GEOTHERMAL GREENHOUSE INFORMATION PACKAGE

Compiled and Edited by
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March 2008

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GEOTHERMAL GREENHOUSE INFORMATION PACKAGE

INTRODUCTION

This package is intended to provide a foundation of background information for persons interested in developing a geothermal greenhouse. The material is divided into ten sections covering issues of crop culture and prices, building and operating a greenhouse, heating system design, listing of vendors, USDA extension offices, trade organizations and periodicals, case studies and bulletin articles on greenhouse operations and several templates for applying for the Farm Bill.

Section 1 – Crop Market Prices contains recent wholesale price information for some typical vegetable and flower crops grown in greenhouses plus seasonal variations for some crop are also included. Sources where to find the current price information is also provided at the end of the section.

Section 2 – Building and Operating a Greenhouse includes information to help with the planning of a greenhouse operation.

Section 3 – Crop Culture Information provides abbreviated culture information for some typical vegetable and flower crops. Such issues as temperature requirements, CO_2, lighting and disease are covered. An extensive list of additional information sources is provided at the end of the section.

Section 4 – Greenhouse Heating Systems section consist the *Chapter 14 – Greenhouses* from the Geothermal Direct Use Engineering and Design Guidebook. It covers the design and performance of various heating equipment commonly used in geothermal greenhouses. The topic of peaking with conventional fuel is also covered.

Section 5 – Greenhouse Heating Equipment Selection Spreadsheet is the supporting information and documentation for a spreadsheet based on Section 4. Included are: screenshots covering the selection and cost of seven types of geothermal greenhouse heating systems and the cell entries. This material is intended for the use by engineers and those familiar with the design of heating systems.

Section 6 – Vendor Information provides a list of vendors for components of geothermal systems, greenhouse structures, and equipment.

Section 7 – Other Information Services provides contact information for the Farm Bill state representative in the USDA State Rural Development Offices, National and International Organizations, and Trade Journals and Newsletters.

Section 8 – Greenhouse Case Studies includes several case studies and a feasibility study using geothermal in greenhouses.

Section 9 – Geo-Heat Center Greenhouse Quarterly Bulletins section includes several Geo-Heat Center bulletin articles in their entirety, plus webpage addresses to all the bulletin articles on greenhouses that are available on our website in PDF format.

Section 10 – Farm Bill Information includes two templates that were developed in 2006 to help with the Farm Bill application. One is for the direct-use of geothermal and the second one is for a geothermal heat pump application.

Section 1
CROP MARKET PRICES

INTRODUCTION

This section contains historical crop prices for selected vegetables and floriculture that are commonly grown in greenhouses. This section also includes sources where to obtain more in depth information.

VEGETABLES

The vegetable prices in Table 1 were taken from the report **Vegetables and Melons Outlook, 2007** by USDA and represents the season average price in $/100 pounds ($/cwt) paid at wholesale to the growers.

Table 1. Vegetable Season Average Price, 2003-2006.

	Season Average Price			
	$/cwt			
Vegetable	**2003**	**2004**	**2005**	**2006**
Tomatoes	37.40	37.60	41.80	43.30
Bell Peppers	30.70	31.50	33.30	34.00
Head Lettuce	18.10	16.90	15.50	16.60
Note: cwt – a unit of measure equal to 100 pounds				

Tables 2 and 3 show the breakdown of the prices of tomatoes and head lettuce on a month-by-month basis respectively.

Table 2. Monthly Price Paid to Growers for Tomatoes, 2002-2005.

	Year			
Month	**2002**	**2003**	**2004**	**2005**
January	38.2	50.90	24.7	15.4
February	28	31.70	32.3	40.90
March	41.7	55.6	41	40.7
April	34.3	30	44.2	65.10
May	29.2	23.7	32.2	49.4
June	32.7	45.7	21.1	40
July	28.3	36.6	22.5	28
August	25.6	40	35.8	26.1
September	23.5	33	37.3	46.1
October	28.2	31	70.8	37.3
November	43.9	31.8	119	36.5
December	53.2	32.1	n/a	n/a

Table 3. Monthly Price Paid to Growers for Head Lettuce, 2002-2005.

	Year			
Month	**2002**	**2003**	**2004**	**2005**
January	25.9	11	16	11.5
Febuary	44.2	11.8	19.7	11.7
March	87.3	10.4	10.5	27.9
April	14.1	12.5	14.8	30.1
May	10.2	21.2	10.5	13.9
June	10.6	32.2	13.3	17.3
July	11.3	11.9	10.7	11
August	14.6	21.5	17.1	13.5
September	14.3	23.9	15.2	12.7
October	13.5	26.3	24.1	12.4
November	10.7	43.6	14.1	9.81
December	10.1	26.2	13.6	16.6

The wholesale price for tomatoes seems to stay constant throughout the year except for a spike in November 2004, and there were no data reported for December 2004 as can be seen in Figure 1. The wholesale price paid to growers for head lettuce also remained constant, but there was a peak from February to March of 2002 as shown in Figure 2. This could have been the result of adverse weather conditions. Head lettuce can be grown in about 35 days with a hydroponic system so the market can recover quickly.

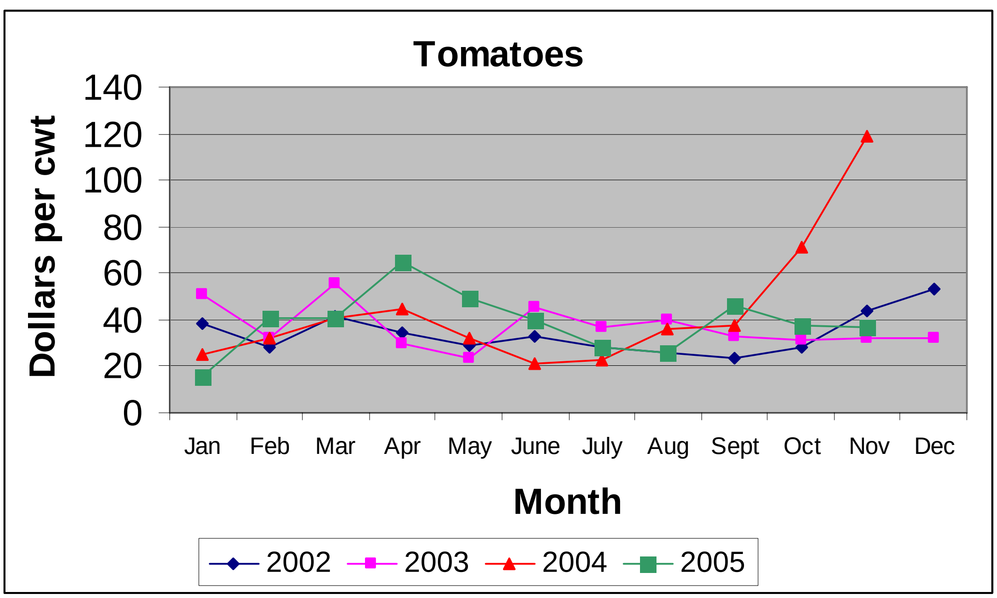

Figure 1. Monthly price paid to growers for tomatoes, 2002-2005.

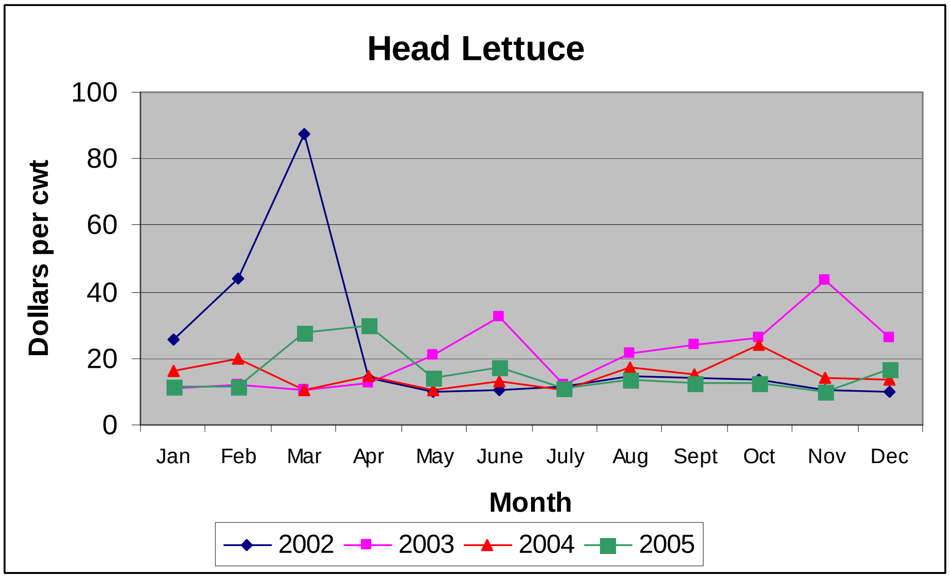

Figure 2. Monthly price paid to growers for head lettuce, 2002-2005.

FLORICULTURE

The floriculture prices in Table 4 were taken from the following publications **Floriculture Crops – 2004 Summary** and **Floriculture Crops – 2006 Summary** by USDA. They represent the average prices paid at wholesale to the grower. These summaries are completed by the National Agriculture Statistics Service (NASS), who compile the information from interviews of all known growers of floriculture in 36 states. To be eligible for the survey, the growers had to have annual gross sales of all floriculture crops exceeding $100,000.

Depending on your area, the price paid at wholesale can vary significantly. An example is the 2006 summary mentioned above where growers in NY were paid $0.742/stem and in MN were paid $0.772/stem for roses, whereas the average was only $0.391/stem.

Table 4. Floriculture wholesale Prices, 2003-2006.

Floriculture		**Wholesale prices**			
		2003	**2004**	**2005**	**2006**
Carnations, Standard	$/stem	0.176	0.182	0.203	0.192
Chrysanthemums, Pompon	$/bunch	1.30	1.33	1.40	1.40
Roses, All	$/stem	0.381	0.398	0.391	0.376
African Violets, Potted <5 inch	$/pot	1.18	1.17	1.16	1.19
African Violets, Potted >5 inch	$/pot	2.33	2.38	2.33	1.95
Chrysanthemums, Potted <5 inch	$/pot	1.78	1.76	1.75	1.56
Chrysanthemums, Potted >5 inch	$/pot	3.01	3.06	3.23	3.13
Easter Lilies, Potted, >5 inch	$/pot	4.19	4.15	4.25	4.16
Poinsettias, Potted <5 inch	$/pot	1.91	1.94	2.04	1.94
Poinsettias, Potted >5 inch	$/pot	4.54	4.57	4.60	4.64
Geraniums from Seed, Potted, <5 inch	$/flat	0.86	0.90	0.88	0.82
Geraniums from Seed, Potted, >5 inch	$/flat	2.05	2.15	2.62	2.19

MORE INFORMATION

There are numerous websites where you can find information on past prices, current markets and the outlook for certain crops. The ones that are the most helpful are listed below.

United States Department of Agriculture – Economic Research Service
http://www.ers.usda.gov/

This website has of information such as the outlook reports for certain crops like vegetables and melons. Below is the abstract from the "Vegetable and Melons Situation and Outlook Yearbook" by Gary Lucier and Alberto Jerardo, July 26, 2007 which can be downloaded from the following webpage.
http://www.ers.usda.gov/publications/vgs/2007/07JulYearbook/VGS2007.pdf

> U.S. production of all vegetables, potatoes, melons, and pulse crops increased less than 1 percent in calendar year 2006. Although fresh and processed imports of these crops were also higher, inventories of processed vegetables coming into the year were lower. As a result, total supplies available for domestic consumption and export were down 1 percent to about 171 billion pounds in 2006. Lower supplies and higher energy costs pushed retail prices for all fresh and processed fruits and vegetables 5 percent above a year earlier—the greatest year-to-year increase since 1998. Because of the reduced supplies and a small gain in export volume, per capita net domestic use (disappearance) of all vegetables, potatoes, melons, and pulse crops declined 3 percent to 428 pounds (freshweight basis) in 2006. Canning vegetables, particularly tomato products, accounted for the majority of the decline in domestic vegetable use in 2006. On a fresh-equivalent basis, per capita disappearance of vegetables for processing (including potatoes and mushrooms) declined 10 percent to about 93 pounds led by a 12-percent reduction in processing tomato use. The decline in tomato use may have been an aberration caused by sharply higher wholesale tomato product prices during the second half of 2006, which slowed demand and prevented stocks from being drawn below year-earlier levels. Tomatoes accounted for about two-thirds of 2006 canning vegetable use. Fresh-market vegetable consumption (including melons, potatoes, sweet potatoes, and mushrooms) totaled about 222 pounds—down less than 1 percent from a year earlier. Fresh-market per capita use increased for commodities such as cauliflower, garlic, snap beans, cabbage, and bell peppers, and declined for spinach, head lettuce, onions, pumpkins, and celery. The U.S. vegetable and melon trade deficit widened in 2006 as the value of imports increased more than the value of vegetable and melon exports. In 2006, about 16 percent of all the vegetables and melons consumed domestically was imported, with 12 percent of potatoes and potato products being sourced from other nations, compared with 6 percent a decade earlier.

USDA Economics and Statistics and Market Information System (ESMIS)
http://usda.mannlib.cornell.edu/MannUsda/homepage.do

The USDA Economics, Statistics and Market Information System (ESMIS) is a collaborative project between Albert R. Mann Library at Cornell University and several agencies of the U.S. Department of Agriculture.

National Agricultural Statistics Service - USDA
http://www.nass.usda.gov/

REFERENCES

Lucier, Gary and Alberto Jerardo, 2006. "Vegetable and Melons Situation and Outlook Yearbook VGS-2007", Electronic Outlook Report from the Economic Research Service. http://www.ers.usda.gov/publications/vgs/2007/07JulYearbook/VGS2007.pdf

National Agriculture Statistics Service, 2007. "Floriculture Crops 2006 Summary", United States Department of Agriculture. http://usda.mannlib.cornell.edu/usda/current/FlorCrop/FlorCrop-07-26-2007.pdf

National Agriculture Statistics Service, 2005. "Floriculture Crops 2004 Summary", United States Department of Agriculture. http://usda.mannlib.cornell.edu/usda/nass/FlorCrop//2000s/2005/FlorCrop-04-26-2005.pdf

Section 2
BUILDING AND OPERATING A GREENHOUSE

INTRODUCTION

Commercial greenhouses offer investment and career possibilities for many firms and individuals. Typical barriers to entry into the industry are relatively low, and net investment levels are not prohibitive. The industry is also highly fragmented, without any dominant leaders in terms of size or net sales. Markets appear to be plentiful throughout the nation, and metropolitan markets are readily served from outlying rural areas.

A large percentage of small businesses fail within the first two years and one of the question you need to ask yourself is “Would owning your own greenhouse business be right for you?” Some of the most important things to consider are:

- Are you willing to work long hours and often seven days a week? - Greenhouse plants must have attention everyday and during some seasons the work can be over 40 hours a week.

- Are you a good planner? - Need to plan when to plant and harvest the crops and those unforeseen problems like the crops are not ready to be harvested.

- Do you have the appropriate knowledge and experience? Have you grown crops commercially or had a garden? - If you have limited experience it might be better to work for a greenhouse operation and gain some experience before starting your own or hire component people where you have limited experience.

- There are some items that need to be thought about before you plan and build a greenhouse. These items will have an affect on location, type and size of the greenhouse. You should start by thinking about the items listed below among other things.

Now that you made the decision to own a greenhouse business there are so many other factors to consider. Here are just a few of the items you need to think about before you can get together a plan.

- Crops to be grown – Will you grow vegetables or flowers?

- The growing period – Will the operation be all year long or seasonally?

- Growing media and system – Will you use hydroponics, soil or other medium? Are you going to uses benches or the floor?

- Annual production – How much can you produce?

- Type of heating / cooling system – What type of heating equipment will you use (gas, propane, geothermal). Will the system be forced air?

- Marketing system – Which type of business would work best for you – retail, wholesale or both?

- Type of greenhouse – Will you use a quonset or gable style greenhouse?

- Do you have a market for your product?

- How will you transport your product to market?

SOUTHWEST TECHNOLOGY DEVELOPMENT INSTITUTE

Southwest Technology Development Institute of New Mexico State University completed a study in 1990, regarding comparative performance for several greenhouse crop productions. The purpose of the studies was to compile a consistent, unbiased comparison of commercial greenhouse costs and the variables affecting those costs. In the study, a hypothetical operation was placed in 11 geographical regions throughout the U.S. The greenhouse was assumed to be four acres and the facilities would use current technologies. Estimates and assumptions were developed for the following items: greenhouse capital costs, economic factors, utility costs, cash flow and operating costs.

Greenhouse structure capital costs varied with location with the northern climates having increased costs to reflect the need for additional thermal curtains. In the west and southwest, evaporative cooling systems were considered. Some of the other variations in prices can be affected by the cost of materials and labor. The total greenhouse costs (includes greenhouse and operating equipment) ranged from \$11.34 - 14.24/ft^2 of greenhouse, with an average price of \$12.65/ft^2 of greenhouse. The construction costs alone were in the \$7.30 - \$8.05/ft^2 range with an average of \$7.44/ft^2. Land costs are a significant portion of the total capital investment.

The economic model created was intended to reflect, as accurately as possible, the financial conditions a grower might encounter when establishing and operating a new venture. Some important factors to consider: state tax, worker's compensation rate, labor wage rate, and property tax rate which will affect an operating budget. Electricity, natural gas and water rates can also vary greatly across the nation. Annual water consumption can be assumes to be approximately five million gallons per acre per year. Labor costs dominate production costs. Utility costs do not appear to be a significant factor, being generally less than 15% of the total budget. Selling price is too varied between seasons and regions to be accurately modeled.

Depending on the region, the operating budget distribution could look like this:

Labor	40-45%
Plants, supplies and materials	16-25%
Utilities (heating, lights, and water use)	6-16%

Loan payment	17-19%
Other(miscellaneous)	8-10%

Transportation of the product is an important consideration for the grower as transportation costs can greatly affect the final selling price of the product and the growers competitive position in various markets. For example, potted plants are among the most expensive greenhouse product to ship.

Because production is fixed, annual revenue is also similarly fixed. Bloom prices do not change dramatically, and no single producer within a region is able to receive substantially higher prices than another producer. Therefore, the opportunity for increased profitability comes from the lowering of operating costs. The price for roses is higher the further one travels east in the US. Two factors that can account for the price differences: demand is higher in the east, raising the price: and supply is more plentiful in the west, lowering the price.

A new firm should carefully evaluate individual sites on a case-by-case basis before selecting a location. A primary consideration is that high levels of quality bloom production are absolutely required, and secondly, the need for a skilled labor force. Another issue that will constrain growth of the industry will continue to be the import of cut-flowers. Be sure you know where you will sell your product BEFORE you plant. You have to have a market for your product; otherwise, when you are ready to harvest, you might not have anybody to sell to.

MORE INFORMATION

There is quite a lot of information on greenhouses and greenhouse operations. Some are easy to find some are not. Links are included below to some that are more useful.

Starting a Greenhouse Business
http://www.aces.edu/pubs/docs/A/ANR-0691/

Selecting and Building a Commercial Greenhouse
http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/jb_building_gh.htm

Greenhouse Construction
http://www.wvu.edu/~agexten/hortcult/greenhou/grencons.htm

Horticulture & Gardening - West Virginia University Extension Service
http://www.wvu.edu/~agexten/hortcult/index.html

Product Mix: Determining My Winners and Losers
http://aggie-horticulture.tamu.edu/greenhouse/nursery/guides/econ/chopt.html

REFERENCES

Maier, B.; Falk, C. L. and W. D. Gorman, 1990. "Comparative Analysis: Greenhouse Cucumber Production." Final Draft Technical Report. Southwest Technology Development Institute, New Mexico State University, Las Cruces, NM.

Whittier, J. and C. L. Fischer, 1990. "Comparative Performance Analysis: Commercial Cut-Flower Rose Production." Southwest Technology Development Institute, New Mexico State University, Las Cruces, NM.

Whittier, J.; Maier, B.; Fischer, C. and R. D. Berghage, 1990. "Comparative Performance Analysis: Commercial Potted Plant Production." Southwest Technology Development Institute, New Mexico State University, Las Cruces, NM.

Starting a Greenhouse Business ANR-0691 Reviewed June 2006 downloaded 12/28/07 http://www.aces.edu/pubs/docs/A/ANR-0691

Selecting and Building a Commercial Greenhouse Fact Sheet downloaded 12/28/07 http://www.umass.edu/umext/floriculture/fact_sheets/greenhouse_management/jb_building.....

Section 3
CROP CULTURE INFORMATION

INTRODUCTION

This section introduces the environmental parameters that can affect the growth of greenhouse crops, basic cultural information for five greenhouse crops, and where to look for more information. The five greenhouse crops presented in this section include:

Tomato,
Cucumber,
Hydroponic lettuce,
Carnation, and
Roses

The cultural information for each crop can include information concerning:

The temperature required for good plant growth,
Different varieties known to grow well in greenhouses,
When the crops should be planted, and
The known pests and diseases that can damage a crop.

ENVIRONMENTAL PARAMETERS

This information was summarized from the following publication: **A Handbook for the Production of CEA-grown Hydroponic Lettuce**, 1995.

Some of the environmental parameters that can affect the growth in the greenhouse are: 1) temperature, 2) relative humidity, 3) carbon dioxide, 4) lights - sunlight, 5) dissolved oxygen (hydroponic systems), 6) pH, and 7) electrical conductivity (hydroponic systems). Careful management of some/all of these parameters is important for all plant growth. A brief explanation of what each one does and why it is important is listed below.

Temperature

The temperature of the greenhouse environment controls the rate of plant growth. Usually, as the temperature increases, chemical processes proceed at faster rates. This process is regulated by enzymes, which perform at their best within a narrow temperature range. If the temperature is above or below this range, the activity of the enzymes starts to deteriorate. This will cause the chemical process to slow down or stop, resulting in stress.

Relative Humidity

The transpiration rate of plants is influenced by the relative humidity (RH) of the greenhouse air. A high relative humidity of greenhouse air causes less water to transpire from the plants, which means the transport of nutrients from the roots to the leaves is lessened. High humidity can also cause disease problems in some cases like mold.

Carbon Dioxide (CO_2)

The amount of photosynthesis (growth) of plants is directly influenced by the concentration of CO_2 in the greenhouse air. Normal concentration of CO_2 in the outside air is 350 ppm. On a bright day, the CO_2 concentration can be depleted to 100 ppm in a closed greenhouse. This will reduce the rate of photosynthesis. Increasing the CO_2 concentration of the greenhouse air can also speed growth.

Lights

Photosynthetically active radiation (PAR) is the light which is useful to plants for the process of photosynthesis. Measurement of PAR gives an indication of the possible amount of photosynthesis and growth being performed by the plant. Artificial (supplemental) lighting may be required in some climates.

Dissolved Oxygen

For hydroponic systems. Dissolved oxygen in the pond's nutrient solution influences the process of respiration. The absence of oxygen in the nutrient solution will stop the process and seriously damage and kill the plant.

pH

The pH of a solution is a measure of the number of hydrogen ions or if the fluid is acidic (<7) or basic (>7). The pH of a solution is important because it controls the availability of the fertilizer salts.

Electrical Conductivity

For hydroponic systems. Electrical conductivity measures the amount of dissolved salts in a solution.

TOMATOES

This information was summarized from the following publications: **Commercial Greenhouse Production Tomatoes**, 1995; and **Greenhouse Tomato**, 1995.

Tomatoes are the most common greenhouse vegetable crop. There are some claims by greenhouse growers that 30 or more pounds of marketable fruit can be expected per plant (or plant space) per year. Such production is only possible using quality facilities and cultural practices. Production of about 20 to 25 pounds would be more realistic, especially in western Oregon. Tomatoes can be grown in a one-crop system (December-to-December) or a two-crop system (August-to-December and January-to-June). In a one-crop system, the crop is started in January and harvest is usually from March through November. The two-crop system is at less risk from crop pests, allows fruit set and harvest when environmental conditions are best, and competition from outdoor productions at its lowest.

Some tomato varieties grown commercially are Jumbo, Tropic, Laura, Caruso, Dombello, Concreto, Perfecto, Dombita, Belmondo, Boa, Trend and Capello. Tomatoes for the US market must be of a large size. Many European varieties are not large enough. It is very important to know your market requirements concerning fruit color, size, and shape before selecting the varieties to use. Variety selection should be made to fit light intensity, fertility and disease resistance requirements. Always test a variety in the season it will be grown before committing to it. Fruits over 6 ounces are preferred, with fruited in the 4-6 ounces marketable, and less than 4 ounces considered small.

Plants have commonly been grown in well-fertilized, well-drained soil (ground-bed production). The system has been largely replaced by a soil-less culture system. Soil-less culture provides the plants with nutrients and anchors by a totally artificial means. The need for soil sterilization, by steam or chemicals, is eliminated which is a major advantage of a soil-less culture. Soil-less culture is not as forgiving of mistakes and is more demanding. Good nutrient media composition and nutrient balance through the entire crop cycle is mandatory.

There are two major soil-less culture systems used: closed system hydroponics--the nutrients are recirculated, and open-system hydroponics or bag culture--new nutrient solution is constantly provided to plants and the excess nutrient solution is not collected and recirculated.

Greenhouse tomatoes are always grown from transplants. A special part of the greenhouse should be used to grow the transplants. It can be either a separate greenhouse or an area divided from the main area, so the temperature can be accurately maintained. The spacing of the plants after transplanting should be 4.5 to 5 square feet per plant under western Oregon conditions; but, 3.5 to 4 square feet is the norm. Select a soil that is rich, loamy, well drained and high in organic material and preferably with a clay base, and a soil pH of 6.5 to 6.8.

The following schedule is a guideline for a typical two crop system. The schedule may change some depending on your location.

	Spring	Fall
Plant seeds in plant bed (or flat)	Nov. 20 - Dec 5	June 10 - 20
Transplant seedlings in pot	Dec. 1 -5	June 20 - July 5
Set plants in greenhouse	Jan 15 -31	Aug 1 - 15
Spray plants for diseases	Every 7 - 10 days	Every 7 - 10 days
Start vibrating plants for pollination	Mar 1 - 15	Sept. 1 - 15

Side dress with nitrogen and potash	4 - 6 times	4 - 6 times
Start harvesting	April 15 - 30	Oct 15 - 30
End harvesting and cleanup house	July 1 - 15	Dec 15 – 31

Accurate temperature, humidity, and carbon dioxide control is important. Temperature requirements for major greenhouse vegetable differ. In general, when light intensities are low cooler temperatures are used. For tomatoes, the daytime temperature should be from 70 to 75^{o}F, at night the temperature should be a minimum of 62 to 65^{o}F. When the temperature exceeds 85 to 90^{o}F, cooling equipment should be used to prevent fruit set failure and for proper red coloring development.

The normal concentration of carbon dioxide in the air is 300 parts per million. If carbon dioxide levels are depleted in the greenhouse environment, plant growth may be limited. Addition of carbon dioxide to greenhouses has been demonstrated to improve vegetable yields. Concentrations of carbon dioxide should be adjusted for light intensity and growth stage as follows:

Bright, sunny weather	1000 ppm
Cloudy weather	750 ppm
Young plants	700 ppm
During moderate ventilation	350 ppm

Under open-field conditions, tomatoes are self pollinating. Flowers need to be agitated mechanically, or fruits need to be set using plant chemical hormones that are sprayed on flower clusters on a regular basis, under greenhouse conditions. There are few varieties that are parthencarpic (need no pollination and are seedless), and these are generally small-to-medium sized.

Assuming a 2-to-3 month harvest period for a fall crop which ends in late-December, a yield of about 8 pounds of fruit per plant is possible (0.8 lb/plant/week is considered good). With a 4-month harvest period from a spring crop, approximately 12-15 pounds can be realized. The yield from a single crop per year system can produce about 25-27 lb/plant (based on 0.5-0.75 lb/plant/week) when the harvest begins about mid-October and ends in July of the following year. The lower output would be due to adverse winter conditions (cloudiness and low-light intensity). Generally, growing a fall crop is less profitable due to low-light intensity, poor fruit set, poor fruit quality, and high-fuel costs.

Some non-pathogenic fruit disorders are: bloom-end rot, gray wall, blotchy ripening, solar yellowing, roughness and scars, and fruit cracks.

The USDA has grade standards for fresh tomatoes and is recognized by 6 official designations. They are:

1. Green - the surface is completely green,
2. Breakers - a definite break in color from green to tannish-yellow, pink or red on no more than 10% of the surface,

3. Turning - more than 10% but less than 30% of the surface, in the aggregate, shows change as in 2) above,
4. Pink - more than 30% but less than 60% shows pink or red color,
5. Light red - more than 60% of aggregate surface is reddish pink or red provide that not more than 90% is red, and
6. Red - more than 90% of surface in the aggregate show red color.

CUCUMBERS

This information was summarized from the following publications: **Commercial Greenhouse Production Cucumbers**, 1995, and **Greenhouse Cucumbers**, 1995.

Cucumbers grow more rapidly than tomatoes and produce earlier. European variety cucumbers are a popular greenhouse crop, producing fruits that weigh about one pound and grow 12 to 14 inches long. In contrast to American cucumbers, European varieties set and develop fruit parthenocarpically (without pollination) resulting in fruits that are seedless. They require no bees for pollination and produce higher yields. Before production, you should determine if a suitable market is available in your area; because, they are distinctly different from conventional slicing cucumbers. Since this type is so different from conventional cucumbers, some market can be found almost all the year round.

Some cucumber varieties grown commercially are: Mustang, Jessica, Optima, and Flamingo (mildew tolerant), Corona, Sandra, Fidelio (powdery mildew tolerant), Fertile, factum, Femfrance, LaReine, Pepinex'69, Pepinova, Pandorex, and Santo. Toska70 is a high-yield, high-quality seedless cucumber cultivar which is not all-female, but doesn't require bees. Always test a variety in the season it will grow before committing to it.

Cucumbers require higher temperatures than tomatoes so they are generally grown as a spring or early summer crop. Cucumbers are grown as a two- or three-crop system a year. The yields for the two-crop systems would be the same but with a three-crop system the fruit quality is usually better. Light sandy-loam soils are preferable. Growing in bag culture or rockwool is generally more costly than growing in soil and control of the nutritional program is more critical. Use three week old plants that are free of disease and insect infestations when transplanting to the greenhouse.

Accurate temperature, humidity, and carbon dioxide are important. The temperature requirements for cucumbers during the day are 75 to 77^{o}F and for night at 70^{o}F until first picking. After picking has started, the nighttime temperature may be reduced by 2^{o} per night until a temperature of 63^{o}F is meet, but only temporarily for 2 to 3 days to stimulate growth. Exceeding the maximum temperatures temporarily can be used to cause some flower abortion and maintain the fruit-vine balance. In general, cooler temperatures are used when light intensities are low.

Carbon dioxide is usually present in the atmosphere at a concentration of 300 ppm. For best results, concentrations of 1,000 to 1,500 ppm in a greenhouse atmosphere should be maintained.

Increases of 20 to 40 percent in yield have been reported for various vegetables, when carbon dioxide levels were increased.

Six-to-nine square feet of space per plant is recommended depending on the variety and cropping system. Plants need to establish a strong root system and vegetable stem before fruit is allowed to set. Until the plant has 8-10 leaf nodes, all lateral branches, flowers, and tendrils should be removed (umbrella method). After 8-10 leaf nodes have developed, allow one female flower to set at each subsequent node.

Greenhouse cucumbers grow very quickly and should never lack water or nutrients. Maintain an adequate supply of water to plant roots. Young plants (mid-winter) in the greenhouse may need to be watered only once every 10 to 14 days. The same plants (mid-summer) may need water daily, requiring an estimated 1/4 to 3/4 gallon per plant per day, depending on its size. During crop growth, the most important element needed is nitrogen.

There are several diseases that can be very serious for European cucumbers which include cucumber and watermelon mosaic, gray mold, powdery mildew and rootknot nematodes. In addition to diseases, the grower must be aware of insects too. Some troublesome pests are the white fly, serpentine leaf miner, and two-spotted mite.

Proper control of plant disease is critical in greenhouse environments; where, high temperatures and humidity are ideal for diseases to develop. Insect and nematode infestation can become rampant under the confined greenhouse conditions. Control most fungus and virus diseases with fungicides, proper sanitation and sterilization of soils, growth media, and equipment. Powdery mildew (Erysiphe) is a common fungus disease on cucumbers; chemical controls are available. Early control of white fly, aphid, and spider mite infestation is important. Nematodes may become a problem in either soil or hydroponic culture. Sterilization of soil or hydroponic media is used as a preventative measure.

The most desirable fruits are 11 inches or longer and average 3/4 to 1 pound. During peak production, fruits need to be removed three or four times a week. A healthy plant should produce 24 to 30 marketable fruits.

HYDROPONIC LETTUCE

This information was summarized from the following publication: **A Handbook for the Production of CEA-Grown Hydroponic Lettuce**, 1995.

The process discussed below is for a production-intensive program, where the lighting and electrical power usage is high. Computer technology is an integral part of this type of production of hydroponic lettuce. For the production of 1000 heads (5 ounce) per day, a 7100 ft^2 growing area is required, which includes spacing of plants at day 21, from 9 plants/ft^2 to 3.5 plants/ft^2. To first grow leaf lettuce hydroponically, the growing process is broken into two different areas: the germination area and the pond area. In the germination area, the seeds are started and grown for

11 days; after 11 days they are transplanted to the pond area. The pond area is where the lettuce is grown until harvested on the 35th day. Below are the steps for a 5-ounce head of leaf lettuce.

Germination

The germination area is where lettuce is grown for the first 11 days. The seedlings develop best under constant lighting conditions with specific closely controlled temperature, relative humidity, carbon dioxide, and irrigation.

The starting temperature is maintained at 68^{o}F. After planting, the seeds should be covered with plastic humidity cover to ensure high relative humidity. After one day, the temperature is raised to 77^{o}C. On the second day after planting, the humidity cover is removed. The high humidity for the first two days is to ensure the seeds do not desiccate. The third and fourth days are for the removal of double seedlings to ensure a uniform crop. It is critical to have consistent environmental conditions and consistent plant growth during this stage. Day five is reserved for selecting seedlings based on the size and expansion of their first true leaf (~ 1 cm diameter). Those unacceptable should be discarded. Expect a 20-30 percent disposal. This is a vital process for the uniformity of the crop. After the fifth day, the seedlings now require watering more frequently due to their growth. Flooding for the sub-irrigation system should take place four times a day for 15 minutes.

Transplanting

The 11th day, the roots of the seedlings has grown through the bottom of the plug tray. The seedlings should now be transplanted to the pond area. When transplanting the seedlings try to avoid damaging the exposed roots. The seedling plugs float in the pond of styrofoam floaters, each plug is inserted into a pre-cut, square, 0.3 in^2 in area, centered on a 15.5 in^2 area styrofoam floater. The floaters with seedlings are then placed and positioned in the pond.

Pond Area

Controlling the environment within the pond area is important, due to the intensity of the program. The temperature controls the rate of plant growth. The set points for the temperature should be 75^{o}F for daytime and 65^{o}F for nights. Relative humidity influences the transpiration rate of plants. High relative humidity of the air causes less water to transpire which causes less transport of nutrients from the roots to the leaves. The set points for relative humidity should be from 30% to 70%. CO_2 concentration influences the amount of photosynthesis (growth) of plants and concentrations of 1000-1500 ppm can speed growth. The environmental set points for CO_2 concentrations should be 1000 ppm for light hours and 350 ppm for dark hours. The measurement of dissolved oxygen indicates the amount of oxygen available in the pond nutrient solution for the roots to use in respiration. Lettuce grows satisfactorily at a level of 4 ppm, but the level should usually be maintained at 8 ppm. The set point for the dissolved oxygen is 4 ppm. The pH of the nutrient solution is a measurement of the number of hydrogen ions and a pH of 5.8 is considered optimum for the described growing system. A range of 5.6 - 6.0 for the pH is acceptable; therefore, the set points should be between 5.6 to 6.0. Electrical conductivity measures the amount of dissolved salts in a solution, and for optimum production, the set points should be from 2920 to 3180 micromho/in.

With the environment controls in place, the seedlings are placed in the pond area where they will stay until harvested. On day 18 the leaves will have expanded to cover much of the styrofoam floaters and a head of lettuce will weigh approximately 0.4 oz. On the 21st, day the leaves will have grown to a point where they will interfere with the growth of neighboring plants. At this time the plants should be respaced, which will allow adequate space for new growth. The new spacing should be changed from 9 plants/ft^2 to 3.5 plants/ft^2, thereby allowing for sufficient lighting and spacing for growth until harvested on the 35th day.. Heads will weigh approximately 0.75 oz. On days 25 and 32, the individual lettuce plants will weigh approximately 1.7 and 4 oz respectively.

Harvesting

The 35th day is reserved for harvesting, at which time the head of lettuce should weigh approximately 5 oz. The consistent growing conditions and proper production scheduling for hydroponic lettuce production ensures the crop size will be uniform in size and quality.

CARNATIONS, DIANTHUS CARYOPHYLLUS L.

This information was summarized from the following publications: **Ball RedBook - Greenhouse Growing**, 1985, and **Growers Guide - Carnations**, 1996.

The carnation is most famous for its use as a cut flower in the florist trade. The carnation is a member of the Caryophyllaceae or pink family. White is still the most popular color, followed by various shades of pink. Carnations are semi-hardy perennials treated as annuals. They grow best in well-drained soil exposed to full sun and cool conditions. The lightly-to-heavily fragrant blooms are excellent for cut flowers and bedding plants, and the miniature types can be used in pot culture. Foliage is slightly-to-light green, linear, and borne on stiff erect stems. Flowers are 2 to 2.5 inches in diameter, usually fully-double, and exhibit a wide range of colors.

Carnations are divided by height into two classes: miniature types especially suited to container production--height range is 10 to 14 inch, and tall types best for growing in the garden range--height range 15 to 24 inch.

Some carnation varieties are:

Standard	Color
Scania	Red
Improved White Sim	White
Nora	Dark Pink
Baranna Soana	Light Pink
Peter’s New Pink Sim	Light Pink

Miniatures	Color
White Elegance	White
Dad's Crimson	Red
Star Five	Red
Tinkerbell	Pink
Barbi	Pink
Goldilocks	Yellow
Elegance	Pink/White Novelty
Orange Picotee	Orange Novelty

Carnations grown as bedding plants are propagated from seed; although, they can be propagated from cuttings. The black seeds are flattened, circular, slightly twisted, and are about 0.1 in. in diameter. There are approximately 14,000 seeds per ounce.

Carnation seeds are readily planted with an automatic seeder or can be sown by hand. The germination medium must be well drained and free of pathogens to prevent disease problems, and should be throughly moistened before receiving the seeds. The pH of the soil should be between 5.5 to 6.5. The seeds are sown on the soil surface and covered with 0.12 inches of fine vermiculite to retain moisture. After sowing, the seed trays should be covered with clear polyethylene to retain the moisture. The optimum germination temperature is 70^{o}F.

Germination begins in 8 to 10 days, but may take as long as two to three weeks. After germination the cover is removed and the temperature is lowered to 60^{o}F until transplanting. Make sure the seedlings are not water stressed during this period. The seedlings will benefit from one or two light feedings with a well balanced fertilizer applied at 50 to 100 ppm nitrogen.

Transplanting takes place when the plant has attained two to four true leaves, this takes about one to four weeks. The pH of the soil should be between 5.5 and 6.5 when the plants are transplanted. A soil test should be performed beforehand so adjustments can be made if necessary. The carnations can be grown in 4-in pots or in flats with 48 to 72 plants per flat. The carnations should be placed flat to flat in full sun and raised off the ground to prevent rooting into the ground. Carnations grow best at cool temperatures. Upon transplanting, the plants should be watered thoroughly and held at a temperature of 60^{o}F for a day or two. After the two days, the daytime setting should be 65^{o}F and the nighttime setting should be 50 to 60^{o}F. For shorter plants, the daytime setting is 50 to 60^{o}F and night setting at 65^{o}F. Carnation standards need disbudding and taping of the flower bud to prevent splits.

Some growers move the carnations outside, after they are well established and growing, to open up greenhouse space for younger plants. The grower needs to protect the plants from freezing temperatures and frost, if this procedure is used.

There are several plant problems which the grower must be aware of. Carnation root rot (fusarium oxysporum) is a common and increasing problem among grower the world over. Also, there are diseases which include leaf scorch - caused by high fluoride content in the water. Some insects they shoul d be aware of are leaf miners, aphids, and spider mites. Carnations are also susceptible to ozone injury which can be caused by improper ventilation of the heating equipment.

ROSES

This information was summarized from the following publication: **Ball RedBook - Greenhouse Growing**, 1985.

With the application of new technology in heat shields, high energy lighting, drip irrigation and fertilizer application, high pressure mist for cooling and humidity control, and CO_2 enrichment, high quality roses can be produced in many areas.

Several varieties of cut roses are:

Hybrid Teas	Color
Forever yours	Red
Samantha (HID lights)	Red
Golden Fantasie	Yellow
Emblem	Yellow
Bridal White	White
Pink Sensation	Pink
Sonia	Pink

Sweethearts and Floribundas	Color
Mary Devor	Red
Sassy	Red
Coed	Yellow
Golden Garnette	Yellow
Bridal Pink	Pink
Junior bridesmaid	Pink
Jack Frost	White

The structure of the greenhouse needs to be one that will give full sunlight to all plants. There should be no shading from other greenhouses, buildings or trees. The house should have 7-ft gutters so the roses will not touch the glass when they are at their highest level of production. Heating should be adequate to supply 60^{o}F in the coldest weather and the source of heat should be from the floor. Rose structures should supply warm humid atmospheres with high light intensity during daytime and at night, a lower humidity with an even warm 60^{o}F. The soil temperature should be at 65^{o}F for winter production.

The time for planting roses is usually between January 1 and June 15. It is generally believed a better practice is to plant in January or February, and bring the plants into production in the early summer. The timing for the harvesting of a rose crop is important too, for there is always an increased demand for at holidays like Christmas, Valentine's Day, Easter, and Mother's Day. To meet the increased demand, enough of your crop needs to be pinched off prior to the holiday.

A very important part of rose production is rose cutting. Where you remove the rose from the plant largely determines the ability of your plant to produce. The most common system of cutting is to cut to the second 5-leaflet leaf on the new wood. This will assure you another rose within 7 weeks (42-45 days) from this cut. Another method is to soft-pinch all breaks as they appear and cut the roses back below the pinch. Roses should be cut twice a day to assure that none will open on the plant and be lost. It is also important that benches be cut at the same time every day since 1 or 2 hours will result in a lot of blasting. Roses can last 5 to 7 days under refrigeration at a 32 - 35^{o}F temperature, 80 percent humidity if cut at the right stage of development. “Sweetheart Roses” and some hybrid teas can last over a week.

The rose plant requires a specific environment in order to control quality and productivity. Controlling the temperature is a very important part of rose culture, especially on timing and quality. The carbon dioxide levels should be maintained between 600 to 800 ppm. Weather can have a very definite effect on the timing of roses. Cold and cloudy weather will slow the crop down considerably; likewise, warm and balmy weather will speed it up. Rose buds should be the size of a pea three weeks before the cut date.

The health of rose plants depends largely on the success in controlling diseases and insect pests. The red spider must be controlled. The second most important pest is powdery mildew. Mildew can ruin a rose crop unless checked. Watch for cold drafts from ventilation or broken glass during the heating season. Avoid sudden drops in temperature.

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Section 4
GREENHOUSE HEATING SYSTEMS

INTRODUCTION

The following pages of this section are reprinted in its entirety from "Chapter 14 – Greenhouses" by Kevin Rafferty of the Geothermal Direct-Use Engineering and Design Guidebook published by the Geo-Heat Center.

CHAPTER 14
GREENHOUSES

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14.1 INTRODUCTION

Greenhouse heating is one of the most common uses of geothermal resources. Because of the significant heating requirements of greenhouses and their ability to use very low- temperature fluids, they are a natural application. The evaluation of a particular greenhouse project involves consideration of the structure heating requirements, and the system to meet those requirements. This chapter is intended to provide information on each of these areas.

14.2 GREENHOUSE CONSTRUCTION

In order to make an evaluation of geothermal heating systems for greenhouses, it is first necessary to examine the different heating requirements imposed by various construction methods.

At one time, greenhouses were constructed exclusively of cypress wood frames and single glass lites. Recent years have seen substantial changes in construction techniques and materials. In general, construction may be considered to fall into one of the following four categories:

1. Glass
2. Plastic film
3. Fiberglass or similar rigid plastics
4. Combination of two and three.

All of the above are generally constructed of steel or aluminum frames.

Glass greenhouses are the most expensive to construct because of both the cost of the glazing material and the requirement for a stronger framework to support the glass. In many cases, fiberglass panels are employed on the side and end walls of the structure. The building profile is generally of peaked design, with 36 and 42 ft widths, and lengths in 20 ft increments most common. This type of greenhouse is preferred by growers whose plants require superior light transmission qualities. In addition to offering the highest light quality, the glass greenhouse also has the poorest energy efficiency. Heating costs are high because of the poor insulating quality of single glazing and the high infiltration of cold air through the many "cracks" in the construction. This issue of high transmission loss has been addressed in recent years through the introduction of new, double glazing panels for glass houses. However, because of the expense of these panels and their effect upon light transmission, most glass greenhouses remain single layer.

Plastic film greenhouses are the newest variation in greenhouse construction techniques. This type of structure is almost always of the arched roof or "quonset hut" design. The roof can come all the way down to the ground or can be fitted with side walls. The side walls, if employed, and end walls are generally of fiberglass construction. Maintenance requirements for the plastic film are high in that it generally requires replacement on 3-year intervals or less, depending on the quality of the material. Most plastic film houses employ a double layer of film separated by air space. The air space is maintained by a small blower that pressurizes the volume between the layers. This double poly design is a very energy efficient approach to greenhouse design. Double poly not only reduces transmission losses (losses through the walls and roof) by 30 to 40%, but also substantially reduces infiltration (in leakage of cold air). Although the plastic film tends to lose more heat than glass through radiation, the net effect is a reduction in heating requirements compared to glass construction. Infiltration is reduced because the "cracks" present in other types of construction are eliminated through the use of the continuous plastic film. As a result, there is less opportunity for the cold outside air to penetrate the structure. The superior energy efficiency of the film construction comes at the price of reduced light transmission, however. As a result, highly light sensitive crops cannot be grown in the double-poly greenhouse as successfully as in other constructions. These greenhouses are generally constructed in 30 ft width, and 100 and 150 ft lengths.

Fiberglass greenhouses are similar in construction to the glass houses described above. They are generally of peaked roof design, but require less structural support as a result of the lower weight of the fiber glass. Heat loss of the fiberglass house is about the same as the glass house. Although the fiberglass material has a lower conductivity than glass, when considered in the overall building heat loss, this has little effect.

14.3 HEATING REQUIREMENTS

In order to select a heating system for a greenhouse, the first step is to determine the peak heating requirement for the structure. Heat loss for a greenhouse is composed of two components: (a) transmission loss through the walls and roof, and (b) infiltration and ventilation losses caused by the heating of cold outside air.

To evaluate transmission loss, the first step is to calculate the surface area of the structure. This surface area should be subdivided into the various materials employed, i.e. square feet of double plastic, square feet of fiberglass, etc.

For example, consider a fiberglass wall, double-poly roof greenhouse 42 ft x 120 ft with 8 ft side walls (see Figure 14.1).

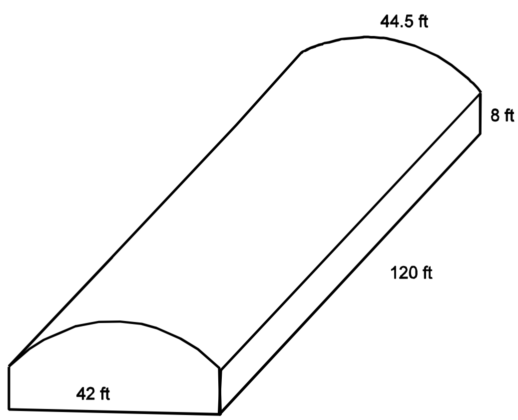


Figure 14.1 Example greenhouse.

Determine the double poly area (roof only):

A_1 = arch width x greenhouse length
A_1 = 44.5 ft x 120 ft
A_1 = 5,340 ft^2

Fiberglass area (side walls and end walls),
Side walls:

A_s = height x length x 2
A_s = 8 ft x 120 ft x 2
A_s = 1,920 ft^2

End walls:

A_e = 1,254 ft^2

Total fiberglass area:

$A_2 = A_s + A_e$
A_2 = 1,254 ft + 1,920 ft
A_2 = 3,174 ft^2.

After determining the total surface area (A) of the various construction materials, this value is then combined with a design temperature difference (ΔT) and a heat loss factor (U) for each component, to calculate the total transmission heat loss (q):

$$q = (A_1 \times \Delta T \times U_1) + (A_2 \times \Delta T \times U_2).$$

The design temperature difference is a function of two values: (a) design inside temperature, and (b) design outside temperature. The inside design value is simply the temperature to be maintained inside the space (typical values appear in Table 14.1 range). The design outdoor temperature is not the coldest outdoor temperature recorded at the site. It is generally considered to be a temperature that is valid for all but 22 h/y during the heating season. Acceptable values for various locations are generally available from state energy offices or organizations such as American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE, 1978).

Table 14.1 Temperature Requirements for Typical Greenhouse Crops

Vegetables	Day	Night
Peppers	65-85	60-65
Tomato	70-75	62-65
Cucumber	75-77	70
Lettuce (hydroponic)	75	65
(Reduce temp. 2° when picking)		
(During germination, humidity 30-70%)		
Flowers		
Roses	60-62	62
Poinsettias	70-80	64-72
Easter Lilies	60	
Carnations	75	50
Geraniums	70-80 (max)	
Fuchsia	70 (min)	65
(min)		

For this example, assume a design outdoor temperature of 0°F and a design indoor temperature of 60°F. This results in a design temperature difference (ΔT) of:

ΔT = 60°F - 0°F
ΔT = 60°F.

The final value in the transmission heat loss equation is the heat transfer coefficient (U). Acceptable values for various materials are shown in Table 14.2.

Table 14.2 Glazing Material U Values[a]

Material	Btu/h ft^2 °F
Glass	1.10
Fiberglass	1.00
Single poly	1.15
Double poly	0.70

a. Roberts, 1985

The U factor is also influenced by wind speed. The above values are based upon a wind speed of 15 mph. If other wind speeds are expected to occur at the design outside condition, then allowances should be made for this by adjusting the U factor are shown in Table 14.3.

Table 14.3 U Values at Various Wind Velocities

Material	Velocity (mph)					
	0	5	10	20	25	30
Glass	0.765	0.951	1.040	1.140	1.160	1.180
Fiberglass	0.695	0.865	0.949	1.034	1.058	1.078
Single poly	0.810	1.000	1.090	1.190	1.210	1.230
Double poly	0.535	0.631	0.675	0.716	0.728	0.736

For the example, the transmission heat loss (q_p) for the double poly roof area is:

$q_p = 5340\ ft^2 \times 60°F \times 0.70\ Btu/h\ ft^2\ °F$
$q_p = 224{,}280\ Btu/h$

and for the fiberglass areas:

$q_F = 3{,}174\ ft^2 \times 60°F \times 1.00\ Btu/h\ ft^2\ °F$
$q_F = 190{,}440\ Btu/h$

Total transmission heat loss (q_1) is then:

$q_1 = q_p + q_F$
$q_1 = 224{,}280\ Btu/h + 190{,}440\ Btu/h$
$q_1 = 414{,}720\ Btu/h$

As mentioned previously, total heat loss is a function of two components: (a) transmission heat loss, and (b) infiltration. For greenhouse design, infiltration is generally analyzed via the air change method. This method is based upon the number of times per hour (ACH) that the air in the greenhouse is replaced by cold air leaking in from outside. The number of air changes which occur is a function of wind speed, greenhouse construction, and inside and outside temperatures. Table 14.4 outlines general values for different types of greenhouse construction.

Table 14.4 Air Change Data for Various Glazing Materials

Material	Air Changes/h
Single glass	2.5 to 3.5
Double glass	1.0 to 1.5
Fiberglass	2.0 to 3.0
Single poly	0.5 to 1.0
Double poly	0.0 to 0.5
Single poly w/low fiberglass sides	1.0 to 1.5
Double poly w/low fiberglass sides	0.5 to 1.0
Single poly w/high fiberglass sides	1.5 to 2.0
Double poly w/high fiberglass sides	1.0 to 1.5

a. Roberts, 1985, ASHRAE, 1978.

As the number of air changes is related to the volume of the greenhouse, after selecting the appropriate figure from above, it is necessary to calculate the volume of the structure. For the example structure, this is most easily accomplished in two steps. These figures do not include ventilation.

Volume (V_1) of the greenhouse:

V_1 = end wall area x greenhouse length
$V_1 = 627\ ft^{-2}\ ft \times 120\ ft$
$V_1 = 75{,}247\ ft^3$

From the Table 14.4, the number of air changes/h (ACH) would be 1.0 to 1.5--use 1.0 (double poly with high fiberglass sides).

Heat loss (q_2) caused by infiltration:

$q_2 = ACH \times V_T \times \Delta T \times 0.018$
$q_2 = 1.0 \times 75{,}247\ ft^3 \times 60°F \times 0.018$
$q_2 = 81{,}260\ Btu/h$

Total greenhouse heating (q_T) requirement:

$q_T = q_1 + q_2$
$q_T = 414{,}720\ Btu/h + 81{,}260\ Btu/h$
$q_T = 495{,}980\ Btu/h$ (98.41 Btu/ft^2 of floor area)

This calculation assumes that infiltration will meet winter ventilation requirements. If artificial ventilation is required in excess of infiltration, this should be added to the peak load.

This is the peak or design heating load for the greenhouse. The heating equipment selected for the structure would have to be capable of meeting this requirement.

14.4 GREENHOUSE HEATING SYSTEMS

There are basically six different geothermal heating systems which are applied to greenhouses:

1. Finned pipe
2. Standard unit heaters
3. Low-temp. unit heaters
4. Fan coil units
5. Soil heating
6. Bare tube.

Often the choice of heating system type is not dictated by engineering considerations such as maximum use of the available geothermal resource or even the most economical system, but on grower preference. Grower preference may be based strictly on past experience and familiarity with growing crops with that system. It may also be influenced by factors such as the type of crop, or potential disease problems. Some crops, such as roses and mums, require closely controlled humidity and a considerable amount of air circulation to prevent leaf mildew. If a radiant floor system is used, auxiliary circulating fans will be required. Tropical and subtropical potted plants, on the other hand, may require high humidity and higher soil temperatures. In this case, a radiant, under the bench system will be preferred, perhaps combined with an overhead air system for snow melting, in order to get maximum sunlight during winter months in areas of high snow fall. Certain flowering plants may require shading to control blooming, thereby enabling the grower to market at the most opportune time. The type and location of the shading cover can affect the placement of heating and air handling equipment and, perhaps, the type of heating.

All these things should be taken into consideration and the heating system designer should maintain close communication with the grower in the selection of type and the placement of heating devices.

The following paragraphs outline the performance of the heating systems mentioned above.

14.4.1 Heat Exchangers

In most geothermal applications, a heat exchanger is required to separate actual heating equipment from the geothermal fluid. This is because of the scaling and corrosion associated with most geothermal fluids. Generally, the heat exchanger is placed between two circulating loops, the geothermal loop and the clean loop, as shown in Figure 14.2.

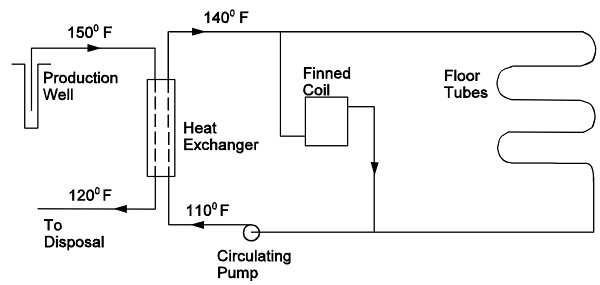


Figure 14.2 Heat exchanger schematic.

As a result of this heat exchanger, there is some loss in the temperature of the fluid available for use in the actual heating equipment. This temperature loss depends upon the type of heat exchanger used. For plate-type heat exchangers, a temperature of 5 to 10°F should be applied, for shell and tube heat exchangers 15 to 20°F, and for homemade configurations 20 to 40°F. For example, assuming a geothermal resource temperature of 150°F is available, use of a plate heat exchanger would result in 140°F supply water, as shown in Figure 14.2.

Now that the heating requirement and supply water temperature has been established, various heating systems can be evaluated with respect to their ability to meet this demand. For geothermal applications, the available geothermal resource temperature has a large impact upon the system chosen. This is a result of the fact that certain types of heating methods yield better results with low-temperature fluid than others.

Table 14.5 Steam and Extended Hot Water Ratings[a] (Bare Element)

Bare Heating Elements	Rows	Hot Water Ratings, Btu/h/lf Average Water Temperature 240°F	230°F	220°F	210°F	200°F	190°F	180°F	170°F
	1	1630	1480	1370	1240	1120	1010	900	790
33 fins/ft	2	2810	2570	2360	2140	1940	1760	1550	1370
	3	3660	3340	3080	2780	2520	2290	2020	1790
40 fins/ft	1	1750	1600	1470	1330	1220	1090	970	850
	2	2930	2670	2460	2220	2010	1830	1610	1430

a. Vulcan, 1976

Finned Pipe

As the name implies, finned pipe is usually constructed of steel or copper pipe with steel or aluminum fins attached to the outside. These fins can either be circular, square or rectangular in shape. In the size range employed in greenhouses, the steel pipe with steel fins is most common.

Since most finned-pipe heating equipment used in geothermal projects was originally designed for standard hot water use, heating capacity is generally based upon 200°F or higher average water temperature and 65°F entering air temperature. If the available supply temperature from the geothermal system is less than the 200°F value, the capacity of the heating equipment, in this case finned pipes, will be less than the rated value. In addition, heating capacity of finned pipe, usually expressed in Btu/h per lineal foot, is influenced by fin size, pipe size and flow velocity. Table 14.5 shows one manufacturer's rating for equipment.

Table 14.6 shows the appropriate de-rating factors to be applied for average water temperatures of <190°F.

Table 14.6 Derating Factors (Vulcan, 1976)

Average Water (°F)	Factor
180	0.80
160	0.62
140	0.47
120	0.30
100	0.17

It is important to note that the capacity of this equipment is indexed to average water temperature, not supply water temperature. In order to find average water temperature (AWT), it is first necessary to calculate the temperature drop (ΔT), which is found according to the following relationship:

$$\Delta T = q/(500 \times Q)$$

where

ΔT = temperature drop (°F)
q = heating requirement (Btu/h)
500 = constant, Btu/h gpm (°F)
Q = flow rate (gpm).

Using the greenhouse example from above, with a requirement of 495,980 Btu/h, assume a 150°F resource, a flow of 50 gpm, and the use of a plate-type heat exchanger.

$$\Delta T = (495{,}980 \text{ Btu/h})/(500 \text{ Btu/h gpm °F} \times 50 \text{ gpm})$$
$$\Delta T = 20°F$$

With a 150°F resource and a 10EF loss across the heat exchanger, this results in a 140°F supply temperature (T_s). Since a 20°F drop from supply to return was calculated, the average water temperature is then:

$$AWT = T_s - (\Delta T/2)$$
$$AWT = 140°F - (20°F/2)$$
$$AWT = 130°F.$$

This provides the information required to select the necessary length of finned-pipe heating element required. Using Table 14.5, for a 2-in. steel element having 4-1/4 in.(1 row) square fins spaced at 33/ft, output at 200°F AWT (factor of 1.00) is 1120 Btu/h lf. Using an interpolated correction factor of 0.385 from Table 14.6, actual capacity will be 0.385 x 1120 Btu/h lf = 431 Btu/h lf at the 130°F AWT.

With this value and the heating requirement of 495,980 Btu/h, calculate the length (l) of element required as:

$$l = (495{,}980 \text{ Btu/h})/(431 \text{ Btu/h lf})$$
$$l = 1{,}151 \text{ ft.}$$

This large length requirement points up the limitation of finned pipe with respect to low temperature. As average water temperature falls below about 150°F, large lengths of finned element are required to meet the heating load in colder regions. As a result, finned pipe is not a particularly good choice for low-temperature resources.

Finned elements are generally installed along the long dimension of the greenhouse adjacent to the outside wall. Improved heat distribution is achieved if about one-third of the total required length is installed in an evenly spaced pattern across the greenhouse floor (ASHRAE 1978). This system has the disadvantage of using precious floor space that would otherwise be available for plants. In addition, it is less capable of dealing effectively with ventilation if it is required. Maintenance requirements are low, particularly if a heat exchanger is used. In addition, the natural convection nature of the finned pipe system does not increase electrical costs as a result of fan operation.

The costs for finned pipe elements are a function of the type and size of piping (steel or copper), and fin spacing (fins/ft). It is not possible to present costs for all combinations of these characteristics; however, Table 14.7 should serve to illustrate cost trends in fin pipe equipment.

For labor cost estimating, a value of 0.25 to 0.35 man hours per lineal foot can be employed for finned pipe installation (Khashab, 1984).

Table 14.7 Comparative Costs of Finned Pipe Elements (Means, 1996)

Element	Cost/lf ($)
Copper/aluminum (3/4 in., 33 fin/ft)	5.40
Copper/aluminum (1 in., 33 fin/ft)	7.50
Steel/steel (1-1/4 in., 33 fin/ft)	11.00
Steel/steel (1-1/4 in., 40 fin/ft)	12.30
Steel/steel (2 in., 24 fin/ft)	10.80
Steel/steel (2 in., 33 fin/ft)	12.60

Standard Unit Heaters

Unit heaters consist of a finned coil and small propeller fan contained in a pre-designed unit. These units are available in either horizontal or vertical configurations and are generally hung from the greenhouse structure at roof level (see Chapter 12, Figures 12.24 and 12.25). Air is discharged either directly into the greenhouse or into a perforated plastic distribution tube ("poly tube").

As with the finned pipe equipment, unit heaters are generally rated at 200°F entering water temperature (EWT) and 60EF entering air temperature (EAT). Changes in either of these two parameters will affect unit capacity (usually expressed in Btu/h). Since most geothermal resources applied to greenhouses are <200°F, some adjustment of unit capacity is necessary. Table 14.8 shows a typical set of manufacturer's performance data for unit heaters at standard conditions (200°F EWT/60°F EAT). To adjust for other conditions, Table 14.9 values are employed. It is important that the gpm values shown in Table 14.8 are met. Providing a unit with a flow less than that shown will decrease capacity.

Table 14.8 Hot Water Unit Heater Ratings[a] (Modine, 1979)

Model	Btu/h	GPM	CFM	Final Air Temp.	HP
A	90,000	9.0	1775	110	1/6
B	133,000	13.4	3240	100	1/3
C	139,000	14.0	2900	107	1/3
D	198,000	20.0	4560	102	1/2
E	224,000	22.0	4590	108	1/2
F	273,000	27.0	5130	108	1/2

a. Standard Conditions, 200°F EWT/60°F EAT.

Because these units are generally constructed with copper tubes, even very small concentrations of dissolved hydrogen sulphide (H_2S) or ammonia (NH_3) will result in rapid failure. In addition, the long path through which the water must flow in the unit heater can result in scaling if the fluid has this tendency. As a result, a unit heater system should not be applied without an isolation heat exchanger.

Using information from the example greenhouse, unit heaters can be selected to meet the heating requirement. Example conditions are given in Table 14.10.

From Table 14.9, find a correction factor of 0.571. This factor is then applied to the capacity values shown in Table 14.8 to adjust them to the system conditions.

Table 14.9 Unit Heater Correction Factors[a] (Modine, 1979)

	EAT(°F)			
EWT (°F)	40	60	80	100
80	0.293	0.143	-0-	-0-
100	0.439	0.286	0.140	0.069
120	0.585	0.429	0.279	0.137
140	0.731	0.571	0.419	0.273
160	0.878	0.714	0.559	0.410
180	1.024	0.857	0.699	0.547
200	1.170	1.000	0.833	0.684

a. To be applied to standard ratings.

Table 14.10 Unit Heater Example Conditions

Condition	Value
Load	495,980 Btu/h
Resource temperature	150°F
Heat exchanger loss	10°F
Supply water temperature	140°F (150-10°F)
Greenhouse inside design temp.	60°F

For greenhouses over 50 ft in length, it is advisable to place unit heaters at each end to allow for better heat distribution. Assuming two units are used in this case, each would need a capacity (q) of:

$$q = (495,980 \text{ Btu/h})/2 = 247,990 \text{ Btu/h}.$$

To convert this to an equivalent in Table 14.8, dividing by the above correction factor of 0.571:

$$q = (247,990 \text{ Btu/h})/0.571 = 434,308 \text{ Btu/h}.$$

A two-unit system will not work because the largest unit capacity for a horizontal configuration is 273,000 Btu/h. The next step is to try a four-unit system--two-unit heaters at each end of the house. In this case, each unit would have a capacity of:

q = (434,308 Btu/h)/2 = 217,154 Btu/h.

This results in half the capacity calculated for the single unit above.

The proper selection would be the "E" unit at a capacity of 224,000 Btu/h. This is slightly more than the required 217,154 and will allow for a margin of safety in the design. As shown, the flow requirement (Q) for the four units will be:

Q = 22 gpm x 4 units = 88 gpm.

If the available flow rate is less than this value, unit capacity would have to be corrected for operation at this reduced flow, possibly resulting in the need for additional units.

Two types of hot-water unit heaters are commonly used in greenhouse applications: horizontal and vertical. Of these two configurations, the horizontal unit is the more common. Vertical unit heaters are generally available in larger capacities than the horizontal units. In addition to the unit heater itself, a "poly tube" adapter is frequently required to attach the distribution system to the front of the heating device. Prices for each of these items are shown in Table 14.11. Capacities for unit heaters are based on 200°F entering water temperature.

Table 14.11 Horizontal and Vertical Unit Heater Costs[a]

Horizontal Unit Heaters	
Capacity[b] (MBH)	Cost ($)
23	822
44	874
66	995
97	1210
133	1294
153	1294
198	1581
257	1811

a. Means, 1996.
b. 1000 Btu/h.

Poly tube adapter costs are given in Table 14.12

Table 14.12 Poly Tube Adapter Costs[a](1996)

Size (in.)	Cost ($)
12	100
18	115
24	175

a. Roper, undated.

Low-Temperature Unit Heaters

Low-temperature unit heaters are similar to standard unit heaters; but, their design is optimized for low-water temperature operation. These units incorporate a more effective water coil and a higher capacity fan. They are larger and heavier than standard unit heaters, and in some applications, may require additional support if suspended from the ceiling. These units are horizontal in configuration and use a propeller-type fan.

Performance of the low-temperature unit heaters falls between that of standard unit heaters and fan-coil units. Performance data for this equipment appear in Table 14.13. Costs appear in Table 14.14.

As indicated in the table, this equipment is rated in terms of its capacity per degree of entering temperature difference (ETD). Entering temperature difference is calculated by subtracting the space air temperature from the supply water temperature. For a greenhouse maintained at 60°F with a supply water temperature of 125 °F, an ETD value of 65°F would result.

Table 14.13 Low-Temperature Unit Heaters Performance Data (Modine, 1985)

Water	Btu/EF of Entering Temperature Difference	
Flow (gpm)	Single Fan (3850 cfm)	Two Fan (7700 cfm)
5	1500	2500
10	2200	3600
15	2500	4300
20	2750	4900
25	2850	5300
30	3000	5650
35	3100	5800
40	3100	6000

Based on the example, greenhouse heat loss of 495,980 Btu/hr, a 125°F supply water temperature, and a 30 °F ΔT, the following calculations can be made:

System flow rate = 495,980 Btu/hr ÷ (500 · 30)
=33.1 gpm

Using two units, the single fan rate would have a capacity of:

33.1 ÷ 2 = 16.6 gpm ea.

From Table 14.13:

Interpolate for capacity @ 16.6 gpm
= 2,580 Btu/hr °F ETD
Capacity = 2,580 · 65
= 167,700 Btu/hr

Number of units required:

= 495,980 Btu/hr ÷ 167,700
=2.96 or 3 units

Two-fan units:

Capacity @ 16.6 gpm = 4,492 Btu/hr °F ETD
@ 65°F ETD capacity
= 4,492 · 65
= 291,980 Btu/hr

Number of units required:

= 495,980 Btu/hr ÷ 291,980 Btu/hr
= 1.70 or 2 units.

Table 14.14 Cost Data for Low-Temperature Unit Heaters

Single fan unit	$2,800
Two-fan unit	$5,100

Fan Coil Units

These units are similar to the standard unit heater discussed previously. They consist of a finned coil and a centrifugal blower in a single cabinet. A few manufacturers offer units in an off-the-shelf line for low temperature greenhouse heating. It is much more common that they are custom selected. The difference between the fan coil unit and the hot-water unit heater is primarily in the coil itself. In the fan coil system, the coil is much thicker and usually has closer fin spacing than the coil in a unit heater. Unit heaters generally have only a one or two row coil. A custom designed coil can have as many as six or eight rows. The additional rows of tubes create more surface area. The added surface area allows for more effective heat transfer, resulting in the ability to extract more heat from the water. To illustrate this, consider the unit heater selected in the previous section. Conditions are given in Table 14.15.

