling fans at the proposed power plant would be the largest source of long-term noise. The nearest human receptor would experience an increase in noise levels from around 50 dBA to a level as high as 70 to 80 dBA. The visual impacts of the proposed power plant facilities from the neighboring residence would include direct sight of the turbine-generator and cooling tower skids and the steam plume. From the viewpoint of NM 338, the addition of a second steam plume close to the first one would result in very minor impact to visual resources from this viewpoint.

The AmeriCulture facilities currently use 50 gpm (190 lpm) of freshwater. The Proposed Action would involve a 300 percent increase in the use of freshwater by AmeriCulture. This increase would be supplied from an additional freshwater well.

The Proposed Action would involve pumping approximately 1,000 to 1,200 gpm (approximately 3,800 to 4,500 lpm) of 232°F (111°C) geothermal fluid from the subsurface geothermal resource. The drawdown at the well was calculated to be approximately 60 ft (18 m) after 20 years of continuous pumping. Continuous pumping of Burgett "B" State well at 1,000 gpm (approximately 4,000 lpm) for 20 years could result in an additional 30 ft (approximately 9 m) drawdown at the AmeriCulture State 1 well. The construction of the AmeriCulture State 1 well and the existing nearby production wells appear adequate to tolerate the drawdowns that would result from withdrawal of geothermal waters at AmeriCulture. Therefore, it appears that the portion of the Lightning Dock KGRA in the vicinity of the AmeriCulture facility would likely be able to supply power to the AmeriCulture facility without substantially degrading the capacity of the resource in the long term.

The cooling tower blowdown water would be mixed with the spent geothermal water and reinjected into the geothermal aquifer where the groundwater temperature would match that of the geothermal water/blowdown water mixture. Impacts to the temperature and quality of the water in the Lightning Dock KGRA resulting from injection are therefore anticipated to be negligible.

The electrical power from the proposed power plant would be used by AmeriCulture. The amount of power from Columbus Electric (the local utility) consumed by AmeriCulture would be reduced to zero. It is anticipated that the power generated by the proposed power plant would be in excess of AmeriCulture's current power needs. Current plans are to sell the excess power to Columbus Electric, a member of Tri-State.

The Federal involvement in partial funding of the proposed power plant, injection well, pipelines and related facilities would result in some temporary employment but would not require permanent additions to the current workforce. The Proposed Action would not result in any major socioeconomic changes.

Other Projects in the Area. The largest single greenhouse operation in the United States is a neighbor to the proposed project. Burgett Geothermal Greenhouses, Inc., grows cut roses using the heat and power generated from the Lightning Dock geothermal resource. The Burgett greenhouse operation was included in the assessment of the existing environment.

Other DOE offices have provided initial partial funding for two other projects in the Lightning Dock KGRA. The first action involves drilling wells into the deep part of the geothermal resource where limited fluid is present, injecting water inot one well, and collecting heated fluid at a nearby well (See Appendix C). If this project proves successful, DOE would consider providing additional unding for construction of a power plant using that geothermal resource, which is deeper than the resource that would be utilized by the Exergy/AmeriCulture project. The proposed system would involve limited removal of fluid from the deeper reservoir.

The second action proposes to develop a 6 MW "combined technologies project" where two geothermal systems would be used to provide heated fluid to generate power. A typical intermediate-depth geothermal system at a depth of 1,200 to 3,000 ft (360 to 900 meters) and a deeper system at 3,000 to 4,000 ft (900 to 1,200 meters) where water would be injected into the hot rock to be heated and extracted at a nearby well. Initial phases of work on these project are being conducted to determine their technical feasibility. DOE will consider providing additional funding for these projects pending the outcome of the feasibility determination.

Two electrical power plants are planned for development in the region of the Proposed Action. Neither of these power plants is planned to use geothermal resources. Tri-State plans to build a 142 MW gas-fired peaking power plant near Lordsburg. Construction is expected to start in 2002, with operations beginning in 2003. Construction would require 175 jobs, while operation would require up to 4 full time employees.

The Public Service Company of New Mexico plans to increase its generating capacity in southern New Mexico by building an 80-MW gas-fired power plant near Lordsburg. Construction is set to begin in January 2002 and operations to begin in July 2002. The capacity would be used to meet the needs of the Public Service Company of New Mexico customers and

excess would be sold on the wholesale market (Journal 2002). An estimated 200 to 300 construction jobs would be involved, but only 6 full time employees.

