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Compilation of Reports

Geothermal Feasibility Study

Prepared for Pueblo of Jemez
Jemez, New Mexico

Prepared By:
McNeil Technologies Inc.

Subcontractor to New Mexico State University

Contract

US Department of Energy
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April 2004

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Executive Summary

The material in this document represents several reports, presentations and all of the relevant electronic files developed for the use of Pueblo of Jemez personnel. The intent of the overall project was to prepare a business plan for the beneficial use of the geothermal resources. To prepare the business plan we first worked with Pueblo of Jemez personnel including the tribal council to learn about the interests and needs of the tribe. This effort was undertaken to determine applicable businesses that were compatible with tribal capabilities as well as offered beneficial economic development opportunities.

We held one workshop, lead by personnel from New Mexico State University, Southwest Technology Development Institute to provide education and material to Pueblo of Jemez personnel. Sandia National Laboratories personnel also collaborated on the workshop. We also had a three-day field trip to inspect geothermal sites in southern New Mexico. We visited geothermal greenhouses in Las Cruces, Radium Springs, and Cotton City. We also visited aquaculture facilities in Las Cruces and Cotton City. The objectives for both the workshop and field trip were to introduce Pueblo of Jemez personnel to geothermal resources, technologies, and business opportunities.

To prepare a business plan, it was necessary to assess market conditions concurrently with determining tribal interests and capabilities. This was an iterative process as we gathered some information, talked with various personnel at the Pueblo, and then revised our efforts according to the feedback we received. We analyzed market opportunities for greenhouses, aquaculture, spas and district heating. We looked at multiple niches within each of these market segments. With feedback from the Tribal Council and the Economic Development Committee (recently re-named the Jemez Community Development Corporation), we eliminated aquaculture as a business opportunity. We then focused on specific niches within the greenhouse market including tree seedlings and herbs for food consumption. We also were directed by Tribal Council to assess the spa market. Our analysis of the greenhouse market indicated an opportunity with herbs but a crowded market space for tree seedlings. Our market analysis for spas indicated it would be economically difficult to develop a stand-alone spa but a spa might be a worthy complement to other retail enterprises.

Concurrent with our geothermal feasibility studies, the Pueblo of Jemez commissioned a Master Plan for the Red Rocks area on the reservation. This is an area that is now being assessed for development of retail enterprises that match tribal cultural needs as well as offer solid business opportunities. We understood the potential to develop a geothermal district heating infrastructure at Red Rocks to provide a sustainable, clean energy

resource for the potential development at Red Rocks. The geothermal system can provide stable energy prices over a long horizon with considerable benefit to the Tribe.

We then prepared two stand-alone reports. One is a business plan for a geothermally-heated greenhouse producing herbs for local and regional markets. The greenhouse would be located at the southern portion of the reservation, away from the retail area. The site has advantages because the geothermal resource is fully confirmed and the surrounding area is agricultural in nature. The challenge to this site is it will require some development (e.g., installation of power lines) and presently the Pueblo focus is on developing the Red Rocks site, not the southern location. Further, even though the business plan suggests it can be a profitable venture, personnel from Jemez will need to take ownership of the plan and move forward with it. The business opportunity will surely change with time.

The second report is a feasibility study of the district heating system at Red Rocks. We compared geothermal to logical alternatives, biomass and propane. Both biomass and geothermal are assessed to be less expensive than propane. We recommend geothermal because of its compatibility with the location.

Much work remains to be done to capture the promise of using geothermal resources on the reservation. While the Red Rocks district heating system is a good idea and has economic merit, it will be necessary to complete resource assessment work. Resource confirmation is needed and can only be accomplished through a drilling program. This is the necessary follow-on work.

The herb greenhouse is a real business opportunity. We understand market conditions change and within some distinct time period, perhaps less than two years, the opportunity will be considerably different and the study will need to be re-visited. While the market data and business opportunity will change, we have provided a powerful electronic tool in the form of a pro forma financial analysis. The spreadsheet model will allow for multiple what-if type assessments with a complete analysis of financial return. We encourage the Pueblo to take advantage of the model.

District Heating System at Red Rocks
Pueblo of Jemez, New Mexico
Feasibility Analysis

Prepared for:
Pueblo of Jemez
Jemez, New Mexico 87024

Funding provided by:
US Department of Energy
Contract DE-FC36-02GO12104

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ABSTRACT

A preliminary analysis of a geothermal district heating system was conducted. The geothermal heating system, located on the Pueblo of Jemez at Red Rocks, is designed to serve commercial retail loads for new structures that may be built in accordance with master planning efforts. The geothermal system was compared with two alternatives, propane and biomass. Biomass is the least costly system but geothermal is preferred due to supply assurance and compatibility with the scenic considerations at Red Rocks. The cost differential between biomass and geothermal is not substantial. Levelized costs for geothermal fluids are estimated to be on the order of $14/MMBtu while biomass is approximately $11/MMBtu, delivered. A geothermal system has the potential to receive financial support from either government agencies or private foundations.

ACKNOWLEDGMENTS

The US Department of Energy funded this study. The Pueblo of Jemez was the prime contractor. The original project manager was Mehrdad Khatibi. Mr. Steve Blodgett and Marti Blad, Ph.D. assumed management responsibility for Jemez approximately 2/3rds of the way through the effort. We are appreciative of their collective efforts to make this project succeed. Mr. Anthony Armijo was an interim project manager who worked with us to ensure we were on track with certain data and image collection activities. His contributions were both timely and helpful. We also extend our thanks to Mr. Tim Armijo, Director of the Pueblo of Jemez Economic Development Department. Mr. Armijo helped coordinate numerous meetings with the Tribal Council, the Jemez Community Development Corporation, and several firms providing master planning services to the Pueblo of Jemez.

McNeil Technologies Inc. was a subcontractor to New Mexico State University, Southwest Technology Development Institute. Mr. James C. Witcher was the Project Manager at NMSU. The authors acknowledge Jim's contribution to the work effort and extend appreciation for his support.

Finally, despite our best efforts at editing and revisions, mistakes may still remain within this document. Any mistakes or omissions are the sole responsibility of the authors. Any questions or comments should be addressed to Jack Whittier, McNeil Technologies Inc., 1155 University Boulevard, Albuquerque, NM 87106.

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Abbreviations and Acronyms

BD	Bone-dry, or containing 0% moisture content; also referred to as oven-dry
BLM	U.S. Bureau of Land Management
Btu	British thermal units
C	Celsius
CCF	hundred cubic feet (ft^3)
CF	cubic feet (ft^3)
CFB	circulating fluidized bed
CFR	Code of Federal Regulations
CHP	combined heat and power
CO	Carbon monoxide
CO_2	Carbon dioxide
DBH	diameter breast height
DEQ	Department of Environmental Quality
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
EIA	U.S. DOE Energy Information Administration
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act
F	Fahrenheit
FICA	Federal Insurance Contributions Act (Social Security)
FUTA	Federal Unemployment Tax Act
H_2	Hydrogen
HHV	higher heating value
HP	Horsepower
GPM	Gallons per Minute
kW	kilowatt
kWh	kilowatt-hour
lb	pounds
LHV	lower heating value
MACRS	Modified Accelerated Cost Recovery System
MC	moisture content
MMCF	Million cubic feet
mi^2	Square miles
MMBF	million board feet
MMBtu	million British thermal units
MSW	Municipal Solid Waste
MW	megawatt
MWh	megawatt-hour
NPV	Net Present Value
N	Nitrogen
NO_x	Oxides of nitrogen
NREL	National Renewable Energy Laboratory
OD	Oven-dry, or containing 0% moisture content; also referred to as bone-dry

ODT	oven dry tons
psi	pounds per square inch
PURPA	Public Utility Regulatory Policy Act
REPA	Renewable Energy Production Incentive
ROI	Return on Investment
RTRP	Reinforced thermosetting resin pipe
SO_x	Oxides of sulfur
S	Sulfur
SUI	State unemployment insurance
TSI	Timber Stand Improvement
USFS	United State Forest Service
VOC	volatile organic compound
wt %	weight percent
WT	Wet tons
yr	year

Executive Summary

A geothermal district heating system has the potential to offer substantial benefits. The primary benefit is a stable energy price for a long period of time. Other benefits include the potential for a competitive price, use of a renewable, non-polluting, resource plus quiet operation. Further, the Pueblo of Jemez could achieve a measure of energy self-sufficiency and retain valuable dollars within the community.

The benefits of the district heating system can be realized if there is proper consideration given to the infrastructure development. It is anticipated that the build-out to realize the Master Plan will take a period of years to accomplish. At the time of this report, Spring 2004, it is uncertain as to the precise nature of the Master Plan although there is a general understanding that the planning effort is directed towards establishing the Red Rocks area as a commercial center to attract and retain retail trade. The intent is to respect the physical aesthetics of Red Rocks while providing limited development to complement Pueblo of Jemez economic goals.

It is understood that for the district heating system to be successful, early incorporation of the pipeline and associated heating systems will be necessary. Simply put, retrofit of buildings to accommodate a new heating system is expensive and often not cost-effective. To realize the long-term advantages of the geothermal district heating system it will be necessary to install the infrastructure well in advance of the build-out of the site. While this means the district heating system will be underutilized in the early years of operation as new loads are being added, it allows for a gradual incorporation of the technology into the planning efforts.

From a delivered cost of energy perspective, geothermal represents the second lowest cost for the range of fuels available at Red Rocks. Biomass is less expensive than geothermal but it can reasonably be argued that geothermal has a slight competitive advantage because of the assurance of supply. Biomass supply is ample and will be for many years. However, given the litigious nature of harvesting material from National Forests, it is difficult to have confidence the biomass supply will be reliable year after year. By contrast, the geothermal resource is directly under the Red Rocks location and is accessible on a continuous basis.

Table ES-1 provides a qualitative comparison between the three energy supply sources that have been addressed in this report. The intent of Table 13 is to provide comparative information to illustrate the differences between the various technologies to foster decision-making. The comparative approach provides several categories of interest relevant to project development including capital and operating considerations, environmental attributes, and inclusion of issues germane to the Pueblo of Jemez.

Capital requirements illustrate a dramatic difference. A propane system has a low initial cost as well as overall low replacement costs. Indeed the capital costs are approximately 10% of the geothermal costs. However, there is little chance to obtain financial support for the system from government or foundation sources. Conversely, both of the renewable technologies have relatively moderate or high initial costs but are good candidates for obtaining financial assistance, largely because of public support for greater adoption of sustainable practices.

From a cash flow perspective, a propane system offers the smallest year-to-year impact on scarce investment funds but not annual operating costs. This is both because of the low initial cost as well as it is not necessary to incur large annual finance costs for debt repayment. Both the biomass system and the geothermal system require moderate or high initial costs that are assumed to be financed over the project lifetime. Annual cash requirements for debt repayment are relatively high compared to a propane system.

Operating costs illustrate one of the conundrums of renewable energy utilization, particularly for the geothermal system. While the initial costs for renewable technologies are high, the annual operating costs are considerably less than for a propane system. Further, the required management and labor skills, particularly for the geothermal system, are low indicating the ease of operating the system. Finally, the geothermal system offers the prospect of stable, predictable fuel prices. Neither the propane or biomass systems can offer similar assurance of price or supply stability. In addition, biomass supply will require several truckloads per week to be delivered to the site.

Levelized annual costs incorporate both capital and operating costs discounted over the project horizon thereby allowing for a comparison among the different technologies on a normalized basis. From the levelized cost perspective, both biomass and geothermal technologies are roughly half as expensive as propane over twenty years. This striking difference illustrates the effect low operating costs have relative to high investment costs (particularly for the geothermal system).

Pueblo of Jemez personnel have expressed considerable concern for the environmental impacts associated with development on the reservation, particularly at the scenic Red Rocks location. Both biomass and geothermal offer attractive environmental or green attributes with both considered sustainable resources over a long period of time. Propane, a fossil fuel, has low air emissions except for CO_2, relative to either biomass or geothermal. Biomass combustion systems do have air emissions of CO_2, CO, NO_x, small levels of SO_x in addition to a small but discernible visible plume from the emission stack. Biomass systems have received air permits in areas with stringent air emission requirements and meet all US Environmental Protection Agency emission levels. Further, societal benefits associated with biomass fuel supply from small diameter material in the surrounding tribal trust lands, Valles Caldera National Preserve and the Santa Fe National Forest are considerable. Amelioration of forest fire threat through the reduction of high stand density coupled with removal of dead or dying trees that are infected by the pine bark beetle has high public value that is difficult to quantify.

A geothermal system will emit no or negligible air emissions. The spent geothermal fluids will be injected back into the aquifer. Care must be exercised in siting the disposal well to assure that valuable potable water supplies are not contaminated. The footprint of the geothermal system is limited to the wellhead and pipeline. The pipeline will require trenching and therefore soil disturbance.

It is also important to consider impacts the proposed energy infrastructure would have on other Pueblo of Jemez activities. For example, both the propane and biomass systems would complement on-going enterprises. There is a small propane supplier business on the reservation and the Walatowa Woodlands Initiative (WWI) presently employs

approximately 10 individuals for thinning and processing small diameter wood products. Either organization could effectively supply fuel to the heating system.

In general, both the biomass and geothermal systems will retain fuel dollars in the local community. Biomass fuel costs will pay for salaries for WWI personnel while the royalty payments associated with the geothermal system will return funds to the tribe to offset utilization of the natural resources.

Table ES-1 Comparative Advantages and Disadvantages, Propane, Biomass and Geothermal Heating Systems at Red Rocks, Pueblo of Jemez

Category	Propane	Biomass	Geothermal
Capital Requirements			
Initial capital investment	Low	Moderate	High
Periodic replacement costs	Low	Low	Moderate
Potential for cost-share capital	Low	High	High
Operating Considerations			
Annual costs	High	Moderate	Low
Levelized costs	High	Moderate	Moderate
Management experience	Low	Moderate	Low
Labor skills	Low	Low	Low
Fuel price stability	Volatile	Variable	Stable
Supply assurance risk	Moderate	High	Low
Green Status			
Sustainable	No	Yes	Yes
Air emissions	Low	Low	None
Greenhouse gas emissions	Moderate	Low	None
Social benefits	No	High	Moderate
Pueblo Considerations			
Complements existing tribal enterprises	Yes	Yes	No
Fuel dollars remain in community	No	Yes	Yes

Recommendations for future actions include the following:

- Given the uncertainty regarding the true nature of the geothermal resource at Red Rocks, a complete drilling exploration / confirmation plan needs to be executed. We recognize the Pueblo of Jemez is pursuing this activity via a recent proposal to BIA.
- The Master Plan should give careful consideration to a district heating system, either biomass or geothermal. The infrastructure for such a system should be designed from the start to accommodate future expansion.
- All buildings that are being considered for the Red Rocks commercial district need to incorporate careful consideration of the energy system. This consideration includes both energy efficiency measures, including solar orientation, as well as accommodation of either geothermal or biomass energy systems. It is strongly recommended that the buildings utilize a hot water circulation loop for space heating.
- Infrastructure development support funds from public organizations should be sought as early as possible. The US Departments of Commerce, Agriculture,

Energy and Interior all have programs that address either renewable energy utilization or infrastructure development.

- The Pueblo of Jemez should begin to consider establishment of a tribal utility authority (TUA) to run the district heating system. The authority would be responsible for management of the system, possibly through the Public Works Department. The overall concept behind a tribal utility authority is tribal self-determination or the extent to which Pueblo of Jemez desires to control various aspects of its destiny. The geothermal district heating system can be utilized to establish the framework for such functions as:
    1. Billing
    2. Operations management
    3. Records keeping and periodic filing with applicable agencies
- Over time the district heating TUA could be expanded to include provision of telecommunications and electricity services.

Introduction

The Pueblo of Jemez has commissioned an initial master planning effort for the Red Rocks area (see location map Figure 1). Fortuitously, the planning work is being conducted concurrently with the geothermal resource assessment and economic feasibility effort funded by the US Department of Energy (DOE). Because of the known geothermal resource potential at Red Rocks, it is prudent to assess the initial feasibility of installing a district heating system to meet the thermal demands for the various buildings that might be constructed.

A geothermal district heating system has the potential to offer substantial benefits. The primary benefit is a stable energy price for a long period of time. Other benefits include the potential for a competitive price, use of a renewable, non-polluting resource plus quiet operation. Further, the Pueblo of Jemez could achieve a measure of energy self-sufficiency and retain valuable dollars within the community.

The benefits of the district heating system can be realized if there is proper consideration given to the infrastructure development. It is anticipated that the build-out to realize the Master Plan will take a period of years to accomplish. At the time of this report, Spring 2004, it is uncertain as to the precise nature of the Master Plan although there is a general understanding that the planning effort is directed towards establishing the Red Rocks area as a commercial center to attract and retain retail trade. The intent is to respect the physical aesthetics of Red Rocks while providing limited development to complement Pueblo of Jemez economic goals.

It is understood that for the district heating system to be successful, early incorporation of the pipeline and associated heating systems will be necessary. Simply put, retrofit of buildings to accommodate a new heating system is expensive and often not cost-effective. To realize the long-term advantages of the geothermal district heating system it will be necessary to install the infrastructure well in advance of the build-out of the site. While this means the district heating system will be underutilized in the early years of operation as new loads are being added, it allows for a gradual incorporation of the technology into the planning efforts.

Figure 1 provides an aerial picture of Red Rocks overlain with a location map. The existing infrastructure for the buildings and roads is shown. Hypothetical wells sites are indicated as well as a possible pipeline route. It is important to note the wells and pipeline are purposely sited to minimize aesthetic concerns and avoid culturally sensitive areas. Not shown on the map but included in the following analysis is another potential pipeline that would travel east and serve a potential retail spa.