Table 14.15 Unit Heater Example[a] (two row)

Condition	Value
Capacity	127,904 Btu/h (0.571 x 224,000)[a]
Air flow	4,590 cfm[b]
Water flow	22 gpm
Supply water temperature	140°F
Leaving water temperature	128.4°F
Leaving air temperature	85.8°F

a. Model E unit heater.
b. Cubic ft/min.

Supplying the same temperature water to a fan coil unit with a four-row coil would result in the values as shown in Table 14.16.

Table 14.16 Fan Coil Example[a] (four-row)

Condition	Value
Capacity	275,171 Btu/h
Air flow	4,590 cfm
Water flow	13.76 gpm
Supply water temp.	140°F
Leaving water temp.	100°F
Air in temp.	60°F
Air out temp.	115°F

a. Four-row coil with 11 fins/in., 2.5 ft x 3.67 ft.

Using only 60% of the water flow, the fan coil unit has the capability to more than double the heat output. In addition, the leaving air temperature is raised to 115°F from 85.8°F.

This benefit is not without cost, however. The fan coil units are generally larger and more bulky than the hot-water unit heater. As a result, they cost more. The larger coils discussed above generally require a larger fan motor to push the air through the added coil resistance. In this case, the unit heater would require a 0.5 horsepower (hp), motor and the fan coil unit would require a 1 hp motor. These factors may be compensated for by increased capacity, thus requiring fewer units.

The ability to extract more heat from each gallon of water pumped reduces well pumping requirements and allows the development of more greenhouse area, using the same resource. As a general rule of thumb, a well designed coil can cool water down to within about 15 to 25°F of the space temperature. For example, if a greenhouse is to be maintained at 60°F and the coils are supplied with water at 120°F, a system ΔT of 120°F - (60°F + 25°F), or 35°F could be achieved. If the well flow is known, then the total heat supplied (q) can be calculated as:

$$q = 500 \times gpm \times \Delta T = Btu/h.$$

This figure can then be compared to greenhouse heat loss to find the total area of greenhouse that can be developed.

The fan coil construction is very similar to that of the unit heater. For the same reasons, it is recommended that they be applied with an isolation heat exchanger. The fan-coil system is the most cost effective method for extracting large quantities of heat from very-low-temperature heating mediums.

Table 14.17 presents pricing information for fan coil equipment.

Table 14.17 Fan Coil Unit Prices (Means, 1996)

Unit (cfm)	Nominal Capacity[a] Btu/hr	Cost ($)
2000	120,000	1750
4000	240,000	2500
6000	360,000	3500
8000	480,000	4500

a. @ 115°F supply air temperature

As with the unit heater, a poly tube adapter would be required if this equipment is to be attached to such a distribution system. For prices, see Table 14.12.

Soil Heating

This system generally involves using the floor of the greenhouse as a large radiator. Tubes, through which warm water is circulated, are buried in the floor of the greenhouse. Heat from warm water is transferred through the tube to the soil and, eventually, to the air in the greenhouse.

In the past, tube materials were generally copper or steel. Because of corrosion and expansion problems with these materials, nonmetallic materials have seen increasing application in recent years. The most popular of these is polybutylene. This material is able to withstand relatively high temperatures (up to - 180°F) and is available in roll form for easy installation. PVC piping is only available in rigid form and is limited with respect to temperature. Polyethylene and similar materials are available in flexible roll form, but are (as PVC) generally limited in terms of temperature handling ability.

A soil heating system is preferred by many operators because it results in very even temperature distribution from floor to ceiling and does not obstruct floor space or cause shadows. However, its ability to supply 100% of the heating requirements of a greenhouse necessitates a rather mild climate and a low inside design temperature. This is caused by the nature of heat transfer in the system. As heating requirements are increased, the required heat output from the floor is increased. In order to produce more heat, the floor surface temperature must be increased. Very quickly a point is reached at which it is difficult to spend extended periods on such a hot floor. In addition, if plants are grown on or near the floor (including benches), heat transfer to the plants may be excessive with a radiant floor system. As a result, this system is generally employed in conjunction with another system such as unit heaters. The floor system supplies the base load for the greenhouse and the secondary system is used for occasional peaking purposes.

The procedure for designing a floor system consists of:

1. Determining the heat load for the greenhouse.
2. Calculating the required floor temperature to meet the load.
3. Calculating the required size, depth and spacing of the tubes.

The load analysis portion of the procedure has been covered. The next step is to determine the required floor surface temperature.

The heat output of the floor (usually expressed in Btu/h ft^2) is a function of the floor surface temperature, greenhouse air temperature and average temperature of unheated surfaces in the room (AUST). Heat output from the floor occurs by two mechanisms: convection and radiation.

After the heat loss of the greenhouse has been calculated, it is divided by the area of the floor which will be used for heating purposes (usually about 10% less than the actual floor area). Using the previous greenhouse example, 42 ft x 120 ft, with a total heat loss of 495,980 Btu/h, the value for heat loss (q/A) is:

$q/A = (495{,}980 \text{ Btu/h})/(42 \text{ ft} \times 120 \text{ ft} \times 0.90)$
$q/A = 109.4 \text{ Btu/h ft}^2$.

This value is then used in the following equation to solve for the required floor surface temperature (ASHRAE, 1984):

$$q/A = 0.15x[(\frac{T_f+460}{100})^4-(\frac{AUST+460}{100})^4]+0.32(T_f-T_a)^{1.32}$$

where

T_f = floor surface temperature
T_a = indoor air temperature.

Before the above can be solved for T_f, a value for AUST must first be calculated. As mentioned earlier, AUST is the area weighted average temperature of unheated surfaces in the room. For a greenhouse, these surfaces are the walls and roof.

Inside surface temperature can be calculated according to the formula below. Referring back to the heat loss example, the greenhouse is constructed of both double poly (roof) and single fiberglass (walls). The calculation for AUST is:

IST = IDT - ((0.595/(1/ U)) x ΔT)

where

IST = inside surface temperature (°F)
IDT = inside design temperature (°F)
U = glazing material U factor, Btu/h ft^2 (°F)
ΔT = design temperature difference (°F).

For the example greenhouse, the inside surface temperature of the double poly roof area is:

IST = 60°F - ((0.595/(1/0.70)) x 60°F)
IST = 35.0°F.

The inside surface temperature for the single fiberglass area is:

IST = 60°F - ((0.595/(1/1.0)) x 60°F)
IST = 24.3°F

$AUST = (A_1 \times IST_1 + A_2 \times IST_2)/(A_1 + A_2)$

$$AUST = \frac{(5{,}340 ft^2 \ x \ 35^oF) + (3{,}174 \ ft^2 \ x \ 24.3^oF)}{(5{,}340 \ ft^2 + 3{,}174 \ ft^2)}$$

AUST = 31.0°F

This value can now be inserted into the equation for floor temperature developed by ASHRAE as:

$$q/A = 0.15((T_f + 460/100)^4 - (31.0 + 460/100)^4) + (0.32(T_f - 60)^{1.32}) = 109.4 \text{ Btu/h ft}^2$$

Solving for T_f:

T_f = 103°F.

This means that in order to meet the peak demand, a floor surface temperature of 103°F would be required. Plants could not be grown on or near such warm soil. In addition, the amount of time that workers could be exposed would be limited. As a result, it would be advisable to supply a portion of the design capacity with this system and the rest with a secondary system. If the system is designed for only 60% of peak requirements (65.5 Btu/h ft^2), a floor temperature of only 84 °F would be required. This figure is close to the maximum recommended floor surface temperature of 85°F for occupied areas. If the greenhouse is occupied only for brief periods, this value can be exceeded somewhat. A secondary system would be used for peaking.

The next step is to determine the depth and spacing of the tubes supplying the heat. Tube spacing and size is dependent upon the available water temperature. Generally, depth is more a function of protecting the tubes from surface activity than system design, and a figure of 2 to 6 in. below the surface is common.

Since it is the purpose of the floor panel system to use the floor as a large radiator, it follows that the installation of the tubing should result in as uniform a floor surface temperature as possible. This is accomplished by two general approaches: (a) placing smaller diameter tubes at close spacing near the surface of the floor, or (b) placing larger tubes spaced further apart at a greater burial depth. The theory behind this approach is to reduce the difference between the distance heat must travel vertically (from the tube to the surface directly above it) and laterally (from each tube to the surface between the tubes)(Adlam, 1947).

The depth at which the tubes are to be buried is often a function of protecting them from surface activity. For burial in the soil floor of a greenhouse, a depth of at least 2 to 3 in. should be employed. If crops are to be grown directly in the soil, depth requirements are such that this type of system becomes impractical.

Tubing size is a function of heating requirements. Common sizes are ½ in., 3/4 in. and 1 in. with the smaller sizes used generally in the 2 to 4 in. depth and the larger lines for depths of 5 in. and greater.

The final determination of the size and spacing is a function of heat output (Btu/ft^2) required, mean water temperature, soil conductivity, and burial depth.

The required heat loss is fixed by the type of greenhouse construction used. Soil conductivity is also fixed by site characteristics. As mentioned earlier, the minimum burial depth is fixed by surface activity. As a result, the choice of size and spacing is balanced against mean water temperature, the single parameter over which the designer has some control. Table 14.18 lists some maximum mean water temperatures for various situations. Employing mean water temperatures above these values will result in floor surface temperatures greater than 90^{0}F. If workers are to spend extended periods in the greenhouse, floor surface temperatures above this value would be unacceptable.

Table 14.18 Maximum Recommended Mean Water Temperatures (ºF)

Polybutylene Burial Depth (in.)	Steel Pipe k = 0.5	Steel Pipe k = 0.75	Tube k =0.5	Tube k = 0.75
1	111	105	124	112
2	116	110	131	120
3	122	115	139	128
4	125	117	144	131
5	128	120	148	135
6	134	125	156	142

a. k = soil conductivity in Btu/hr ft ºF

In addition to the maximum mean water temperature, it is also important when making this calculation to be aware of system ΔT (supply temperature minus return water temperature) and its impact upon system design. Temperature drops above approximately 15ºF should employ a double serpentine to balance the circuit output. For ΔT below 15ºF, a single serpentine can be used as shown in Figure 14.3.

Using the heating requirement and floor surface temperature calculated above, some combinations of tubing size and spacing can be determined. It will be assumed that, because of surface activity, the tubes would have to be buried a minimum of 3 in. below the surface. Soil conductivity is 0.75 Btu/h ft^2 ºF. Resource temperature is 140ºF and a flow of 60 gpm is available. Polybutylene tubing will be employed. Plate heat exchanger loss is 7ºF.

As a result of the heat exchanger loss, 133ºF fluid will be available for supply. If the entire flow is used, the system ΔT would be:

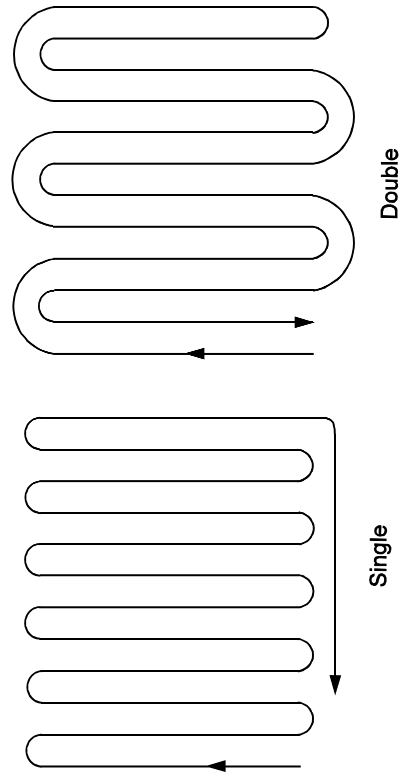


Figure 14.3 Single- and double-serpentine piping layout.

ΔT = (297,108 Btu/h)/(500 Btu/h gpm ºF x 60 gpm) = 9.9ºF

The resulting mean water temperature (Tw) would be:

Tw = 133ºF - (9.9ºF/2) = 128ºF

This value is equal to the recommended maximum mean water temperature found in Table 14.18, so design can proceed. If this value had been above the recommended temperature, either the tubes would have to be buried deeper or the radiant floor system operated at a lower supply-water temperature.

Subtracting the required floor surface temperature from the mean water temperature results in the tube-to-surface temperature difference. Using this and the value from Figure 14.4, the heat out-put per lineal foot (lf) of tube can be determined. From Figure 14.4, for a burial depth of 3 in., a value of 1.60 Btu/h lf ºF for 3/4 in. tubing results. For 1 in. tubing due to greater surface area, the value would be (1.60 x 1.00/0.75) = 2.13 Btu/h lf ºF.

The heat output per lf for each of these tubes would be arrived at by multiplying the Btu/hr lf ºF value times the tube-to-surface temperature difference.

For 3/4 in. tube: 1.60 x (128ºF - 84ºF) = 70.4 Btu/h lf

For 1 in. tube: 2.13 x (128ºF - 84ºF) = 93.7 Btu/h lf

The tube spacing is determined by dividing the tube output per lineal foot into the heating requirement (per square foot).

For 3/4 in. tube: (65.5 Btu/ft^2 h)/(70.4 Btu/h lf) = 0.93 lf/ft^2

For 1 in. tube: (65.5 Btu/ft^2 h)/(93.7 Btu/h lf) = 0.70 lf/ft^2.

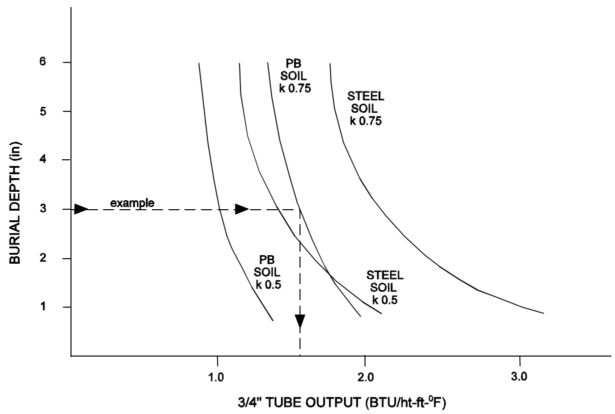


Figure 14.4 Heat output for radiant floor system.

Taking the inverse of the above results and multiplying by 12 in./ft yields tube spacing:

For 3/4 in. tube: (1/0.93) x 12 = 12.9 in.

For 1 in. tube: (1/0.70) x 12 = 17.1 in.

In most cases, because of losses downward and at the edges, a safety factor of 10 to 15% is added to the tube requirements. This is most conveniently accomplished by reducing the tube spacing by 10 to 15%.

In order to demonstrate the sensitivity of the system to other parameters, Table 14.19 shows some additional tube spacing calculations that are made:

Table 14.19 Tube Spacing (in.)

				Tubing	
	Soil k	Depth	MWT	3/4 in.	1 in.
Base case	0.75	3	128	12.9	17.1
	0.5	3	128	8.10	10.8
	0.75	6	128	10.23	13.6
	0.5	3	118	8.94	11.9
	0.5	6	118	5.43	7.2

Using the base case tube spacing and 3/4 in. tubes, a total of 4,218 ft of tubing will be required. In order that a reasonable pressure drop will be attained, the total 60 gpm flow would be divided among a number of individual circuits. At a velocity of approximately 3 ft/s, each circuit would carry 5 gpm. This would require 12 circuits for the total flow. If the 1 in. tubing is used, a smaller number of higher flow circuits could be employed.

As suggested above, a heat exchanger is used in this case. This is for two reasons: protection from scaling and control of temperature.

Control of temperature is the most critical. The only method of controlling the output of a floor system is by controlling the water temperature in the tubes. The use of a heat exchanger allows this control to be carried out more easily. The flow of geothermal fluid to the exchanger is regulated to maintain a given supply temperature to the heating loop as shown in Figure 14.2.

As suggested in the example, a great deal of piping material is required to supply just 60% of the peak requirement of a greenhouse in a cold location. In addition, the inability to grow directly in or on the soil surface also restricts the wide acceptance of this type of system.

The cost of both polybutylene and polyethylene piping is a function of pipe size and the standard dimension ratio (SDR). The SDR is related to the nominal pipe size divided by the wall thickness, or as the SDR increases, the wall thickness decreases. Material costs shown in Table 14.20 are for SDR 11. This material is rated at 100 psi at 180ºF (polybutylene) and 160 psi at 70ºF (polyethylene).

Table 14.20 Polyethylene and Polybutylene Pipe Costs (Means, 1996)

Size (in.)	Polybutylene ($/lf)	Polyethylene ($/lf)
1/4	0.32	-
3/8	0.40	-
1/2	0.40	0.20
3/4	0.74	0.29
1	1.25	0.44

Bare Tube System

This system involves the use of bare tubing, usually small diameter polybutylene or similar material. The tubing is installed either on the floor or suspended under benches. It is preferable for the tubing to be located low in the greenhouse, although a portion may be located overhead. Regardless of the installation location, it is very important that the tubing be arranged such that each tube is separated from the others. If the tubes are bunched together, the effective surface area of each is reduced, thus lowering heating capacity.

In colder regions, this system encounters the same problem as the floor panel system in that large quantities of tubing are required to meet the design requirement.

Control of the system in many cases has been manual by way of gate valves. However, as with the floor panel system, the use of a heat exchanger can allow accurate control of temperature and, hence, output. Design of a system is based upon the average water temperature of the heating loop. For a system using a heat exchanger:

1. Determine the flow of geothermal fluid available. We will assume 80 gpm at 150°F for the example case.

2. Calculate the greenhouse heat loss; i.e., 495,980 Btu/h for the example.

3. Determine the temperature drop in the available water flow:

   $\Delta T = q/(500 \times gpm)$
   $\Delta T = (495{,}980 \text{ Btu/h})/(500 \text{ Btu/h gpm } ^oF \times 80 \text{ gpm})$
   $\Delta T = 12.4^oF$.

4. Determine heating loop average water temperature (AWT) using:

   Ts = Tg - 10°F

   where

   Ts = supply temperature (°F)
   Tg = geothermal resource temp. (°F)
   Ts = 150°F - 10°F
   Ts = 140F

   AWT = Ts - (ΔT/2)
   AWT = 140°F - (12.4°F/2)
   AWT = 134°F

5. Calculate heat output per foot of tubing based on the average water temperature (AWT) using:

   $$q/l = ((1.016 \times (1/D)^{0.2} \times (1/T_{avg})^{0.181} \times (?\ T^{1.266})) + ((15.7 \times 10^{-10}) \times (T_1^{\ 4} - T_2^{\ 4}))) \times ft^2/lf \text{ pipe}$$

   where

   D = tube outside diameter (in.)
   T_{ave} = 460 + (AWT + T_{air})/2
   ΔT = AWT - (T_{air} + 3°F)
   T_1 = 460 + AWT
   T_2 = 460 + T_3
   T_3 = (AUST + T_{air})/2

Using a 3/4 in. tube, 60°F air temperature and 134°F AWT, Btu/h lf for the example case:

$$((1.016 \times (1/1.05)^{0.2} \times (1/557)^{0.181} \times (71)^{1.266}) + ((15.7 \times 10^{-10}) \times ((594)^4 - (505)^4))) \times (0.275)$$

q/l = 45.1 Btu/h lf

The total length (l) required to meet the design load becomes:

l = (495,980 Btu/h)/(45.1 Btu/h lf)
l = 10,997 lf

This length requirement can then be compared to requirements for other tubing sizes and water temperatures to determine the most economical system.

Costs for polybutylene and polyethylene piping used in the bare tube system are shown under the previous section.

The procedures presented in this chapter are intended to familiarize the reader with some of the considerations appropriate to greenhouse heating systems. It is strongly recommended that the services of a consulting engineer be retained for final design purposes.

14.5 PEAKING WITH FOSSIL FUEL

To this point, design methods in this chapter have been based upon meeting 100% of the peak load with the geothermal heating equipment. Under some circumstances, a strategy in which the geothermal system is designed for less than 100% of the peak may be worthwhile.

A situation where this may be considered is one in which a grower wishes to expand an existing operation, but is faced with limited resource flow. Using low-temperature effluent from the existing facility, it may be difficult to configure a system which will meet the peak load, particularly with bare tube-type terminal equipment. In this case, designing the geothermal system for 50 to 70% of the peak and meeting the remaining load with a conven-tional system may have some merit. In most climates, this design will still allow the geothermal to meet 95% or more of the annual heating energy requirement.

14.5.1 Climate Considerations

The rationale behind using different base load and peak load heating systems lies in the annual temperature profile. Figure 14.5 presents a comparison of the number of hours per year at various temperatures. It is apparent that the annual number of hours at very low outside temperatures is quite low compared to the number of hours at more moderate tempeatures.

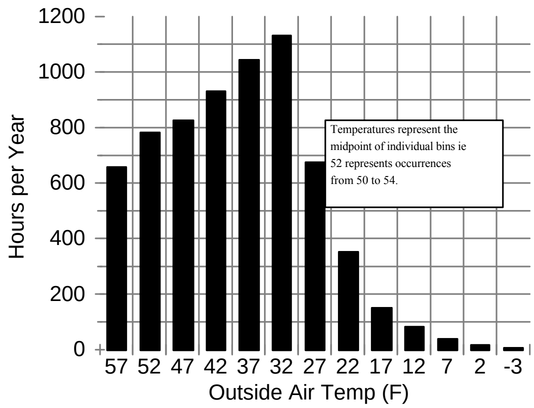


Figure 14.5 Temperature occurrences, Klamath Falls, Oregon.

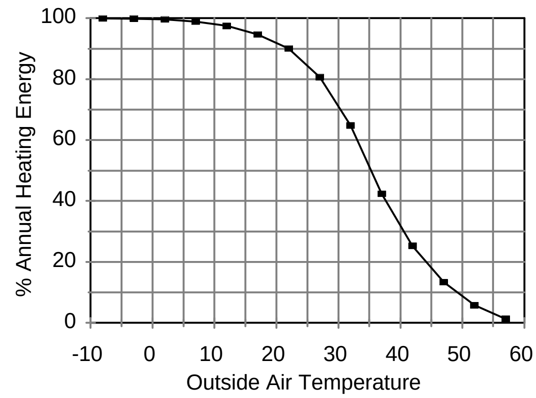


Figure 14.6 Annual heating energy requirement.

This data is arranged in 5ºF increments (i.e., 70E to 74 ºF). These 5ºF increments are known as temperature "bins" and data from which it comes is referred to as bin data. Bin data for many locations in the U.S. is published by the Defense Department in Engineering Weather Data, AFM 88-29, 1978.

It is apparent from Figure 14.5, that a system designed for 100% of the peak load actually operates at those conditions for only a very few hours per year. As a result, a system designed for 100% of the peak load is grossly underutilized.

The amount of energy required to heat a building (on an annual basis) is determined by the number of hours occurring at outside temperatures less than the temperature maintained in the structure. The quantity of annual energy required at a particular temperature bin is determined by the number of hours at that bin and the temperature difference between it and the inside temperature of the structure. Summing the number of hours at various outside temperatures permits the development of a cumulative heating requirement curve similar to that in Figure 14.6 . This particular plot was developed for an inside temperature of 60ºF using the weather data from Figure 14.6. The plot indicates the percentage of annual heating requirements occurring above (or below) a particular outside air temperature. For example, reading vertically from 30ºF to the intersection with the curve and then horizontally to the axis, yields a figure of approximately 71%. That is, 71% of the annual heating requirement occurs at this design temperature.

This is significant since the normal design temperature in the Klamath Falls area is 0ºF. A system designed for 30ºF would be only 50% the size of a system designed for 100% of the load (IDT 60ºF). Despite this, it could capture 71% of the annual heating requirements. In addition to this, the down-sized system would capture most of the remaining 29% of heating energy requirement by operating in parallel with a peaking system.

Figure 14.7 presents a plot of the annual energy requirements which could be met by a base load system designed for various percentages of the peak load. This plot assumes that the base load system continues to operate (at its maximum capacity) in parallel with the peak load system below the balance point. The 50% (of peak load) system described above would capture approximately 93% of the annual heating requirements of the structure (assuming a 60ºF IDT, 0ºF ODT and Figure 14.5 weather data).

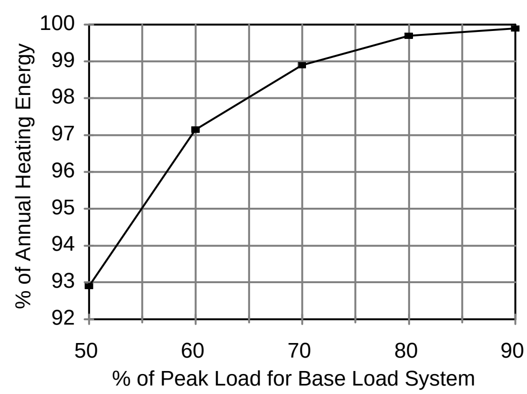


Figure 14.7 Annual heating energy capture, 60ºF inside temperature, Klamath Falls, Oregon.

It is clear that due to the nature of temperature occurrences, the base load heating system is capable of meeting only half the peak heating requirement and still meets more than 90% of the annual heating energy needs of a structure.

14.5.2 <u>Peaking Equipment Capital Costs</u>

Two broad approaches are available for the use of conventionally-fired peak heating equipment in a hot-water greenhouse heating system: individual unit heaters and central peaking boiler.

Individual unit heaters offer the advantage of zero floor space requirements (since they can be hung from the ceiling). Because each unit requires accessory equipment (flue pipe, thermostat, distribution "poly tube", fuel line, electrical connection, etc.), the cost of a given amount of heating capacity is relatively high in comparison to the boiler approach. This affect is compounded by the need to use a large number of units to assure adequate air distribution. For example, consider a 1-acre greenhouse for which a peaking system capacity of 1,300,000 Btu/hr is required. Although it is possible to supply this capacity with just three or four large units, to assure adequate air distribution, a minimum of 8 or 10 units should be employed. Costs for unit heater capacity assuming 10 units per acre appear in Figure 14.8.

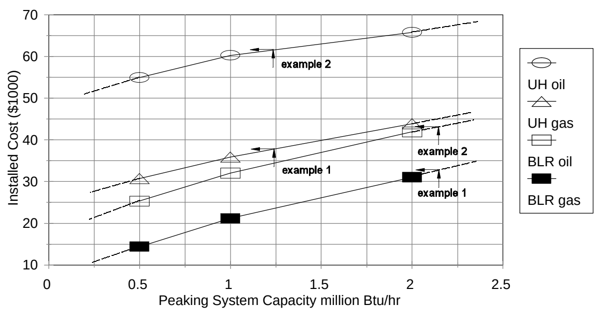


Figure 14.8 Peaking equipment costs.

The costs shown include, for the propane- (or natural gas), fired unit heaters (UH gas): unit heater (blower type), installation, flue pipe and cap, thermostat and wire, fuel distribution pipe (inside greenhouse), and electrical connection (120 v). Costs for the oil unit heater (UH oil) equipment reflects the much higher cost for this type of unit and includes the cost of a double-wall oil storage tank (2500 gal). Oil-fired unit heaters are much more expensive (50 - 80% depending upon size) than equivalent capacity gas-fired units. This fact along with the cost of the oil tank tends to push the cost of the oil-fired unit heater system far above the other alternatives. All unit heater equipment costs assume the use of blower-type units.

The central boiler (BLR) approach involves the installation of a peaking boiler downstream of the geothermal heat exchanger. The boiler's function is to boost the supply water temperature to the heating equipment during the peak load period. The higher water temperature allows a downsized tubing system to provide the required capacity to meet the space heating requirement. Because only a single piece of equipment (along with its accessory equipment) is required, the cost of a given heat output is much lower than for the unit heater equipment cited above. Figuer 14.8 presents costs for both propane- (BLR gas) and oil-fired (BLR oil) cast iron boiler equipment. These costs include boiler, stack, electrical connection, fuel lines, controls, 3-way valve, circulating pump, installation, and for the oil system, a double-wall storage tank of 2500 gal.

14.5.3 Controls and Operational Considerations

The object of the peaking equipment is to provide the capacity difference between the structure's requirement and the capacity of the base load (geothermal) system. This task must be accomplished in such a way as to produce even heat output without compromising the performance of the base load system.

Peaking with individual unit heaters is a simple process with regard to controls. Each individual unit is equipped with a thermostat which initiates operation of the unit when additional capacity is required in the zone that it serves. To eliminate unnecessary operation, it is useful to incoprorate an outside temperature driven lockout to prevent use of the peaking unit above the balance point temperature.

For the boiler design, the situation is somewhat more complex. This results from the boiler being incorporated into the heating loop. Because the boiler changes the temperature of the supply water, it not only influences the output of the terminal equipment, but also the capacity of the geothermal heat exchanger.

Figure 14.9 presents a common design for installing a boiler on a circulating water loop. Located downstream of the heat exchanger, the boiler's function is to raise the supply water temperature to the terminal equipment during the peak heat load period. This is accomplished by resetting the supply water upward as the outside air temperature decreases. Table 14.21 presents a typical temperature reset schedule. In this case, the boiler begins operation between 30 and 25^{o}F outside air temperature. Actual temperatures will vary with system design.

As the supply water temperature rises, the output of the terminal equipment rises. At the same time, the temperature of the return water rises as well.

The rise in return temperature occurs at a rate less than the supply water increase due to the higher output of the terminal equipment (which results in an increasing system ΔT). However, the rising return water temperature erodes the capacity of the geothermal heat exchanger to the extent that its capacity at the peak condition (0^{o}F outside) is approximately 50% of its capacity prior to the initiation of boiler operation.

The impact of this decreased geothermal heat exchanger capacity is illustrated in Table 14.22 which compares the performance of unit heaters and boiler peaking strategies for the same example case.

As indicated for this example, the boiler design requires approximately 78% more peaking fuel than the unit heater design. At the peak condition (0^{o}F), the unit heater supplies 58% of the heating energy needs of the structure compared to the boiler's 27%.

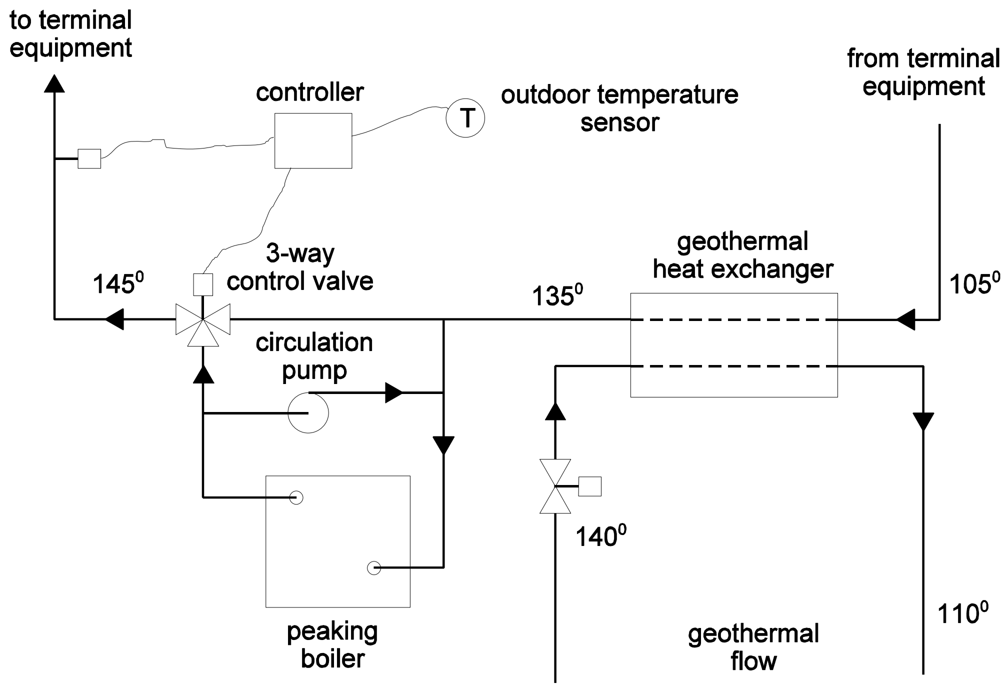


Figure 14.9 Heating system flow diagram.

Table 14.21 Typical Supply Water Temperature Reset Schedule and System Performance

Outside Air Temp (°F)	Supply Water Temp (°F)	Return Temp	Geothermal Heat Exchanger Capacity	Greenhouse Load	Required Boiler Output	% Geothermal
25	140	105.0	2,116,000	2,116,000	0	100
20	149	109.6	1,866,000	2,418,000	552,000	77
15	159	114.1	1,627,000	2,721,000	1,092,000	60
10	168	118.3	1,407,000	3,023,000	1,616,000	47
5	177	122.3	1,197,000	3,325,000	2,128,000	36
0	186	126.3	989,000	3,627,000	2,638,000	27

Table 14.22 Comparison of Boiler and Unit Heater Peaking Strategies

Outside Air Temp (°F)	Hrs/Yr	Boiler Fuel (gal Propane)	% Geothermal	Unit Heater Fuel (gal Propane)	% Geothermal
20	352	3,107	77	1,687	88
15	150	2,591	66	1,440	78
10	82	2,085	47	1,180	70
5	39	1,317	36	748	64
0	17	617	27	407	58
		9,717 gal		5,462 gal	

Table 14.23 Peaking System Sizing Requirements (60ºF Inside, 0ºF Outside)

Base Load System Capacity (% of Peak)	Unit Heater System Peaking Capacity (% of Peak)	Boiler Peaking Capacity (% of Peak)
40	60	93
60	40	73
80	20	27

This means that the required capacity of the peaking boiler is larger than that of the unit heater equipment for the same application. This disparity in required capacity at the peak load becomes more pronounced as the percentage of peak load carried by the base load system decreases. For example, a system in which the base load capacity is 40% of the peak would suggest a peaking boiler sized for 60% of the load. In fact, due to issues discussed above, the boiler would have to be sized for 93% of the peak. Table 14.23 provides a summary of the peaking boiler and unit heater sizing requirements for selected base load system capacities.

Figures 14.11, 14.12 and 14.13 present heating energy displaced for unit heater type peaking systems in three different climates for a variety of inside temperatures set points. Figures 14.14, 14.15 and 14.16 present the same information for boiler peaking system. In each case in these figures, the results are strongly influenced by day setpoint temperature (the first value as indicated in the key of each figure). Although the percentages of displaced energy appear to be quite similar to the unit heater values for boiler system, because the heating energy requirement for greenhouses are so high, small percentage differences translate into substantial fuel cost differences.

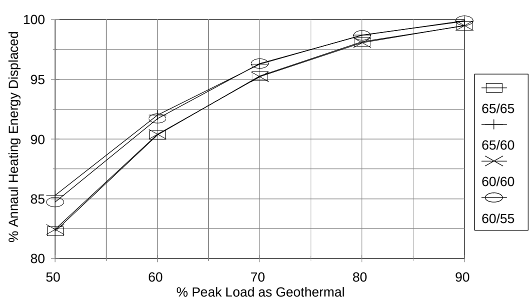


Figure 14.10 Unit heater annual energy displaced, Helena, MT.

Table 14.24 presents the fuel consumption for 1-acre greenhouse in the three climates for the same temperature set points as in Figures 14.10 through 14.15. Using the Klamath Falls climate data as an example, for a system with a base load capacity of 60% of the peak and a 60º day/60ºF

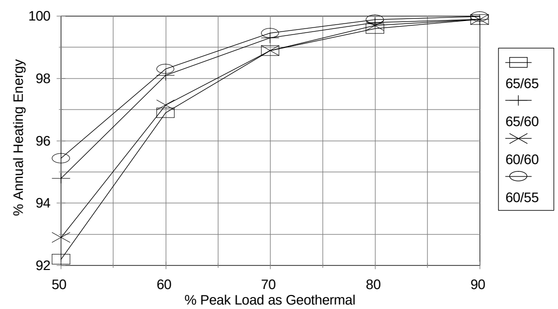


Figure 14.11. Unit heater annual energy displaced, Klamath Falls, OR

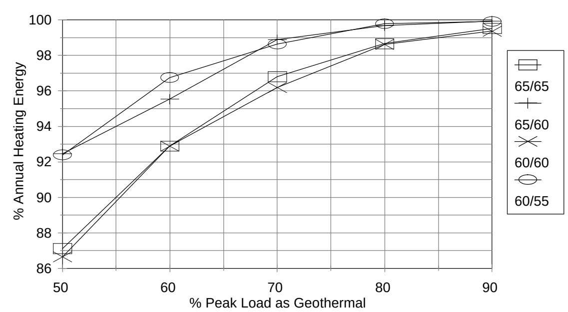
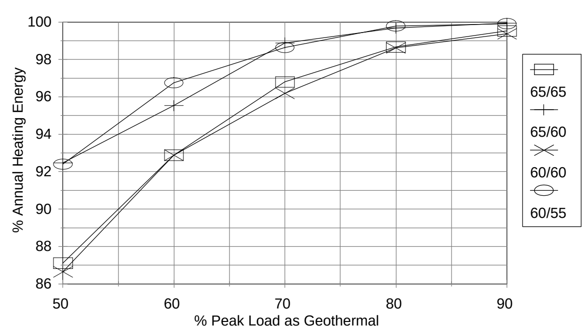


Figure 14.12. Unit heater annual energy displaced,



San Bernardino, CA.

Figure 14.13. Boiler annual energy displaced, Helena, MT.

night set point, the boiler system would displace 94.8% of the annual heating requirements compared to 97.2% for the unit heater design.

Table 14.24 Fuel Consumption for 1-Acre Greenhouse - Btu x 10^9

	Helena, MT	Klamath Falls, OR	San Bernardino, CA
60°/60°	7.36	5.59	1.78
60°/55°	6.37	4.52	1.09
65°/60°	7.59	5.81	1.88
65°/65°	8.69	6.96	2.77

Notes: Double poly roof, single fiberglass sides, 1 ACH.
To convert to gallons of propane per year, divide by 63,000.
To convert to gallon of fuel oil per year, divide by 93,000.
To convert to therms of natural gas, divide by 70,000.
Conversions assume 70% efficiency.
At $1.00/gal and 70% efficiency, fuel oil cost $10.20/$10^9$ Btu and propane $15.87/$10^9$ Btu. At the same efficiency at $0.50 per therm, gas cost $7.14/$10^9$ Btu.

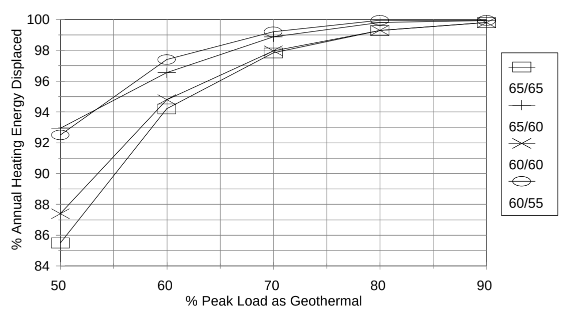


Figure 14.14 Boiler annual energy displaced, Klamath Falls, OR.

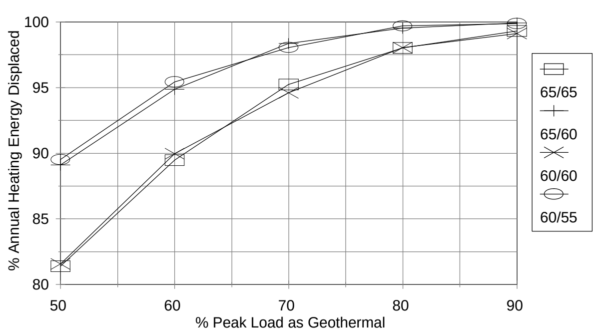


Figure 14.15 Boiler annual energy displaced, San Bernardino, CA.

Although these figures seem comparable, attaching fuel consumption values to them clearly indicates the difference. Using data from Table 14.24, assuming the use of propane as the fuel, the boiler would require 4,613 gal/yr and the unit heater system 2,484 gal/yr.

14.5.4 Cost of Implementation

Using Figures 14.10 through 14.15 along with Table 14.24, the capital cost for equipment and the annual fuel cost can be calculated for any application (based on the three climates for which data is provided). As discussed above, the boiler approach is characterized by lower equipment cost than the unit heater approach, but higher fuel consumption in a given application. As a result of this, for a given set of conditions, there will be an optimum system from a total cost standpoint.

Calculation of the lowest cost system for a particular application involves consideration of equipment ownership cost (capital cost and financing), fuel costs, equipment maintenance and fan energy (unit heater system).

This is best illustrated with an example. Consider a 1-acre greenhouse to be built in a moderate climate (Klamath Falls) in which effluent from an existing facility will be used as the supply for the new construction. Using the effluent will permit the heating system to meet 55% of the peak load. Propane will be employed for the peaking fuel and inside temperature set point will be 60°F day and night.

Assuming a double poly roof/single fiberglass construction, the peak heating load for the structure is determined to be 2.77 x 10^6 Btu/hr. As a result, the unit heater peaking equipment would be sized for 0.45 × 2,770,000 = 1,247,000 Btu/hr. The boiler would be sized (interpolating from Table 14.23) for 0.78 × 2,770,000 = 2.16 x 10^6 Btu/hr. From Figure 14.8, the capital cost for the peaking system would be $38,000 for the unit heaters and $32,500 for the boiler. Based on 15 years at 8% financing, the annual cost of the unit heater equipment would be $4,440 and $3,797 for the boiler system.

Table 14.25. Summary of Peaking System Costs - Propane Example

	Unit Heaters		Boiler	
	$	$/ft²	$	$/ft²
Equipment (15 yrs at 8%)	4,440	0.102	3,797	0.087
Maintenance (2% of capital)	760	0.017	650	0.015
Electricity ($0.07/kWh)	269	0.006	0	0
Fuel ($1.00/gal)	4,436	0.102	7,986	0.183
Total	9,905	0.227	12,433	0.285

Table 14.26. Summary of Peaking System Annual Costs - Fuel Oil Example

	Unit Heaters		Boiler	
	$	$/ft²	$	$/ft²
Equipment (15 yrs at 8%)	7,243	0.166	4,965	0.114
Maintenance (2% of capital)	1,240	0.029	850	0.020
Electricity ($0.07/kWh)	269	0.006	0	0.000
Fuel ($1.00/gal)	3,005	0.069	5,410	0.124
Total	11,757	0.270	11,225	0.258

Using Figures 14.11 and 14.14, along with Table 14.24, the annual propane consumption for the unit heater system would be 4,436 gallons ((1 - 0.95) C 5.59 x 10^9 ÷ 63,000) and 7,986 gallons ((1 - 0.91) C 5.59 x 10^9 ÷ 63,000) for the boiler system.

Assuming a value of 2% of capital cost for equipment maintenance, the cost for the boiler system would be $650/yr and for the unit heater system $760/yr. Fan energy consumption is a function of the size and number of unit heaters installed. Assuming 10 units at 125,000 Btu/hr each, the fan motor in each unit would be 1/3 hp. For 10 units, 3.3 hp or approximately 2.9 kW at 85% efficiency. For 1325 hours per year operation, the electric consumption would amount to 3842 kWh or about $269 at $0.07/kWh.

Table 14.25 presents a summary of the costs for the two peaking systems in both $ and $/ft² of greenhouse.

In this case, the unit heater design is the clear choice due to its lower equipment and fuel costs. If fuel oil was to be the peaking fuel in the same situation, the results are quite different. Table 14.26 presents the results for the oil case.

In the case of fuel oil, the much higher cost of oil-fired unit heater equipment tends to be the pivotal cost item. Despite the lower fuel costs for the unit heater system, the boiler design is the most economic choice.

Figures 14.16, 14.17 and 14.18 summarize the cost data discussed in the previous section and present the total costs associated with the peaking system for the three climates discussed in this report. In each case, the costs are presented in $/ft² of greenhouse, a value commonly used in the greenhouse industry.

Figures 14.16, 14.17 and 14.18 are based on a constant 60° set point (night and day) in the greenhouse. Because the set point temperature, and whether or not set back is used, has a substantial impact upon energy usage, the above conclusions are valid for the 60° set point only. For other temperatures calculations, using Figures 14.10 through 14.15 and Table 14.24 should be done.

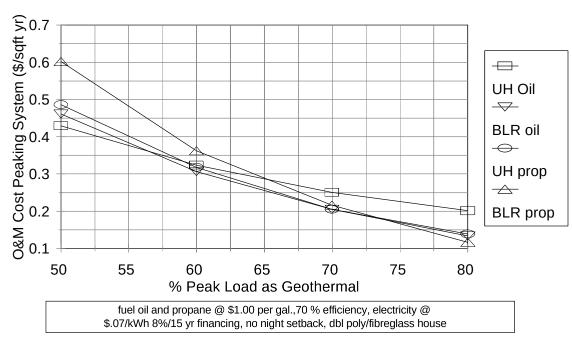


Figure 14.16 Peaking system cost, Helena, MT.

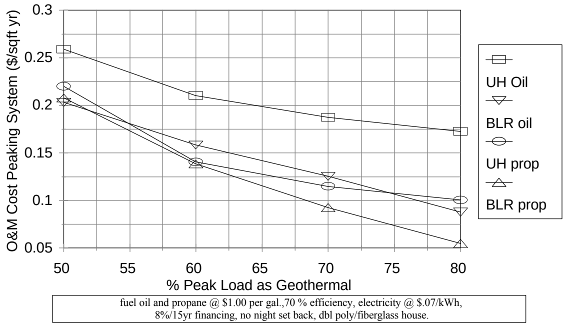


Figure 14.17 Peaking system cost, Klamath Falls, OR.

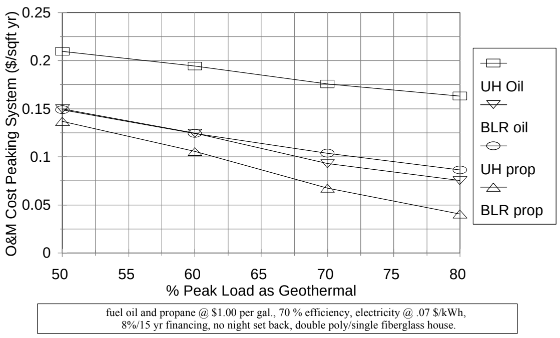


Figure 14.18. Peaking system cost, San Bernardino, CA.

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Section 5
GREENHOUSE HEATING EQUIPMENT SECTION SPREADSHEET

INTRODUCTION

The following pages include the Greenhouse Heating Equipment Selection Spreadsheet developed by Kevin Rafferty.

The Greenhouse Heating Equipment Selection Spreadsheet (GHS) is a tool for evaluating the performance of various types of heating systems for greenhouses. Specifically, seven systems are considered: unit heaters (UH), finned pipe (FP), bare tube (BT), fan coil units (FC), combination fan coil/bare tube (FC/BT), low-temperature unit heaters (GLW), and propane unit heaters (PP).

The spreadsheet is comprised of seven individual areas, the primary input and output and six additional areas each of which covers one of the system types described above. One portion of the spreadsheet covers both the fan coil and fan coil/bare tube system input output. After each area there will be a screenshot of the spreadsheet plus the spreadsheet cell entries used for an EXCEL spreadsheet.

The spreadsheet cell entry that is a permanent entry or calculation is shown in black. If the cell entry is blue and italic then it is used for data entry. A value has been added to that cell entry that matches the screenshot for the given area. This allows for comparison to the screenshot when entering the program.

The primary input contains 16 individual input items covering supply water temperature, greenhouse size, construction materials, and economics data. The primary output is divided into two areas. The first provides information concerning the peak heat loss of the greenhouse. The second area contains a table which provides information about the economics of the various types of heating systems for the greenhouse under consideration. Values for both capital and operating costs are displayed. The far right hand column of the table indicates total annual costs (owning, maintenance and electrical costs) for each of the systems per square foot of greenhouse floor area. These values can be compared to determine the lowest cost system for the particular application. The remaining six sections cover the details of each of the individual systems and the costs associated with them.

The costs calculated on the individual system screens and finally for the primary output table, consider only the costs of the terminal heating equipment and branch lines. Because all six systems are compared at the same supply water temperature and delta T, the costs for the central equipment and piping would be the same. The only variation in cost for individual systems is for the terminal equipment itself.

It is necessary to be familiar with greenhouse heating systems and hydronic design before using this spreadsheet. Users unfamiliar with the equipment are advised to review Section 4 - Greenhouse Heating Systems prior to using the spreadsheet.

PRIMARY INPUT

1. Supply Water Temperature (^oF). Enter the supply water temperature which will be available to the heating equipment in the greenhouse. This temperature will be less than the well production temperature because of losses in delivery and across the heat exchanger (assuming an isolation plate heat exchanger is used). If a plate-type heat exchanger is used, a value of 5 to 10^oF less than well temperature should be entered.

2. Delta T (^oF). Enter the design temperature drop for the system. All heating equipment is compared in the spreadsheet using this temperature drop.

3. Floor Area (ft^2). Enter the floor area of the greenhouse to be evaluated. If the development is very large, it may be useful to break the total area up into smaller units.

4. Wall Area (ft^2). Enter the total wall area of the greenhouse under consideration. This value is used to calculate heat loss for the structure.

5. Wall "U" (Btu/hr ft^2 ^oF). Enter the overall U value for the wall material of the greenhouse. This value is used to calculate heat loss for the structure.

6. Roof Area (ft^2). Enter the total surface area of the roof of the greenhouse. This value is used in the calculation of the structure's heat loss.

7. Roof "U" (Btu/hr ft^2 ^oF). Enter the overall U value for the roof covering material. This value is used in the calculation of the structure's heat loss.

8. Inside Design Temperature (^oF). Enter the inside temperature to be maintained under maximum heating load conditions. This value is used in the determination of design temperature difference for heat loss calculation.

9. Outside Design Temperature (^oF). Enter the outside temperature for which the heating system will be designed. This value in conjunction with Input #9 is used to calculate the design temperature difference for heat loss calculations.

10. Average Ceiling Height (ft). Enter the value which best reflects the average ceiling height inside the greenhouse. This figure is used in the determination of the volume of the house for infiltration heat loss calculation.

11. Air Change Rate (changes/hr). Enter the value for the number of air changes per hour appropriate to the type of greenhouse construction planned. This value is used in the calculation of the infiltration heating load.

12. Degree Days. Enter the number of heating degree days appropriate to the climate where the greenhouse is to be located. This value is used to determine the number of full load hours over which the heating system will operate. Operating hours are then used in the determination of electricity use (fans) for the system.

13. Electric Rate ($/kWh). Enter the electric rate which will be appropriate to the greenhouse operation. This value is used in the calculation of annual electrical cost for the heating system.

14. Interest Rate (as decimal). Enter the rate at which purchase of the heating system will be made (mortgage rate). This value is used in the calculation of the owning costs of the system.

15. Loan Term (years). Enter the number of years for which the financing will run (mortgage term). This value is used in the calculation of owning cost for the system.

16. Labor Rate. Enter the cost per hour of labor to be used for installation of the equipment.

PRIMARY OUTPUT

1. Peak Heat Loss (Btu/hr). This is the design heat loss for the greenhouse. It is the value which the heating system must supply to maintain inside temperature at the design outdoor temperature condition.

   = Wall Loss + Roof Loss + Infiltration

2. Wall Loss (Btu/hr). This is the heat loss associated with the walls of the greenhouse.

   = Wall Area * (Inside Design Temperature - Outside Design Temperature) * Wall "U"

3. Roof Loss (Btu/hr). This is the heat loss associated with the roof of the greenhouse.

   = Roof Area * (Inside Design Temperature - Outside Design Temperature) * Roof "U"

4. Infiltration Loss (Btu/hr). This is the heat loss associated with the leakage of cold air into the greenhouse.

   = (Greenhouse Floor Area * Average Ceiling Height * Air Change Rate) * .018 * (Inside Design Temperature - Outside Design Temperature)

5. Loss per Square Foot (Btu/hr ft^2). This is the peak heat loss divided by floor area.

   = Peak Heat Loss ÷ Floor Area

The following section is the primary output of the spreadsheet. It compares the overall costs for seven different heating systems: Unit Heaters (UH), Finned Pipe (FP), Bare Tubing (BT), Fan Coil (FC), combination Fan Coil/Bare Tubing (FC/BT), Low-Temperature Unit Heaters (GLW), and Gas-Fired Unit Heaters (GUH). In each case, the capital cost per square foot is displayed followed by the annual cost (again per square foot of floor area) of maintenance, electricity and ownership. The three annual costs are then summed to arrive at a total annual cost per square foot. Each column is described individually below:

System Type. As described above.

Capital Cost. This is the capital cost for only the terminal equipment of the heating system. Since the spreadsheet is arranged to compare the system using a common ΔT and supply water temperature, the cost of the main mechanical equipment (circulating pump, heat exchanger and loop piping) would be the same for all systems. As a result, these costs are not included in the calculation. Only the costs of the actual heating devices are included.

The cost includes both equipment itself, labor for installation, and branch supply and hot water lines for each type of system. The total of these costs is divided by the greenhouse floor area to arrive at the displayed value. Details of the cost calculation are covered in the individual system screens. Equipment and labor costs are calculated separately and combined with a 20% overhead/contingency factor to arrive at the total cost.

Annual Maintenance. This value is the calculated maintenance cost for each system. Generally, mechanical equipment is calculated at 2% of capital cost and piping at 1% of capital cost. The total maintenance costs are then divided by the floor area to arrive at the displayed value.

Annual Electrical Costs. This is the cost of operating the fans associated with equipment in which fans are used (UH, FC, FC/BP and GLW). Fan horsepower is determined using manufacturers data and it is assumed the fans are cycled with the unit. (See individual system screens.) This horsepower is then converted into an electrical kW and multiplied by the number of units and the number of full load hours ([Degree Days * 24] ÷ Design Temperature Difference) to arrive at total annual electrical use. This figure multiplied by the electric rate (Input #13) yields a value for annual electric cost. This value is divided by the floor area of the greenhouse to arrive at the displayed value.

Annual Owning Cost. The value displayed is the capital cost for the system multiplied by a capital cost recovery factor and divided by the floor area of the greenhouse. Stated another way, it is the annual mortgage payment divided by the floor area. The capital cost is calculated at each system screen. The capital cost recovery factor is calculated based upon the interest rate (Input #14) and loan term (Input #15) specified in the input.

Total Annual Cost. This figure is the sum of the annual maintenance, annual electric and annual owning costs for each system. It is the basis for comparison of one system to another. The lower the annual cost per square foot, the more economical the heating system.

INPUT / OUTUT SCREENSHOT

GREENHOUSE HEATING EQUIPMENT SELECTION SPREADSHEET

	INPUT		
1.	Supply Water Temp	150	F
2.	Delta t	40	F
3.	Floor Area	44000	sqft
4.	Wall area	4380	sqft
5.	Wall "U"	1.00	btu/hrsqft
6.	Roof area	52800	sqft
7.	Roof "U"	1.00	btu/hrsqft
8.	Inside Design Temp	65	F
9.	Outside Design Temp.	10	F
10.	Average Ceiling Height	10	ft
11.	Air Change Rate	0.75	changes/hr
12.	Degree Days	4500	
13.	Elec Rate	0.05	$/kwh
14.	Interest Rate as decimal	0.08	
15.	Loan Term	15	years
16.	Labor Rate	35.00	$/hr

	OUTPUT		
1.	Peak Heat Loss	3471600	btu/hr
2.	Wall Loss	240900	btu/hr
3.	Roof Loss	2904000	btu/hr
4.	Infiltration	326700	btu/hr
5.	Loss per sq ft	78.90	btu/hrsqft

System Type	CAPITAL COST $/sqft	---- ANNUAL COSTS ($/SQFT YR)------- Annual Maint.	Annual Elec	Annual Owning	Total Annual
UH	1.475	0.018	0.019	0.172	0.209
FP	4.684	0.015	0.000	0.547	0.562
BP	0.972	0.005	0.000	0.114	0.119
FC	1.257	0.017	0.016	0.147	0.180
FC/BP	1.235	0.013	0.003	0.144	0.160
GLW	1.170	0.017	0.016	0.137	0.169
PROP	0.863	0.015	0.010	0.101	0.127
FLH	1,963.64				
%flh	64.80		24.24		

INPUT / OUTUT SPREADSHEET CELL ENTRIES

A:B1: GREENHOUSE HEATING EQUIPMENT SELECTION SPREADSHEET

A:B3: INPUT

A:A4: 1.
A:B4: Supply Water Temp
A:E4: *150*
A:F4: F

A:A5: 2.
A:B5: Delta t
A:E5: *40*
A:F5: F

A:A6: 3.
A:B6: Floor Area
A:E6: *44000*
A:F6: sqft

A:A7: 4.
A:B7: Wall area
A:E7: *4380*
A:F7: sqft

A:A8: 5.
A:B8: Wall “U”
A:E8: *1*
A:F8: btu/hrsqft

A:A9: 6.
A:B9: Roof area
A:E9: *52800*
A:F9: sqft

A:A10: 7.
A:B10: Roof “U”
A:E10: *1*
A:F10: btu/hrsqft

A:A11: 8.
A:B11: Inside Design Temp
A:E11: *65*
A:F11: F

A:A12: 9.
A:B12: Outside Design Temp
A:E12: *10*
A:F12: F

A:A13: 10.
A:B13: Average Ceiling Height
A:E13: *10*
A:F13: ft

A:A14: 11.
A:B14: Air Change Rate
A:E14: *0.75*
A:F14: changes/hr

A:A15: 12.
A:B15: Degree Days
A:E15: *4500*

A:A16: 13.
A:B16: Elec Rate
A:E16: *0.05*
A:F16: $/kWh

A:A17: 14.
A:B17: Interest Rate (as decimal)
A:E17: *0.08*

A:A18: 15.
A:B18: Loan Term
A:E18: *15*
A:F18: years

A:A19: 16.
A:B19: Labor Rate
A:E19: *35*
A:F19: $/hr

A:B21: OUTPUT

A:A23: 1.
A:B23: Peak Heat Loss
A:E23: =E24+E25+E26
A:F23: btu/hr

A:A24: 2.
A:B24: Wall Loss
A:E24: =E7*(E11-E12)*E8
A:F24: btu/hr

A:A25: 3.
A:B25: Roof Loss
A:E25: =E9*(E11-E12)*E10
A:F25: btu/hr

A:A26: 4.
A:B26: Infiltration
A:E26: =(E6*E13/60)*1.08*(E11-E12)*E14
A:F26: btu/hr

A:A27: 5.
A:B27: Loss per sq ft
A:E27: =E23/E6
A:F27: btu/hrsqft

A:C32: CAPITAL
A:D32: —— ANNUAL COSTS ($/SQFT YR)———-
A:B33: System
A:C33: COST
A:D33: Annual
A:E33: Annual
A:F33: Annual
A:G33: Total

A:B34: Type
A:C34: $/sqft
A:D34: Maint.
A:E34: Elec
A:F34: Owning
A:G34: Annual

A:B36: UH
A:C36: =M23*1.2/E6
A:D36: =M21*0.02/E6
A:E36: =M13*M7*C44*E16/E6
A:F36: =(C36*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G36: =D36+E36+F36

A:B37: FP
A:C37: =((S18+(S19*E19)))*1.2/E6
A:D37: =S18*0.01/E6
A:E37: 0
A:F37: =(C37*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G37: =D37+E37+F37

A:B38: BP
A:C38: =Z27*1.2/E6
A:D38: =Z25*0.01/E6
A:E38: 0
A:F38: =(C38*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G38: =D38+E38+F38

A:B39: FC
A:C39: =AF21*1.2/E6
A:D39: =AF25*0.02/E6
A:E39: =AF29*AF7*C44*E16/E6
A:F39: =(C39*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G39: =D39+E39+F39

A:B40: FC/BP
A:C40: =(AG21*1.2/E6)
A:D40: =((AG25*0.02)+(Z12*AG19*0.01))/E6
A:E40: =(AG29*AG7*C44*E16/E6)*((100-C45)/100)
A:F40: =(C40*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G40: =D40+E40+F40

A:B41: GLW
A:C41: =((AM17+(AM18*E19)))*1.2/E6
A:D41: =AM17*0.02/E6
A:E41: =((AM12*AM6/E6)*C44)*E16
A:F41: =(C41*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G41: =D41+E41+F41

A:B42: PROP
A:C42: =AR17*1.2/E6
A:D42: =(AR14*0.03)/E6
A:E42: =(AR6*AR13*C44*E16*((100-E45)/100)
A:F42: =(C42*((1+E17)^E18)*(E17/(((1+E17)^E18)-1)))
A:G42: =D42+E42+F42

A:B44: FLH
A:C44: =E15*24/(E11-E12)

A:B45: %flh
A:C45: =((AG6-10)*1.56)+18
A:E45: +((AR6-10)*1.56)+18

UNIT HEATERS

The general approach to using the Unit Heaters calculation is to first specify a number of units. The spreadsheet then calculates a required capacity per unit based on the number selected. Check to make sure that this capacity is equal to or less than the corrected capacity of the largest unit listed in the table below. If the required capacity is greater, increase the number of units. The spreadsheet then calculates the installation labor hours per unit, cost per unit and kW per unit for the size unit selected. The spreadsheet then uses the output from the sheet to generate the values for annual costs shown in the primary output.

Input

1. Number of Units. Enter the number of units desired for space heating. For greenhouses over 80 ft on the long dimension, units should be placed at both ends of the house. Spacing between individual units should not be more than 50 ft. Under certain conditions, the number of units will be affected by the capacity available from the largest unit.

Output

Capacity per Unit. This figure is the output required per unit based on the peak heating load of the greenhouse and the number of units specified in Input #1. It is important to verify that the required capacity does not exceed the corrected capacity of the largest unit (see table at bottom of screen). If this is the case, the number of units selected must be raised until the required capacity is equal to or less than the corrected capacity of the largest unit.

Cost of Selected Unit. The spreadsheet selects the cost of the unit that best matches the required capacity per unit, from the table below.

Hours per Unit. The spreadsheet selects the labor hours for the selected unit from the table below.

kW per Unit. The spreadsheet selects the kW/unit value listed for the unit size selected. This value is used to calculate the electrical costs shown in the primary output.

Indoor Design Temperature. Displayed for convenience. Value is taken from Primary Input #8.

Supply Water Temperature. Displayed for convenience. Value is taken from Primary Input #1.

Delta T. Displayed for convenience. Value is taken from Primary Input #2.

Temperature Correction Factor. Calculated from manufacturer's data. Used to calculate combined correction factor below.

Flow Correction Factor. Calculated from manufacturer's data. Used to calculate combined correction factor below.

Combined Correction Factor. Temperature Correction Factor * Flow Correction Factor. Used for calculating corrected unit heater capacities in the table below.

Total Equipment Cost. This is the total cost of the equipment, including labor, for the number of units specified. Calculated as (Cost of Selected Unit * Number of Units). This figure is used for calculation of values shown in primary output (first screen).

Total Hours. Total labor time required for installation of the number of units specified. Calculated as: Number of Units * Hours per Unit. See note at bottom of table.

Total Cost. Value shown is the sum of total Equipment cost plus total hours times cost per hour entered at Input #16.

The table shown on the unit heater screen lists the rated capacity (at 200^o EWT and 60^o EAT) for several models. Using the correction factor calculated above, the rated capacity is reduced to reflect the specified conditions of water temperature and delta T. Costs for the unit heaters and branch lines are listed under the Material Cost column. Installation man-hours are listed for each unit. Finally, the electrical kW is listed for each unit. Unit heater costs and labor include allowance for: 20 ft of 1-in. copper pipe, 2 1-in. ball valves, 1-in. zone valve 24V wire and thermostat, 115 V wiring, air vent and 2 1-in. unions. $255 material, 7.1 hours labor.

UNIT HEATERS SCREENSHOT

UNIT HEATERS		
1) # of units	24	
Required Capacity Per Unit	144650	Btu/hr
Cost of Selected Unit	1,630	
Hours per Unit	18	
KW per unit	0.35	
Indoor Design Temp	65	F
Supply Water Temp	150	F
Delta T	40	F
Temp Correction Factor	0.61	
Flow Correction Factor	0.85	
Combined Correction	0.52	
Total Equipment Cost	39120	$
Total Hours	427.2	
Total Cost	54072	

Rated	Corrected	Material Cost*	man-hours	KW/unit
15700	8170	620	8.70	0.03
24500	12749	620	8.90	0.06
29000	15090	670	9.10	0.06
47000	24457	720	9.40	0.09
63000	32783	755	9.80	0.09
81000	42149	835	10.00	0.11
90000	46832	945	10.30	0.23
133000	69208	1005	11.10	0.23
139000	72330	1100	11.70	0.35
198000	103031	1180	13.50	0.35
224000	116561	1630	15.10	0.35
273000	142058	1630	17.80	0.35

note: unit heater costs and labor include allowance
for 20 ft 1" copper piping, 2-1" ball valves, 1"zone valve

UNIT HEATERS SPREADSHEET CELL ENTRIES

A:J5: UNIT HEATERS

A:J7: 1) # of units
A:M7: *24*

A:J9: Required Capacity Per Unit
A:M9: =E23/M7
A:N9: Btu/hr

A:J11: Cost of Selected Unit
A:M11:
=IF(M9>J30,IF(M9>J31,IF(M9>J32,IF(M9>J33,IF(M9>J34,IF(M9>J35,IF(M9>J36,IF(M9>J37,IF(M9>J38,IF(M9>J39,IF(M9>J40,K41,K40),K39),K38),K37),K36),K35),K34),K33),K32),K31),K30)

A:J12: Hours per Unit
A:M12:
=IF(M9>J30,IF(M9>J31,IF(M9>J32,IF(M9>J33,IF(M9>J34,IF(M9>J35,IF(M9>J36,IF(M9>J37,IF(M9>J38,IF(M9>J39,IF(M9>J40,L41,L40),L39),L38),L37),L36),L35),L34),L33),L32),L31),L30)

A:J13: KW per unit
A:M13:
=IF(M9>J30,IF(M9>J31,IF(M9>J32,IF(M9>J33,IF(M9>J34,IF(M9>J35,IF(M9>J36,IF(M9>J37,IF(M9>J38,IF(M9>J39,IF(M9>J40,M41,M40),M39),M38),M37),M36),M35),M34),M33),M32),M31),M30)

A:J15: Indoor Design Temp
A:M15: =E11
A:N15: F

A:J16: Supply Water Temp
A:M16: =E4
A:N16: F

A:J17: Delta T
A:M17: =E5
A:N17: F

A:J18: Temp Correction Factor
A:M18: =(0.36-((M15-50)*0.00735))+((M16-100)*0.0072)

A:J19: Flow Correction Factor
A:M19: =1-((M17-20)*0.00733)

A:J20: Combined Correction
A:M20: =M18*M19

A:J21: Total Equipment Cost
A:M21: =M7*M11
A:N21: $

A:J22: Total Hours
A:M22: =M12*M7

A:J23: Total Cost
A:M23: M21+(E19*M22)

A:K27: Material
A:I28: Rated
A:J28: Corrected
A:K28: Cost*
A:L28: man-hours
A:M28: KW/unit

A:I30: *15700*
A:J30: =M$20*I30
A:K30: *620*
A:L30: *8.70*
A:M30: *0.033*

A:I31: *24500*
A:J31: =M$20*I31
A:K31: *620*
A:L31: *8.9*
A:M31: *0.06*

A:I32: *29000*
A:J32: =M$20*I32
A:K32: *670*
A:L32: *9.10*
A:M32: *0.06*

A:I33: *47000*
A:J33: =M$20*I33
A:K33: *720*
A:L33: *9.4*
A:M33*: 0.088*

A:I34: *63000*
A:J34: =M$20*I34
A:K34: *755*
A:L34: *9.8*
A:M34: *0.088*

A:I35: *81000*
A:J35: =M$20*I35
A:K35: *835*
A:L35: *10.0*
A:M35: *0.112*

A:I36: *90000*
A:J36: =M$20*I36
A:K36: *945*
A:L36: *10.3*
A:M36: *0.226*

A:I37: *133000*
A:J37: =M$20*I37
A:K37: *1005*
A:L37: *11.1*
A:M37: *0.226*

A:I38: *139000*
A:J38: =M$20*I38
A:K38: *1100*
A:L38: *11.70*
A:M38: *0.352*

A:I39: *198000*
A:J39: =M$20*I39
A:K39: *1180*
A:L39: *13.50*
A:M39: *0.352*

A:I40: *224000*
A:J40: =M$20*I40
A:K40: *1630*
A:L40: *15.10*
A:M40: *0.352*

A:I41: *273000*
A:J41: =M$20*I41
A:K41: *1630*
A:L41: *17.80*
A:M41: *0.352*

A:I42: note: unit heater costs and labor include allowance

A:I43: for 20 ft 1" copper piping, 2-1" ball valves, 1"zone valve

FINNED PIPE

Input

1. Number of Circuits. Enter the number of individual circuits of finned pipe to be installed in the greenhouse. The number of circuits should be selected to result in a velocity (Output #7) of between .75 and 3.5 ft per second.

Output

Average Water Temperature. Ratings for finned pipe are based upon average water temperature. This value is calculated from the Supply Water Temperature and delta T specified in the primary unit.

Inside Design Temperature. Displayed for convenience. Taken from primary input.

Required Length. The total length of finned pipe required to meet the peak heating load based on the corrected capacity per foot at the specified water temperature.

Temperature Correction Factor. Calculated from the average water temperature and inside design temperature. This value is used to correct the rated capacity of the finned element (shown in the table) to the corrected capacity appropriate to your particular application.

Length per Circuit. Length calculated from the number of circuits specified and the total length required. You may wish to adjust the number of circuits to arrive at a length per circuit which is a multiple of the dimension of the greenhouse in which the pipe is to be installed.

Flow per Circuit. Value is arrived at by dividing the total flow rate by the number of circuits specified in Input #1.