Irreversible and Irretrievable Commitment of Resources. This section describes the major irreversible and irretrievable commitments of resources that can be identified at the level of analysis conducted for this EA. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource or limit those factors that are renewable only over long periods of time. Examples of nonrenewable resources are minerals, including petroleum, and cultural resources.

An irretrievable commitment of resources refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations. Examples of irretrievable resources are the loss of production, harvest, or recreational use of an area. While an action may result in the loss of a resource that is irretrievable, the action may be reversible. For instance paving over farmland results in the irretrievable loss of harvests from that land. However, the parking lot could be removed and crops grown again. Hence, the action is reversible.

The construction and operations of the proposed power plant and the direct use application at AmeriCulture would require the irreversible and irretrievable commitment of building materials.

The cooling water used by the proposed power plant would be a minor irretrievable consumption of water. Up to 100 gpm (approximately 380 lpm) of freshwater would be used in the cooling tower. Some would be reinjected, however, the remainder would be lost through evaporation. The use of the geothermal water and heat represent a larger irretrievable impact to the geothermal resource. However, the same amount of geothermal fluid used will be reinjected and the resource's heat production potential greatly exceeds the proposed use. Both the geothermal fluid and heat would likely recover soon after the proposed use by AmeriCulture ceased.

Relationship Between Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity. The actual construction of the proposed power plant and direct use application at AmeriCulture would result in the short term disturbance of the ground immediately surrounding the location of the wells, pipelines, and power plant skid. The operation of the power plant and direct use require short-term use of freshwater, geothermal fluid, and heat. The power provided by the proposed action would cause overall enhancements of the long-term productivity of the AmeriCulture operations. While causing some short-term disruption and use of resources, the information gained from the operation of the power plant would provide for long-term improvement of knowledge of the geothermal resource and the feasibility of small-scale low-temperature geothermal power plants.

6.0 AGENCY CONTACTS

Below is a list of agencies that have been contacted for information in support of the environmental assessment.

6.1 FEDERAL AGENCIES

- New Mexico Ecological Field Office
  U. S. Fish and Wildlife Service

- Albuquerque District
  U.S. Army Corps of Engineers

- El Paso Field Office
  Albuquerque District
  U.S. Army Corps of Engineers

6.2 STATE AGENCIES

- New Mexico Department of Game & Fish

- New Mexico Oil Conservation Division

- New Mexico State Land Office

- Museum of New Mexico, Archaeological Records Management System

- New Mexico State Historic Preservation Office

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APPENDIX A

GLOSSARY OF TERMS:

Acre-foot	A unit of measurement used to describe volumes of water. 1 ac-ft is 1 foot of water covering a land area of 1 acre (approximately 325,000 gallons [1,230,000 liters]).
Acre	A unit of measurement used to define area. 1 acre = 0.405 hectares
Air Quality	The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare. Air quality is often expressed in terms of the pollutant for which concentrations are the highest percentage of a standard (e.g., air quality may be unacceptable if the level of one pollutant is 150% of its standard, even if levels of other pollutants are well below their respective standards).
Alkali	A soluble salt or mixture thereof present in some soils of arid regions due to high evaporation rates.
Alluvial	A process of land morphology caused by water.
Ambient	Natural condition of the environment at any given time.
Anastomosing	A pattern of stream formation visibly similar to a braid.
Aquifer	A body of rock or sediment that is capable of transmitting groundwater and yielding usable quantities of water to wells or springs. *EPA regulations define "aquifer" as follows (different regulations vary slightly in wording):* An underground geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to wells or springs.
Axial	Extending in a direction essentially perpendicular to the plane of a cyclic structure (wheel spokes).
Basalt	A type of igneous rock seen in lava flows.
Basin	A hydrologic area that is bounded by geographic features whereby any water falling within its boundary will be drained internally.
Baseload Plants	Electricity generating units that are operated to meet the constant or minimum load on the system. The cost of energy from such units is usually the lowest available to the system.
Benchmark	A fixed point on the earth's surface from which measurements can be made over great temporal separation.
Binary-Cycle Plant	A geothermal electricity generating plant employing a closed-loop heat exchange system in which the heat of the geothermal fluid (the "primary fluid") is transferred to a lower-boiling-point fluid (the "secondary" or "working" fluid), which is thereby vaporized and used to drive a turbine/generator set.
Bound	Something that limits or restrains. Confine.
Breccia	A sedimentary rock that is formed by the compaction of angular, broken particles into a greater mass.