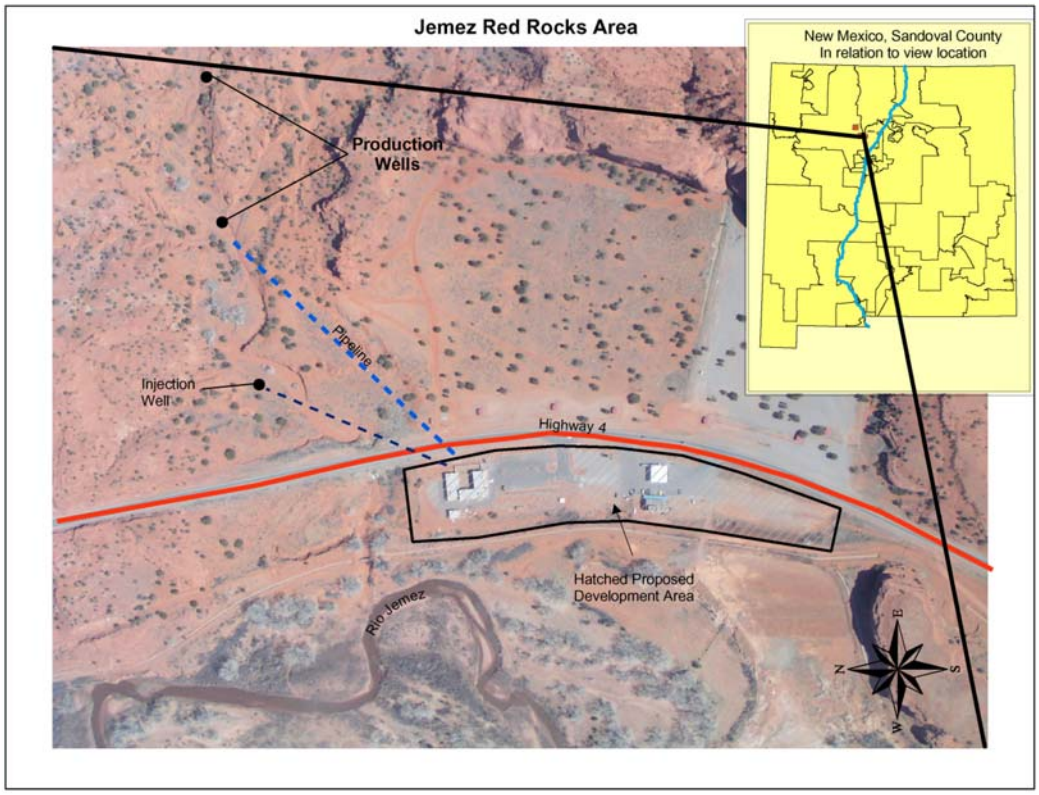

Figure 1 Red Rock Location Map

Geothermal Resource[1]

No thermal springs or thermal wells exist in the Red Rocks area along Highway 4 north of the main Jemez Pueblo village. However, the area overlies possible subsurface flow paths for the outflow plume from the Valles geothermal system to the north (Goff and others, 1988). Heat flow and temperature gradient information indicates potential for a lateral outflow plume geothermal reservoir beneath the area. There are several likely reservoir targets but drilling needs to be accomplished to have certainty there is a viable resource at the site.

We have had numerous discussions regarding the likelihood of "finding" geothermal resources at the Red Rocks location. At this time, Spring 2004, it is considered highly likely that a substantial reservoir exists at the site and that successful drilling could be accomplished in the immediate vicinity of the Red Rocks area. The Pueblo of Jemez has applied for funds from the Bureau of Indian Affairs to conduct preliminary drilling at the site to help confirm the presence of geothermal fluids.

For the purposes of this report, it is assumed there is a reservoir that is capable of producing 150°F fluids with flow rates in excess of 500 gallons per minute (gpm). The

[1] The material in this section is derived from Witcher, James C., Geothermal Reservoirs and Geothermal Drilling at Jemez Pueblo, March 31, 2004 (draft).

estimated depth to the reservoir is 1,000 feet and the reservoir is assumed to have a lifetime in excess of fifty years. Water quality is assumed to be comparable to the geothermal fluids from the well located on the southern portion of the reservation.[2]

Heating Load

Development at Red Rocks is presently limited to the convenience store and the Cultural Center, each building representing a modest thermal load for both space and water heating. Future development will follow the Master Plan presently being developed for the Pueblo of Jemez by Artic Slope, Inc. In absence of known loads, it is possible to forecast demand based on a mix of different building types that represent the current thinking regarding applicable uses for the site.

As shown in Table 1, we have developed a hypothetical mix of buildings for the Red Rocks location. The hypothetical mix of buildings represent different space and water demands as a result of the varying usage requirements for the buildings. When the site is actually built out, it is anticipated there will be a slightly different mix of buildings than presented in this report.

It should be clearly understood, the hypothetical mix of buildings was not developed in conjunction with the Master Planning effort. The timing was such that we did not have access to sufficient information to determine what types of buildings are likely to be at the development site. Therefore we have projected a mix of buildings that represents some of the discussion and sentiment that we heard expressed at various planning meetings. The hypothetical mix is just that, an estimate of a possible thermal load for buildings that do not presently exist nor are there any concrete plans to construct them at this time. Rather, there are plans to construct some buildings at the site and to the extent the hypothetical mix reflects a plausible scenario, then the load projection helps focus the planning efforts.

In Table 1 the thermal load is based upon 45,000 square feet of buildings. At this time we believe this would be the maximum build-out for the Red Rocks area and thus our estimates are for the highest level of thermal demand. The buildings shown in Table 1 represent a varied mix of light commercial uses, all of modest size. It is possible to envision small offices as well as a restaurant. We understand there are provisions to build a public safety facility at Red Rocks and it is possible to expand the current meeting space at the Cultural Center. A spa represents the largest portion of the thermal load, approximately 60%.[3] Because the spa represents such a large fraction of the load, the assumptions and calculations associated with determining the thermal demand are presented in Appendix A. It is likely the spa would be located some distance away from the specific Red Rocks area that presently contains the Convenience store, probably to the east and north.

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[2] Water quality is assumed to be approximately 3,300 ppm tds. A full chemical constituent analysis is available for the southern location from Witcher, James C., "Jemez Pueblo Geothermal Assessment," Table 2, page 9, prepared for New Mexico Research and Development Institute, March 1991.

[3] We have performed a market analysis for a spa. It is clear there is growing demand for therapeutic spas, both for tribal members as well as for retail trade. The market analysis is included as a separate report under this contract.

Annual thermal demand is estimated to be approximately 4,851 MMBtu/year. Peak demand is similarly estimated to be 3 MMBtu/hr. with an annual load factor of approximately 17% when fully operational. The load factor represents the annual utilization of the system and reflects the climatic conditions at the Pueblo of Jemez. Average heating degree days are around 4,500.[4]

Table 1 Estimated Thermal Loads for Hypothetical Buildings at Red Rocks

Building Type	Space Heating (Btu/sq. ft. / yr.)**	Water Heating (Btu/sq. ft. / yr.)**	Sq. Ft	MMBtu/yr.	%***
Office	24.3	8.7	5,000	165	3%
Retail	30.6	5.1	10,000	357	7%
Lodging	22.7	51.4	-	0	0%
Public Assembly	53.6	17.5	10,000	711	15%
Spa*	22.7	2,736	5,000	2,850	59%
Food Service	30.9	27.5	-	0	0%
Warehouse	15.7	2.0		0	0%
Public Safety	27.8	23.4	15,000	768	16%
Total			45,000	4,851	100%

*Spa water heating is MMBtu/year
**Source: EIA, 1998
***Totals may not equal 100% due to rounding

Not all of the construction will take place in one year; rather it is assumed build out will be accomplished over a five-year period. As illustrated in Figure 2, the estimated development rate starts slowly and then gains momentum. It is assumed there is continuous building for the five-year period.

[4] Heating engineers who wanted a way to relate each day's temperatures to the demand for fuel to heat buildings developed the concept of heating degree days. To calculate the heating degree days for a particular day, find the day's average temperature by adding the day's high and low temperatures and dividing by two. If the number is above 65, there are no heating degree days that day. If the number is less than 65, subtract it from 65 to find the number of heating degree days. For example, if the day's high temperature is 60 and the low is 40, the average temperature is 50 degrees. 65 minus 50 is 15 heating degree days.

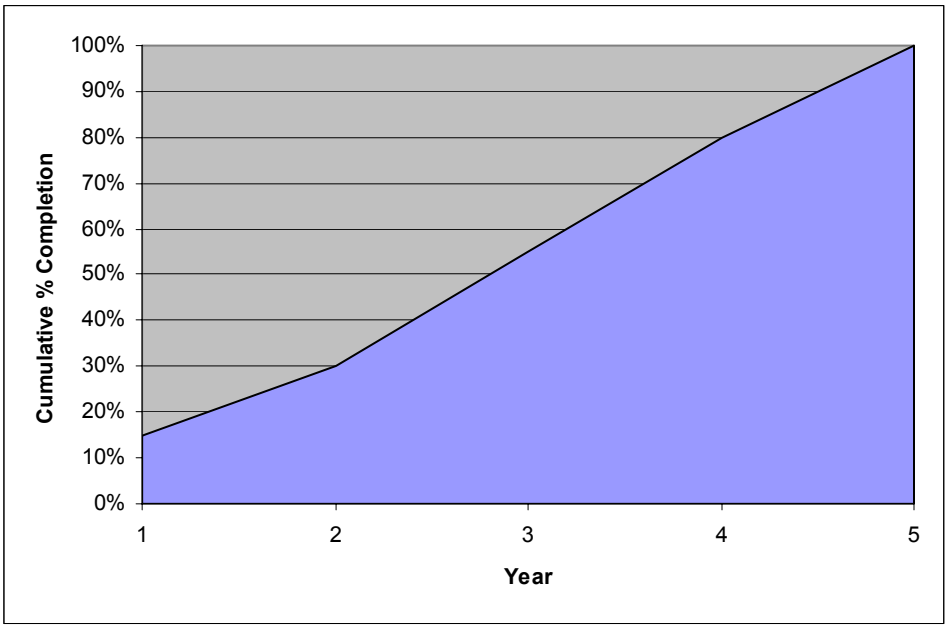

Figure 2 Estimated Development Rate for Construction of Facilities at Red Rocks

Distribution Pipeline[5]

A transmission pipeline is required to transport the geothermal fluid. Geothermal fluid for Jemez direct use applications will be transported in the liquid phase and has some of the same design considerations as water distribution systems. Several factors including pipe material, dissolved chemical components, size, installation method, head loss and pumping requirements, temperature, insulation, pipe expansion and service taps should be considered before final specification.

Based on experience in New Mexico, mostly at greenhouses in the southern portion of the state, fiberglass piping is recommended for the district heating system at the Red Rocks location. The following section identifies several technical parameters for fiberglass piping.

Fiberglass piping, commonly referred to as RTRP (reinforced thermosetting resin pipe) or FRP (fiberglass reinforced plastic), is available in a wide variety of configurations. Two materials are epoxy resin and polyester resin. In addition, the piping is available in lined and unlined versions. The epoxy resin piping with an epoxy liner is generally selected for geothermal applications. Both epoxy resin and polyester resin systems can be compounded to be serviceable to temperatures of 300°F, well above the likely temperatures at Red Rocks. Regardless of the type of fiberglass material used, care must be taken to maintain operating pressure high enough to prevent flashing of hot fluids. At high temperatures (>boiling point), the RTRP systems are susceptible to damage when fluid flashes to vapor. The forces associated with the flashing may spall the fibers at the interior of the pipe surface. It is not anticipated that temperatures will exceed boiling at Red Rocks.

[5] Much of the material in this section is derived from a report entitled "Piping" authored by Kevin Rafferty, PE at the Oregon Institute of Technology, Geo-Heat Center, undated.

Fiberglass piping is available from a number of manufacturers but, at the distributor and dealer level, it is considerably less common than steel. Most manufacturers produce sizes 2 in. and larger. As a result, if fiberglass is to be employed, another material would have to be used for branch and small diameter piping of <2 in.

As with all nonmetallic piping, the method of joining is a large consideration with respect to both installation time and expense. With FRP piping, a variety of methods are available, including mechanical (keyed, threaded and flanged) and adhesive type jointing. Of these, the bell and spigot/adhesive has seen the widest application in geothermal systems.

In making the choice between the mechanical and adhesive type of joining, consideration should include piping cost, fitting cost, contractor familiarity, and probable installation temperature.

The cost of the keyed joint piping is approximately 10% more than the bell and spigot/adhesive joint in the 6 in. size. Alternate versions of mechanical joining are somewhat more expensive. The added cost of the keyed-type joint can be compensated for by the reduced labor necessary to complete the joint. Fitting cost should be carefully weighed with any mechanical joining system. If a large number of fittings are required, fitting material cost can quickly overshadow the labor savings. In addition to the amount of labor required, the adhesive joint also demands a greater technical skill on the part of the installer. The epoxy adhesive must be properly mixed and applied to the joint under acceptable conditions to ensure a reliable set. One of the most important of these conditions is temperature.

Below approximately 75°F, curing time is substantially increased. As a result, if installation is to occur in a reasonable length of time, a special heating blanket must be applied to each joint after makeup to ensure proper curing. As with most other piping systems, the mechanical draw method is preferred for joint assembly.

Two recent developments that may be considerations are gasketed slip joint and integral thread joining. The slip joint approach provides for installation very similar to Tyton joint ductile iron or AC pressure pipe. Integral thread (with a double "O" ring) piping is also less labor intensive and low cost.

The axial expansion of FRP is approximately twice that of steel. However, because of the relatively low axial modulus, forces developed as a result of this expansion are only 3 to 5% that of steel under the same conditions. As a result, for buried installations with at least 3 ft of cover, sufficient restraint is provided by the overlying soil and no special precautions need be made for expansion other than adequate thrust blocking. For aboveground installations (on hangers), changes in direction are the most economical method of allowing for expansion.

Fittings are available from most manufacturers in a wide variety of configurations. In general, the bell and spigot/ epoxy joint system offers a greater number of fittings than the keyed joint system. In fact, it is likely that some field made adhesive joints will be required even if a keyed joint system is selected. Fittings are available to convert from the fiberglass connections system to standard flange connections. Saddle fittings of fiberglass

construction are available for service connections. Standard piping lengths are 20, 30, and 40 ft.

We have estimated the cost for a pipeline from a well site adjacent and north of the Red Rocks. The pipeline passes under state highway 4 and terminates at the convenience store. The convenience store is simply a proxy for the commercial development area at Red Rocks. The pipeline also goes to the east of Red Rocks to serve potential spa users in casitas that may be located in a remote area. As shown in Table 2, the pipeline is estimated to run 5,000 feet from the well(s) to the convenience store and the potential casitas east and north of Red Rocks. Distances are necessarily rough estimates given that a precise drilling location is not known nor is the actual location of new construction adjacent to the convenience store or for the potential casitas.

The pipeline is a 6" FRP and is estimated to cost approximately $135,000 or about $27 per linear foot, installed. We have purposely been conservative in the cost estimate. For example, the Masson Greenhouse in Radium Springs, NM estimates its FRP pipeline to cost $15/linear foot, also for 6" FRP. The cost estimates in Table 2 exhibit considerable uncertainty. We do not presently know precise locations for building loads nor for well sites, thus all distances are rough estimates. While we believe a 6" pipeline is sufficient to meet peak demands (see the next section), it is possible a 4" pipeline may be sufficient if the demand is less than we currently estimate. A 4" pipeline may be 25% less expensive for capital costs although installation costs would remain the same.

Table 2 Estimated Cost for Geothermal Distribution and Injection Pipeline

Category	Units	Value	Total
Capital Cost			
Pipeline	Feet	5,000	
Pipeline (6")	$/ft	$ 18	
Subtotal, pipe	$		$ 90,000
Joint fittings	# (20' sections)	213	
Joint fittings	$/ea.	$ 21	
Subtotal, fittings	$		$ 4,463
Ells	#	25	
Ells	$	$ 150	
Subtotal, Ells	$		$ 3,750
Tees	#	$ 12.50	
Tees	$	217	
Subtotal, Tees	$		$ 2,713
Installation			
Trenching rate	Ft/hr	50	
Trenching rate	Ft./day	400	
Machine labor rate	$/hour	$ 40.00	
Machine rate	$/day	$ 200	
Time	Days	12.5	
Subtotal, machine	$		$ 2,500
Subtotal, labor for trenching	$		$ 4,000
Pipe installation	ft/day	500	
Duration	Days	10	
Labor	# Persons	3	
Daily wage	$/day	$ 75.00	
Subtotal, labor for pipe	$		$ 2,250
Backfill	Ft./day	1,000	
Subtotal, backfill	$		$ 2,600
Subtotal			$ 112,275
Engineering fees	%	20%	$ 22,455
Total			$ 134,730
Total	$/ft.		$ 26.95

Preliminary Engineering / Economic Analysis

1.1 Introduction

The intent of the economic analysis is to determine the levelized cost of production for geothermal energy supplying the demand estimated in Section 0. Our interest is to assess the financial viability for a geothermal installation relative to the closest competitor, in this case either propane or biomass.

Our approach was to utilize a spreadsheet pro forma income model to project annual cash flows over the project horizon. In this fashion we are able to calculate both the net present value (NPV) of the project as well as the levelized cost of production. We are

also able to perform multiple "what-if" or sensitivity calculations by varying the multiple inputs and assumptions.

As with almost all renewable energy technologies, geothermal systems are capital intensive. Indeed the operating costs are only a small fraction of the total costs of ownership. Thus the challenge is to ensure adequate cash flow to allow for realization of economic viability. In many cases the strategic value of a renewable energy investment needs to be recognized by incorporation of a long-term vision.

1.1 Capital Costs

Capital costs for the geothermal system are presented in both Table 3 and Figure 3. We assume there is one production well and one injection well for disposal of spent fluids (see Appendix B for an itemization of well drilling costs).[6] The two wells are assumed to be drilled to 1,000 feet each. There is a closed-loop pipeline that is isolated from the geothermal fluids by a heat exchanger. The fluid in the closed loop is provided first to a small storage tank and then distributed to the various thermal loads. The wells and pipeline constitute approximately 70% of the total installed costs for the geothermal system. The entire system, with engineering and contingency, is estimated to cost approximately $900,000.

Table 3 Estimated Capital Costs for Geothermal District Heating System, Red Rocks

Capital Costs	$
Controls	$ 15,000
Injection well	$273,750
Miscellaneous	$ 25,000
Pipeline	$112,275
Production wells	$273,750
Pumps	$ 50,000
Storage	$ 20,000
Subtotal	$769,775
Engineering	$ 50,000
Contingency (10%)	$ 76,978
Total	$896,753

[6] The requirement for two wells is subject to one important assumption. It is possible exploration efforts at Red Rocks will identify a resource in excess of 180F. Should this be the case, then it would be possible to eliminate the need for two wells by utilizing a downhole heat exchanger in a single well. The single well would need to be a larger diameter well than is discussed in this section but the incremental well and heat exchanger costs would be considerably lower than for two wells.