Velocity. The water velocity which results from the circuiting specified (Input #1) and the flow per circuit. Should be between .75 and 3.5 ft per second.

Peak Flow. Peak flow is based upon the peak heat load for the greenhouse and the delta T specified in the primary input section (#2).

Total Equipment Cost. Total cost for the finned pipe. Calculated for the total length * cost per foot from table below.

Total Hours. The total number of hours required for installation of the required length of finned pipe appearing in Output #3.

Total Cost. Value shown is the sum of the total equipment cost plus total labor hours times he cost per hour entered at Input #16.

FINNED PIPE SCREENSHOT

FINNED PIPE				
1.) # of Circuits			10.00	
Average Water Temp			130	F
Inside Design Temp			65	F
Required Length			7702	ft
Temp Correction factor			0.31	
Length per Circuit			770	ft
Flow per Circuit			17.36	gpm
Velocity			3.75	ft/sec
Peak Flow			174	gpm
Total Equipment Cost			63929	$
Total Hours			3081	
Total Cost			171762	
size	rated	crctd	Cost/lf	hours
1.25	1440	450.72	8.30	0.40

FINNED PIPE SPREADSHEET CELL ENTRIES

A:P5: FINNED PIPE
A:P7: 1.) # of Circuits
A:S7: *10*

A:P10: Average Water Temp
A:S10: =M16-(M17/2)
A:T10: F

A:P11: Inside Design Temp
A:S11: =M15
A:T11: F

A:P12: Required Length
A:S12: =E23/R24
A:T12: ft

A:P13: Temp Correction factor
A:S13: =(0.1+((S10-100)*0.0071))+(0.008*(65-M15))

A:P14: Length per Circuit
A:S14: =S12/S7
A:T14: ft

A:P15: Flow per Circuit
A:S15: =S17/S7
A:T15: gpm

A:P16: Velocity
A:S16: =(S15/(7.49*60))/(((((1.1*P24)/2)^2)*3.14)/144)
A:T16: ft/sec

A:P17: Peak Flow
A:S17: =E23/(500*M17)
A:T17: gpm

A:P18: Total Cost
A:S18: =S24*S12
A:T18: $

A:P19: Total Hours
A:S19: =S12*T24

A:P23: size
A:Q23: rated
A:R23: Corrected
A:S23: Cost/lf
A:T23: hours

A:P25: *1.25*
A:Q25: *1440*
A:R25: =S13*q24
A:S25: *8.3*
A:T25: *0.4*

BARE TUBE

General Procedure

The bare tube section involves an iterative approach to arrive at the correct system design. Information concerning the tubing (size, length, emissivity and cost) is input along with a trial water flow rate (per tube circuit). Next the output is checked for agreement between the calculated ΔT (Output #7) and the ΔT specified in the primary input (#2). The sheet is rerun with new flow rates until the output #7 value agrees with the primary input #2.

Depending upon the application, it may not be possible to make bare tube calculations for larger ΔTs. To evaluate the accuracy of the calculated delta T, check the delta T values in the table at the bottom of the screen.

Input

1. Tube OD. Enter the outside diameter of the tube to be used for the system. Most systems employ polyethylene tubing of 1 in. or less for heating purposes.

2. Water Flow. Enter the trial water flow for each tubing circuit. This value will have to be adjusted several times in order to arrive at a calculated ΔT (output #7) equal to the system ΔT specified in the primary input section (#2).

3. Emissivity. Enter the emissivity of the tubing used for heating. This value is used in the calculation of the radiant tube output.

4. Horizontal (1.016) Vertical (1.235). Enter the value appropriate to the installation of the tubing. Most systems install the tubing horizontally on the floor or under the benches.

5. Tube Length. Enter the length of each circuit of tubing. Generally, circuits should be less than about 600 feet to limit water side pressure drop. It is also useful to make the length a multiple of the greenhouse dimension over which the tubing will be installed. For example, if the greenhouse length is 100 ft a 400 tube length would allow for 4 passes over the 100 ft dimension.

6. Tube Unit Cost. Enter the cost per foot for the tubing to be used in the system. Be careful to consider the temperature at which the system will be working. Polyethylene which is relatively inexpensive is serviceable to approximately 150^oF. EPDM which is more expensive must be used for temperatures above this.

Output

Air Temperature. Displayed for convenience. This value is taken from the inside design temperature (primary input #8).

Entering Water Temperature. Displayed for convenience. This value is taken from the supply water temperature (primary input #1).

Total Unit Output. This is the calculated heat output per foot of tubing. It is the sum of outputs 4 and 5, and is used to calculate the total number of feet of pipe required.

Convective Unit Output. Calculated heat output per foot of pipe due to convection.

Radiant Unit Output. Calculated heat output per foot of pipe due to radiation.

Total Output. Calculated output per circuit. Total unit output * tube length (Input #5).

Delta T. Calculated temperature drop through each circuit. The screen should be re-run with new water flow (Input #2) until the Delta T value shown agrees with the Delta T specified in the primary input section (#2). Delta T is calculated by an iterative process in the table shown below.

Outlet Temperature. Temperature at outlet of each circuit. Calculated from supply water temperature (Primary Input #1) minus Delta T (Output #7).

Total Length. Calculated tubing length requirement based on peak load (Primary Output #1) divided by Total Unit Output (Output #3).

Number of Loops. Calculated by dividing the total length by the tubing length per circuit (Input #5).

Total Cost. Cost for tubing. Calculated by multiplying Total Length (Output # 9) times tubing cost (Input #6). Used for calculation in Primary Output section.

Total Hours. Man-hours required for installation of tubing. Calculated by multiplying .0025 hrs/ft times the total length requirement.

The table which appears at the bottom of the Bare Pipe screen is used to calculate the unit convective output, unit radiant output, total output per foot, total output per loop and delta T values which appear in the outputs above. These calculations are performed in an iterative fashion in which the average water temperature from the previous run is used as the input value for the subsequent run. In this way, the spreadsheet is able to "zero in" on the actual output values. A total of 5 runs are made to produce the values. In some cases (very long circuits or very low water flow rates), the accuracy of this calculation may be poor.

BARE TUBING SCREENSHOT

BARE TUBING		
1.) Tube OD	0.75	inches
2.) Water flow	0.60	gpm
3.) Emmisivity	0.90	
4.) Horiz (1.016) Vert (1.235)	1.016	
5.) Tube length	481	ft
6.) Tube unit cost	0.17	$/lf
Delta T	40.2	F
Air temperature	65	F
Ent. water temp p.	150	F
Total unit output	25.1	btu/hr lf
Convective unit output	12.2	btu/hr lf
Radiant unit output	12.9	btu/hr lf
Total output	12059	
Outlet temperature	109.8	F
Total length	138470	ft
Number of loops	288	
Total equipment cost	23540	$
Total hours	346	hrs
Total Cost	35656	

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
sqft/lf	0.2	122.3	132.9	129.0	130.4	129.9
surf temp	144.1	118.3	128.1	124.5	125.9	125.4
unit conv	86.3	52.7	65.1	60.5	62.2	61.6
unit rad	89.5	56.2	68.4	63.8	65.5	64.9
btu/hrlf	34.5	21.4	26.2	24.4	25.1	24.8
btu/hr	16599.6	10281.1	12604.2	11737.7	12059.2	11939.7
delta t	55.3	34.3	42.0	39.1	40.2	39.8

BARE TUBING SPREADSHEET CELL ENTRIES

A:V5: BARE TUBING

A:V7: 1. Tube OD
A:Z7: *0.75*
A:AA7: inches

A:V8: 2. Water flow
A:Z8: *0.60*
A:AA8: gpm
A:V9: 3. Emmisivity
A:Z9: *0.90*

A:V10: 4. Horiz (1.016) Vert(1.235)
A:Z10: *1.016*

A:V11: 5. Tube length
***A:Z11**: 481*
A:AA11: ft

A:V12: 6. Tube unit cost
***A:Z12:** 0.17*
A:AA12 : $/lf

A:V14: Delta T
A:Z14: =AA37
A:AA14: F

A:V16: Air temperature
A:Z16: =M15
A:AA16: F

A:V17: Ent. water temp
A:Z17: =M16
A:AA17: F

A:V18: Total unit output
A:Z18: =AA35
A:AA18: btu/hr lf

A:V19: Convective unit output
A:Z19: =W31*AA33
A:AA19: btu/hr lf

A:V20: Radiant unit output
A:Z20: =W31*AA34
A:AA20: btu/hr lf

A:V21: Total output
A:Z21: =AA36

A:V22: Outlet temperature
A:Z22: =Z17-Z14
A:AA22: F

A:V23: Total length
A:Z23: =E23/Z18
A:AA23: ft

A:V24: Number of loops
A:Z24: =Z23/Z11

A:V25: Total equipment cost
A:Z25: =Z23*Z12
A:AA25: $

A:V26: Total hours
A:Z26: =0.0025*Z23
A:AA26: hrs

A:V27: Total Cost
A:Z27: =Z25+(Z26*E19)

A:W30: Run 1
A:X30: Run 2
A:Y30: Run 3
A:Z30: Run 4
A:AA30: Run 5
A:AB30: Run 6

A:V31: sqft/lf
A:W31: =((Z7)*3.14*12)/144
A:X31: =Z17-(W37/2)
A:Y31: =Z17-(X37/2)
A:Z31: =Z17-(Y37/2)
A:AA31: =Z17-(Z37/2)
A:AB31: =Z17-(AA37/2)

A:V32: surf temp
A:W32: =Z17-((Z17-Z16)*0.07)
A:X32: =X31-((X31-Z16)*0.07)
A:Y32: =Y31-((Y31-Z16)*0.07)
A:Z32: =Z31-((Z31-Z16)*0.07)
A:AA32: =AA31-((AA31-Z16)*0.07)
A:AB32: =AB31-((AB31-Z16)*0.07)

A:V33: unit conv
A:W33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+Z17)/2)))^0.181)*((W32-Z16)^1.266)
A:X33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+X32)/2)))^0.181)*((X32-Z16)^1.266)
A:Y33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+Y32)/2)))^0.181)*((Y32-Z16)^1.266)
A:Z33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+Z32)/2)))^0.181)*((Z32-Z16)^1.266)
A:AA33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+AA32)/2)))^0.181)*((AA32-Z16)^1.266)
A:AB33: =Z10*((1/(Z7/1))^0.2)*((1/(460+((Z16+AB32)/2)))^0.181)*((AB32-Z16)^1.266)

A:V34: unit rad
A:W34: =1.74E-09*Z9*(((460+W32)^4)-((460+Z16)^4))
A:X34: =1.74E-09*Z9*(((460+X32)^4)-((460+Z16)^4))
A:Y34: =1.74E-09*Z9*(((460+Y32)^4)-((460+Z16)^4))
A:Z34: =1.74E-09*Z9*(((460+Z32)^4)-((460+Z16)^4))
A:AA34: =1.74E-09*Z9*(((460+AA32)^4)-((460+Z16)^4))
A:AB34: =1.74E-09*Z9*(((460+AB32)^4)-((460+Z16)^4))

A:V35: btu/hrlf
A:W35: =(W33+W34)*W31
A:X35: =(X33+X34)*W31
A:Y35: =(Y33+Y34)*W31
A:Z35: =(Z33+Z34)*W31
A:AA35: =(AA33+AA34)*W31
A:AB35: =(AB33+AB34)*W31

A:V36: btu/hr
A:W36: =W35*Z11
A:X36: =X35*Z11
A:Y36: =Y35*Z11
A:Z36: =Z35*Z11
A:AA36: =AA35*Z11
A:AB36: =AB35*Z11

A:V37: delta t
A:W37: =W36/(500*Z8)
A:X37: =X36/(500*Z8)
A:Y37: =Y36/(500*Z8)
A:Z37: =Z36/(500*Z8)
A:AA37: =AA36/(500*Z8)
A:AB37: =AB36/(500*Z8)

FAN COIL UNITS

The fan coil sheet contains 2 columns of input/output data: one for the fan coil system (left) and one for the Fan Coil/Bare Tube system (right). The following relates only to the fan coil system.

The general procedure for the fan coil system is to specify a number of units and a leaving air temperature. The entering and leaving water temperatures along with the inside air temperature are carried over from the primary input section. Using this input, the spreadsheet calculates the required air flow and coil configuration (rows and fins per inch). The number of rows is rounded off (for which ever fin spacing is closest to a whole number). Using the calculated nominal ton value, figures for unit cost and man-hours are selected from the nearest size unit in the table at the bottom of the screen. The spreadsheet then calculates the total equipment and labor costs and transfers these values to the primary output section.

Input

1. <u>% of Load as Fan Coil</u>. Not used for fan coil only systems,

2. <u>Number of Units</u>. Enter the number of units required. This figure will usually be less than the number of unit heaters specified. Fan coil equipment is capable of higher capacity per unit and is much less effected by low supply water temperature than unit heater equipment.

3. <u>Leaving Air Temperature</u>. Enter the temperature of the air leaving the fan coil unit. If poly tube distribution is used, a maximum of 135°F should be entered for this value. The figure, however, must also be considered in light of the supply water temperature available. A supply air temperature of approximately 20°F less than the supply water temperature is generally possible with 4-row coils or less. The pricing data contained in the spreadsheet assumes that a maximum of 4-row coils would be used. For a given supply water temperature, as the required supply air temperature is increased the coil capacity in terms of more rows and closer fin spacing must be increased.

Output

Capacity per Unit. This is the calculated capacity required per unit based on the number of units specified (#1 above) and the peak heating load.

Entering Water Temperature. Displayed for convenience. Taken from Primary Input #1.

Nominal Tons. The calculated capacity in nominal tons of the fan coil units. Cost data for fan coil units is indexed to the air flow and cooling capacity. As a result, the nominal ton value is calculated in order to determine equipment cost.

Rows Required. Hot water coils transfer heat to the air based on the temperature difference between the water and the air, and the quantity of heat transfer area. Area is a function of the number of rows of tubes the coil has and the spacing of the fins. Shown here are the required rows of tubes at 3 different fin spacings which a coil must have to meet the specified performance. As mentioned elsewhere, the cost data the program uses assumes that a maximum of 4 rows will be used. If the rows required displays a value of greater than 4 rows, leaving air temperature should be reduced to decrease coil surface area requirements.

Cost per Unit. The spreadsheet selects the cost per unit for the unit necessary to meet the required capacity. Values are found in the table at the bottom of the screen.

Labor Hours. The spreadsheet selects the man-hours labor for installation of the unit selected from the table.

Foot of Tube Required. The length of tubing required to meet the portion of the load met by the tubes (1-Input #1). The figure displayed includes both labor and material for the tubing. Calculation not required for fan coil only systems.

Cost of Tubing. Cost for tubing material and installation for the length calculated above. Calculation not required for fan coil only systems.

Total Cost. Values shown is sum of the total equipment cost plus the total labor hours times the cost per hour entered at Input #19. Also includes tubing cost for FC/BT systems.

Leaving Water Temperature. Displayed for convenience. Taken from Supply Water Temperatures (Primary Input #1) minus Delta T (Primary Input #2).

Indoor Design Temperature. Displayed for convenience. Taken from Primary Input #8).

Air Flow per Unit. The calculated air flow required at the specified supply air temperature and capacity per unit. The spreadsheet uses the value to calculate the fan horsepower and to determine the nominal tons below.

Total Equipment Cost. The total equipment cost (fan coil units) calculated from the cost per unit times the number of units.

LMTD. An intermediate value used in the calculation of the coil rows required. Calculated from entering and leaving air temperatures, and entering and leaving water temperatures.

Face Area. Calculated coil face area based upon a 500 foot per minute face velocity. All coil calculations are based on a 500 fpm face velocity.

Air Pressure Drop @ 10 FPI. Calculated air pressure drop across the coil for fan power calculations. Value is expressed in inches of water gauge (in.w.g.) And is based on a fin spacing of 10 fins per inch.

Fan kW @ 10 FPI. Calculated fan electrical energy requirement based upon a 90% motor efficiency, a 50% fan efficiency, calculated air flow and air pressure drop. This value is used for calculating annual electrical consumption for the primary output.

Total Man-Hours. Man-hours per unit times the number of units specified in the input. This value is used to calculate the total labor costs for installation of the fan coil units.

The costs and labor for the FC units includes allowance for: 2 1-in. unions, 2 l-in. ball valves, 1 1-in. zone valve, 20 ft of 1-in. copper pipe, automatic air vent, thermostat and 24v wiring, 115v wiring.

FAN COIL/BARE TUBE

The fan coil/bare tube input and output is located on the same section as the Fan Coil system. With the exception of one additional input item, the FC/BT analyses is operated the same as the FC.

The FC/BP system is one in which the greenhouse is heated the majority of the time by the bare tubing. Only during peak periods do the fan coil units operate. The use of this system greatly reduces annual electrical requirements and in some cases, the number of fan coil units required. Because the fan coil units are located in series with and downstream of the bare tubes, the supply water temperature available is less.

The comments below address only the difference between the FC/BT and FC procedures.

Input

The first input item is the percentage of the peak load which will be handled by the fan coil units. Sizing the fan coil units for 30 to 40 percent of the load would, in most locations, allow the tubes to provide 90+% of the annual heating needs. It may be useful to experiment with the value to arrive at the optimum value (lowest annual cost) for your project.

1. Number of Units. Because the fan coil units will supply only a portion of peak load, the number of units required can be lower than for the fan coil system. A minimum number will be required to achieve adequate air distribution, however.

2. Entering Water Temperature. The entering water temperature displayed is the value which results from subtracting the temperature drop through the bare pipe from the primary supply water temperature. This lower supply water temperature may necessitate a lower supply air temperature for the fan coil units under the FC/BT system compared to the FC system.

FAN COIL / BARE TUBING SCREENSHOT

FAN COIL UNITS			FC/BT	
1. % of load as Fan Coil		---------	40	% FC
2. Number of Units		10	10	
3. Leaving Air Temp		125	110	
Capacity per Unit		347160	138864	btu/hr
Entering Water Temp		150	126	F
Nominal Tons		13.39	7.14	
Rows Required		----------		
8	FPI	4.96	4.51	
10	FPI	4.14	3.77	
12	FPI	3.62	3.29	
Cost per Unit		3700	2175	
Labor hrs		26	13	
Ft of tube required		--------	73865	
Cost of tubing		--------	19020	
Total Cost		46100	45285	
Leaving Water Temp		110	110	F
Indoor Design Temp		65	65	F
Air Flow Per Unit		5357	2857	cfm
Total Equipment Cost		37000	21750	
LMTD		34.03	28.04	F
Face Area		10.71	5.71	sqft
Air Press. Drop @ 10 FPI		0.51	0.48	in wg
Fan KW @ 10 FPI		0.72	0.36	
Total Man-hours		260	129	

tons	$	man hours
1	1080	9.70
2	1400	10.00
3	1925	11.00
4	2000	11.50
5	2125	12.00
7.5	2175	12.90
8	2600	17.30
10	2750	18.50

12	3175	20.90	
15	3700	26.00	
20	4675	40.00	
25	3500	44.00	

ewt - lat	25.00	16.00
lwt - eat	45.00	45.00

FAN COIL / BARE TUBING SPREADSHEET CELL ENTRIES

A:AC4: FAN COIL UNITS
A:AG4: FC/BP

A:AC6: 1. % of load as Fan Coil
A:AF6: *————-*
A:AG6: *35*
A:AH6: % FC

A:AC7: 2. Number of Units
A:AF7: *10*
A:AG7: *10*

A:AC8: 3. Leaving Air Temp
A:AF8: 125
A:AG8: 110

A:AC10: Capacity per Unit
A:AF10: =E23/AF7
A:AG10: =(AG6/100)*E23/AG7
A:AH10: btu/hr

A:AC11: Entering Water Temp
A:AF11: =M16
A:AG11: =AF11-(((100-AG6)/100)*M17)
A:AH11: F

A:AC12: Nominal Tons
A:AF12: =AF24/400
A:AG12: =AG24/400

A:AC13: Rows Required
A:AF13: —————

A:AC14: 8
A:AD14: FPI
A:AF14: =AF10/(AF26*AF27*192)
A:AG14: =AG10/(AG26*AG27*192)

A:AC15: 10
A:AD15: FPI
A:AF15: =AF10/(AF27*AF26*230)
A:AG15: =AG10/(AG27*AG26*230)

A:AC16: 12
A:AD16: FPI
A:AF16: =AF10/(AF27*AF26*263)
A:AG16: =AG10/(AG27*AG26*263)

A:AC17: Cost per Unit
A:AF17:
=IF(AF12>1.1,IF(AF12>2.1,IF(AF12>3.1,IF(AF12>4.2,IF(AF12>5.5,IF(AF12>7.6,IF(AF12>8.2,IF(AF12>10.5,IF(AF12>12.5,IF(AF12>15.5,IF(AF12>20.5,AE45,AE44),AE43),AE42),AE41),AE40),AE39),AE38),AE37),AE36),AE35),AE34)
A:AG17:
=IF(AG12>1.1,IF(AG12>2.1,IF(AG12>3.1,IF(AG12>4.2,IF(AG12>5.5,IF(AG12>7.6,IF(AG12>8.2,IF(AG12>10.5,IF(AG12>12.5,IF(AG12>15.5,IF(AG12>20.5,AE45,AE44),AE43),AE42),AE41),AE40),AE39),AE38),AE37),AE36),AE35),AE34)

A:AC18: Labor hrs.
A:AF18:
=IF(AF12>1.1,IF(AF12>2.1,IF(AF12>3.1,IF(AF12>4.2,IF(AF12>5.5,IF(AF12>7.6,IF(AF12>8.2,IF(AF12>10.5,IF(AF12>12.5,IF(AF12>15.5,IF(AF12>20.5,AF45,AF44),AF43),AF42),AF41),AF40),AF39),AF38),AF37),AF36),AF35),AF34)
A:AG18:
=IF(AG12>1.1,IF(AG12>2.1,IF(AG12>3.1,IF(AG12>4.2,IF(AG12>5.5,IF(AG12>7.6,IF(AG12>8.2,IF(AG12>10.5,IF(AG12>12.5,IF(AG12>15.5,IF(AG12>20.5,AF45,AF44),AF43),AF42),AF41),AF40),AF39),AF38),AF37),AF36),AF35),AF34)

A:AC19: Ft of tube required
A:AF19: -----------
A:AG19: =(E23*((100-AG6)/100))/(Z18*((((Z17+AG11)/2)-Z16)/((Z17-(Z14/2))-Z16)))

A:AC20: Cost of Tubing
A:AF20: -----------
A:AG20: =(0.0025*AG19*E19)+(Z12*AG19)

A:AC21: Total Cost
A:AF21: =AF25+(AF30*E19)
A:AG21: =AG25+(AG30*E19)+AG20

A:AC22: Leaving Water Temp
A:AF22: =AF11-M17
A:AG22: =AF11-M17
A:AH22: F

A:AC23: Indoor Design Temp
A:AF23: =M15
A:AG23: =AF23
A:AH23: F

A:AC24: Air Flow Per Unit
A:AF24: =AF10/(1.08*(AF8-AF23))
A:AG24: =AG10/(1.08*(AG8-AG23))
A:AH24: cfm

A:AC25: Total Equipment Cost
A:AF25: =AF17*AF7
A:AG25: =AG17*AG7

A:AC26: LMTD
A:AF26: =(AD49-AD48)/(LN(AD49/AD48))
A:AG26: =(AE49-AE48)/(LN(AE49/AE48))
A:AH26: F

A:AC27: Face Area
A:AF27: =AF24/500
A:AG27: =AG24/500
A:AH27: sqft

A:AC28: Air Press. Drop @ 10FPI
A:AF28: =0.23+((AF15-1)*0.09)
A:AG28: =0.23+((AG15-1)*0.09)
A:AH28: in wg

A:AC29: Fan KW @ 10 FPI
A:AF29: =((((5.2*AF24*AF28)/(0.5*33000)))/0.9)*0.746
A:AG29: =((((5.2*AG24*AG28)/(0.5*33000)))/0.9)*0.746
A:AC30: Total Man-hours

A:AF30: =AF18*AF7
A:AG30: =AG18*AG7

A:AD33: tons
A:AE33: $
A:AF33: man hours

A:AD34: *1*
A:AE34: *1080*
A:AF34: *9.70*

A:AD35: *2*
A:AE35: *1400*
A:AF35: *10.00*

A:AD36: *3*
A:AE36: *1925*
A:AF36: *11.00*

A:AD37: *4*
A:AE37: *2000*
A:AF37: *11.50*

A:AD38: *5*
A:AE38: *2125*
A:AF38: *12.00*

A:AD39: *7.5*
A:AE39: *2175*
A:AF39: *12.90*

A:AD40: *8*
A:AE40: *2600*
A:AF40: *17.30*

***A:AD41**: 10*
***A:AE41:** 2750*
***A:AF41:** 18.50*

***A:AD42:** 12*
***A:AE42:** 3175*
***A:AF42:** 20.90*

***A:AD43**: 15*
***A:AE43:** 3700*
***A:AF43:** 26.00*

***A:AD44:** 20*
***A:AE44:** 4675*
***A:AF44:** 40.00*

***A:AD45:** 25*
***A:AE45:** 3500*
***A:AF45:** 44.00*

A:AC48: ewt-lat
A:AD48: =AF11-AF8
A:AE48: =AG11-AG8

A:AC49: lwt-eat
A:AD48: =AF22-AF23
A:AE48: =AG22-AG23

GLW UNIT HEATERS

GLW is the designation for one manufacturer's equipment line which is specifically designed for low-temperature greenhouse heating. The equipment is similar to conventional unit heater design but with an improved coil for greater heat output at low supply water temperature.

The GLW section is operated in much the same fashion as the unit heater screen. A number of units is selected. From this and the supply water temperature and Delta T, the spreadsheet calculates the capacity of the two models of GLW equipment. It then selects the appropriate unit and enters its cost, labor and electrical kW in the appropriate places. It is necessary to adjust the number of units so as to arrive at a capacity per unit close to one of the calculated capacity values in the table at the bottom of the screen. It is also useful to check the total cost associated with a small number of large units (GLW 660) compared to a larger number of small units (GLW 330).

Input

1. Number of Units. Enter the number of units selected for heating the greenhouse. Generally, due to the higher performance of the GLW equipment, the number of units required is comparable to fan coil equipment and less than conventional unit heaters. The number of units also should be coordinated with the calculated capacity per unit displayed in the table below.

Output

Capacity per Unit. Calculated capacity required per unit based upon the peak heating load and the number of units specified.

Cost of Selected Unit. The cost, from the table below, of the unit selected.

Hours per Unit. The installation labor hours, from the table below, of the unit selected.

kW per Unit. The kW, from the table below, for the unit selected. Value is used for calculating electrical costs in the Primary Output.

Indoor Design Temperature. Displayed for convenience. Taken from Primary Input.

Supply Water Temperature. Displayed for convenience. Taken from Primary input.

Delta T. Displayed for convenience. Taken from Primary Input.

Total Cost. Number of units times the cost per unit. Value is used in cost calculations for Primary Output.

Total Hours. Number of units times the hours per unit. Value is used in cost calculations for Primary Output.
Flow per Unit. Calculated water flow per unit based on the capacity per unit and the specified Delta T.

Table. Shown in the table below are the capacity, cost, installation labor and electrical requirements (kW) for the two models of GLW equipment available. The capacity is automatically calculated based on the supply water temperature and flow rate from above. The costs and labor for the GLW units includes allowance for: 2 1-in. unions, 2 1-in. ball valves, 1 1-in. zone valve, 20 ft of 1-in. copper pipe, automatic air vent, thermostat and 24v wiring, 115v wiring. Sizes of components increase to 1-1/2 for GLW660 unit.

GLW UNIT HEATS SCREENSHOT

GLW UNIT HEATERS					
# of Units			10		
Capacity per Unit			347160	btu/hr	
Cost of Selected Unit			3693	$	
Labor per Unit			17.10	hrs	
KW per Unit			0.70		
Indoor Design Temp			65	F	
Supply Temp			150	F	
Delta T			40	F	
Total Cost			36930	$	
Total Hours			171		
Flow per unit			17.4	gpm	
	Capacity	cost	hours	kw	
GLW330	218438	2115	13.30		0.35
GLW660	377956	3693	17.10		0.70

GLW UNIT HEATERS SPREADSHEET CELL ENTRIES

A:AJ4: GLW UNIT HEATERS

A:AJ6: # of Units
A:AM6: *10*

A:AJ8: Capacity per Unit
A:AM8: =E23/AM6
A:AN8: btu/hr

A:AJ10: Cost of Selected Unit
A:AM10: =IF(AM8>1.1*AK22,AL23,AL22)
A:AN10: $

A:AJ11: Labor per Unit
A:AM11: =IF(AM10=AL22,AM22,AM23)
A:AN11: hrs

A:AJ12: KW per Unit
A:AM12: =IF(AM10=AL22,AN22,AN23)

A:AJ14: Indoor Design Temp
A:AM14: =M15
A:AN14: F

A:AJ15: Supply Temp
A:AM15: =M16
A:AN15: F

A:AJ16: Delta T
A:AM16: =M17
A:AN16: F

A:AJ17: Total Cost
A:AM17: =AM10*AM6
A:AN17: $

A:AJ18: Total Hours
A:AM18: =AM11*AM6

A:AJ19: Flow per unit
A:AM19: =AM8/(500*AM16)
A:AN19: gpm

A:AK21: Capacity
A:AL21: cost
A:AM21: hours
A:AN21: kw

A:AJ22: *GLW330*
A:AK22: =(AM15-AM14)*(10^(3.2+(((LOG10(AM19))-0.69)*0.382)))
A:AL22: *2115*
A:AM22: *13.30*
A:AN22: *0.35*

A:AJ23: *GLW660*
A:AK23: =(AM15-AM14)*(10^(3.398+(((LOG10(AM19))-0.69)*0.455)))
A:AL23: *3693*
A:AM23: *17.10*
A:AN23: *0.7*

GAS-FIRED UNIT HEATERS

Gas-fired unit heaters are sometimes used as a peaking system in greenhouses in which geothermal serves as the base-load system. This can be the case were the geothermal temperature is very low or where effluent from one house is used to heat a second facility. This section of the spreadsheet calculates the number and capacity of unit heaters required to meet a user defined percentage of the peak heating load.

Input

1. Number of Units. Enter the number of individual heating units required. As with all systems, some minimum number of units is typically necessary to assure adequate air distribution within the structure.

1. Percent of Design. Enter the percentage of the design load to be met by the gas-fired units. Any value up to 100% can be entered. Typically in base load/peak load designs, the peaking system (gas-fired) is designed to carry 40 to 50% of the peak load.

Output

Capacity per Unit. This is the required capacity (in Btu/hr) of the individual units required based on the percentage of the load to be handled and the number of units specified. This value must be equal to or less than the largest unit listed in the table at the bottom of the page.

Capacity in MBH. This is the capacity from the above output divided by 1000.

Cost per Unit. This is the cost of the unit size to most closely meet the capacity per unit value. The cost includes (as detailed in the box following the table below) the necessary flue pipe, branch gas piping and electrical connections to make the unit functional.

Hours per Unit. This is the total man-hours necessary to install the unit heater and the related components.

kW. This is the electrical demand of the motor the unit heater is equipped with. The value is used in the calculation of the operating costs for the system.

Total Equipment Costs. This is the total cost for the equipment associated with the unit heaters. It is determined by multiplying the cost per unit times the number of units.

Total Labor Hours. This is the total labor man-hours necessary to install the unit heaters and related equipment. It is determined from the hours per unit times the number of units.

Total. This is the total cost for the labor and materials for the unit heaters. It does not include the main gas piping necessary to serve the units. The length of this pipe and its cost is a function of the layout of the greenhouse.
$/sq ft. This is the total cost from above divided by the floor area of the greenhouse as entered at Input #3.

The table at the bottom of the page includes the cost, labor and electrical requirements of the unit heaters indexed to unit capacity. This data can be updated when necessary to reflect inflation. Prices indicated are current as of January 2002. The labor and equipment figures above include an allowance for: 12 ft of flue pipe, flue cap and collar, 115v wiring, 24v wiring, thermostat, shut-off valve and 20 ft of gas line.

GAS FIRED UNIT HEATERS SCREENSHOT

PROPANE UNIT HEATERS	
Number of Units	14
Percent of design	100
Capicity per unit	247971
Capacity in MBH	248
Cost per unit	1600
hrs per unit	18.9
kW per unit	0.44
Total eq. cost	22400
Total labor hrs	264.6
Total	31661
$/sq ft	0.72

capacity	cost	hrs	kW
40	715	13	0.03
60	770	13.2	0.03
80	825	13.6	0.05
100	930	13.8	0.05
120	1005	14.1	0.22
140	1055	14.5	0.33
160	1085	14.9	0.33
200	1220	16.2	0.33
240	1400	16.8	0.33
280	1600	17.9	0.44
320	1775	18.9	0.50

GAS FIRED UNIT HEATERS SPREADSHEET CELL ENTRIES

A:AP4: PROPANE UNIT HEATERS

A:AP6: Number of Units
A:AR6: *14*

A:AP7: Percent of Design
A:AR7: *100*

A:AP9: Capacity per unit
A:AR9: =E23*(AR7/100)/AR6

A:AP10: Capacity in MBH
A:AR10: =AR9/1000

A:AP11: Cost per unit
A:AR11:
=IF(AR10>AP30,IF(AR10>AP31,IF(AR10>AP32,IF(AR10>AP33,IF(AR10>AP34,IF(AR10>AP35,IF(AR10>AP36,IF(AR10>AP37,IF(AR10>AP38,IF(AR10>AP39,AQ40,AQ39),AQ38),AQ37),AQ36),AQ35),AQ34),AQ33),AQ32),AQ31),AQ30)

A:AP12: hrs per unit
A:AR12:
=IF(AR10>AP30,IF(AR10>AP31,IF(AR10>AP32,IF(AR10>AP33,IF(AR10>AP34,IF(AR10>AP35,IF(AR10>AP36,IF(AR10>AP37,IF(AR10>AP38,IF(AR10>AP39,AR40,AR40),AR39),AR38),AR37),AR36),AR35),AR34),AR33),AR32),AR31)

A:AP13: kW per unit
A:AR13:
=IF(AR10>AP30,IF(AR10>AP31,IF(AR10>AP32,IF(AR10>AP33,IF(AR10>AP34,IF(AR10>AP35,IF(AR10>AP36,IF(AR10>AP37,IF(AR10>AP38,IF(AR10>AP39,AS40,AS39),AS38),AS37),AS36),AS35),AS34),AS33),AS32),AS31),AS30)

A:AP14: Total eq. cost
A:AR14: =AR6*AR11

A:AP15: Total labor hrs
A:AR15: =AR12*AR6

A:AP17: Total
A:AR17: =(E19*AR15)+AR16+AR14

A:AP18: $/sq ft
A:AR18: =AR17/E6

A:AP29: capacity
A:AQ29: cost
A:AR29: hrs
A:AS29: kW

A:AP30: *40*
A:AQ30: *715*
A:AR30: *13*
A:AS30: *0.031*

A:AP31: *60*
A:AQ31: *770*
A:AR31: *13.2*
A:AS31: *0.03*

A:AP32: *80*
A:AQ32: *825*
A:AR32: *13.6*
A:AS32: *0.047*

A:AP33: *100*
A:AQ33: *930*
A:AR33: *13.8*
A:AS33: *0.047*

A:AP34: *120*
A:AQ34: *1005*
A:AR34: *14.1*
A:AS34: *0.22*

A:AP35: *140*
A:AQ35: *1055*
A:AR35: *14.5*
A:AS35: *0.33*

A:AP36: *160*
A:AQ36: *1085*
A:AR36: *14.9*
A:AS36: *0.33*

A:AP37: *200*
A:AQ37: *1220*
A:AR37: *16.2*
A:AS37: *0.33*

A:AP38: *240*
A:AQ38: *1400*
A:AR38: *16.8*
A:AS38: *0.33*

A:AP39: *280*
A:AQ39: *1600*
A:AR39: *17.9*
A:AS39: *0.44*

A:AP40: *320*
A:AQ40: *1775*
A:AR40: *18.9*
A:AS40: *0.*

Section 6
VENDOR INFORMATION

INTRODUCTION

The section includes a listing of vendors for greenhouse supplies, hydroponic systems, greenhouse manufacturers, plant materials, and components of geothermal systems. Below is only a partial listing of the available vendors and does not include endorsement of a particular company over others. This listing was last updated in February 2008

GREENHOUSE SUPPLIES

BFG Supply
PO BOX 479
14500 Kinsman RD.
Burton, OH 44021
(440) 834-1883
(800) 883-0234
www.bfgsupply.com

Brighton By-Products Co.
PO Box 23
New Brighton, PA 15066
(412) 846-1220
(800) 245-3502

Florist Products, Inc.
2242 N. Palmer Dr.
Schaumburg, IL 60195
(312) 885-2242

E. C. Geiger
Box 2852
Harleysville, PA 19438
(215) 256-8835
(800) 443-4437

Griffin Greenhouse Supplies
1629 Main St.
Tewksbury, MA 01876
(978) 851-4346
www.griffins.com

A. H. Hummert Seed Co.
2746 Chouteau Ave.
St. Louis, MO 63103
(800) 325-3055

Al Saffer and Co.
Pearl & Williams Streets
Port Chester, NY 10573
(914) 937-6565

Slater Supply Co.
143 Allen Blvd.
Farmingdale, NY 11735
(516) 249-7080

X. S. Smith, Inc.
Drawer X
Red Bank, NJ 07701
(201) 222-4600

Stuppy Greenhouse Supply Div.
PO Box 12456
Kansas City, MO 64116
(800) 821-2132

HYDROPONIC SYSTEMS

Agro Dynamics
12 Elkins Road
East Brunswick, NJ 08816
(800) 872-2476

CropKing
PO Box 310
Medina, OH 44258
(216) 725-5656

Gro-Master Division
Midwest Trading
PO Box 384
St. Charles, IL 60174
(312) 888-1728

Hydro-Gardens
PO Box 9707
Colorado Springs, CO 80932
(719) 495-2266

Smithers-Oasis
PO Box 118
Kent, OH 44240
(800) 321-8286

GREENHOUSE MANUFACTURERS AND SUPPLIERS

Jaderloon Co.
PO Box 685
Irmo, SC 29063
(803) 798-4000

Lord and Burnham
2 Main St.
Irvington-on-Hudson, NY 10533
(914) 591-8800

Ludy Greenhouse Mfg., Corp.
PO Box 141
New Madison, OH 45346
(513) 996-1921

Oehmsen Midwest, Inc.
505 S. Baldwin St.
George, IA 51237
(712) 475-2833

National Greenhouse Co.
Box 100
Pana, IL 62557
(271) 562-3919

Nexus Greenhouse Systems
PO Box 908
Zellwood, FL 32798
(305) 886-1724

V and V Noordland, Inc.
PO Box 739
Medford, NY 11763
(516) 698-2300
Poly Growers
Box 359
Muncy, PA 17756
(717) 546-3216

Rough Bros.
5513 Vine St.
Cincinnati, OH 45216
(513) 242-0310

Van Wingerden Greenhouse Co.
4078 Haywood Rd.
Horse Shoe, NC 28742
(704) 891-7389

Vary Greenhouses
Box 248
Lewiston, NY 14092
(416) 945-9691

Winandy Greenhouse Co.
2211 Peacock Rd.
Richmond, IN 47374
(317) 935-2111

PLANT MATERIALS - SEEDS AND PLANTS

Ball Seed Co.
PO Box 335
West Chicago, IL 60185
(800) 323-3677

Bruinsma Seeds
PO Box 1463
High River, Alberta, Canada
(403) 652-4768

H. B. Davis Seed Co.
50 Railroad Ave.
Box 5047
Albany, NY 12205
(518) 489-5411

De Ruiter Seeds, Inc.
PO Box 20228
Columbus, OH 43220
(614) 459-1498

G. S. Grimes Seeds
201 West Main Street
Smethport, PA 16749
(800) 241-7333

Fred C. Gloecker Co.
600 Mamaroneck Ave.
Harrison, NY 10528-1631
(914) 698-2300

McHutchison and Co., Inc.
PO Box 95
Ridgefield, NJ 07657
(201) 943-2230

Henry F. Michel Co.
PO Box 160
King of Prussia, PA 19406
(215) 265-4200

Northrup King
PO Box 959
Minneapolis, MN 55440
(800) 328-2420

S. S. Skidelsky
685 Grand Ave.
Ridgefield, NJ 07657
(201) 943-7840

Utica Seed Co.
Harold Gardner Menands Market
Albany, NY 12204
(518) 434-6521

Van Bourgondien & Sons, Inc.
245 Farmingdale Rd.
Babylon, NY 11702
(516) 669-3500

Vandenberg Bulb Co., Inc.
1 Black Meadow Rd.
Chester, NY 10918
(914) 469-9161

Vaughan’s Seed Co.
5300 Katrine Ave.
Downers Grove, IL 60515
(800) 323-7253

Walters Gardens, Inc.
PO Box 137
Zeeland, MI 49464
(616) 772-4697

Yoder Bros., Inc.
PO Box 230
Barberton, OH 44230
(216) 745-2143

WELL PUMPS

Lineshaft Turbine

ITT- Goulds Pumps
Headquarters
240 Fall St.
Seneca Falls, NY 13148
(315) 568-2811
www.gouldspumps.com

Johnston Pump Company
800 Koomey
Brookshire, TX 77423
(281) 934-6009

Layne / Verti-line Pumps
A Division of Pentair Pump Group
PO Box 6999
Kansas City, KS 66106
(913) 371-5000
www.laynebowler.com

Peerless Pumps
Sterling Fluid Systems Group
PO Box 7026
Indianapolis, IN 46207-7026
(317) 924-7305
www.peerlesspump.com

Dresser-Rand
1200 West Sam Houston Pkwy. N
Houston, TX 77043
(713) 467-2221
www.dresser-rand.com

Submersible Electric

Centrilift
Corporate Offices
22 W. Stuart Roosa Dr.
Claremore, OK 74017
(918) 341-9600
centrilift.bakerhughesdirect.com

Schlumberger
300 Schlumberger Dr.
Sugar Land, TX 77478
(281) 285-8500
www.slb.com

Franklin Electric
400 E. Spring Street
Bluffton, IN 46714
(260) 824-2900
(800) 348-2420
www.franklinpumps.com

VARIABLE SPEED DRIVES

Centrilift
Corporate Offices
22 W. Stuart Roosa Dr.
Claremore, OK 74017
(918) 341-9600
centrilift.bakerhughesdirect.com

General Electric Industrial Systems CM&C
1501 Roanoke Boulevard
Salem, VA 24153
(540) 387-7000
www.geindustrial.com

Dan Fuss Graham Company
8800 W. Bradley Road
Milwaukee, WI 53223
(414) 355-8800

Mitsubishi Electric Automation, Inc.
500 Corporate Woods Pkwy.
Vernon Hills, IL 60061
(847) 478-2100
www.meau.com

Parametrics
284 Racebrook Road
Orange, CT 06477
(203) 795-0811

Square D Corporation
11950 W. Lake Park Dr. #240
Milwaukee, WI 53212
(414) 359-0959

PLATE HEAT EXCHANGER

Alfa-Laval Thermal
5400 International Trade Dr.
Richmond, VA 23231
(804) 222-5300
www.alfalaval.com

Invensys APV
Heat Transfer
1200 Westash St.
Goldsboro, NC 27530
(919) 735-4570
www.apv.com

Graham Manufacturing Company
20 Florence Avenue
Batavia, NY 14020
(585) 343-2216
www.graham-mfg.com

Bell and Gossett
ITT Industries
8200 N. Austin Ave.
Morton Grove, IL 60053
(847) 966-3700
www.bellgossett.com

Paul Mueller Company
1600 W. Phelps
Springfield, MO
(417) 831-3000
800-MUELLER
www.paulmueller.com

Tranter Inc.
Texas Division
PO Box 2289
Wichita Falls, TX 76307
(940) 723-7125
www.tranter.com

PIPING

Polybutylene / Polyethylene

Central Plastics Corporation
39605 Independence
Shawnee, OK 74301
(800) 645-3872
www.centralplastics.com

Performance Pipe
5088 W. Park Blvd., Suite 500
Plano, TX 75093
(800)-527-0662
cpchem.com/enu/performance_pipe.asp

Vanguard Piping Systems
8125 North Fraser Way
Burnaby, BC
CANADA V5J 5M8
(888)-747-3739
www.vanguard.ca

Fiberglass

Ameron FCPD
Fiberglass Composite Pipe Division
Group Headquarters
9720 Cypresswood, Ste. 325
Houston, TX 77070
(832) 912-8282
www.ameronfpd.com

Talbot International Inc.
17545 Kuykendahl, Suite D
Spring, TX 77379
(281) 376-1255

Smith Fiberglass Products, Inc.
Reinforced Plastics Division
2700 W 65th Street
Little Rock, AR 72209
(501) 568-4010
www.smithfiberglass.com

Pre-Insulated

Perma-Pipe Incorporated
A Subsidiary of MFRI, Inc.
7720 Lehigh Avenue
Niles, IL 60714-3491
(847) 966-2235
www.permapipe.com

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Rovanco Piping Systems
20535 SE Frontage Road
Joliet, IL 60436
(815) 741-6700
www.rovanco.com

Thermal Pipe Systems, Inc.
5205 W. Woodmill Drive, Suite 33
Wilmington, DE 19808
(303) 999-1588
www.thermalpipesystems.com

Thermacor Process, Inc
PO Box 76179
Ft. Worth, TX 76179
(817) 847-7300
www.thermcor.com

SPACE HEATING EQUIPMENT

Carrier Corporation
PO Box 4808
Carrier Parkway
Syracuse, NY 13221
(315) 432-6620
www.carrier.com

McQuay International
13600 Industrial Park Blvd.
Minneapolis, MN 55441
(763) 553-5330
(800) 432-1342
www.mcquay.com

Pace – York International
9800 SE McBrod Avenue
Portland, OR 97222
(503) 659-5880
www.york.com

The Trane Company
Commercial Systems Group
2727 South Avenue
La Crosse, WI 54601-7599
(608) 787-3445
www.trane.com

York International Corporation
631 S Richmond Avenue
York, PA 17403
(717) 771-7890
www.york.com

Section 7
OTHER INFORMATION SERVICES

INTRODUCTION

The section provides contact information for the Farm Bill state representative in the USDA State Rural Development Offices, National and International Organizations and Trade Journals and Newsletters

USDA STATE RURAL DEVELOPMENT OFFICES

The contact information below comes from the Federal Register, Vol. 72, No. 55, March 22, 2007 for the announcement of "Inviting Applications for Renewable Energy Systems and Energy Efficiency Improvements Grants and Guaranteed Loans." For more information see the following webpage http://www.rurdev.usda.gov/rbs/farmbill/index.html

Alabama
Mary Ann Clayton
USDA Rural Development
Sterling Centre, Suite 601
4121 Carmichael Rd.
Montgomery, AL 36106-3683
(334) 279-3615

Alaska
Dean Stewart
USDA Rural Development
800 West Evergreen, Suite 201
Palmer, AK 99645-6539
(907) 761-7722

Arizona
Alan Watt
USDA Rural Development
230 N. First Avenue, Suite 206
Phoenix, AZ 85003-1706
(602) 280-8769

Arkansas
Shirley Tucker
USDA Rural Development
700 West Capital Avenue, Room 3416
Little Rock, AR 72201-3225
(501) 301-3280

California
Charles Clendenin
USDA Rural Development
430 G. Street, AGCY 4169
Davis, CA 95616-4169
(530) 792-5825

Colorado
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Floral Marketing Association (FMA)
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Section 8
GREENHOUSE CASE STUDIES

INTRODUCTION

This section includes a several case studies and a feasibility study using geothermal in greenhouses. The first case study is located in Hagerman, Idaho and uses 130^{o}F water for heating the greenhouse. The second case study is located near Newcastle, UT and uses 175 to 195^{o}F water. The last item, a feasibility of geothermal heat pumps for greenhouse heating.

CANYON BLOOMERS
(Formerly M & L Greenhouses)
Hagerman, Idaho

Gene Culver
Geo-Heat Center

LOCATION

These greenhouses are located along the Snake River, approximately 30 miles northwest of Twin Falls, Idaho and near the town of Hagerman. There are also several more greenhouse operations, a catfish/tilapia/alligator farm, hot springs spa/resorts and residential heating within about three miles in either direction along the river. Elevation is about 3800 ft ASL and average annual temperature about 50ºF.

RESOURCES

The resource is known as the Banbury Hot Springs area. Most of the wells are in an area about 10 miles long by one mile wide. The occurrence of thermal water in the area appears to be fault controlled. The better (higher flow and temperature) wells occur on the down-throw side of the fault. Temperatures range from 77 to 162ºF. Water quality is generally good–pH 7.9 - 9.5, total dissolved solids 230 - 420 mg/l with higher temperature fluids having higher pH and TDS. Artesian heads range from slightly above, to 360 ft above, land surface. Based on heat flow data, depth of circulation to attain the highest temperatures in the wells is about 4400 ft and since most wells are only 420 - 700 ft deep, convective transport along faults is indicated. Probable maximum temperature based on geothermometers is about 195ºF.

Canyon Bloomers utilizes two wells, one 505 ft deep will produce about 400 gpm at 107ºF; the other 1,000 ft deep produces about 250 gpm at 130ºF.

UTILIZATION

M & L Greenhouses started operation in 1970 with one greenhouse using propane and electricity for heating. In 1974, the 107ºF well was drilled and the greenhouse converted to geothermal. Currently, there are 20 houses of 5,000 sq ft each (2.3 acres). Geothermal at 130ºF is used in fan coil units, then cascaded to radiant floors in 16 of the houses. The remaining four use water cascaded from the 16 in their radiant floors. Water is also cascaded to radiant floors in the large office and shop, and to a swimming pool. Three houses have table top heating using 107ºF water and the owners residence uses mostly 107ºF water in radiant floors, but can be switched to 130ºF water if needed. Total peak flow is 450 gpm providing an estimated installed capacity of 1.9 MWt. Annual energy use is estimated at 14.3 x 10^9 Btu/yr.

Canyon Bloomers is a contract grower supplying 2,000 varieties of annual spring plants to large retailers. Their growing season starts about mid-December and finishes in late-June.

OPERATING COST

Operating costs for the geothermal system is minimal; since, the wells have an artesian head. Wellhead pressure in the shallower 107ºF well varies from 60 psi down to 20 psi at peak flow. A booster pump is required only when wellhead pressure is down near 20 psi. The other well is not pumped. Fan coil units last about 15 years and cost about $2,600. The black steel piping has had no problems. "Sometimes weak acid is run, through the pipes to clean them," the owner reported.

REGULATORY/ENVIRONMENTAL ISSUES

During the late-1970s and early-1980s, there was a large increase in the number of wells in the area. As a result, artesian heads and flows decreased. The Idaho Water

Resources Department instituted a "Ground Water Management Area" in 1983 meaning that no new commercial well water rights will be issued.

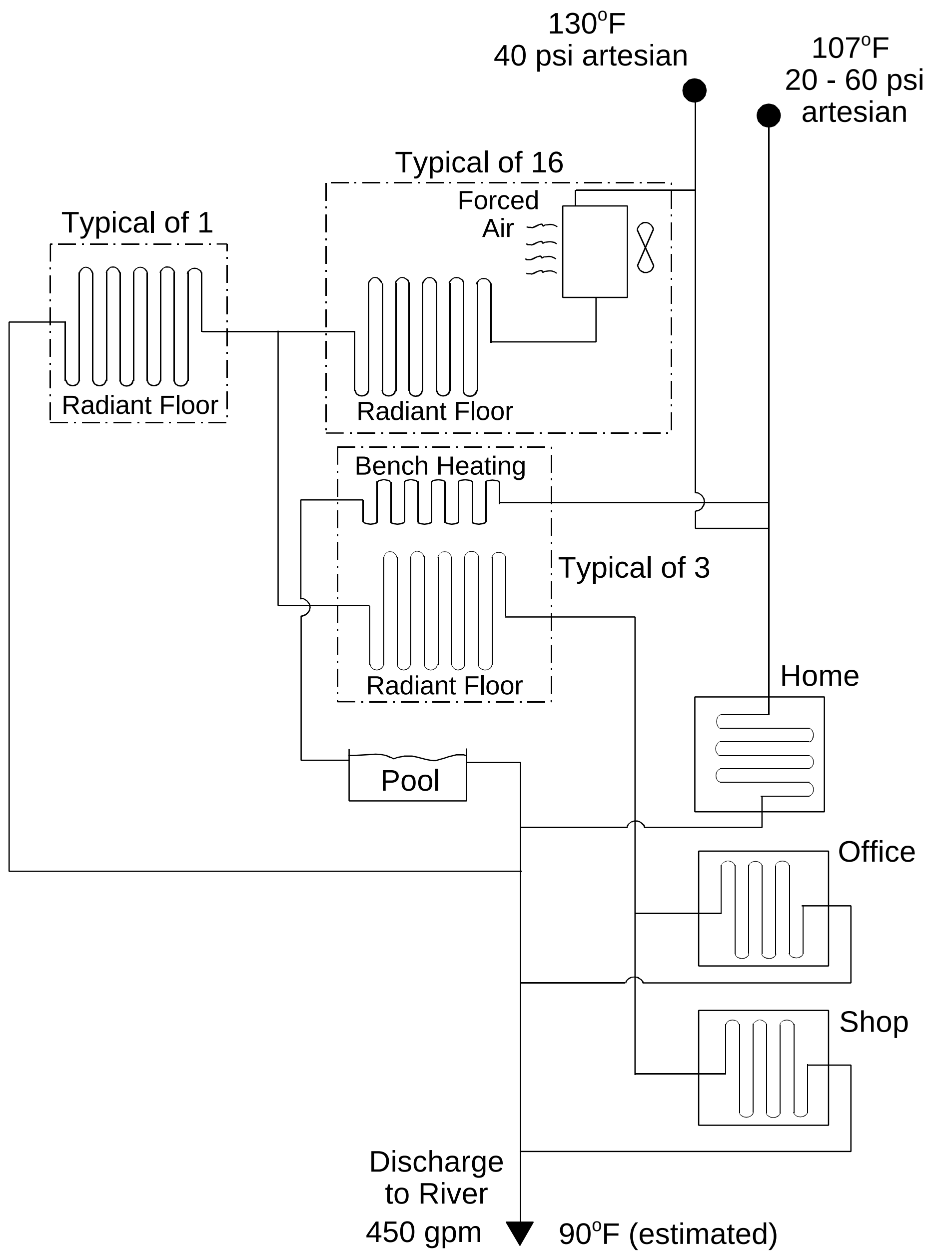
There have been concerns voiced about geothermal uses thermally polluting the Snake River. Most of the users discharge relatively cool effluent so nothing has come of the concerns to date.

PROBLEMS AND SOLUTIONS

Aside from the artesian head loss, there have been no major problems. Very early on, it was learned that copper piping rapidly corroded and galvanized piping tended to scale and plug, but since the operation was small, the conversion to black iron was fairly easy and inexpensive.

CONCLUSIONS

This operation demonstrates the feasibility of utilizing very low temperature geothermal resources. Several of the greenhouses, the residence, shop and office are heated by 107°F geothermal water. The operation started small and grew as the owner learned greenhousing and geothermal, and was not afraid to try using the lower than normal temperatures.



MILGRO-NEWCASTLE GREENHOUSES
NEWCASTLE, UTAH

LOCATION

The Milgro facility is located just west of the town of Newcastle, UT, approximately 37 miles west of Cedar City in southern Utah. The elevation of approximately 5,000 ft results in substantial heating requirements and below zero temperatures are commonly encountered in the winter. Milgro is the largest potted plant grower in the U.S. and in addition to its 1,000,000-sq ft geothermally-heated facility in Newcastle, it also maintains substantial conventionally-heated operations near Los Angeles.

RESOURCE

The Newcastle area has long been recognized as rich in geothermal resources. Prior to the initial development of the Milgro facility, there were three other geothermally-heated greenhouses in the immediate area (all except one now owned by Milgro). There are currently numerous wells in the area producing water in the 190º F to 205ºF range. The wells all penetrate sediments of the Escalante Valley consisting of alternating sequences of clay, silt, sand and gravel. The source of the fluids is thought to be from a buried point source associated with a range front fault approximately 3/4 mile southeast of the main production area (Blackett, 2001). The geothermal fluids flow laterally toward the northwest through the permeable portions of the sediments. Wells individually produce flows up to 1500 gpm.

Recently, production at the Milgro facility has fallen off in the #2 well. In addition, a new injection well, despite intersecting substantial intervals of apparently permeable materials, does not accept the expected flow.

UTILIZATION

Two production wells equipped with vertical, oil-lubricated lineshaft pumps produce the flow for the system. The wells are both approximately 600 ft deep. Water from the two wells (1700 gpm at peak) is delivered to the greenhouse facility; where, the pressure is raised by individual 30-hp booster pumps for each of three 224,000 sq-ft-ranges. From the booster pump, the water is delivered to individual sub- zones in each range where a 4-way valve diverts the water either to the heating tubes under the benches or to disposal. Prior to the development of the two most recent ranges (#4 and #5), the water was all disposed of in a single injection well or to the surface (when flows exceeded the capacity of the injection well). With the development of the two newest ranges, water previously disposed of directly is now routed through the new ranges.

In the original three ranges, heating is provided by half-inch diameter EPDM tubes installed under the benches. This places the heat at the plant root level for maximum effectiveness in potted plant production. In the two newer ranges, which were developed for cut flower production, heat is supplied by two different systems--½-inch diameter tubes on the floor and 1-1/4-inch diameter overhead finned pipe. Effluent water from the other three ranges is boosted by two individual pumps for ranges 4 and 5--one 7 ½ hp for the overhead finned pipe and one 15 hp for the tubes. The head house building is heated with 18 unit heaters connected to the distribution pipe to the ranges. All distribution pipe for the ranges is steel with grooved end joining and is located overhead in the head house. Typical greenhouse inside temperature is 72°F day and 65°F night and varies with the crop.

Disposal of the water is a combination of surface and injection. The first injection well was drilled in 1993 and for several years accepted almost all of the system effluent. It was equipped with a pressure diverting valve such that water in excess of what the well could accept was diverted to surface percolation ponds for disposal. A new injection well was drilled in 2002 with the hope that it would accept all of the system effluent.

Using a figure of 23 acres, the peak geothermal heating load is approximately 51 million Btu/hr (14.9 MWt) based on an outside design temperature of 0°F. The annual use is approximately 93 billion Btu; assuming, that 75% of the sunlight hours, the sun meets the heating load.

OPERATING COSTS

Operating costs, specific to the geothermal portion of the greenhouse are not available from Milgro; however, some general cost data can be inferred from available information. The total maintenance budget for the facility is $16,000 per month. This figure includes maintenance on the structures, vehicles, electrical systems, plant growing equipment and the geothermal system. An interesting point is that this amounts to less maintenance per square foot for the geothermal facility than for Milgro's conventionally-heated greenhouses in the Los Angeles area --though this is related to the fact that the conventionally heated structures are much older.

The geothermal system includes a total of approximately 485 hp in connected load associated with pumping (well pumps and booster pumps) and approximately 9 hp in unit heater fans. Assuming that the well pumps are operated in rough proportion to the heating requirements (#1 well pump is equipped with a variable-frequency drive) and that the booster pumps are operated more or less continuously in the heating season along with the unit heater motors, a total electricity consumption of 1,500,000 kWh per year would result. At a cost of $0.045 per kWh, this would amount to approximately $67,500 per year.

REGULATORY/ENVIRONMENTAL ISSUES

Geothermal fluids in Utah are regulated as "a special kind of underground resource." The use of or injection of the fluid constitutes a beneficial use of the waters of the state and as such water rights are required from the State Division of Water Rights. In addition, rights to a geothermal resource or fluids are based upon the principle of "correlative rights" conveying the right of each landowner to produce his equitable share of underlying resources. Well construction and permitting is regulated by the Division of Water Resources of the Department of Natural Resources. Because all of the facilities fluids are injected no special environmental permits associated with disposal are required.

PROBLEMS AND SOLUTIONS

Despite the very large size of this system, operation has been very reliable over the nine years it has been in operation. In general, the early problems were in the area of hardware and the more recent problems have been associated with the resource. The initial design of the system was based upon the use of plate heat exchangers to isolate the heating system from the geothermal fluid. Due to slow system response time, these heat exchangers were removed from the system in 1995. Since that time, geothermal water has been used directly in the heating equipment (primarily EPDM tubing). The relatively benign nature of the water (approximately 1100 ppm TDS, pH 8) has resulted in few problems. One area that was troublesome was that of control valves. These valves are used throughout the system to provide temperature control for individual zones in the ranges. Numerous failures of standard valves were experienced due to exposure to the geothermal water until replacement valves were coated internally with teflon. Well pumps encountered less than acceptable service life early on. In an effort to reduce failures in the bowl assembly, bearing lengths were increased and the result has been a typical service between overhauls for the pumps of approximately six years.

More recently problems have centered on wells and possibly the geothermal resource itself. An injection well was installed in 1993. This well was initially able to accept most of the system effluent however it periodically was necessary to pump the well to re-establish it's ability to accept water. In addition, this well did not have a sufficient enough surface seal to prevent water from migrating up along the casing to the surface. This caused erosion of the area around the well head. Eventually this well's capacity was reduced to the point that it would not accept a significant flow. A new injection well was drilled in 2002 several hundred feet north of the existing injection well. It is not clear at this point how much water this well will be able to accept.

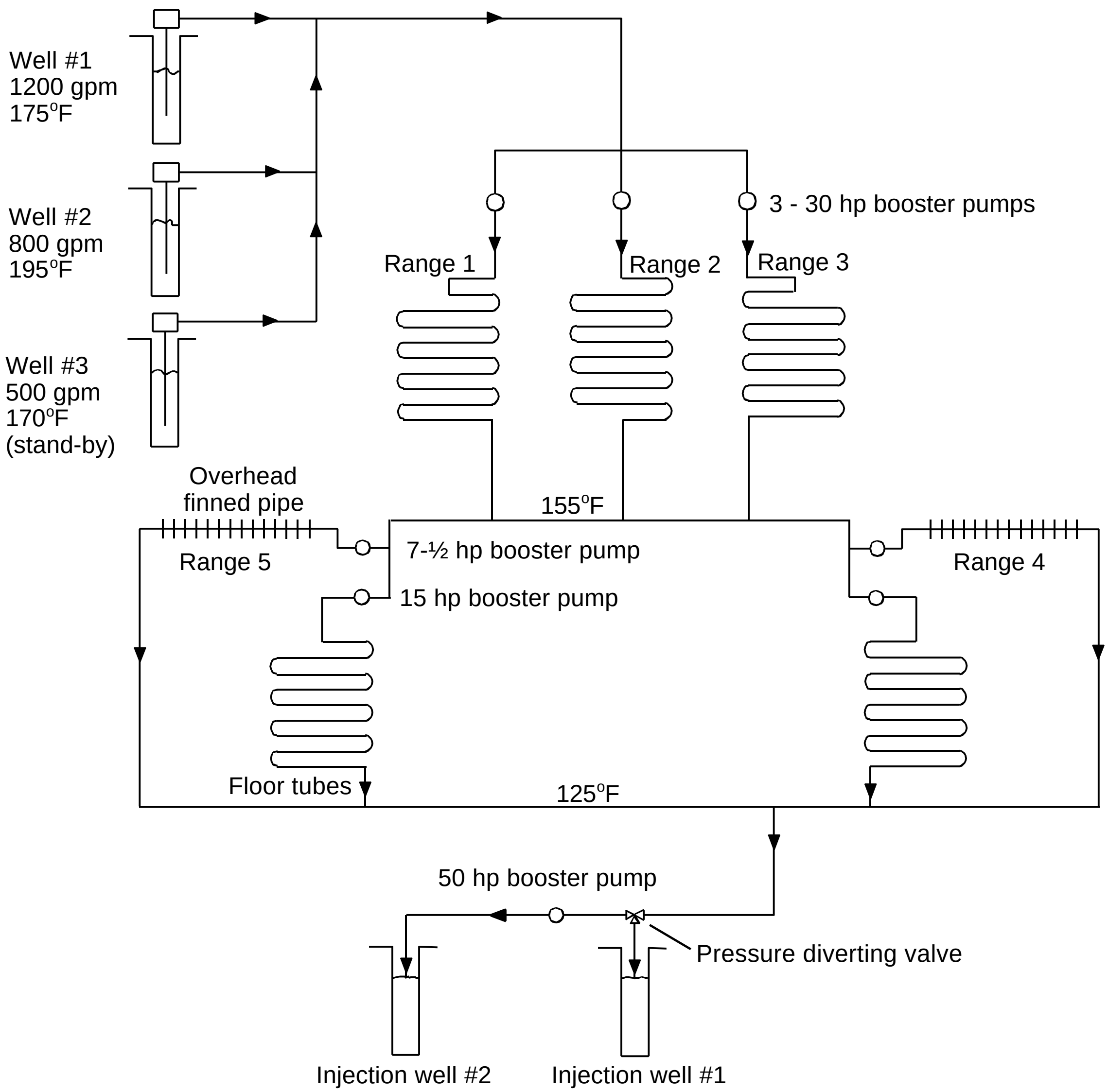
Production from well #2 has recently decreased by approximately 30%. It is not clear what the reason is for this since water level measurement facilities are not available in the wells. There has been some decrease in static levels (thought to be about 12 ft) but this should not be sufficient to eliminate key production zones. As a temporary measure, a pipeline is being installed to transfer water from another Milgro well located east of the wells #1 and #2. Production wells #1 and #2 have experienced drops in temperature of approximately 10°F in the recent past. It is thought that the reduced flows and temperatures may be related to the ongoing drought in the area and the lack of complete injection of system effluent. These issues are the subject of ongoing work at this writing.

CONCLUSIONS

The Milgro-Newcastle greenhouse is one of the largest and most successful direct use applications in the country. The recent issues associated with the well performance are at least in part related to the substantial and rapid growth that the operation has undergone. It is expected that through careful monitoring and design, the local resource will be capable of supporting the existing and planned facilities well into the future.

REFERENCES

Blackett, R. E., 2001. "Newcastle Utah Small-Scale Geothermal Power Development Project." Report to NREL for Phase I Task II - Preliminary Well Development. Utah Geological Survey, Southern Regional Office.



Milgro-Newcastle Greenhouse Schematic

Greenhouse Heating with Geothermal Heat Pump Systems

by Andrew Chiasson, P.E.

ABSTRACT

The objective of this study is to examine the feasibility of greenhouse heating with geothermal heat pump (GHP) systems. Both closed- and open-loop systems are examined at four locations across the U.S. and a net present value analysis is conducted for a 20-year life-cycle for various GHP base-load fractions.

Results show that it would only be under situations of relatively low ground loop installation costs and/or relatively high natural gas costs that some portion of a greenhouse could be economically heated with a closed-loop GHP system. At natural gas costs of about \$0.60/therm (\$0.21/m^3), no fraction of a closed-loop GHP system is economically feasible for the cases examined. At natural gas costs from \$0.60/therm to \$1.00/therm (\$0.21/m^3 to \$0.35m^3), closed-loop GHP systems begin to emerge as economically viable, but only at low loop installation costs, on the order of \$5.50/ft (\$18/m). At these rates, the feasible ground loop size would only be capable of handling 15-30% of the total annual heating demands of the greenhouse. At ground loop installation costs of \$10/ft (\$33/m), natural gas costs would have to exceed \$1.50/therm (\$0.53/m^3) for closed-loop GHP systems to be considered economically viable.

Open-loop GHP systems show considerably more favorable economics than closed-loop systems. At natural gas costs of about \$0.60/therm (\$0.21/m^3), an open-loop system could feasibly be installed to handle 25-30% of annual greenhouse heating demands. At \$0.75/therm (\$0.26/m^3) natural gas cost, the feasible annual base-load handled by an open-loop system would increase to 60% and then again to about 85% at \$1.00/therm (\$0.35m^3) natural gas cost. Of course, open-loop systems would need to be sited at locations with sufficient ground water supply.

INTRODUCTION

The success and economic benefits of heating greenhouses with low-temperature geothermal resources (i.e. groundwater temperatures >140^{o}F (60^{o}C)) has lead to the question of whether or not lower temperature resources could be exploited with the aid of geothermal heat pumps (GHPs). This study seeks to answer that question, and therefore the objective is to determine the feasibility of heating greenhouses with GHP systems. Both closed- and open-loop systems are examined at four locations across the United States: Boston, MA; Dallas, TX, Denver, CO; and Seattle, WA. A number of GHP base-load combinations are examined for the four locations to find the lowest 20-year life-cycle cost at various natural gas rates and GHP installation costs.

GREENHOUSE HEATING SYSTEMS

Of the many types of greenhouse heating systems, the two most common types are fan-coil systems and bare-tube systems. The particular system chosen by a grower depends on many factors such as economics, type of crop, and preference.

In a comparison study of this type, assumptions need to be made about the greenhouse heating system that is being displaced by the GHP system. GHPs are of two types: water-to-water and water-to-air. Water-to-water heat pumps would displace a low-temperature fossil-fuel fired boiler system. Water-to-air heat pumps would displace fan systems, where the conventional heat source could either be a boiler with unitary hot water fan coil system or a direct gas-fired air-handling type system. Therefore, for comparison purposes in this study, the greenhouse heating system considered is a simple bare-tube system where the base-load heat demand is supplied by a water-to water GHP system and the remaining heat demands are supplied by a natural gas-fired, low-temperature boiler.