Brine	A geothermal solution containing appreciable amounts of sodium chloride or other salts.
BTU	British thermal unit. The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at standard conditions. (Equal to 252 calories)
Caldera	A volcanic landform created by the collapse of a composite volcanic summit into the evacuated magma chamber. It has the appearance of a cauldron or basin.
Capillary Action	The action of molecules of a liquid, usually water, adhering to a media thereby traveling along the surface until cohesion becomes stronger than adhesion.
Cap Rocks	Rocks of low permeability that overlie a geothermal reservoir.
Cascading Heat	A process that uses a stream of geothermal hot water or steam to perform successive tasks requiring lower and lower temperatures.
Channel	A confined pathway that can carry liquids within banks across a landscape.
Clastic	Made up of fragments of preexisting rocks.
Condensate	Water formed by condensation of steam.
Condenser	Equipment that condenses turbine exhaust steam into condensate.
Confined	Entirely bounded.
Conglomerate	A sedimentary rock formed by the compaction of rounded to sub-rounded particles into a greater mass.
Cooling Tower	A structure in which heat is removed from hot condensate.
Coprolites	Preserved human feces.
Critical habitat	Habitat essential to the conservation of an endangered or threatened species that has been designated as critical by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the Endangered Species Act and its implementing regulations (50 *CFR* 424). (See endangered species and threatened species.) The lists of Critical Habitats can be found in 50 CFR 17.95 (fish and wildlife), 50 CFR 17.96 (plants), and 50 CFR 226 (marine species).
Crust	Earth's outer layer of rock. Also called the lithosphere.
Cumulative Impacts	Impacts on the environment that result when the incremental impact of a proposed action is added to the impacts from other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes the other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
Decibel	A unit for expressing the relative intensity of sounds on a logarithmic scale from zero for the average least perceptible sound to about 130 for the average level at which sound causes pain to humans. For traffic and industrial noise measurements, the A-weighted decibel (dBA), a frequency-weighted noise unit, is widely used.

	The A-weighted decibel scale corresponds approximately to the frequency response of the human ear and thus correlates well with loudness.
Detritus	Loose material that results directly from disintegration.
Direct Use	Use of geothermal heat without first converting it to electricity, such as for space heating and cooling, food preparation, industrial processes, etc.
District Heating	A type of direct use in which a utility system supplies multiple users with hot water or steam from a central plant or well field.
Downtime	The period of time in which a facility would not be operational.
Drawdown	The result of well pumping which removes water at the pump head faster than it can migrate to the area resulting in a cone of depression.
Drilling	Boring into the earth to access geothermal resources, usually with oil and gas drilling equipment that has been modified to meet geothermal requirements.
Dry Steam	Very hot steam that doesn't occur with liquid.
Duripan	A subsurface soil horizon that is cemented by illuvial silica, usually opal or microcrystalline forms of silica, to the degree that less than 50 percent of the volume of air-dry fragments will slake in water or HCl.
Efficiency	The ratio of the useful energy output of a machine or other energy-converting plant to the energy input.
Endangered Species	Plants or animals that are in danger of extinction through all or a significant portion of their ranges and that have been listed as endangered by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the Endangered Species Act and its implementing regulations (50 CFR 424). (See threatened species.) The lists of endangered species can be found in 50 CFR 17.11 (wildlife), 50 CFR 17.12 (plants), and 50 CFR 222.23(a) (marine organisms). *Note: Some states also list species as endangered. Thus, in certain cases a state definition would also be appropriate.*
Enhanced Geothermal Systems	Rock fracturing, water injection, and water circulation technologies to sweep heat from the unproductive areas of existing geothermal fields or new fields lacking sufficient production capacity.
Environmental Assessment (EA)	A concise public document that a Federal agency prepares under the National Environmental Policy Act (NEPA) to provide sufficient evidence and analysis to determine whether a proposed agency action would require preparation of an environmental impact statement (EIS) or a finding of no significant impact. A Federal agency may also prepare an EA to aid its compliance with NEPA when no EIS is necessary or to facilitate preparation of an EIS when one is necessary. An EA must include brief discussions of the need for the proposal, alternatives, environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted. [See finding of no significant impact, environmental impact statement, and National Environmental Policy Act.]
Environmental Justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation,