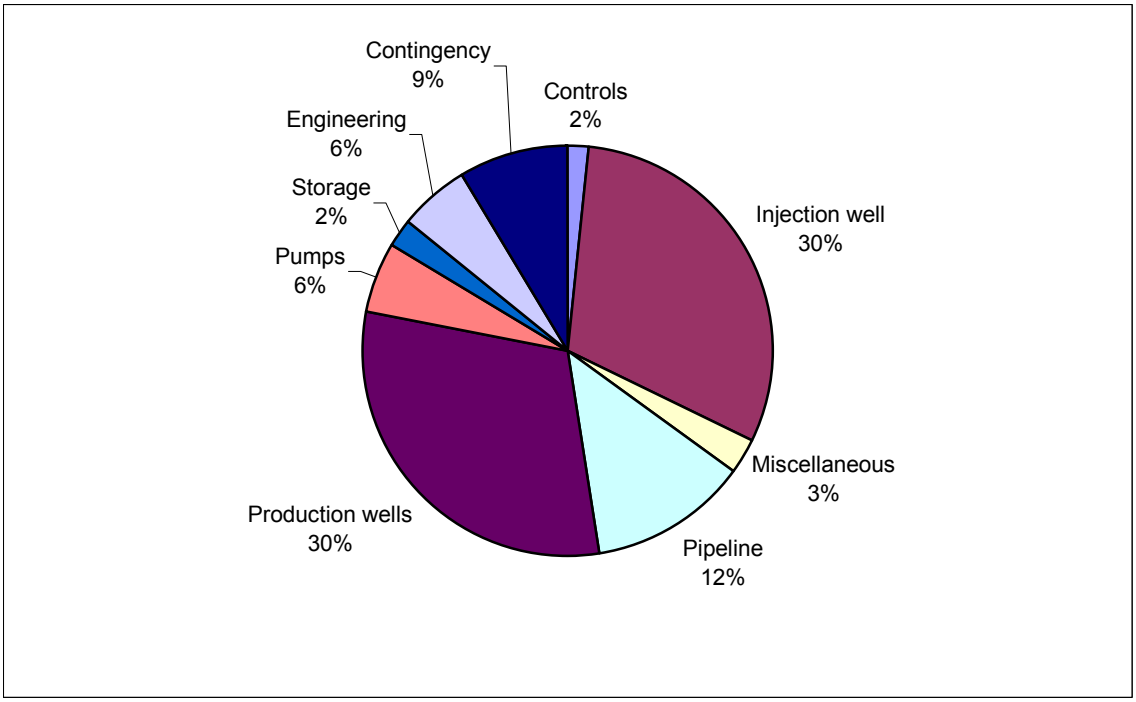

Figure 3 Estimated Capital Costs, Geothermal District Heating System

1.1 Operating Costs

Estimated operating costs for the district heating system are presented in Table 4. The annual expenses for utilities and labor are reasonably equal and are also low.

Table 4 Estimated Annual Operating Costs, Geothermal District Heating System, Red Rocks

Category	Units	Value
Utilities	$	$ 16,623
Labor	$	$ 24,822
Total		$ 41,445

Annual utility charges are a function of estimated demand, usage, and the associated utility charges. As presented in Table 5, annual electricity charges are estimated at slightly under $17,000.

Table 5 Estimated Electricity Demand and Energy Consumption, Geothermal District Heating System, Red Rocks

Item	Number	Units	Value	Calculated Demand (kW)	% Operation	Calculated Energy (kWh)
Pumps	5	hp	10	37.5	17%	54,203
Well pump	1	hp	75	56.25	17%	81,304
Miscellaneous	5	watts	100	0.5	17%	723
Total				94		136,229
Demand charge		$/kW/month	$10.00			$ 11,310
Energy charge		$/kWh	$0.039			$ 5,313
Total						$ 16,623

Jemez Mountains Electric Cooperative Inc
Rate 3, Large Power Service

Labor costs for the geothermal system consist of an individual in the Public Works Department performing routine monitoring and maintenance functions. In general, the labor time burden should not be consuming for one individual, indeed we envision the responsibilities representing one FTE but spread over three individuals (see Table 6).[7]

Table 6 Estimated Labor Costs, Geothermal District Heating System, Red Rocks

Category	# of persons	Hourly Rate	Salary
Supervisor	0.25	$15.00	$7,800
Labor	0.5	$6.00	$6,240
Administrative	0.25	$6.00	$3,120
Total payroll	1		$17,160
Overtime Allow.		10%	$1,716
Benefits		35%	$5,946
Annual payroll			$24,822

Benefit assumptions for labor are shown in Table 7.

Table 7 Estimated Benefit Rate, Geothermal District Heating System, Red Rocks

Benefits	%
401k	3.00%
FICA	7.65%
FUTA	1.00%
SUI	1.00%
Workman's Compensation	7.00%
Health Insurance	15.00%
TOTAL	34.65%

[7] Wage and fringe rates obtained from Pueblo of Jemez, office of financial compliance.

1.1 Spreadsheet Model Economic Inputs

The pro forma model utilizes a number of economic assumptions (see Table 8). We have incorporated inflation rate projections from the US Department of Energy as well as interest rate projections from the Federal Reserve Bank for financing the project. The accelerated depreciation schedule allows for six-year depreciation.

Table 8 Economic / Financial Assumptions for Pro Forma Model

Category	Units	Value
Annual inflation rate	%	1.0%
Loan interest rate	%	4%
Down payment on loan	%	10%
Loan term	years	20
Income tax rate	%	5%
Depreciation method	MACRS	

1.1 Propane System

Propane represents one conventional choice of heating technologies for this location. Propane unit heaters are common throughout the Pueblo and both the Convenience store and the Cultural Center rely upon propane. For comparative purposes we have calculated the levelized cost of propane over a 20-year project horizon. As presented in Table 9, the levelized cost of propane is estimated to be over $20/MMBtu. Propane heaters capable of supplying 3 MMBtu/hr. are estimated to cost approximately $12,000.

Table 9 Levelized Cost of Propane, Pueblo of Jemez

Category	Units	Value
Price of propane	$/gallon	$ 1.40
Energy content of propane	Btu/gallon	91,600
Propane conversion efficiency	%	75%
Cost of delivered energy	$/MMBtu	$ 20.38

1.1 Biomass System

Biomass (wood chips) represents another potential energy source for providing thermal energy to the various loads. Due to advances in technology and changing economic conditions, wood fuels are emerging as preferred energy sources for many public buildings throughout the west. Concurrently, forest health issues in the New Mexico are an increasing cause for concern for area residents. The severely crowded forests are increasing the likelihood for catastrophic fires, pest infestation, and decreasing water run-off necessary for aquifer recharge. The US Forest Service, the state of New Mexico, local agencies and private landowners are in the process of either thinning small diameter material or contemplating actions to remove increased quantities of trees. The Pueblo of Jemez Walatowa Woodlands Initiative (WWI) is active in these programs and has a skilled crew for providing biomass supply.

We have developed a preliminary estimate of a biomass heating system designed to serve the same load as the geothermal system, including the same pipeline. Utilization of the pipeline allows for siting the biomass system away from the buildings. The biomass

system incorporates a semi-automated fuel delivery mechanism, common for commercial operation. A utility building houses the actual boiler while there is provision for a wood chip storage shed for up to three weeks supply. The installed costs are nearly half of the geothermal system.

The biomass supply is assumed to come from wood thinning projects being conducted by the Walatowa Woodlands Initiative crews. We have assumed the highest cost for biomass, $50/wet ton delivered to Red Rocks. Chips would be derived from thinning operations and delivered to the site. Labor is assumed to be one and one-half times as high as for the geothermal system because there is more time required for fuel handling, ash disposal, and general maintenance.

The levelized cost for biomass is calculated to be approximately $11/MMBtu, far less expensive than propane. The selling price for biomass energy would likely be 25-50% higher to capture cash flow considerations to allow for profitable system operation.

Table 10 Estimated Capital and Operating Costs, Biomass Heating System for Red Rocks

Category	Description	Units	Value
Capital Costs			
Wood boiler	3 MMBtu/hr	$	$ 100,000
Building for boiler	Metal bldg.	$	$ 100,000
Chip storage shed	2 week supply	$	$ 100,000
Piping		$	$ 112,275
Controls		$	$ 5,000
Miscellaneous		$	$ 25,000
Engineering		$	$ 50,000
Subtotal			$ 492,275
Operating Costs			
Biomass cost	Delivered	$/wet ton	$ 50
Wood energy content	Ponderosa Pine	Btu/ton	8,000,000
Efficiency		%	80%
Cost of biomass		$/MMBtu	$ 7.81
Energy Calculations			
Peak energy demand		MMBtu/hr	3
Load Factor			20%
Annual energy demand		MMBtu/yr	5,911
Annual biomass cost		$/year	$ 46,177
Levelized Cost		$/MMBtu	$ 10.97

1.1 Geothermal System

The district heating system at Red Rocks will be used year round. The load will peak in the winter to meet the space heating demand but the spa allows for a significant base load that is assumed to be constant throughout the year. As stated earlier, the annual load factor is projected to be about 17%.

The selling price of geothermal is subject to the need to cover the cost of production and to remain competitive. Natural gas is not available on the reservation and it is unlikely a

natural gas pipeline will be installed in the foreseeable future. Electricity is generally far too expensive for large-scale space and water heating. Propane is the most common fuel on the reservation and is presently priced at about $1.40 per gallon or about $20.38/MMBtu. Biomass is projected to cost about $11/MMBtu. Biomass-derived thermal energy would be sold at approximately $13-16/MMBtu (25-50% higher than the cost of production). Thus geothermal should be priced at or near the biomass price, based solely on pricing considerations.

To facilitate the analysis, we created five different scenarios to illustrate the sensitivity of the model to changes in input assumptions and to perform "what if" calculations. Table 11 presents the variables that are modified between the five scenarios. Scenario A is a base case condition in which all capital and operating costs are paid for by the Pueblo of Jemez. The selling price is set at $14/MMBtu because that is approximately the levelized cost of production and is competitive with the biomass cost. Scenario B retains the same selling price ($14/MMBtu) but the capital costs are set to zero while the operating costs are covered by the operations of the utility system.[8] Scenario C is also represents a subsidized condition in which the Pueblo of Jemez is responsible for 20% of the capital costs plus all of the operating costs. Similar to Scenario B, funds would need to be obtained from an outside organization. For Scenario C, the selling price remains at $14/MMBtu but the capital costs represent a 20% investment by the Pueblo of Jemez. The fourth scenario, D, is identical to Scenario C except that the selling price is adjusted to set the NPV to zero. Finally, because cash flow is also a major concern besides NPV, Scenario E represents an iterative calculation to find the selling price that allows for positive annual cash flow by the fifth year of system operation. Recall our assumption that it is in the fifth year that the entire build-out is completed.

Table 11 Scenario Description for Economic Evaluation of a Geothermal District Heating System, Red Rocks, Pueblo of Jemez

Scenario	Capital Costs	Selling Price ($/MMBtu)
A	100%	$ 14.00
B	0%	$ 14.00
C	20%	$ 14.00
D	20%	$ 13.65
E	20%	$ 17.00

As presented in Table 12, levelized cost of production and NPV results are shown for the five different scenarios. For Scenario A the levelized cost of production, $14.26 is below the selling price resulting in a net loss of approximately $8.7 million over 25 years. For Scenario B, the NPV is positive $2.4 million. Scenario C, which represents a 20% capital cost-share by Pueblo of Jemez, is nearly a breakeven condition, showing a negative NPV of approximately $91,000. Scenario D illustrates the effect of driving the NPV to zero. To do so requires a selling price of approximately $13.65/MMBtu. Under the

[8] For capital costs to be zero it would be necessary for the Pueblo of Jemez to obtain funding for infrastructure development, perhaps from a public agency such as the Bureau of Indian Affairs, the Department of Commerce, or the Department of Energy.

assumptions for Scenario D, this is the minimum selling price that would cover annual costs. Scenario E has the highest NPV, over $3 million, but also the highest selling price, $18.5/MMBtu but cash flow is positive in the fifth year of operation.

Table 12 Calculated Financial Projections for Geothermal District Heating, Red Rocks, Pueblo of Jemez

Scenario	Capital Costs	Selling Price ($/MMBtu)	Levelized Cost ($/MMBtu)	NPV	Years to Positive Cash Flow
A	$ 846,753	$ 14.00	$ 14.26	($8,666,616)	never
B	$ -	$ 14.00	$ 5.46	$2,409,587	5
C	$ 179,351	$ 14.00	$ 7.23	$262,122	11
D	$ 179,351	$ 13.65	$ 7.23	$0	12
E	$ 179,351	$ 18.50	$ 7.23	$3,345,703	5

Annual cash flow is an important financial consideration beyond the calculation of NPV. While NPV suggests the overall project viability, the necessity to manage cash on an year to year basis is critical. For each Scenario we have calculated annual cash flows as well as cumulative cash flow. None of the five scenarios illustrates positive annual cash flow from the project outset. This is a direct consequence of the rate of build-out at Red Rocks. The necessity to incur the full capital costs at the project outset and modest operating costs are simply too large for minimal revenue flow in the first few years. This is a very important observation since development may stall after project initiation. Should the build-out not be accomplished then there would be no assurance of positive NPV or annual cash flow in later years.

Figure 4 provides an illustrative cash flow projection for Scenario E (recall this scenario is designed to minimize years to positive annual cash flow by setting a high selling price). Annual net cash reaches a low of negative $64,000 in year three and begins a steady positive climb for the rest of the project lifetime.

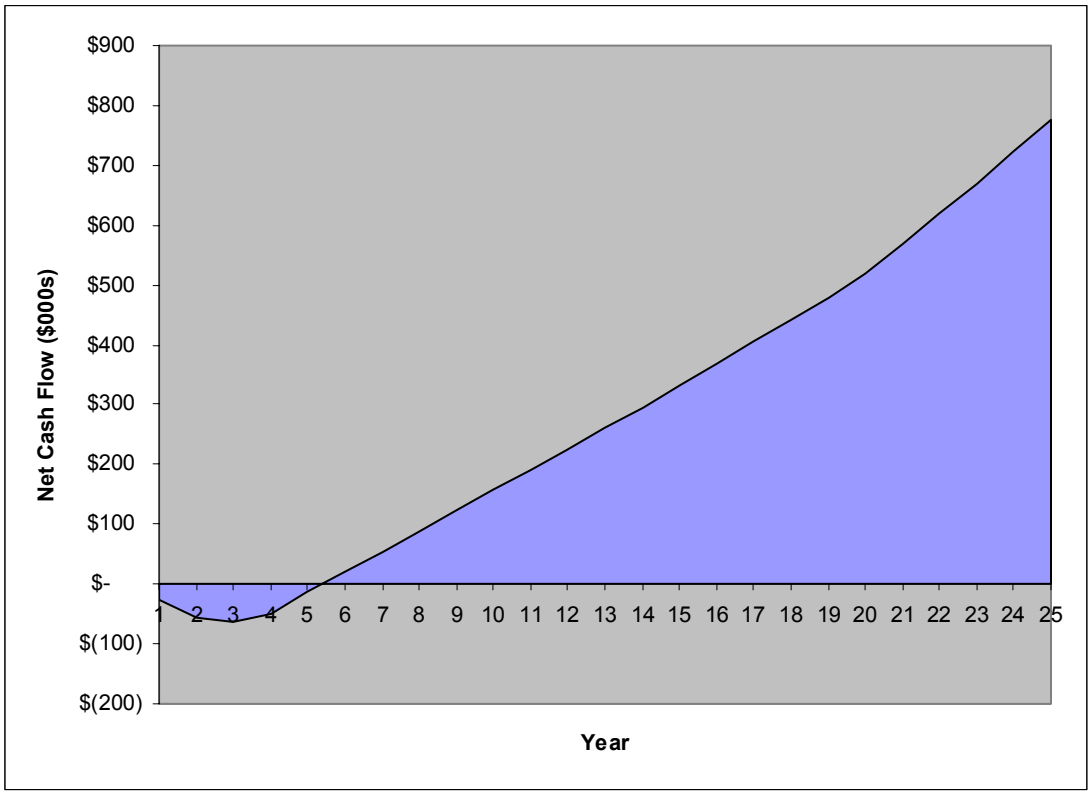

Figure 4 Projected Cash Flow, Scenario E, Geothermal District Heating System, Pueblo of Jemez

Conclusions

First it is important to clearly recognize that the results of this analysis are the product of many assumptions about future development at Red Rocks. While there is always uncertainty with financial modeling, the degree of uncertainty with this analysis is considerable. The extent to which the development at Red Rocks follows both the mix of building types, thermal loads and development rate will have a considerable impact on the financial viability of the district heating system. We believe we have made credible assumptions regarding the mix of building types and development rate, however there could be major deviations from these assumptions that dramatically affect the financial results, both positively and negatively.

The prospect for constructing the infrastructure for a geothermal district heating system at Red Rocks is intriguing. As noted in the Introduction, geothermal energy can provide for substantial benefits, encompassing a broad range of economic, environmental and social attributes. However, to realize the benefits it is necessary to make a financial case that the use of the geothermal resources is justified. The intent of this work is to assess the likely costs associated with geothermal development and to provide an initial estimate of the financial feasibility.

We are aware the Pueblo of Jemez has requested funds for continued geothermal exploration at Red Rocks. Confirmation of the resource is essential to allow for the development of the geothermal district-heating infrastructure.

From a delivered cost of energy perspective, geothermal represents the second lowest cost for the range of fuels available at Red Rocks. Biomass is less expensive than geothermal but it can reasonably be argued that geothermal has a slight competitive advantage because of the assurance of supply. Biomass supply is ample and will be for many years. However, given the litigious nature of harvesting material from National Forests, it is difficult to have confidence the biomass supply will be reliable year after year. By contrast, the geothermal resource is directly under the Red Rocks location and is accessible on a continuous basis.