GREENHOUSE HEATING LOADS

Hourly heating loads were calculated for a **1 acre** (4047 m^2**) greenhouse** using typical meteorological year (TMY) data for Boston, MA, Dallas, TX, Denver, CO, and Seattle, WA. Heat transfer processes included in the calculations were: *solar heat gain, conduction through the structure, convection, infiltration, and ground conduction*. Greenhouse construction was assumed to be fiberglass with a set-point temperature of 65^{o}F (18.3^{o}C) and infiltration losses of 1 air-change per hour. Greenhouse cooling was assumed to be accomplished by another means, such as natural ventilation or evaporative cooling.

Hourly heating loads for the year are shown in Figure 1. As might be expected, Denver and Boston show the most extreme heating loads. An interesting and important result is shown in Figure 2, which is a plot of the fraction of total annual heating demands versus the fraction of the peak load that a base-load system would be designed to handle. This is significant since a base-load system (the GHP system in this case) sized at 50% of the peak load could meet about 92% of the total annual heating requirements.

ECONOMIC ANALYSIS

Closed-Loop GHP System

The hourly loads shown in Figure 1 were converted to monthly total and peak loads, and using a software program, ground loops were sized for each city for several GHP part load cases (100%, 75%, 50%, 33%, 25%, 10%, and 0%). The loop-sizing software also computes heat pump power consumption.

A net present value (NPV) analysis of a 20-year life cycle was used to compare alternatives for the various part load cases. Equipment costs for natural gas-fired boiler systems were taken from R.S. Means Mechanical Cost Data and water-to-water heat pump material and installation costs were assumed at $1000/ton ($284/kW) of heat pump capacity. Ground loop installation costs are commonly reported per foot of vertical bore, and for this study, a range of $4/ft to $12/ft ($13/m to $39/m) was examined, which is representative of the widely varying values observed across the U.S.

Annual operating costs included fuel and maintenance costs. A range of natural gas costs from \$0.50 to \$2.00 per therm (\$0.18/m^3 to \$0.70/m^3) was examined. Electricity cost was fixed at $0.10/kW-hr. Annual boiler maintenance costs were assumed at 2% of capital cost. A discount rate of 6% was assumed.

Results of the closed-loop economic analysis are presented in Figure 3 in the form of a contour plot. Results were similar for all cities examined. The plot shows contours of the GHP fraction of the total heating system that yields the lowest NPV at various natural gas rates and ground loop installation costs. A review of Figure 3 reveals that at natural gas prices of about $0.80/therm (\$0.25/m^3), it would not be justifiable to heat any portion of a greenhouse with a closed-loop GHP system unless the ground loop could be installed at very low cost of about $5/ft ($16.40/m). At these rates, it would only be feasible to install a ground loop capable of handling 15-30% of the total annual heating requirements. At a loop installation cost of $10/ft ($33/m), natural gas prices would have to exceed \$1.50/therm (\$0.53/m^3) to justify installing a ground loop to handle 15-30% of the total annual heating requirements.

Open-Loop GHP System

The same overall approach was taken in the economic analysis of the open-loop systems as for the closed-loop systems with the following differences. The capital cost range of the open loop systems were taken from *Outside the Loop Newsletter* (Vol. 1, No.1, 1998). These costs, shown in Figure 4, are expressed per ton (and kW) of delivered capacity for various well configurations and include costs of production and injection wells, well tests, pumps, piping to the building, heat exchangers, controls, and 15% contingency. For the operating costs, additional electrical loads were included to account for a submersible pump operating under an assumed vertical head of 100 ft (30.48 m).

Results of the open-loop economic analysis are presented in Figure 5. The plot shows contours of the GHP fraction of the total heating system that yields the lowest NPV at various natural gas rates and open loop installation costs. A review of Figure 5 shows much greater feasibility of greenhouse heating with open-loop GHP systems over closed-loop systems. At natural gas prices of about \$0.80/therm (\$0.25/m^3), it would be economically feasible to install an open-loop GHP system up to a cost of about \$600/ton (\$170/kW). This open loop cost covers most of the well configurations shown in Figure 4. For this cost, an approximate 40% open-loop system (relative to the peak load) could feasibly be installed and would be capable of handling about 80% of the total annual heating demands (see Figure 2). Note also the relative "flatness" of the 0.1 to 0.4 curves in Figure 5 from about \$200/ton to \$600/ton (\$57/kW to \$170/kW). This reflects the economies of scale with open loop systems; only two to four wells are needed if enough ground water is present. Thus, a greenhouse would need to be sited at a location where there is sufficient ground water supply.

CONCLUDING SUMMARY

This study has examined the feasibility of greenhouse heating with closed- and open-loop GHP systems. Heating loads were computed for four climates across the U.S. The net present value of a 20-year life-cycle was determined for various GHP base-load fractions.

The results of this study show that the feasibility of heating greenhouses with closed-loop GHP systems is strongly dependent on the natural gas cost and the ground loop installation cost. It would not be economically justifiable to heat any portion of a greenhouse using a closed-loop GHP system unless loop installation costs were as low as \$4/ft to \$5/ft (\$13/m to \$16.40/m) and natural gas prices exceeded \$0.75/therm (\$0.26/m^3). This represents a very marginal situation at 2005 rates. On the contrary, for the cases examined, open loop systems appear to be quite economically feasible above natural gas rates of about \$0.60/therm (\$0.21/m^3).

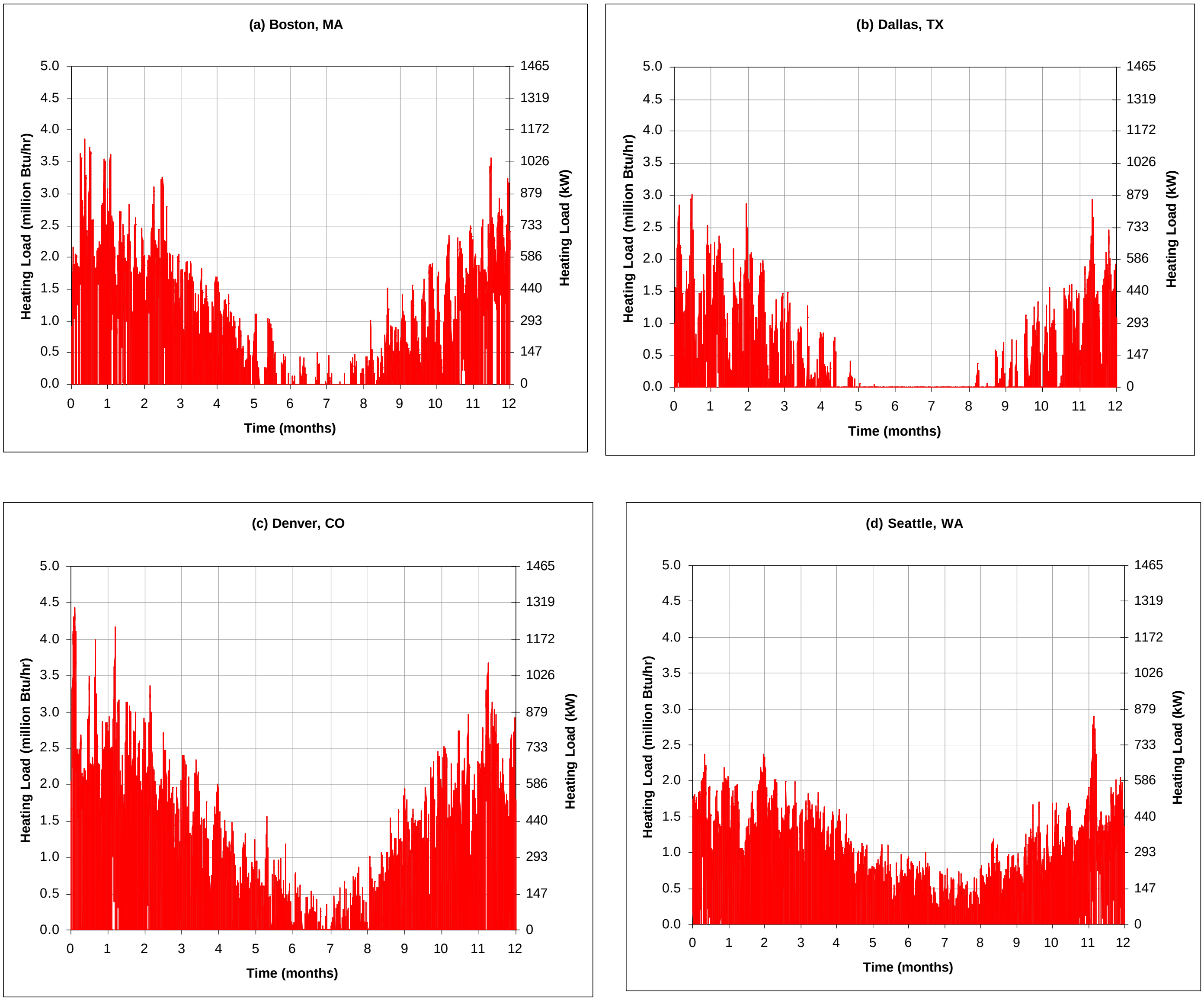


***Figure 1**. Hourly heating loads on an annual basis.*

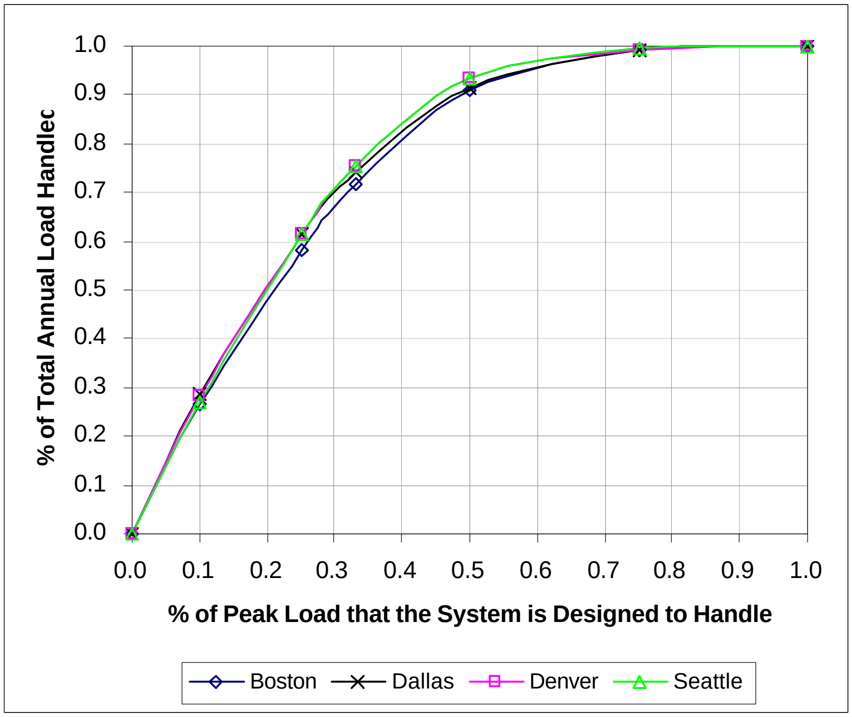


Figure 2*. Fraction of total annual heating load actually handled versus design fraction of peak load for a base-load system.*

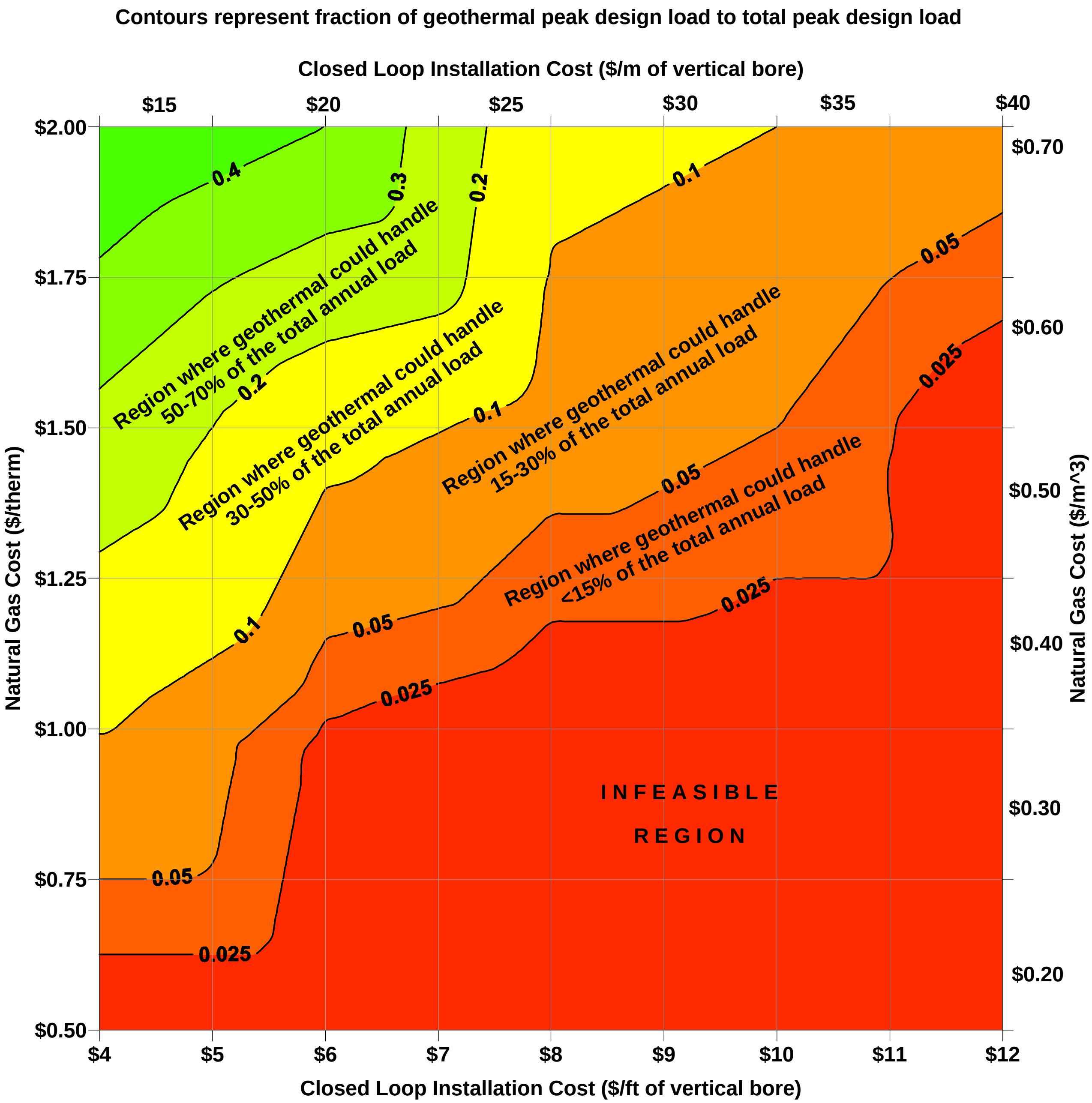


Figure 3*.* *Closed-loop GHP system fraction providing lowest net present value of a 20-year life cycle at various natural gas costs and closed-loop installation costs. (Results derived from Boston, Dallas, Denver, and Seattle climate data.)*

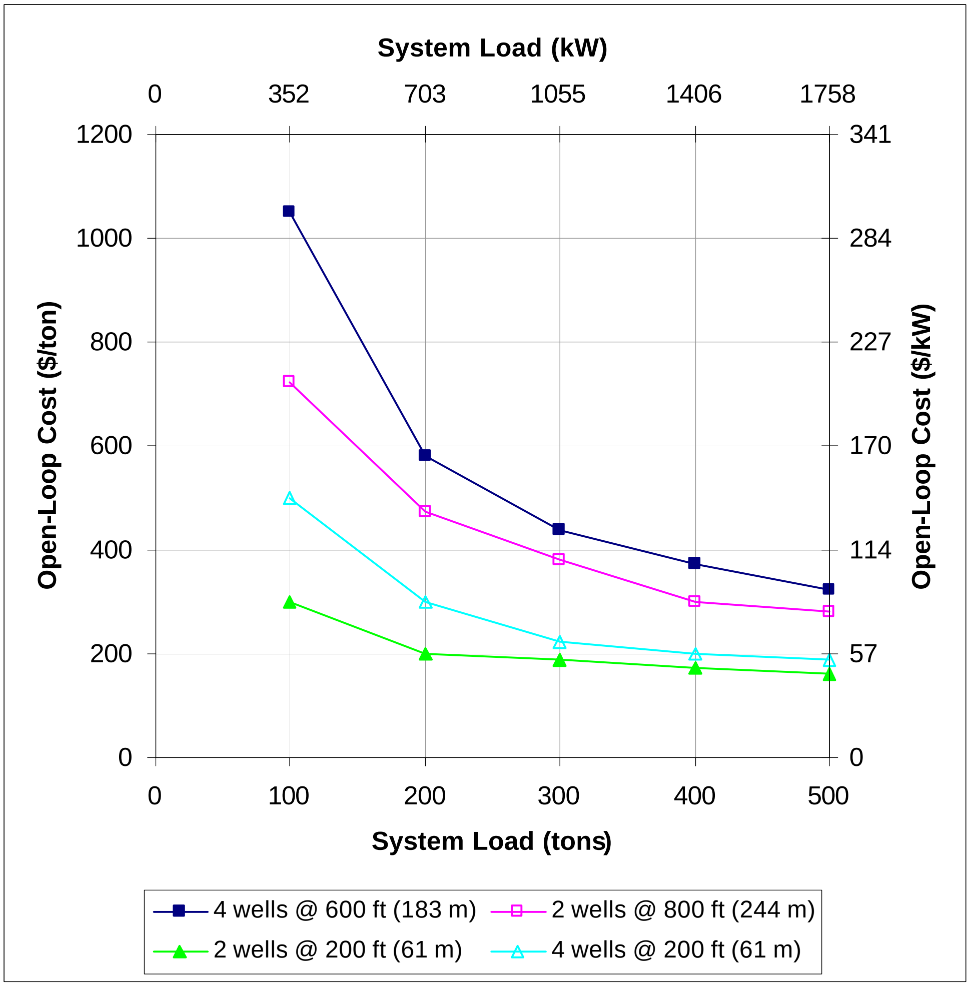


Figure 4. *Open-loop system costs for 60°F groundwater (Source: Outside the Loop Newsletter, Vol. 1, No. 1, 1998).*

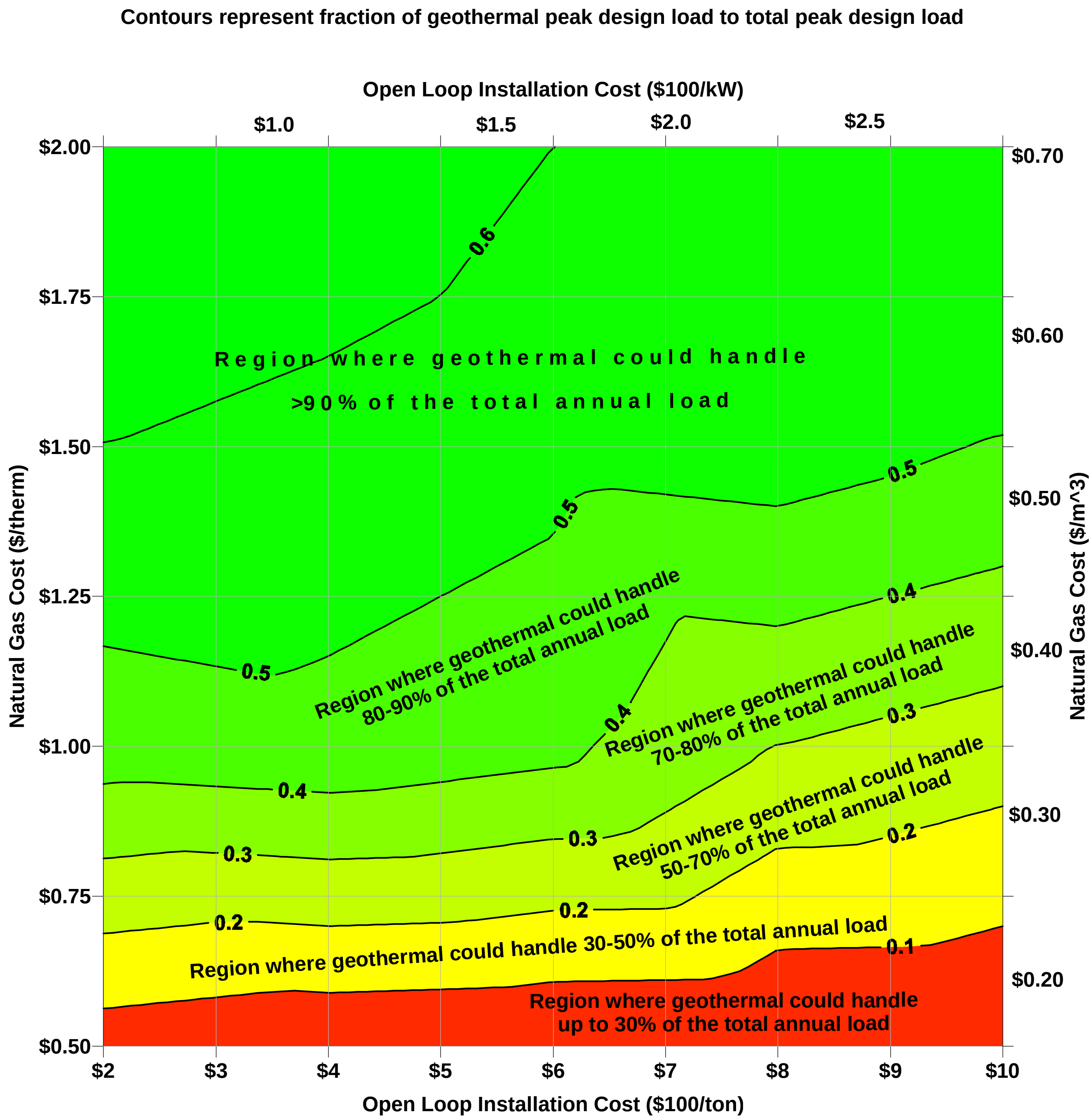


***Figure 5**. Open-loop GHP system fraction providing lowest net present value of a 20-year life cycle at various natural gas costs and open-loop installation costs. (Results derived from Boston, Dallas, Denver, and Seattle climate data.)*

Section 9
GEO-HEAT CENTER
GREENHOUSE BULLETIN ARTICLES

INTRODUCTION

This section includes several Geo-Heat Center bulletin articles in their entirety, plus webpage addresses to all the bulletin articles on greenhouses that are available on our website in PDF format.

The sample bulletin articles are

- "Castlevalley Greehouses, Newcastle" by Robert Blackett and John W. Lund
- "Utah Hot Springs and Allan Plant Company Greenhouses" by Robert Blackett and John W. Lund
- "Masson Radium Springs Farm" by James C. Whitcher and John W. Lund
- "J & K Growers, Las Cruces, New Mexico" by John W. Lund
- "Greenhouse Carbon Dioxide for Use in Greenhouses" by M.G. Dunstall and G. Graber
- "Greenhouse Climate Factors" by Kiril Popovski

CASTLEVALLEY GREENHOUSES, NEWCASTLE

Robert Blackett
Utah Geological Survey
Cedar City, UT

John W. Lund
Geo-Heat Center

***Castlevalley greenhouses showing geothermal water supply lines*.**

BACKGROUND ON ESCALANTE VALLEY

Newcastle, Utah is a rural farming community located about 30 miles west of Cedar City, Utah along the southeastern edge of the Escalante Valley in Iron County. The Newcastle geothermal resource, low-to-moderate temperature hydrothermal system, was accidentally discovered in 1975 during an aquifer test of an irrigation well. Upon pump-testing of the well, Christensen Brothers--a local farming company (owners of Castlevalley Greenhouses)--discovered that the well had penetrated a geothermal aquifer. Termed a "blind" geothermal resource, there are no obvious surface manifestations such as hot springs or fumaroles to suggest that a geothermal system is present at depth. The water in the well was near the boiling point and reportedly flashed to steam when pumped to the surface. Subsequent studies by the University of Utah, Department of Geology and Geophysics (Chapman, et al., 1981), the Utah Geological Survey (UGS) (Blackett and Shubat, 1992) and the University of Utah Research Institute (Ross, et al., 1990; 1994) defined a buried zone of suspected geothermal upflow along the nearby Antelope Range fault that they postulate as the source of the hot water.

Studies also defined a shallow aquifer that channel the outflow of geothermal fluids into the subsurface of the Escalante Valley. Geothermal production wells, typically 500 ft (150 m) deep, tap the geothermal fluid in this unconfined aquifer. The fluids cool by conduction and probably mix with shallow groundwater at the system margins. A maximum temperature of 266°F (130°C) was measured in a 1981 geothermal exploration well (CHR-1), which penetrated the geothermal aquifer (outflow plume). Exploratory drilling in the summer of 2001 in the same location as CHR-1, however, yielded lower temperatures (~243°F, 117°C). Production wells at the greenhouses generally yield fluids in the range of 167 to 203°F (75 to 95°C). Chemical signatures or "geothermometers" suggest maximum resource temperatures of 266 to 302°F (130 to 150°C).

GEOTHERMAL STUDIES

Blackett and Shubat (1992) prepared a case study of the Newcastle geothermal system based on previous work and the results of detailed geologic mapping and various geophysical surveys. D. S. Chapman (Blackett, et al., 1990) developed a heat-flow map of the Newcastle area using data from about 30 exploratory, thermal-gradient drill holes. He reported an anomalous heat loss of 12.4 thermal megawatts (MW_t). A more recent calculation (Ross, et al, 1994), which accounted for corrected well positions and used the method of Chapman, yielded an anomalous heat loss of 13.8 MW_t. Ross and others (1990) completed electrical resistivity and self-potential (SP) studies which provided independent evidence for the location of the thermal fluid up-flow zone. A well-defined 108 millivolt (mV) SP minimum was mapped between temperature-gradient monitor wells with greatest heat flow and above the projected intersection of northwest-trending structures with the Antelope Range fault. Two lesser minima of -44 mV and -36 mV were also mapped to the southwest, above the buried Antelope Range fault. Numerical models of dipole-dipole resistivity profiles resolve near-vertical low-resistivity (4 ohm-m) bodies which are interpreted as up-flow zones. A low-resistivity (4 ohm-m) layer at a depth of about 150 ft (45 m) within the alluvium extending to the northwest is interpreted as the geothermal outflow plume.

UTILIZATION

Castlevalley Greenhouses consists of nine arched, double plastic covered building heated with 210ºF (99ºC) water. These greenhouses cover an area of about 33,750 ft^2 or 0.77 acres (0.31 ha) Water at around 350 gpm (22 L/s) is supplied to fan coil heaters at the end of each house. The main crop is tomatoes grown hydroponically. These are marketed by the owners through southern Utah. A few bedding plants are also grown.

Interior of a greenhouse showing the hydroponic growing system.

Fan coil heaters at the end of a greenhouse.

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UTAH HOT SPRING AND ALLAN PLANT COMPANY GREENHOUSES

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Remain of one of the cisterns used for hot water collection for the resort (Bob Blackett).

BACKGROUND

Utah Hot Springs issue from several orifices in Pleistocene valley fill sediments at the western edge of the Pleasant View spur, or salient, about 300 ft (90 m) west of U.S. 89 on the Box Elder-Weber County line. Utah hot springs is within an urban-industrial setting adjacent to a utility corridor, highway, and Interstate 15. The springs were used for a time at a now-defunct resort, and are currently used to heat a small commercial greenhouse operation. The maximum temperature reported is 145°F (63°C); although, temperatures reported in most studies ranged between 135°F and 137°F (57°C and 58.5°C) (Murphy and Gwynn, 1979). Minor geothermal exploration was conducted in the early 1980s, but the resource is poorly defined. Although the area is industrial, large-scale development could be problematic due to the number of listed sensitive plant and animal species (10) possibly in the area. Small-scale geothermal power development, however, would likely blend well with other uses. Zoning restrictions in this "urban-fringe" area could impede some types of future development (Blackett, et al., 2004).

GEOLOGY

Utah Hot Springs are situated nearly due west of the boundary between the Weber and Brigham City segments of the Wasatch fault, where Personius (1990) describes surficial deposits and structural geology along these two fault segments. His work shows that at least three Holocene faults on the west flank of the Pleasant View spur postdate Bonneville Lake cycle (between 30 and 10 ka) deposits and trend roughly at right angles to the Brigham City segment of the Wasatch Fault. The three faults are marked by 10-16-ft (3-5-m) high scarps formed in Bonneville-Lake-cycle lacustrine gravels. The northernmost scarp also appears to cut Holocene fluvial and lacustrine deposits near the hot springs. He also notes that the springs appear localized at the intersection of this young fault and an older buried fault, described by Davis (1985), that flanks the west side of the spur.

Total dissolved solids content of Utah Hot Springs water ranges between 18,900 and 25,200 mg/L, consisting mainly of sodium chloride. In addition to the high salinity, the water contains 3 to 5 mg/L dissolved iron that oxidizes and precipitates when the water is aerated. The iron compounds have reportedly led to scale buildup in piping and heat exchangers within the greenhouses. Felmlee and Cadigan (1978) have reported that the water also contains measurable quantities of radium (66 µµg/L) and uranium (0.04 µg/L). Cole (1983) included Utah Hot Springs as part of a geothermal-geochemical research project, and suggested that the hot spring discharge fluids appear to have circulated to depths in excess of 3 mile (5 km), thermally equilibrating with reservoir rock at temperatures above 392ºF (200ºC).

UTILIZATION

The hot springs were on the Hensley/Salt Lake Cutoff emigrant trail used in the 1850s. At the turn of the century, a resort with a geothermally heat pool was built. Special trains were run from Salt Lake City and Ogden to the resort while it was in use. The resort was torn down about 1970; however two cisterns remain, that were used to collect the spring water. The springs presently flow under the railroad and across a gentle slope. They are deep red from the iron oxide that has precipitated from the water Water, at a rate of about 100 gpm (6.3 L/s) is collected at this point for the greenhouses run by Allan Plant Company. A total of 24 double plastic covered greenhouses are heated with the geothermal water. These greenhouses, covering about 52,000 ft^2 or 1.19 acres (0.48 ha) are used to raise bedding plants (mainly geraniums) and poinsettias, which are sold wholesale to garden centers throughout northern Utah. Approximately 300,000 flats of bedding plants and 8,000 poinsettias are sold annually.

Water enters the greenhouses at about 135°F (57°C) and supplies heat to the plants through PVC pipes under the tables, and then exits around 90°F (32°C). This radiant heat keeps the greenhouses at the desired 60 to 65°F (16 to 18°C), and heat is required year around, as in the summer, heat is needed for the seed propagation sand beds. Because of the high iron content in the water, special fittings are provided at intervals to the bottom of the heating pipes. These are flushed out with a hose three or four times a year.

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Interior of a greenhouse with the PVC heating pipes under the benches.

Spring water with iron precipitations -- greenhouses in background.

MASSON RADIUM SPRINGS FARM

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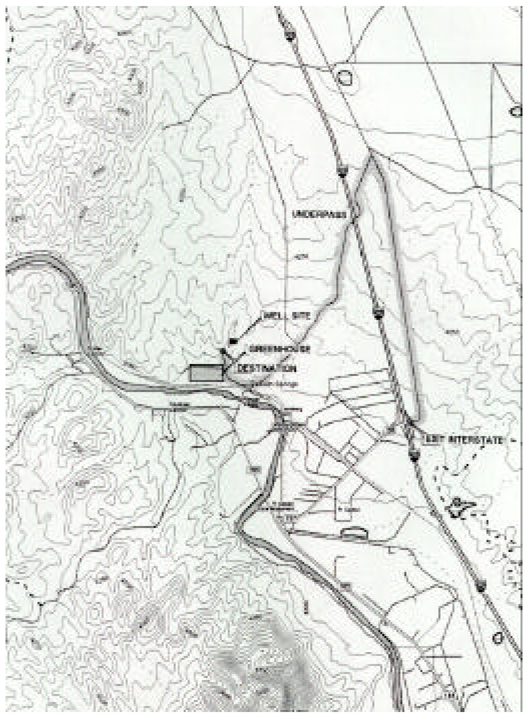

Figure 1. Location map of the Masson Greenhouses (Witcher, 2001).

INTRODUCTION

The Masson Radium Springs Farm geothermal greenhouses are located on private land in southern New Mexico 15 miles north of Las Cruces and just west of Interstate 25 near the east bank of the Rio Grande adjacent the Federal Radium Springs KGRA (Figure 1). The operation started in 1987 with four acres of geothermally-heated greenhouses (Whittier, et al., 1991). Prior to startup at Radium Springs, Masson was one of the first clients in the SWTDI/NMSU business incubator and research Geothermal Facility. Masson selected New Mexico and the Radium Springs area to take advantage of the sunshine, ease of climate control because of the dry desert air, a willing and trainable work force, and geothermal heat. Today, the greenhouses employ 110 people, and cover 16 acres in two major modules, each with shipping and warehousing buildings attached (Photo 1). The Masson Radium Springs Farm is the production facility for Alex R. Masson, Inc. of Linwood, Kansas which handles distribution, marketing, and sales of wholesale potted flowering and tropical plants. The markets cover southern Arizona, New Mexico, west Texas, and the mid-west, and the products are sold under the registered trade name of Sunflower Sue (http://www.sunflowersue.com/). The Masson Radium Springs Farm geothermal greenhouses are used to produce more than 30 groups of potted plant products including season products such as poinsettias.

GEOLOGY AND HYDROGEOLOGY

The Radium Springs geothermal system is one the largest in the southern Rio Grande rift and the main thermal anomaly extends northward from Radium Springs nearly 10 miles over a 3-mile wide swath. The Radium Springs geothermal system is confined to a late-Tertiary horst block bound on the east by a major Pleistocene normal fault, and on the west by several smaller late Tertiary and Quaternary faults (Seager, 1975). However, the pre-Tertiary bedrock or reservoir host in the horst is dominated by large-scale Laramide reverse faults and associated folds, and minor thrust

Photo 1. Two views of the greenhouses.

faults in Precambrian granite and Paleozoic limestones. These deformed rocks are apart of the frontal convergence zone of a very large basement-cored and northwest-trending Laramide uplift that has since been sliced apart by north-striking Tertiary rift normal faults (Seager, et al., 1986). The Laramide compressional deformation of Precambrian and Paleozoic rocks with an overprinting of extensional faults forms a favorable host for the deep or parent reservoir at Radium Springs and northward in the subsurface to San Diego Mountain. The deep reservoir is confined by up to 1,000 feet of altered andesitic volcanic mud flows (lahars), and muddy gravely sand and muddy andesitic boulder conglomerate of Eocene age called the Palm Park Formation (Seager, 1975).

At Radium Hot Springs, a low angle, north-dipping rhyolite dike acts as the conduit or "hydrogeologic discharge window" out of the deep Precambrian-Paleozoic reservoir for thermal water flow to the surface across the Palm Park aquitard (Witcher, 1988 and 2001). Because the shallow rhyolite dike of probable Oligocene age is also highly fractured, it forms a shallow outflow plume reservoir at Radium Springs that ultimately discharges thermal water into the near surface river gravels and sands of the Rio Grande.

The geothermal water at Radium Springs is a sodium chloride type with total dissolved solids (TDS) between 3,600 and 3,700 mg/L (Witcher, 1995 and 2001). Because of the high chloride content between 1,500 and 1,700 mg/L, chemical corrosion becomes an issue, requiring titanium alloys to be used in the heat exchangers.

Currently, three wells, drilled on private land, are online for production purposes. A fourth well, Masson 36 well, is on a Federal BLM lease held by Masson and has not gone into production due in part to the costly requirements of installing and maintaining energy meters for production monitoring to determine royalties. The Masson 36 well is probably capable of producing more than 1,500 gpm of 210ºF (Witcher, 2001) (see vol. 22, no. 4 - December 2001 - issue of the *GHC Quarterly Bulletin* for details on this latter well).

Pump and recovery tests of a shallow (<250 ft depth) Masson geothermal well in the fractured rhyolite dike reservoir indicates a transmissivity of about 45,000 gpd/ft (Gross, 1986). Pump testing also shows that the shallow reservoir has some hydraulic connection to the near surface cold fresh water aquifer. Quantitative properties of the deep reservoir are not known at this time. However, this reservoir is isolated from near surface cold aquifers by up to 1,000 ft of clayey aquitard (Palm Park Formation) and probably has significant solution permeability in addition to fracture permeability.

Besides the geothermal resource, the site also has a cold near surface aquifer that is used for irrigation. This aquifer is recharged from the nearby Rio Grande and consists of fluvial sands and gravels. Because of the requirements of irrigation with many crops grown in the greenhouses, a reverse osmosis unit is used to tailor the freshwater quality to specific needs.

GREENHOUSE GEOTHERMAL HEATING

The Masson greenhouse facility consists of 16 acres of single wall fiberglass sides with double-poly roofs. Daytime and summer cooling is provided with evaporative pads and fans. The heating and cooling of the greenhouse environment is monitored and controlled by computer.

The greenhouse space is heated by geothermal energy from three wells that are located on private land. Masson 32 and 33 are shallow wells less than 350 ft depth in the rhyolite dike reservoir and produce 165ºF water. Masson 36 was drilled during the last year to 800 ft depth and produces at 199ºF water from the deep reservoir. Flows vary from 430 gpm in summer to 720 gpm in winter for Masson 32 and 33 , and 750 gpm in winter for Masson 36. The water is stored in a newly construct 167,000 gallon storage tank that is used mainly for night-time heating (Photo 2) , and then fed thru two large titanium plate heat exchangers (Photos 3 and 4). The geothermal water that is cooled to 110 to 130ºF is then injected back into the shallow rhyolite reservoir with three shallow (<250 ft depth) injection wells at a location on the outflow plume down hydraulic gradient from the production wells.

In general, two types of heating arrangements are done in the greenhouses. In the older greenhouses, plotted plants are placed on benches underlain with finned tubing, black plastic and iron pipe for heating. In the older greenhouses, the finned tubing and piping is also run along the

Photo 2. The 167,000-gallon storage tank.

Photo 3. The two new plate heat exchangers.

Photo 4. The existing plate heat exchanger (Jim Witcher).

base of the greenhouse walls for heating. The most of the newer greenhouses use floor heating and the potted plants are placed directly on the concrete floor. In addition to heating, this arrangement conserves irrigation water and fertilizers by avoiding runoff and promoting recycling. Polybutylene tubing is embedded in the concrete floor for heating.

Maximum installed geothermal heating capacity is 44.1 x 10^6 Btu/hr (12.9 MWt). Maximum annual energy use is probably around 76.8 x 10^9 Btu for a minimum capacity factor of about 0.20. Annual energy use per acre is assumed to be between 4.2 and 4.8 x 10^9 Btu/acre/yr based upon the energy use of the SWTDI/NMSU Geothermal Greenhouse Facility in Las Cruces.

CONCLUSION

In addition to lowering overall energy costs, the Radium Springs geothermal resource gives Masson several advantages in production that has enabled the company to be less dependent upon other growers. For example, the company is able to grow its own stock plants that would normally be purchased from a plant specialist. Because of the economical geothermal heat, the company is able to be it's own supplier for starter plant material, such as unrooted chrysanthemum cuttings, for final grow out at Radium Springs. With this approach, plants are more readily adapted to the environment and production schedules can be reduced and product quality improved.

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J & K GROWERS
LAS CRUCES, NEW MEXICO

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J & K Growers are located adjacent to the New Mexico State University (NMSU) campus in Las Cruces. They use geothermal energy to heat 1.6 acres of 18 poly-covered greenhouses and cold frames. At first the owners, Kerry and John Krumrine, grew all potted plants and bedding crops on the ground to limit costs, especially with the use of in-ground heat. However, later they decided to put the crops on benches and further, from the buried heating source to increase air circulation, lower soil temperature and thus, decrease disease and pest problems. Also, this limited the stress of working at ground level. They initially produced potted crops, mostly cyclamen, exacum, and geraniums; however, they have changed to bedding plants as they have proven to be less work and more profitable. They also grow some poinsettias.

The Krumrines got their start in 1988 by leasing the 6,000-ft^2 "incubator" greenhouse on NMSU administered by the Southwest Technology Development Institute (STDI). This greenhouse is provided to potential commercial growers to get their feet wet and to see if the client really wants to have a "green thumb." After a year successfully growing poinsettias, they moved to their present location on land owned by a gravel pit business. The landowner drilled the geothermal well by accident, but did not need the hot water to wash his sand and gravel. Thus, the Krumrines uses only the heat and return the water to a pond for the landowners use. A 50-gpm pump draws water from the well at 148°F into a 30,000-gallon tank adjacent to the greenhouses.

The geothermal water is used directly from the tank in the green-house heating systems which consists of 3-inch black poly-butylene pipe main supply and return lines with simple thermostats connected to spa pumps to push water through the system. Each greenhouse of approximately 3,000-ft^2 in area, has 2-inch branch lines that run at about bench height (2-feet off the ground), and then 3/4-inch branch lines from these pipes run underground at four to six inches beneath the gravel greenhouse floor and buried in sand. These underground loops are each about 1,000 feet in length. An additional line heats 15,000 ft^2 of cold frames to keep the crops from freezing.

The geothermal system proved its value when strong winds collapsed one of the greenhouses. The below bench and underground heating system kept the plants warm, even though the Krumrine's had to crawl on their hands and knees to service the crops. An overhead system would have been destroyed. They also have installed kerosene back-up heaters, but only have had to use them once--which created an unpleasant odor in the greenhouses.

The cost to operate the heating system is about 60 percent of natural gas heat costs. The hot water bill at the peak (about four weeks out of the year) is around $500 per month (1992 figures), and considerably less the rest of the year. The only drawback is that since the geothermal water is used directly in the heating system, calcite deposits have built up inside the pipes reducing the flow and heat output. The well is on federal land; thus, a royalty is paid based on an annual average energy use per acre.

This material was summarized and edited from an article in *Greenhouse Manager* magazine (June, 1992) by Sami Harman Thomas title: "Geothermal Energy Fuels Success - New Mexico Couple Find Down-to-Earth Heat Supply," pp. 56-60, and from the Editor/Author's visit to the site (see page 30, Figure 1, for location map).

GEOTHERMAL CARBON DIOXIDE FOR USE IN GREENHOUSES

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2. University of Stuttgart, Germany and Geothermal Institute

INTRODUCTION

Geothermal fluids often contain carbon dioxide, which is a very effective growth stimulant for plants in greenhouses. Studies have shown that as CO_2 concentration is increased from a normal level of 300 ppm (mmol/kmol) to levels of approximately 1000 ppm crop yields may increase by up to 15% (Ullmann's Encyclopedia of Industrial Chemistry, 1989). It is suggested that geothermal greenhouse heating offers a further opportunity for utilization of the carbon dioxide present in the fluid. The main difficulty is that plants react adversely to hydrogen sulphide which is invariably mixed, at some concentration, with the CO_2 from geothermal fluids. Even very low H_2S concentrations of 0.03 mg/kg can have negative effects on the growth of plants (National Research Council, 1979). Therefore, an appropriate purification process for the CO_2 must be used to avoid elevated H_2S levels in the greenhouses. The use of adsorption and absorption processes is proposed.

Two purification processes have been modelled using the ASPEN PLUS software package, using the Geothermal Greenhouses Ltd. operation in Kawerau New Zealand as an example. A greenhouse area of 8000 m^2, which would create a demand for approximately 20 kg CO_2 per hour, was chosen based on a proposed expansion at Kawerau. The Kawerau operation currently takes geothermal steam (and gas) from a high temperature 2-phase well to heat an area of 1650 m^2. Bottled carbon dioxide is utilized at a rate of about 50 kg per day, to provide CO_2 levels of 800 mg/kg when the greenhouse is closed and 300 to 350 mg/kg whilst venting. In England and the Netherlands, CO_2 levels of 1000 mg/kg are often used (Ullmann's Encyclopedia of Industrial Chemistry, 1989) and similar concentrations are desired at Kawerau, but current costs of 0.60 NZ$/kg for bottled CO_2 are too high (Foster, 1995).

H_2S LEVELS

Plants are very sensitive to elevated H_2S levels in the air. Small concentrations of 0.03 mg/kg (0.04 microg/liter) result in damage to some plants while other plant species (e.g., lettuce and sugar beets) show growth stimulation. However, all plants show deleterious effects at higher H_2S concentrations of 0.3 mg/kg (0.4 microg/liter) (National Research Council, 1979). In this study a hydrogen sulfide concentration of 0.03 mg/kg is considered acceptable if 1000 mg/kg CO_2 is added to the greenhouse atmosphere. The required CO_2 purity is, therefore, 99.997%. An H_2S content of 30 mg/kg or 40 ppm (mmol/kmol) in the CO_2, or less, has to be achieved by the purification process.

Because individual plant species respond differently, higher H_2S concentrations might be tolerable. In many geothermal areas the characteristic "rotten-egg" odor of H_2S can be detected, indicating concentrations of 0.01 to 0.2 mg/kg H_2S; higher than the concentrations where negative effects on plant growth have been observed. It is likely, therefore, that many crops currently grown in geothermal greenhouses are H_2S tolerant species, requiring less intensive CO_2 purification. The effects of hydrogen sulfide on greenhouse staff are less problematic; since, the concentrations are well below those set for US industry at 15 mg/m^3 (10 mg/kg) for an 8-hr workday and a 40-hr work week.

Non-condensable gas is typically present at 1 to 10 wt% in geothermal steam. Carbon dioxide is usually the main component, with hydrogen sulfide the next most important (approximately 1 to 5% of the CO_2 concentration). Minor components are nitrogen, ammonia, hydrogen, methane, and other gases. In this work, a geothermal steam composition of 98.6 mol% H_2O, 1.4 mol% CO_2 and 0.03 mol% H_2S was assumed. All other components were neglected. The values are typical for the main steam pipeline at Kawerau (Geothermal & Nuclear Sciences Ltd., 1992). The steam condition was assumed to be 12 bar (absolute) at saturation conditions.

ABSORPTION

An absorption process is suggested for recovery of CO_2, which will first require cooling of the fluid stream to condense the steam fraction. This heat could be used to warm the greenhouse. The water fraction remaining in the gases depends on the condensation pressure and temperature. Normally a low water fraction is an advantage, but the required heat transfer area increases enormously as full condensation is approached. Sizing of the heat rejection system is, therefore, critical to the success of such an operation and sensitivity to this parameter has been investigated.

Absorption is the uptake of gases by a liquid solvent. The equilibrium solubility determines the distribution of the absorbed material between the liquid and vapor phases. Depending on its volatility, the solvent can also appear in the vapor phase. During physical absorption, the absorbed molecules become polarized but remain chemically unchanged. In chemical absorption, a chemical conversion takes place. Equilibrium between the phases is determined by general thermodynamic principles and was predicted using theoretical models available within the ASPEN PLUS package. As yet, no comparison with between predicted and experimental data has been made; but, experience with other simulations indicates that accuracy greater than 80% can be expected for the equilibrium prediction.

In an absorber, gas and liquid are brought in contact counter currently. The solvent removes one or more components from the gas mixture, more or less selectively. Normally, the laden solvent is withdrawn from the bottom of the absorber column and freed of the absorbed gas in a recycling system. It is then returned to the absorber. In most cases reversible processes are used and the dissolved components are released chemically unchanged.

PHYSICAL AND CHEMICAL ABSORPTION

The pressure dependence of physical and chemical absorption is significantly different. Typical equilibrium lines are shown in Figure 1, where loading capacity is presented as a function of the dissolved component. Physical absorption processes generally follow Henry's Law, so the liquid mol fraction of a component depends strongly on partial pressure (line b, Fig. 1). In chemical absorption, however, the equilibrium line is sharply bowed. After chemical saturation of the solvent, only weak physical absorption takes place. At low partial pressure the absorption capacity of the chemical solvent is much higher than that of the physical solvent; whereas, at higher partial pressure the opposite applies.

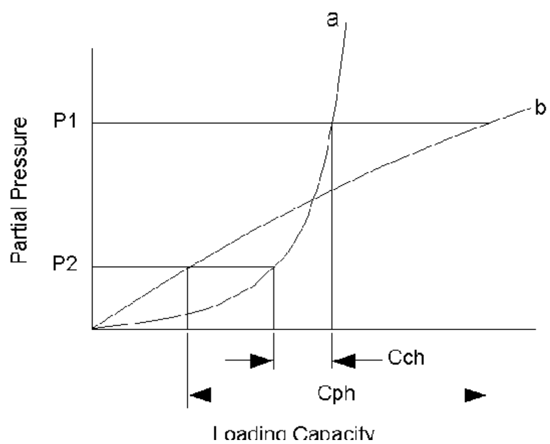

Figure 1. Equilibrium lines for chemical and physical absorption (Ullmann's Encyclopedia of Industrial Chemistry, 1989).

The strong pressure dependence of physical solubility can be utilized for solvent regeneration; since, pressure reduction releases most of the absorbed gas. However, if the dissolved components are chemically bound, less gas is released ($\Delta cch < \Delta cph$) and reboiling is almost always needed for regeneration of a chemical absorbent. Heat required for reboiling could be provided by hot geothermal fluids in this case.

In a physical absorption process, the solvent circulation rate is nearly proportional to the quantity of the gas to be cleaned. In contrast, the solvent circulation rate for a chemical process is proportional to the quantity of gas to be removed. This means chemical absorption processes are most economical with low levels of impurity; whilst, physical processes are more suitable for bulk removal of impurities. Examples of both processes have been investigated. The main difficulty is to find an appropriate absorbent that selectively absorbs H_2S.

THE PHYSICAL ABSORPTION PROCESS

Water was selected as the absorbent for the physical process, since it is cheap and freely available and H_2S and CO_2 have different solubilities in water. Unfortunately, although H_2S is considerably more soluble than CO_2, both gases are only slightly soluble in water. Relatively high circulation rates are, therefore, required. Solubility decreases with increasing temperature, so absorption should take place at a low temperature. Despite the low solubility and high flow rates in this small scale application, a relatively simple process is required, and the use of water is considered appropriate.

The flow sheet of an absorption process with water is shown in Figure 2. After condensation and cooling to 120ºC, the steam/gas fraction is separated in a flash tank at 10 bar and fed into the base of the absorber column; while, the separated water is removed for further use or disposal. Cool water fed into the top of the column absorbs the H_2S and some CO_2 as it passes downward, and purified CO_2 flows from the top of the absorber.

The gas laden absorbent is then flashed at 3 bar, releasing mainly CO_2, which is recycled into the absorber column by the compressor. Without recycling, much of the CO_2 would be lost with the H_2S. Flash regeneration alone is not sufficient to achieve the required CO_2 purity so a steam heated regeneration column is used as a final stage. At 133ºC, almost all the absorbed CO_2 and H_2S are released in this column and a water purity of 0.5 ppb H_2S is achieved. Heat needed for regeneration could be supplied using the heat exchanger in which the inlet steam is condensed; however, low cost steam is available and direct injection of steam seems appropriate. Finally, the water stream is recycled to the absorber after rejecting heat to the greenhouse.

Unfortunately, the process as presented cannot reduce the H_2S to 40 ppm, due to a limitation on the purity of the regenerated water. This process can remove H_2S from the CO_2 down to 400 ppm so residual H_2S must then be removed using an appropriate adsorption process. It is possible to achieve a CO_2 purity of 99.997 % (40 ppm H_2S) with a more complex absorption process using water, but the high water flow rates and heat loads are unlikely to be economical.

Production of approximately 20 kg/hr CO_2 requires an inlet steam flow of 1200 kg/hr (~40 kg/hr CO_2). After initial separation 37 kg/hr CO_2 is passed to the absorber, where 22 kg of CO_2 are recovered, at a water flow rate of 4000 kg/hr. About 0.5 kg/hr of H_2S is removed, reducing H_2S content from 1.4% to 400 ppm. Unrecovered CO_2 is removed with the H_2S. The predicted power requirement is 4.3 kW, made up of water pump power (3.3 kW - efficiency 30%) and gas recycle compressor power (1.0 kW - efficiency 72%). The CO_2 recovery rate increases if the flash tank pressure is reduced (or temperature increased); but, water circulation rates and compressor power increase significantly. Regeneration requires 800 kg/hr steam to heat the circulating water to 133ºC so approximately 1250 kW_{th} of heat is removed from the steam in total. It is anticipated that a reasonable proportion of this heat can be used in the greenhouse.

One major constraint is the need to condense inlet steam in the presence of very high levels of non-condensable gases. This would require a large heat exchanger area and careful attention to heat exchanger design. A range of higher condensing temperatures have, therefore, been considered; with

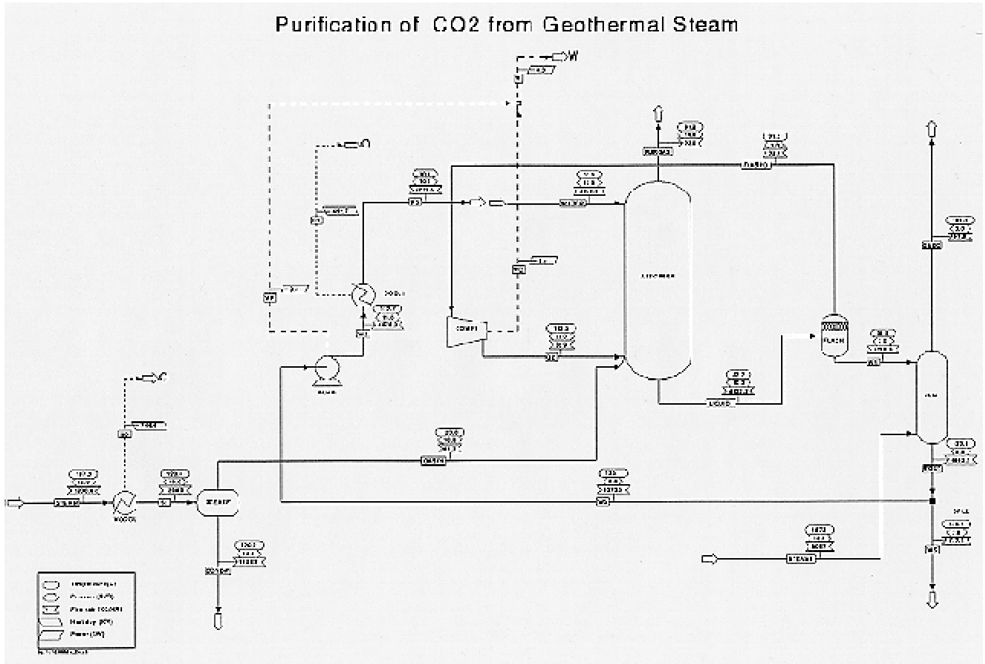

Figure 2. Flow sheet arrangement for absorption process with water.

absorber inlet temperature varied between 24 and 50ºC. The influence on the required water flow rate, electrical power requirement, flow rate of regeneration steam, and water cooling load can be seen in Figure 3. Production of purified CO_2 increases by about 10% as the temperature increases from 24 to 50ºC.

Gas solubility decreases at higher temperatures; so, the absorber flow rate and regenerator steam flow both increase with temperature. Pump power increases correspondingly, although higher pump efficiency is predicted for larger pumps; hence, the change in power curve slope at 32ºC. The cooling load also increases; but, due to an increased temperature difference, the heat transfer area is reduced. Purified CO_2 production increases slightly at higher temperatures; since, less CO_2 is absorbed with the H_2S.

TEMPERATURE OF GAS INLET STREAM

The heat exchanger area required for condensing the inlet steam depends on the outlet temperature. Lower temperatures require disproportionately larger areas; as, the non-condensable gas partial pressure rises in the condenser. Sensitivity to this parameter was tested by varying temperature in cooler from 70 to 170ºC.

As the water saturation temperature is approached (10 bar - 180ºC), the steam fraction increases significantly, heating the bottom stage of the absorber column (Fig. 4). The increased temperature reduces CO_2 absorption and production of purified gas increases. More gas is recycled, increasing compressor power slightly. The cooling load reduces and the required heat exchanger area is greatly decreased due to the a higher temperature difference and higher water fraction in the non-condensable gases. Because the electricity costs increase significantly for a small increase in purified gas flow, it is advisable to reduce the gas inlet temperature as far as possible within economic limits imposed by the cooling load.

REQUIRED CARBON DIOXIDE PURITY

The purity achieved in the absorption process determines the costs for the second purification stage, which is an adsorption process. Water flow rates decrease significantly if higher H_2S levels in the purified CO_2 are specified. Compressor and pump power also reduce (Fig. 5). For example, the power requirement decreases from 4.3 to 2.9 kW if a CO_2 purity of 99.90% instead of 99.96% is acceptable. Furthermore, the flow rate of purified CO_2 increases if higher H_2S levels are specified; since, less CO_2 is absorbed with the H_2S. Increasing the H_2S level from 200 to 1500 ppm provides over 50% more CO_2. Obviously it is important to carefully evaluate the required CO_2 purity for the first stage.

SIZE OF ABSORBER AND REGENERATION COLUMN

The vessel sizing option of the ASPEN PLUS program has been used to estimate vessel size. For the base process described, an absorber column size of 1.5 m height and 0.27 m diameter with a random packing of 1-inch plastic pall rings would be sufficient. Pressure drop in the column is negligible due to the very low gas flow rate. The regeneration column requires a larger diameter (0.47m), due to the higher flow rate, once again assuming random packing with 1-inch plastic pall rings. A packing height of 1 to 1.5 m is expected to be sufficient. These values show that the vessels are relatively small and pipes could probably be used to construct the columns, keeping costs down.

CHEMICAL ABSORPTION PROCESS USING MDEA

Chemical absorption of unwanted hydrogen sulfide was also investigated. Several solvents are available, and aqueous amine solutions have been used extensively in the oil and gas industry (Ullmann's Encyclopedia of Industrial Chemistry, 1989). In this horticultural application selective removal of H_2S is important. Good selectivity is shown by tertiary

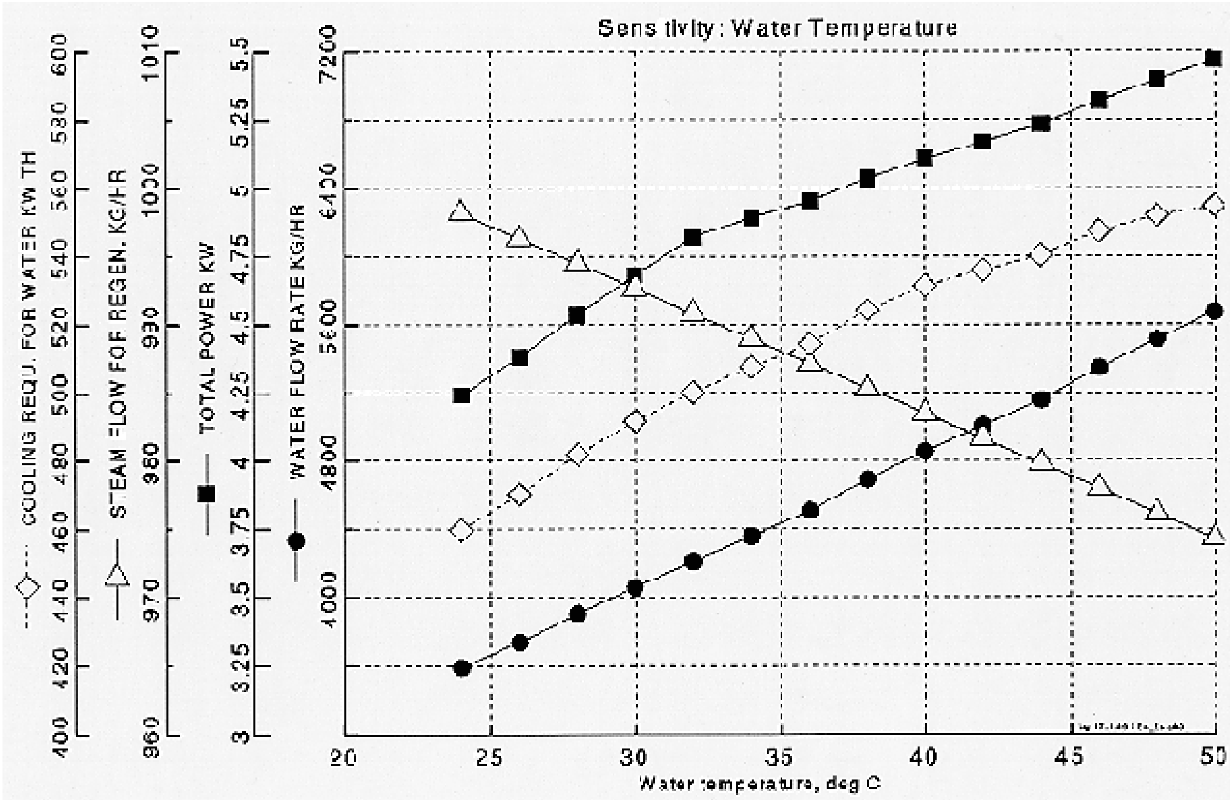

Figure 3. Influence of water temperature on mass flow rates, cooling load and power requirements.

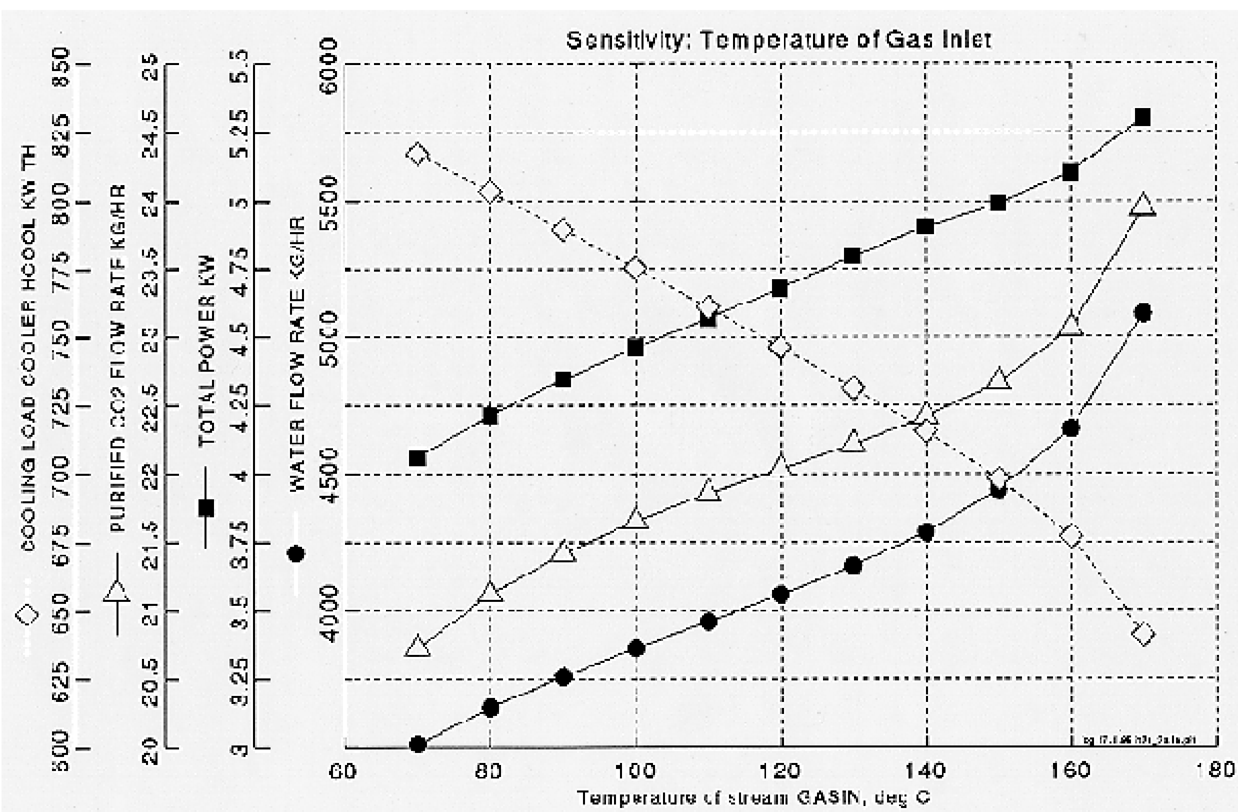

Figure 4. Influences of gas inlet temperature on water flow rate, power requirements, condenser cooling load, and purified CO_2 flow rate.

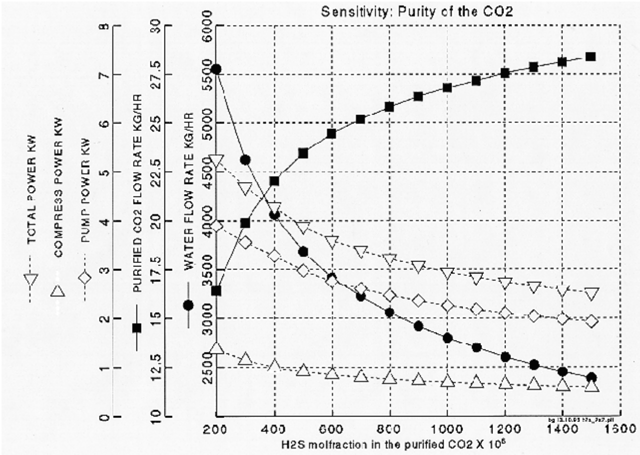

Figure 5. Influence of the specified H_2S fraction in the purified CO_2 on the absorption process.

alkanol-amines (Ullmann's Encyclopedia of Industrial Chemistry, 1989; Savage, et al., 1986), of which the most commonly used is an aqueous solution of n-methyldiethanolamine (MDEA). Chemical equilibria for the MDEA solvent were calculated using the ASPEN PLUS built-in data bank. Typically MDEA concentrations of 2.5 to 4.5 mol per liter are used for acid gas absorption (Kohl, et al., 1995). For this simulation a 4 M aqueous MDEA solution (27% by weight) has been chosen.

An H_2S concentration of 1000 ppm in the purified CO_2 stream has been specified for this process. Residual H_2S is then removed in an appropriate adsorption process, as for the physical absorption process. Although higher purities can be achieved, a very high heat duty is required for solvent regen-eration. Furthermore, as CO_2 is absorbed with the H_2S it becomes difficult to selectively recover CO_2.

The flow sheet for the simulated absorption process with MDEA is shown in Figure 6. This process is similar to that used for physical absorption with water with the following modifications:

- Inlet steam (and gas) is condensed at 2.5 bar and 100°C, as a lower absorber pressure is acceptable;
- Absorber column temperatures are higher and the MDEA solution enters the column at 70°C;
- Purified CO_2 is cooled to 60°C in a gas cooler and condensed water is separated out. This step was included for satisfactory simulation of the H_2S fraction in the purified CO_2, as the high water fraction in the absorber gas outlet results in a low H_2S mol fraction. In practice, this step may not be necessary;
- The flash tank is slightly heated to improve CO_2 recycling to the absorber; as, pressure reduction alone is not sufficient;
- Regeneration of the chemical solvent requires the use of a true reboiling process; where, the solvent is evaporated and stripped with its own vapor, rather than heating directly with steam containing H_2S, and
- Water lost from the solvent in the gas outlet stream is replaced by make-up water at a temperature of 30°C before recycling to the absorber.

Compared to the absorption process with water the main differences with MDEA are:

- Absorbent flow rate is substantially lower with 785 kg/hr required, compared to more than 4000 kg/hr;
- The pump and compressor are much smaller due to the lower flow rate and the reduced pressure differences. The power requirement is 0.4 kW, about 10% that of the water system, and capital cost will be lower;
- Regenerator heat loads are relatively high (780 kW) at the required purity (~50 ppm H_2S). This heat load could be met by condensing about 1200 kg/hr steam, so initial condensation of the inlet steam/gas mixture could supply the regenerator. Ultimately, most of this heat is rejected from the regeneration column at lower temperatures (~100°C) and much of it could be used in the greenhouse;
- The circulating solvent requires just 26 kW of cooling to achieve the required temperature of 70°C;
- The temperature of the purified gas is relatively high at 87°C, and
- Approximately 11 g/hr MDEA are lost in the waste gas outlet stream. Cooling the outlet stream and recycling the condensate can reduce this loss significantly. Only trace amounts of MDEA are expected in the purified CO_2. Condensed water from the purified CO_2 stream should be recycled as it contains 120 ppm MDEA.

The MDEA absorption process has the advantage of lower circulation rates, lower electricity demand, lower pressures, and higher cooling temperatures. The disadvantages compared with the water absorption system are a higher heat requirement, lower CO_2 purity and minor losses of MDEA.

ADSORPTION PROCESS FOR FURTHER PURIFICATION OF THE CO_2

Purities achieved with either of the absorption processes discussed are not sufficient for direct use of the CO_2 in greenhouses. Further purification is, therefore, required to reduce H_2S concentration from 400 or 1000 ppm to 40 ppm or less. Approximately 5 to 20 g/hr of H_2S has to be removed in this final step, so a simple solution is an adsorption process without adsorbent regeneration. The advantages of an adsorption process are high selectivity and a loading capacity that is almost independent of partial pressure.