	and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations. (See minority population and low-income population.)
Ephemeral	Lasting a very short time. Often used to define a short lived stream.
Epicenter	The location at the earth's surface which is centrally located above the seismic center of an earthquake movement.
Evaporate	The phase change of a liquid to a gas whereby the volume of liquid is reduced due to loss to the atmosphere.
Evapotranspiration	The combined loss of water from a given area, and during a specified period of time, by evaporation from the soil surface and by transpiration from plants.
Facies	A part of rock or group of rocks that differs from the whole formation (as in composition, age, or fossil content).
Fault	A fracture or fracture zone in the Earth's crust along which slippage of adjacent Earth material has occurred at some time.
Flash Stream	Steam produced when the pressure on a geothermal liquid is reduced. Also called flashing.
Fluvial	The deposition of material by moving water.
Square-Foot	An English unit of measurement used to define area. 1 ft^2 = 0.093 m^2.
Fumarole	A vent or hole in the Earth's surface, usually in a volcanic region, from which steam, gaseous vapors, or hot gases issue.
Geothermal	Of or relating to the Earth's interior heat.
Geothermal Energy	The Earth's interior heat made available to man by extracting it from hot water or rocks.
Geothermal Fluid	Fluid pumped from the ground to be used in an application where potable water is not achievable. Often there are high total dissolved solids in geothermal fluid.
Geothermal Gradient	The rate of temperature increase in the Earth as a function of depth. Temperature increases an average of 1° Fahrenheit for every 75 feet in descent.
Geothermal Heat Pumps	Devices that take advantage of the relatively constant temperature of the Earth's interior, using it as a source and sink of heat for both heating and cooling. When cooling, heat is extracted from the space and dissipated into the Earth; when heating, heat is extracted from the Earth and pumped into the space.
Geyser	A spring that shoots jets of hot water and steam into the air.

Geysers, The	A large geothermal steam field located north of San Francisco.
Graben	A block of the earth's crust separated by faults from adjacent relatively lifted blocks (horsts).
Groundwater	Water below the ground surface in a zone of saturation.
Heat Flow	Movement of heat from within the Earth to the surface, where it is dissipated into the atmosphere, surface water, and space by radiation.
Hectare	A measure of area equal to 10,000 square meters or 2.47 acres.
Horst	A block of the earth's crust separated by faults from adjacent relatively depressed blocks (grabens).
Hydrothermal Resources	Underground systems of hot water and/or steam.
Igneous	A type of rock that is formed from by the solidification of intrusive or extrusive magma.
Indurated	The process of hardening.
Inholdings	Ownership of land partially or completely contained within a land area owned or managed by another.
Injection	The process of returning spent geothermal fluids to the subsurface. Sometimes referred to as reinjection.
Intermittent	Occurring occasionally. Not constant.
Intermontane	Situated between mountains.
KGRA	Known Geothermal Resource Area. A region identified by the U.S. Geological Survey as containing geothermal resources.
Kilowatt	A unit of electric power equal to 1,000 watts. Abbreviated kW.
Kilowatt-Hour	The energy represented by 1 kilowatt of power consumed for a period of 1 hour, equal to 3,413 BTU's. Abbreviated kWh.
Load	The simultaneous demand of all customers required at any specified point in an electric power system.
Low-Income Population	Low-income populations, defined in terms of Bureau of the Census annual statistical poverty levels (Current Population Reports, Series P-60 on Income and Poverty), may consist of groups or individuals who live in geographic proximity to one another or who are geographically dispersed or transient (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. (See environmental justice and minority population.)
Magma	Molten rock within the Earth, from which igneous rock is formed by cooling.