Table 13 provides a qualitative comparison between the three energy supply sources that have been addressed in this report. The intent of Table 13 is to provide comparative information to illustrate the differences between the various technologies to foster decision making. The comparative approach provides several categories of interest relevant to project development including capital and operating considerations, environmental attributes, and Pueblo of Jemez "factors".

Capital requirements illustrate a dramatic difference. A propane system has a low initial cost as well as overall low replacement costs. Indeed the capital costs are approximately 10% of the geothermal costs. However, there is little chance to obtain financial support for the system from government or foundation sources. Conversely, both of the renewable technologies have relatively moderate or high initial costs but are good candidates for obtaining financial assistance, largely because of public support for greater adoption of sustainable practices.

From a cash flow perspective, a propane system offers the smallest year-to-year impact on scarce investment funds but not annual operating costs. This is both because of the low initial cost as well as it is not necessary to incur large annual finance costs for debt repayment. Both the biomass system and the geothermal system require moderate or high initial costs that are assumed to be financed over the project lifetime. Annual cash requirements for debt repayment are relatively high compared to a propane system.

Operating costs illustrate one of the conundrums of renewable energy utilization, particularly for the geothermal system. While the initial costs for renewable technologies are high, the annual operating costs are considerably less than for a propane system. Further, the required management and labor skills, particularly for the geothermal system, are low indicating the ease of operating the system. Finally, the geothermal system offers the prospect of stable, predictable fuel prices. Neither the propane or biomass systems can offer similar assurance of price or supply stability. In addition, biomass supply will require several truckloads per week to be delivered to the site.

Levelized annual costs incorporate both capital and operating costs discounted over the project horizon thereby allowing for a comparison among the different technologies on a normalized basis. From the levelized cost perspective, both biomass and geothermal technologies are roughly half as expensive as propane over twenty years. This striking difference illustrates the effect low operating costs have relative to high investment costs (particularly for the geothermal system).

Pueblo of Jemez personnel have expressed considerable concern for the environmental impacts associated with development on the reservation, particularly at the scenic Red Rocks location. Both biomass and geothermal offer attractive environmental or green

attributes with both considered sustainable resources over a long period of time. Propane, a fossil fuel, has low air emissions except for CO_2, relative to either biomass or geothermal. Biomass combustion systems do have air emissions of CO_2, CO, NO_x, small levels of SO_x in addition to a small but discernible visible plume from the emission stack. Biomass systems have received air permits in areas with stringent air emission requirements and meet all US Environmental Protection Agency emission levels. Further, societal benefits associated with biomass fuel supply from small diameter material in the surrounding tribal trust lands, Valles Caldera National Preserve and the Santa Fe National Forest are considerable. Amelioration of forest fire threat through the reduction of high stand density coupled with removal of dead or dying trees that are infected by the pine bark beetle has high public value that is difficult to quantify.

A geothermal system will emit no or negligible air emissions. The spent geothermal fluids will be injected back into the aquifer. Care must be exercised in siting the disposal well to assure that valuable potable water supplies are not contaminated. The footprint of the geothermal system is limited to the wellhead and pipeline. The pipeline will require trenching and therefore soil disturbance.

It is also important to consider impacts the proposed energy infrastructure would have on other Pueblo of Jemez activities. For example, both the propane and biomass systems would complement on-going enterprises. There is a small propane supplier business on the reservation and the Walatowa Woodlands Initiative (WWI) presently employs approximately 10 individuals for thinning and processing small diameter wood products. Either organization could effectively supply fuel to the heating system.

In general, both the biomass and geothermal systems will retain fuel dollars in the local community. Biomass fuel costs will pay for salaries for WWI personnel while the royalty payments associated with the geothermal system will return funds to the tribe to offset utilization of the natural resources.

Table 13 Comparative Advantages and Disadvantages, Propane, Biomass and Geothermal Heating Systems at Red Rocks, Pueblo of Jemez

Category	Propane	Biomass	Geothermal
Capital Requirements			
Initial capital investment	Low	Moderate	High
Periodic replacement costs	Low	Low	Moderate
Potential for cost-share capital	Low	High	High
Operating Considerations			
Annual costs	High	Moderate	Low
Levelized costs	High	Moderate	Moderate
Management experience	Low	Moderate	Low
Labor skills	Low	Low	Low
Fuel price stability	Volatile	Variable	Stable
Supply assurance risk	Moderate	High	Low
Green Status			
Sustainable	No	Yes	Yes
Air emissions	Low	Low	None
Greenhouse gas emissions	Moderate	Low	None
Social benefits	No	High	Moderate
Pueblo Considerations			
Complements existing tribal enterprises	Yes	Yes	No
Fuel dollars remain in community	No	Yes	Yes

Recommendations

Several recommendations are immediately apparent including:

- Given the uncertainty regarding the true nature of the geothermal resource at Red Rocks, a complete drilling exploration / confirmation plan needs to be executed. We recognize the Pueblo of Jemez is pursuing this activity via a recent proposal to BIA.
- The Master Plan should give careful consideration to a district heating system, either biomass or geothermal. The infrastructure for such a system should be designed from the start to accommodate future expansion.
- All buildings that are being considered for the Red Rocks commercial district need to incorporate careful consideration of the energy system. This consideration includes both energy efficiency measures, including solar orientation, as well as accommodation of either geothermal or biomass energy systems. It is strongly recommended that the buildings utilize a hot water circulation loop for space heating.
- Infrastructure development support funds from public organizations should be sought as early as possible. The US Departments of Commerce, Agriculture, Energy and Interior all have programs that address either renewable energy utilization or infrastructure development. A list of agencies and some of their programs is provided in Appendix D.

- The Pueblo of Jemez should begin to consider establishment of a tribal utility authority to run the district heating system. The authority would be responsible for management of the system, possibly through the Public Works Department. The overall concept behind a tribal utility authority is tribal self-determination or the extent to which Pueblo of Jemez desires to control various aspects of its destiny. The geothermal district heating system can be utilized to establish the framework for such functions as:
    4. Billing
    5. Operations management
    6. Records keeping and periodic filing with applicable agencies
- Over time the district heating TUA could be expanded to include provision of telecommunications and electricity services.

Appendix A Spa Thermal Load Calculations

The thermal demand for the hypothetical spa is based upon a number of assumptions. First, it is assumed that each tub is emptied after every use. Such operation is seen as important to ensure cleanliness and reduce the possibility for transmission of water borne infectious agents. Other assumptions and calculations are shown in the table below.

We assume there are 15 tubs, each of 500 gallon capacity and each used 20% of a 12-hour day. Assuming two-to-three persons per tub, this would be about 100 people per day, all year around. This estimate is probably the high end of possible usage given our current understanding of market demand.

Category	Units	Value
SUPPLY		
Weight of water	Lbs.	8.33
Conversion (minutes to hour)	Minutes	60
Production Temperature	F	145
Return Temperature	F	95
Temperature differential (delta T)	F	50
Flow rate	gpm	250
Peak production potential	MMBtu/hour	6
Annual load factor	%	20%
THERMAL DEMAND		
Tubs	#	15
Capacity (each tub)	gallons	500
Load factor	%	20%
Daily utilization	hours	12
Daily demand	gallons/day	18,000
Annual demand	gallons/year	6,570,000
Energy requirement	MMBtu/year	2,736
PERSON DEMAND		
People per tub	#	3
Time in tub	hours	1
Daily utilization	hours	12
Load factor	%	20%
Number of tubs	#	15
People per day	#	108

Appendix B Projected Drilling Costs, Red Rocks

A.	FIXED QUANTITY ITEMS			LOW	HIGH	LOW	HIGH
	ITEM	*AMOUNT*	*UNIT*	*UNIT PRICE*	*UNIT PRICE*	*ITEM TOTAL*	*ITEM TOTAL*
1	MOBILIZATION	1	job	$15,000.00	$20,000.00	$15,000.00	$20,000.00
2	DEMOBILIZATION	1	job	$10,000.00	$15,000.00	$10,000.00	$15,000.00
B.	**VARIABLE QUANTITY ITEMS**						
	(RIG TIME AND DRILLING)						
1	RIG TIME (standby)	20	hour	$250.00	$300.00	$5,000.00	$6,000.00
2	RIG TIME (non-drilling operations)	10	hour	$300.00	$350.00	$3,000.00	$3,500.00
3	AUGER CONDUCTOR HOLE (17 1/2 inch rotary)	20	feet	$125.00	$200.00	$2,500.00	$4,000.00
4	DRILL SURFACE CASING HOLE (12 1/2 inch rotary)	500	feet	$65.00	$80.00	$32,500.00	$40,000.00
5	DRILL PRODUCTION HOLE (8/1/2 inch rotary)	500	feet	$60.00	$70.00	$30,000.00	$35,000.00
C.	**VARIABLE QUANTITY ITEMS**						
	(CASING AND TUBING)						
1	CONDUCTOR CASING (13 3/8 inch)	30	feet	$45.00	$55.00	$1,350.00	$1,650.00
2	SURFACE CASING (9 5/8 inch)	500	feet	$25.00	$40.00	$12,500.00	$20,000.00
3	SURFACE CASING CENTRALIZERS	8	items	$100.00	$100.00	$800.00	$800.00
4	SURFACE CASING FLOAT COLLAR	1	item	$1,000.00	$1,000.00	$1,000.00	$1,000.00
5	SURFACE CASING FLOAT SHOE	1	item	$500.00	$500.00	$500.00	$500.00
6	PRODUCTION CASING CENTRALIZERS	25	items	$100.00	$100.00	$2,500.00	$2,500.00
7	PRODUCTION CASING HANGER	1	item	$1,700.00	$1,700.00	$1,700.00	$1,700.00
8	PRODUCTION BLANK CASING (7 inch)	300	feet	$25.00	$35.00	$7,500.00	$10,500.00
9	PRODUCTION SCREEN (7 inch)	200	feet	$40.00	$55.00	$8,000.00	$11,000.00
D.	**VARIABLE QUANTITY ITEMS**						
	(WELL SITE EQUIPMENT)						
1	BOPE RENTAL (ANNULAR)	10	days	$1,500.00	$1,500.00	$15,000.00	$15,000.00
2	DIVERTER/ROTATING HEAD RENTAL	10	days	$1,000.00	$1,000.00	$10,000.00	$10,000.00
3	DRILLING WELL HEAD/GATE VALVE	1	items	$2,500.00	$5,000.00	$2,500.00	$5,000.00
4	FRAC TANK RENTAL	1	items	$5,000.00	$8,000.00	$5,000.00	$8,000.00
E.	**VARIABLE QUANTITY ITEMS**						
	(MONITORING AND TESTING EQUIPMENT)						
1	HYDROGEN SULFIDE EQUIPMENT	10	days	$1,200.00	$1,800.00	$12,000.00	$18,000.00
2	HOLE ORIENTATION DEVICE	14	days	$500.00	$500.00	$7,000.00	$7,000.00
F.	**VARIABLE QUANTITY ITEMS**						
	(CEMENT CASING)						
1	CEMENT CONDUCTOR CASING	1	job	$2,000.00	$4,000.00	$2,000.00	$4,000.00
2	CEMENT SURFACE CASING	1	job	$25,000.00	$35,000.00	$25,000.00	$35,000.00
G.	**CONTRACTOR REIMBURSABLE**						
	SUPPLIES AND DRILLING MUD						
1	REIMBURSEMENT OF AUTHORIZED PURCHASES	n/a	n/a	n/a	n/a	$10,000.00	$15,000.00
2	GEOPHYSICAL LOGGING	n/a	n/a	n/a	n/a	$6,000.00	$10,000.00
3	GEOLOGIC AND ENGINEERING SERVICES	n/a	n/a	n/a	n/a	$7,000.00	$12,000.00
	TOTAL FOR ITEMS A.1 THRU G.3					$235,350.00	$312,150.00

Appendix C Explanation of Financial Calculations

The following section explains the rationale behind the financial calculations presented in the pro forma income model and the accompanying Microsoft Excel spreadsheet.

What If

This is the tab that "runs" the spreadsheet. All of the financial measures are reported on this page. If the user desires to run sensitivity or what if calculations, this is the page to do so. One may vary the capital costs and the selling price.

Financial Statements

The Income Statement, Balance Sheet and Cash Flow statement are included on this page. These are the standard accounting documents a company uses to track finances.

Assumptions

The assumptions page lists the economic variable impacting the business. These include: annual inflation rate, loan interest rate, down payment on loan, loan term, effective income tax rate and depreciation method.

Depreciation

This page includes depreciation of the capital equipment and calculates loan payments for capital equipment. The depreciation approach is the Modified Accelerated Cost Recovery System (MACRS). The model also incorporates a 30% first year depreciation in addition to MACRS values. The percentage values for MACRS are shown in Table 14.

Table 14 MACRS Depreciation Values

Year	% Depreciation
1	**20.00%**
2	**32.00%**
3	**19.20%**
4	**11.52%**
5	**11.52%**
6	**5.76%**

Capital Costs

This page lists the major capital costs and shows the relative cost of each of the major capital cost items. The components of the major capital costs are shown in greater detail on separate worksheets.

Utilities

Utilities are one of the operating costs for the district heating system. This page projects electricity consumption and power demand for the system.

Geothermal

This page outlines the various costs of the geothermal system. The major components are a production well, injection well, distribution line, storage tank, controls, pumps and a heat exchanger. The well is approximately 1,000 feet deep producing fluids at 145°F.

There is ample reason to believe the well will flow artesian only necessitating a pump for the injection well.

Propane
This tab provides information on the cost of using propane to meet the thermal demand.

Payroll
This page describes the labor rates and personnel, including benefits.

Appendix D Summary of New Mexico-Based Financial Resources

ACCION New Mexico
http://www.accionnewmexico.org/
ACCION New Mexico is a nonprofit organization that increases access to business credit, makes loans, and provides training which enable emerging entrepreneurs to realize their dreams and be catalysts for positive economic and social change.

Enchantment Land Certified Development Company (ELCDC)
http://www.elcdc.com/
Assists communities with their economic development goals by offering New Mexico small businesses long-term, fixed interest rate financing for real estate and equipment needs. The applicant puts up a minimum of 10% of the total funds for a project. Single purpose type facilities could require up to an additional 5% down, and new/start-up businesses another 5%. The SBA (via the ELCDC) provides up to 40% or $1,000,000 ($1.3 million in certain circumstances), whichever is less, and the private sector lender provides the balance of the money. The SBA portion of the loan is at a fixed rate for a term of 10 or 20 years. The bank portion of the loan is at market rates and terms.

Minority Business Development Agency
http://www.mbda.gov/
The Minority Business Development Agency funds Business Development Centers around the country to assist with the start-up, expansion and development of minority-owned firms. Minority Business Development Centers (MBDCs), Native American Business Development Centers (NABDCs), and Business Resource Centers (BRCs) provide individualized management and technical assistance to minority entrepreneurs at every stage of business development. Minority Business Opportunity Committees (MBOCs) coordinate Federal, state and local business resources. They are designed to identify business opportunities and leverage existing programs to increase market access for minority-owned firms. Contact information for the local office is below:

<u>New Mexico Statewide MBDC</u>
718 Central Avenue S.W.
Albuquerque, NM 87102
Tel: (505) 843-7114
Fax: (505) 242-2030
info@nedainc.net

National Center for American Indian Enterprise Development
http://www.ncaied.org
Services are designed to assist Indian tribes, organizations, and individuals in achieving their economic objectives through enhanced business management. The southwest office is located at:
953 E. Juanita Avenue
Mesa, AZ 85204
Tel: (480) 545-1298
Fax: (480) 545-4208

Native American Business Alliance
http://www.native-american-bus.org
The mission of the organization are: to facilitate mutually beneficial relationships between private and public businesses with Native American owned companies and t***o*** educate the communities on Native American culture, paving the way for future generations. The Native American Business Alliance will hold its 2004 Convention at the Hyatt Tamaya Resort and Spa near Santa Fe and Albuquerque on April 25-27, 2004

New Mexico Community Foundation (NMCF)
http://www.nmcf.org
The New Mexico Community Foundation is a statewide endowment building and grant-making organization that serves and invests in New Mexico's communities and their people.

Small Business Administration Programs
http://www.sba.gov/nm/financing.html

MicroLoan Program
The MicroLoan Program was developed to increase the availability of very small loans to prospective small business borrowers. Under this program, the SBA makes funds available to nonprofit intermediaries, who in turn make loans to eligible borrowers in amounts that range from under $100 to a maximum of $25,000. The average loan size is $10,000. Completed applications can usually be processed by the intermediary in less than one week. The following link lists MicroLoan participants in New Mexico: http://www.sba.gov/nm/micnm.html.

Preferred/Certified Lenders
Certified lenders are those who have been heavily involved in regular SBA loan-guaranty processing and have met certain other criteria. They receive a partial delegation of authority and are given a three-day turnaround by the SBA on their applications (they may also use regular SBA loan processing). Certified lenders account for nearly a third of all SBA business loan guaranties. The following link includes a list of PLP/CLP participating banks in New Mexico: http://www.sba.gov/nm/plpnm.html

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Market Analysis, Tree Seedling Greenhouse
Pueblo of Jemez, New Mexico

Prepared for:
Pueblo of Jemez
Jemez, New Mexico 87024

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March 31, 2004

DISCLAIMER

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Overview

McNeil Technologies focused its efforts on exploring the feasibility of raising tree seedlings in a greenhouse, utilizing the geothermal resources as an economically competitive source of energy. Research was conducted on the Internet and phone calls were made to people involved in the business of growing or purchasing seedlings.

Defining the Product

A seedling is a young tree, not larger than four inches in diameter. There are two major types of seedlings: (1) container and (2) bareroot. *Bareroot* stock is typically grown in native soil in open fields. This type of seedling would not take advantage of the geothermal resource, and is not product being considered.

Container seedlings are grown in artificial media in a controlled environment, such as a greenhouse. They are also referred to as "plug" seedlings, because they are harvested with the root systems and growing medium forming a cohesive plug. *Miniplugs* are grown in very small containers for transplanting later. Container seedlings are typically grown in one year or less.

The key question is whether there is a demand for container seedlings in the Pueblo of Jemez area (New Mexico and surrounding states), and if so, whether Jemez can profitably meet this demand.