Selective adsorption of H_2S can be achieved using activated carbon. The loading capacity of 50-min activated coconut-shell charcoal for H_2S is approximately 10 to 25 % by weight (i.e., 1 kg of activated charcoal can adsorb 100 to 250 g of H_2S) (Kohl, et al., 1995). Other activated carbon products are expected to have similar capacities. Assuming a loading capacity of 10%, approximately 25 to 100 g/hr

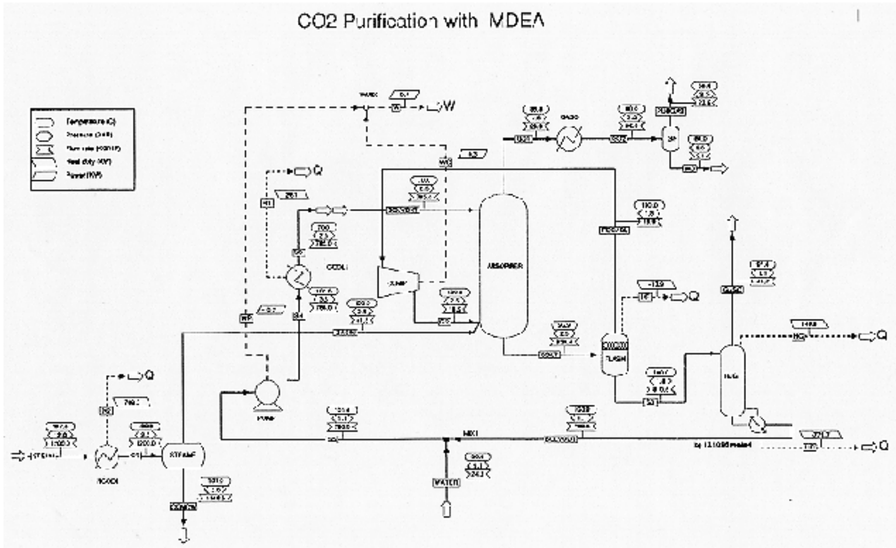

Figure 6. Flow scheme for chemical absorption with MDEA solution.

activated carbon would be required for final purification of CO_2 that had been pre-treated in one of the absorption processes. The costs of activated carbon products are 0.70 to 5.50 $US/kg (Encyclopedia of Chemical Technology, 1992). Material costs for this adsorption process are, therefore, relatively low. However, the operating cost involved in exchanging the activated carbon filters should be considered.

Assuming electricity costs of 0.07 $US/kWh and a cost of 3.5 $US/kg activated carbon, the total costs are approximately 0.40 $US/hr for the process with water and 0.35 $US/hr for the process with MDEA. The costs for both methods are similar because the achieved purity with the MDEA process is lower than that achievable with the water process, increasing the activated carbon consumption. The value of the purified gas is approximately 8.4 $US/hr or 70,000 $US/year, which is many times greater than the costs calculated above (approximately 3,500 $US/year).

The required quantity of activated carbon depends on the purity achieved by the absorption process and an economic optimum for the combination of both processes requires careful further study.

CONCLUSION

The use of geothermal carbon dioxide for growth stimulation of plants is possible, if a purification process is used to reduce the initial hydrogen sulfide content. Alone, an absorption process using water or aqueous MDEA is not feasible at the required purity. However, both processes are suitable for bulk removal of H_2S and it is possible to remove residual H_2S with an activated carbon adsorption process.

Power requirements for purification of 20 kg CO_2/hr are relatively small: 4.3 kW for physical absorption with water and 0.4 kW for chemical absorption with MDEA. Activated carbon consumption is approximately 20 to 100 g/hr. Running costs are approximately 0.40 $US/hr for the physical process with water and 0.35 $US/hr for the chemical process with MDEA. The product value is about 8.4 $US/hr; so, either of these combination processes appear economically attractive compared to current use of bottled CO_2.

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GREENHOUSE CLIMATE FACTORS

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INTRODUCTION

There are many examples of geothermally heated greenhouses throughout the world, even in warmer climates. The main reason for using geothermal heating systems is that greenhouses are one of the largest energy consumer in agriculture. This concentrated demand for energy can be satisfied, in the case of geothermal, by siting facilities near wells even though they are located far from urban areas and industrial concentrations.

The reasons for this high energy requirement are in the nature of the greenhouse construction itself:

- Greenhouses are typically constructed of light materials that have very poor insulating qualities, and

- The "internal" climate of the greenhouse are usually significantly different than the external one, especially during the colder seasons.

GREENHOUSE CLIMATE

One of the main tasks in greenhouse construction is to optimize the conditions for plant development, generally during the off-season from normal outside field production. The "internal" or greenhouse climate factors required for the optimal plant development involve photosynthesis and respiration.

Photosynthesis, or the active process, is the formation of carbon dioxide through solar radiation and can be expressed by the following simplified balance equation:

$$6CO_2 + 6H_2O + 2{,}810 \text{ kJ} = C_6H_{12}O_6 + 6O_2 \qquad (1)$$

On the contrary, respiration is expressed as:

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + 2{,}810 \text{ kJ} \qquad (2)$$

These equations do not represent the real situation, which is more complicated, but can be used to define the energy aspect of greenhouse climate: the water transport, CO_2 separation and energy intake, along with the creation of chlorophyll and O_2 that result from the natural or artificial application of light.

It is not possible to understand greenhouse energy demands in order to calculate heat (or coldness) requirements, without the essential knowledge of the "greenhouse climate." This climate is composed of parameters that are variable and interdepedndent, and are influenced by external climate changes, the stage of the plant development and other factors.

In principal, four physical phenomena are responsible for the differences between greenhouse and external climatic conditions:

1. Solar radiation, in particular the short waves, penetrates the glass or plastic covering of the greenhouse practically without any loss. On reaching the soil surface, plant canopy, heating installation, etc., the radiation changes to long-wave, and can no longer pass through the covering, or with difficulty. Most of the radiation is trapped within the greenhouse space, raising the inside temperature;

2. The enclosed air within the greenhouse is stagnant: local air velocity is much smaller than it is outside and the effects of temperature transfer are entirely different;

3. The concentration of plant mass in the greenhouse space is much higher than outside. Artificial control of humidity and condensation clearly creates a different mass transfer from outside the greenhouse, and

4. The presence of heating and other installations changes some of the energy characteristics of greenhouse climate.

Taking into account the real meaning of the equation (1) and (2), and the associated physical phenomena, it is possible to simplify the definition of greenhouse climate and to state that it is a physical process of predominantly energy related character. The main processes are the water transport between the plant canopy, air and soil in the greenhouse, the chlorophyll composition and degradation under the influence of solar light, energy transfer, and CO_2 and O_2 flow.

The values of these parameters, their interdependencies and changes determine the limiting conditions and character of greenhouse climate.

LIGHT

Light is the most significant parameter for the plant development and life. All the active life process in it can be achieved only in the presence and active influence of light.

When speaking about natural light, meaning solar light, it is necessary to distinguish:

- Solar radiation with specific influence to the life processes of the plants, and

- Solar radiation with energy related influence to the plants, directly or indirectly through the influence of the environment.

By the use of different scientific methodologies and investigations of changes in photosynthetical, phototropical, photomorphogenical and other plant activities, it is found that only the part of total solar spectrum between 400 and 700 nm influences significantly plants life processes (Figure 1). That determines the quality of transparent materials for greenhouse cover– it must be maximally transparent to this part of the solar spectrum.

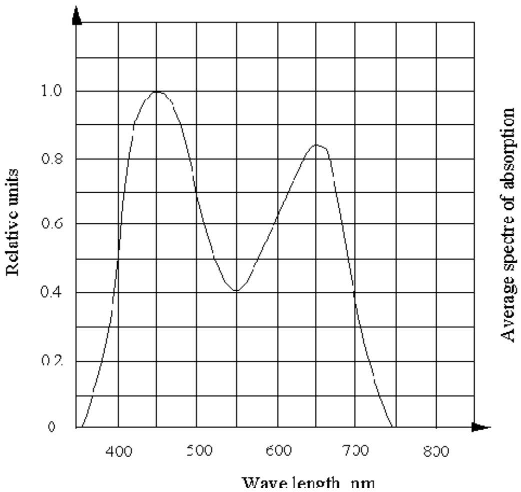

Figure 1. Average specter of absorption "in vitro" of chlorophyll pigments (Dogniaux & Nisen, 1975).

The intensity of the energy related part of the total spectrum of solar radiation (i.e., the infra-red one) offers the necessary energy to the plant (Equation 1). Depending on its intensity, life processes are more or less active (Figure 2). Up to some characteristical levels (different for different species) life processes increase their activities; but, after a point, they start to decrease. Below and above these characteristical light intensities, there is no life activity in the plant. Below, because active life processes need light to be activated. Above, because the plant is over- heated and processes of "cooling" are activated.

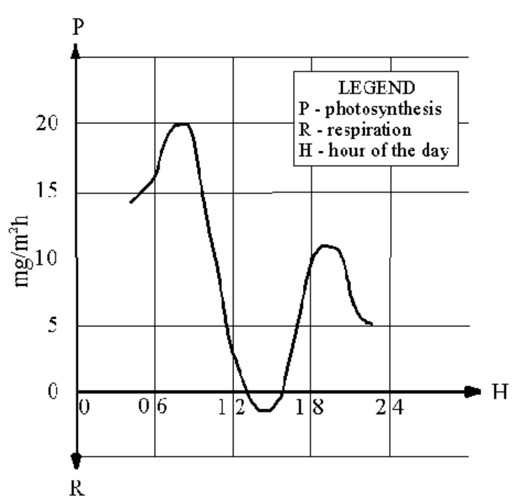

Figure 2. Changes of photosynthetical activity during the summer day (Kamenev, 1975).

To improve light conditions, artificial light is used when the natural one is not available, or shaded when the light intensity is too high.

Light intensity also affects the values of other parameters of greenhouse climate.

AIR TEMPERATURE

Air temperature influences the energy balance of the plant canopy through the convective heat transfer to the plant leaves and bodies. Depending on the character of the air movement in the greenhouse, it is more or less near the temperature of the plant itself.

The optimal level of the air temperature in the greenhouse depends on the photosynthetical activity of the plant in question, under the influence of the intensity of solar radiation on disposal (Figure 3) (i.e., for each light intensity, there is an optimal air [leaf] temperature, enabling maximum photosynthetical activity).

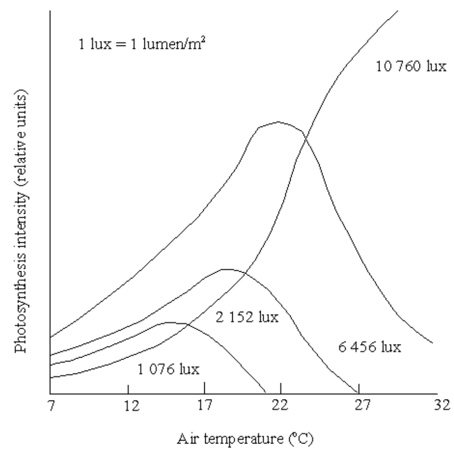

Figure 3. Photosynthesis activity vs. light and air temperature conditions (tomato culture)(Kamenev, 1975).

Due to the changeable character of greenhouse climate, it is not possible to provide the "optimal" air temperature for some plants due to interdependencies of the light intensity and other parameters of greenhouse climate.

Trials to define norms for optimal temperature values or intervals should not be understood as a tool for determination of optimal greenhouse climate (Table 1), but as a basis orientation for the choice of design values for calculation of greenhouse heat requirements and consumption.

SOIL OR PLANT BASE TEMPERATURE

Soil, or plant base temperature influences the energy balance of the plant canopy, too. The influence is by conduction heat transfer directly between the soil structure and through convection between the plant roots and water flow around them.

Through a great number of experiments and investigations, it is proven that:

- Optimal soil (or base) temperature depends on the stage of development of the plant in question (Table 2);

Table 1. USSR Norms for Optimal Values of Air Temperature and Humidity in Greenhouses for Vegetable Cultivation (Source: Kamenev, 1975)

	Inside Air Temperature (°C)							
		Development			Harvesting			Relative Humidity of the Air (%)
Vegetable	Germination	Day*	Day*	Night	Day	Night	Young Plants	
Cucumbers	17-18	22-25	27-30	17-18	25-30	18-20	13-15	85-95
Watermelon and melons	17-18	22-25	27-30	17-18	25-30	18-20	13-15	65-75
Tomatoes, apple, paprika, and beans	10-12	20-22	25-27	10-13	22-28	15-17	8-10	50-60
Lettuce, celery and garlic	8-9	17-18	20-26	8-12				70-80
Spinach and parsley	8-9	15-16	20-21	8-9				70-80
Radish and cabbage	6-7	12-13	16-18	7-8				65-75

* Inside design temperature ranges for different crops.

- Optimal soil (or base) temperature depends on the light intensity available, and
- Soil (or base) temperature influences the value of the optimal air temperature (i.e., higher soil temperature requires lower air temperature and vice versa).

Table 2. Optimal Soil Temperatures for the Tomato Culture

	Optimal Soil Temperature Intervals	
Phase of Development	Low Intensity of Light (°C)	Strong Intensity of Light (°C)
Development before flowering	13-14	17-20
Flowering	15-16	19-22
Harvesting	20-22	23-25

It is necessary to stress that moving away from the optimal values influences the development of the root system of the plant, in the production capacity and the quality of the product. Going to lower values means decreasing production and going to higher values means drying of the root system, and in that way also reducing the production capacity and quality of the products.

Thus, if knowing the nature and requirements of plants, it is possible to influence significantly the heat consumption of a greenhouse through the balance between the air and soil temperatures during the plant cultivation.

CO_2 CONCENTRATION

Normal CO_2 concentration in the atmosphere is about 0.03%. In the case of a closed room under influence of high light intensity and, therefore, high photosynthetical activity (Equation 1), it changes quickly. During a bright day, its concentration can decrease to 0.01% in only a couple of hours for a good tight greenhouse.

As the CO_2 is an active participant of the chlorophyll assimilation, it is a greenhouse parameter of crucial importance. Also through a long process of experimentation and investigation, it is proven that:

- For constant temperature conditions in a greenhouse, CO_2 concentration influences directly the intensity of photosynthetical activity, and

- Optimal concentration of CO_2 in the greenhouse depends directly on the light intensity on disposal (Figure 4).

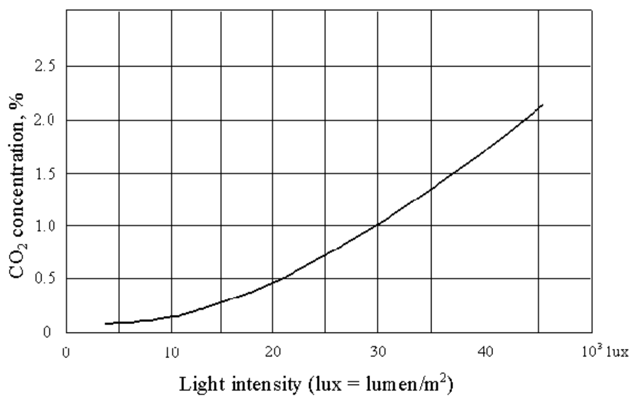

Figure 4. Optimal concentration of CO_2 in the cultivation area of a greenhouse depending on the light intensity (Denis, et al., 1978).

Through the ventilation of greenhouse closed space with 5-6 (vol/h) air exchange, it is possible to keep about a 0.02% CO_2 concentration. It is a compromise, because going to 9-10 (vol/h) exchange enables one to keep about a 0.03% concentration, but this influences significantly the heat consumption of the greenhouse. Middle- and northwest-European climatic conditions require the use of artificial measures to keep the necessary optimal CO_2 concentration; but, in the southern regions, usually controlled ventilation is sufficient.

AIR MOVEMENT IN THE GREENHOUSE

The character and velocity of the air movement in the greenhouse influences:

- The intensity of the heat transfer between the air and plant canopy, and

- The intensity of the water exchange between the air and plant canopy.

At the same time, both processes are directly connected to the energy balance of the plant canopy and, in that way, the intensity of the life processes in it.

It is found that velocities between 0.2 and 0.7 m/s provides the optimal heat exchange if the air stream is vertical (i.e., from bottom to the top of the plant). With some types of heating installations, it is easy to obtain this; but, with most of them, it creates a negative influence in the heat consumption of the greenhouse. Before making the final choice of the heating installation for a greenhouse, it is very important to investigate its positive and negative sides connected to the character of air movement in the greenhouse interior.

WATER TRANSPORT IN A GREENHOUSE

Water transport between the plant canopy and the environment is one of the most important parameters of the photosynthetical activity (Equation 1). It has been proved that it depends mainly on:

- The light intensity on disposal (Figure 5);

- Temperature of the environment (Figure 5), and

- Root characteristics of the plant in question in combination with the "ability" of the cultivation base to offer the necessary water quantity, but also on the air humidity of the plant environment.

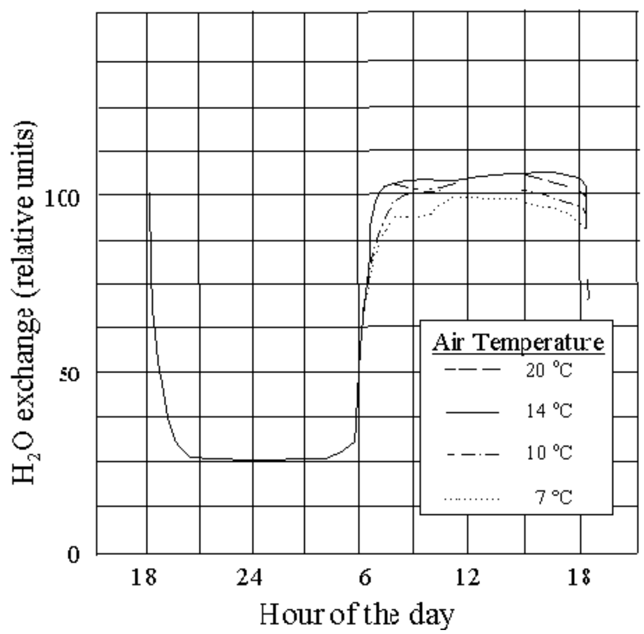

Figure 5. H_2O exchange of tomato plants before flowering.

The last parameters are of particular interest, since they influence the greenhouse climate characteristics. There is a direct relationship between the air humidity and soil moisture (or artificial cultivation base characteristics) in a greenhouse.

Air humidity directly influences transpiration of the plant leaves. Optimal intervals are rather small and difficult to be achieve in a closed room, filled with crops of high transpiration (Table 1). Lower humidity means drying of the plant and reduced production. Higher humidity produces more leaves, lower quality of fruits and sensitive to a number of plant diseases.

The intensity of the water transport of the plants depends directly on the light intensity (Curve ETP outside (light conditions), Figure 6). It is normally smaller in greenhouses and is connected to the light transmittance of their material (Curve ETP inside (light conditions), Figure 6). Depending on the stage of the plant root development and air humidity in the closed room, real water transport is smaller even than the inside one (Curve actual ETP, Figure 6).

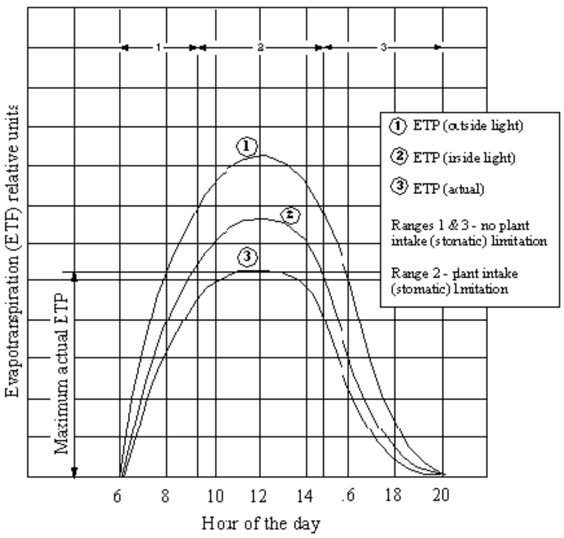

Figure 6. Potential evapo-transpiration (ETP) in a greenhouse (Dogniaux, Nisen, 1975).

HEATING INSTALLATION

Heating installation is an active parameter of the greenhouse climate because it influences:

- The character and velocity of the internal air movement (Figure 7);

- The radiation intercepted by crops by exposure pipe view factor to the heating elements, and in that way, tempera-ture distribution of the plant leaves (Figure 8), and

- Vertical and horizontal distribution of internal air temperatures (Figure 9), and the effect on the plant leaves temperatures.

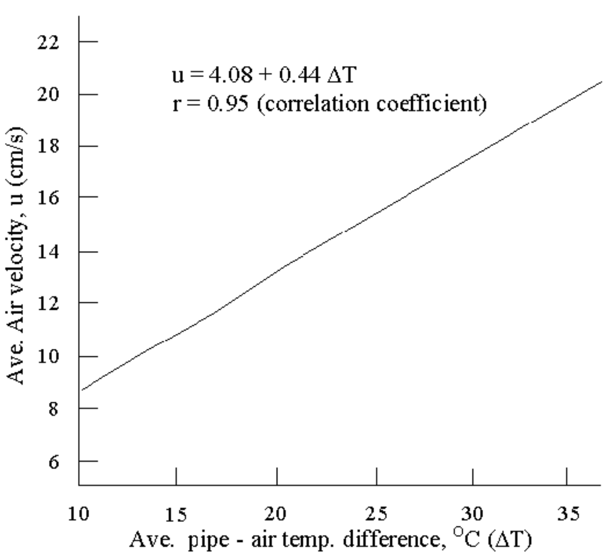

Figure 7. Internal air velocity as a function of temperature difference between the pipe surface and the air (Slanghellni, 1983).

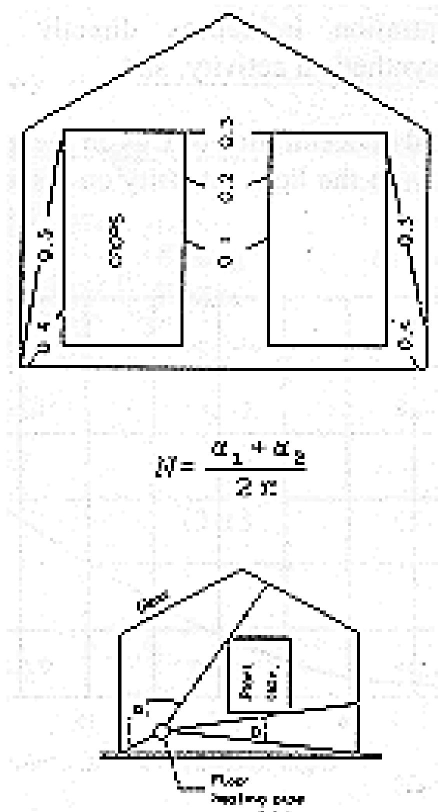

Figure 8. Effect of radiation interception by crops on the pipe view factor of heating pipes (Okada and Takakura, 1978).

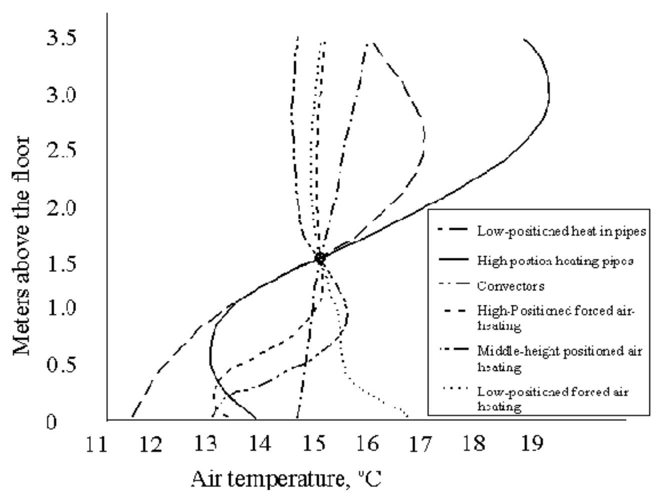

Figure 9. Vertical air temperature profiles in a greenhouse heated by different types of heating installations.

The type and location of the heating installations influences the temperature distribution and internal air movements (i.e., energy distribution and water transport of the plant canopy), which ultimately impacts the intensity and distribution of the photosynthesis.

ENVIRONMENT

The environment of a greenhouse includes the outside air, atmosphere and soil around it. Since the greenhouse climate is enclosed by transparent partitions, it is actively influenced by the outside environment.

A transparent wall has no (or very small) thermal inertia and each change of outside temperature conditions directly influences the ones in the greenhouse. The wall is transparent to a significant part of the solar radiation spectrum, and each change of it means a change of the inside climate conditions. Numerous leaks and the ventilation openings allow the outside air to enter in the greenhouse. Each change in velocity and direction changes directly the temperature distribution in the greenhouse. During the night and cloudy days, the atmosphere radiates "coldness" to the greenhouse interior and changes the temperature distribution of the plant canopy. Exposed parts are always colder than non-exposed ones (Figure 8).

OPTIMAL GREENHOUSE CLIMATE

When taking into account Equation 1 and the known dependence of the plant life processes on the light composition and intensity, the "greenhouse" climate is a rather simple physical quantity:

$$GK = F(I, T_a>, CO_2, H_2O) \qquad (3)$$

where:
I = Light intensity (W/m^2, lumens)
T_a = Plant leaves temperature (K)
CO_2 = CO_2 concentration in the air around the plant canopy (%), and
H_2O = Internal air humidity and soil (plant base) humidity (i.e., moisture) (%).

Temperatures and partly the light are quantities of an energy nature and the others are not.

For each plant and its stage of development, it is possible to define the optimal values of influencing parameters, and then it is necessary to keep them constant. That should result in maximum production results and quality of the fruits and flowers. In a number of laboratories, it has been experimentally proven that this way of thinking is a correct one.

Unfortunately, it has also been proven that it is difficult to make a profit. Even distribution of light with a defined spectrum and intensity means extremely expensive lightening installation and high development costs. The solution is in the use of natural light when available. Even distribution of temperatures in the plant canopy means very expensive insulated partitions between the cultivation room and the environment, and the use of expensive air-conditioning installations. The solution is in the use of natural heat on disposal (solar radiation) and the use of acceptable cheap heating installations.

The general solution using transparent partitions between two climates has been accepted. It allows the capture of the available natural light and particularly the energy part of it.

Unfortunately, such a partition cannot be a real barrier between two different climates. It allows light, heat and air transfer between them and, in that way, makes them interdependent. The outside climate becomes an active participant in the creation of the inside one.

With such pre-conditions, a rather simple physical quantity composed of three parameters (T_a, CO_2 and H_2O) which are depended on the fourth one (I) with known characteristics, becomes extremely complicated. Even nonenergy parameters change the character of energy producing ones. For example, to keep the necessary CO_2 concentration, it is necessary to ventilate the greenhouse (heat loss) or to produce it in an artificial way (heat gain); to keep the necessary air humidity, it is necessary to ventilate the greenhouse (heat loss or gain) or to make artificial humidification (heat loss); etc. Optimal CO_2 concentration depends on the light intensity and temperatures. Higher temperatures--higher CO_2 concentration (i.e., additional ventilation and temperature drop as a consequence of the outside colder air). Higher inside temperatures provoke stronger photosynthesis activity, which means higher plant transpiration (i.e., higher air humidity) then necessary and requiring additional ventilation, which means temperature drop (additional heating is necessary).

These make the greenhouse climate a complicated physical quantity with the following characteristics:

- Composed of the long list of parameters of the inside and outside greenhouse environment. They are interdependent between themselves in very different and often opposite ways;
- All the involved parameters are directly or indirectly of an energy nature. They cause or are the reason for creation of energy transfers in the greenhouse and to its environment, and
- Taking into account that all the parameters which are directly involved in the process of photosynthesis depend on the light characteristics and intensity, greenhouse climate is of a changeable nature:

$$GK = F(t) \qquad (4)$$

Two very important conclusions can be extracted from that:

- The composition of optimal conditions for the plant development ("optimal greenhouse climate") involves a long list of influencing parameters with different influence on the crucial ones and different inertia to the short-time changes of light conditions on disposal. Therefore, one can speak not about "optimal climate," but about "optimal compromise" of influencing factors to the plant life conditions, and

- Even if the nature and interdependencies of the parameters of the greenhouse climate are known, it is not possible to define a final mathematical expression of it because some illogical "estimations" are involved.

  They cause the following consequences:

- One dimensional mathematical expression of "greenhouse climate" and, therefore, "optimal greenhouse climate" doesn't exists. It is always a set of expressions defining different physical quantities of known mutual interdependencies, and

- Composition of the optimal compromises is always connected to a chosen number of influencing parameters, in order to simplify the calculations and the selection of installations and equipment for the greenhouse climate creation. Usually, that is the internal air temperature, CO_2 concentration and air humidity, which depend on the light intensity available. The necessary corrections, connected to the plant, construction, installations and local climate specifics are determined by empirical simulations, based on the previous investigations.

It is very important to always have in mind that even the greenhouse climate is composed of energy parameters and, therefore, it is of an energy nature. Its real nature is biological and complex.

Any mathematical expression of it gives only an approximation. It is never, and cannot be complete and precise.

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Section 10
FARM BILL INFORMATION

INTRODUCTION

The Farm Security and Rural Investment Act of 2002 (the Farm Bill) established the **Renewable Energy Systems and Energy Efficiency Improvements Program** under Title IX, Section 9006. This program currently funds grants and loan guarantees to agricultural producers and rural small business for assistance with purchasing renewable energy systems and making energy efficiency improvements.

This section includes two templates that were developed in 2006 to help with the Farm Bill application. One is for the direct-use of geothermal and the second one is for a geothermal heat pump application.

A link has been provided below for more information on the Farm Bill.

http://www.rurdev.usda.gov/rbs/farmbill/

Fizer Dairy Geothermal Heating

A Proposal Prepared for the United States Department of Agriculture
2002 Farm bill Initiative: The Renewable Energy And Energy Efficiency Program
USDA Farm Bill Section 9006

For Purchase and Installation of a Renewable Energy System at the Fizer Dairy Farm in Berger Idaho

This template has been prepared as a guide to allow users to see the type of information required to receive grant funding from the USDA Section 9006 program. This template uses fictitious names, dollar values and project descriptions. It was prepared as an example of what a complete proposal submitted to the USDA under the Renewable Energy Systems guidelines might look like. This template was not prepared by and has not been approved or scored by the USDA.

The project described in this proposal is for purchasing and installing a Renewable Energy System. If this project was being considered as an Energy Efficiency Improvement project, it would require slightly different information, including an energy efficiency audit.

February 2006

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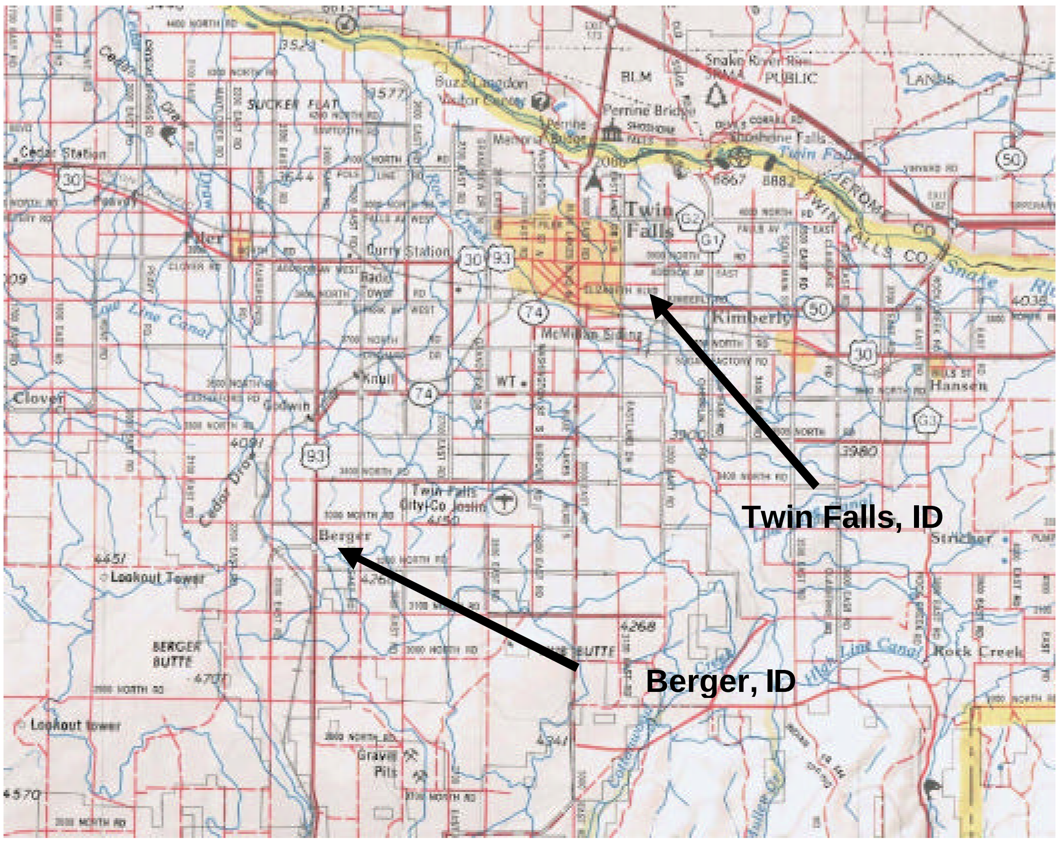
Fizer Dairy Geothermal Heating

Project Summary

This project, entitled Fizer Dairy Geothermal Heating, seeks to decrease some of the Fizer Dairy's high-energy costs by using the geothermal resource found on the farm located in southern Idaho near the town of Berger (population 134) about 6 miles southwest of Twin Falls, Idaho. The project is for the purchase of a renewable energy system and geothermal components necessary to supply hot water for our dairy operations.



The geothermal resources in this area are well known and documented in a number of studies, but they have not been widely used for industrial processes. Over 100 high yield irrigation, stock and domestic wells, ranging in temperature from 20 - 84°C (68 - 182°F) and in depth from 200 to over 3,000 feet, have been drilled in the area. Fresh vegetables are produced in greenhouses near Berger. Warm water fish species are bred locally in cooling ponds. Most water is used for irrigation, although there is some space heating of homes. This project involves drilling a supply and an injection well and installing equipment to heat process water and buildings at the Fizer Dairy.

We believe that we will experience significant financial savings by using the geothermal resource in our dairy operations. Recognizing the potential cost savings involved with the use of geothermal energy we plan to use the geothermal resource for:

1. Cleaning our facilities, and processing equipment.
2. Space heating and cooling all the buildings on our dairy operation.

3. Installing pipes under the driveway to melt snow where milk haulers will come daily to transport our milk to a producer.

The engineering study indicates that the annual heating energy required to heat the buildings (does not include driveway heating) is 426 million BTU's which is 4,259.9 therms. At today's natural gas costs of 1.255 $/therm this project would reduce the Fizer Dairy Farm natural gas bill by approximately $5,346 a year. Given the rising cost of natural gas, these savings are expected to increase in years to come. The local natural gas supplier, Intermountain Gas, has applied to the Idaho Public Utilities Commission for permission to raise natural gas prices 28% effective October 1, 2005.

This project will be designed and engineered to meet the intended purpose of providing heat to the facility, and it will meet all applicable public safety regulations and laws.

Total project cost is estimated to be $81,889. The implementation of this project hinges on receiving a grant in the amount of $20,472 (25% of the total project cost) from the USDA's Renewable Energy/Energy Efficiency Improvements Program (Section 9006). The estimated timeframe for project completion is approximately 5 months from the date Mr. Fizer signs the grant agreement and the funds are obligated. A detailed project timeline which covers planning, permitting, construction and startup is included with the technical section of this application. The anticipated operational date for the geothermal system is April 2006.

Eligibility

Applicant Eligibility

Willard Fizer and his wife Edith function as the sole owners of Fizer Dairy Farm. The Fizer's two sons, Michael and Patrick Fizer, assist with daily operations and maintenance of the dairy. Fizer Dairy Farm exists as a sole proprietorship. No parent, subsidiary or affiliate organizations involved with Fizer Dairy affect this project. Fizer Dairy is a small dairy that milks 260 cows twice a day. A milk distributor comes twice daily and picks up milk at our dairy farm and transfers it to a dairy producer.
Fizer Dairy Farms exists as an eligible applicant for the USDA Rural Development Farm Bill section 9006, "Renewable Energy Systems and Energy Efficiency Improvements Program" based on the following:

- Fizer Dairy Farm operates as an agricultural producer engaged in the production and handling of dairy products
- Mr. Fizer earns over 90% of his income from this dairy operation
- Fizer Dairy exists as a sole proprietorship
- The sole owner of Fizer Dairy, Mr. Willard Fizer, is a citizen of the United States, as are his wife Edith and two sons Michael and Patrick
- Mr. Fizer does not have any outstanding judgments obtained by the United States in Federal Court, and is not delinquent in the payment of Federal income taxes or Federal debt
- Mr. Fizer demonstrates financial need. Financial analysis shows Mr. Fizer would not be able to maintain his cash flow and income over the long term without this grant assistance. A letter from Fizer's lending institution has been included in this application. The project will not be attempted without grant assistance.
- Mr. Fizer has never applied for nor received a grant or loan from USDA or any other Federal Agency

Project Eligibility

Fizer Dairy is an eligible project based on the following reasons:

- The Fizer Dairy project will increase the efficiency of our dairy operations by utilizing the renewable geothermal energy source abundantly available on our property
- The project is for the purchase of a renewable energy system, geothermal components necessary to supply hot water for our dairy operations.
- The components proposed for this project are all commercially available, with proven operating histories, established designs and installation procedures.
- This project is located in a rural area near Berger Idaho. Berger is located in Twin Falls county (pop. 65,000) approximately 8 miles SW of the town of Twin Falls. Berger is not considered an urbanized area adjacent to any city or town with a population over 50,000.
- Willard Fizer, owner and operator of the farm, has no plans to sell the farm in the foreseeable future and fully expects to own and control the proposed project for the period required to pay off the debt incurred by the system. Once trained by the system installers on the operations and maintenance of the system, Mr. Fizer will be responsible for the operations and maintenance of the system.
- The annual revenue from Mr. Fizer's farming and dairy operation and the fuel savings from the project are sufficient to provide for the operation, management, and debt service for the life of the project
- This project will allevi ate approximately 85% of Mr. Fizer's annual natural gas utility bill.
- He will perform the routine maintenance himself and, therefore, will not have to pay for this service.

Operation Description

The Fizer Dairy operations are located on approximately 30 acres of the 360 total acres owned and operated by Willard and Edith Fizer. Willard and Edith Fizer have operated the dairy for 19 years. However, the dairy has actually been in operation for over 30 years. Prior to Mr. Willard Fizer's management, the dairy was owned and operated by his father, Robert Fizer.

Aerial view of the Fizer Dairy. Photo from Google Earth

The operation currently has approximately 400 cows, 2 enclosed buildings for milking and processing the milk, 3 silos for storing feed and multiple covered stalls and feeding areas for the livestock. Some but not all of the feed used in the dairy operation is grown at the Fizer farm which has approximately 320 acres of farmable land irrigated with a center pivot irrigation system. Standard farm equipment for planting, harvesting, storing and moving hay and grain crops are part of this farming operation. The proposed heating system will heat approximately 1800 ft^2 of enclosed space used for milking and milk processing, after which the geothermal fluid will then be used to warm 1600 ft^2 of driveway and loading area before being reinjected into the aquifer.

This is a family run dairy with occasional part time and seasonal labor help. The future plans are to turn the operation over to Willard Fizer's son Michael, when Willard Fizer retires. This dairy operation will be controlled by the Fizer family for the life of the project.

Financial Information

Fizer Dairy is a small family operated dairy that is not a subsidiary of any parent company or corporation, and does not have any subsidiary or affiliates at other locations. In 2005, the last full accounting year, the dairy had total income of $856,500 and total expenses of $795,925 with a net income of $60,575. The gross market value for agricultural products sold is $756,000 for milk products, $19,000 for calves, and $63,000 for cattle sold. Mr. Fizer and his wife Edith have no nonfarm income. A Balance Sheet, Current Year Profit and Loss Statement, and Pro Forma Profit and Loss Statement are included in Appendix B of this application. Copies of the Fizer's Federal Income Tax Returns for 2002, 2003 and 2004 are included in Appendix E of this application.
The assumptions used for the financial projections for 2006, 2007 and 2008 are:

- The dairy operation will remain the same size with no increase in livestock or milk production
- Labor rates will increase 1% per year
- Payroll Taxes will increase 1.5% in year 1, 1.5% in year 2 and 1.5% in year 3
- Operating Interest dollars will increase by 18.2% in year 1 and remain steady at $22K for the next 3 years
- Feed costs will decrease from $327K to $320K and remain steady for the next 3 years
- Property taxes will not change in the next 3 years
- Natural Gas costs will decrease from approximately $5,300 to zero
- Other utility cost will remain constant at about $25K

Cost details for these and other expenses are available in the Pro Forma Profit and Loss Statement in Appendix B,

Matching Funds

Funding for this geothermal project will come from Fizer Dairy operating Funds, a loan from Idaho Farm Credit Services, and a grant from the USDA for a purchase and installation of a Renewable Energy System. The details of the funding are presented below.

Source Of Funding	Dollar Amount	Status	Contact Information
Fizer Dairy Operating Funds	3,500	Available from Savings Account	Willard Fizer P.O. Box 6748, Berger ID (208)-526-1000
Idaho Farm Credit Services	57,917	Loan Approved	Mr. Patrick Lanley, Sr Business Analyst, Idaho Farm Credit Services, P.O. Box 1625, Idaho Falls, ID 83415, (208) 526-1000
USDA 9006 Grant	20,472	Pending Award of Grant	Mr. John Farmer, Business Program Specialists, USDA Rural Development, 725 Jensen Grove Drive, Blackfoot, ID 83221 (208)-785-5840

Total Project Cost 81,889

Project Cost

The proposed modification and upgrade to the Fizer Dairy, to take advantage of the geothermal resource on the property is estimated to cost $81,889. This grant proposal is requesting the maximum 25% of that total, or $20,472. A summary of the cost is presented below, with additional detail provided in the project timeline and the engineering design in Appendix A.

Fizer Dairy Geothermal Heating Project - Estimated Cost

Planning and Permitting	**Quantity**	**Units**	**Unit Cost**	**Total**
Engineering Consultant - Detailed Design	48	hours	120	$5,760
Drilling Surety bond	1	lump	5000	$5,000
Drilling Permit - Production Well	1	llump	200	$200
Drilling Permit - Injection Well	1	lump	200	$200
Injection Well Permit	1	lump	300	$300
Engineering Consultant - Construction & Installation	32	hours	120	$3,840
			Subtotal	$15,300
*** Construction**				
Injection and Production Well				$29,750
Distribution Piping				$10,000
Space Heating Load 1 - Milk Barn				$2,700
Space Heating Load 2 - Bulk Tank Room				$2,618
Hot Water Load 1 - Cow Washing				$1,923
Hot Water Load 2 - Floors, Utters				$1,923
Snow Melting				$17,675
			Subtotal	$66,589
			Total Project Cost	**$81,889**

* Details on Construction Cost Estimate Sheet

The payback costs for this project have been calculated using three methods. The simple payback formula is:

Simple Payback Period (in years) = $\frac{Total Eligible\ Project Cost}{Annual Savings or Income}$

The total eligible project cost is estimated at $81,889. The cost of natural gas saved in 2006 $'s is $5,346.

Payback period = $\frac{\$81,889}{\$5,346/yr}$ Simple Payback = 15 years

However, it's reasonable to assume that the price of natural gas would increase during the life of this system. Two alternative calculations were made, assuming the price of natural gas increased 2.5% a year and 5.0% a year. Using a 2.5% increase in natural gas prices, the payback would be in the 13th year. Using a 5% increase in natural gas prices each year, the payback would be in the 11th year.

Technical Report – Fizer Dairy

Introduction

Idaho has abundant geothermal resources, especially the central and southern parts of the state where the majority of the geothermal wells and springs are found. These resources have been developed over the last 100+ years for recreation, district heating, domestic heating, aquaculture, and greenhouse operations. Fizer Dairy is located near Berger, Idaho, in this area of abundant geothermal resources.

Geothermal Direct Use Requirements

I. Qualifications of Project Team

This project was conceptually planned prior to preparing this USDA Farm Bill Section 9006 application. Willard Fizer is somewhat familiar with geothermal direct use applications. Mr. Fizer contacted a licensed Professional Engineer (PE) with significant experience in direct use geothermal applications, design and construction for preliminary guidance on the project. The overall project will consist of designing, bidding, and building a geothermal heating system for parts of the Fizer Dairy.

Project Management - Mr. Willard Fizer will serve as the project manager. Prior to taking over the family dairy farm business he received his BS in Chemistry from Utah State University, in Logan, Utah. Willard Fizer has 25 years of agriculture experience, including 20 years of owning, operating and managing the Fizer Dairy in Berger, Idaho. Willard will be directly responsible for the dairy operations after the project changes have been implemented.

Design, Engineering & Installation Oversight – Mr. Andrew Chase, the project engineer works for GeoHeat Applications LLC., and holds Bachelors and Masters Degrees in Geological Engineering and a Masters Degree in Mechanical Engineering. He is a licensed Professional Engineer in Idaho, Washington and Oregon with 10 years of experience in design and installation of geothermal systems. Mr. Chase can be contacted at (541) 885-1750

Systems Operation - Mr. Fizer will be directly responsible for servicing, operating and maintaining the geothermal heating system once installed. He will receive training from the equipment manufactures and the project engineer. He will be assisted by his two sons Michael, and Patrick who once trained by the system installer on the operations and maintenance of the systems, will be primarily responsible for the operations and maintenance. The key components and moving parts in the system are primarily pumps and motors, with which Mr. Fizer, as a dairy owner and operator, and his sons have extensive installation, maintenance and repair experience.

Equipment Manufacturers - The equipment being installed is comprised of “off-the-shelf” components that can be supplied by a number of manufacturers. None of the components for the proposed system are one-of-a-kind or special order. None of the components require special design and will not be custom manufactured. Bids will be requested from a number of suppliers in order to get the best pricing for all the components.

To the best of our knowledge there currently are no dairies in south central Idaho that use geothermal resources to heat their facilities.

II. Agreements and Permits

The Idaho Department of Water Resources (IDWR) and the Department of Environmental Quality (DEQ) are the lead agencies for administering and enforcing the rules and regulations governing water use and quality in Idaho. IDWR is responsible for issuing water rights, well construction permits and underground fluid injection wells.

Idaho, policies governing geothermal resources are published in the Geothermal Resources Act (Idaho Code Title 42-40). The State of Idaho has a separate definition for low temperature geothermal resources. Low temperature geothermal resources are "…ground water having a temperature of greater than 85 °F (29 °C) and less than 212 °F (100 °C) in the bottom of a well…". Low-level geothermal resources are administered by the Department of Water Resources. The Fizer Dairy Farm water is 160°F and therefore is considered a low temperature geothermal resource. Low temperature geothermal water use, including space heating, and irrigation, is regulated with the rules governing groundwater appropriation and well drilling regulations. Appropriate forms and notifications for drilling are available on the internet. It is anticipated that it will take approximately 3 weeks to get the appropriate permits from the state of Idaho for this project.

Rules and regulations governing well construction are in IDAPA 37 Title 3 Chapter 9. Rule 30-Construction of Low Temperature Geothermal Resource Wells is presented in Idaho Administrative Code 37 Title 3 Chapter 4- Drilling for Geothermal Resources Rules. The regulatory process for developing a low temperature, direct use geothermal project in Idaho consists of the following steps:

- Gain access to lands either through lease or direct ownership.
- Contact local and/or county agencies to ensure compliance with local land use laws including building permits and zoning restrictions.
- Secure water right. (IDWR)
- Obtain well construction permit/develop production well. (IDWR)
- Determine fluid disposal plan and obtain permits for either underground injection or surface disposal. (DEQ)

The Fizer Dairy Farm does not fall within an IDWR area of drilling concern and no additional well construction requirements are necessary. Fizer Dairy farms own all the water rights within a 3-mile radius of the proposed project and currently have a valid water rights permit. The Fizer Dairy Farm is not within a designated ground water management areas (GWMAs) or critical ground water areas (CGWAs). We have contacted county planning and health departments to check for any additional regulations or ordinances covering well placement and construction and there are none in this location.

A drilling prospectus will be submitted to DWR prior to construction. A surety bond or cash bond as required by Idaho code section 42-233 with DWR. The amount of the bond ranges from $5000, up to $20,000, as determined by the depth and temperature of the well. There will be a drilling permit fee of $200. The well will be drilled by a licensed and bonded well contractor. In addition, this low temperature geothermal well has specific casing requirements including the sealing of the casing to prevent cooling of the resource due to intermingling with cold-water aquifers.

The preferred method of disposing of geothermal fluids is to return them to the ground by way of injection wells. Fizer Dairy Farms plans to drill an injection well to dispose of the water after it has passed through their heating systems. IDWR administers the Idaho Waste Disposal and Injection Well program. Geothermal heat wells and closed loop heat pump return wells are both classified in Idaho as Class V injection wells. Injection wells that are more than 18 feet deep must apply for a permit from DWR prior to construction. This applies to closed-loop heat exchange wells, if they are deeper than 18 feet (5.5 m). Fizer Dairy Farms will apply for the $100 permit. There will be a

30-day review period in addition to the normal processing time for this injection will permit. The proposed Fizer Dairy Farms project is expected to require less than 50 gpm of fluid, and may be exempt from the permit provisions. This will be determined with consultation with IDWR personnel.

We have contacted the county and inquired about zoning and code requirements and there are none that affect this project.

There are no licenses required to own and operate the type of equipment we are proposing to install.

State health officials have been contacted and they indicated that as long as the temperatures meet the state health code requirements for cleaning and operation, there will be not be any changes in our existing permits and periodic inspections.

Most of the components of the proposed system are piping and valves which come with standard manufacturer warranties. Depending on which manufacture we choose, the warranties for the heat exchangers and controllers will vary but will be what is commonly accepted within the industry.

The entire project will be on Fizer Dairy property, and there will be no environmental impacts. The water used in this system is essentially in a closed loop and will be extracted from on well and injected to another well. The process used for washing and cleaning will not change, other than the source of the heat for the water, and thus no environmental impacts.

III. Resource Assessment

The current well producing water for the Fizer Dairy Farm was drilled to a total depth of 280 ft in 1982. Water temperature has been recorded on yearly basis since the well was drilled, and it ranges between 162°F and 165°F. The water level in the well has been measured twice a year since drilling in 1982 and it fluctuates between 208 and 220 ft below ground surface. The well was originally pump tested at a flowing rate of 320 gpm. The daily requirements of the farm range from 20 to 35 gpm. The proposed geothermal heating system is estimated to require less than 50gpm. The water from the well has been tested at a state approved water quality laboratory on a number of occasions. The most recent tests had the following results:

Temperature	73°C (163°F)
pH	7.6
Sodium (Na)	22 mg/L
Potassium (K)	5.1 mg/L
Calcium (Ca)	43 mg/L
Silica (SiO_2)	16 mg/L

Information available on the geothermal reservoir in this area indicates that a distance of 300 ft between the production and injection wells is sufficient to avoid thermal breakthrough and cooling of the geothermal fluids pumped from the supply well. The injection will be drilled to a depth of 325 feet so the cooler injected water will not result in thermal breakthrough and cooling of the supply well.

IV. Design and Engineering

A preliminary design of this project was prepared by John Doe with the assistance of Mr. Fizer. The preliminary design and calculations are presented in **Appendix A**. Mr. Doe a mechanical engineer with GeoHeat Applications LLC., is a licensed Professional Engineer (PE) with 10 years of experience in research and development, design and construction of geothermal direct use projects. GeoHeat Applications LLC., has worked on hundreds of projects both in the U.S. and internationally over the last 20 years. They work exclusively on geothermal direct use applications.

This project consists of: 1) drilling a 250' supply well, 2) installing piping from the supply well to the facilities to be heated, 3) retrofitting the existing boiler and installing heat exchange equipment, 4) installing a 1,600 ft^2 concrete slab with radiant heat tubing in a parking area, 5) drilling and completing a 325' injection well, 6) installing piping from the new heating equipment to the injection well.

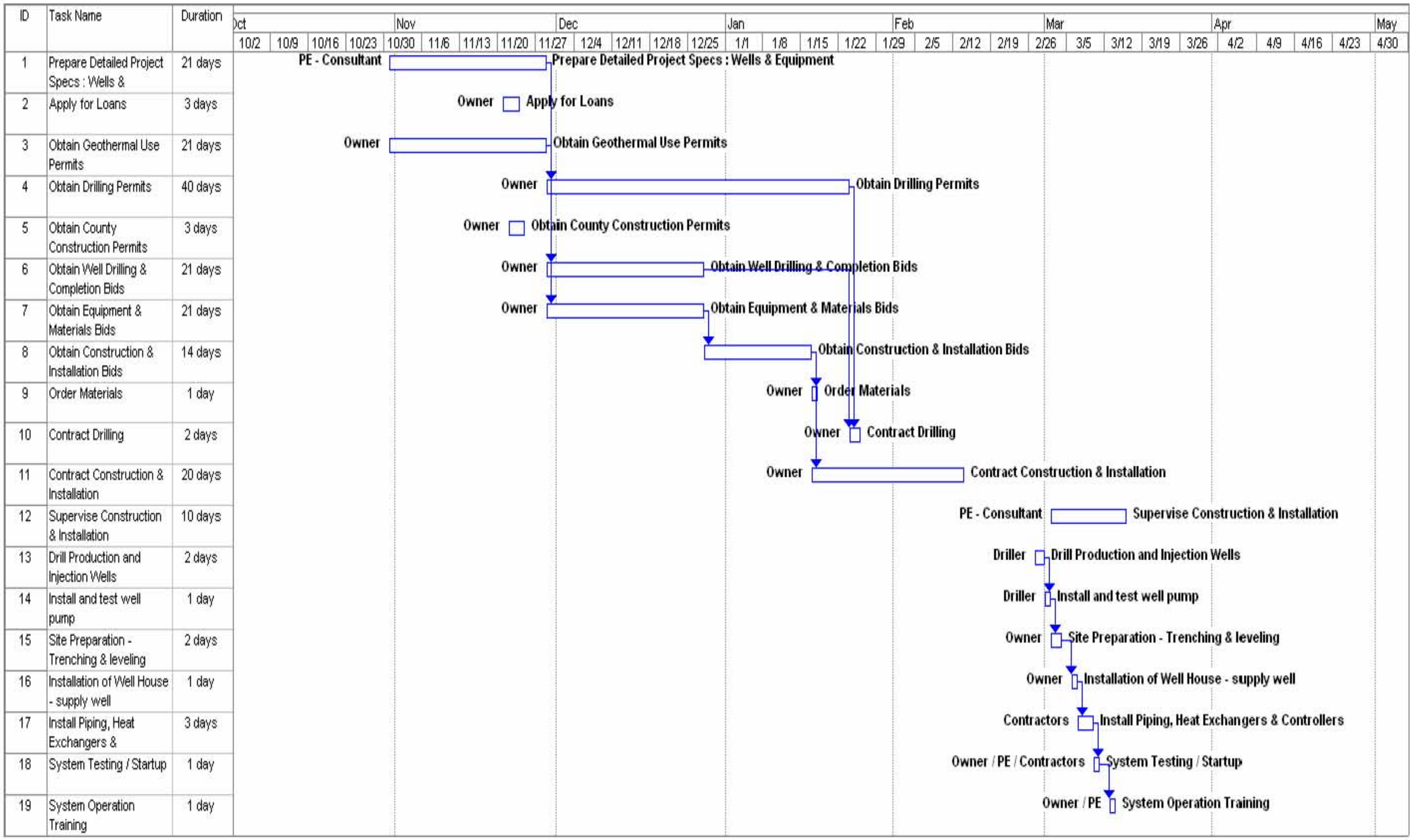
Mr. Fizer became interested in using the geothermal resource available on his property after attending a geothermal direct use workshop in Boise, Idaho sponsored by the Department of Energy GeoPowering The West program. The recent increase in fuel cost for operating the dairy led to an in-depth analysis of how the dairy could reduce costs. The geothermal option was selected because he already owns the resource, and it would require minimal disruption of his operations to install a geothermal system. This project will require drilling one production and one disposal well, and trenching to install approximately 200 ft of 3-inch pipe. Once the piping is installed there will be no land use impacts. The disposal well will have a footprint of approximately 50 ft^2 when finished. There is ample room and a number of locations where the injection will can be placed. There will be no impacts to air quality, water quality, and wildlife habitat. There will be no noise pollution, soil degradation or odor associated with this project.

Mr. Fizer plans to leave the current natural gas heating systems in place to provide backup heating capability should it ever be necessary.

Fizer Dairy Farms and the adjacent 360 acres has been owned and operated by Willard and Edith Fizer for 19 years. The dairy has actually been in operation for over 30 years. Prior to Mr. Willard Fizer's management, the dairy was owned and operated by his father, Robert Fizer. This is a family run dairy, and the future plans are to turn the operation over to Willard Fizer's son Michael, when Willard Fizer retires. This dairy operation will be controlled by the Fizer family for the life of the project.

V. Project Development Schedule

Significant tasks for this project include preparation of detailed specifications, obtaining required permits, obtaining material and construction bids, ordering materials, construction and startup. A detailed timeline for the project is presented in the timeline diagram. The entire project is expected to take a little over 5 months (October 31 to March 13) from inception to completion. The project will be completed within 1 year of the date of approval from USDA.



ID	Task Name	Duration
1	Prepare Detailed Project Specs : Wells &	21 days
2	Apply for Loans	3 days
3	Obtain Geothermal Use Permits	21 days
4	Obtain Drilling Permits	40 days
5	Obtain County Construction Permits	3 days
6	Obtain Well Drilling & Completion Bids	21 days
7	Obtain Equipment & Materials Bids	21 days
8	Obtain Construction & Installation Bids	14 days
9	Order Materials	1 day
10	Contract Drilling	2 days
11	Contract Construction & Installation	20 days
12	Supervise Construction & Installation	10 days
13	Drill Production and Injection Wells	2 days
14	Install and test well pump	1 day
15	Site Preparation - Trenching & leveling	2 days
16	Installation of Well House - supply well	1 day
17	Install Piping, Heat Exchangers &	3 days
18	System Testing / Startup	1 day
19	System Operation Training	1 day

VI. Financial Feasibility

Project management - No outside project management cost will be incurred on this project. The small size of this project allows Mr. Fizer, the dairy owner to function as the project manager. He has experience in designing and managing construction of upgrades to the dairy facilities over the past 20 years.

Resource Assessment - A detailed resource assessment is not required for this project. The geothermal resource has been adequately defined and tested with the existing well. Pump tests, chemical analysis of the water and annual temperature measurements over the life of the existing well confirm that an adequate resource exists.

Project Design - A preliminary design (Appendix A) has been completed by a licensed Professional Engineer with experience in geothermal direct use applications. Approximately 50 hours of additional engineering consultations at approximately $120.00/hr ($6,000 total) will be required to complete the design, installation and startup.

Project Permitting -Project permitting will be performed by Mr. Fizer. His time will not be charged to the project. The cost of permits including a drilling permit, injection well permit and bond for the drilling operations are expected to cost less than $600 for the two wells. The drilling bond will be approximately $500. There will also be local construction permits required for the parking pad and upgrades to the facilities. These local construction permits are anticipated to be less than $250.

Site preparation – The proposed location for the two wells area clear of underground and overhead obstructions, and are not encumbered by any easements or legal constraints. No special siting requirements are applicable. All site preparation work will be done by employees of Fizer Dairy. The dairy has the necessary equipment and tools for trenching operations and earth moving that would be associated with providing a drilling pad, pipe trenching and leveling and compacting requirements for the 1,600 ft^2 pad. The dairy also has the necessary equipment and skills for any modifications to existing facilities or equipment that are required prior to installation of the new equipment.

Installation – Installation cost are included in the cost estimate in Appendix A.

Financing – Initial discussions have been held with Mr. Fizer's financial institution. They have agreed to provide financing based on the information provided in this application assuming the USDA grant covers 25% of the project cost.

Startup – There will be no special startup costs associated with this project, other than the engineer consultation fee described in the Project Design section above.

Maintenance Costs – Maintenance cost are predicted to be similar to the maintenance cost with the current operation. The new system will add additional circulation pumps and control systems, but these components have low failure rates and minimal maintenance costs associated with them.

Annual Revenue and Expenses - This project is not designed to provide direct revenue to Fizer Dairy by selling power. Energy cost savings, by using geothermal resources instead of natural gas is the ultimate goal. The current system for heating the Fizer Dairy facilities relied on boilers fired with natural gas. The current price of natural gas is from Intermountain Gas is approximately $1.2555/therm. The estimated annual heating required for Fizer Dairy is 547MMBtu or 5,470 therms. This includes the new heated pad for delivery and loading of milk products. With a boiler operating at 80% efficiency, approximately 6,838 therms of natural gas would be required to meet the annual heating demand, which, at today's Intermountain Gas

Company rates, would cost about $6,864. Fizer Dairy has other gas needs that would not be affected by this project.

Investment, Productivity, Tax, Loan and Grant Incentives – Mr. Fizer is exploring the possibility of obtaining a loan through the State of Idaho. The state has a low interest loan program, administered by the Energy Division of the Idaho Department of Water Resources, makes funds available at a 4% interest rate for energy efficiency projects including geothermal energy projects. Loans are available for retrofit only, with the exception of some renewable resources. In commercial, industrial, agricultural, and public sectors there is a minimum loan amount of $1,000 and a maximum cap of $100,000. Loans are repaid in five years or less. For existing homes or businesses, the savings from reduced usage of conventional fuel must be sufficient to pay for the project's installation cost (e.g. simple payback of 15 years or less). While the program's financing requires repayment within five years, this further stipulation for existing homes and businesses states that the project's cumulative energy savings over a fifteen year period must be great enough to offset the cost of the project.

VII. Equipment Procurement

Equipment Availability – The materials required for this project are standard off the shelf items. With the exception of the heat exchangers and pressure tank, most are available in home and ranch supply stores, or local plumbing supply business. The heat exchangers are available from multiple suppliers including Alfa-Laval, APV, Armstrong, SWEP, and Tranter. Pressure tanks are also available from multiple suppliers such as Flexcon, Franklin Pump Company, and ITT Industries. Heat exchangers and a pressure tank, and associated controls can be delivered to the site within 20 days of ordering them. Procurement of the components of this system will be done in an "open and free" competitive basis.

VIII. Equipment Installation

System Installation – The plan for construction and installation is shown in the project timeline. This timeline estimates the entire construction portion of the project to be 11 days from initial well drilling, to system startup and shakedown.

Equipment installation will be done in accordance with all applicable safety and work rules.

It is anticipated that there will be no disruption in the twice-daily milking operations at the dairy, both during construction, and during startup of the system.

System Startup and Shakedown - System start-up will be carried out by a qualified well pump and controls technician in conjunction with a qualified hydronic heating and plumbing technician. System start-up will consist of verifying operation of thermostats and controls as designed, and verifying system pressures and flow rates as designed.

IX. Operations and Maintenance

Operation Requirements – The system operation will be based on thermostatic controls and pressure sensed in the pressure tank. When a thermostat calls for heating, appropriate valves will open at the heat exchanger, allowing flow of geothermal water through the heating system. When the pressure correspondingly drops in the pressure tank, the well pump will be energized. The pump speed will be controlled by pressure in the tank.

Maintenance Requirements - The circulating pumps will require a quarterly visual inspection to see that seals and connections are not leaking. Otherwise the pumps and motors have no routine maintenance requirements. The heat exchangers will require routine inspection and may require annual cleaning or de-scaling.

Warranties - The electric motors used in the system are all 1 hp or smaller, and have standard 1 year warranties from the manufactures. Downhole pumps for the production well typically come with 1 to 2 year warranties from the manufacturer. The heat exchangers typically have a 1-year warranty.

Expected Equipment Design Life – The water used in this well has low solids and corrosives content, and therefore equipment life should not be affected by the water chemistry. Heat exchangers used in similar applications have functioned with out failure for 15 to 20 years, and thus this is the expected life of the heat exchangers on this project. Submersible pumps in similar well conditions have life expectancies of 12 -15 years. Circulation pumps used in similar applications have performed for more than 15 years with occasional maintenance on the seals. The piping used in the system should be good for 50 years or more. The pressure tank has a life expectancy of 15 years.

Risk Management / Equipment Failures – The proposed system form an engineering standpoint in not a complex system. Components most susceptible to failure are controllers and pumps, which are standard off the shelf items that can be delivered and installed in 24 hrs by Mr. Fizer.

Technology Transfer – This will be the first dairy in Southern Idaho to be heated by geothermal fluids. We intended to provide access for the College of Southern Idaho, in nearby Twin Falls, ID to visit our facilities and collect data to support their programs in the Water Resource Management and Farm Management and Air Conditioning / Refrigeration / Heating Technology. We also plan to share information on the systems performance with local and state dairy operators through the local USDA CREES office at 246 Third Avenue East in Twin Falls, Idaho.

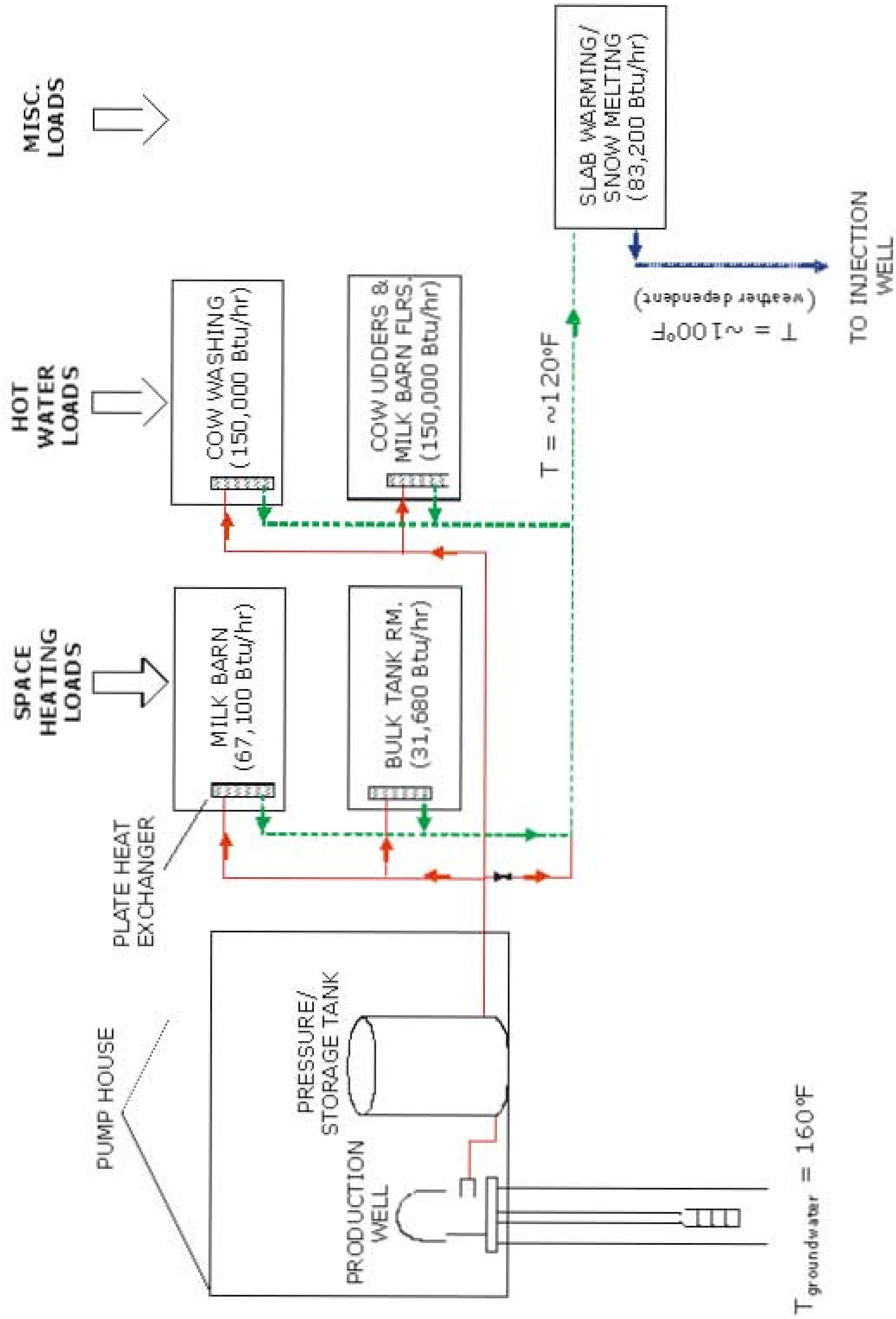
X. Decommissioning

There are no plans to decommission this system. If anything it might be expanded at a future date if the dairy operations were to grow substantially.