Magnitude	A number representing the intrinsic or apparent intensity of an earthquake on a logarithmic scale.
Mantle	The Earth's inner layer of molten rock, lying beneath the Earth's crust and above the Earth's core of liquid iron and nickel.
Megawatt	A unit of electrical measurement equal to 1,000 kilowatts.
Metamorphic	A type of rock formed by recrystalization of an existing rock either by heat or by pressure.
Meteorological	Of relating to the atmosphere and weather.
Meter	A unit of metric measurement used to define distance. 1 meter = 3.3 feet.
Minority Population	Minority populations exist where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than in the general population or other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority" refers to individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. "Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. (See environmental justice and low-income population.)
National Environmental Policy Act of 1969 (NEPA)	NEPA is the basic national charter for protection of the environment. It establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. Section 102(2) contains "action-forcing" provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information.
Normal Fault	A fault in which the hanging wall has been displaced downward in relation to the footwall.
Orogeny	The process of mountain building involving non-uniform movement of faults and plates comprising the lithosphere, usually associated with plate tectonics.
Particulate Matter	Any finely divided solid or liquid material, other than uncombined (i.e., pure) water. A subscript denotes the upper limit of the diameter of particles included. Thus, PM_{10} includes only those particles equal to or less than 10 micrometers (0.0004 inch) in diameter; $PM_{2.5}$ includes only those particles equal to or less than 2.5 micrometers (0.0001 inch) in diameter.
Peaking Plants	Electricity generating plants that are operated to meet the peak or maximum load on the system. The cost of energy from such plants is usually higher than from baseload plants.

Perennial	Year long.
Permeability	The capacity of a substance (such as rock) to transmit a fluid. The degree of permeability depends on the number, size, and shape of the pores and/or fractures in the rock and their interconnections. It is measured by the time it takes a fluid of standard viscosity to move a given distance. The unit of permeability is the Darcy.
pH	A unit of measurement depicting the reactivity of a substance. A pH below 7.0 is acidic, while a pH above 7.0 is basic or alkaline. 7.0 is neutral.
Physiographic	A conjunction of physical geography used to define distinct demarcations of land. A region all parts of which are similar in geologic structure and climate and which has consequently had a unified geomorphic history. A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.
Piedmont	The eroded flank of a mountain that forms a curtain of debris at the toe slope.
Plate Tectonics	A theory of global-scale dynamics involving the movement of many rigid plates of the Earth's crust. Tectonic activity is evident along the margins of the plates where buckling, grinding, faulting, and volcanism occur as the plates are propelled by the forces of deep-seated mantle convection currents. Geothermal resources are often associated with tectonic activity, since it allows groundwater to come in contact with deep subsurface heat sources.
Pleistocene	A period in geologic time generally associated with the ice age.
Plume	The elongated volume of contaminated water or air originating at a pollutant source such as an outlet pipe or a smokestack. A plume eventually diffuses into a larger volume of less contaminated material as it is transported away from the source.
Plutonic Bodies	A typically large mass of intrusive igneous rock.
Pluvial	Originally a term used to describe mesic conditions; has come to be commonly used to describe Pleistocene lakes.
Porosity	The ratio of the aggregate volume of pore spaces in rock or soil to its total volume, usually stated as a percent.
Pyroclastic	Formed by or involving fragmentation as a result of volcanic or igneous action.
Relative Humidity	The percent saturation of water vapor in a given air mass relative to what the air mass is capable of holding. Relative humidity is based on temperature whereby the warmer an air mass becomes, the greater amount of water vapor it is capable of storing. If an air mass cools, the percent saturation relative to the cooling air masses storage capacity will increase up to 100 % (dew point), then condensation of the vapor will occur.
Relict	A relief feature or rock remaining after other parts have disappeared.
Reservoir	A natural surface or underground container of liquids, such as water or steam (or, in the petroleum context, oil or gas).
Salinity	A measure of the quantity or concentration of dissolved salts in water.