Given the need for reforestation due to fire, the US government and state and local agencies would be the most likely consumers. Moreover, public sector clients are likely to place larger orders, making marketing efforts more cost effective (compared with marketing to small-volume purchasers in the private sector).

Competitors and Potential Partners

1.1 State Forestry Agencies

State forestry management agencies run their own greenhouses for reforestation purposes. The New Mexico State Forestry Division provides over 45 species of low cost seedlings for reforestation, erosion control, riparian restoration, wildlife habitat, windbreaks and Christmas tree plantations. Since 1960, more than four million trees have been purchased through this program. To qualify to purchase these seedlings, a person must own at least one acre of land in New Mexico and the plantings must support conservation efforts.

The types of seedlings available are as follows: bare root, small container (one season growth), large container (two season growth), styro-block (two season growth), or one gallon (three season growth).

The seedlings may be picked up at one of the Forestry Division's delivery points or shipped via UPS *at no extra charge.* Seedling prices range from $0.72-$3.00 per tree,

with a minimum purchase of 15-50 trees, depending on the type of species and duration of growing seasons.

The Forestry Division grows trees largely as a public service and does not make a profit. It provides high quality seedlings through its cooperation with the New Mexico State University seed research program.

The New Mexico Energy, Minerals and Natural Resources Department encourages the planting of trees throughout the state through the New Mexico Re-Leaf Tree-Planting Grant Program. Funding for projects comes entirely from donations through corporations, Seedling Distribution Program, PIT Personal Income Tax "check-off" box and is Tax deductible. Support is provided for low-income buyers.

The New Mexico State Forestry Division rarely contracts out for additional seedlings. When it does, it solicits bids and selects the firm with the lowest cost and greatest technical expertise.

1.1 US Forest Service Federal Nurseries

The Charles E Bessey Nursery in Nebraska is one of six federal nurseries. There is also one in California, one in Oregon, two in Idaho, and one in Michigan. The nursery originally had a 4,000 square-foot greenhouse with a capacity of 380,000 seedlings; a new greenhouse has just been added, bringing the capacity to 640,000 seedlings per year. The nursery employs two full-time and six part-time personnel, and over 50 people during peak work periods.

Its primary mission is to provide seedlings to national forests in Region 2, the states of Nebraska and Kansas, the Bureau of Land Management, and the Bureau of Indian Affairs. Its primary market is state agencies. The state of Nebraska is planning to buy some seedlings from the Colorado Forest Service, because it wants larger containers than this nursery has available.

The Lincoln National Forest (New Mexico) is in need of seedlings due to forest fires, and the Arapahoe and Shoshone tribes wanted seedlings. There is some demand in Arizona and New Mexico due to forest fires.

The nursery works on a prior order basis, meaning they plant what they know they can sell. Prices are relatively high ($370/1000) in styroblock 160 containers. The company Cal Forest in Etna, California is selling seedlings for only $230-250. The California company produces 12-15 million containers per year. Canadian companies are also a major competitor.

The US Forest Service may be able to provide grants to Jemez for a nursery through its rural economic development program. The budget for this program has been cut, so it is unclear what the funding situation will be for 2004.

1.1 Bureau of Indian Affairs

The BIA is generally self-sufficient, and it has five greenhouses that supply seedlings for the New Mexico region (with a total capacity of 600,000 seedlings). These greenhouses also sell seedlings outside of BIA.

The Zuni greenhouse currently has some demand for its seedlings in Arizona due to the fires. This demand should last about two years. The Fort Apache greenhouse has had no

demand for the past two years. At one time, they grew trees for the Apache Sitgreaves National Forest, but now they are buying some trees from a Navajo tribe and from the Zuni greenhouse. The Navajo are selling seedlings for $0.75 each.

Initial Findings and Recommendations

We had several conversations with various government nursery and seedling program representatives to determine whether outside support is needed to meet demand. It appears that when gaps occur, they are filled by buying seedlings from counterparts in the government. During 2002, the Forest Service produced more seedlings than usual due to forest fires (a 7% increase from the previous year at about 31 million seedlings). In 2002, Region 3 (New Mexico and Arizona), only purchased 145,000 seedlings through private contracts. Despite forest fires, reforestation activities have fallen sharply over the past decade; reforestation efforts are not keeping pace with reforestation needs.

An entire crop can be wiped out by disease or sudden temperature problems in the greenhouse. If the crop is not sold, it can become useless (difficult to transplant). There is also a major learning curve, although there may be a tribal training program available through the US Forest Service.

Prices range from $0.23 to $3.00 per seedling. If Jemez offered seedlings at a competitive price of $0.30 and sold 400,000 seedlings, it would earn $120,000. At $0.75, the price the Navajo are getting, the sales income would be $300,000. Given the extensive lists of costs (see below), it may take a long time to break even. Note that labor is not included in the list of costs.

An average of one laborer is needed for 200,000 seedlings and one supervisor for 3,000,000 seedlings. Thus, employment benefits are minimal. However, at peak times, as many as 50 people may be needed.

Given that possible markets are volatile (based on budgets for reforestation and the frequency of forest fires), it is not recommended that the Pueblo of Jemez pursue a tree seedling greenhouse.

Possible Costs

- Main greenhouse
- Shades or fans for main greenhouse
- Cold storage is needed for extracted stock – refrigerated building or shade house
- Management office
- Geothermal power supply
- Backup power (utility hook up and generator)
- Insurance
- Alarm system
- Irrigation system
- If fertilizer is injected through the irrigation system, may need to install backflow preventers.
- An assessment of water suitability is needed
- Water filtration or chlorination may be needed (equipment)?

- Environmental control equipment (computer to monitor conditions, etc.)
- Pallets, forklift, benches (can be homemade)
- Tractor
- Seedling production, extraction and handling equipment
- Conveyors
- Containers – *the choice of container will determine design of propagation area, types of benches, and the choice of handling and production equipment.* The container selection will depend on species being grown, conditions for outplanting, and specifications of consumers (who may supply the containers).
- Storage racks
- Growing media (inputs for artificial dirt)
- Pesticides, sprayers
- Storage/shipping boxes
- Need a refrigerated delivery van. Alternatively, Jemez could use overnight mail, but the pickup costs and reliability of parcel carriers could make this option prohibitive.
- Fuel costs, vehicle insurance, maintenance and depreciation are factors. Need to deliver the stock to the storage or the outplanting site.
- Road must be accessible for delivery of supplies and shipping of stock. Repairs or paving may be needed

Native Herbs, Inc. – A Business Plan
Pueblo of Jemez, New Mexico

Prepared for:
Pueblo of Jemez
Jemez, New Mexico 87024

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DISCLAIMER

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Executive Summary

Native Herbs, Inc. will grow and sell organically certified fresh-cut herbs for culinary use. Sales of culinary herbs have grown substantially as Americans have become more health conscious and have begun to enjoy a greater diversity of cuisine. Certified organic herbs are cultivated on more than 90,000 acres in the U.S.[i]

Organic fresh herbs can be grown outdoors or in greenhouses. Native Herbs will operate a greenhouse using an on-site geothermal source, providing important competitive advantages. Using a greenhouse will enable Native Herbs to supply its customers year-round. Moreover, the geothermal energy source is both low-cost and resistant to price fluctuations. Most of the herbal greenhouses in New Mexico and Colorado shut down during the winter because they cannot operate at a profit when heating bills increase.

Native Herbs, Inc. will offer fresh cut herbs at a competitive price. Initially, it will target sales to distributors in order to break into the market. As it establishes a brand name and reputation for quality, Native Herbs will begin selling directly to grocery stores and restaurants. Sales will be focused on the local market in order to minimize transportation costs and to capitalize on the desire of consumers to support New Mexico's own growers. Native Herbs will sell approximately 9,000 pounds of fresh herbs per year.

The initial capital costs for the business will be $305,875. The Pueblo of Jemez will contribute approximately $25,000 in cash to start the business. There are no lease costs for the land, since it owns the reservation. The Net Present Value of the firm is $1,082,528, based on the first ten years of operation. Cash flow will become positive between years four and five.

Geothermal costs are not included as part of the initial investment costs because it is assumed a demonstration grant will be obtained for this portion of the project. If geothermal costs are included, capital costs grow to $568,425 and cash flow becomes positive in year six. If geothermal costs are not included, Native Herbs will break even somewhere between years four and five.

Profitability will be highly dependent on selling direct to grocery stores and restaurants, since packaging greatly increases the selling price (from $6.00 to $32.00 per pound). Switching from sales to distributors to direct sales will enable Native Herbs to reap these benefits. Native Herbs will begin making the transition to direct sales in the second year of operation, targeting 25% direct sales in year two, 35% in year three, 50% in year four, 80% in year five and 90% in year six.

Operating a greenhouse is a new endeavor for the Pueblo of Jemez, and Native Herbs will take part in various training programs in greenhouse management and business offered by the state of New Mexico. A professional grower will be retained to manage the facility and interface with customers. A marketing specialist will join the staff to expand sales. Residents of the Pueblo will be hired to harvest the crops and operate the greenhouse.

Native Herbs, Inc. will be responsive to changes in demand for different herbs. Crops will be substituted to meet customer demand, which fluctuates with changes in season and in response to economic and culinary trends. This strategy will help ensure a steady

revenue stream. The business plan shows that Native Herbs, Inc. will be a profitable venture.

Business Opportunity

The market for specialty herb crops has been growing rapidly in the United States over the past several years. Although growing takes place on a relatively small scale, these crops sell at high prices compared to traditional vegetable crops. It is possible to operate a greenhouse business that focuses solely on herbs.

More than 400 species of plants are grown for the US herb and spice industry. This industry consists of several market segments, based on the many uses of herbs: food, medicine, cosmetics and decoration – to name just a few. Each market segment involves different certifications and marketing techniques. Therefore, it is important to focus on one market segment and develop a brand name and reputation in a specific area.

One of the most promising market segments is the culinary herbs business. It is a segment that benefits from having a greenhouse, since culinary herbs are in demand year-round by grocery stores and restaurants. Preliminary phone calls to potential buyers – both wholesalers and retailers in New Mexico -- indicate that there is room for more suppliers in the regional market. Some of the most popular culinary herbs are basil, cilantro (coriander), chives, chervil, dill, oregano, mint, parsley, rosemary, sage, tarragon and thyme.[ii] [iii] Due to the high demand for basil relative to other herbs, at least 50 percent of the greenhouse production will be dedicated to this herb. Due to this high proportion, the projections in this business plan are based primarily on the market for basil.

Since many herbs are temperature sensitive, building a greenhouse enables producers to grow crops throughout all four seasons. A greenhouse will be built on the southern end of the Jemez reservation, taking advantage of the on-site geothermal resource. Since energy is one of the major costs of a greenhouse business, Native Herbs, Inc. will be able to save on fuel bills – giving it a competitive advantage in the marketplace.

Business Form

Native Herbs, Inc. is an 8(A) firm owned and operated by residents of the Pueblo of Jemez. The firm, established in 2004, is a grower of organically certified fresh herbs for sale to regional food markets including restaurants, grocery stores and open-air markets. The 8(A) designation (applied for) allows for certain preferential product purchase treatment at regional state and federal institutions.

Native Herbs benefits from its location, enabling it to offer a high quality product at a competitive price. Its herb products are grown in a greenhouse to allow for year-round product sales. The greenhouse is geothermally heated, thereby capturing a low-cost, stably priced energy source to allow for maintenance of proper growing temperatures. The New Mexico location fosters the growing of a healthy plant due to the low humidity and abundant sunshine. Low humidity reduces the incidence of plant disease and insects. Abundant sunshine, particularly in the winter, allows for production without the use of expensive artificial lighting.

Market

1.1 Trends

The U.S. has experienced substantial growth in the sales of herbal products. Basil consumption, for example, has increased eight-fold since 1960.[iv] This trend reflects healthier lifestyles and an increase in ethnic cooking which uses herbs. Thai, Italian and Mediterranean are some of the restaurants and styles of cooking that use these herbs.

In general, prices for specialty crops such as herbs are high compared to traditional field crops. Based on a pound per square foot of greenhouse space, prices for herbs are much higher than for tomatoes or other food crops. In addition, prices for fresh cut herbs have tended to be more stable than for other herb products, such as such as herbs grown for medicinal supplements.[v]

1.1 Size

California, Florida, Hawaii and New Jersey are the major producers of wholesale fresh-cut culinary herbs in the U.S. However, the U.S. production of herbs is only a fraction of the worldwide total. The US produced 2,500 acres of basil in 2000, compared to 25,000 acres produced worldwide.[vi] Overseas competitors include: Israel, Mexico, Peru, Costa Rica, Canada and France (see **Table 15** below). These countries ship fresh herbs to the U.S. by air freight; they are able to compete with US suppliers because shipping costs are offset by low labor costs and high productivity. Mexico is the top producer of sweet basil, largely due to the fact that it offers this product at a low price.[vii]

Locally, there is only one year-round herbal greenhouse in New Mexico -- Aroma Fresca. B. Riley Fresh Herbs, Inc. and Bluebird Herb Farm grow herbs only during the warmer parts of the year. There may be other growers of herbs in the area, but if they exist, they are probably very small-scale operations.

Table 15 Estimated Number of Acres Cultivated for Specialty Herb Crops in North America and Worldwide[viii]

Crop	North America (Ac.)	World (Ac.)
Basil	2,500	25,000
Dill	10,000	91,500
Parsley	62,000	620,000
Mint	40,000	600,000
Sage	6,000	400,000
Thyme	6,000	82,000

1.1 Market Niche

There are many uses and markets for herbs, and each market segment is relatively thin. Native Herbs, Inc. will focus on culinary herbs, which is a relatively accessible market for new entrants.

Pharmaceutical companies and wholesalers are selling a growing volume of medicinal herbs. These herbs are used as alternatives or complements to traditional medicine.

However, medicinal botanicals require a high level of expertise and a significant amount of time and expense dedicated to marketing efforts.[ix] The start-up costs of some medicinal herbs are prohibitive; Echinacea, one of the most popular herbal supplements, takes three years to harvest and may require a $10,000 per acre investment. It is also grown outdoors, rather than in a greenhouse environment.[x]

There is a crossover market segment for medicinal plants such as chamomile, mint and Echinacea, which are frequently used in herbal teas (known in this case as nutraceuticals). However, competition from the world market is strong in this area.[xi] Moreover, the evolving regulatory environment governing natural medicinal products brings an additional element of uncertainty and risk.

Essential oils are distilled from herbs for their aromatic value. They are used in cosmetics, fragrances, certain foods and aromatherapy products. Herbs typically used for essential oils include anise, rosemary, sage, coriander, caraway, calendula, "Omega" flax, parsley, sage, sweet basil, sweet fennel, lavender, chamomile, dill and others. These markets represent a small cottage industry, served mostly by individuals. Due to its small scale and intensive marketing, this niche will not be the primary niche targeted by Native Herbs, Inc.

Certain trends have boosted the market for fresh herbs: healthier lifestyles, proliferation of ethnic foods which use herbs, and the greater use of herbs in finer restaurants.[xii] In terms of fresh, culinary herbs – there is no substitute. If a recipe calls for fresh basil, it is difficult to replace the flavor and aroma it provides. This applies to food consumed in restaurants, as well as food bought in grocery stores and cooked at home. Recent studies show that a growing number of consumers prefer fresh-cut produce. Although not specific to herbs, a survey found that 76% of all households purchase fresh-cut produce at least once a month. Eighty-five percent purchase fresh-cut produce every few months or more. Sales have grown from $5 billion in 1994 to $10-12 billion in recent years.[xiii]

1.1 Products

Native Herbs, Inc. will adapt its crop mix to adjust for fluctuations in the demand for specific products. Basil is by far in the greatest demand by grocery stores as well as restaurants. Rosemary, thyme, mint, chives and dill are also popular sellers.

Native Herbs, Inc. will be flexible, since the demand for various herbs will fluctuate with season and market conditions. In addition, crop quality may fluctuate, making diversification a good insurance policy. Approximately half of the greenhouse will be dedicated to basil, with the other half dedicated to varying amounts of the other popular herbs.

Marketing Strategies

In order to minimize shipping and transportation costs, sales efforts will target local customers in urban areas – places such as Rio Rancho, White Rock, Los Lunas, Albuquerque and Santa Fe. Staying local will also help Native Herbs, Inc. become an established name in the marketplace. However, Native Herbs, Inc. may need to expand its marketing efforts if it cannot meet sales targets based only on local customers. Although it is further away, Taos has many stores and upscale restaurants that could be interested in fresh herbs. While the initial target market is within New Mexico, it will be important to

investigate expanding to Arizona and Colorado. Specifically, Durango is within easy delivery distance as is Pagosa Springs. Larger metropolitan areas like Flagstaff and Colorado Springs are also potential additional market outlets.

1.1 Organic Certification

Native Herbs, Inc. will seek organic certification for its products. Organic certification opens doors to customers who might not otherwise be available; it does not appear to have any real disadvantages. Organic foods represent the fastest growing segment of the retail food industry, with a growth rate of 20-25% annually. Organic products are available in nearly 20,000 natural food stores and 73% of conventional grocery stores in the U.S.[xiv]

Obtaining organic certification is expected to broaden the market potential and the cost is minimal. The New Mexico Organic Commodities Commission (NOCC) is accredited by the US Department of Agriculture (USDA) as an organic certifier. To qualify for an "organic" label, growers cannot use synthetic fertilizers or pesticides, antibiotics, genetic engineering, irradiation or sewage sludge in the growing process. The most recent requirement imposed by the federal government is that seeds must be organic.[xv]

The federal government will pay up to 75% of the certification costs (up to $500) through September 30, 2004.[xvi] This discount is due to a $60,000 grant to the NOCC under the 2002 Farm Bill. Even if this time period is missed, working with the NOCC is probably less expensive than working with other certifiers in New Mexico because it is a state agency. The cost is a $150 application fee, plus one-half of one percent of gross sales.[xvii] The NOCC follows up with visits and inspections.

1.1 Product Distribution

The product distribution strategy will change with time. Initially, it will be necessary to work almost exclusively with product wholesalers such as Aroma Fresca or B. Riley. A wholesaler can store, handle and package the herbs, thereby reducing certain costs and labor for Native Herbs. Wholesalers have access to a wide range of existing customers. Working with wholesalers can provide Native Herbs, Inc. with immediate market access for its product.