Appendix A – Engineering Design

- **Process Diagram**
- **Heating Loads Summary**
- **Heat Exchanger Summary**
- **Construction Cost Estimate**

Appendix A: Process Diagram



Appendix A:	**Design and Engineering**				
	Heating Loads Summary				
		Values in red are computed from input data.			
Space Heating Loads					
Load 1:	**Milk Barn**				
	Floor space	1,220	ft^2		
	Design outdoor air temperature:	-6	°F		
	Design intdoor air temperature:	70	°F		
	Annual heating degree days	7,100			
	Heat loss at design condition	55	Btu/hr-ft^2		
	Peak Heating Load	**67,100**	Btu/hr		
	Annual heating energy required	**150**	million Btu		
Load 2:	**Bulk Tank Room**				
	Floor space	576	ft^2		
	Design outdoor air temperature:	-6	°F		
	Design intdoor air temperature:	70	°F		
	Annual heating degree days	7,100			
	Heat loss at design condition	55	Btu/hr-ft^2		
	Peak Heating Load	**31,680**	Btu/hr		
	Annual heating energy required	**71**	million Btu		
Hot Water Heating Loads					
Load 1:	**Cow Washing**				
	Peak flow rate	5	gpm		
	Inlet water temperature	50	°F		
	Desired outlet water temperature	110	°F		
	Gallons per day required	600	gpd		
	Peak Heating Load	**150,000**	Btu/hr		
	Annual heating energy required	**110**	million Btu		
Load 2:	**Cow Udders & Milk Barn Floors**				
	Peak flow rate	5	gpm		
	Inlet water temperature	50	°F		
	Desired outlet water temperature	110	°F		
	Gallons per day required	520	gpd		
	Peak Heating Load	**150,000**	Btu/hr		
	Annual heating energy required	**95**	million Btu		
Miscellaneous Loads					
Load 1:	**Slab Warming/Snow Melting**	(From ASHRAE HVAC Apps Handbook, 2003)			
	From Pre-Injection Water				
	Location of snow melting data	Boise, ID			
	Slab surface area to be heated	1,600	ft^2		
	Heat flux required (99th percentile)	52	Btu/hr-ft^2		
	Peak Heating Load	**83,200**	Btu/hr		
	Annual heating energy required	75,464	Btu/ft^2		
		121	million Btu		

Appendix A: Design and Engineering

Heat Exchanger Summary

Space Heating Loads

Load 1: **Milk Barn**

Source Side:			*Load Side:*		
Fluid	water		Fluid	water	
Inlet temperature	160	°F	Inlet temperature	100	°F
Outlet temperature	120	°F	Outlet temperature	140	°F
Flow rate	3.4	gpm	Flow rate	3.4	gpm
Pressure drop	0.44	psi	Pressure drop	0.54	psi
Heat transfer area	6.0				ft^2

Load 2: **Bulk Tank Room**

Source Side:			*Load Side:*		
Fluid	water		Fluid	water	
Inlet temperature	160	°F	Inlet temperature	100	°F
Outlet temperature	120	°F	Outlet temperature	140	°F
Flow rate	1.6	gpm	Flow rate	1.6	gpm
Pressure drop	0.05	psi	Pressure drop	0.05	psi
Heat transfer area	4.9				ft^2

Hot Water Heating Loads

Load 1: **Cow Washing**

Source Side:			*Load Side:*		
Fluid	water		Fluid	water	
Inlet temperature	160	°F	Inlet temperature	50	°F
Outlet temperature	120	°F	Outlet temperature	110	°F
Flow rate	7.5	gpm	Flow rate	5.1	gpm
Pressure drop	2.58	psi	Pressure drop	1.48	psi
Heat transfer area	2.3				ft^2

Load 2: **Cow Udders & Milk Barn Floors**

Source Side:			*Load Side:*		
Fluid	water		Fluid	water	
Inlet temperature	160	°F	Inlet temperature	50	°F
Outlet temperature	120	°F	Outlet temperature	110	°F
Flow rate	7.5	gpm	Flow rate	5.1	gpm
Pressure drop	2.58	psi	Pressure drop	1.48	psi
Heat transfer area	2.3				ft^2

Miscellaneous Loads

Load 1: **Slab Warming/Snow Melting From Pre-Injection Water**

Source Side:			*Load Side:*		
Fluid	water		Fluid	40% glycol	
Inlet temperature	120	°F	Inlet temperature	84	°F
Outlet temperature	90	°F	Outlet temperature	97	°F
Flow rate	5.5	gpm	Flow rate	16	gpm
Pressure drop	0.85	psi	Pressure drop	6.18	psi
Heat transfer area	9.0				ft^2

Appendix A: Design and Engineering Construction Cost Estimate					
Construction Cost Estimate	Quantity	Units	Unit Cost	Sub Total	Totals
GEOTHERMAL RESOURCE					
Production Well					
Drilling & materials	250	ft	$30	$7,500	
Well pump, pressure tank, controls	1	lump	$2,000	$2,000	
Production well pump house	1	lump	$1,500	$1,500	
Injection Well					
Drilling & materials	325	ft	$30	$9,750	
PVC piping from radiant slab to injection well	300	ft	$30	$9,000	
					$29,750
THERMAL ENERGY DISTRIBUTION					
Distribution Piping					
3-in. pre-insulated steel, trench & backfill, pipe bedding, associated fittings & valves	200	ft	$50	$10,000	
					$10,000
THERMAL ENERGY UTILIZATTION					
Space Heating Load 1 - Milk Barn					
Retrofit from existing boiler (for forced-air retrofit, add costs of water-air coil + valves + expansion tank + water lines + PRV)					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat exchanger	6	ft^2	$75	$450	
Circulating pump, controls	1	lump	$500	$500	
					$2,700
Space Heating Load 2 - Bulk Tank Room					
Retrofit from existing boiler (for forced-air retrofit, add costs of water-air coil + valves + expansion tank + water lines + PRV)					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat exchanger	4.9	ft^2	$75	$368	
Circulating pump, controls	1	lump	$500	$500	
					$2,618
Hot Water Load 1 - Cow Washing					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat exchanger	2.3	ft^2	$75	$173	
					$1,923
Hot Water Load 2 - Floors, Utters					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat exchanger	2.3	ft^2	$75	$173	
					$1,923
Snow Melting					
Radiant slab construction	1600	ft^2	$10	$16,000	
Heat exchanger	9	ft^2	$75	$675	
Circulating pump, controls	1	lump	$1,000	$1,000	
					$17,675
CONSTRUCTION GRAND TOTAL					**$66,588**

Appendix B – Financial Statements

- **Balance Sheet or Financial Statement**
- **Current Year Profit and Loss Statement or Income Statement or Earnings Statement**
- **Pro Forma Profit and Loss Statement**

Fizer Dairy

Balance Sheet or Financial Statement

As of December 31, 2005

ASSETS		
Current Assets		
	Cash	23,000
	Account Receivables (milk)	36,000
	Feed on Hand	125,000
	Calves for Sale	3,000
	Total Current Assets	187,000
Fixed Assets		
60	Heifers, 6 to 16 months	50,000
	240 head Cows	240,000
	Farm Equipment	240,000
	Irrigation Equipment	75,000
	Trucks	85,000
	360 Acres Land	540,000
	Dairy Buildings and Equipment	575,000
	Retirement Accounts	74,000
	Depreciation	-586,000
	Total Fixed Assets	**1,293,000**
	Total Assets	**1,480,000**
LIABILITIES		
Current Debts		
	Account Payables	36,000
	Operating Line of Credit, Farm Credit	90,000
	Swather Annual Payment, Wells Fargo	15,000
	Center Pivot Loan Payment, Valmont Financial	11,000
	Cattle loan current payment, FCS	13,000
	Total Current Debts	**165,000**
Long Term Debt		
	Swather loan Wells Fargo Bank	30,000
	Center Pivot loan Valmont Financial	29,000
	Cattle Loan Farm Credit	75,000
	Land/Dairy Buildings Farm Credit	778,000
	Total Long Term Debt	**912,000**
	Total Debt	**1,077,000**
EQUITY		**403,000**

Fizer Dairy

Current Year Profit and Loss Statement, or Income Statement, or Earnings Statement

January 1 through December 31, 2005

INCOME		
	Milk Sold	756,000
	Calves Sold	19,000
	Cattle Sold	63,000
	Government Payments	18,500
	Total Income	**856,500**
EXPENSES		
	Labor	74,000
	Payroll Taxes	6,500
	Repairs	6,200
	Interest (Operating	18,000
	Interest (Other)	60,000
	Rent/Lease	32,000
	Feed	327,000
	Seed	13,000
	Fertilizer	68,000
	Chemicals	17,000
	Custom Hire	8,000
	Supplies	11,000
	Breeding/Veterinarian	17,000
	Fuel, Gas, Oil	33,000
	Property Taxes	12,300
	Insurance	4,700
	Natural Gas	5,100
	Utilities	24,125
	Depreciation	59,000
	Total Expenses	**795,925**
NET INCOME		**60,575**

Fizer Dairy

PRO FORMA PROFIT AND LOSS STATEMENT

also known as an income statement or earnings statement

	HISTORICAL or ACTUAL			PROJECTED or PRO FORMA		
INCOME	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Milk Sold	728,000	708,000	756,000	730,000	730,000	730,000
Calves Sold	17,900	15,300	19,000	18,000	18,000	18,000
Cattle Sold	61,300	53,000	63,000	58,000	58,000	58,000
Government Payments	20,460	21,300	18,500	18,000	18,000	18,000
Total Income	**827,660**	**797,600**	**856,500**	**824,000**	**824,000**	**824,000**
EXPENSES						
Labor	66,000	68,000	74,000	75,000	76,000	77,000
Payroll Taxes	5,900	6,100	6,500	6,600	6,700	6,800
Repairs	13,400	16,800	6,200	10,000	10,000	10,000
Interest (Operating	14,000	15,400	18,000	22,000	22,000	22,000
Interest (Other)	57,000	53,000	60,000	58,000	56,000	54,000
Rent/Lease	32,000	32,000	32,000	32,000	32,000	32,000
Feed	308,000	311,000	327,000	320,000	320,000	320,000
Seed	14,000	14,500	13,000	13,500	13,500	13,500
Fertilizer	52,000	54,500	68,000	74,000	74,000	74,000
Chemicals	14,000	15,200	17,000	17,000	17,000	17,000
Custom Hire	15,000	17,000	8,000	11,000	11,000	11,000
Supplies	13,000	11,300	11,000	12,000	12,000	12,000
Breeding/Veterinarian	19,000	18,600	17,000	18,000	18,000	18,000
Fuel, Gas, Oil	23,000	25,300	33,000	33,000	33,000	33,000
Property Taxes	11,800	12,100	12,300	12,300	12,300	12,300
Insurance	4,600	4,600	4,700	4,700	4,700	4,700
Natural Gas	5,100	4,200	5,100	0	0	0
Utilities	24,125	25,300	24,125	25,000	25,000	25,000
Depreciation	72,000	68,000	59,000	56,000	53,000	49,000
Total Expenses	**763,925**	**772,900**	**795,925**	**800,100**	**796,200**	**791,300**

	HISTORICAL or ACTUAL			PROJECTED or PRO FORMA		
NET INCOME	**63,735**	**24,700**	**60,575**	**23,900**	**27,800**	**32,700**

Appendix C – Dun and Bradstreet Number

Dun and Bradstreet DUNS Number

A Dun and Bradstreet Universal Numbering System (DUNS) number is required on a complete USDA Grant Proposal. Here is some information on what the DUNS number is.

What is the D-U-N-S Number?
The D&B D-U-N-S Number is a unique nine-digit identification sequence, which provides unique identifiers of single business entities, while linking corporate family structures together. D&B links the D&B D-U-N-S Numbers of parents, subsidiaries, headquarters and branches on more than 70 million corporate family members around the world. Used by the world's most influential standards-setting organizations, it is recognized, recommended and/or required by more than 50 global, industry and trade associations, including the United Nations, the U.S. Federal Government, the Australian Government and the European Commission. In today's global economy, the D&B D-U-N-S Number has become the standard for keeping track of the world's businesses.

Why should you have a D-U-N-S Number?

- It enhances the credibility of your business in the marketplace
- It enables potential customers, suppliers and lenders to easily identify and learn about your company
- The U.S. government and many major corporations require their suppliers and contractors to have a D-U-N-S Number

Please note that getting a D-U-N-S Number alone will not establish a D&B credit file for your company. If you are requesting a D-U-N-S Number because you need to show others that your business is creditworthy, you will probably need to establish a credit file.

Obtaining and DUNS number.
From the website: http://www.grants.gov/RequestaDUNS

In order to register with the Central Contractor Registry, a requirement for registering with Grants.gov, your organization will need a Data Universal Number System (DUNS) Number. A DUNS number is a unique nine-character identification number provided by the commercial company Dun & Bradstreet (D&B).

What is the process? If your organization is located in the United States, you can request and register for a DUNS number by calling 1-866-705-5711. If your organization is located outside of the United States, you can request and register for a DUNS number online via web registration.

If your organization does not have a DUNS number, you should ask the chief financial officer, grant administrator, or authorizing official of your organization to register for a DUNS number. It is possible to request a DUNS number online via web registration.

Appendix D – Lender Credit Commitment Letter

N

Idaho Farm Credit Services

February 25, 2005

To Whom It May Concern:

Idaho Farm Credit Services agrees to provide financing in an amount no greater than $60,000 for the purchase of materials and labor for the conversion to geothermal energy sources for Willard D. Fizer, owner of Fizer Dairy, of Berger, Idaho. This letter is a commitment by Idaho Farm Credit Services to finance 75% the project up to $61,400.

Sincerely,

Patrick Lanley
Sr. Business Analyst
Idaho Farm Credit Services

Appendix E – Federal Income Tax Returns

- **2002 Form 1040 U.S. Individual Income Tax Return for Willard D. and Edith A. Fizer**
- **2003 Form 1040 U.S. Individual Income Tax Return for Willard D. and Edith A. Fizer**
- **2004 Form 1040 U.S. Individual Income Tax Return for Willard D. and Edith A. Fizer**

2002 Form 1040

Form **1040** Department of the Treasury—Internal Revenue Service
U.S. Individual Income Tax Return **2002** (99) IRS Use Only—Do not write or staple in this space.

Label (See instructions on page 21.) Use the IRS label. Otherwise, please print or type.

For the year Jan. 1–Dec. 31, 2002, or other tax year beginning , 2002, ending , 20			OMB No. 1545-0074
Your first name and initial: Willard D	Last name: Fizer		Your social security number: XXX | XX | XXXX
If a joint return, spouse's first name and initial: Edith A	Last name: Fizer		Spouse's social security number: YYY | YY | YYYY
Home address (number and street). If you have a P.O. box, see page 21. F.O. Box 67468		Apt. no.	▲ **Important!** ▲ You must enter your SSN(s) above.
City, town or post office, state, and ZIP code. If you have a foreign address, see page 21. Berger, Idaho			

Presidential Election Campaign (See page 21.) Note. Checking "Yes" will not change your tax or reduce your refund. Do you, or your spouse if filing a joint return, want $3 to go to this fund? ▶ You: ☐ Yes ☑ No Spouse: ☐ Yes ☑ No

Filing Status — Check only one box.

1 ☐ Single
2 ☑ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See page 21.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child (year spouse died ▶). (See page 21.)

Exemptions

6a ☑ Yourself. If your parent (or someone else) can claim you as a dependent on his or her tax return, do not check box 6a
b ☑ Spouse
c Dependents:

(1) First name Last name	(2) Dependent's social security number	(3) Dependent's relationship to you	(4) ✓ if qualifying child for child tax credit (see page 22)
Michael Fizer	zzz | zz | zzzz	Son	☐
Patrick Fizer	uuu | uu | uuuu	Son	☐
			☐
			☐
			☐

If more than five dependents, see page 22.

d Total number of exemptions claimed

No. of boxes checked on 6a and 6b: 2
No. of children on 6c who: • lived with you; • did not live with you due to divorce or separation (see page 22)
Dependents on 6c not entered above: 2
Add numbers on lines above ▶ 4

Income

Attach Forms W-2 and W-2G here. Also attach Form(s) 1099-R if tax was withheld.

If you did not get a W-2, see page 23.

Enclose, but do not attach, any payment. Also, please use Form 1040-V.

Line	Description	Line	Amount
7	Wages, salaries, tips, etc. Attach Form(s) W-2	7	
8a	Taxable interest. Attach Schedule B if required	8a	
b	Tax-exempt interest. Do not include on line 8a — 8b		
9	Ordinary dividends. Attach Schedule B if required	9	
10	Taxable refunds, credits, or offsets of state and local income taxes (see page 24)	10	
11	Alimony received	11	
12	Business income or (loss). Attach Schedule C or C-EZ	12	
13	Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐	13	
14	Other gains or (losses). Attach Form 4797	14	
15a	IRA distributions — 15a — b Taxable amount (see page 25)	15b	
16a	Pensions and annuities — 16a — b Taxable amount (see page 25)	16b	
17	Rental real estate, royalties, partnerships, S corporations, trusts, etc. Attach Schedule E	17	
18	Farm income or (loss). Attach Schedule F	18	
19	Unemployment compensation	19	
20a	Social security benefits — 20a — b Taxable amount (see page 27)	20b	
21	Other income. List type and amount (see page 29)	21	
22	Add the amounts in the far right column for lines 7 through 21. This is your total income ▶	22	

Adjusted Gross Income

Line	Description	Line	Amount
23	Educator expenses (see page 29)	23	
24	IRA deduction (see page 29)	24	
25	Student loan interest deduction (see page 31)	25	
26	Tuition and fees deduction (see page 32)	26	
27	Archer MSA deduction. Attach Form 8853	27	
28	Moving expenses. Attach Form 3903	28	
29	One-half of self-employment tax. Attach Schedule SE	29	
30	Self-employed health insurance deduction (see page 33)	30	
31	Self-employed SEP, SIMPLE, and qualified plans	31	
32	Penalty on early withdrawal of savings	32	
33a	Alimony paid b Recipient's SSN ▶	33a	
34	Add lines 23 through 33a	34	
35	Subtract line 34 from line 22. This is your adjusted gross income ▶	35	

For Disclosure, Privacy Act, and Paperwork Reduction Act Notice, see page 76. Cat. No. 11320B Form **1040** (2002)

Form 1040 (2002) Page 2

Tax and Credits

36 Amount from line 35 (adjusted gross income) . . . 36

37a Check if: ☐ You were 65 or older, ☐ Blind; ☐ Spouse was 65 or older, ☐ Blind.
Add the number of boxes checked above and enter the total here . . . ▶ 37a

b If you are married filing separately and your spouse itemizes deductions, or you were a dual-status alien, see page 34 and check here . . . ▶ 37b ☐

Standard Deduction for—
- People who checked any box on line 37a or 37b or who can be claimed as a dependent, see page 34.
- All others:

Single, $4,700
Head of household, $6,900
Married filing jointly or Qualifying widow(er), $7,850
Married filing separately, $3,925

38 Itemized deductions (from Schedule A) or your standard deduction (see left margin) . . 38

39 Subtract line 38 from line 36 . . . 39

40 If line 36 is $103,000 or less, multiply $3,000 by the total number of exemptions claimed on line 6d. If line 36 is over $103,000, see the worksheet on page 35 . . . 40

41 Taxable income. Subtract line 40 from line 39. If line 40 is more than line 39, enter -0- . . 41

42 Tax (see page 36). Check if any tax is from: a ☐ Form(s) 8814 b ☐ Form 4972 . . . 42

43 Alternative minimum tax (see page 37). Attach Form 6251 . . . 43

44 Add lines 42 and 43 . . . ▶ 44

45 Foreign tax credit. Attach Form 1116 if required . . . 45

46 Credit for child and dependent care expenses. Attach Form 2441 46

47 Credit for the elderly or the disabled. Attach Schedule R . . 47

48 Education credits. Attach Form 8863 . . . 48

49 Retirement savings contributions credit. Attach Form 8880 . 49

50 Child tax credit (see page 39) . . . 50

51 Adoption credit. Attach Form 8839 . . . 51

52 Credits from: a ☐ Form 8396 b ☐ Form 8859 . . . 52

53 Other credits. Check applicable box(es): a ☐ Form 3800 b ☐ Form 8801 c ☐ Specify ______ 53

54 Add lines 45 through 53. These are your total credits . . . 54

55 Subtract line 54 from line 44. If line 54 is more than line 44, enter -0- . . . ▶ 55

Other Taxes

56 Self-employment tax. Attach Schedule SE . . . 56

57 Social security and Medicare tax on tip income not reported to employer. Attach Form 4137 . . 57

58 Tax on qualified plans, including IRAs, and other tax-favored accounts. Attach Form 5329 if required . 58

59 Advance earned income credit payments from Form(s) W-2 . . . 59

60 Household employment taxes. Attach Schedule H . . . 60

61 Add lines 55 through 60. This is your total tax . . . ▶ 61

Payments

62 Federal income tax withheld from Forms W-2 and 1099 . . 62

63 2002 estimated tax payments and amount applied from 2001 return . 63

64 Earned income credit (EIC) . . . 64

If you have a qualifying child, attach Schedule EIC.

65 Excess social security and tier 1 RRTA tax withheld (see page 56) 65

66 Additional child tax credit. Attach Form 8812 . . . 66

67 Amount paid with request for extension to file (see page 56) 67

68 Other payments from: a ☐ Form 2439 b ☐ Form 4136 c ☐ Form 8885 . 68

69 Add lines 62 through 68. These are your total payments . . . ▶ 69

Refund

Direct deposit? See page 56 and fill in 71b, 71c, and 71d.

70 If line 69 is more than line 61, subtract line 61 from line 69. This is the amount you overpaid 70

71a Amount of line 70 you want refunded to you . . . ▶ 71a

▶ b Routing number ☐☐☐☐☐☐☐☐☐ ▶ c Type: ☐ Checking ☐ Savings

▶ d Account number ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

72 Amount of line 70 you want applied to your 2003 estimated tax ▶ 72

Amount You Owe

73 Amount you owe. Subtract line 69 from line 61. For details on how to pay, see page 57 ▶ 73

74 Estimated tax penalty (see page 57) . . . 74

Third Party Designee

Do you want to allow another person to discuss this return with the IRS (see page 58)? ☐ Yes. Complete the following. ☐ No

Designee's name ▶ Phone no. ▶ ( ) Personal identification number (PIN) ▶ ☐☐☐☐☐

Sign Here

Joint return? See page 21. Keep a copy for your records.

Under penalties of perjury, I declare that I have examined this return and accompanying schedules and statements, and to the best of my knowledge and belief, they are true, correct, and complete. Declaration of preparer (other than taxpayer) is based on all information of which preparer has any knowledge.

Your signature | Date | Your occupation | Daytime phone number ( )

Spouse's signature. If a joint return, both must sign. | Date | Spouse's occupation

Paid Preparer's Use Only

Preparer's signature ▶ | Date | Check if self-employed ☐ | Preparer's SSN or PTIN

Firm's name (or yours if self-employed), address, and ZIP code ▶ | EIN | Phone no. ( )

Form 1040 (2002)

2003 Form 1040

Form **1040** Department of the Treasury—Internal Revenue Service
U.S. Individual Income Tax Return 2003 (99) IRS Use Only—Do not write or staple in this space.

For the year Jan. 1–Dec. 31, 2003, or other tax year beginning , 2003, ending , 20 OMB No. 1545-0074

Label			
(See instructions on page 19.)	Your first name and initial: Willard D	Last name: Fizer	Your social security number: XXX | XX | XXXX
Use the IRS label.	If a joint return, spouse's first name and initial: Edith A	Last name: Fizer	Spouse's social security number: YYY | YY | YYYY
Otherwise, please print or type.	Home address (number and street). If you have a P.O. box, see page 19.: P.O. Box 67468	Apt. no.	▲ Important! ▲
	City, town or post office, state, and ZIP code. If you have a foreign address, see page 19.: Berger, Idaho		You must enter your SSN(s) above.

Presidential Election Campaign (See page 19.)
Note. Checking "Yes" will not change your tax or reduce your refund.
Do you, or your spouse if filing a joint return, want $3 to go to this fund? ▶ You: ☐ Yes ☑ No Spouse: ☐ Yes ☑ No

Filing Status
Check only one box.
1 ☐ Single
2 ☑ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See page 20.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child. (See page 20.)

Exemptions
6a ☑ Yourself. If your parent (or someone else) can claim you as a dependent on his or her tax return, do not check box 6a
b ☑ Spouse
No. of boxes checked on 6a and 6b: 2
c Dependents:

(1) First name Last name	(2) Dependent's social security number	(3) Dependent's relationship to you	(4) ✓ if qualifying child for child tax credit (see page 21)
Michael Fizer	zzz | zz | zzzz	Son	☐
Patrick Fizer	uuu | uu | uuuu	Son	☐
			☐
			☐
			☐

If more than five dependents, see page 21.
No. of children on 6c who: • lived with you • did not live with you due to divorce or separation (see page 21)
Dependents on 6c not entered above: 2
d Total number of exemptions claimed
Add numbers on lines above ▶ 4

Income
Attach Forms W-2 and W-2G here. Also attach Form(s) 1099-R if tax was withheld.
If you did not get a W-2, see page 22.
Enclose, but do not attach, any payment. Also, please use Form 1040-V.

Line	Description	Box	
7	Wages, salaries, tips, etc. Attach Form(s) W-2	7	
8a	Taxable interest. Attach Schedule B if required	8a	
b	Tax-exempt interest. Do not include on line 8a | 8b		
9a	Ordinary dividends. Attach Schedule B if required	9a	
b	Qualified dividends (see page 23) | 9b		
10	Taxable refunds, credits, or offsets of state and local income taxes (see page 23)	10	
11	Alimony received	11	
12	Business income or (loss). Attach Schedule C or C-EZ	12	
13a	Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐	13a	
b	If box on 13a is checked, enter post-May 5 capital gain distributions | 13b		
14	Other gains or (losses). Attach Form 4797	14	
15a	IRA distributions | 15a | b Taxable amount (see page 25)	15b	
16a	Pensions and annuities | 16a | b Taxable amount (see page 25)	16b	
17	Rental real estate, royalties, partnerships, S corporations, trusts, etc. Attach Schedule E	17	
18	Farm income or (loss). Attach Schedule F	18	
19	Unemployment compensation	19	
20a	Social security benefits | 20a | b Taxable amount (see page 27)	20b	
21	Other income. List type and amount (see page 27)	21	
22	Add the amounts in the far right column for lines 7 through 21. This is your total income ▶	22	

Adjusted Gross Income

Line	Description	Box	
23	Educator expenses (see page 29)	23	
24	IRA deduction (see page 29)	24	
25	Student loan interest deduction (see page 31)	25	
26	Tuition and fees deduction (see page 32)	26	
27	Moving expenses. Attach Form 3903	27	
28	One-half of self-employment tax. Attach Schedule SE	28	
29	Self-employed health insurance deduction (see page 33)	29	
30	Self-employed SEP, SIMPLE, and qualified plans	30	
31	Penalty on early withdrawal of savings	31	
32a	Alimony paid b Recipient's SSN ▶	32a	
33	Add lines 23 through 32a	33	
34	Subtract line 33 from line 22. This is your adjusted gross income ▶	34	

For Disclosure, Privacy Act, and Paperwork Reduction Act Notice, see page 77. Cat. No. 11320B Form **1040** (2003)

Tax and Credits

Standard Deduction for—
- People who checked any box on line 36a or 36b or who can be claimed as a dependent, see page 34.
- All others:

Single or Married filing separately, $4,750

Married filing jointly or Qualifying widow(er), $9,500

Head of household, $7,000

35 Amount from line 34 (adjusted gross income) . . . 35

36a Check if: ☐ You were born before January 2, 1939, ☐ Blind. ☐ Spouse was born before January 2, 1939, ☐ Blind. Total boxes checked ▶ 36a

b If you are married filing separately and your spouse itemizes deductions, or you were a dual-status alien, see page 34 and check here ▶ 36b ☐

37 Itemized deductions (from Schedule A) or your standard deduction (see left margin) . . 37

38 Subtract line 37 from line 35 . . . 38

39 If line 35 is $104,625 or less, multiply $3,050 by the total number of exemptions claimed on line 6d. If line 35 is over $104,625, see the worksheet on page 35 . . . 39

40 Taxable income. Subtract line 39 from line 38. If line 39 is more than line 38, enter -0- . . 40

41 Tax (see page 36). Check if any tax is from: a ☐ Form(s) 8814 b ☐ Form 4972 . . . 41

42 Alternative minimum tax (see page 38). Attach Form 6251 . . . 42

43 Add lines 41 and 42 . . . ▶ 43

44 Foreign tax credit. Attach Form 1116 if required . . . 44

45 Credit for child and dependent care expenses. Attach Form 2441 45

46 Credit for the elderly or the disabled. Attach Schedule R . . 46

47 Education credits. Attach Form 8863 . . . 47

48 Retirement savings contributions credit. Attach Form 8880 . 48

49 Child tax credit (see page 40) . . . 49

50 Adoption credit. Attach Form 8839 . . . 50

51 Credits from: a ☐ Form 8396 b ☐ Form 8859 . . . 51

52 Other credits. Check applicable box(es): a ☐ Form 3800 b ☐ Form 8801 c ☐ Specify ______ 52

53 Add lines 44 through 52. These are your total credits . . . 53

54 Subtract line 53 from line 43. If line 53 is more than line 43, enter -0- . . . ▶ 54

Other Taxes

55 Self-employment tax. Attach Schedule SE . . . 55

56 Social security and Medicare tax on tip income not reported to employer. Attach Form 4137 . . 56

57 Tax on qualified plans, including IRAs, and other tax-favored accounts. Attach Form 5329 if required . 57

58 Advance earned income credit payments from Form(s) W-2 . . . 58

59 Household employment taxes. Attach Schedule H . . . 59

60 Add lines 54 through 59. This is your total tax . . . ▶ 60

Payments

If you have a qualifying child, attach Schedule EIC.

61 Federal income tax withheld from Forms W-2 and 1099 . . 61

62 2003 estimated tax payments and amount applied from 2002 return . 62

63 Earned income credit (EIC) . . . 63

64 Excess social security and tier 1 RRTA tax withheld (see page 56) 64

65 Additional child tax credit. Attach Form 8812 . . . 65

66 Amount paid with request for extension to file (see page 56) 66

67 Other payments from: a ☐ Form 2439 b ☐ Form 4136 c ☐ Form 8885 . 67

68 Add lines 61 through 67. These are your total payments . . . ▶ 68

Refund

Direct deposit? See page 56 and fill in 70b, 70c, and 70d.

69 If line 68 is more than line 60, subtract line 60 from line 68. This is the amount you overpaid 69

70a Amount of line 69 you want refunded to you . . . ▶ 70a

▶ b Routing number ▶ c Type: ☐ Checking ☐ Savings

▶ d Account number

71 Amount of line 69 you want applied to your 2004 estimated tax ▶ 71

Amount You Owe

72 Amount you owe. Subtract line 68 from line 60. For details on how to pay, see page 57 ▶ 72

73 Estimated tax penalty (see page 58) . . . 73

Third Party Designee

Do you want to allow another person to discuss this return with the IRS (see page 58)? ☐ Yes. Complete the following. ☐ No

Designee's name ▶ Phone no. ▶ ( ) Personal identification number (PIN) ▶

Sign Here

Joint return? See page 20. Keep a copy for your records.

Under penalties of perjury, I declare that I have examined this return and accompanying schedules and statements, and to the best of my knowledge and belief, they are true, correct, and complete. Declaration of preparer (other than taxpayer) is based on all information of which preparer has any knowledge.

Your signature | Date | Your occupation | Daytime phone number ( )

Spouse's signature. If a joint return, both must sign. | Date | Spouse's occupation

Paid Preparer's Use Only

Preparer's signature ▶ | Date | Check if self-employed ☐ | Preparer's SSN or PTIN

Firm's name (or yours if self-employed), address, and ZIP code ▶ | EIN | Phone no. ( )

Form 1040 (2003)

2004 Form 1040

Form **1040** Department of the Treasury—Internal Revenue Service
U.S. Individual Income Tax Return 2004 (99) IRS Use Only—Do not write or staple in this space.

For the year Jan. 1–Dec. 31, 2004, or other tax year beginning , 2004, ending , 20 OMB No. 1545-0074

Label

(See instructions on page 16.) Use the IRS label. Otherwise, please print or type.

LABEL HERE

Your first name and initial: Willard D	Last name: Fizer	Your social security number: XXX ¦ XX ¦ XXXX
If a joint return, spouse's first name and initial: Edith A	Last name: Fizer	Spouse's social security number: YYY ¦ YY ¦ YYYY
Home address (number and street). If you have a P.O. box, see page 16.: P.O.BOX 67468	Apt. no.	▲ **Important!** ▲ You must enter your SSN(s) above.
City, town or post office, state, and ZIP code. If you have a foreign address, see page 16.: Berger, Idaho		

Presidential Election Campaign (See page 16.)
Note. Checking "Yes" will not change your tax or reduce your refund.
Do you, or your spouse if filing a joint return, want $3 to go to this fund? ▶ You: ☐ Yes ☑ No Spouse: ☐ Yes ☑ No

Filing Status

Check only one box.

1 ☐ Single
2 ☑ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See page 17.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child (see page 17)

Exemptions

6a ☑ Yourself. If someone can claim you as a dependent, do not check box 6a
b ☑ Spouse
c Dependents:

(1) First name Last name	(2) Dependent's social security number	(3) Dependent's relationship to you	(4) ✓ if qualifying child for child tax credit (see page 18)
Michael Fizer	ZZZ ¦ ZZ ¦ ZZZZ	Son	☐
Patrick Fizer	UUU ¦ UU ¦ UUUU	Son	☐
			☐
			☐

If more than four dependents, see page 18.

d Total number of exemptions claimed

Boxes checked on 6a and 6b
No. of children on 6c who:
• lived with you
• did not live with you due to divorce or separation (see page 18)
Dependents on 6c not entered above
Add numbers on lines above ▶ **4**

Income

Attach Form(s) W-2 here. Also attach Forms W-2G and 1099-R if tax was withheld.

If you did not get a W-2, see page 19.

Enclose, but do not attach, any payment. Also, please use Form 1040-V.

7 Wages, salaries, tips, etc. Attach Form(s) W-2 — 7
8a Taxable interest. Attach Schedule B if required — 8a
b Tax-exempt interest. Do not include on line 8a — 8b
9a Ordinary dividends. Attach Schedule B if required — 9a
b Qualified dividends (see page 20) — 9b
10 Taxable refunds, credits, or offsets of state and local income taxes (see page 20) — 10
11 Alimony received — 11
12 Business income or (loss). Attach Schedule C or C-EZ — 12
13 Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐ — 13
14 Other gains or (losses). Attach Form 4797 — 14
15a IRA distributions 15a | b Taxable amount (see page 22) — 15b
16a Pensions and annuities 16a | b Taxable amount (see page 22) — 16b
17 Rental real estate, royalties, partnerships, S corporations, trusts, etc. Attach Schedule E — 17
18 Farm income or (loss). Attach Schedule F — 18
19 Unemployment compensation — 19
20a Social security benefits 20a | b Taxable amount (see page 24) — 20b
21 Other income. List type and amount (see page 24) — 21
22 Add the amounts in the far right column for lines 7 through 21. This is your total income ▶ — 22

Adjusted Gross Income

23 Educator expenses (see page 26) — 23
24 Certain business expenses of reservists, performing artists, and fee-basis government officials. Attach Form 2106 or 2106-EZ — 24
25 IRA deduction (see page 26) — 25
26 Student loan interest deduction (see page 28) — 26
27 Tuition and fees deduction (see page 29) — 27
28 Health savings account deduction. Attach Form 8889 — 28
29 Moving expenses. Attach Form 3903 — 29
30 One-half of self-employment tax. Attach Schedule SE — 30
31 Self-employed health insurance deduction (see page 30) — 31
32 Self-employed SEP, SIMPLE, and qualified plans — 32
33 Penalty on early withdrawal of savings — 33
34a Alimony paid b Recipient's SSN ▶ — 34a
35 Add lines 23 through 34a — 35
36 Subtract line 35 from line 22. This is your adjusted gross income ▶ — 36

For Disclosure, Privacy Act, and Paperwork Reduction Act Notice, see page 75. Cat. No. 11320B Form **1040** (2004)

Tax and Credits

37 Amount from line 36 (adjusted gross income) — 37

39a Check if: ☐ You were born before January 2, 1940, ☐ Blind. ☐ Spouse was born before January 2, 1940, ☐ Blind. Total boxes checked ▶ 39a

b If your spouse itemizes on a separate return or you were a dual-status alien, see page 31 and check here ▶ 39b ☐

Standard Deduction for—
- People who checked any box on line 39a or 39b **or** who can be claimed as a dependent, see page 31.
- All others:

Single or Married filing separately, $4,850

Married filing jointly or Qualifying widow(er), $9,700

Head of household, $7,150

39 Itemized deductions (from Schedule A) or your standard deduction (see left margin) — 39

40 Subtract line 39 from line 37 — 40

41 If line 37 is $107,025 or less, multiply $3,100 by the total number of exemptions claimed on line 6d. If line 37 is over $107,025, see the worksheet on page 33 — 41

42 **Taxable income.** Subtract line 41 from line 40. If line 41 is more than line 40, enter -0- — 42

43 Tax (see page 33). Check if any tax is from: a ☐ Form(s) 8814 b ☐ Form 4972 — 43

44 **Alternative minimum tax** (see page 35). Attach Form 6251 — 44

45 Add lines 43 and 44 ▶ 45

46 Foreign tax credit. Attach Form 1116 if required — 46

47 Credit for child and dependent care expenses. Attach Form 2441 — 47

48 Credit for the elderly or the disabled. Attach Schedule R — 48

49 Education credits. Attach Form 8863 — 49

50 Retirement savings contributions credit. Attach Form 8880 — 50

51 Child tax credit (see page 37) — 51

52 Adoption credit. Attach Form 8839 — 52

53 Credits from: a ☐ Form 8396 b ☐ Form 8859 — 53

54 Other credits. Check applicable box(es): a ☐ Form 3800 b ☐ Form 8801 c ☐ Specify ______ — 54

55 Add lines 46 through 54. These are your **total credits** — 55

56 Subtract line 55 from line 45. If line 55 is more than line 45, enter -0- ▶ 56

Other Taxes

57 Self-employment tax. Attach Schedule SE — 57

58 Social security and Medicare tax on tip income not reported to employer. Attach Form 4137 — 58

59 Additional tax on IRAs, other qualified retirement plans, etc. Attach Form 5329 if required — 59

60 Advance earned income credit payments from Form(s) W-2 — 60

61 Household employment taxes. Attach Schedule H — 61

62 Add lines 56 through 61. This is your **total tax** ▶ 62

Payments

63 Federal income tax withheld from Forms W-2 and 1099 — 63

64 2004 estimated tax payments and amount applied from 2003 return — 64

65a **Earned income credit (EIC)** — 65a

b Nontaxable combat pay election ▶ 65b

If you have a qualifying child, attach Schedule EIC.

66 Excess social security and tier 1 RRTA tax withheld (see page 54) — 66

67 Additional child tax credit. Attach Form 8812 — 67

68 Amount paid with request for extension to file (see page 54) — 68

69 Other payments from: a ☐ Form 2439 b ☐ Form 4136 c ☐ Form 8885 — 69

70 Add lines 63, 64, 65a, and 66 through 69. These are your **total payments** ▶ 70

Refund

Direct deposit? See page 54 and fill in 72b, 72c, and 72d.

71 If line 70 is more than line 62, subtract line 62 from line 70. This is the amount you **overpaid** — 71

72a Amount of line 71 you want **refunded to you** ▶ 72a

▶ b Routing number ▶ c Type: ☐ Checking ☐ Savings

▶ d Account number

73 Amount of line 71 you want **applied to your 2005 estimated tax** ▶ 73

Amount You Owe

74 **Amount you owe.** Subtract line 70 from line 62. For details on how to pay, see page 55 ▶ 74

75 Estimated tax penalty (see page 55) — 75

Third Party Designee

Do you want to allow another person to discuss this return with the IRS (see page 56)? ☐ Yes. Complete the following. ☐ No

Designee's name ▶ Phone no. ▶ ( ) Personal identification number (PIN) ▶

Sign Here

Joint return? See page 17. Keep a copy for your records.

Under penalties of perjury, I declare that I have examined this return and accompanying schedules and statements, and to the best of my knowledge and belief, they are true, correct, and complete. Declaration of preparer (other than taxpayer) is based on all information of which preparer has any knowledge.

Your signature | Date | Your occupation | Daytime phone number ( )

Spouse's signature. If a joint return, **both** must sign. | Date | Spouse's occupation

Paid Preparer's Use Only

Preparer's signature ▶ | Date | Check if self-employed ☐ | Preparer's SSN or PTIN

Firm's name (or yours if self-employed), address, and ZIP code ▶ | EIN | Phone no. ( )

Form **1040** (2004)

Appendix F – Self Evaluation Scoring Sheet

USDA will score each proposal with a set scoring criteria. That criteria have been used in the following attachment to self score this proposal. USDA requires the applicant to "self score" their proposal and provide that assessment as part of the proposal. The USDA guidance on the self scoring process includes this information:

Self-Evaluation Score

Self-score the project using the evaluation criteria in RD Instruction 4280-B, Section 4280.112(e)

To justify the score, submit the total score along with appropriate calculations and attached documentation, or specific cross-references to information elsewhere in the application.

NOTE: A spreadsheet application was used to "self score" this template application. A brief example of the cross-references or documentation is presented after the self score sheets, but it is not complete for the entire scoring process for this template. Complete cross-reference documentation would be expected in a regular application.

Scoring Summary

	Awarded Points	Category	Maximum Possible Points
	15	Energy Replacement Total Points (15 point maximum)	15
	5	Energy Savings Total Points (20 point maximum - 15 + 5 point bonus)	15
	5	Energy Savings Professional Energy Audit Bonus (5 point maximum)	5
	0	Energy Generation Total Points (10 point maximum)	10
	10	Environmental Benefits Total Points (10 point maximum)	10
	10	Commercial Availability Total Points (10 points maximum)	10
	35	Technical Merit Total Points (35 point maximum)	35
	15	Readiness Total Points (15 point maximum)	15
	10	Small Ag Producer / Very Small Business Total Points (10 point maximum)	10
	5	Simplified Application/Low Cost Project Total Points (5 point maximum)	5
	5	Previous Grantees and Borrowers Total Points (5 point maximum)	5
	4	Return on Investment Total Points (10 point maximum)	10
82%	**119**	**Total Score (out of 145 possible)**	145

1 Quantity of energy replaced, produced or saved

(i) Energy Replacement

If the proposed renewable energy system is intended primarily for self-use by the agricultural producer or rural small business and will provide energy replacement of:

(A) greater than zero, but equal to or less than 25 percent, 5 points will be awarded;

(B) greater than 25 percent, but equal to or less than 50 percent, 10 points will be awarded;

(C) or greater than 50 percent, 15 points will be awarded

426,000,000 = Estimated quantity of renewable energy (BTU's) to be generated over a 12 month period.

426,000,000 = Estimated quantity of energy (BTU's) consumed over the same 12 month period during the previous year.

1 = Generation /Consumption

[15] Energy Replacement Total Points (15 point maximum)

(ii) Energy Savings

If the estimated energy expected to be saved by the installation of the energy efficiency improvements will be from:

(A) 20 percent up to, but not including 30 percent, 5 points will be awarded;

(B) 30 percent up to, but not including 35 percent, 10 points will be awarded; or,

(C) 35 percent or greater, 15 points will be awarded

Energy savings will be determined by the projections in an energy assessment or audit. Projects with total eligible project costs of $50,000 or less that opt to obtain a professional energy audit will be awarded an additional 5 points.

[5] Energy Savings Total Points (20 point maximum - 15 + 5 point bonus)

[5] Energy Savings Professional Energy Audit Bonus (5 point maximum)

(iii) Energy Generation

If the proposed renewable energy system is intended primarily for production of energy for sale, 10 points will be awarded.

[0] Energy Generation Total Points (10 point maximum)

2 Environmental Benefits

If the purpose of the proposed system contributes to the environmental goals and objectives of other Federal, State, or local programs, 10 points will be awarded.
Points will only be awarded for this paragraph if the applicant is able to provide documentation from an appropriate authority supporting this claim.

10	Environmental Benefits Total Points (10 point maximum)

3 Commercial Availability

(A) If the proposed system or improvement is currently commercially available and replicable, 5 points will be awarded.
(B) If the proposed system or improvement is commercially available and replicable and is also provided with a 5-year or longer warranty providing the purchaser protection against system degradation or breakdown or component breakdown, 10 points will be awarded.

10	Commercial Availability Total Points (10 points maximum)

4 Technical Merit Score

Each subparagraph has its own maximum possible score and will be scored according to the following criteria:

- a If the description in the subparagraph has no significant weaknesses and exceeds the requirements of the subparagraph, 100 percent of the total possible score for the subparagraph will be awarded.
- b If the description has one or more significant strengths and meets the requirements of the subparagraph, 80 percent of the total possible score will be awarded for the subparagraph.
- c If the description meets the basic requirements of the subparagraph, but also has several weaknesses, 60 percent of the points will be awarded.
- d If the description is lacking in one or more critical aspects, key issues have not been addressed, but the description demonstrates some merit or strengths, 40 percent of the total possible score will be awarded.
- e If the description has serious deficiencies, internal inconsistencies, or is missing information, 20 percent of the total possible score will be awarded.
- f If the description has no merit in this area, 0 percent of the total possible score will be awarded.
- g The total possible points for Technical Merit is 35 points

10	(A) Qualifications of the Project Team (maximum score of 10 points)

The applicant has described the project team service providers, their professional credentials, and relevant experience. The description supports that the project team service, equipment, and installation providers have the necessary professional credentials, licenses, certifications, or relevant experience to develop the proposed project.

5	(B) Agreements and Permits (maximum score of 5 points)

The applicant has described the necessary agreements and permits required for the project and the schedule for securing those agreements and permits.

10	(C) Energy or Resource Assessment (maximum score of 10 points)

The applicant has described the quality and availability of a suitable renewable resource or an assessment of expected energy savings for the proposed system.

30	(D) Design and Engineering (maximum score of 30 points)

The applicant has described the design, engineering, and testing needed for the proposed project. The description supports that the system will be designed, engineered, and tested so as to meet its intended purpose, ensure public safety, and comply with applicable laws, regulations, agreements, permits, codes, and standards.

5	(E) Project Development Schedule (maximum score of 5 points)

The applicant has described the development method, including the key project development activities and the proposed schedule for each activity. The description identifies each significant task, its beginning and end, and its relationship to the time needed to initiate and carry the project through to successful completion. The description addresses grantee or borrower project development cashflow requirements.

20	(F) Project Economic Assessment (maximum score of 20 points)

The applicant has described the financial performance of the proposed project, including the calculation of simple payback. The description addresses project costs and revenues, such as applicable investment and production incentives, and other information to allow the assessment of the project's cost effectiveness.

5	(G) Equipment Procurement (maximum score of 5 points)

The applicant has described the availability of the equipment required by the system. The description supports that the required equipment is available, and can be procured and delivered within the proposed project development schedule.

5	(H) Equipment Installation (maximum score of 5 points)

The applicant has described the plan for site development and system installation.

5	(I) Operation and Maintenance (maximum score of 5 points)

The applicant has described the operations and maintenance requirements of the system necessary for the system to operate as designed over the design life.

5	(J) Dismantling and Disposal of Project Components (maximum score of 5 points)

The applicant has described the requirements for dismantling and disposing of project components at the end of their useful life and associated wastes.

Calculation of Technical Merit Score
To determine the actual points awarded a project for Technical Merit, the following procedure will be used: The score awarded for paragraphs (A) through (J):
Will be added together and then divided by 100, the maximum possible score, to achieve a percentage. This percentage will then be multiplied by the total possible points of 35 to achieve the points awarded for the proposed project for Technical Merit.

100	Total of Technical Merit A-J
1	Total of Technical Merit A-J / 100

35	Technical Merit Total Points (35 point maximum)

5 Readiness

(A) If the applicant has written commitments from the source(s) confirming commitment of 50 percent up to but not including 75 percent of the matching funds prior to the Agency receiving the complete application, 5 points will be awarded.

(B) If the applicant has written commitments from the source(s) confirming commitment of 75 percent up to but not including 100 percent of the matching funds prior to the Agency receiving the complete application, 10 points will be awarded.

(C) If the applicant has written commitments from the source(s) of matching funds confirming commitment of 100 percent of the matching funds prior to the Agency receiving the complete application, 15 points will be awarded.

15	Readiness Total Points (15 point maximum)

6 Small Agricultural Producer / Very Small Business

(A) If the applicant is an agricultural producer producing agricultural products with a gross market value of less than $600,000 in the preceding year, 5 points will be awarded.

(B) If the applicant is an agricultural producer producing agricultural products with a gross market value of less than $200,000 in the preceding year or is a very small business 10 points will be awarded.

10	Small Ag Producer / Very Small Business Total Points (10 point maximum)

7 Simplified Application/Low Cost Projects

If the applicant is eligible for and uses the simplified application process or the project has total eligible project costs of $200,000 or less, 5 points will be awarded.

5	Simplified Application/Low Cost Project Total Points (5 point maximum)

8 Previous Grantees and Borrowers

If an applicant has not been awarded a grant or loan under this program within the 2 previous Federal fiscal years, 5 points will be awarded.

5	Previous Grantees and Borrowers Total Points (5 point maximum)

9 Return on Investment

If the proposed project will return the cost of the investment in:
(A) less than 4 years, 10 points will be awarded;
(B) 4 years up to but not including 8 years, 4 points will be awarded;
(C) 8 years up to 11 years, 2 point will be awarded.

4	Return on Investment Total Points (10 point maximum)

Scoring Justification

1) Section 1 (ii) Quantity of energy replaced, produced or saved
The BTU quantities are found in Appendix A – Heating Loads Summary. The 121 million BTU's that will be used for Slab Warming/Snow Melting were not used in the calculations on the scoring sheet because this is not a required to operate the dairy, but is a very efficient use of the spent geothermal fluid.

2) Section 2 Environmental Benefits.
This project helps meet the US Environmental Protection Agency goal of listed below, by switching from a natural gas heating system with its combustion emissions, to a clean geothermal heating system with no air emissions.

EPA's Goals [from 2003-2008 EPA Strategic Plan: Direction for the Future]
http://www.epa.gov/history/org/origins/goals.htm

Goal 1: Clean Air and Global Climate Change
Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with businesses and other sectors.

3) Section 4a Team Qualifications

The team qualifications are presented in the “Technical Report section I Qualifications of Project Team found on page 9 of this proposal.

Appendix G – USDA and Other Federal Application Forms

This appendix contains the forms required by USDA to be a complete Section 9006 Grant Application

- **Certification for Contracts, Grants and Loans – RD Instructions 1940-Q Exhibit A-1**
- **USDA Certification Regarding Debarment, Suspension, and Other Responsibility Matters – Primary Covered Transactions – Form AD-1047**
- **USDA Equal Opportunity Agreement – Form FD 400-1**
- **USDA Assurance Agreement – Form RD 400-4**
- **Budget Information – Construction Programs – Form 424C**
- **Assurances – Construction Programs – Form 424D**
- **Application for Federal Assistance – Standard Form 424 (SF 424)**
- **Disclosure of Lobbying Activities – Standard Form LLL**
- **USDA Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – Lower Tier covered Transactions – Form AD-1048**
- **USDA Certification Regarding Drug-Free Workplace Requirements (Grants) Alternative I – for Grantees Other Than Individuals – Form AD-1049**
- **USDA Request For Environmental Information – Form RD 1940-20**

CERTIFICATION FOR CONTRACTS, GRANTS AND LOANS

The undersigned certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant or Federal loan, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant or loan.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant or loan, the undersigned shall complete and submit Standard Form - LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all sub awards at all tiers (including contracts, subcontracts, and sub grants under grants and loans) and that all sub recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

____

(name) (date)

____

(title)

U.S. DEPARTMENT OF AGRICULTURE

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

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This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989, Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency with which this transaction originated.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name **PR/Award Number or Project Name**

Name(s) and Title(s) of Authorized Representative(s)

Signature(s) **Date**

Form AD-1048 (1/92)

Instructions for Certification

1. By signing and submitting this form, the prospective lower tier participant is providing the certification set out on the reverse side in accordance with these instructions.

2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

5. The prospective lower tier participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

6. The prospective lower tier participant further agrees by submitting this form that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

7* A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

•U. S.GPO: 1996-757-776/201 07

FORM APPROVED
OMB No. 0575-0018

UNITED STATES DEPARTMENT OF AGRICULTURE

EQUAL OPPORTUNITY AGREEMENT

This agreement, dated ______________________________ between
____

(herein called "Recipient" whether one or more) and United States Department of Agriculture (USDA), pursuant to the rules and regulations of the Secretary of Labor (herein called the 'Secretary') issued under the authority of Executive Order 11246 as amended, witnesseth:

In consideration of financial assistance (whether by a loan, grant, loan guaranty, or other form of financial assistance) made or to be made by the USDA to Recipient, Recipient hereby agrees, if the cash cost of construction work performed by Recipient or a construction contract financed with such financial assistance exceeds $10,000 - unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965.

1. To incorporate or cause to be incorporated into any contract for construction work, or modification thereof, subject to the relevant rules, regulations, and orders of the Secretary or of any prior authority that remain in effect, which is paid for in whole or in part with the aid of such financial assistance, the following "Equal Opportunity Clause":

During the performance of this contract, the contractor agrees as follows:

(a) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited, to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the USDA setting forth the provisions of this nondiscrimination clause.

(b) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(c) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the USDA, advising the said labor union or workers' representative of the contractor's commitments under this agreement and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of all rules, regulations and relevant orders of the Secretary of Labor.

(e) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, rules, regulations, and orders, or pursuant thereto, and will permit access to his books, records, and accounts by the USDA Civil Rights Office, and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(f) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation or order of the Secretary of Labor, or as otherwise provided by Law.

(g) The contractor will include the provisions of paragraph 1 and paragraph (a) through (g) in every subcontract or purchase order, unless exempted by the rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the USDA may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the USDA, the contractor may request the United States to enter into such litigation to protect the interest of the United States.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collections is 0575-0018. The time required to complete this information collection is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

2. To be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, that if the organization so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality or subdivision of such government which does not participate in work on or under the contract.
3. To notify all prospective contractors to file the required 'Compliance Statement', Form RD 400-6, with their bids.
4. Form AD-425, Instructions to Contractors, will accompany the notice of award of the contract. Bid conditions for all nonexempt federal and federally assisted construction contracts require inclusion of the appropriate "Hometown" or "Imposed" plan affirmative action and equal employment opportunity requirements. All bidders must comply with the bid conditions contained in the invitation to be considered responsible bidders and hence eligible for the award.
5. To assist and cooperate actively with USDA and the Secretary in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary, that it will furnish USDA and the Secretary such information such as, but not limited to, Form AD 560, Certification of Nonsegregated Facilities, to submit the Monthly Employment Utilization Report, Form CC-257, as they may require for the supervision of such compliance, and that it will otherwise assist USDA in the discharge of USDA's primary responsibility for securing compliance.
6. To refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive Order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by USDA or the Secretary of Labor pursuant to Part II, Subpart D, of the Executive Order.
7. That if the recipient fails or refuses to comply with these undertakings, the USDA may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this grant (contract, loan, insurance, guarantee); refrain from extending any further assistance to the organization under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such organization; and refer the case to the Department of Justice for appropriate legal proceedings.

Signed by the Recipient on the date first written above.

____
Recipient

____
Recipient

(CORPORATE SEAL)

____
Name of Corporate Recipient

Attest:

____
Secretary

By ______________________________
President

USDA
Form RD 400-4
(Rev. 3-97)

FORM APPROVED
OMB No. 0575-0018

ASSURANCE AGREEMENT

(Under Title VI, Civil Rights Act of 1964)

The ____
(name of recipient)

____
(address)

("Recipient" herein) hereby assures the U. S. Department of Agriculture that Recipient is in compliance with and will continue to comply with Title VI of the Civil Rights Act of 1964 (42 USC 2000d et. seq.), 7 CFR Part 15, and Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, or the Farm Service Agency, (hereafter known as the " Agency") regulations promulgated thereunder, 7 C.F.R. §1901.202. In accordance with that Act and the regulations referred to above, Recipient agrees that in connection with any program or activity for which Recipient receives Federal financial assistance (as such term is defined in 7 C.F.R. §14.2) no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination.

1. Recipient agrees that any transfer of any aided facility, other than personal property, by sale, lease or other conveyance of contract, shall be, and shall be made expressly, subject to the obligations of this agreement and transferee's assumption thereof.
2. Recipient shall:

   (a) Keep such records and submit to the Government such timely, complete, and accurate information as the Government may determine to be necessary to ascertain our/my compliance with this agreement and the regulations.

   (b) Permit access by authorized employees of the Agency or the U.S. Department of Agriculture during normal business hours to such books, records, accounts and other sources of information and its facilities as may be pertinent to ascertaining such compliance.

   (c) Make available to users, participants, beneficiaries and other interested persons such information regarding the provisions of this agreement and the regulations, and in such manner as the Agency or the U.S. Department of Agriculture finds necessary to inform such persons of the protection assured them against discrimination.
3. The obligations of this agreement shall continue:

   (a) As to any real property, including any structure, acquired or improved with the aid of the Federal financial assistance, so long as such real property is used for the purpose for which the Federal financial assistance is made or for another purpose which affords similar services or benefits, or for as long as the Recipient retains ownership or possession of the property, whichever is longer.

   (b) As to any personal property acquired or improved with the aid of the Federal financial assistance, so long as Recipient retains ownership or possession of the property.

   (c) As to any other aided facility or activity, until the last advance of funds under the loan or grant has been made.
4. Upon any breach or violation this agreement the Government may, at its option:

   (a) Terminate or refuse to render or continue financial assistance for the aid of the property, facility, project, service or activity.

   (b) Enforce this agreement by suit for specific performance or by any other available remedy under the laws of the United States or the State in which the breach or violation occurs.

Rights and remedies provided for under this agreement shall be cumulative.

In witness whereof, ____ on this
(name of recipient)

date has caused this agreement to be executed by its duly authorized officers and its seal affixed hereto, or, if a natural person, has hereunto executed this agreement.

____
Recipient

(S E A L)

____
Date

Attest: ______________________________
Title

____
Title

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0570-0018. The time required to complete this information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

OMB Approval No. 0348-0041

BUDGET INFORMATION - Construction Programs

NOTE: Certain Federal assistance programs require additional computations to arrive at the Federal share of project costs eligible for participation. If such is the case, you will be notified.

COST CLASSIFICATION	a. Total Cost	b. Costs Not Allowable for Participation	c. Total Allowable Costs (Columns a-b)
1. Administrative and legal expenses	$ .00	$ .00	$ 0 .00
2. Land, structures, rights-of-way, appraisals, etc.	$ .00	$ .00	$ 0 .00
3. Relocation expenses and payments	$ .00	$ .00	$ 0 .00
4. Architectural and engineering fees	$ .00	$ .00	$ 0 .00
5. Other architectural and engineering fees	$ .00	$ .00	$ 0 .00
6. Project inspection fees	$ .00	$ .00	$ 0 .00
7. Site work	$ .00	$ .00	$ 0 .00
8. Demolition and removal	$ .00	$ .00	$ 0 .00
9. Construction	$ .00	$ .00	$ 0 .00
10. Equipment	$ .00	$ .00	$ 0 .00
11. Miscellaneous	$ .00	$ .00	$ 0 .00
12. SUBTOTAL *(sum of lines 1-11)*	$ 0 .00	$ 0.00	$ 0 .00
13. Contingencies	$ .00	$ .00	$ 0 .00
14. SUBTOTAL	$ 0 .00	$ 0.00	$ 0 .00
15. Project (program) income	$ .00	$ .00	$ 0 .00
16. TOTAL PROJECT COSTS *(subtract #15 from #14)*	$ 0 .00	$ 0.00	$ 0 .00
FEDERAL FUNDING			
17. Federal assistance requested, calculate as follows: (Consult Federal agency for Federal percentage share.) Enter the resulting Federal share.	Enter eligible costs from line 16c Multiply X _______%	To autocalculate, press TAB key after entering percent. These instructions will not print.	$ 0.00

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Prescribed by OMB Circular A-102

INSTRUCTIONS FOR THE SF-424C

Public reporting burden for this collection of information is estimated to average 180 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0041), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

This sheet is to be used for the following types of applications: (1) "New" (means a new [previously unfunded] assistance award); (2) "Continuation" (means funding in a succeeding budget period which stemmed from a prior agreement to fund); and (3) "Revised" (means any changes in the Federal Government's financial obligations or contingent liability from an existing obligation). If there is no change in the award amount, there is no need to complete this form. Certain Federal agencies may require only an explanatory letter to effect minor (no cost) changes. If you have questions, please contact the Federal agency.

Column a. - If this is an application for a "New" project, enter the total estimated cost of each of the items listed on lines 1 through 16 (as applicable) under "COST CLASSIFICATION."

If this application entails a change to an existing award, enter the eligible amounts *approved under the previous award* for the items under "COST CLASSIFICATION."

Column b. - If this is an application for a "New" project, enter that portion of the cost of each item in Column a. which is *not* allowable for Federal assistance. Contact the Federal agency for assistance in determining the allowability of specific costs.

If this application entails a change to an existing award, enter the adjustment [+ or (-)] to the previously approved costs (from column a.) reflected in this application.

Column. - This is the net of lines 1 through 16 in columns "a." and "b."

Line 1 - Enter estimated amounts needed to cover administrative expenses. Do not include costs which are related to the normal functions of government. Allowable legal costs are generally only those associated with the purchases of land which is allowable for Federal participation and certain services in support of construction of the project.

Line 2 - Enter estimated site and right(s)-of-way acquisition costs (this includes purchase, lease, and/or easements).

Line 3 - Enter estimated costs related to relocation advisory assistance, replacement housing, relocation payments to displaced persons and businesses, etc.

Line 4 - Enter estimated basic engineering fees related to construction (this includes start-up services and preparation of project performance work plan).

Line 5 - Enter estimated engineering costs, such as surveys, tests, soil borings, etc.

Line 6 - Enter estimated engineering inspection costs.

Line 7 - Enter estimated costs of site preparation and restoration which are not included in the basic construction contract.

Line 9 - Enter estimated cost of the construction contract.

Line 10 - Enter estimated cost of office, shop, laboratory, safety equipment, etc. to be used at the facility, if such costs are not included in the construction contract.

Line 11 - Enter estimated miscellaneous costs.

Line 12 - Total of items 1 through 11.

Line 13 - Enter estimated contingency costs. (Consult the Federal agency for the percentage of the estimated construction cost to use.)

Line 14 - Enter the total of lines 12 and 13.

Line 15 - Enter estimated program income to be earned during the grant period, e.g., salvaged materials, etc.

Line 16 - Subtract line 15 from line 14.

Line 17 - This block is for the computation of the Federal share. Multiply the total allowable project costs from line 16, column "c." by the Federal percentage share (this may be up to 100 percent; consult Federal agency for Federal percentage share) and enter the product on line 17.

OMB Approval No. 0348-0042

ASSURANCES - CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0042), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the Awarding Agency. Further, certain Federal assistance awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance, and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project costs) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the assistance; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will not dispose of, modify the use of, or change the terms of the real property title, or other interest in the site and facilities without permission and instructions from the awarding agency. Will record the Federal interest in the title of real property in accordance with awarding agency directives and will include a covenant in the title of real property aquired in whole or in part with Federal assistance funds to assure non-discrimination during the useful life of the project.

4. Will comply with the requirements of the assistance awarding agency with regard to the drafting, review and approval of construction plans and specifications.

5. Will provide and maintain competent and adequate engineering supervision at the construction site to ensure that the complete work conforms with the approved plans and specifications and will furnish progress reports and such other information as may be required by the assistance awarding agency or State.

6. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

7. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

8. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

9. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

10. Will comply with all Federal statutes relating to non-discrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681 1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

11. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal and federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

12. Will comply with the provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

13. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333) regarding labor standards for federally-assisted construction subagreements.

14. Will comply with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

15. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

16. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

17. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

18. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

19. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE

APPLICANT ORGANIZATION	DATE SUBMITTED
	May 12, 2015

SF-424D (Rev. 7-97) Back

Version 7/03

APPLICATION FOR FEDERAL ASSISTANCE

2. DATE SUBMITTED		Applicant Identifier
1. TYPE OF SUBMISSION: Application: ☐ **Construction** ☐ **Non-Construction**; Pre-application: ☐ **Construction** ☐ **Non-Construction**	**3. DATE RECEIVED BY STATE**	State Application Identifier
	4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICANT INFORMATION

Legal Name:	**Organizational Unit**: Department:
Organizational DUNS:	Division:
Address: Street:	**Name and telephone number of person to be contacted on matters involving this application (give area code)** Prefix: / First Name:
City:	Middle Name
County:	Last Name
State: / Zip Code	Suffix:
Country:	Email:
6. EMPLOYER IDENTIFICATION NUMBER *(EIN):* ☐☐-☐☐☐☐☐☐☐	Phone Number (give area code) / Fax Number (give area code)
8. TYPE OF APPLICATION: ☐ **New** ☐ **Continuation** ☐ **Revision** If Revision, enter appropriate letter(s) in box(es) (See back of form for description of letters.) ☐ ☐ Other (specify)	**7. TYPE OF APPLICANT:** (See back of form for Application Types) Other (specify)
	9. NAME OF FEDERAL AGENCY:
10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: ☐☐-☐☐☐ TITLE (Name of Program):	**11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:**
12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.):*	
13. PROPOSED PROJECT Start Date: / Ending Date:	**14. CONGRESSIONAL DISTRICTS OF:** a. Applicant / b. Project

15. ESTIMATED FUNDING:		**16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?**
a. Federal	$ .00	a. Yes. ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON
b. Applicant	$ .00	
c. State	$ .00	DATE:
d. Local	$ .00	b. No. ☐ PROGRAM IS NOT COVERED BY E. O. 12372
e. Other	$ .00	☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW
f. Program Income	$ .00	**17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?**
g. TOTAL	$ .00	☐ Yes If "Yes" attach an explanation. ☐ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Authorized Representative

Prefix	First Name	Middle Name
Last Name		Suffix
b. Title		c. Telephone Number (give area code)
d. Signature of Authorized Representative		e. Date Signed

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Standard Form 424 (Rev.9-2003)
Prescribed by OMB Circular A-102

Reset Form

INSTRUCTIONS FOR THE SF-424

Public reporting burden for this collection of information is estimated to average 45 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0043), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

This is a standard form used by applicants as a required face sheet for pre-applications and applications submitted for Federal assistance. It will be used by Federal agencies to obtain applicant certification that States which have established a review and comment procedure in response to Executive Order 12372 and have selected the program to be included in their process, have been given an opportunity to review the applicant's submission.

Item:	Entry:	Item:	Entry:
1.	Select Type of Submission.	11.	Enter a brief descriptive title of the project. If more than one program is involved, you should append an explanation on a separate sheet. If appropriate (e.g., construction or real property projects), attach a map showing project location. For preapplications, use a separate sheet to provide a summary description of this project.
2.	Date application submitted to Federal agency (or State if applicable) and applicant's control number (if applicable).	12.	List only the largest political entities affected (e.g., State, counties, cities).
3.	State use only (if applicable).	13	Enter the proposed start date and end date of the project.
4.	Enter Date Received by Federal Agency Federal identifier number: If this application is a continuation or revision to an existing award, enter the present Federal Identifier number. If for a new project, leave blank.	14.	List the applicant's Congressional District and any District(s) affected by the program or project
5.	Enter legal name of applicant, name of primary organizational unit (including division, if applicable), which will undertake the assistance activity, enter the organization's DUNS number (received from Dun and Bradstreet), enter the complete address of the applicant (including country), and name, telephone number, e-mail and fax of the person to contact on matters related to this application.	15	Amount requested or to be contributed during the first funding/budget period by each contributor. Value of in kind contributions should be included on appropriate lines as applicable. If the action will result in a dollar change to an existing award, indicate only the amount of the change. For decreases, enclose the amounts in parentheses. If both basic and supplemental amounts are included, show breakdown on an attached sheet. For multiple program funding, use totals and show breakdown using same categories as item 15.
6.	Enter Employer Identification Number (EIN) as assigned by the Internal Revenue Service.	16.	Applicants should contact the State Single Point of Contact (SPOC) for Federal Executive Order 12372 to determine whether the application is subject to the State intergovernmental review process.
7.	Select the appropriate letter in the space provided. A. State B. County C. Municipal D. Township E. Interstate F. Intermunicipal G. Special District H. Independent School District I. State Controlled Institution of Higher Learning J. Private University K. Indian Tribe L. Individual M. Profit Organization N. Other (Specify) O. Not for Profit Organization	17.	This question applies to the applicant organization, not the person who signs as the authorized representative. Categories of debt include delinquent audit disallowances, loans and taxes.
8.	Select the type from the following list: • "New" means a new assistance award. • "Continuation" means an extension for an additional funding/budget period for a project with a projected completion date. • "Revision" means any change in the Federal Government's financial obligation or contingent liability from an existing obligation. If a revision enter the appropriate letter: A. Increase Award B. Decrease Award C. Increase Duration D. Decrease Duration	18	To be signed by the authorized representative of the applicant. A copy of the governing body's authorization for you to sign this application as official representative must be on file in the applicant's office. (Certain Federal agencies may require that this authorization be submitted as part of the application.)
9.	Name of Federal agency from which assistance is being requested with this application.		
10.	Use the Catalog of Federal Domestic Assistance number and title of the program under which assistance is requested.		

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB 0348-0046

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352
(See reverse for public burden disclosure.)