Scoping	An early and open process for determining the scope of issues to be addressed in an environmental impact statement (EIS or EA) and for identifying the significant issues related to a proposed action.
Sedimentary	A type of rock that is formed by the compaction and compression of detritus.
Seismic	Of, subject to, or caused by an earthquake.
Semiconfined	Partially bounded.
Sheetflow	The action of water flowing in a sheet-like manner rather than channelized.
Sheetwash	See Sheetflow.
Subbasin	A basin that is wholly encapsulated within a larger basin.
Subsidence	A sinking of an area of the Earth's crust due to fluid withdrawal and pressure decline.
Surface Water	All bodies of water on the surface of the earth and open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, and estuaries.
Surplus	Excess.
TDS	Total dissolved solids. Used to describe the amount of solid materials in water.
Tectonic	The action of land formation due to geological and structural catalysts.
Temperature Inversion	The atmospheric process of warm air capping cool air below it resulting in a highly stable atmosphere and a lack of vertical air circulation. Often times, temperature inversions are associated with high levels of atmospheric pollution and typically are not displaced until the arrival of the next storm system.
Thermal Gradient	The rate of increase or decrease in the Earth's temperature relative to depth.
Threatened Species	Any plants or animals that are likely to become endangered species within the foreseeable future throughout all or a significant portion of their ranges and which have been listed as threatened by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures set out in the Endangered Species Act and its implementing regulations (50 CFR 424). (See endangered species.) The lists of threatened species can be found at 50 *CFR* 17.11 (wildlife), 17.12 (plants), and 227.4 (marine organisms). *Note: Some states also list species as threatened. Thus, in certain cases a state definition would also be appropriate.*
Topographic Relief	The existence and character of land height differences from one location to another.
Transmission Line	Structures and conductors that carry bulk supplies of electrical energy from power-generating units.
Transmissivity	The ability for a media to transmit a substance from one location to another.

Tuff	A rock composed of the finer kinds of volcanic detritus usually fused together by heat.
Turbine	A bladed, rotating engine activated by the reaction or impulse, or both, of a directed current of fluid. In electric power applications, such as geothermal plants, the turbine is attached to and spins a generator to produce electricity.
Unconfined	Without bounds.
Unconsolidated	Lacking internal strength and firmness.
Vapor-Dominated	A geothermal reservoir system in which subsurface pressures are controlled by vapor rather than by liquid. Sometimes referred to as a dry-steam reservoir.
Well Logging	Assessing the geologic, engineering, and physical properties and characteristics of geothermal reservoirs with instruments placed in the wellbore.
Wetlands	Those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas (e.g., sloughs, potholes, wet meadows, river overflow areas, mudflats, natural ponds). *Jurisdictional wetlands* are those wetlands protected by the Clean Water Act. They must have a minimum of one positive wetland indicator from each parameter (i.e., vegetation, soil, and hydrology). The U.S. Army Corps of Engineers requires a permit to fill or dredge jurisdictional wetlands.

APPENDIX B

TETRA TECH, INC.

One Towne Centre
6121 Indian School Road N.E., Suite 205
Albuquerque, New Mexico 87110
(505) 881-3188 Main Number
(505) 881-3283 FAX

January 30, 2002

TTAL-LTR-02-003

Ms. Joy Nicholopoulos
Field Supervisor
New Mexico Ecological Services Field Office
Fish and Wildlife Service
2105 Osuna NE
Albuquerque, NM 87113

RE: Comments of Concern and a List of Federally Listed Threatened and Endangered Species for a Portion of Hidalgo County, NM.

Dear Joy Nicholopoulos:

Tetra Tech is preparing an environmental assessment for the National Renewable Energy Lab for the building of a proposed small-scale (~1 Mw) geothermal power plant approximately 5 miles north-northeast of Cotton City, New Mexico in Hidalgo County. Included are a project description and project maps which indicate projected site layout.

We would appreciate receiving a list of animal species receiving Federal protection that your records indicate may be in the vicinity of the project area. Also, we would value any comments of concern you may have regarding these listed species. This information will be of assistance in preparing the environmental assessment and a related biological report.

Please contact me at the above address, or at 881-3188 if you have any questions.

Sincerely,

Cliff Jarman
Project Manager

Attachments: As stated

FILE: USFWS letter.doc

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

April 9, 2002

Cons. # 2-22-02-I-317

Mr. George K. Pratt
Tetra Tech, Inc.
One Towne Centre
6121 Indian School Road NE, Suite 205
Albuquerque, New Mexico 87110

Dear Mr. Pratt:

This responds to your April 2, 2002, fax requesting information on threatened or endangered species or important wildlife habitats that could be affected by the Department of Energy's National Renewable Energy Lab for the proposed construction of a small-scale geothermal power plant approximately 5 miles north-northeast of Cotton City, Hidalgo County, New Mexico.