Several distributors have expressed a willingness to sell Native Herb products if the firm is able to meet service and quality requirements. While price is important, service and quality are generally higher order considerations.

Service requirements include the necessity of delivering fresh herbs in a timely manner to a local distribution point. Herbs must be cut late in the afternoon, kept in constant refrigeration, and delivered to the distribution point by 6:00 AM, six days per week. The delivery points are all located within a one-hour drive of the Pueblo of Jemez.

Product quality is reflected in the crispness of the plant, the overall product color, and the lack of damage to the product. Damage can occur as a result of contact with ice (i.e., the preferred method of refrigeration is a cooler filled with ice), as well as handling from the cutting process.

After the first year of operation, Native Herbs will begin to distribute directly to a select number of customers. Since the wholesaler adds a mark-up before the product goes to the retailer, Native Herbs may be able to realize a greater profit by bypassing the middle

man. A retailer (such as a grocery store) typically charges a margin of 40 percent over the grower's selling price, and a wholesaler (indirect distribution) typically charges 22 percent.[xviii] Mark-ups are even higher for fresh herbs. Direct distribution will allow for greater revenue potential but will incur additional sales and product costs.

When Native Herbs, Inc. sells directly to grocery stores, it will need to do its own packaging. Packaging involves weighing the herbs, putting them in packages, and labeling the packages. It is not a complicated process, but it is labor intensive and must be completed quickly prior to chilling the herbs and shipping them.

Native Herbs will be able to compete with large wholesalers by differentiating its products in terms of price, organic certification and the appeal of offering "locally grown" products. Since it may take some time to perfect logistics management and refine the flavor of the crops, the biggest advantage Native Herbs has in the short-run is the ability to compete on the basis of cost.

In the long run, great care will be taken to build and maintain a customer base -- particularly once the direct sales approach is pursued. Since many herbs are mass-produced at a relatively low cost by foreign growers, Native Herbs, Inc. will seek buyers that reward high quality with higher prices.

Customers

It is anticipated that all sales will be to distributors during the first year of operation. As Native Herbs, Inc. becomes more comfortable with running a greenhouse business, it will expand sales to other types of customers and begin direct sales. Table 16 illustrates this progression.

Table 16 Mix of Sales Between Distributors and Direct Sales, Native Herbs, Inc.

Sales	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
% Indirect	100%	75%	66%	50%	20%	10%
% Direct	0%	25%	34%	50%	80%	90%
Revenue	$56,304	$118,473	$142,058	$183,699	$261,703	$289,963

1.1 Distributors

Distributors typically depend heavily on a few sources for most herbs. Quality of product and reliability of supply are the two most important factors cited in choosing growers. B. Riley and Aroma Fresca both expressed possible interest in obtaining herbs from Native Herbs, Inc. for their existing customers. Another New Mexico greenhouse, the Bluebird Herb Farm, operates only part of the year and often buys from suppliers due to their short growing season.

B. Riley

Donna Tran at B. Riley stated that the most important factors in selecting herb growers are: price, quality and service. The company may be interested in buying herbs from outside sources if its conditions are met.

The selling price for herbs is $10.50 per pound for all types. The mark-up is 0-50%, with a 50% mark-up on basil. The company sells 70-100 pounds/day of basil six days per week.

Aroma Fresca

Aroma Fresca grows organic herbs and sells them wholesale to grocery stores and restaurants. The company also sells direct from its warehouse.

Susie Blott, President of Aroma Fresca Inc., noted that she buys herbs from other growers. Anyone she buys from must have organic certification, but Ms. Blott noted that this process could probably be completed in as little as 60 days if done by the in-state certification body.

The company buys 200 pounds of basil per week, mostly from California, Arizona and Mexico. Aroma Fresca buys a total of 125-150 pounds of all other herbs combined (chives, dill, mint, rosemary, sage, tarragon, bay leaf, oregano, etc.). There are season variations, with March-May being the slower months.

It is noteworthy that Aroma Fresca does not grow herbs in the winter due to continuing water shortages and high energy costs. It is cheaper for Aroma Fresca to buy the herbs than to grow them in the winter.

Bluebird Herb Farm

Presently, Bluebird is trying to sell its herb greenhouse. This means there may be a gap in production and could lead to market opportunities in the Taos area.

1.1 Retail Stores

Gourmet and organic grocery stores are good targets because they cater to health-conscious customers and those who value fresh produce. Native Herbs will target these customers in year two. Grocery stores typically buy from regional warehouses, but conversations with produce managers in New Mexico and Colorado reflected a desire to support local businesses. Native Herbs intends to pursue contracts with Albertsons, Whole Foods, and Smiths.

1.1 Restaurants

Upscale restaurants in Albuquerque and Santa Fe have suppliers of fresh herbs, just as they do suppliers of fresh fish and other ingredients. Hotels and spas in the area also serve food and may use fresh herbs. The restaurant market is not an immediate target for Native Herbs but will be pursued starting in the second year.

1.1 Farmers Markets

Farmers markets sell herbs, primarily on a seasonal basis. There may be an opportunity for Native Herbs to fill a gap in the market and sell some herbs during the off-season (fall and winter). Red Rocks, Corrales, Los Ranchos, Santa Fe and Albuquerque are locations of farmers markets where Native Herbs will sell its product.

Personnel

Four full-time and two part-time employees will be required to operate Native Herbs, Inc. The key person will be the grower, who is responsible for all aspects of running the

greenhouse -- product selection, crop cultivation, and product sales. A part-time administrative person will assist the grower managing the office, including correspondence, filing, etc. A part-time delivery person will be charged with transporting the herbs. Two workers will cultivate, harvest and process the crop. A professional grower will be hired to determine the growing techniques that deliver the best results. Some of the key variables are: choice of growing media, moisture levels, temperature, spacing between plants, seeding, fertilization, pest control, harvesting techniques, and storage conditions.

The grower must have knowledge of herb markets as well as horticulture, since it may be necessary to experiment with different crops as demand fluctuates. More time will be required for marketing than production.[xix] Therefore, the grower must have an understanding of food marketing and distribution. This person must be able to talk with distributors and retailers to negotiate orders and contracts.

The non-managerial staff will have important functions. An administrative person will be needed to manage payroll, finances and other office functions. It is anticipated this person will be employed by the Department of Finance and Administration and will have part of their salary covered by greenhouse operations. This person will work closely with the grower and will help oversee productivity. A driver will be needed for deliveries and will work half-days. Reliable greenhouse workers will be needed to maintain, harvest and process the crops for delivery.

Revenue permitting, a marketing specialist will be added in year five.The business is highly dependent on maintaining customer relations and expanding direct sales, and this person will seek out and negotiate new sales contracts.

Regulatory Climate

Since the location of the greenhouse is zoned for agricultural activity, Native Herbs, Inc. should be able to grow crops for commercial purposes. In addition, Native Herbs, Inc. will need to register as a business entity. Native Herbs will need to apply for organic certification (described earlier). Further, Native Herbs will seek to obtain 8(A) status which may take as long as one year to obtain. Assistance in performing these registrations can be provided by the state small business support agencies listed in Appendix B-1.

Financials

1.1 Investment

The initial major capital costs include a greenhouse, geothermal system, utility connection, fresh water supply and delivery van. It is estimated that a new, 24,000 square foot greenhouse will cost $240,000. The major cost categories for the greenhouse are: frame, covering, end walls, floor, heating, cooling, watering, benches and construction. Approximately 85% of the space in the greenhouse will be productive growing area.

The geothermal system will cost $262,550. This investment in capital infrastructure will be cost effective, since the levelized cost of propane (the alternative source of heat) is $16.81/MMBtu, compared with $13.38/MMBtu for geothermal. It is assumed that the geothermal system will be paid for through a grant.

Establishing a fresh water supply will cost approximately $30,875 and a delivery van will cost $20,000. The distribution of capital costs is exhibited in Figure 5 and further detailed in the appendices.

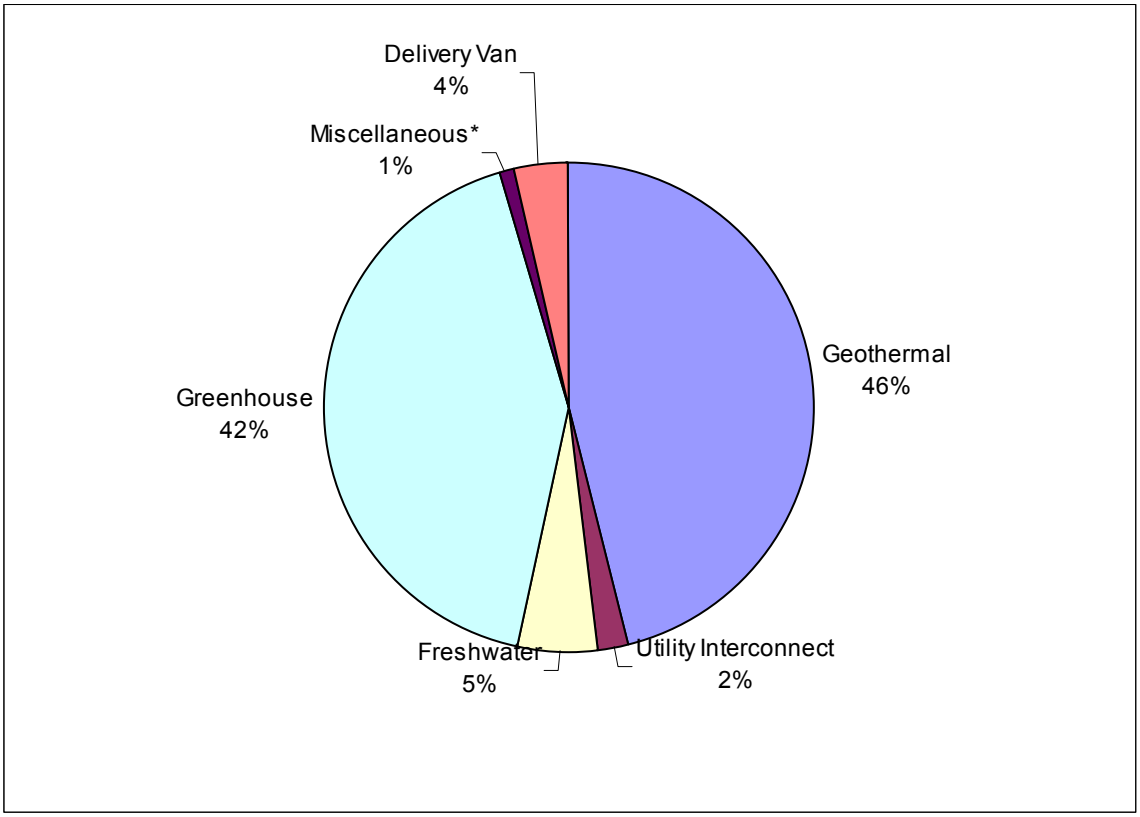


Figure 5 Distribution of Capital Costs, Native Herbs Inc.

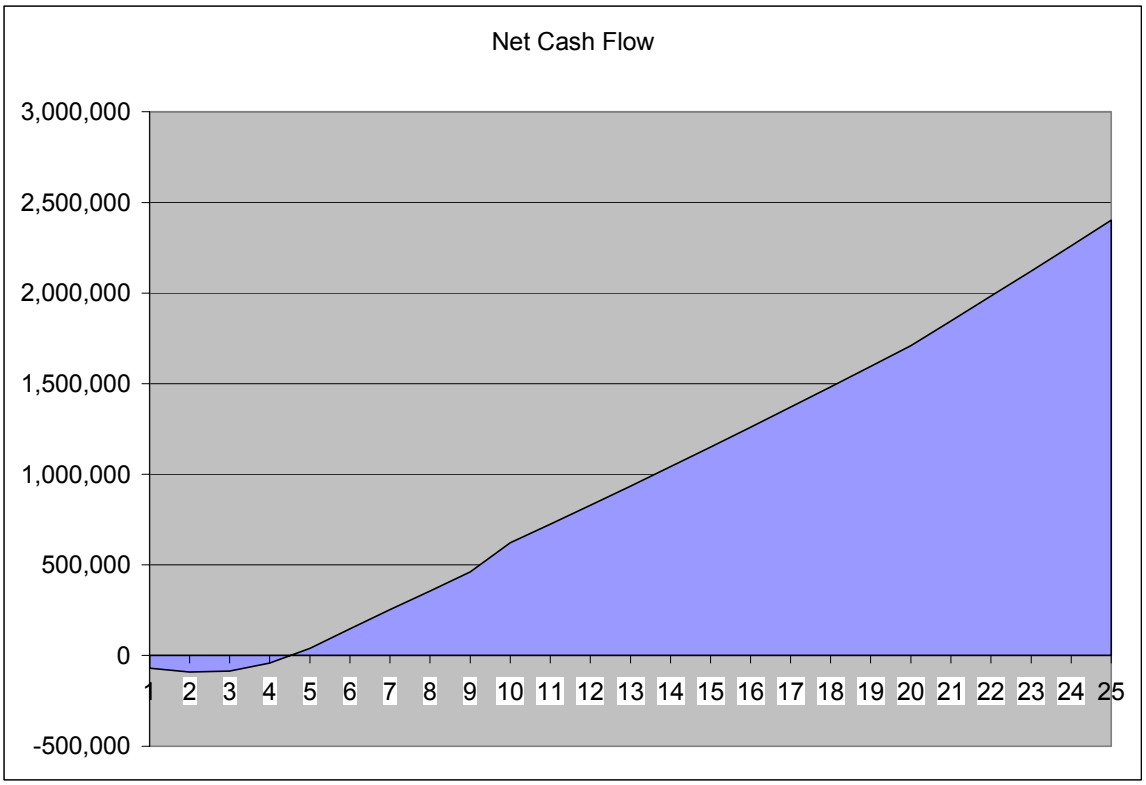
1.1 Revenue Projections

A spreadsheet pro forma income model was used to input costs and revenue and project annual cash flows over the business horizon. In this fashion we are able to calculate both the net present value (NPV) of the business venture as well as the levelized cost of production. We are also able to perform multiple "what-if" or sensitivity calculations by varying the multiple inputs and assumptions. The financial statements are included in the Appendices.

Revenues will vary with the sales volume and type of product sold. Pre-packaged items sell at a much higher price than bulk herbs. Packaged herbs sell for $1.00-3.47/oz in grocery stores ($16-55.52/lb). Prices for bulk sales range from $1.60-10.50 per pound. See the appendices for more details. Native Herbs will have revenues of $56,304 in year one, $118,473 in year two and $261,703 by year five. This increase in revenue reflects the growing portion of direct sales as shown in Table 16.

Based on revenue projections, net cash flow will be positive between years four and five, see Table 17.

Table 17 Projection of Net Cash Flow, Native Herbs Inc.



The Net Present Value (NPV) is $11,810,428 based on a 25-year life cycle. If the time horizon is shortened to 10 years, the NPV is $1,082,528. The five-year NPV is a negative $229,558.

Competitive Advantages and Threats

The market for fresh cut herbs is rather limited, and the barriers to entry are relatively low. New competitors could easily arise in New Mexico and surrounding states. The greatest threat is within the state, since out-of-state growers need to cover higher transportation costs. Native Herbs, Inc. will work hard to uphold the quality of the product and service provided in order to remain competitive.

Due to low labor costs, there is also substantial competition from foreign growers, particularly south of the border. The threat of foreign herbs flooding the market is more of a consideration in the grocery store business than in dealing with restaurants, which are known to prefer working with a familiar supplier (to ensure that quality is consistent).

Since there are few jobs on the reservation and surrounding area, it should be relatively easy to attract labor at competitive wages. Native Herbs should at least be able to compete with other local growers in this respect.

The fact that Native Herbs has its own low cost energy source is something that few, if any, competitors will be able to duplicate. Aroma Fresca does not grow as much during the winter due to high heating costs. Bluebird Herb Farm, which heats with propane, appears to be closed most of the winter (according to its web site). Dwyer Greens & Flowers, a greenhouse that grows herbs and flowers near New Castle, Colorado, is closed in the winter – despite having a 4,000 square foot greenhouse.[xx] The low-cost energy advantage will enable Native Herbs, Inc. to produce herbs that are inexpensive enough to sell to other greenhouse operators.

As a newcomer to the market, Native Herbs will build strategic alliances with wholesalers and other greenhouse operations in the state. With lower operating costs, it may able to sell herbs to other greenhouses – which have wide distribution networks – under a mutually beneficial arrangement. Buying from Native Herbs will allow these greenhouses to satisfy customer demand year-round, and it would facilitate market penetration for Native Herbs, Inc.

Recommendations

Native Herbs, Inc. has the potential to become a strong small-scale business in the culinary herbs market. These specialty crops command a high price per acre, and the greenhouse operation offers the flexibility to adapt crop selection to maximize profits.

The following actions should be taken to ensure success:

- Take advantage of the training and grants offered by state and federal government agencies. Areas which may be eligible for support include: geothermal power, Native American business, and rural business.

- Obtain organic certification and differentiate the product through this label

- Build a name and learn the business by working through distributors initially and expanding to direct sales later.

- Target local sales (e.g. New Mexico, ideally within 50 miles) to minimize transportation costs.

Using its competitive advantages of on-site geothermal energy, land ownership and geographic location, Native Herbs will be able to compete on the basis of cost and expand its distribution. By year five, the company should be profitable, and the company should be worth over $1 million by year ten.

Appendix A-1: Explanation of Financial Calculations

The following section explains the rationale behind the financial calculations presented in the business plan. It is organized to follow the sequence of the spreadsheets.

1.1 Return Measures

These pages provide graphical representations of the financial position of the company. The Net Cash Flow becomes positive between Years 4 and 5. The second graph shows the distribution of major costs. From the pie chart we can see that payroll is the largest recurring cost, representing 58% of expenses. Fixed plant costs represent 21% of the pie. Common financial measures such as Net Present Value, Return on Investment are also listed. The value of the investment over 25 years is nearly $12 million.

1.1 Break Even

The Break Even Analysis indicates how much needs to be produced to cover costs. Due to factors such as depreciation and changes in production mix, the break even volume fluctuates over time. Note that the yield inputs, greenhouse space and prices can be adjusted to create "what if" scenarios. The most profitable scenario is to sell packaged herbs directly to customers. Selling direct enables Native Herbs to obtain a much higher price. Since the total crop production is estimated to be 9,384 pounds, the volume of production required to cover costs cannot be less than this amount. If it is less, it means the company is operating at a loss.