1. Type of Federal Action: b
a. contract
b. grant
c. cooperative agreement
d. loan
e. loan guarantee
f. loan insurance

2. Status of Federal Action: a
a. bid/offer/application
b. initial award
c. post-award

3. Report Type: a
a. initial filing
b. material change
For Material Change Only:
year ________ quarter ________
date of last report ______________

4. Name and Address of Reporting Entity:
☒ **Prime** ☐ **Subawardee**
Tier ______, *if known*:

Congressional District, *if known*: 4c 2nd

5. If Reporting Entity in No. 4 is a Subawardee, Enter Name and Address of Prime:

Congressional District, *if known*:

6. Federal Department/Agency:
US Department of Agriculture

7. Federal Program Name/Description:
Renewable Energy and Energy Efficiency Program USDA

CFDA Number, *if applicable*: _____________

8. Federal Action Number, *if known*:

9. Award Amount, *if known*:
$

10. a. Name and Address of Lobbying Registrant (*if individual, last name, first name, MI*):
Fizer, Willard D
P.O. Box 67468
Berger, Idaho
83402

b. Individuals Performing Services (*including address if different from No. 10a*) (*last name, first name, MI*):

11. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Signature: ______________________
Print Name: Willard Berger
Title: ______________________
Telephone No.: 208-526-7468 Date: 9/29/05

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Standard Form LLL (Rev. 7-97)

PRINT

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C. section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a covered Federal action. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.
2. Identify the status of the covered Federal action.
3. Identify the appropriate classification of this report. If this is a followup report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity for this covered Federal action.
4. Enter the full name, address, city, State and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.
5. If the organization filing the report in item 4 checks "Subawardee," then enter the full name, address, city, State and zip code of the prime Federal recipient. Include Congressional District, if known.
6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organizationallevel below agency name, if known. For example, Department of Transportation, United States Coast Guard.
7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.
8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitation for Bid (IFB) number; grant announcement number; the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."
9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.
10. (a) Enter the full name, address, city, State and zip code of the lobbying registrant under the Lobbying Disclosure Act of 1995 engaged by the reporting entity identified in item 4 to influence the covered Federal action.

    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10 (a). Enter Last Name, First Name, and Middle Initial (MI).
11. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is OMB No. 0348-0046. Public reporting burden for this collection of information is estimated to average 10 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0046), Washington, DC 20503.

U.S. DEPARTMENT OF AGRICULTURE

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989, Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency with which this transaction originated.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name **PR/Award Number or Project Name**

Name(s) and Title(s) of Authorized Representative(s)

Signature(s) **Date**

Form AD-1048 (1/92)

Instructions for Certification

1. By signing and submitting this form, the prospective lower tier participant is providing the certification set out on the reverse side in accordance with these instructions.

2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

5. The prospective lower tier participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

6. The prospective lower tier participant further agrees by submitting this form that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

7* A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

Form AD-1048 (1/92)

•U. S.GPO: 1996-757-776/201 07

UNITED STATES DEPARTMENT OF AGRICULTURE

CERTIFICATION REGARDING
DRUG-FREE WORKPLACE REQUIREMENTS (GRANTS)
ALTERNATIVE I - FOR GRANTEES OTHER THAN INDIVIDUALS

This certification is required by the regulations implementing Sections 5151-5160 of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701 *et seq.*), 7 CFR Part 3017, Subpart F, Section 3017.600, Purpose. The January 31, 1989, regulations were amended and published as Part II of the May 25, 1990 **Federal Register** (pages 21681-21691). Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the grant.

(Before completing Certification, read instructions on page 2)

Alternative I

A. The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about --

(1) The dangers of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --

(1) Abide by the terms of the statement; and

(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, State, zip code)

____

____

____

Check ☐ if there are workplaces on file that are not identified here.

____
Organization Name

____
Award Number or Project Name

____
Name and Title of Authorized Representative

____
Signature Date

INSTRUCTIONS FOR CERTIFICATION

1. By signing and submitting this form, the grantee is providing the certification set out on pages 1 and 2.

2. The certification set out on pages 1 and 2 is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

3. Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

4. Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

5. If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph three).

6. Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules:

   "Controlled" substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

   "Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

   "Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

   "Employee" means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

USDA
Form RD 1940-20
(Rev. 6-99)

Position 3

FORM APPROVED
OMB No. 0575-0094

REQUEST FOR ENVIRONMENTAL INFORMATION

Name of Project

Location

Item 1a. Has a Federal, State, or Local Environmental Impact Statement or Analysis been prepared for this project?
☐ Yes ☐ No ☐ Copy attached as EXHIBIT I-A.

1b. If "No." provide the information requested in Instructions as EXHIBIT I.

Item 2. The State Historic Preservation Officer (SHOP) has been provided a detailed project description and has been requested to submit comments to the appropriate Rural Development Office. ☐ Yes ☐ No Date description submitted to SHPO ______________

Item 3. Are any of the following land uses or environmental resources either to be affected by the proposal or located within or adjacent to the project site(s)? *(Check appropriate box for every item of the following checklist).*

	Yes	**No**	**Unknown**
1. Industrial.	☐	☐	☐
2. Commercial.	☐	☐	☐
3. Residential..	☐	☐	☐
4. Agricultural	☐	☐	☐
5. Grazing	☐	☐	☐
6. Mining, Quarrying	☐	☐	☐
7. Forests	☐	☐	☐
8. Recreational	☐	☐	☐
9. Transportation	☐	☐	☐
10. Parks	☐	☐	☐
11. Hospital	☐	☐	☐
12. Schools	☐	☐	☐
13. Open spaces	☐	☐	☐
14. Aquifer Recharge Area	☐	☐	☐
15. Steep Slopes	☐	☐	☐
16. Wildlife Refuge	☐	☐	☐
17. Shoreline	☐	☐	☐
18. Beaches	☐	☐	☐
19. Dunes	☐	☐	☐
20. Estuary	☐	☐	☐
21. Wetlands	☐	☐	☐
22. Floodplain	☐	☐	☐
23. Wilderness *(designated or proposed under the Wilderness Act)*	☐	☐	☐
24. Wild or Scenic River *(proposed or designated under the Wild and Scenic Rivers Act)*	☐	☐	☐
25. Historical, Archeological Sites *(Listed on the National Register of Historic Places or which may be eligible for listing)*	☐	☐	☐
26. Critical Habitats *(endangered /threatened species)*	☐	☐	☐
27. Wildlife	☐	☐	☐
28. Air Quality	☐	☐	☐
29. Solid Waste Management	☐	☐	☐
30. Energy Supplies	☐	☐	☐
31. Natural Landmark *(Listed on National Registry of Natural Landmarks)*	☐	☐	☐
32. Coastal Barrier Resources System	☐	☐	☐

Item 4. Are any facilities under your ownership, lease, or supervision to be utilized in the accomplishment of this project, either listed or under consideration for listing on the Environmental Protection Agency's List of Violating Facilities? ☐ Yes ☐ No

______________________________ Signed: ______________________________

(Date) *(Applicant)*

____

(Title)

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collections is 0575-0094. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

INSTRUCTIONS FOR PREPARING FORM RD 1940-20

Federal agencies are required by law to independently assess the expected environmental impacts associated with proposed Federal actions. It is extremely important that the information provided be in sufficient detail to permit Rural Department to perform its evaluation. Failure to provide sufficient data will delay agency review and a decision on the processing of your application.

This information request is designed to obtain an understanding of the area's present environmental condition and the project's elements that will affect the environment. Should you believe that an item does not need to be addressed for your project, consult with the RD office from which you received this Form before responding. In all cases when it is believed that an item is not applicable, explain the reasons for this belief.

It is important to understand the comprehensive nature of the information requested. Information must be provided for a) the site(s) where the project facilities will be constructed and the surrounding areas to be directly and indirectly affected by its operation and b) the areas affected by any primary beneficiaries of the project. The amount of detail should be commensurate with the complexity and size of the project, and the magnitude of the expected impact. Some examples:

A small community center project may not require detailed information on air emissions, meteorological conditions and solid waste management.

A water resource, industrial development, or housing development project will require detailed information.

Item la - Compare the Environmental Impact Statement or Analysis that was previously prepared with the information requested in the instructions for Item lb below to be sure that every point in the information request is covered in the Environmental Impact Statement or Analysis. If any of the requested information is not covered, attach to the Environmental Impact Statement or Analysis a supplemental document that corrects any deficiencies or omissions.

Item lb - Provide responses to the following items in the order listed and attach as EXHIBIT I. In order to understand the full scope of the land uses and environmental factors that need to be considered in responding to these items, it may be helpful to complete Item 3 of the Form before completing these narrative responses. If your application is for a project that Rural Development has classified as a Class I action, complete only parts (1), (2), (13), (15), (16), and (17) of this Item. The Rural Development office from which you received this Form can tell you if your application falls within the Class I category.

(1) Primary Beneficiaries

Identify any existing businesses or major developments that will benefit from the proposal, and those which will expand or locate in the area because of the project. These businesses or major developments hereafter will be referred to as primary beneficiaries.

(2) Area Description

(a) Describe the size, terrain, and present land uses as well as the adjacent land uses of the areas to be affected. These areas include the site(s) of construction or project activities, adjacent areas, and areas affected by the primary beneficiaries.

(b) For each box checked "Yes" in item 3, describe the nature of the effect on the resource. If one or more of boxes 17 through 22 is checked "Yes" or "Unknown," contact Rural Development for instructions relating to the requirements imposed by the Floodplain Management and Wetland Protection Executive Orders.

(c) Attach as Exhibit II the following: 1) a U.S. Geological Survey "15 minute" ("7 1/2 minute" if available) topographic map which clearly delineates the area and the location of the project elements; 2) the Federal Emergency Management Administration's floodplain map(s) for the project area; 3) site photos; 4) if completed, a standard soil survey for the project area; and 5) if available, an aerial photograph of the site. If a floodplain map is not available, contact Rural Development for additional instructions relating to the requirements imposed by the Floodplain Management Executive Order.

(3) Air Quality

(a) Provide available air quality data from the monitoring station(s) either within the project area or, if none exist nearest the project area.

(b) Indicate the types and quantities of air emissions to be produced by the project facilities and its primary beneficiaries. If odors will occur, indicate who will be affected.

(c) Indicate if topographical or meteorological conditions hinder the dispersal of air emissions.

(d) Indicate the measures to be taken to control air emissions.

(4) Water Quality

(a) Provide available data on the water quality of surface or underground water in or near the project area.

(b) Indicate the source, quality, and available supply of raw water and the amount of water which the project is designed to utilize.

(c) Describe all of the effluents or discharges associated with the project facilities and its primary beneficiaries. Indicate the expected composition and quantities of these discharges prior to any treatment processes that they undergo and also prior to their release into the environment.

(d) Describe any treatment systems which will be used for these effluents and indicate their capacities and their adequacy in terms of the degree and type of treatment provided. Indicate all discharges which will not be treated. Describe the receiving waters and their uses (e.g., recreational) for any sources of treated and untreated discharge.

(e) If the treatment systems are or will be inadequate or overloaded, describe the steps being taken for necessary improvements and their completion dates.

(f) Describe how surface runoff will be handled if not discussed in (d) above.

(5) Solid Waste Management

(a) Indicate the types and quantities of solid wastes to be produced by the project facilities and its primary beneficiaries.

(b) Describe the methods for disposing of these solid wastes plus the useful life of such methods.

(c) Indicate if recycling or resource recovery programs are or will be used.

(6) Transportation

(a) Briefly describe the available transportation facilities serving the project area.

(b) Describe any new transportation patterns which will arise because of the project.

(c) Indicate if any land uses, such as residential, hospitals, schools or recreational, will be affected by these new patterns.

(d) Indicate if any existing capacities of these transportation facilities will be exceeded. If so, indicate the increased loads which the project will place upon these facilities, particularly in terms of car and truck traffic.

(7) Noise

(a) Indicate the major sources of noise associated with the project facilities and its primary beneficiaries.

(b) Indicate the land uses to be affected by this noise.

(8) Historic/Archeological Properties

(a) Identify any known historic/archeological resources within the project area that are either listed on the National Register of Historic Places or considered to be of local and state significance and perhaps eligible for listing in the National Register.

(b) Attach as EXHIBIT III any historical/archeological survey that has been conducted for the project area.

(9) Wildlife and Endangered Species

(a) Identify any known wildlife resources located in the project area or its immediate vicinity.

(b) Indicate whether to your knowledge any endangered or threatened species or critical habitat have been identified in the project area or its immediate vicinity.

(10) Energy

(a) Describe the energy supplies available to the project facilities and the primary beneficiaries.

(b) Indicate what portion of the remaining capacities of these supplies will be utilized.

(11) Construction

Describe the methods which will be employed to reduce adverse impacts from construction, such as noise, soil erosion and siltation.

(12) Toxic Substances

(a) Describe any toxic, hazardous, or radioactive substances which will be utilized or produced by the project facilities and its primary beneficiaries.

(b) Describe the manner in which these substances will be stored, used, and disposed.

(13) Public Reaction

(a) Describe any objections which have been made to the project.

(b) If a public hearing has been held, attach a copy of the transcript as EXHIBIT IV. If not, certify that a hearing was not held.

(c) Indicate any other evidence of the community's awareness of the project such as through newspaper articles or public notification.

(14) Alternatives to the Proposed Project

Provide a description of any of the following types of alternatives which were considered:

(a) Alternative locations.

(b) Alternative designs.

(c) Alternative projects having similar benefits.

(15) Mitigation Measures

Describe any measures which will be taken to avoid or mitigate any adverse environmental impacts associated with the project.

(16) Permits

(a) Identify any permits of an environmental nature which are needed for the project.

(b) Indicate the status of obtaining each such permit and attach as EXHIBIT V any that have been received.

(17) Other Federal Actions

Identify other federal programs or actions which are either related to this project or located in the same geographical area and for which you are filing an application, have recently received approval, or have in the planning stages.

Item 2 - All applicants are required to provide the State Historic Preservation Officer (SHPO) with (a) a narrative description of the project's elements and its location, (b) a map of the area surrounding theproject which identifies the project site, adjacent streets and other identifiable objects, (c) line drawings or sketches of the project and (d) photographs of the affected properties if building demolition or renovation is involved. This material must be submitted to the SHPO no later than submission of this Form to Rural Development . Additionally, the SHPO must be requested to submit comments on the proposed project to the Rural Development office processing your application.

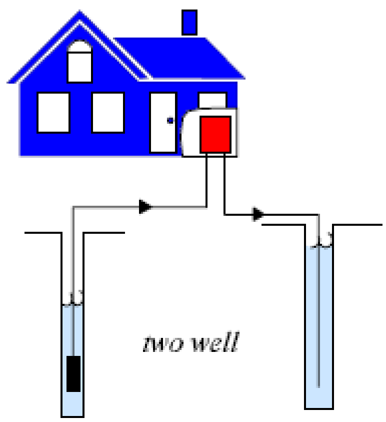
Item 3 - Self-explanatory.

Item 4 - Self-explanatory.

Hart Dairy Heating and Cooling Energy Efficiency Improvement

A Proposal Prepared for the United States Department Of Agriculture
2002 Farm bill Initiative: The Renewable Energy And Energy Efficiency Program
USDA Farm Bill Section 9006

For Purchase and Installation of a Geothermal Heat Pump Well-to-Well Energy Efficient System at the Hart Dairy Farm in Shelly, Idaho



This template has been prepared as a guide to allow users to see the type of information required to receive grant funding from the USDA Section 9006 program. This template uses fictitious names, dollar values and project descriptions. It was prepared as an example of what a complete proposal submitted to the USDA under the Renewable Energy Systems guidelines might look like. This template was not prepared by and has not been approved or scored by the USDA.

The project described in this proposal is for purchasing and installing an Energy Efficiency Improvement system (Ground Source Heat Pump).

August 2006

Table of Contents

I. Forms, Certifications and Organizational Documents

This section contains the following forms and certifications required by the USDA 9006 program.

Form SF-424 “Application for Federal Assistance”

FormSF-424C “Budget Information – Construction Programs”

Form SF-424D “Assurances – Construction Programs”

Form RD 1940-20 “Request for Environmental Information”

AD-1049 “Certification Regarding Drug-Free Workplace Requirements (Grants) Alternative 1-For Grantees Other than Individuals”

AD-1048 “Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tiered Covered Transactions”

Exhibit A-1 of RD Instruction 1940-Q “Certification for Contracts Grants and Loans”

Form SF-LLL “Disclosure of Lobbying Activities”

AD-1047 “Certification Regarding Debarment, Suspension, and Other Responsibility Matters – Primary Covered Transactions”

Form RD 400-1 “Equal Opportunity Agreement

Form RD 400-4 “Assurance Agreement”

APPLICATION FOR FEDERAL ASSISTANCE

Version 7/03

2. DATE SUBMITTED 29 September 2006	Applicant Identifier
1. TYPE OF SUBMISSION: Application: ☑ Construction ☐ Non-Construction; Pre-application: ☐ Construction ☐ Non-Construction	
3. DATE RECEIVED BY STATE	State Application Identifier
4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICANT INFORMATION

Legal Name: Lee Hart	**Organizational Unit:** Department:
Organizational DUNS:	Division:
Address: Street: P.O. Box 6748	**Name and telephone number of person to be contacted on matters involving this application (give area code)** Prefix: 208-526-1000 First Name:
City: Shelly	Middle Name
County: Bingham	Last Name
State: Idaho Zip Code 83402	Suffix:
Country:	Email:
6. EMPLOYER IDENTIFICATION NUMBER *(EIN)*: x x - x x x x x x x	Phone Number (give area code) / Fax Number (give area code)
8. TYPE OF APPLICATION: ☑ New ☐ Continuation ☐ Revision. If Revision, enter appropriate letter(s) in box(es) (See back of form for description of letters.) ☐ ☐ Other (specify)	**7. TYPE OF APPLICANT:** (See back of form for Application Types) L Other (specify)
	9. NAME OF FEDERAL AGENCY: United States Department of Agriculture
10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: ☐☐-☐☐☐ TITLE (Name of Program):	**11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:** Use of Geothermal Resources for Heating and Processing At a Dairy
12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.)*:	
13. PROPOSED PROJECT Start Date: 31 October 2006 Ending Date: 7 March 2007	**14. CONGRESSIONAL DISTRICTS OF:** a. Applicant Mike Simpson - Idaho 2nd; b. Project Mike Simpson - Idaho 2nd

15. ESTIMATED FUNDING:		
a. Federal	$	21,895 .00
b. Applicant	$	65,685 .00
c. State	$	.00
d. Local	$	0 .00
e. Other	$	0 .00
f. Program Income	$	0 .00
g. TOTAL	$	87,580 .00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. Yes. ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON

DATE:

b. No. ☐ PROGRAM IS NOT COVERED BY E. O. 12372

☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes" attach an explanation. ☑ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Authorized Representative		
Prefix Mr.	First Name Lee	Middle Name
Last Name Hart		Suffix
b. Title		c. Telephone Number (give area code) 208-526-1000
d. Signature of Authorized Representative		e. Date Signed 29 September 2006

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Standard Form 424 (Rev.9-2003)
Prescribed by OMB Circular A-102

Reset Form

INSTRUCTIONS FOR THE SF-424

This is a standard form used by applicants as a required face sheet for pre-applications and applications submitted for Federal assistance. It will be used by Federal agencies to obtain applicant certification that States which have established a review and comment procedure in response to Executive Order 12372 and have selected the program to be included in their process, have been given an opportunity to review the applicant's submission.

Item:	Entry:	Item:	Entry:
1.	Select Type of Submission.	11.	Enter a brief descriptive title of the project. If more than one program is involved, you should append an explanation on a separate sheet. If appropriate (e.g., construction or real property projects), attach a map showing project location. For preapplications, use a separate sheet to provide a summary description of this project.
2.	Date application submitted to Federal agency (or State if applicable) and applicant's control number (if applicable).	12.	List only the largest political entities affected (e.g., State, counties, cities).
3.	State use only (if applicable).	13	Enter the proposed start date and end date of the project.
4.	Enter Date Received by Federal Agency Federal identifier number: If this application is a continuation or revision to an existing award, enter the present Federal Identifier number. If for a new project, leave blank.	14.	List the applicant's Congressional District and any District(s) affected by the program or project
5.	Enter legal name of applicant, name of primary organizational unit (including division, if applicable), which will undertake the assistance activity, enter the organization's DUNS number (received from Dun and Bradstreet), enter the complete address of the applicant (including country), and name, telephone number, e-mail and fax of the person to contact on matters related to this application.	15	Amount requested or to be contributed during the first funding/budget period by each contributor. Value of in kind contributions should be included on appropriate lines as applicable. If the action will result in a dollar change to an existing award, indicate only the amount of the change. For decreases, enclose the amounts in parentheses. If both basic and supplemental amounts are included, show breakdown on an attached sheet. For multiple program funding, use totals and show breakdown using same categories as item 15.
6.	Enter Employer Identification Number (EIN) as assigned by the Internal Revenue Service.	16.	Applicants should contact the State Single Point of Contact (SPOC) for Federal Executive Order 12372 to determine whether the application is subject to the State intergovernmental review process.
7.	Select the appropriate letter in the space provided. A. State B. County C. Municipal D. Township E. Interstate F. Intermunicipal G. Special District H. Independent School District I. State Controlled Institution of Higher Learning J. Private University K. Indian Tribe L. Individual M. Profit Organization N. Other (Specify) O. Not for Profit Organization	17.	This question applies to the applicant organization, not the person who signs as the authorized representative. Categories of debt include delinquent audit disallowances, loans and taxes.
8.	Select the type from the following list: • "New" means a new assistance award. • "Continuation" means an extension for an additional funding/budget period for a project with a projected completion date. • "Revision" means any change in the Federal Government's financial obligation or contingent liability from an existing obligation. If a revision enter the appropriate letter: A. Increase Award B. Decrease Award C. Increase Duration D. Decrease Duration	18	To be signed by the authorized representative of the applicant. A copy of the governing body's authorization for you to sign this application as official representative must be on file in the applicant's office. (Certain Federal agencies may require that this authorization be submitted as part of the application.)
9.	Name of Federal agency from which assistance is being requested with this application.		
10.	Use the Catalog of Federal Domestic Assistance number and title of the program under which assistance is requested.		

OMB Approval No. 0348-0041

BUDGET INFORMATION - Construction Programs

NOTE: Certain Federal assistance programs require additional computations to arrive at the Federal share of project costs eligible for participation. If such is the case, you will be notified.

COST CLASSIFICATION	a. Total Cost	b. Costs Not Allowable for Participation	c. Total Allowable Costs (Columns a-b)
1. Administrative and legal expenses	$ 0 .00	$ 0.00	$ 0 .00
2. Land, structures, rights-of-way, appraisals, etc.	$ 0 .00	$ 0.00	$ 0 .00
3. Relocation expenses and payments	$ 0 .00	$ 0.00	$ 0 .00
4. Architectural and engineering fees	$ 16,260 .00	$ 0.00	$ 16,260 .00
5. Other architectural and engineering fees	$ .00	$ 0.00	$ 0 .00
6. Project inspection fees	$ .00	$ 0.00	$ 0 .00
7. Site work	$ .00	$ 0.00	$ 0 .00
8. Demolition and removal	$ 0 .00	$ 0.00	$ 0 .00
9. Construction	$ 21,000 .00	$ 0.00	$ 21,000 .00
10. Equipment	$ 50,320 .00	$ 0.00	$ 50,320 .00
11. Miscellaneous	$ .00	$ 0.00	$ 0 .00
12. SUBTOTAL *(sum of lines 1-11)*	$ 87,580 .00	$ 0.00	$ 87,580 .00
13. Contingencies	$ .00	$ 0.00	$ 0 .00
14. SUBTOTAL	$ 87,580 .00	$ 0.00	$ 87,580 .00
15. Project (program) income	$ 0 .00	$ 0.00	$ 0 .00
16. TOTAL PROJECT COSTS *(subtract #15 from #14)*	$ 87,580 .00	$ 0.00	$ 87,580 .00
FEDERAL FUNDING			
17. Federal assistance requested, calculate as follows: (Consult Federal agency for Federal percentage share.) Enter the resulting Federal share.	Enter eligible costs from line 16c Multiply X 25.00 %	To autocalculate, press TAB key after entering percent. These instructions will not print.	$ 21,895.00

Previous Edition Usable

Authorized for Local Reproduction

Standard Form 424C (Rev. 7-97)
Prescribed by OMB Circular A-102

INSTRUCTIONS FOR THE SF-424C

Public reporting burden for this collection of information is estimated to average 180 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0041), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

This sheet is to be used for the following types of applications: (1) "New" (means a new [previously unfunded] assistance award); (2) "Continuation" (means funding in a succeeding budget period which stemmed from a prior agreement to fund); and (3) "Revised" (means any changes in the Federal Government's financial obligations or contingent liability from an existing obligation). If there is no change in the award amount, there is no need to complete this form. Certain Federal agencies may require only an explanatory letter to effect minor (no cost) changes. If you have questions, please contact the Federal agency.

Column a. - If this is an application for a "New" project, enter the total estimated cost of each of the items listed on lines 1 through 16 (as applicable) under "COST CLASSIFICATION."

If this application entails a change to an existing award, enter the eligible amounts *approved under the previous award* for the items under "COST CLASSIFICATION."

Column b. - If this is an application for a "New" project, enter that portion of the cost of each item in Column a. which is *not* allowable for Federal assistance. Contact the Federal agency for assistance in determining the allowability of specific costs.

If this application entails a change to an existing award, enter the adjustment [+ or (-)] to the previously approved costs (from column a.) reflected in this application.

Column. - This is the net of lines 1 through 16 in columns "a." and "b."

Line 1 - Enter estimated amounts needed to cover administrative expenses. Do not include costs which are related to the normal functions of government. Allowable legal costs are generally only those associated with the purchases of land which is allowable for Federal participation and certain services in support of construction of the project.

Line 2 - Enter estimated site and right(s)-of-way acquisition costs (this includes purchase, lease, and/or easements).

Line 3 - Enter estimated costs related to relocation advisory assistance, replacement housing, relocation payments to displaced persons and businesses, etc.

Line 4 - Enter estimated basic engineering fees related to construction (this includes start-up services and preparation of project performance work plan).

Line 5 - Enter estimated engineering costs, such as surveys, tests, soil borings, etc.

Line 6 - Enter estimated engineering inspection costs.

Line 7 - Enter estimated costs of site preparation and restoration which are not included in the basic construction contract.

Line 9 - Enter estimated cost of the construction contract.

Line 10 - Enter estimated cost of office, shop, laboratory, safety equipment, etc. to be used at the facility, if such costs are not included in the construction contract.

Line 11 - Enter estimated miscellaneous costs.

Line 12 - Total of items 1 through 11.

Line 13 - Enter estimated contingency costs. (Consult the Federal agency for the percentage of the estimated construction cost to use.)

Line 14 - Enter the total of lines 12 and 13.

Line 15 - Enter estimated program income to be earned during the grant period, e.g., salvaged materials, etc.

Line 16 - Subtract line 15 from line 14.

Line 17 - This block is for the computation of the Federal share. Multiply the total allowable project costs from line 16, column "c." by the Federal percentage share (this may be up to 100 percent; consult Federal agency for Federal percentage share) and enter the product on line 17.

OMB Approval No. 0348-0042

ASSURANCES - CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0042), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the Awarding Agency. Further, certain Federal assistance awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance, and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project costs) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the assistance; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will not dispose of, modify the use of, or change the terms of the real property title, or other interest in the site and facilities without permission and instructions from the awarding agency. Will record the Federal interest in the title of real property in accordance with awarding agency directives and will include a covenant in the title of real property aquired in whole or in part with Federal assistance funds to assure non-discrimination during the useful life of the project.

4. Will comply with the requirements of the assistance awarding agency with regard to the drafting, review and approval of construction plans and specifications.

5. Will provide and maintain competent and adequate engineering supervision at the construction site to ensure that the complete work conforms with the approved plans and specifications and will furnish progress reports and such other information as may be required by the assistance awarding agency or State.

6. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

7. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

8. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

9. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

10. Will comply with all Federal statutes relating to non-discrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681 1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

11. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal and federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

12. Will comply with the provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

13. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333) regarding labor standards for federally-assisted construction subagreements.

14. Will comply with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

15. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

16. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

17. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

18. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

19. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE Owner
APPLICANT ORGANIZATION Hart Dairy	DATE SUBMITTED September 7, 2006

SF-424D (Rev. 7-97) Back

USDA
Form RD 1940-20
(Rev. 6-99)

Position 3

FORM APPROVED
OMB No. 0575-0094

REQUEST FOR ENVIRONMENTAL INFORMATION

Name of Project

Location

Item 1a. Has a Federal, State, or Local Environmental Impact Statement or Analysis been prepared for this project?
☐ Yes ☐ No ☐ Copy attached as EXHIBIT I-A.

1b. If "No." provide the information requested in Instructions as EXHIBIT I.

Item 2. The State Historic Preservation Officer (SHOP) has been provided a detailed project description and has been requested to submit comments to the appropriate Rural Development Office. ☐ Yes ☐ No Date description submitted to SHPO ______________

Item 3. Are any of the following land uses or environmental resources either to be affected by the proposal or located within or adjacent to the project site(s)? *(Check appropriate box for every item of the following checklist).*

	Yes	No	Unknown
1. Industrial	☐	☐	☐
2. Commercial	☐	☐	☐
3. Residential	☐	☐	☐
4. Agricultural	☐	☐	☐
5. Grazing	☐	☐	☐
6. Mining, Quarrying	☐	☐	☐
7. Forests	☐	☐	☐
8. Recreational	☐	☐	☐
9. Transportation	☐	☐	☐
10. Parks	☐	☐	☐
11. Hospital	☐	☐	☐
12. Schools	☐	☐	☐
13. Open spaces	☐	☐	☐
14. Aquifer Recharge Area	☐	☐	☐
15. Steep Slopes	☐	☐	☐
16. Wildlife Refuge	☐	☐	☐
17. Shoreline	☐	☐	☐
18. Beaches	☐	☐	☐
19. Dunes	☐	☐	☐
20. Estuary	☐	☐	☐
21. Wetlands	☐	☐	☐
22. Floodplain	☐	☐	☐
23. Wilderness *(designated or proposed under the Wilderness Act)*	☐	☐	☐
24. Wild or Scenic River *(proposed or designated under the Wild and Scenic Rivers Act)*	☐	☐	☐
25. Historical, Archeological Sites *(Listed on the National Register of Historic Places or which may be eligible for listing)*	☐	☐	☐
26. Critical Habitats *(endangered /threatened species)*	☐	☐	☐
27. Wildlife	☐	☐	☐
28. Air Quality	☐	☐	☐
29. Solid Waste Management	☐	☐	☐
30. Energy Supplies	☐	☐	☐
31. Natural Landmark *(Listed on National Registry of Natural Landmarks)*	☐	☐	☐
32. Coastal Barrier Resources System	☐	☐	☐

Item 4. Are any facilities under your ownership, lease, or supervision to be utilized in the accomplishment of this project, either listed or under consideration for listing on the Environmental Protection Agency's List of Violating Facilities? ☐ Yes ☐ No

______________________________ Signed: ______________________________
(Date) *(Applicant)*

____
(Title)

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collections is 0575-0094. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

INSTRUCTIONS FOR PREPARING FORM RD 1940-20

Federal agencies are required by law to independently assess the expected environmental impacts associated with proposed Federal actions. It is extremely important that the information provided be in sufficient detail to permit Rural Department to perform its evaluation. Failure to provide sufficient data will delay agency review and a decision on the processing of your application.

This information request is designed to obtain an understanding of the area's present environmental condition and the project's elements that will affect the environment. Should you believe that an item does not need to be addressed for your project, consult with the RD office from which you received this Form before responding. In all cases when it is believed that an item is not applicable, explain the reasons for this belief.

It is important to understand the comprehensive nature of the information requested. Information must be provided for a) the site(s) where the project facilities will be constructed and the surrounding areas to be directly and indirectly affected by its operation and b) the areas affected by any primary beneficiaries of the project. The amount of detail should be commensurate with the complexity and size of the project, and the magnitude of the expected impact. Some examples:

A small community center project may not require detailed information on air emissions, meteorological conditions and solid waste management.

A water resource, industrial development, or housing development project will require detailed information.

Item la - Compare the Environmental Impact Statement or Analysis that was previously prepared with the information requested in the instructions for Item lb below to be sure that every point in the information request is covered in the Environmental Impact Statement or Analysis. If any of the requested information is not covered, attach to the Environmental Impact Statement or Analysis a supplemental document that corrects any deficiencies or omissions.

Item lb - Provide responses to the following items in the order listed and attach as EXHIBIT I. In order to understand the full scope of the land uses and environmental factors that need to be considered in responding to these items, it may be helpful to complete Item 3 of the Form before completing these narrative responses. If your application is for a project that Rural Development has classified as a Class I action, complete only parts (1), (2), (13), (15), (16), and (17) of this Item. The Rural Development office from which you received this Form can tell you if your application falls within the Class I category.

(1) Primary Beneficiaries

Identify any existing businesses or major developments that will benefit from the proposal, and those which will expand or locate in the area because of the project. These businesses or major developments hereafter will be referred to as primary beneficiaries.

(2) Area Description

(a) Describe the size, terrain, and present land uses as well as the adjacent land uses of the areas to be affected. These areas include the site(s) of construction or project activities, adjacent areas, and areas affected by the primary beneficiaries.

(b) For each box checked "Yes" in item 3, describe the nature of the effect on the resource. If one or more of boxes 17 through 22 is checked "Yes" or "Unknown," contact Rural Development for instructions relating to the requirements imposed by the Floodplain Management and Wetland Protection Executive Orders.

(c) Attach as Exhibit II the following: 1) a U.S. Geological Survey "15 minute" ("7 1/2 minute" if available) topographic map which clearly delineates the area and the location of the project elements; 2) the Federal Emergency Management Administration's floodplain map(s) for the project area; 3) site photos; 4) if completed, a standard soil survey for the project area; and 5) if available, an aerial photograph of the site. If a floodplain map is not available, contact Rural Development for additional instructions relating to the requirements imposed by the Floodplain Management Executive Order.

(3) Air Quality

(a) Provide available air quality data from the monitoring station(s) either within the project area or, if none exist nearest the project area.

(b) Indicate the types and quantities of air emissions to be produced by the project facilities and its primary beneficiaries. If odors will occur, indicate who will be affected.

(c) Indicate if topographical or meteorological conditions hinder the dispersal of air emissions.

(d) Indicate the measures to be taken to control air emissions.

(4) Water Quality

(a) Provide available data on the water quality of surface or underground water in or near the project area.

(b) Indicate the source, quality, and available supply of raw water and the amount of water which the project is designed to utilize.

(c) Describe all of the effluents or discharges associated with the project facilities and its primary beneficiaries. Indicate the expected composition and quantities of these discharges prior to any treatment processes that they undergo and also prior to their release into the environment.

(d) Describe any treatment systems which will be used for these effluents and indicate their capacities and their adequacy in terms of the degree and type of treatment provided. Indicate all discharges which will not be treated. Describe the receiving waters and their uses (e.g., recreational) for any sources of treated and untreated discharge.

(e) If the treatment systems are or will be inadequate or overloaded, describe the steps being taken for necessary improvements and their completion dates.

(f) Describe how surface runoff will be handled if not discussed in (d) above.

(5) Solid Waste Management

(a) Indicate the types and quantities of solid wastes to be produced by the project facilities and its primary beneficiaries.

(b) Describe the methods for disposing of these solid wastes plus the useful life of such methods.

(c) Indicate if recycling or resource recovery programs are or will be used.

(6) Transportation

(a) Briefly describe the available transportation facilities serving the project area.

(b) Describe any new transportation patterns which will arise because of the project.

(c) Indicate if any land uses, such as residential, hospitals, schools or recreational, will be affected by these new patterns.

(d) Indicate if any existing capacities of these transportation facilities will be exceeded. If so, indicate the increased loads which the project will place upon these facilities, particularly in terms of car and truck traffic.

(7) Noise

(a) Indicate the major sources of noise associated with the project facilities and its primary beneficiaries.

(b) Indicate the land uses to be affected by this noise.

(8) Historic/Archeological Properties

(a) Identify any known historic/archeological resources within the project area that are either listed on the National Register of Historic Places or considered to be of local and state significance and perhaps eligible for listing in the National Register.

(b) Attach as EXHIBIT III any historical/archeological survey that has been conducted for the project area.

(9) Wildlife and Endangered Species

(a) Identify any known wildlife resources located in the project area or its immediate vicinity.

(b) Indicate whether to your knowledge any endangered or threatened species or critical habitat have been identified in the project area or its immediate vicinity.

(10) Energy

(a) Describe the energy supplies available to the project facilities and the primary beneficiaries.

(b) Indicate what portion of the remaining capacities of these supplies will be utilized.

(11) Construction

Describe the methods which will be employed to reduce adverse impacts from construction, such as noise, soil erosion and siltation.

(12) Toxic Substances

(a) Describe any toxic, hazardous, or radioactive substances which will be utilized or produced by the project facilities and its primary beneficiaries.

(b) Describe the manner in which these substances will be stored, used, and disposed.

(13) Public Reaction

(a) Describe any objections which have been made to the project.

(b) If a public hearing has been held, attach a copy of the transcript as EXHIBIT IV. If not, certify that a hearing was not held.

(c) Indicate any other evidence of the community's awareness of the project such as through newspaper articles or public notification.

(14) Alternatives to the Proposed Project

Provide a description of any of the following types of alternatives which were considered:

(a) Alternative locations.

(b) Alternative designs.

(c) Alternative projects having similar benefits.

(15) Mitigation Measures

Describe any measures which will be taken to avoid or mitigate any adverse environmental impacts associated with the project.

(16) Permits

(a) Identify any permits of an environmental nature which are needed for the project.

(b) Indicate the status of obtaining each such permit and attach as EXHIBIT V any that have been received.

(17) Other Federal Actions

Identify other federal programs or actions which are either related to this project or located in the same geographical area and for which you are filing an application, have recently received approval, or have in the planning stages.

Item 2 - All applicants are required to provide the State Historic Preservation Officer (SHPO) with (a) a narrative description of the project's elements and its location, (b) a map of the area surrounding theproject which identifies the project site, adjacent streets and other identifiable objects, (c) line drawings or sketches of the project and (d) photographs of the affected properties if building demolition or renovation is involved. This material must be submitted to the SHPO no later than submission of this Form to Rural Development . Additionally, the SHPO must be requested to submit comments on the proposed project to the Rural Development office processing your application.

Item 3 - Self-explanatory.

Item 4 - Self-explanatory.

UNITED STATES DEPARTMENT OF AGRICULTURE

CERTIFICATION REGARDING
DRUG-FREE WORKPLACE REQUIREMENTS (GRANTS)
ALTERNATIVE I - FOR GRANTEES OTHER THAN INDIVIDUALS

This certification is required by the regulations implementing Sections 5151-5160 of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701 *et seq.*), 7 CFR Part 3017, Subpart F, Section 3017.600, Purpose. The January 31, 1989, regulations were amended and published as Part II of the May 25, 1990 **Federal Register** (pages 21681-21691). Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the grant.

(Before completing Certification, read instructions on page 2)

Alternative I

A. The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about --

(1) The dangers of drug abuse in the workplace;

(2) The grantee's policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --

(1) Abide by the terms of the statement; and

(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, State, zip code)

____

____

____

Check ☐ if there are workplaces on file that are not identified here.

____
Organization Name

____
Award Number or Project Name

____
Name and Title of Authorized Representative

____
Signature Date

INSTRUCTIONS FOR CERTIFICATION

1. By signing and submitting this form, the grantee is providing the certification set out on pages 1 and 2.

2. The certification set out on pages 1 and 2 is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

3. Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

4. Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

5. If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph three).

6. Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules:

   "Controlled" substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

   "Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

   "Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

   "Employee" means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

U.S. DEPARTMENT OF AGRICULTURE

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989, Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency with which this transaction originated.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name | **PR/Award Number or Project Name**

Name(s) and Title(s) of Authorized Representative(s)

Signature(s) | **Date**

Form AD-1048 (1/92)

Instructions for Certification

1. By signing and submitting this form, the prospective lower tier participant is providing the certification set out on the reverse side in accordance with these instructions.

2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

5. The prospective lower tier participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

6. The prospective lower tier participant further agrees by submitting this form that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

7* A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

Form AD-1048 (1/92)

•U. S.GPO: 1996-757-776/201 07

CERTIFICATION FOR CONTRACTS, GRANTS AND LOANS

The undersigned certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant or Federal loan, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant or loan.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant or loan, the undersigned shall complete and submit Standard Form - LLL, "Disclosure of Lobbying Activities," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including contracts, subcontracts, and subgrants under grants and loans) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

____

Lee Hart 29 September 2006

____

Owner, Hart Dairy

oOo

DISCLOSURE OF LOBBYING ACTIVITIES

Approved by OMB 0348-0046

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352
(See reverse for public burden disclosure.)

1. Type of Federal Action:	2. Status of Federal Action:	3. Report Type:
[b] a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	[a] a. bid/offer/application b. initial award c. post-award	[a] a. initial filing b. material change **For Material Change Only:** year _________ quarter _________ date of last report ______________

4. Name and Address of Reporting Entity: [x] Prime [ ] Subawardee Tier ______, *if known*: **Congressional District**, *if known*: 4c 2nd	**5. If Reporting Entity in No. 4 is a Subawardee, Enter Name and Address of Prime:** **Congressional District**, *if known*:
6. Federal Department/Agency: US Department of Agriculture	**7. Federal Program Name/Description:** Renewable Energy and Energy Efficiency Program USDA CFDA Number, *if applicable*: _____________
8. Federal Action Number, *if known*:	**9. Award Amount,** *if known*: $
10. a. Name and Address of Lobbying Registrant (*if individual, last name, first name, MI*): Hart, Lee P.O. Box 6748 Shelly Idaho 83402	**b. Individuals Performing Services** (*including address if different from No. 10a*) (*last name, first name, MI*):
11. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	Signature: ____________________ Print Name: Lee Hart Title: ____________________ Telephone No.: 208-526-1000 Date: 9/29/06
Federal Use Only:	Authorized for Local Reproduction Standard Form LLL (Rev. 7-97)

PRINT

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C. section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a covered Federal action. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.
2. Identify the status of the covered Federal action.
3. Identify the appropriate classification of this report. If this is a followup report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity for this covered Federal action.
4. Enter the full name, address, city, State and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.
5. If the organization filing the report in item 4 checks "Subawardee," then enter the full name, address, city, State and zip code of the prime Federal recipient. Include Congressional District, if known.
6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organizational level below agency name, if known. For example, Department of Transportation, United States Coast Guard.
7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.
8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitation for Bid (IFB) number; grant announcement number; the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."
9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.
10. (a) Enter the full name, address, city, State and zip code of the lobbying registrant under the Lobbying Disclosure Act of 1995 engaged by the reporting entity identified in item 4 to influence the covered Federal action.

    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10 (a). Enter Last Name, First Name, and Middle Initial (MI).
11. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB Control Number. The valid OMB control number for this information collection is OMB No. 0348-0046. Public reporting burden for this collection of information is estimated to average 10 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0046), Washington, DC 20503.

U.S. DEPARTMENT OF AGRICULTURE

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions

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This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989 Federal Register (pages 4722-4733). Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the proposed covered transaction.

(BEFORE COMPLETING CERTIFICATION, READ INSTRUCTIONS ON REVERSE)

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) have not within a three-year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Hart Dairy

Organization Name | PR/Award Number or Project Name

Lee Hart, Owner

Name(s) and Title(s) of Authorized Representative(s)

29 September 2006

Signature(s) | Date

Clear Form

Form AD-1047 (1/92)

Instructions for Certification

1. By signing and submitting this form, the prospective primary participant is providing the certification set out on the reverse side in accordance with these instructions.

2. The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out on this form. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

3. The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

4. The prospective primary participant shall provide immediate written notice to the department or agency to whom this proposal is submitted if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

5. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. You may contact the department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

6. The prospective primary participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

7. The prospective primary participant further agrees by submitting this form that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

8. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

9. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

10. Except for transactions authorized under paragraph 6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

UNITED STATES DEPARTMENT OF AGRICULTURE

FORM APPROVED
OMB No. 0575-0018

EQUAL OPPORTUNITY AGREEMENT

This agreement, dated September 29, 2006 between September 29, 2006
(herein called "Recipient" whether one or more) and United States Department of Agriculture (USDA), pursuant to the rules and regulations of the Secretary of Labor (herein called the 'Secretary') issued under the authority of Executive Order 11246 as amended, witnesseth:

In consideration of financial assistance (whether by a loan, grant, loan guaranty, or other form of financial assistance) made or to be made by the USDA to Recipient, Recipient hereby agrees, if the cash cost of construction work performed by Recipient or a construction contract financed with such financial assistance exceeds $10,000 - unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965.

1. To incorporate or cause to be incorporated into any contract for construction work, or modification thereof, subject to the relevant rules, regulations, and orders of the Secretary or of any prior authority that remain in effect, which is paid for in whole or in part with the aid of such financial assistance, the following "Equal Opportunity Clause":

During the performance of this contract, the contractor agrees as follows:

(a) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited, to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the USDA setting forth the provisions of this nondiscrimination clause.

(b) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(c) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the USDA, advising the said labor union or workers' representative of the contractor's commitments under this agreement and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of all rules, regulations and relevant orders of the Secretary of Labor.

(e) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, rules, regulations, and orders, or pursuant thereto, and will permit access to his books, records, and accounts by the USDA Civil Rights Office, and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(f) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation or order of the Secretary of Labor, or as otherwise provided by Law.

(g) The contractor will include the provisions of paragraph 1 and paragraph (a) through (g) in every subcontract or purchase order, unless exempted by the rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the USDA may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the USDA, the contractor may request the United States to enter into such litigation to protect the interest of the United States.

2. To be bound by the above equal opportunity clause with respect to its own employment practices when it participates in federally assisted construction work: Provided, that if the organization so participating is a State or local government, the above equal opportunity clause is not applicable to any agency, instrumentality or subdivision of such government which does not participate in work on or under the contract.
3. To notify all prospective contractors to file the required 'Compliance Statement', Form RD 400-6, with their bids.
4. Form AD-425, Instructions to Contractors, will accompany the notice of award of the contract. Bid conditions for all nonexempt federal and federally assisted construction contracts require inclusion of the appropriate "Hometown" or "Imposed" plan affirmative action and equal employment opportunity requirements. All bidders must comply with the bid conditions contained in the invitation to be considered responsible bidders and hence eligible for the award.
5. To assist and cooperate actively with USDA and the Secretary in obtaining the compliance of contractors and subcontractors with the equal opportunity clause and the rules, regulations, and relevant orders of the Secretary, that it will furnish USDA and the Secretary such information such as, but not limited to, Form AD 560, Certification of Nonsegregated Facilities, to submit the Monthly Employment Utilization Report, Form CC-257, as they may require for the supervision of such compliance, and that it will otherwise assist USDA in the discharge of USDA's primary responsibility for securing compliance.
6. To refrain from entering into any contract or contract modification subject to Executive Order 11246 of September 24, 1965, with a contractor debarred from, or who has not demonstrated eligibility for, Government contracts and federally assisted construction contracts pursuant to the Executive Order and will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by USDA or the Secretary of Labor pursuant to Part II, Subpart D, of the Executive Order.
7. That if the recipient fails or refuses to comply with these undertakings, the USDA may take any or all of the following actions: Cancel, terminate, or suspend in whole or in part this grant (contract, loan, insurance, guarantee); refrain from extending any further assistance to the organization under the program with respect to which the failure or refund occurred until satisfactory assurance of future compliance has been received from such organization; and refer the case to the Department of Justice for appropriate legal proceedings.

Signed by the Recipient on the date first written above.

______________________ Recipient	______________________ Recipient
(CORPORATE SEAL)	______________________ Name of Corporate Recipient
Attest:	By Lee Hart ______________________ President
______________________ Secretary	

Position 3

USDA
Form RD 400-4
(Rev. 3-97)

FORM APPROVED
OMB No. 0575-0018

ASSURANCE AGREEMENT
(Under Title VI, Civil Rights Act of 1964)

The Lee Hart
(name of recipient)

P.O. Box 6748 Shelly, Idaho 83402
(address)

("Recipient" herein) hereby assures the U. S. Department of Agriculture that Recipient is in compliance with and will continue to comply with Title VI of the Civil Rights Act of 1964 (42 USC 2000d et. seq.), 7 CFR Part 15, and Rural Housing Service, Rural Business-Cooperative Service, Rural Utilities Service, or the Farm Service Agency, (hereafter known as the " Agency") regulations promulgated thereunder, 7 C.F.R. §1901.202. In accordance with that Act and the regulations referred to above, Recipient agrees that in connection with any program or activity for which Recipient receives Federal financial assistance (as such term is defined in 7 C.F.R. §14.2) no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination.

1. Recipient agrees that any transfer of any aided facility, other than personal property, by sale, lease or other conveyance of contract, shall be, and shall be made expressly, subject to the obligations of this agreement and transferee's assumption thereof.
2. Recipient shall:

   (a) Keep such records and submit to the Government such timely, complete, and accurate information as the Government may determine to be necessary to ascertain our/my compliance with this agreement and the regulations.

   (b) Permit access by authorized employees of the Agency or the U.S. Department of Agriculture during normal business hours to such books, records, accounts and other sources of information and its facilities as may be pertinent to ascertaining such compliance.

   (c) Make available to users, participants, beneficiaries and other interested persons such information regarding the provisions of this agreement and the regulations, and in such manner as the Agency or the U.S. Department of Agriculture finds necessary to inform such persons of the protection assured them against discrimination.
3. The obligations of this agreement shall continue:

   (a) As to any real property, including any structure, acquired or improved with the aid of the Federal financial assistance, so long as such real property is used for the purpose for which the Federal financial assistance is made or for another purpose which affords similar services or benefits, or for as long as the Recipient retains ownership or possession of the property, whichever is longer.

   (b) As to any personal property acquired or improved with the aid of the Federal financial assistance, so long as Recipient retains ownership or possession of the property.

   (c) As to any other aided facility or activity, until the last advance of funds under the loan or grant has been made.
4. Upon any breach or violation this agreement the Government may, at its option:

   (a) Terminate or refuse to render or continue financial assistance for the aid of the property, facility, project, service or activity.

   (b) Enforce this agreement by suit for specific performance or by any other available remedy under the laws of the United States or the State in which the breach or violation occurs.

Rights and remedies provided for under this agreement shall be cumulative.

In witness whereof, Lee Hart on this
(name of recipient)

date has caused this agreement to be executed by its duly authorized officers and its seal affixed hereto, or, if a natural person, has hereunto executed this agreement.

____
Recipient

(S E A L)

9/29/06
Date

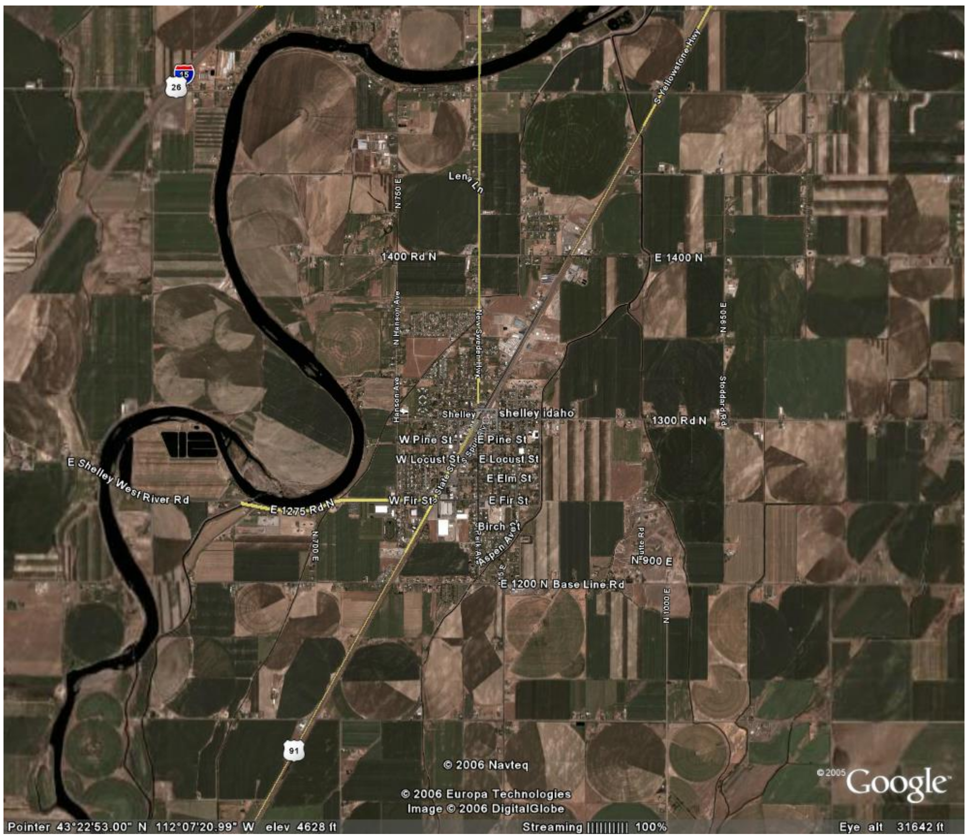
Attest: ______________________________
Title

____
Title

According to the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0570-0018. The time required to complete this information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

II. Project Summary

This project, entitled Hart Dairy Heating and Cooling Energy Efficiency Improvement**,** seeks to decrease some of the Hart Dairy's high-energy costs by using ground source heat pump technology on the farm located in southeast Idaho about 3 miles from the town of Shelley (population 3,813) in Bingham County, Idaho. The project is for the purchase of a renewable energy system and geothermal components necessary to supply hot water for our dairy operations.



Satellite Image of Shelly Idaho from Google Earth.com

We believe that we will experience significant financial savings by using the geothermal resource via a ground source heat pump in our dairy operations. Recognizing the potential cost savings involved with the use of geothermal energy we plan to use the geothermal resource for:

1. Cleaning our facilities, and processing equipment.
2. Space heating and cooling all the buildings on our dairy operation.

The engineering study indicates that the annual energy required to heat and cool the buildings is 552 million BTU's (426M heating and 126M cooling) which is 5,520 therms. Today we are purchasing gas from Intermountain Gas Company at the rate of 1.255 $/therm this project would reduce the Hart Dairy Farm natural gas bill by approximately $6,927 a year. Given the rising cost of natural gas, these savings are expected to increase in years to come. The local natural gas supplier, Intermountain Gas, has applied to the Idaho Public Utilities Commission for permission to raise natural gas prices 28%. If this rate increase is approved, this project would result in $8,866 in annual savings.

This project will be designed and engineered to meet the intended purpose of providing heat and chilling capacity to the facility, and it will meet all applicable public safety regulations and laws.

Total project cost is estimated to be $87,580. The implementation of this project hinges on receiving a grant in the amount of $21,895 (25% of the total project cost) from the USDA's Renewable Energy/Energy Efficiency Improvements Program (Section 9006). The estimated timeframe for project completion is approximately 5 months from the date Mr. Hart signs the grant agreement and the funds are obligated. A detailed project timeline which covers planning, permitting, construction and startup is included with the technical section (Section V) of this application. The anticipated operational date for the geothermal system is February 2007.

Eligibility

Applicant Eligibility

Lee Hart and his wife Elle function as the sole owners of Hart Dairy Farm. The Hart's two sons, Charles and John Hart, assist with daily operations and maintenance of the dairy. Hart Dairy Farm exists as a sole proprietorship. No parent, subsidiary or affiliate organizations involved with Hart Dairy affect this project. Hart Dairy is a small dairy that milks 260 cows twice a day. A milk distributor comes twice daily and picks up milk at our dairy farm and transfers it to a dairy producer. Mr. Lee Hart, owner of Hart Dairy Farms exists as an eligible applicant for the USDA Rural Development Farm Bill section 9006, "Renewable Energy Systems and Energy Efficiency Improvements Program" based on the following:

- Hart Dairy Farm operates as an agricultural producer engaged in the production and handling of dairy products
- Mr. Hart earns over 90% of his income from this dairy operation
- Hart Dairy exists as a sole proprietorship
- The sole owner of Hart Dairy, Mr. Lee Hart, is a citizen of the United States, as are his wife Elle and two sons Charles and John
- Mr. Hart does not have any outstanding judgments obtained by the United States in Federal Court, and is not delinquent in the payment of Federal income taxes or Federal debt
- Mr. Hart demonstrates financial need. Financial analysis shows Mr. Hart would not be able to maintain his cash flow and income over the long term without this grant assistance. A letter from Hart's lending institution has been included in this application (Appendix C). The project will not be attempted without grant assistance.
- Mr. Hart has never applied for nor received a grant or loan from USDA or any other Federal Agency

Project Eligibility

Hart Dairy is an eligible project based on the following reasons:

- The Hart Dairy project will increase the efficiency of our dairy operations by utilizing the renewable geothermal energy source abundantly available on our property
- The project is for the purchase of a renewable energy system, geothermal components necessary to supply hot water for our dairy operations.
- The components proposed for this project are all commercially available, with proven operating histories, established designs and installation procedures.
- This project is located in a rural area near Shelly, Idaho. Shelly is located in Bingham county (pop. 41,735) approximately 12 miles south of the town of Idaho Falls. Shelly is not considered an urbanized area adjacent to any city or town with a population over 50,000.
- Lee Hart, owner and operator of the dairy, has no plans to sell the dairy in the foreseeable future and fully expects to own and control the proposed project for the

period required to pay off the debt incurred by the system. Once trained by the system installers on the operations and maintenance of the system, Mr. Hart will be responsible for the operations and maintenance of the system.

- The annual revenue from Mr. Hart's farming and dairy operation and the fuel savings from the project are sufficient to provide for the operation, management, and debt service for the life of the project
- This project will alleviate approximately 85% of Mr. Hart's annual natural gas utility bill.
- He will perform the routine maintenance himself and, therefore, will not have to pay for this service.

Operation Description

The Hart Dairy operations are located on approximately 30 acres of the 360 total acres owned and operated by Lee and Elle Hart. Lee and Elle Hart have operated the dairy for 19 years. However, the dairy has actually been in operation for over 30 years. Prior to Mr. Lee Hart's management, the dairy was owned and operated by his father, John Hart Sr.

Aerial view of the Hart Dairy. Photo from Google Earth

The operation currently has approximately 400 cows, 2 enclosed buildings for milking and processing the milk, 3 silos for storing feed and multiple covered stalls and feeding areas for the livestock. Some but not all of the feed used in the dairy operation is grown at the Hart farm which has approximately 320 acres of farmable land irrigated with a center pivot irrigation system. Standard farm equipment for planting, harvesting, storing and moving hay and grain crops are part of this farming operation. The proposed heating system will heat approximately 1800 ft^2 of enclosed space used for milking and milk processing, and supply energy for the milk processing chilling needs for the dairy.

This is a family run dairy with occasional part time and seasonal labor help. The future plans are to turn the operation over to Lee Hart's son Charles, when Lee Hart retires. This dairy operation will be controlled by the Hart family for the life of the project.

Financial Information

Hart Dairy is a small family operated dairy that is not a subsidiary of any parent company or corporation, and does not have any subsidiary or affiliates at other locations. In 2005, the last full accounting year, the dairy had total income of $856,500 and total expenses of $795,925 with a net income of $60,575. The gross market value for agricultural products sold is $756,000 for milk products, $19,000 for calves, and $63,000 for cattle sold. Mr. Hart and his wife Elle have no nonfarm income. A copy of the Hart's Federal Income Tax Return for 2005 is included in Appendix D of this application. A current year Profit and Loss Statement is included in Appendix E of this application. The assumptions used for the financial projections for 2006, 2007 and 2008 are:

- The dairy operation will remain the same size with no increase in livestock or milk production
- Labor rates will increase 1% per year
- Payroll Taxes will increase 1.5% in year 1, 1.5% in year 2 and 1.5% in year 3
- Operating Interest dollars will increase by 18.2% in year 1 and remain steady at $22K for the next 3 years
- Feed costs will decrease from $327K to $320K and remain steady for the next 3 years
- Property taxes will not change in the next 3 years
- Natural Gas costs will decrease from approximately $5,300 to zero
- Other utility cost will remain constant at about $25K

III. Matching Funds

Funding for this geothermal project will come from Hart Dairy operating Funds, a loan from Idaho Farm Credit Services, and a grant from the USDA for a purchase and installation of a Renewable Energy System. The details of the funding are presented below.

Source of Funding	$ Amount	Status	Contact Information
Hart Dairy Operating Funds	4,000	Available from Savings Account	Lee Hart P.O. Box 6748, Shelly ID (208) 526-1000
Idaho Farm Credit Services	61,685	Approved Loan	Mr. Patrick Lanley, Sr Business Analyst, Idaho Farm Credit Services, P.O. Box 1625, Idaho Falls, ID (208) 526-1000
USDA 9006 Grant	21,895	Pending Award of USDA Grant	Mr. John Farmer, Business Program Specialist, USDA Rural Development, 725 Jensen Grove Drive, Blackfoot, ID 83221 (208) 785-5840

Total Project Cost 87,580

Project Cost

The proposed modification and upgrade to the Hart Dairy, to take advantage of the geothermal heat pump efficiencies is estimated to cost $87,580. This grant proposal is requesting the maximum 25% of that total, or $21,895. Project cost details are presented below.

Hart Dairy Well to Well GSHP Project - Estimated Cost

<u>Planning and Permitting</u>	**Quantity**	**Units**	**Unit Cost $'s**	**Total**
Engineering Consultant - Detailed Design	48	hours	120	$5,760
Drilling Surety bond	1	lump	5,000	$5,000
Drilling Permit - Production Well	1	lump	200	$200
Drilling Permit - Injection Well	1	lump	200	$200
Injection Well Permit	1	lump	300	$300
Engineering Consultant - Construction & Installation	40	hours	120	$4,800
			Planning & Permitting Subtotal	***$16,260***

<u>Well Construction</u>	**Quantity**	**Units**	**Unit Cost $'s**	**Total**
Production Well				
Drilling & Materials	250	feet	30	$7,500
Well pump, pressure tank, controls	1	lump	2,000	$2,000
Injection Well				
Drilling & Materials	250	feet	30	$7,500
Distribution Piping				
PVC pipe, trench & backfill, pipe bending, associated fittings & valves	200	feet	20	$4,000
			Well Construction Subtotal	***$21,000***
<u>Geothermal Energy Utilization</u>				
Main Heat Exchanger (plate type)	12	ton	50	$600
Space Heating Load 1 - Milk Barn (retrofit from existing boiler)				
Wall cut, piping, fittings	1	lump	1,750	$1,750
Heat Pump (water-to-water)	6	ton	1,500	$9,000
Circulating pump, controls	2	lump	500	$1,000
Space Heating Load 2 Bulk Tank Room (retrofit from existing boiler)				
Wall cut, piping, fittings	1	lump	1,750	$1,750
Heat Pump (water-to-water)	3	ton	1,500	$4,500
Circulating pump, controls	2	lump	500	$1,000
Hot Water Load 1 - Cow Washing				
Wall cut, piping, fittings	1	lump	1,750	$1,750
Heat Pump (water-to-water)	3.5	ton	1,500	$5,250
Hot water storage tank (w/backup)	300	gallon	12	$3,600
Circulating pump, controls	2	lump	500	$1,000
Hot Water Load 2 - Floors, Udders				
Wall cut, piping, fittings	1	lump	1,750	$1,750
Heat Pump (water-to-water)	3	ton	1,500	$4,500
Hot water storage tank (w/backup)	260	gallon	12	$3,120
Circulating pump, controls	2	lump	500	$1,000
Milk Chilling				
Wall cut, piping, fittings	1	lump	1,750	$1,750
Heat Pump (water-to-water)	4	ton	1,500	$6,000
Storage tank (assume existing tank)	0	gallon	0	$0
Circulating pump, controls	2	lump	500	$1,000
			Geothermal Energy Utilization Subtotal	***$50,320***
			Total Estimated Project Cost	***$87,580***

IV. Self Evaluation Scores

* 7 CFR 4280.112	Scoring Summary *		
	Awarded Points	Category	Maximum Possible Points
(e)(1)(i)	15	Energy Replacement Total Points (15 point maximum)	15
(e)(1)(ii)	15	Energy Savings Total Points (20 point maximum - 15 + 5 point bonus)	15
(e)(1)(ii)	5	Energy Savings Professional Energy Audit Bonus (5 point maximum)	5
(e)(1)(iii)	0	Energy Generation Total Points (10 point maximum)	10
(e)(2)	0	Environmental Benefits Total Points (10 point maximum)	10
(e)(3)	10	Commercial Availability Total Points (10 points maximum)	10
(e)(4)	35	Technical Merit Total Points (35 point maximum)	35
(e)(5)	15	Readiness Total Points (15 point maximum)	15
(e)(6)	5	Small Ag Producer / Very Small Business Total Points (10 point maximum)	10
(e)(7)	5	Simplified Application/Low Cost Project Total Points (5 point maximum)	5
(e)(8)	5	Previous Grantees and Borrowers Total Points (5 point maximum)	5
(e)(9)	2	Return on Investment Total Points (10 point maximum)	10
	112	**Total Score (out of 145 possible)** 77%	145

(e)(1) **Quantity of energy replaced, produced or saved**

(e)(1)(i) *Energy Replacement*

If the proposed renewable energy system is intended primarily for self-use by the agricultural producer or rural small business and will provide energy replacement of:

(A) greater than zero, but equal to or less than 25 percent, **5** points will be awarded;

(B) greater than 25 percent, but equal to or less than 50 percent, **10** points will be awarded;

(C) or greater than 50 percent, **15** points will be awarded

426,000,000	= Estimated quantity of renewable energy (BTU's) to be **generated** over a 12 month period.
426,000,000	= Estimated quantity of energy (BTU's) **consumed** over the same 12 month period during the previous year.
1	= Generation /Consumption

15	Energy Replacement Total Points (**15** point maximum)

(e)(1)(ii) *Energy Savings*

If the estimated energy expected to be saved by the installation of the energy efficiency improvements will be from:

(A) 20 percent up to, but not including 30 percent, **5** points will be awarded;

(B) 30 percent up to, but not including 35 percent, **10** points will be awarded; or,

(C) 35 percent or greater, **15** points will be awarded

Energy savings will be determined by the projections in an energy audit.
Projects with total eligible project costs of $50,000 or less that opt to obtain a professional energy audit will be awarded an additional **5** points.

15	Energy Savings Total Points (**20** point maximum - 15 + 5 point bonus)
5	Energy Savings Professional Energy Audit Bonus (**5** point maximum)

(e)(1)(iii)	*Energy Generation*	
	If the proposed renewable energy system is intended primarily for production of energy for sale, 10 points will be awarded.	
	0	Energy Generation Total Points (10 point maximum)
(e)(2)	**Environmental Benefits**	
	If the purpose of the proposed system contributes to the environmental goals and objectives of other Federal, State, or local programs, **10** points will be awarded.	
	Points will only be awarded for this paragraph if the applicant is able to provide documentation from an appropriate authority supporting this claim.	
	0	Environmental Benefits Total Points (**10** point maximum)
(e)(3)	**Commercial Availability**	
	(A) If the proposed system or improvement is currently commercially available and replicable, **5** points will be awarded.	
	(B) If the proposed system or improvement is commercially available and replicable and is also provided with a 5-year or longer warranty providing the purchaser protection against system degradation or breakdown or component breakdown, **10** points will be awarded.	
	10	Commercial Availability Total Points (**10** points maximum)
(e)(4)	**Technical Merit Score**	
(e)(4)(i)	Each subparagraph has its own maximum possible score and will be scored according to the following criteria:	
	a	If the description in the subparagraph has no significant weaknesses and exceeds the requirements of the subparagraph, 100 percent of the total possible score for the subparagraph will be awarded.
	b	If the description has one or more significant strengths and meets the requirements of the subparagraph, 80 percent of the total possible score will be awarded for the subparagraph.
	c	If the description meets the basic requirements of the subparagraph, but also has several weaknesses, 60 percent of the points will be awarded.
	d	If the description is lacking in one or more critical aspects, key issues have not been addressed, but the description demonstrates some merit or strengths, 40 percent of the total possible score will be awarded.
	e	If the description has serious deficiencies, internal inconsistencies, or is missing information, 20 percent of the total possible score will be awarded.
	f	If the description has no merit in this area, 0 percent of the total possible score will be awarded.
	g	The total possible points for Technical Merit is 35 points
(e)(4)(i)(A)	10	(A) Qualifications of the Project Team (maximum score of **10** points)
		The applicant has described the project team service providers, their professional credentials, and relevant experience. The description supports that the project team service, equipment, and installation providers have the necessary professional credentials, licenses, certifications, or relevant experience to develop the proposed project.
(e)(4)(i)(B)	5	(B) Agreements and Permits (maximum score of **5** points)
		The applicant has described the necessary agreements and permits required for the project and the schedule for securing those agreements and permits.
(e)(4)(i)(C)	10	(C) Energy or Resource Assessment (maximum score of **10** points)
		The applicant has described the quality and availability of a suitable renewable resource or an assessment of expected energy savings for the proposed system.
(e)(4)(i)(D)	30	(D) Design and Engineering (maximum score of **30** points)
		The applicant has described the design, engineering, and testing needed for the proposed project. The description supports that the system will be designed, engineered, and tested so as to meet its intended purpose, ensure public safety, and comply with applicable laws, regulations, agreements, permits, codes, and standards.