We have enclosed a current list of federally-endangered, threatened, candidate species, and species of concern that may be found in Hidalgo County, New Mexico. Additional information about these species is available on the internet at <http://nmrareplants.unm.edu>, <http://nmnhp.unm.edu/bisonm/bisonm.cfm>, and <http://ifw2es.fws.gov/endangeredspecies>. Under the Endangered Species Act, as amended (Act), it is the responsibility of the Federal action agency or its designated representative to determine if a proposed action "may affect" any threatened, endangered, or proposed species, or critical habitat, and if necessary, to consult with us further. If your action area has suitable habitat for any of these species, we recommend that species-specific surveys be done during the appropriate flowering/breeding season to evaluate any possible project-related impacts.

Candidates and species of concern have no legal protection under the Act and are included in this document for planning purposes only. We monitor the status of these species. If significant declines are detected, these species could potentially be listed as endangered or threatened. Therefore, actions that may contribute to their decline should be avoided. We recommend that candidates and species of concern be included in your surveys.

Under Executive Order 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance their natural and beneficial values. We recommend you contact the U.S. Army Corps of Engineers for permitting requirements under Section 404 of the Clean Water Act if your proposed action could impact wetlands. These

habitats should be conserved through avoidance, or mitigated to ensure no net loss of wetlands functions and values.

The Migratory Bird Treaty Act (MBTA) provides a year-round no hunting season for non-game birds and prohibits the taking of migratory birds, nests, and eggs, except as permitted. To minimize the likelihood of adverse impacts to all birds protected under the MBTA, we recommend construction activities occur outside the general migratory bird nesting season of March through August, or that areas proposed for construction during the nesting season be surveyed, and if necessary, avoided until nesting is complete.

Please keep in mind that the scope of federally-listed species compliance also includes any interrelated or interdependent project activities (e.g., equipment staging areas, offsite borrow material areas, or utility relocations) and any indirect and cumulative effects. We suggest you contact the New Mexico Department of Game and Fish, and the New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division for information regarding fish, wildlife, and plants of State concern.

Thank you for your concern for endangered species and New Mexico's wildlife habitats. If you have any questions, please contact Delfinia Montaño at the letterhead address or at (505) 346-2525, ext. 117.

Sincerely,

Joy E. Nicholopoulos

Joy E. Nicholopoulos
Field Supervisor

Enclosure

cc: (w/o enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

TETRA TECH NUS, INC.
2300 Buena Vista S.E. ▪ Suite 110 ▪ Albuquerque, N.M. 87106
(505) 247-4933 ▪ FAX (505) 247-8151 ▪ www.tetratech.com

April 3, 2002

Cliff Jarman, Project Manager
Tetra Tech Inc.
One Towne Centre
6121 Indian School Road NE
Suite 205
Albuquerque, NM 87110

Dear Mr. Jarman:

Enclosed you will find five copies of the report entitled *Cultural Resource Survey for a Proposed Geothermal Development Near Cotton City, Hidalgo County, New Mexico*. Also enclosed are five copies of the NMCRIS Laboratory of Anthropology investigation record.

It has been a pleasure doing this project for you; please let me know if you need assistance on any future projects.

Sincerely,

Katherine J. Roxlau
Cultural Resource Specialist

Enclosures

APPENDIX C

Description of Flow Enhancement Technologies. In the petroleum industry, acidization is a treatment often used to increase reservoir permeability in carbonate rocks, and/or to remove near-wellbore drilling damage. An acidic fluid, typically a solution of hydrochloric acid, is pumped into an isolated portion of the wellbore to partially dissolve and open up new or existing fractures, or to enhance the near-wellbore permeability. The acidization work associated with the development of our EGS reservoir in carbonate rocks will be done by an experienced oilfield service company (Halliburton or equivalent) and should provide an initial indication of the potential for increasing the natural flow of this deeper geothermal zone. It will be carried out in our first (characterization) wellbore at depths between 1500-2100 ft, a region believed to consist of porous and fractured limestone mixed with other rock types. Prior to conducting the acidization work (and subsequent hydraulic fracturing), cores obtained from the continuously cored interval from 1500 to 2100 ft will be examined to provide assurance that the rocks within this target interval can be developed into a suitably productive reservoir using EGS techniques, and more specifically that the planned acidization treatment will be successful in enhancing the formation permeability.