The situation is less profitable if sales are made through distributors. In this case, the sales price falls from $32 to $6 per pound, and much more volume needs to be grown to cover costs. In fact, if 100% of sales were made to distributors, Native Herbs would need to grow 51,027 pounds in the first year, 32,430 in 29, 249 in the third year. The required volume is much higher when selling indirectly -- 51,027 pounds as opposed to 7,937 pounds.

In reality, Native Herbs will sell a portion of its crop directly and a portion indirectly. The first year, all sales will be indirect, with a growing proportion of direct sales. This page illustrates the importance of increasing the ratio of direct sales.

1.1 Financial Statements

The Income Statement, Balance Sheet and Cash Flow statement are included on this page. These are the standard accounting documents a company uses to track finances.

1.1 Assumptions

The assumptions page lists the economic variable impacting the business. These include: annual inflation rate, loan interest rate, down payment on loan, loan term, effective income tax rate and depreciation method.

1.1 Depreciation

This page includes depreciation of the capital equipment and calculates loan payments for capital equipment. The depreciation approach is the Modified Accelerated Cost Recovery System (MACRS). The model also incorporates a 30% first year depreciation in addition to MACRS values.

Table 18 MACRS Depreciation Values

Year	% Depreciation
1	20.00%
2	32.00%
3	19.20%
4	11.52%
5	11.52%
6	5.76%

1.1 Capital Costs

This page lists the major capital costs and shows the relative cost of each. The geothermal system is the largest cost at 46%, followed by the greenhouse at 42%. The components of the major capital costs are shown in greater detail on separate worksheets.

1.1 Utilities

Utilities are one of the major costs for a greenhouse. This page projects energy demand for the greenhouse.

1.1 Geothermal

This page outlines the various costs of the geothermal system. The major components are a production well, injection well, distribution line, storage tank, controls, pumps and a heat exchanger. The well is approximately 300 feet producing fluids at 145°F. There is ample reason to believe the well will flow artesian only necessitating a pump for the injection well.

1.1 Propane

The costs of using geothermal are lower than propane once the capital costs of the geothermal system have been covered. The levelized energy costs of geothermal are $13.38 per million Btu, in contract to propane, which is $16.81.

1.1 Payroll

This page describes the labor rates and personnel, including benefits. A grower and two laborers are required throughout the life of the business. In year five, a marketing person will be added to boost direct sales. Time is also allocated for part-time delivery and administrative persons. Detailed information about job responsibilities can be found in the main text of the business plan.

1.1 Fresh Water

A freshwater production well and distribution system will need to be drilled and installed at the southern location. These are estimated costs for such a system providing 16 gallons per minute of capacity.

1.1 Greenhouse

The greenhouse costs include the structure as well as the interior components (growing benches, heating and cooling, etc.). This page outlines the major investments required to start and operate the business. The costs on this page assume that plants will be grown using organic methods of production. Unless otherwise stated, costs are based on sweet basil production, which will be the dominant crop. The following section covers calculations and cites data sources for cost estimates used when it is not self-evident.

The cost of growing media was calculated as follows. There are 20,400 square feet of growing space. The growing beds contain approximately 8 inches of dirt, or .67 feet.

13,668 cubic feet of dirt are needed. This translates to 506 cubic yards. Assuming that a compost mixture will be used, prices are based on BioComp-Class I from A1 Organics, which costs $18.40/yd3. The annual cost is $9,310.40. Due to soil loss through harvesting and other activities, it is assumed that a total of 10% of the growing media will need to be replaced each year. This is based on conversations with greenhouse and nursery suppliers, so as A1-Organics based in Eaton, Colorado.

Organic seeds are available for $8.95/25g. Twenty-five grams are equivalent to .055 pounds. The cost is then $162.73 per pound. See http://www.veseys.com/store.cfm?product=2169. Approximately .4,683 pounds of seed will be needed (see http://www.icomm.ca/survival/herbs.don/herbs1.htm). The total cost for seeds amounts to $76.21. Note that organic seeds and other inputs are significantly more expensive than regular seeds, but they must be used in order to obtain organic certification.

Organic fertilizer containing nitrogen, phosphorous and potassium (Raingrow Organic Fertilizer) was found for $16.95 per kilogram. This is an all-purpose fertilizer, but the grower may ultimately recommend an alternative. http://www.veseys.com/store.cfm?product=1824&CFID=3783617&CFTOKEN=27463083

King Organic Bug Killer is available for $17.95 per two kilogram bag. Pesticides will be selected to target specific insects or bacteria, but this pesticide was selected because it is effective against a wide range of pests.

The line item for plastic bags and labels is based on the assumption is that there will be approximately 7,000 pounds of production per year. With a conservative estimate that one-ounce packages will be used, this means that 112,000 packages will be sold per year if all sales are made to grocery stores. However, in the second year, only 25% of production, or 1,750 pounds, is sold to stores. This equals 28,000 bags.

The costs for fuel and delivery vehicle maintenance are estimated on mileage covered by the delivery van. The van will make round-trips between the Pueblo of Jemez and Santa Fe two times per week , totally 150 miles for each trip. The van will make round-trips to Albuquerque, averaging approximately 100 miles per trip, three times per week. This totals 600 miles per week, for 50 weeks per year or a total of 30,000 miles. The current federal mileage reimbursement is $.375, so the total cost is $11,250 for the first year. We have assumed a 10% per year increase in the mileage rate.

Appendix A-2: Retail Prices for Packaged Herbs

Selling Prices for Fresh Cut Herbs in Grocery Stores

Store	Whole Foods, NM	Albertsons, NM	Safeway, CO
Description	2 oz Aroma Fresca (NM), $1.99 each, organic	.75 oz Dahn Brothers (TX) $1.79 each, not organic	.66 oz and 2 oz Herb Thyme (CA), not organic
Basil	$1.00/oz	$2.31/oz	$1.60/oz $3.47/oz
Rosemary	$1.00/oz	$2.31/oz	$1.60/oz
Marjoram	$1.00/oz		$3.47/oz
Oregano	$1.00/oz		$3.47/oz
Tarragon	$1.00/oz		$3.47/oz
Bay Leaf	$1.00/oz		$3.47/oz
Dill	$1.00/oz		$3.47/oz
Thyme	$1.00/oz	$2.31/oz	
Sage	$1.00/oz		$3.47/oz
Mint	$1.00/oz	$2.31/oz	$1.60/oz
Lemon Grass	$1.00/oz		
Sorrel	$1.00/oz		
Chives	$1.00/oz		$3.47/oz

Appendix A-3: Retail Prices for Bulk Herbs

Fresh Cut Herb Prices (2001) to the Restaurant Trade (US$)[xxi]			B. Riley Fresh Herbs, Inc. Price List 2/4/04	Montana report, price data from late 1990s/2000	Osage Gardens, Inc.
Herb	4oz	1lb	1lb		
Arugula		10.00	10.50		
Basil		7.50-8.25	5.00	1.60-8.00	8.00
Chevril	*5.00*	*20.00*	N/A		
Chives		10.00	10.50		
Cilantro		6.00	N/A		
			10.50	2.21-2.45	
Mint	*3.00-4.50*	*12.00-18.00*	10.50		
Oregano	4.00	10.00	10.50		
Parsley		6.00	10.50	4.80	
Rosemary	*4.00*	*16.00*	10.50		
Sage	N/A	N/A	10.50		
Tarragon	N/A	N/A	10.50		
Thyme	*4.00*	*16.00*	10.50	2.52-2.80	
Watercress	*3.00*	*12.00*	N/A		
Other	*4.00-5.25*	*16.00-21.00*	N/A		

Italics = numbers were given only on a 4oz basis and multiplied to get the per/lb cost which is not entirely accurate, since they would be slightly lower at the "bulk" rate.

Appendix A-4: Break-Even Analysis

Mixed Sales Break Even Analysis		% Mix	Weighted CM	Break Even Units	
CM to distributor	$4.79	100%	$4.79		
CM direct	$30.79	0%	$0.00		
			$4.79	52,021	Year 1
	$4.91	75%	$3.68		
	$31.43	25%	$7.86		
			$11.54	13,604	Year 3
	$4.97	66%	$3.28		
	$31.76	34%	$10.80		
			$14.08	10,030	Year 4
	$5.03	20%	$1.01		
	$32.09	80%	$25.67		
			$26.68	6,912	Year 5

Appendix E-5: Income Statement

Income Statement	1 **Year 1**	2 **Year 2**	3 **Year 3**	4 **Year 4**	5 **Year 5**	6 **Year 6**	7 **Year 7**	8 **Year 8**	9 **Year 9**	10 **Year 10**
Revenue										
Sales	56,304	118,473	142,058	183,699	261,703	289,963	292,862	295,791	298,749	301,736
Total Revenue	56,304	118,473	142,058	183,699	261,703	289,963	292,862	295,791	298,749	301,736
Costs and Expenses										
Variable Cost										
Plant production	11,361	11,475	11,589	11,705	11,822	11,941	12,060	12,181	12,302	12,425
Subtotal, Variable Costs	11,361	11,475	11,589	11,705	11,822	11,941	12,060	12,181	12,302	12,425
Fixed Costs										
Depreciation	130,185	66,276	39,766	23,859	23,859	11,930	0	0	0	25,011
Payroll	83,868	84,707	85,554	86,409	129,817	131,115	132,426	133,750	135,088	136,439
Utilities	14,980	15,129	15,281	15,433	15,588	15,744	15,901	16,060	16,221	16,383
Interest on loan balances	10,652	10,294	9,922	9,535	9,133	8,714	8,279	7,826	7,356	8,912
Other (advertising, legal, office supplies, etc.)	4,702	4,749	4,797	4,845	4,893	4,942	4,992	5,042	5,092	5,143
Subtotal, Fixed Costs	244,386	181,155	155,319	140,082	183,290	172,445	161,598	162,678	163,756	191,888
Total Expenses	255,748	192,630	166,908	151,787	195,112	184,385	173,658	174,859	176,059	204,313
Income (Loss) from operations	-199,444	-74,157	-24,851	31,911	66,591	105,578	119,205	120,932	122,690	97,423
Other income and (expense) (e.g. interest)										
Provision for income taxes	-9,972	-3,708	-1,243	1,596	3,330	5,279	5,960	6,047	6,135	4,871
Net Income (Loss)	-189,471	-70,449	-23,608	30,316	63,261	100,299	113,244	114,885	116,556	92,552

Appendix A-6: Balance Sheet

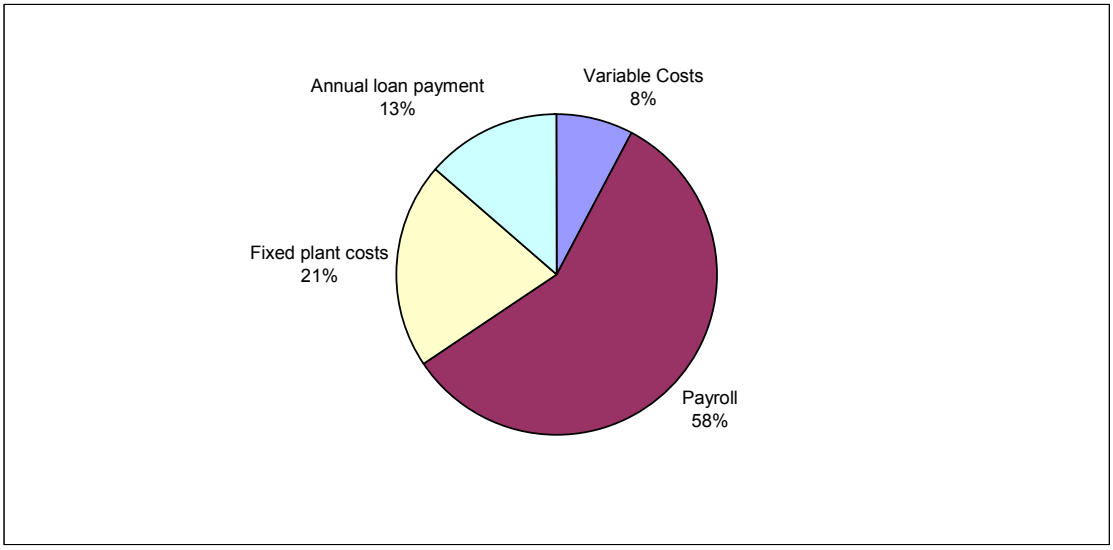
Balance Sheet										
Assets										
Cash	-70,001	-90,338	-86,381	-41,426	40,729	146,820	252,932	356,110	460,487	621,860
Other current assets	0	0	0	0	0	0	0	0	0	0
Other current assets	0	0	0	0	0	0	0	0	0	0
Total current assets	-70,001	-90,338	-86,381	-41,426	40,729	146,820	252,932	356,110	460,487	621,860
Capital Eqipment (net)	165,690	99,414	59,648	35,789	11,930	0	0	0	0	31,832
Other long-term assets	0	0	0	0	0	0	0	0	0	0
Other long-term assets	0	0	0	0	0	0	0	0	0	0
Total long-term assets	165,690	99,414	59,648	35,789	11,930	0	0	0	0	31,832
Total assets	95,689	9,076	-26,733	-5,637	52,659	146,820	252,932	356,110	460,487	653,691
Liabilities										
Accounts payable	12,787	9,631	8,345	7,589	9,756	9,219	8,683	8,743	8,803	10,216
Income taxes payable (loss carryforward)	-9,972	-13,680	-14,923	-13,327	-9,997	-4,719	0	0	0	0
Other current liabilities	0	0	0	0	0	0	0	0	0	0
Total current liabilities	2,815	-4,049	-6,577	-5,738	-242	4,501	8,683	8,743	8,803	10,216
Notes payable/financing	257,345	248,045	238,373	228,314	217,853	206,973	195,658	183,890	171,652	214,049
Other long-term liabilities	0	0	0	0	0	0	0	0	0	0
Other long-term liabilities	0	0	0	0	0	0	0	0	0	0
Total long-term liabilities	257,345	248,045	238,373	228,314	217,853	206,973	195,658	183,890	171,652	214,049
Total liabilities	260,160	243,996	231,796	222,576	217,611	211,473	204,341	192,633	180,455	224,264
Net equity	-164,471	-234,921	-258,529	-228,213	-164,952	-64,653	48,591	163,477	280,033	429,427

Appendix A-7: Projected Cash Flow Statement

Cash Flow Statement										
Beginning cash balance (funding required)	25,000	-70,001	-90,338	-86,381	-41,426	40,729	146,820	252,932	356,110	460,487
Net income (Loss)	-189,471	-70,449	-23,608	30,316	63,261	100,299	113,244	114,885	116,556	92,552
Depreciation & non-cash expenses	130,185	66,276	39,766	23,859	23,859	11,930	0	0	0	25,011
Change in current assets excluding cash	0	0	0	0	0	0	0	0	0	0
Change in current liabilities	2,815	-6,864	-2,529	840	5,496	4,743	4,182	60	60	1,413
Investment in Capital & other assets	-295,875	0	0	0	0	0	0	0	0	0
Net borrowing and other liabilities	257,345	-9,300	-9,672	-10,059	-10,461	-10,880	-11,315	-11,768	-12,238	42,397
Ending cash balance (funding required)	-70,001	-90,338	-86,381	-41,426	40,729	146,820	252,932	356,110	460,487	621,860

Appendix A-8: Return Measures

Financial Return	Value	Years 1-5	Years 1-10
Net Present Value	$11,810,428	($229,558)	$1,082,528
Return on Investment	5%		
Breakeven (lbs/year)			

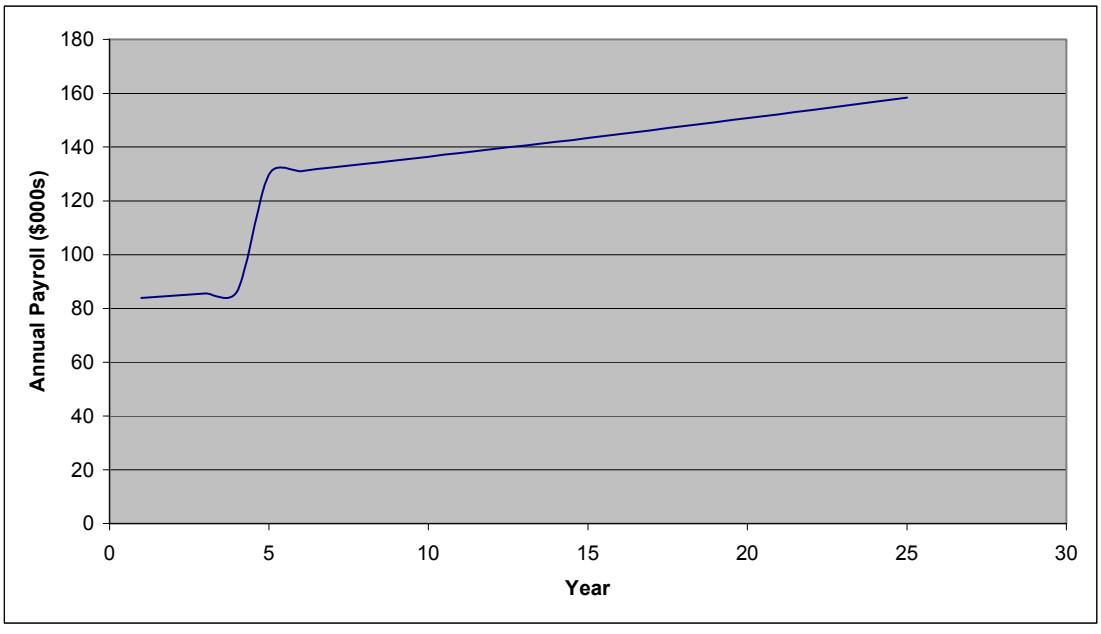


Appendix A-9: Payroll

Category	# of persons	Hourly Rate	Salary (years 1-4)	Salary (years 5-25)
Grower	1	$15.00	$31,200	$31,200.00
Labor	2	$5.15	$21,424	$21,424.00
Administrative	0.25	$5.15	$2,678	$2,678.00
Delivery	0.25	$5.15	$2,678	$2,678.00
Marketing (year 5)	1	$14.00		$29,120.00
Total payroll	4.5		$57,980	$87,100
Overtime Allow.		10%	$5,798	$8,710
Benefits		35%	$20,090	$30,180
Annual payroll			$83,868	$125,990