Hydraulic stimulation (fracturing) will also be employed to improve the lateral permeability of the reservoir interval between 1500 to 2100 feet. The objective is to better connect the production well – through the interval of vuggy and fractured limestone -- to the natural system of near-vertical faults and fractures occurring in this region that provide the principal conduits for the upward flow of hot geofluid. Hydraulic fracturing has been employed to a limited extent in the conventional (i.e., hydrothermal) geothermal industry in the past, but concerns about impairing the productivity of the naturally fractured reservoirs by creating leakage paths or direct short circuit paths from injection to production wells have always dominated decisions regarding the extent to which this method of stimulation has been used.

Prior to commencing hydraulic fracturing operations, in order to preclude any degradation to the existing shallow geothermal system, we will carefully case and cement a string of surface casing through the current fractured rhyolite producing interval at about 300 feet, and extending beyond this interval to a final depth of 600 feet. We will then conduct hydraulic fracturing operations at pressures higher than those typical of commercial geothermal operations to date. Our team possesses considerable expertise in high-pressure hydraulic fracturing as a result of direct experience with hot dry rock (HDR) fracturing operations in the US and elsewhere.

Extracted from AmeriCulture, Inc. Internal Document

Our overall plan is to develop a *vertical* EGS system with the cooled geofluid injected into a deeper region of competent limestone, capturing heat from the surrounding rock as it flows upward through the induced system of hydraulic fractures toward the principal reservoir interval between 1500 and 2100 feet, then mixing with the upwelling geofluid also flowing into this interval. This in not unlike the operation of the current HDR project at Soultz (the European Community HDR project at Soultz-sous-Forets in France), where the cooled geofluid is returned to the reservoir to mix with the naturally occurring hot fluids before production at the surface under the action of a submersible pump. (At Soultz, the injection rate is equal to the production rate, but tracer testing indicates that only a small portion of the reinjected fluid is returned to the surface at any one time.).

Experience in the US, Japan and Europe, where high-pressure hydraulic fracturing has been employed to enhance natural geofluid productivity in conjunction with numerous HDR [or more properly, hot wet rock (HWR) projects], indicates that the induced fracture systems almost always develop in near-vertical directions. For this reason, the relatively small horizontal separation between our two wellbores should not be a disadvantage, since a near-vertical system of open hydraulic fractures should adequately connect the deep injection well to the production well through the intervening vuggy limestone interval, with the injected fluid considerably augmented by the natural upward flow of hot geofluid in nearby natural faults and fractures. To gain the fullest possible understanding of our fracture-enhanced system, we will utilize microseismic monitoring to follow the course of our fracturing operations and employ tracer testing during the initial flow testing of our completed system.

Operation of the EGS System. During circulation, pressure will be maintained at levels high enough to inject all of the spent geofluid. To a degree, the required pressure will be dependent on the specific characteristics of the fracture system, but our experience indicates that it should be on the order of 1,000 psi or less for a system at this depth. Experience at HDR sites around the world further indicates that pressure-propped fracture systems are in a constant state of flux as circulation proceeds, with cooler pathways closing off and new pathways developing. We expect this to be the case for our system and will confirm that fact by periodic tracer testing. We thus anticipate that our system will be a true "heat mining" operation with our recirculated fluid drawing thermal energy from portions of the hot rock in the reservoir that would not be accessible to geothermal fluids under naturally existing pressure and flow conditions. We will further employ a downhole pump after the manner

of the European HDR Project currently underway at Soultz in northeastern France to enhance our geofluid production rate to reach the required 950,000 pounds of fluid per hour (about 1900 gpm at ambient temperatures) for our power plant feed. Our water will be rejected from the plant at 200°F. About 10% of the produced geofluid will be lost to the atmosphere via the cooling towers of the power plant. The remaining 90% will be used for thermal applications in the AmeriCulture fish-rearing facility after being rejected from the power plant and prior to reinjection into the reservoir. Based on previous experience with this reservoir and recent flow testing described below, we anticipate the net water withdrawal of about 200 gpm will be well within the long-term sustainable limits of productivity for this reservoir.

The Power Plant. The geothermal resource that is presently available at the AmeriCulture site is 232°F, but the goal of our EGS project is to achieve temperatures of 300°F. In preparing this project plant, we have therefore looked at power plant performance over a resource temperature range of 230 to 300°F.