Benefits	%
401k	3.00%
FICA	7.65%
FUTA	1.00%
SUI	1.00%
Workman's Compensation	7.00%
Health Insurance	15.00%
TOTAL	34.65%

Payroll Chart



Appendix A-10: Economic Input Assumptions

Category	Units	Value
Economic		
Annual inflation rate	%	1.0%
Loan interest rate	%	4%
Downpayment on loan	%	10%
Loan term	years	20
Electricity cost	$/kWh	$ 0.100
Income tax rate	%	5%
Depreciation method	MACRS	

Appendix A-11: Utility and Geothermal Calculations

Item	Number	Units	Value	Calculated Demand (kW)	% Operation	Calculated Energy (kWh)
Fans	4	hp	5	15	30%	39,420
Pumps	5	hp	10	37.5	30%	98,550
Lights	40	watts	100	4	30%	10,512
Miscellaneous	5	watts	100	0.5	30%	1,314
Total				57		149,796

Appendix A-12: Geothermal Detail

Category	Units	Input	Value	Comment
Production Well				
# of wells	#	1		Approx. 300 feet
Subtotal			$ 109,025	
Distribution Line				
Distance	Feet	1,000		
$/foot	$	$15		4 inch fiberglass
Trenching	$	$1,000		Ditch Witch
Labor	$	$1,000		
Subtotal			$ 17,000	
Injection Well				
# of wells	#	1		Approx. 300 feet
Subtotal			$ 109,025	
Miscellaneous				
Storage Tank	$	1	$ 15,000	Approx. 15,000 gallons
Controls	$		$ 2,500	
Pumps	$	1	$ 5,000	For injection
Heat Exchanger	$	1	$ 5,000	Between greenhouse and well
Subtotal			$ 27,500	
Total			$ 262,550	

A.	FIXED QUANTITY ITEMS				LOW	HIGH	LOW	HIGH
	ITEM	*SPEC*	*AMOUNT*	*UNIT*	*UNIT PRICE*	*UNIT PRICE*	*ITEM TOTAL*	*ITEM TOTAL*
1	MOBILIZATION	10.1	1	job	$10,000.00	$15,000.00	$10,000.00	$15,000.00
2	DEMOBILIZATION	10.2	1	job	$7,000.00	$10,000.00	$7,000.00	$10,000.00
B.	**VARIABLE QUANTITY ITEMS**							
	(RIG TIME AND DRILLING)							
1	RIG TIME (standby)	10.4	20	hour	$200.00	$250.00	$4,000.00	$5,000.00
2	RIG TIME (non-drilling operations)	10.5	3	hour	$250.00	$300.00	$750.00	$900.00
3	AUGER CONDUCTOR HOLE (17 1/2 inch rotary)	6.2	20	feet	$125.00	$200.00	$2,500.00	$4,000.00
4	DRILL SURFACE CASING HOLE (12 1/2 inch rot	6.3	150	feet	$55.00	$65.00	$8,250.00	$9,750.00
5	DRILL PRODUCTION HOLE (8/1/2 inch rotary)	6.8	150	feet	$45.00	$60.00	$6,750.00	$9,000.00
C.	**VARIABLE QUANTITY ITEMS**							
	(CASING AND TUBING)							
1	CONDUCTOR CASING (13 3/8 inch)	6.2	30	feet	$45.00	$55.00	$1,350.00	$1,650.00
2	SURFACE CASING (9 5/8 inch)	6.4	150	feet	$25.00	$40.00	$3,750.00	$6,000.00
3	SURFACE CASING CENTRALIZERS	10.7	5	items	$100.00	$100.00	$500.00	$500.00
4	SURFACE CASING FLOAT COLLAR	6.4	1	item	$1,000.00	$1,000.00	$1,000.00	$1,000.00
5	SURFACE CASING FLOAT SHOE	6.4	1	item	$500.00	$500.00	$500.00	$500.00
6	PRODUCTION CASING CENTRALIZERS	6.11	5	items	$100.00	$100.00	$500.00	$500.00
7	PRODUCTION CASING HANGER	6.11	1	item	$1,700.00	$1,700.00	$1,700.00	$1,700.00
8	PRODUCTION BLANK CASING (7 inch)	6.11	50	feet	$25.00	$35.00	$1,250.00	$1,750.00
9	PRODUCTION SCREEN (7 inch)	6.11	100	feet	$40.00	$55.00	$4,000.00	$5,500.00
D.	**VARIABLE QUANTITY ITEMS**							
	(WELL SITE EQUIPMENT)							
1	DIVERTER/ROTATING HEAD RENTAL	6.6	3	days	$1,000.00	$1,000.00	$3,000.00	$3,000.00
2	DRILLING WELL HEAD/GATE VALVE	6.6	1	items	$2,500.00	$5,000.00	$2,500.00	$5,000.00
E.	**VARIABLE QUANTITY ITEMS**							
	(MONITORING AND TESTING EQUIPMENT)							
1	HYDROGEN SULFIDE EQUIPMENT	10.9	3	days	$1,200.00	$1,800.00	$3,600.00	$5,400.00
2	HOLE ORIENTATION DEVICE	10.1	3	days	$500.00	$500.00	$1,500.00	$1,500.00
F.	**VARIABLE QUANTITY ITEMS**							
	(CEMENT CASING)							
1	CEMENT CONDUCTOR CASING	6.2	1	job	$2,000.00	$4,000.00	$2,000.00	$4,000.00
2	CEMENT SURFACE CASING	10.11	1	job	$7,000.00	$15,000.00	$7,000.00	$15,000.00
G.	**CONTRACTOR REIMBURSABLE**							
	SUPPLIES AND DRILLING MUD							
1	REIMBURSEMENT OF AUTHORIZED PURCHAS	10.12	n/a	n/a	n/a	n/a	$5,000.00	$10,000.00
2	GEOPHYSICAL LOGGING	n/a	n/a	n/a	n/a	n/a	$3,000.00	$7,000.00
3	GEOLOGIC AND ENGINEERING SERVICES	n/a	n/a	n/a	n/a	n/a	$3,000.00	$10,000.00
	TOTAL FOR ITEMS A.1 THRU G.3						$84,400.00	$133,650.00

Appendix A-13: Propane Comparison

Capital Cost		
Furnace	#	15
Furnace	$	$ 500
Controls	$	$ 300
Total	$	$ 7,822
Operating Inputs		
Propane	$/gallon	$ 1.40
Energy Content	Btu/gallon	91,600
Burner efficiency	%	75%
Energy Content	$/MMBtu	$ 20.38
Greenhouse Thermal Load		
Size	sq. ft.	24,000
Peak load	Btu/hr.	1,128,322
Annual load	MMBtu/yr.	2,462
Annual load per square foot	Mbtu/sq. ft.	103
Annual load	gallons	35,837
Annual budget	$	$ 50,171.76
Propane escalation rate	$	2.5%
Years		25
Geothermal System		
Weght of water	Lbs.	8.33
Conversion (minutes to hour)	Minutes	60
Production Temperature	F	140
Return Temperature	F	100
Temperature differential (delta T	F	40
Flow rate	gpm	60
Peak production potential	MMBtu/hour	1.2
Annual load factor	%	25%
Annual production	MMBtu	2,627
Levelized cost	$/MMBtu	$ 13.38
Propane	0	1
Price of propane	$ 1.40	1.435
Cost of propane	$ 50,171.76	$ 51,426.06
PV factor	1	0.961538462
discounted propane	$ 50,171.76	$ 49,448.13
sum of pvs	$ 827,762.06	
total consumption	49240	
levelized cost	$ 16.81	

Appendix A-14: Greenhouse

Category	Units	Input	Comment
Structure (fixed cost)			
Size	Square Feet	24,000	
Installed Cost	$/sq. ft.	$ 10	
Total	$	$ 240,000	
Other (fixed costs)			
Trays	Case	$ 203	3 @$67.60
Shelving		$ 300	
Tools		$ 500	spades, pruners, wheelbarrow
Scales		$ 200	for weighing herbs
Growing media			
Plant Insurance			
Vehicle Insurance		$ 1,000	
Legal fees		$ 500	
Office Supplies		$ 500	
Advertising		$ 1,500	
Subtotal, other		$ 4,702	
Variable Costs			
Seeds		$ 76	
Fertilizer		$ 17	
Pesticides		$ 18	
Plastic bags		$ -	$7.02/1000
Product Labels		$ -	$133/1000
Growing media			compost @$18.40/cubic yard
Auto fuel and maintenance		$ 11,250	
Assume 10%/yr of compost lost due to replanting, etc.			
Total Variable Costs		$ 11,361	

Appendix B-1: Summary of New Mexico-Based Financial Resources

ACCION New Mexico
http://www.accionnewmexico.org/
ACCION New Mexico is a nonprofit organization that increases access to business credit, makes loans, and provides training which enable emerging entrepreneurs to realize their dreams and be catalysts for positive economic and social change.

Enchantment Land Certified Development Company (ELCDC)
http://www.elcdc.com/
Assists communities with their economic development goals by offering New Mexico small businesses long-term, fixed interest rate financing for real estate and equipment needs. The applicant puts up a minimum of 10% of the total funds for a project. Single purpose type facilities could require up to an additional 5% down, and new/start-up businesses another 5%. The SBA (via the ELCDC) provides up to 40% or $1,000,000 ($1.3 million in certain circumstances), whichever is less, and the private sector lender provides the balance of the money. The SBA portion of the loan is at a fixed rate for a term of 10 or 20 years. The bank portion of the loan is at market rates and terms.

Minority Business Development Agency
http://www.mbda.gov/
The Minority Business Development Agency funds Business Development Centers around the country to assist with the start-up, expansion and development of minority-owned firms. Minority Business Development Centers (MBDCs), Native American Business Development Centers (NABDCs), and Business Resource Centers (BRCs) provide individualized management and technical assistance to minority entrepreneurs at every stage of business development. Minority Business Opportunity Committees (MBOCs) coordinate Federal, state and local business resources. They are designed to identify business opportunities and leverage existing programs to increase market access for minority-owned firms. Contact information for the local office is below:

<u>New Mexico Statewide MBDC</u>
718 Central Avenue S.W.
Albuquerque, NM 87102
Tel: (505) 843-7114
Fax: (505) 242-2030
info@nedainc.net

National Center for American Indian Enterprise Development
http://www.ncaied.org
Services are designed to assist Indian tribes, organizations, and individuals in achieving their economic objectives through enhanced business management. The southwest office is located at:
953 E. Juanita Avenue
Mesa, AZ 85204

Tel: (480) 545-1298
Fax: (480) 545-4208

Native American Business Alliance
http://www.native-american-bus.org
The mission of the organization are: to facilitate mutually beneficial relationships between private and public businesses with Native American owned companies and t***o*** educate the communities on Native American culture, paving the way for future generations. The Native American Business Alliance will hold its 2004 Convention at the Hyatt Tamaya Resort and Spa near Santa Fe and Albuquerque on April 25-27, 2004

The New Mexico Community Development Fund
http://www.nmcdlf.org/
Provides loans, training and technical assistance to businesses and non-profit organizations in New Mexico. In Albuquerque, contact (505) 243-3196. Services include: developing business plans, financial planning and analysis, completing the Loan Fund's application, marketing planning and promotion, record keeping and accounting systems, and legal and tax referrals.

New Mexico Community Foundation (NMCF)
http://www.nmcf.org
The New Mexico Community Foundation is a statewide endowment building and grant-making organization that serves and invests in New Mexico's communities and their people.

New Mexico Small Business Development Center (NMSBDC)
http://www.nmsbdc.org/index.html
The NMSBDC provides support in business planning, marketing, and financing. It also provides entrepreneurship training for women and minority-owned business programs. The NMSBDC works closely with local lenders, the Small Business Administration, and a variety of government and non-government lending programs serving New Mexico. While the NMSBDC does not provide direct financing, it can help identify specific financing needs and develop the proposals required by various financial institutions. The NMSBDC has helped entrepreneurs obtain more than $200 million in investment and lending capital in just the last ten years. The following link on the NMSBDC web site is to SBA lenders in the state http://www.nmsbdc.org/images/sbalenders.gif.

Small Business Administration Programs
http://www.sba.gov/nm/financing.html

<u>MicroLoan Program</u>
The MicroLoan Program was developed to increase the availability of very small loans to prospective small business borrowers. Under this program, the SBA makes funds available to nonprofit intermediaries, who in turn make loans to eligible borrowers in amounts that range from under $100 to a maximum of $25,000. The average loan size is

$10,000. Completed applications can usually be processed by the intermediary in less than one week. The following link lists MicroLoan participants in New Mexico: http://www.sba.gov/nm/micnm.html.

Preferred/Certified Lenders

Certified lenders are those who have been heavily involved in regular SBA loan-guaranty processing and have met certain other criteria. They receive a partial delegation of authority and are given a three-day turnaround by the SBA on their applications (they may also use regular SBA loan processing). Certified lenders account for nearly a third of all SBA business loan guaranties. The following link includes a list of PLP/CLP participating banks in New Mexico: http://www.sba.gov/nm/plpnm.html

The Small Business Investment Company (SBIC)

The Small Business Investment Companies are private investment firms licensed by the SBA. With their own capital and with funds borrowed at favorable rates through the Federal Government, SBICs provide venture capital to small independent businesses, both new and already established. In New Mexico, this company is:

TD Origen Capital Fund, L.P.
J. Michael Schafer, Manager
150 Washington Avenue, Suite 201
Santa Fe, NM 87501
voice (203) 629-8700
fax (203) 629-9293
jceliberti@tullisdickerson.com

SCORE "Counselors to America's Small Business"

http://www.score.org/

SCORE "Counselors to America's Small Business" is a nonprofit association dedicated to providing entrepreneurs with free, confidential face-to-face and email business counseling.

The Albuquerque chapter has provided help to over 10,000 clients in start-up or existing businesses in New Mexico. SCORE presents a monthly workshop "Essentials for Starting A New Business." See http://www.abqscore.org/ for more information.

625 Silver Avenue, SW, Suite 320
Albuquerque, NM 87102
PHONE: (505) 346-7909 FAX: (505) 346-6711
EMAIL: abqscore@swcp.com

For a list of federal funding sources for native American tribes, agriculture and small business go to http://www.cfda.gov.

Appendix D-1: Technical Information Resources

The Business of Herbs www.gardennet.com/BOH/

Osage Gardens, Inc. – Organic Growers of Fine Culinary Herbs
Tom and Sarah Rumery
PO Box 993
New Castle, CO 81647
tsrosage@sopris.net
970-984-2040 office
970-984-9684 greenhouse
970-984-2191 fax

Mountain Valley Development Center – complex includes a hydroponic greenhouse that sells herbs
Glenwood Springs, CO
970-945-2306

New Mexico Farmers Market Association
505-983-4098
http://www.farmersmarketsnm.org

Aroma Fresca – organic herbs
Susie Blott, President
505-890-4134

B. Riley Fresh Herbs
Donna Tran
505-275-0902
http://www.brileyfreshherbs.com/

Bluebird Herb Farm
http://www.bludbirdherbfarm.com/

New Mexico agricultural resources
http://www.agmrc.org/directories/states/newmexico.html

New Mexico Organic Commodities Commission (NMOCC)
516 Chama Street NE, Room D
Albuquerque , NM 87108
Phone: 505-266-9849
Fax: 505-266-0649
URL: no website at this time
Email Contact: joan.quinn@state.nm.us

New Mexico State University Cooperative Extension Service
505-852-2668
http://www.cahe.nmsu.edu
Offers classes periodically on agricultural issues
Hershel Muniz - works on agricultural and small business development with native Americans
Del Jiminez – works with greenhouses – direct line (505) 852-4241
Christina Turner works with Jemez Pueblo
Charles Martin – knows about herb yields

Information on New Mexico Farmers Markets
http://www.farmersmarketsnm.org/links.html

Information on packaging
http://www.flexpackmag.com/
Focuses on the marketing impact of packaging
http://www.brandpackaging.com/

Greenhouse Supplies
Hydro-Gardens (719) 495-2266 Colorado Springs

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[i] http://www.ers.usda.gov/publications/aib777/aib777/pdf
[ii] http://oregonstate.edu/Dept/NWREC/herbs.html
[iii] http://gardennetwork.tripod.com/garden_store/herbs_gardening/isbn_1567184308.htm
[iv] http://www.newcrops.uq.edu.au/newslett/ncn16154.htm
[v] http://www.newcrops.uq.edu.au/newslett/ncn16154.htm
[vi] http://151.121.3.150/tmd/FSMIP/FY2000/MTO294.pdf (p. 7)
[vii] http://attar.ncat.org/attar-pub/gh-herbhold.html
[viii] *Market Opportunities and Strategic Directions for Specialty Herbs and Essential Oil Crops in Montana,* February 27, 2002, prepared for the Montana Department of Agriculture, Watts and Associates, Billings, MT, p. 7.
[ix] http://151.121.3.150/tmd/FSMIP/FY2000/MTO294.pdf
[x] http://151.121.3.150/tmd/FSMIP/FY2000/MTO294.pdf (p. 58)
[xi] http://151.121.3.150/tmd/FSMIP/FY2000/MTO294.pdf
[xii] http://www.metis-settlements.org/evs/herbs.html
[xiii] http://www.fresh-cuts.org/fcf.html
[xiv] http://www.agr.state.il.us/marketing/fmi&nra2004.html
[xv] The following web site, however, lists several sources of organic seeds: http://www.lamontanita.com/docs/newsletterarticles/2002/Mar2002/ItchyGreenThumb.html.
[xvi] Telephone interview with Joanie Quinn from the NOCC.
[xvii] http://www.bizjournals.com/Albuquerque/stores/2003/04/07/story4.html
[xviii] *AG Strategies,* February 1999, "Pricing Horticulture Products," pp. 1 and 4.
[xix] http://www.metis-settlements.org/evs/herbs.html
[xx] http://www.dwyergreens.com
[xxi] http://www.richters.com/Resources/freshcut-restaurant.html