(e)(4)(i)(E)	5	(E) Project Development Schedule (maximum score of **5** points)
		The applicant has described the development method, including the key project development activities and the proposed schedule for each activity. The description identifies each significant task, its beginning and end, and its relationship to the time needed to initiate and carry the project through to successful completion. The description addresses grantee or borrower project development cashflow requirements.
(e)(4)(i)(F)	20	(F) Project Economic Assessment (maximum score of **20** points)
		The applicant has described the financial performance of the proposed project, including the calculation of simple payback. The description addresses project costs and revenues, such as applicable investment and production incentives, and other information to allow the assessment of the project's cost effectiveness.
(e)(4)(i)(G)	5	(G) Equipment Procurement (maximum score of **5** points)
		The applicant has described the availability of the equipment required by the system. The description supports that the required equipment is available, and can be procured and delivered within the proposed project development schedule.
(e)(4)(i)(H)	5	(H) Equipment Installation (maximum score of 5 points)
		The applicant has described the plan for site development and system installation.
(e)(4)(i)(I)	5	(I) Operation and Maintenance (maximum score of **5** points)
		The applicant has described the operations and maintenance requirements of the system necessary for the system to operate as designed over the design life.
(e)(4)(i)(J)	5	(J) Dismantling and Disposal of Project Components (maximum score of **5** points)
		The applicant has described the requirements for dismantling and disposing of project components at the end of their useful life and associated wastes.
(e)(4)(ii)		Calculation of Technical Merit Score To determine the actual points awarded a project for Technical Merit, the following procedure will be used: The score awarded for paragraphs (A) through (J): Will be added together and then divided by 100, the maximum possible score, to achieve a percentage. This percentage will then be multiplied by the total possible points of 35 to achieve the points awarded for the proposed project for Technical Merit.
	100	Total of Technical Merit A-J
	1	Total of Technical Merit A-J / 100
(e)(4)	35	Technical Merit Total Points (**35** point maximum)
(e)(5)	**Readiness**	
		(A) If the applicant has written commitments from the source(s) confirming commitment of 50 percent up to but not including 75 percent of the matching funds prior to the Agency receiving the complete application, **5** points will be awarded.
		(B) If the applicant has written commitments from the source(s) confirming commitment of 75 percent up to but not including 100 percent of the matching funds prior to the Agency receiving the complete application, **10** points will be awarded.
		(C) If the applicant has written commitments from the source(s) of matching funds confirming commitment of 100 percent of the matching funds prior to the Agency receiving the complete application, **15** points will be awarded.
	15	Readiness Total Points (**15** point maximum)

(e)(6)	**Small Agricultural Producer / Very Small Business**	
	(A) If the applicant is an agricultural producer producing agricultural products with a gross market value of less than $600,000 in the preceding year, **5** points will be awarded.	
	(B) If the applicant is an agricultural producer producing agricultural products with a gross market value of less than $200,000 in the preceding year or is a very small business **10** points will be awarded.	
	5	Small Ag Producer / Very Small Business Total Points (**10** point maximum)
(e)(7)	**Simplified Application/Low Cost Projects**	
	If the applicant is eligible for and uses the simplified application process or the project has total eligible project costs of $200,000 or less, **5** points will be awarded.	
	5	Simplified Application/Low Cost Project Total Points (**5** point maximum)
(e)(8)	**Previous Grantees and Borrowers**	
	If an applicant has not been awarded a grant or loan under this program within the 2 previous Federal fiscal years, **5** points will be awarded.	
	5	Previous Grantees and Borrowers Total Points (**5** point maximum)
(e)(9)	**Return on Investment**	
	If the proposed project will return the cost of the investment in: (A) less than 4 years, **10** points will be awarded; (B) 4 years up to but not including 8 years, **4** points will be awarded; (C) 8 years up to 11 years, **2** point will be awarded.	
	2	Return on Investment Total Points (**10** point maximum)
*** This scoring summary was prepared from information 7 CFR Part 4280 in the Federal Register / Vol. 70, No. 136/ Monday, July 18. 2005 / Rules and Regulations**		

V. Technical Report – Hart Dairy

Introduction

Idaho has abundant geothermal resources, especially the central and southern parts of the state where the majority of the geothermal wells and springs are found. These resources have been developed over the last 100+ years for recreation, district heating, domestic heating, aquaculture, and greenhouse operations. Some of these geothermal resources are used for direct use heating applications in dairies. Mr. Hart has had discussions with some of those dairy owners. Originally Mr. Hart looked into direct use geothermal heating, but learned that he does not have a high temperature resource in his area. He then considered the next alternative, ground source heat pumps or geoexchange units.

I. Qualifications of Project Team

This project was conceptually planned prior to preparing this USDA Farm Bill Section 9006 application. Lee Hart is somewhat familiar with geothermal direct use and ground source heat pumps or geoexchange applications. Mr. Hart first had an energy audit performed on his dairy operations, and then contacted a licensed Professional Engineer (PE) with significant experience in geoexchange applications, design and construction for preliminary guidance on the project. The overall project will consist of designing, bidding, and building a ground source heat pump or geoexchange heating system for parts of the Hart Dairy.

Project Management - Mr. Lee Hart will serve as the project manager. Prior to taking over the family dairy farm business he received his BS in Mechanical Engineering from the University of New Mexico in Albuquerque, NM. Lee Hart has 25 years of agriculture experience, including 20 years of owning, operating and managing the Hart Dairy in Shelly, Idaho. Lee will be directly responsible for the dairy operations after the project changes have been implemented.

Energy Auditor – Mr. Donald Kilowatt PE., is president of Idaho Energy Associates Inc. in Sun Valley, ID (208-526-7468). He is a registered Professional Engineer in the state of Idaho, and a Certified Energy Manager (CEM) with certification from the Association of Energy Engineers. In addition, he also holds a Bonneville Power Administration "Residential Energy Auditor Certification". Mr. Kilowatt performed an energy audit at Hart Dairy in the spring of 2006. Mr. Kilowatt can be contacted at (208) 526-7468

Design, Engineering & Installation Oversight – Mr. Andrew Chiasson, the project engineer works for the GeoHeat Center at the Oregon Institute of Technology in Klamath Falls, Oregon. He holds Bachelors and Masters Degrees in Geological Engineering and a Masters Degree in Mechanical Engineering. He is a licensed Professional Engineer in Idaho, Washington and Oregon with 10 years of experience in design and installation of geothermal systems. Mr. Chiasson can be contacted at (541) 885-1750

System Installation – Mr. Hart has contacted two SE Idaho drilling companies and two local Heating, Ventilation and Air Conditioning (HVAC) contractors who have expressed interest in bidding on the job. Both drilling companies are licensed in the state of Idaho and have experience in geothermal drilling and ground source heat pump applications. The HVAC companies both have personnel on staff that are certified as Geoexchange Designers through the Association of Energy Engineers and the Geothermal Heat Pump Consortium (GHPC). They are also certified in installation of geoexchange systems through the International Ground Source Heat Pump Association.

Systems Operation - Mr. Hart will be directly responsible for servicing, operating and maintaining the geothermal heating system once installed. As mentioned previously, Mr. Hart has a BS degree in Mechanical Engineering. He will receive training from the equipment manufactures and the project engineer. He will be assisted by his two sons Charles and John, who once trained by the system installer on the operations and maintenance of the systems, will be primarily responsible for the operations and maintenance. The key components and moving parts in the system are primarily pumps and motors, with which Mr. Hart, as a dairy owner and operator, and his sons have extensive installation, maintenance and repair experience. In addition, the heat exchanger equipment is very similar to equipment associated with his milk chilling process.

Equipment Manufacturers - The equipment being installed is comprised of "off-the-shelf" components that can be supplied by a number of manufacturers. None of the components for the proposed system are one-of-a-kind or special order. None of the components require special design and will not be custom manufactured. Bids will be requested from a number of suppliers in order to get the best pricing for all the components.

To the best of our knowledge there currently are no dairies in southeast Idaho that use ground source heat pumps or geoexchange systems to heat their facilities.

II. Agreements and Permits

The Idaho Department of Water Resources (IDWR) and the Department of Environmental Quality (DEQ) are the lead agencies for administering and enforcing the rules and regulations governing water use and quality in Idaho. IDWR is responsible for issuing water rights, well construction permits and underground fluid injection wells.

Water for ground source heat pumps or geoexchange systems, is regulated with the rules governing groundwater appropriation and well drilling regulations in Idaho. Appropriate forms and notifications for drilling are available on the internet. It is anticipated that it will take approximately 3 weeks to get the appropriate permits from the state of Idaho for this project. Rules and regulations governing well construction are in IDAPA 37 Title 3 Chapter 9.

The Hart Dairy Farm does not fall within an IDWR area of drilling concern and no additional well construction requirements are necessary. Hart Dairy farms own all the water rights within a 3-mile radius of the proposed project and currently have a valid water rights permit. The Hart Dairy Farm is not within a designated ground water management areas (GWMAs) or critical ground water areas (CGWAs). We have contacted county planning and health departments to check for any additional regulations or ordinances covering well placement and construction and there are none in this location.

A drilling prospectus will be submitted to IDWR prior to construction. A surety bond or cash bond as required by Idaho code section 42-233 with IDWR. The amount of the bond ranges from $5000, up to $20,000, as determined by the depth and temperature of the well. There will be a drilling permit fee of $200. The well will be drilled by a licensed and bonded well contractor.

The preferred method of disposing of geoexchange fluids is to return them to the ground by way of injection wells. Hart Dairy Farms plans to drill an injection well to dispose of the water after it has passed through their heating systems. IDWR administers the Idaho Waste Disposal and Injection Well program. Geothermal heat wells and closed loop heat pump return wells are both classified in Idaho as Class V injection wells. Injection wells that are more than 18 feet deep must apply for a permit from IDWR prior to construction. This applies to closed-loop heat exchange wells, if they are deeper than 18 feet (5.5 m). Hart Dairy Farms will apply for the $100 permit. There will be a 30-day review period in addition to the normal processing time for this injection will permit. The proposed Hart Dairy Farms project is expected to require less than 50 gpm of fluid, and may be exempt from the permit provisions. This will be determined with consultation with IDWR personnel.

We have contacted the county and inquired about zoning and code requirements and there are none that affect this project.

There are no licenses required to own and operate the type of equipment we are proposing to install.

State health officials have been contacted and they indicated that as long as the temperatures meet the state health code requirements for cleaning and operation, there will be not be any changes in our existing permits and periodic inspections.

Most of the components of the proposed system are piping and valves which come with standard manufacturer warranties. Depending on which manufacture we choose, the warranties for the heat exchangers and controllers will vary but will be what is commonly accepted within the industry.

The entire project will be on Hart Dairy property, and there will be no environmental impacts. The water used in this system is essentially in a closed loop and will be extracted from on well and injected to another well. The process used for washing and cleaning will not change, other than the source of the heat for the water, and thus no environmental impacts.

III. Energy Assessment

We contacted both the local natural gas supplier and electric suppliers to our farm to inquire about an energy audit. Both indicated they did not have the capability to perform they type of audit required by the solicitation. We then contacted Idaho Energy Associates and contracted with them for an energy audit. The complete audit is included in Appendix A. A summary of the final report is presented here:

"Mr. Donald Kilowatt, PE of Idaho Energy Associates Inc. performed this energy audit of the Hart Dairy operations on April 3, 2006. The purpose of the energy audit was to determine if it would be cost effective for Mr. Hart to switch from natural gas to ground source heat pump or geoexchange technology to supply heating and chilling needs for his milking and milk processing operations. While the audit did look at other energy sources and uses such as electricity, no recommendations on those energy uses were included. This audit is not intended to provide detailed specifications for a geoexchange system, as Mr. Hart has hired an engineering firm that specializes in geothermal systems to perform that work. The results of this audit indicate that Mr. Hart could expect to invest approximately $90,000 in wells and equipment and realize a simple project payback in approximately 12 years based on current natural gas prices. If natural gas prices are assumed to increase 5% a year, the simple payback would occur in approximately 10 years. In addition, there are some energy conservation improvements that Mr. Hart could make that would lower his energy consumption, immediately, even if he were to choose not to move forward with conversion to a geoexchange system.. In summary, the milking barn and bulk tank room facilities at Hart Dairy would be ideal candidates for a geoexchange system for facility heating and process heating and cooling."

IV. Design and Engineering

Mr. Hart became interested in using the geothermal resource available on his property after attending a geothermal direct use workshop in Boise, Idaho sponsored by the Department of Energy GeoPowering The West program. The recent increase in fuel cost for operating the dairy led to an in-depth analysis of how the dairy could reduce costs. The geothermal option was selected because he already owns the resource, and it would require minimal disruption of his operations to install a ground source heat pump or geoexchange system.

A preliminary design of this project was prepared by Andrew Chiasson with the assistance of Mr. Hart. The preliminary design and calculations are presented in Appendix B. Mr. Chiasson, from the GeoHeat Center at the Oregon Institute of Technology in Klamath Falls, Oregon., is a licensed Professional Engineer (PE) with 10 years of experience in research and development, design and construction of geothermal direct use projects. The GeoHeat Center, has worked on hundreds of projects both in the U.S. and internationally over the last 20 years. The GeoHeat Center works exclusively on geothermal direct use and geoexchange applications.

This project will be designed by a licensed professional engineer to meet all of the local, state and federal laws, regulations, agreements, permits, codes and standards required for ground source heat pump or geoexchange systems. Well drilling, construction and equipment installation will be done by licensed professionals.

This project consists of: 1) drilling a 250' supply well, 2) installing piping from the supply well to the facilities to be heated, 3) retrofitting the existing boiler and installing heat exchange equipment, 4) drilling and completing a 250' injection well, 5) installing piping from the new heating equipment to the injection well.

This project will require drilling one production and one disposal well, and trenching to install approximately 200 ft of 3-inch pipe. Once the piping is installed there will be no land use impacts. The disposal well will have a footprint of approximately 50 ft^2 when finished. There is ample room and a number of locations where the injection will can be placed. There will be no impacts to air quality, water quality, and wildlife habitat. There will be no noise pollution, soil degradation or odor associated with this project.

Mr. Hart plans to leave the current natural gas heating systems in place to provide backup heating capability should it ever be necessary.

Hart Dairy Farms and the adjacent 360 acres has been owned and operated by Lee and Elle Hart for 19 years. The dairy has actually been in operation for over 30 years. Prior to Mr. Lee Hart's management, the dairy was owned and operated by his father, Robert Hart. This is a family run dairy, and the future plans are to turn the operation over to Lee Hart's son Charles when Lee Hart retires. This dairy operation will be controlled by the Hart family for the life of the project.

Potential equipment suppliers of the major components (Heat Pump, Chillers, and Piping) are listed below. Other suppliers may be identified by the contractor at the time of bidding.

Heat Pump Equipment

McQuay International 13600 Industrial Park Blvd. Plymouth, MN 55440 Ph: (763) 553-5330 Fax: (763) 553-5177	Trane, Commercial Systems Group 2727 South Ave. La Crosse, WI 54601 Ph: (608) 787-3445	York International Corporation 631-T Richmond Avenue P.O. Box 1592 York, PA 17405-1592 Ph: (717) 771-7890

Chillers, Absorption / Adsorption

Carrier Corporation (ABS) Carrier Parkway Syracuse, NY 13221 Ph: (315) 432-6000	Harris Thermal Transfer Products (ABS) 615 S. Springbrook Rd. Newberg, OR Ph: (503) 538-1260	Aero Tech Mfg. Incorporated (ABS) 395 W. 1100 N North Salt Lake, UT 84054 Ph: (801) 292-0493
KRUM International (ADS) 3314 Walnut Bend Ln. Houston. TX 77042 Ph: (713) 784-0303	The Trane Company (ABS) Commercial Systems Group 2727 South Avenue La Crosse, WI 54601-7599 Ph: (608) 787-3445	Yazaki North America, Inc.(ABS) 6700 Haggery Rd. Canton, MI 48187 Ph: (734) 983-1000 Small Tonnage Lithium Bromide
York International Corporation (ABS) 631 S. Richland Ave. P.O. Box 1592 York, PA 17405 Ph: (717) 771-7890	McQuay International 13600 Industrial Park Blvd. Plymouth, MN 55441 Ph: (763) 553-5330 Fax: (763) 553-5177	

Piping

Polybutylene / Polyethylene Central Plastics Corporation Box 3129 Shawneee, OK 74301 Ph: 1 (800) 645-3872 (405) 273-6302	Plexco 1050 Busse Rd. #200 Bensenville, IL 60106 Ph: (630) 350-3700	Vanguard Industries 901 N. Vanguard Street McPherson, KS 67460 Ph: 1 (800) 775-5039 (316) 241-6369

Plate Heat Exchangers

Alfa-Laval Thermal 5400 International Trade Dr. Richmond, VA 23231 Ph: (804) 222-5300	APV Americas, Heat Transfer 395 Fillmore Avenue Tonawanda Industrial Park Tonawanda, NY 14150 Ph: (716) 692-3000	Graham Manufacturing Company 20 Florence Avenue Batavia, NY 14021 Ph: (716) 343-2216
Bell and Gossett ITT Industries 8200 N. Austin Ave. Morton Grove, IL 60053 Ph: (800) 243-8160 (847) 966-3700	Paul Mueller Company P.O. Box 828 Springfield, MO 65801 Ph: (417) 831-3000	Tranter Inc. Texas Division P.O. Box 2289 Wichita Falls, TX 76307 Ph: (940) 723-7125

V. Project Development Schedule

Significant tasks for this project include preparation of detailed specifications, obtaining required permits, obtaining material and construction bids, ordering materials, construction and startup. A detailed timeline for the project is presented in the Table 1 and the timeline diagram. The entire project is expected to take a little over 5 months from inception to completion. The project will begin as soon as USDA approval is received. The project work and completion is not dependent on seasonal conditions and can begin at any time during the year. The project will be completed within 1 year of the date of approval from USDA.

Table 1 Project Schedule

Task	Duration	Start Date	Finish Date	Resource Name
Prepare Detailed Project Specs : Wells & Equipment	21 days	4/3/06	5/1/06	PE - Consultant
Apply for Loans	3 days	5/1/06	5/3/06	Lee Hart
Obtain Drilling Permits	40 days	5/2/06	6/26/06	Lee Hart
Obtain County Construction Permits	3 days	5/22/06	5/24/06	Lee Hart
Obtain Well Drilling & Completion Bids	21 days	5/29/06	6/26/06	Lee Hart
Obtain Equipment & Materials Bids	21 days	5/29/06	6/26/06	Lee Hart
Obtain Construction & Installation Bids	14 days	6/27/06	7/14/06	Lee Hart
Order Materials	1 day	7/17/06	7/17/06	Lee Hart
Contract Drilling	2 days	6/27/06	6/28/06	Lee Hart
Contract Construction & Installation	20 days	7/17/06	8/11/06	Lee Hart

Supervise Construction & Installation	10 days	8/18/06	8/31/06	PE - Consultant
Drill Production and Injection Wells	2 days	8/17/06	8/18/06	Driller
Install and test well pump	1 day	8/21/06	8/21/06	Driller
Site Preparation - Trenching & leveling	2 days	8/22/06	8/23/06	Lee Hart
Installation of Well House - supply well	1 day	8/24/06	8/24/06	Lee Hart
Install Piping, Heat Exchangers & Controllers	3 days	8/25/06	8/29/06	Contractors
System Testing / Startup	1 day	8/30/06	8/30/06	Lee Hart / PE / Contractors
System Operation Training	1 day	8/31/06	8/31/06	Lee Hart / PE

VI. Project Economic Assessment

The payback costs for this project have been calculated using three methods. The simple payback formula is:

Simple Payback Period (in years) = $\frac{TotalEligible\,\mathrm{Pr}\,ojectCost}{AnnualSavingsorIncome}$

The total eligible project cost is estimated at $87,580. The cost of natural gas saved in 2006 $'s is $6,927.

Payback period = $\frac{\$87{,}580}{\$6{,}927\,/\,yr}$ Simple Payback = 12.6 years

However, it's reasonable to assume that the price of natural gas would increase during the life of this system. Two alternative calculations were made, assuming the price of natural gas increased 2.5% a year and 5.0% a year. Using a 2.5% increase in natural gas prices, the payback would be in the 11th year. Using a 5% increase in natural gas prices each year, the payback would be in the 10th year.

Project management - No outside project management cost will be incurred on this project. The small size of this project allows Mr. Hart, the dairy owner to function as the project manager. His education as a mechanical engineer and his experience in designing and managing construction of upgrades to the dairy facilities over the past 20 years qualify him to be the project manager.

Resource Assessment - A detailed resource assessment is not required for this project. The resource (water) has been adequately defined and tested with the existing well. Pump tests, chemical analysis of the water and annual temperature measurements over the life of the existing well confirm that an adequate resource exists.

Project Design - A preliminary design (Appendix B**)** has been completed by a licensed Professional Engineer with experience in geothermal direct use applications. Approximately 50 hours of additional engineering consultations at approximately $120.00/hr ($6,000 total) will be required to complete the design, installation and startup.

Project Permitting -Project permitting will be performed by Mr. Hart. His time will not be charged to the project. The cost of permits including a drilling permit, injection well permit and bond for the drilling operations are expected to cost less than $600 for the two wells. The drilling bond will be approximately $500.

Site preparation – The proposed location for the two wells are clear of underground and overhead obstructions, and are not encumbered by any easements or legal constraints. No special siting requirements are applicable. All site preparation work will be done by employees of Hart Dairy. The dairy has the necessary equipment and tools for trenching operations and earth moving that would be associated with providing a drilling pad, pipe trenching and leveling. The dairy also has the necessary equipment and skills for any modifications to existing facilities or equipment that are required prior to installation of the new equipment.

Installation – Installation cost are included in the cost estimate in Appendix B.

Financing – Initial discussions have been held with Mr. Hart's financial institution. They have agreed to provide financing based on the information provided in this application assuming the USDA grant covers 25% of the project cost. A copy of their letter of commitment is provided in Appendix C of this proposal. Also included is a copy of Mr. Hart's Federal Tax return for 2005 (Appendix D).

Startup – There will be no special startup costs associated with this project, other than the engineer consultation fee described in the Project Design section above.

Maintenance Costs – Maintenance cost are predicted to be similar to the maintenance cost with the current operation. The new system will add additional circulation pumps and control systems, but these components have low failure rates and minimal maintenance costs associated with them.

Annual Revenue and Expenses - This project is not designed to provide direct revenue to Hart Dairy by selling power. Energy cost savings, by using geothermal resources instead of natural gas is the ultimate goal. The current system for heating the Hart Dairy facilities relied on boilers fired with natural gas. The current price of natural gas is from Intermountain Gas is approximately $1.2555/therm. The estimated annual heating required for Hart Dairy is 547MMBtu or 5,470 therms. With a boiler operating at 80% efficiency, approximately 6,838 therms of natural gas would be required to meet the annual heating demand, which, at today's Intermountain Gas Company rates, would cost about $6,864. Hart Dairy has other gas needs that would not be affected by this project.

Investment, Productivity, Tax, Loan and Grant Incentives – Mr. Hart is exploring the possibility of obtaining a loan through the State of Idaho. The state has a low interest loan program, administered by the Energy Division of the Idaho Department of Water Resources, which makes funds available at a 4% interest rate for energy efficiency projects including geothermal energy projects. Loans are available for retrofit only, with the exception of some renewable resources. In commercial, industrial, agricultural, and public sectors there is a minimum loan amount of $1,000 and a maximum cap of $100,000. Loans are repaid in five years or less. For existing homes or businesses, the savings from reduced usage of conventional fuel must be sufficient to pay for the project's installation cost (e.g. simple payback of 15 years or less). While the program's financing requires repayment within five years, this further stipulation for existing homes and businesses states that the project's cumulative energy savings over a fifteen year period must be great enough to offset the cost of the project.

VII. Equipment Procurement

Equipment Availability – The materials required for this project are standard off the shelf items. With the exception of the heat exchangers and pressure tank, most are available in home and ranch supply stores, or local plumbing supply business. The heat exchangers are available from multiple suppliers including those mentioned in the design section above. Pressure tanks are also available from multiple suppliers such as Flexcon, Franklin Pump Company, and ITT Industries. Heat exchangers and a pressure tank, and associated controls can be delivered to the site within 20 days of ordering them.

Procurement of the components of this system will be done in an "open and free" competitive basis.

VIII. Equipment Installation

System Installation – The plan for construction and installation is shown in the project timeline. This timeline estimates the entire construction portion of the project to be 11 days from initial well drilling, to system startup and shakedown. Equipment installation will be done by licensed professionals in accordance with all applicable safety and work rules.

It is anticipated that there will be no disruption in the twice-daily milking operations at the dairy, both during construction, and during startup of the system.

System Startup and Shakedown - System start-up will be carried out by a qualified well pump and controls technician in conjunction with a qualified hydronic heating and plumbing technician. System start-up will consist of verifying operation of thermostats and controls as designed, and verifying system pressures and flow rates as designed.

IX. Operations and Maintenance

Operation Requirements – The system operation will be based on thermostatic controls and pressure sensed in the pressure tank. When a thermostat calls for heating, appropriate valves will open at the heat exchanger, allowing flow of geothermal water through the heating system. When the pressure correspondingly drops in the pressure tank, the well pump will be energized. The pump speed will be controlled by pressure in the tank.

Maintenance Requirements - The circulating pumps will require a quarterly visual inspection to see that seals and connections are not leaking. Otherwise the pumps and motors have no routine maintenance requirements. The heat exchangers will require quarterly inspection and may require annual cleaning or de-scaling.

Warranties - The electric motors used in the system are all 1 hp or smaller, and have standard 1 year warranties from the manufactures. Downhole pumps for the production well typically come with 1 to 2 year warranties from the manufacturer. The heat exchangers typically have a 1-year warranty.

Expected Equipment Design Life – The water used in this well has low solids and corrosives content, and therefore equipment life should not be affected by the water chemistry. Heat exchangers used in similar applications have functioned with out failure for over 20 years, and thus this is the expected life of the heat exchangers on this project. Submersible pumps in similar well conditions have life expectancies of 12 -15 years. Circulation pumps used in similar applications have performed for more than 15 years with occasional maintenance on the seals. The piping used in the system should be good for 50 years or more. The pressure tank has a life expectancy of 15 years.

Risk Management / Equipment Failures – The proposed system form an engineering standpoint in not a complex system. Components most susceptible to failure are controllers and pumps, which are standard off the shelf items that can be delivered and installed in 24 hrs by Mr. Hart.

Technology Transfer – This will be the first dairy in southeastern Idaho to be heated by ground source heat pump or geoexchange technology. We intended to provide access for the Eastern Idaho Technical College in nearby Idaho Falls, Idaho to visit our facilities and collect data to support their programs in Air Conditioning / Refrigeration / Heating Technology. We also plan to share information on the systems performance with local and state dairy operators through the local USDA CREES office in Blackfoot Idaho.

X. Decommissioning

There are no plans to decommission this system. If anything, it might be expanded at a future date if the dairy operations were to grow substantially.

XI. Insurance

There are special insurance requirements for this project and the resulting system. The dairy is not located in a government defined flood zone. Our insurance carrier has indicated that the ground source heat pump or geoexchange equipment will be covered under our existing policy with no increased cost.

Appendix A. Energy Audit

An energy audit was conducted by Idaho Energy Associates Inc., in April. The letter report and the checklist used for the audit are included in this appendix.

April 10, 2006

Mr. Lee Hart
Hart Dairy
1455 South, 2000 East
Shelly, Idaho

Summary

Mr. Donald Kilowatt, PE of Idaho Energy Associates Inc. performed this energy audit of the Hart Dairy operations on April 3, 2006. The purpose of the energy audit was to determine if it would be cost effective for Mr. Hart to switch from natural gas to ground source heat pump or geoexchange technology to supply heating and chilling needs for his milking and milk processing operations. While the audit did look at other energy sources and uses such as electricity, no recommendations on those energy uses were included. This audit is not intended to provide detailed specifications for a geoexchange system, as Mr. Hart has hired an engineering firm that specializes in geothermal systems to perform that work. The results of this audit indicate that Mr. Hart could expect to invest approximately $90,000 in wells and equipment and realize a simple project payback in approximately 12 years based on current natural gas prices. If natural gas prices are assumed to increase 5% a year, the simple payback would occur in approximately 10 years. In addition, there are some energy conservation improvements that Mr. Hart could make that would lower his energy consumption, immediately, even if he were to choose not to move forward with conversion to a geoexchange system. A copy of the field audit criteria is attached to this report.

Situation Report

This energy audit was requested by Mr. Lee Hart to support his application to the USDA for and Energy Efficiency Grant through the USDA 9006 program. This audit consisted of a walkthrough and inspection of the Hart Dairy operations, using a 73 element checklist divided into seven categories. The seven general categories are: General Requirements (4 elements); Energy Efficiency Compliance (45 elements in 6 groups); Site Responsiveness (5 elements); Water Conservation (6 elements).; Materials Sensitivity (5 elements); Healthiness (5 elements); and Environmental Releases (3 elements). The complete checklist is attached to this report.

The Hart Dairy operations are located in Snake River Plain of SE Idaho approximately 3 miles south of the town of Shelly. The elevation at their location is 4,609 feet above sea level. Mean average temperatures for the area are presented in Table 1.

Table 1. Mean Average Temperatures at Shelly Idaho

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temp °F	17.1	22.2	33.4	41.8	50.9	59.8	67.5	66.8	55.6	43.5	30.1	18.1

Currently all of the heating and cooling requirements for the dairy operation are accomplished with natural gas fueled systems. The dairy typically milks 260 cows twice a day in a 12 station milking barn that is approximately 1,200 sq ft (50'l, 24'w, 12'h) with a 12 foot ceiling. The milking barn is constructed of cinderblock and steel with R21 insulation in the ceiling. There are no windows in the milking barn. The milking operations require about 1,300 gallons of heated water each day, for washing the cattle and the facilities. Hot water is currently provided from a 60hp gas fired boiler. Rinse water for the milking operations is required to be 160ºF. Milk processing requires chilling approximately 2,200 gallons a day of milk from approximately 90º F down to 34ºF. The chiller being used is a Griton IBC 6106. The bulk tank room where the milk chilling and storage operations are conducted is approximately 576 sq ft and has 10' ceilings. (24'l x 24'w x 10'h). This building is also constructed of cinderblock with an insulated metal roof. These buildings are heated by natural gas ceiling mounted heating units.

Natural gas is provided by Intermountain Gas Company at the rate of $1.255 /therm. Hart Dairy's annual natural gas bill was $8,247 last year. This total includes natural gas applications in the home and shop, which are not considered in this energy audit.

Potential Improvements

Hart Dairy can decrease their energy consumption in their dairy operations in three ways.
1) While the hygiene and cleaning requirements of the buildings preclude the use of insulation on the walls, there can be some heating efficiencies gained by adding some insulation to the ceiling in both buildings.
2) There are a number of pipe runs in the facility that could benefit from pipe insulation and still meet the hygiene and cleaning requirements.
3) The operation could decrease their natural gas consumption by approximately 5,500 therms by converting to a ground source heat pump system for heating and chilling operations in the milk barn and bulk tank room.

Technical Analysis

By far, the biggest energy savings for Hart Dairy is associated with converting the water heating and milk chilling operations to a ground source heat pump or geoexchange system. This would save the operation approximately 5,500 therms of natural gas energy load each year. This is approximately $7,000 per year in reduced natural gas costs at the current price. Increased electrical load associated with the circulation pumps necessary for the geoexchange system are estimated to add approximately $440 / year at the current Rocky Mountain Power rate of $0.059897 per kWh. The current electric service provider, Rocky Mountain Power also has some incentives Mr. Hart may qualify for when he installs a geoexchange system.

Mr. Hart plans to add insulation to the ceiling of both buildings to bring the insulation factor to R36. This will entail minimal cost and is not part of the grant application this energy audit is supporting. Mr. Hart also plans to add additional insulation to some of the piping in his facilities. Both tasks are expected to cost less than $400 combined and will be done during routine maintenance of the facilities.

This audit is not intended to provide detailed specifications for a geoexchange system, as Mr. Hart has contacted a professional engineer to provide that service. However, based on systems that our firm, Idaho Energy Associates Inc., have been involved with in the past, we estimate that this application will require approximately 10-12 tons of main heat exchanger capacity, and 20 tons (6 tons – space heating barn, 3 tons – space heating tank room, 4 tons – cow washing water, 3 tons – cleaning water, 4 tons – milk chilling) of heat pump capacity to convert the system from natural gas to geoexchange. Well drilling, piping, pumps, controllers and heat exchangers for a system of this size typically fall in the $75,000 to $100,000 range.

Potential Improvements Description

Ground source heat pumps or geoexchange systems have been used throughout the world for dozens of years. The technology which is similar to operating a common household refrigerator is well known, and in recent years there have been many refinements that have improved reliability and durability of the systems in addition to lowering the overall cost of geoexchange systems. The performance characteristics of the geoexchange units are well know and documented. All that is required to make a comparison between a geoexchange and natural gas based system is the inlet water temperature, the price of natural gas, and the price of electricity that will operate the pumps in the geoexchange system. Knowing these factors allows qualified engineers to calculate unit sizing to replace natural gas or electric systems. This energy audit does not provide specifications for equipment or design of a geoexchange systems. Mr. Hart has hired an engineering firm that specializes in geothermal systems to perform that work.

A review of the energy bills for Hart Dairy indicates that in the past year (March 2005 to March 2006) the dairy used 6,571 therms of natural gas. Mr. Hart has one gas meter on his property. Some of the natural gas was used for heating of the residence and office space of the dairy. This energy audit did not include the residence or office space; therefore we were unable to determine the exact usage for the milking and processing applications alone. However, the engineering study Mr. Hart has commissioned will be able to quantify this energy requirement.

Mr. Hart has adequate space adjacent to his milking barn and bulk tank room to install a well to well heat pump system. The well heads and piping will not interfere with other operations at the dairy. Existing piping in the buildings can be used for hot water delivery. Additional insulation on that piping is recommended. There is ample room in the milking and processing buildings to install the heat exchanger and other pieces of equipment associated with a geoexchange system.

A geoexchange system will incorporate some small electrical pumps that were not part of the original heating system. These pumps are similar to the pumps the dairy uses to move milk products throughout the process. Mr. Hart has ample experience with inspection and maintenance of this type of equipment so overall system maintenance should not be an issue.

In summary, the milking barn and bulk tank room facilities at Hart Dairy would be ideal candidates for a geoexchange system for facility heating and process heating and cooling.

The information, calculations and conclusions in this report are valid for the configuration and use of the Hart Dairy facilities at the time of my audit on 3 April 2006.

Respectfully,

Donald Kilowatt, PE
Idaho Energy Associates Inc.
Sun Valley, Idaho

Energy Audit Checklist

Project Title: Hart Dairy Heating and Cooling Energy Efficiency Improvement

Location: 1455 South 2000 East, Shelly, Bingham County, Idaho

Date: 3 April 2006

Auditor: Donald Kilowatt, PE

This checklist identifies various energy efficient and sustainable design techniques and technologies that should be considered for any new building design, existing building modification, or complete building renovation. The checklist provides a method to consider energy efficient and sustainable concepts for the primary energy consuming building systems.

Checklist Item	Requirements Met	Not Applicable	Comments
1. GENERAL REQUIREMENTS			
1. Has ASHRAE Standard 90.1 been consulted for all energy related specification and design activities for this project? ASHRAE Standard 90.1 is an excellent source of building design guidelines to be applied for new building construction and existing building renovations or major modifications.	☐	X	
2. Has ANSI/ASHRAE/IESNA Standard 100-1995 or is equivalent been consulted for Energy Conservation in Existing Buildings? This standard provides many good tools and guidelines to assist with energy efficiency in existing buildings.	X	☐	
3 Has a life cycle cost approach been used to evaluate, compare, and select energy efficient and sustainable design parameters over standard building design parameters with an emphasis on selection of the best life cycle cost option? NBS Handbook 135 and its annual supplement contain current economic factors and energy and construction escalation rates.	X	☐	Not Applicable – this it not new construction
4 Have other sources of information for energy efficient and sustainable design techniques and technologies been consulted? Other significant sources of information include, but are not limited to the US Green Building Council at www.usgbc.org and several texts including the Sustainable Building Technical Manual available through the US Green Building Council. The LEED™ Rating System Version 2.1 contains many additional sustainable design concepts and can be found at: www.usgbc.org/LEED/publications.asp .	X	☐	Owner researched a number of energy efficiency options and improvements. Most were not cost effective for the current operations.
2. ENERGY EFFICIENCY COMPLIANCE			
Lighting Systems			
1. Has an effort been made to limit lighting levels to the minimum needed to meet IESNA (Illuminating Engineering Society of North America) Standards or other applicable Energy Efficiency Standards?	X	☐	Lighting was evaluated and it meets current guidelines
2. *Has task lighting been considered?* If task lighting for desktop or benchtop work is provided, the general area lighting can often be designed at lower light levels than when task lighting is not part of a facility design or planned operations.	☐	X	

Checklist Item	Requirements Met	Not Applicable	Comments
3. *Have compact fluorescent lamps been considered?* Incandescent lamps should not be used at all. Applications that have historically used incandescent lamps should now only have compact fluorescent lamps specified.	X	☐	100% of the lighting in the facilities is fluorescent lighting
4. *Have efficient exit lighting fixtures been specified?* Single Sided: **5 watts or less** Double Sided: **10 watts or less** Note: LED exit light fixtures are an excellent choice for very low maintenance and energy use.	☐	X	
5. *Has T-8 fluorescent technology been specified?* Standard fluorescent technology is now T-8 lamps with electronic ballasts. Ballasts should be selected as follows: Frequent Switching (3 hour cycles or less): specify **rapid start ballasts** Longer lighting cycles (12 hours typical): specify **instant start ballasts** Ballasts with a **low ballast factor (.77 to .87)** should be chosen for most applications as they will perform with lower energy use.	X	☐	Owner is aware of the benefits and will change to new technology as funding becomes available
6. *Have efficient HID lamps been specified?* If High Intensity Discharge (HID) fixtures are specified, select the most energy efficient type that will provide the needed color rendering for the application. Remember to research the application to determine if a more energy efficient type can be used! Typical applications include: Exterior: Low or High Pressure Sodium Interior: High Pressure Sodium or Metal Halide Alternative Technologies: Multiple Lamp compact Fluorescent or ICETRON high discharge fluorescent technologies.	X	☐	Current exterior lighting meets the recommendations

Checklist Item	Requirements Met	Not Applicable	Comments
7. *Has a lighting control system been considered that will automatically control all of the individual lighting fixtures and systems?* For large multi-use facilities, a complete lighting control system should be specified that controls the lighting according to work schedules.	X	☐	Automatic lighting is not necessary nor economically feasible for this operation
8. *Have motion sensors been specified?* Motion sensor controls should be specified for all common use areas. The following types of technologies are available: Passive Infrared (PIR): Offices, classrooms, conference rooms, and others that Provide for a direct line of sight to the sensor. Ultrasonic: Restrooms, libraries, and others where the area is typically cluttered or equipment and machinery can block a direct line of sight to the sensor. Dual Technology: Cubicle areas, and other areas with difficult environments such as high or variable air flow.	☐	X	
9. *Has outside lighting been configured and zoned so that some or all of the fixtures can be turned off during low use periods such as late at night or over the weekends?*	X	☐	This is a 24/7 operation. Outside lights have sensors to control dusk to dawn operation. All lights must be on at night.
HVAC and Mechanical Systems			
1. *Will the specified HVAC system be incapable of simultaneous heating and cooling?* Simultaneous heating and cooling has historically been an effective method to control building temperatures, but has been proven to be a significant waste of energy. New HVAC system designs or modifications must not operate through principles of simultaneous heating and cooling.	X	☐	The proposed geoexchange system meets these recommendations
2. *Have electronic temperature controls been specified that are capable of being programmed to setback the temperature whenever the facility is unoccupied?* The following temperature settings provide a general guide for typical work areas during off hours: Heating: **55° F** (but can be set as low as 45°F) Cooling: **System turned off**	X	☐	

Checklist Item	Requirements Met	Not Applicable	Comments
3. *Have economizer controls been considered?* Economizer controls open dampers to bring in additional outside air to cool the facility during cooler weather. Economizer controls should be standard in HVAC designs to take advantage of cooler weather.	X	☐	
4. *Have efficient chillers been specified?* Minimum energy performance specifications for chillers are listed in Chapter 6 of ASHRAE 90.1.	X	☐	The geoexchange system will use best available technology for chilling requirements.
5. *Have heat recovery systems been considered?* Laboratory, industrial, and process facilities that utilize once-through / 100% fresh air are always good candidates for heat recovery systems.	X	☐	
6. Have de-stratification strategies been considered to cycle trapped warm air from the ceiling level back to the floor level?	X	☐	An existing fan system was designed and installed for this purpose.
7. **Has insulation been specified for all hot and chilled water, refrigerant, steam, and glycol lines?**	X	☐	This is part of the new design.
8. *Have high efficiency motors with variable frequency controllers been considered for all rotating equipment applications?*	X	☐	All of the new pump motors and controllers will be high efficiency models
9. *Has properly sized equipment been specified?* Oversize equipment is generally not energy efficient and can result in increased maintenance and repair costs due to short cycling. Undersize or misapplied equipment will not adequately condition the facility and can also be costly to maintain.	X	☐	The owner has made arrangements for a Geoexchange specialist with a PE license to design the system.
10. *Have heat pumps been considered?* Even through heat pumps are less efficient in cold arid regions, they should still be considered for water to air and geothermal applications. If heat pumps are being considered, the facility operator and maintenance personnel should be contacted to discuss their ability to operate and maintain the heap pumps correctly. Heat pumps must be correctly sized and care should be taken to ensure that heat pump systems are installed by the sub-contractor exactly as specified in the design. Geothermal heat pump technologies work more effectively in regions with cold winter seasons. In general, the ground makes a better heat sink or source than does widely fluctuating air temperatures.	X	☐	This audits primary goal is to support conversion of the dairy water heating and chilling systems from natural gas to a geoexchange or ground source heat pump system.

Checklist Item	Requirements Met	Not Applicable	Comments
11. *Have passive solar heating applications been considered?* Passive solar heating technologies are proven to work in our climate and should always be included in building designs when determined to be cost effective. Water heating, space heating, and make up air preheating through the use of a transpired solar wall collector are all methods to obtain passive solar heating gains for a facility.	X	☐	Passive solar heating is not a cost effective option in this area.
12. *Has protection been considered for outside condensers?* Wind carries debris that can damage condenser fins over time. Such damage will reduce airflow and condenser capacity. For condensers that are subject to high wind conditions, some type of barrier should be provided that reduces the potential for fin damage but will not restrict airflow through the condenser.	☐	X	There will be no outside condensers.
13. *Has a location or shading for condensers been considered that will provide the least or most solar heat gain as applicable for the system needs?*	☐	X	
14. *Have efficient chilled water drinking fountains been specified?* Chilled water drinking fountains should have temperature settings no lower than 55°F and should include controls to not run during unoccupied periods. This control can be obtained through the use of occupancy sensors or possibly through a dedicated circuit and connection to the building's energy management system.	☐	X	There are no drinking fountains in the effected buildings.
15. *Have point source or tankless water heaters been considered?* Point source water heaters result in construction savings by only having to install a single cold water line where the need location is a long distance from the water heater. Tankless water heaters result in lower energy use and lower maintenance costs over conventional water heaters. Either of these water heating technologies are applicable to low water use areas and can save significant energy and maintenance related costs.	X	☐	This audit is supporting an application for a grant to install a geoexchange or ground source heat pump system.
Building Envelope			
1. *Has orientation to maximize daylighting been considered?* North facing windows provide glare-free daylighting strategies. South and west facing windows can provide unwanted heat gain and glare, which can be avoided by specifying view windows with a transmittance factor <0.18 and clerestory windows (above head height) with a transmittance factor of around 0.38.	☐	X	Buildings are already in place and have no windows.

Checklist Item	Requirements Met	Not Applicable	Comments
2. *Have insulated and coated windows been specified?* Windows should be insulated and/or coated at least as follows: North facing: **Triple glazing without low-e coating** South, East, and West facing: **Double glazing with low-e coating** Note: Very cold regions should consider triple glazing on all windows.	☐	X	No windows in buildings
3. *Have insulated outside personnel doors been specified?*	X	☐	Already in place.
4. *Have insulated equipment and garage doors with use-appropriate weather-stripping been specified?*	☐	X	
5. *Are vestibules part of the design for outside personnel doors? Are the vestibules non-heated?* Vestibules are designed in facilities to reduce infiltration of unconditioned air. The primary doors are insulted and weather-stripped whereas the secondary doors (either inside or outside) are typically not insulated and are not weather stripped. Vestibules installed outside the primary building envelope are often designed with fire sprinklers which then must be protected from freezing. This is accomplished by installing a heater in the vestibule or by propping the inside vestibule doors open during the winter. These practices negate the benefits of the vestibules. When appropriate and when code can be met, these types of vestibules should have the inside doors insulated and weather-stripped and should be specified without heat or sprinkler systems.	☐	X	Facility does not have nor need vestibules. Traffic does not warrant them.
6. *Has roofing with reflectance and emissivity of at least 0.9 been considered for buildings that require more heating than cooling?*	X	☐	Owner has taken this roofing option under advisement and may act on this during another fiscal year.
7. *Has the appropriate amount of insulation been specified?* The minimum standard for insulation is ASHRAE Standard 90.1. The Energy Cost Budget whole building simulation method described in section 11 of Standard 90.1 can be used to increase the energy efficiency of the building envelope by the percentages listed in the LEED™ Rating System Version 2.1. Additional insulation to increase the design points for a LEED™ certification score must be evaluated for life cycle cost effectiveness. The maximum amount of insulation should be specified in the design that will provide for maximum life cycle cost effectiveness rather than simple minimum first cost.	X	☐	Owner has agreed to increase insulation in the ceiling of the two buildings.

Checklist Item	Requirements Met	Not Applicable	Comments
8. *Have interior and exterior treatments been considered that will reduce the need for energy use?* Light colored interiors generally increase the perception of high light levels. Dark exterior treatments are a good choice for buildings with high internal heating requirements.	X	☐	Interior treatments are limited by Food Health Safety requirements, but currently support this item.
Automated Control Systems			
1. *Has a complete building control system been considered that will control all building functions?*	X	☐	
2. *Is the selected building control system compatible with other local existing building control systems so they can be networked together when applicable?*	☐	X	There are no other buildings associated with these two buildings.
3. *Have as many systems as possible been specified to be controlled by the automated system so they cannot be inadvertently left on by the tenants?* The following systems are the minimum that should be connected to the automated building controls: • All HVAC systems • Humidification systems • General area lighting • Outside lighting • Water heating equipment • Safety and Security systems	X	☐	
Miscellaneous Strategies and Features			
1. Have on-site co-generation systems been considered to supplement the building energy load? Co-generation includes a variety of energy producing systems that use waste energy or naturally occurring energy sources to offset the amount and cost of purchased energy needed for a facility or process. Many of these types of systems are becoming widely used and may reduce the overall life cycle cost of the facility. The types of systems typically associated with co-generation include waste steam reuse for electric generation, any of a variety of renewable sources such as wind or solar to reduce electricity use requirements, and employing existing standby generation systems to offset peak loading periods with their associate electrical demand costs.	X	☐	This system would not economically support any cogeneration systems.

Checklist Item	Requirements Met	Not Applicable	Comments
2. *Have photovoltaic solar systems been considered?* The cost effectiveness and dependability of active solar systems are steadily improving. Photovoltaic solar systems are particularly applicable to projects that would need to have electrical lines installed over a significant distance.	X	☐	Photovoltaic solar systems are not cost competitive in this location and situation.
3. Have emerging power alternatives been considered? Emerging technologies include alternate fuels, wind, solar, fuel cells, micro-turbines, flywheels, and others at they become available and should be implementing into building designs as they are found to be cost effective.	☐	X	
4. *Has metering and sub-metering been specified that will interface with the building controls system so that energy consumption data can be electronically and remotely monitored, controlled, and compiled?*	☐	X	
5. *Have Energy Star™ products and appliances been specified?*	X	☐	Where appropriate they have been discussed and recommendations made.
6. Has sub-metering been specified that will meter each section of the facility that has a different purpose or function? A multi-purpose facility should have sub-metering for functional areas such as laboratories, office areas, industrial processes, or food service.	☐	X	
7. Has landscaping been considered that will provide the maximum energy benefit for the facility? Deciduous trees provide shade and reduced heat gain in the summer while allowing needed heat gain in the winter. Evergreens are effective in providing year round protection from prevailing winds. Earthen berms provide reduced insulation needs.	X	☐	Landscaping was examined and the existing landscaping was judged to be outstanding from an energy savings standpoint.
Maintenance Considerations			
1. Have designs been reviewed to ensure adequate access to mechanical and electrical equipment, which ensures ease of maintenance? When maintenance is completed correctly and as scheduled, the energy using system is more capable of operating efficiently as designed.	X	☐	The design for the geoexchange system has not been completed, but it will have this element in the design review.

Checklist Item	Requirements Met	Not Applicable	Comments
2. Have designs been reviewed to ensure that the layout reduces or eliminates the chance that the building's contents will be located in a manner that impedes airflow for the building's HVAC system? Restricted airflow can put a building's HVAC system in an out-of-balance condition that results in employee discomfort and increased energy use.	☐	X	
3. Have HVAC controls been located away from the intended location of office and process equipment? Equipment that puts off heat can result in operational problems for a facility when this equipment is located near HVAC controls. Problems can include the inability of the tenants to control the building's HVAC system and increased costs to retrofit the facility after it has been completed.	X	☐	This will be an element in the design done by the PE.
3. SITE RESPONSIVENESS			
1. *Has the impact to local ecosystems been considered when specifying the building location?* A description of the analysis and selected features that minimize the impact of the building to local ecosystems will be required for inclusion in the Energy Efficiency and Sustainable Design Report.	☐	X	Buildings have been the same location for over 15 years.
2. *Has the selected building site avoided locating on prime farmland, within 100 feet of wetlands, or less than 5 feet above a 100 year flood plain?*	☐	X	This audit is for a retrofit of existing buildings.
3. *Have transportation needs and local transportation systems been considered for the building location and site selection?* The selected site location and building design should provide for ease of bus transportation, car or van pool parking spaces, and bike racks when applicable.	☐	X	
4. *Has the outside lighting of neighboring facilities been taken into account when determining the outside lighting needs for a new facility to avoid over lighting the space between facilities?*	☐	X	There are no neighboring facilities with outside lighting.
5. *Has outside lighting been limited to the lowest illumination required by IESNA and is shielded to avoid skyward reflection?*	☐	☐	

Checklist Item	Requirements Met	Not Applicable	Comments
4. WATER CONSERVATION			
1. *Has an analysis been performed that addresses the reduction, control, and treatment of site runoff?* A storm water runoff plan should be prepared that addresses strategies to minimize erosion and the potential washing of oils or other pollutants from parking lots or work areas into streams or sewers both during construction and building occupation. This plan in addition to a description of any other features considered or implemented to reduce, control, or treat site runoff will be required for inclusion in the Energy Efficiency and Sustainable Design Report.	X	☐	The facility has existing permits to operate as a dairy in Idaho.
2. *Has pervious paving been considered as a method to reduce storm water runoff?*	☐	X	
3. *Have low water use fixtures been specified for all casual water use applications?* Maximum flow rates for fixtures should be specified as follows: Faucets: **2.0 gpm** Showers **2.2 gpm** gpm = gallons per minute Toilets: **1.6 gpf** gpf = gallons per flush Urinals: **1.0 gpf**	X	☐	Where applicable, these criteria have been passed on the design engineer.
4. *Has landscaping been selected that will minimize the need for irrigation?* Grass and high maintenance vegetation requires frequent irrigation and cultivation. Xeriscaping is a method of using plants and landscaping materials native to dry regions, and which require little or no additional irrigation.	☐	X	Existing landscaping will not be disturbed by the proposed installation of a geoexchange system.
5. *If irrigation is required, have drip systems operated by timers or by moisture sensors been considered?*	☐	X	
6. *Have strategies been considered to recycle or reuse water and minimize the treatment of waste water?* Grey water can often be used for irrigation purposes. Treatment of waste water usually costs more than treating potable water initially.	X	☐	Wastewater is addressed in the facilities operating permits with the State of Idaho.

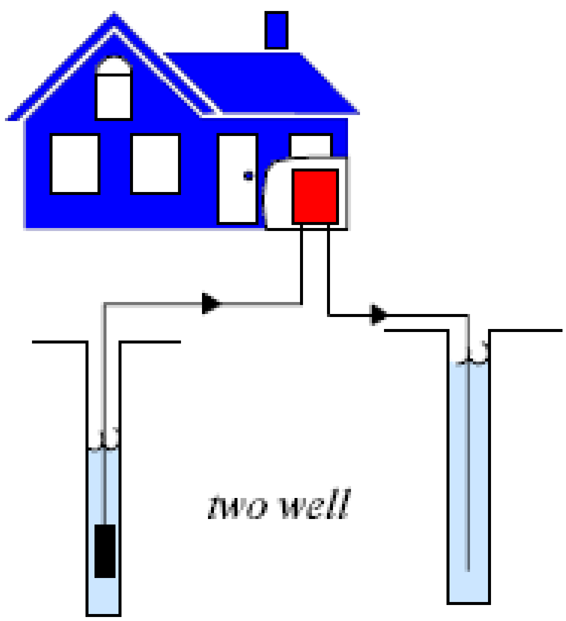
Checklist Item	Requirements Met	Not Applicable	Comments
5. MATERIALS SENSITIVITY			
1. *Have existing buildings been considered for renovation and rehabilitation rather than building a new facility for this project need?* Reusing existing facilities when cost effective will significantly reduce the amount of material waste in both the D&D of the existing facility as well as waste generated while constructing the new facility. A description of existing facilities considered and the practicality and cost effectiveness of their renovation will be required for inclusion in the Energy Efficiency and Sustainable Design Report.	X	☐	
2. *Have materials been specified that contain a maximum of recycled content?*	X	☐	
3. *Have construction methods been specified that will result in the least amount of left over material needing disposal or reuse?*	☐	X	This would be part of the design being done by a PE. Recommendations have been made to the owner of the facility.
4. *For construction process that will require a large amount of left over material or scrap, have materials been specified that are fully recyclable or can be used for another project?*	☐	X	This would be part of the design being done by a PE. Recommendations have been made to the owner of the facility.
5. *Have rapidly renewable material for building products been considered?* Examples of rapidly renewable materials include: • Wood cellulose insulation instead of fiber bat insulation • Linoleum flooring instead of vinyl • Cotton wall covering rather than synthetic materials • Certified wood	X	☐	This recommendation was made to the owner to pass along to the design engineer.
6. HEALTHINESS			
1. *Does the design include measures or technologies that minimize the potential for Indoor Air Quality problems during operation of the facility?* Specify low VOC and low urea formaldehyde resin content in paint, sealant, coating, carpet, composite wood, adhesive, and agrifiber products.	X	☐	
2. *Have independent ventilation systems been specified for chemical use and storage rooms, laboratories, copy rooms, and janitorial supply and storage rooms?*	☐	X	

Checklist Item	Requirements Met	Not Applicable	Comments
3. *Does the design ensure that landscaping that will require pesticides is not placed near doors, air intakes, or operable windows?*	☐	X	
4. *Have daylighting strategies been considered?* Daylighting generally means that some combination of building orientation, window placement, light shelves, skylights, and daylighting controls have been utilized to displace artificial light with natural light without adding unwanted thermal gain or glare, and to automatically control building lighting systems when natural light levels are sufficient.	☐	X	This is a modification of existing buildings
5. *Has a combination of direct and indirect lighting been considered?* Conference rooms and certain office floor plans can benefit from the installation of "direct and indirect luminaries". The use of a combination of direct and indirect lighting can, in many cases, reduce the overall lighting electric load and may provide for a lower installation cost. Applying this principle can result in an improved life cycle cost benefit.	☐	X	
7. ENVIRONMENTAL RELEASES			
1. *Have pre-cut or pre-fabricated materials been specified to reduce on-site waste generation whenever possible?*	☐	X	
2. Have changeable or movable materials or systems been considered for facilities that are subject to change? Building systems or operational systems that are modifiable for new or different configurations will result in reduced life cycle demotion and related waste and costs.	X	☐	A recommendation was made to the owner to include this in the design by the PE.
3. *Does the design include space for recycling centers or containers?*	☐	X	

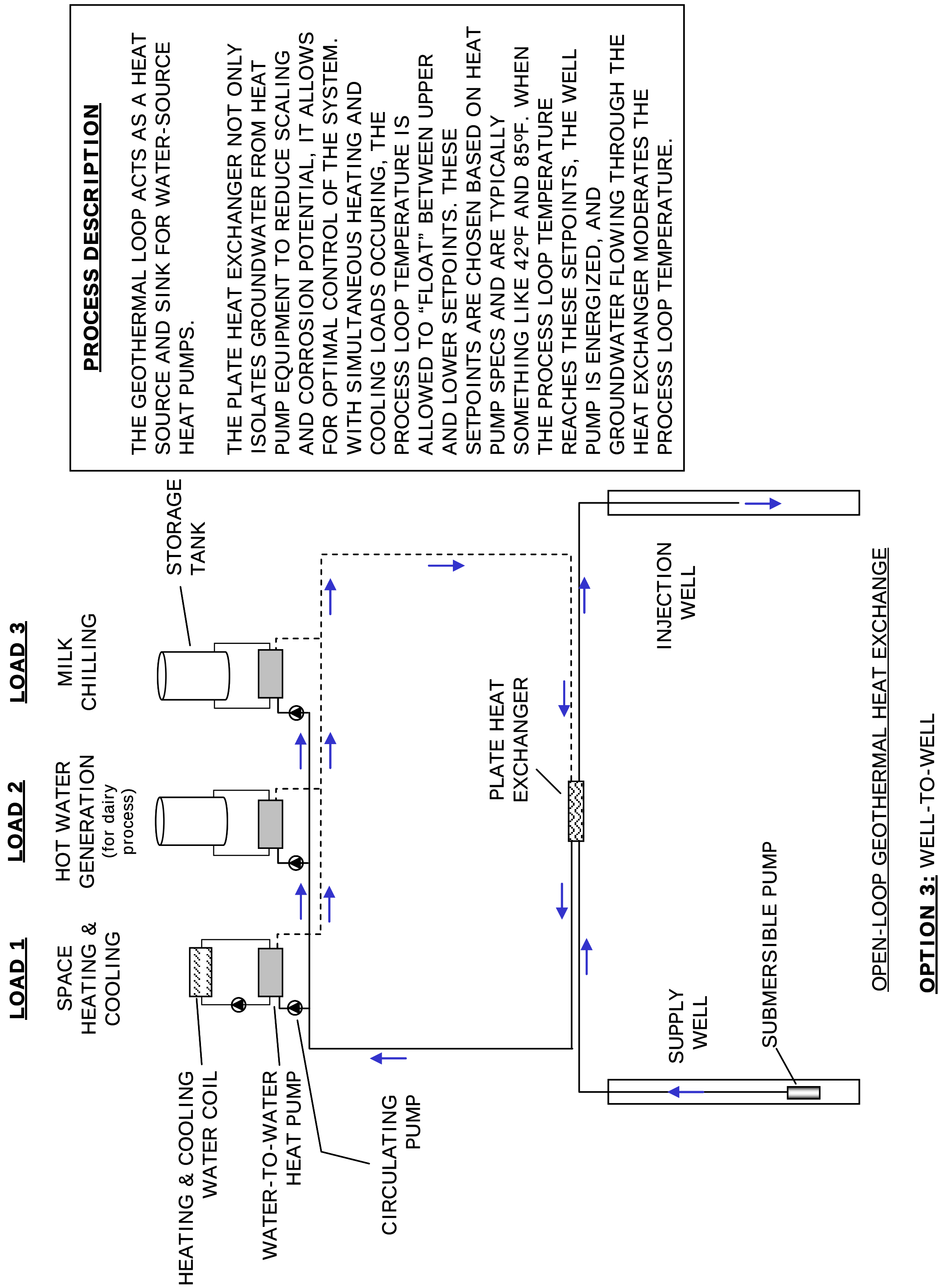
Appendix B. Engineering Design

Process Diagram - Open-Loop Geothermal System

- **Heating Loads Summary**
- **Cooling Loads Summary**
- **Construction Cost Estimate – Open-Loop (Well-to-Well)**



Appendix B: Process Diagram (Open-Loop Geothermal)



Appendix B: Design and Engineering Heating Loads Summary

Values in red are computed from input data.

Space Heating Loads

Load 1: Milk Barn

Floor space	1,220	ft^2
Design outdoor air temperature:	-6	^oF
Design indoor air temperature:	70	^oF
Annual heating degree days	7,100	
Heat loss at design condition	55	Btu/hr-ft^2
Peak heating Load	67,100	Btu/hr
Annual heating energy required	150	million Btu

Load 2: Bulk Tank Room

Floor space	576	ft^2
Design outdoor air temperature:	-6	^oF
Design indoor air temperature:	70	^oF
Annual heating degree days	7,100	
Heat loss at design condition	55	Btu/hr-ft^2
Peak heating Load	31,680	Btu/hr
Annual heating energy required	71	million Btu

Hot Water Heating Loads

Load 1: Cow Washing

Gallons per day required	600	gpd
Number of events per day	2	
Minimum storage required	300	gal
Recovery time	4	hr
Peak flow rate	1.3	gpm
Inlet water temperature	50	^oF
Desired outlet water temperature	110	^oF
Peak Heating Load	37,500	Btu/hr
Annual heating energy required	110	million Btu

Load 2: Cow Udders & Milk Barn Floors

Gallons per day required	520	gpd
Number of events per day	2	
Minimum storage required	260	gal

Recovery time	4	hr
Peak flow rate	1.1	gpm
Inlet water temperature	50	^oF
Desired outlet water temperature	110	^oF
Peak Heating Load	32,500	Btu/hr
Annual heating energy required	95	million Btu
Total Heating Load		
Peak hourly	168,780	Btu/hr
Annual	426	million Btu

Appendix B: Design and Engineering Cooling/Refrigeration Loads Summary

Values in red are computed from input data.

Space Cooling Loads			
Load 1:	**Milk Barn**		
	Floor space	1,220	ft^2
	Cooling load per sq. ft	250	ft^2/ton
	Annual equivalent full load hours	1,000	hr
	Peak cooling Load	58,560	Btu/hr
	Annual cooling energy required	59	million Btu
Load 2:	**Bulk Tank Room**		
	Floor space	576	ft^2
	Cooling load per sq. ft	250	ft^2/ton
	Annual equivalent full load hours	1,000	hr
	Peak cooling Load	27,648	Btu/hr
	Annual cooling energy required	28	million Btu
Process Cooling Loads			
Load 1:	**Milk Chilling**		
	Gallons per day produced	2,340	gpd
	Starting milk temperature	90	^oF
	Chilled milk temperature	34	^oF
	Cooling Load (on storage tank)	45,549	Btu/hr
	Annual cooling energy required	40	million Btu
Total Cooling Load			
	Peak hourly	131,757	Btu/hr
		11.0	tons
	Annual	126	million Btu

Appendix B: Design and Engineering Construction Cost Estimate **Construction Cost Estimate**	**Quantity**	**Units**	**Unit Cost**	**Sub Total**	**Totals**
GEOTHERMAL RESOURCE OPEN-LOOP SYSTEM (WELL-TO-WELL)					
Production Well					
Drilling & materials	250	ft	$30	$7,500	
Well pump, pressure tank, controls	1	lump	$2,000	$2,000	
Injection Well					
Drilling & materials	250	ft	$30	$7,500	
Distribution Piping					
PVC pipe, trench & backfill, pipe bedding, associated fittings & valves	200	ft	$20	$4,000	$21,000
GEOTHERMAL ENERGY UTILIZATTION					
Main Heat Exchanger (plate type)	12	ton	$50	$600	$600
Space Heating Load 1 - Milk Barn					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat pump (water-to-water)	6	ton	$1,500	$9,000	
Circulating pump, controls	2	lump	$500	$1,000	$11,750
Space Heating Load 2 - Bulk Tank Room					
Retrofit from existing boiler					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat pump (water-to-water)	3	ton	$1,500	$4,500	
Circulating pump, controls	2	lump	$500	$1,000	$7,250
Hot Water Load 1 - Cow Washing					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat pump (water-to-water)	3.5	ton	$1,500	$5,250	
Hot water storage tank (w. backup)	300	gal	$12	$3,600	
Circulating pump, controls	2	lump	$500	$1,000	$11,600
Hot Water Load 2 - Floors, Udders					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	

Heat pump (water-to-water)	3	ton	$1,500	$4,500	
Hot water storage tank (w. backup)	260	gal	$12	$3,120	
Circulating pump, controls	2	lump	$500	$1,000	$10,370
Milk Chilling					
Wall cut, piping, fittings	1	lump	$1,750	$1,750	
Heat pump (water-to-water)	4	ton	$1,500	$6,000	
Storage tank (assume existing already)	0	gal	$0	$0	
Circulating pump, controls	2	lump	$500	$1,000	$8,750
CONSTRUCTION GRAND TOTAL					**$71,320**

Appendix C. Financial Commitment Letter

Idaho Farm Credit Services

February 25, 2005

To Whom It May Concern:

Idaho Farm Credit Services agrees to provide financing in an amount no greater than $65,000 for the purchase of materials and labor for the conversion to geothermal energy sources for Lee Hart owner of Hart Dairy, of Shelly, Idaho. This letter is a commitment by Idaho Farm Credit Services to finance 75% the project up to $65,000.

Sincerely,

Patrick Lanley
Sr. Business Analyst
Idaho Farm Credit Services

Appendix D. Federal Tax Return

Form **1040** Department of the Treasury—Internal Revenue Service **U.S. Individual Income Tax Return 2005** (99) IRS Use Only—Do not write or staple in this space.

For the year Jan. 1–Dec. 31, 2005, or other tax year beginning , 2005, ending , 20 OMB No. 1545-0074

Label (See instructions on page 16.) Use the IRS label. Otherwise, please print or type. LABEL HERE

Your first name and initial	Last name		Your social security number
If a joint return, spouse's first name and initial	Last name		Spouse's social security number
Home address (number and street). If you have a P.O. box, see page 16.		Apt. no.	▲ You must enter your SSN(s) above. ▲
City, town or post office, state, and ZIP code. If you have a foreign address, see page 16.			Checking a box below will not change your tax or refund.

Presidential Election Campaign ▶ Check here if you, or your spouse if filing jointly, want $3 to go to this fund (see page 16) ▶ ☐ You ☐ Spouse

Filing Status

Check only one box.

1 ☐ Single
2 ☐ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See page 17.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child (see page 17)

Exemptions

6a ☐ Yourself. If someone can claim you as a dependent, do not check box 6a
b ☐ Spouse
c Dependents:

(1) First name Last name	(2) Dependent's social security number	(3) Dependent's relationship to you	(4) ✓ if qualifying child for child tax credit (see page 19)
			☐
			☐
			☐
			☐

If more than four dependents, see page 19.

d Total number of exemptions claimed

Boxes checked on 6a and 6b ____
No. of children on 6c who:
• lived with you ____
• did not live with you due to divorce or separation (see page 20) ____
Dependents on 6c not entered above ____
Add numbers on lines above ▶ ☐

Income

Attach Form(s) W-2 here. Also attach Forms W-2G and 1099-R if tax was withheld.

If you did not get a W-2, see page 22.

Enclose, but do not attach, any payment. Also, please use Form 1040-V.

Line	Description		Line	Amount
7	Wages, salaries, tips, etc. Attach Form(s) W-2		7	
8a	Taxable interest. Attach Schedule B if required		8a	
b	Tax-exempt interest. Do not include on line 8a	8b		
9a	Ordinary dividends. Attach Schedule B if required		9a	
b	Qualified dividends (see page 23)	9b		
10	Taxable refunds, credits, or offsets of state and local income taxes (see page 23)		10	
11	Alimony received		11	
12	Business income or (loss). Attach Schedule C or C-EZ		12	
13	Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐		13	
14	Other gains or (losses). Attach Form 4797		14	
15a	IRA distributions	15a	b Taxable amount (see page 25) 15b	
16a	Pensions and annuities	16a	b Taxable amount (see page 25) 16b	
17	Rental real estate, royalties, partnerships, S corporations, trusts, etc. Attach Schedule E		17	
18	Farm income or (loss). Attach Schedule F		18	
19	Unemployment compensation		19	
20a	Social security benefits	20a	b Taxable amount (see page 27) 20b	
21	Other income. List type and amount (see page 29)		21	
22	Add the amounts in the far right column for lines 7 through 21. This is your total income ▶		22	

Adjusted Gross Income

Line	Description		Line	Amount
23	Educator expenses (see page 29)	23		
24	Certain business expenses of reservists, performing artists, and fee-basis government officials. Attach Form 2106 or 2106-EZ	24		
25	Health savings account deduction. Attach Form 8889	25		
26	Moving expenses. Attach Form 3903	26		
27	One-half of self-employment tax. Attach Schedule SE	27		
28	Self-employed SEP, SIMPLE, and qualified plans	28		
29	Self-employed health insurance deduction (see page 30)	29		
30	Penalty on early withdrawal of savings	30		
31a	Alimony paid b Recipient's SSN ▶	31a		
32	IRA deduction (see page 31)	32		
33	Student loan interest deduction (see page 33)	33		
34	Tuition and fees deduction (see page 34)	34		
35	Domestic production activities deduction. Attach Form 8903	35		
36	Add lines 23 through 31a and 32 through 35		36	
37	Subtract line 36 from line 22. This is your adjusted gross income ▶		37	

For Disclosure, Privacy Act, and Paperwork Reduction Act Notice, see page 78. Cat. No. 11320B Form **1040** (2005)

Appendix E. Hart Dairy Income Statement

Hart Dairy

Current Year Profit and Loss Statement, or Income Statement, or Earnings Statement

January 1 through December 31, 2005

INCOME		
	Milk Sold	756,000
	Calves Sold	19,000
	Cattle Sold	63,000
	Government Payments	18,500
	Total Income	**856,500**
EXPENSES		
	Labor	74,000
	Payroll Taxes	6,500
	Repairs	6,200
	Interest (Operating	18,000
	Interest (Other)	60,000
	Rent/Lease	32,000
	Feed	327,000
	Seed	13,000
	Fertilizer	68,000
	Chemicals	17,000
	Custom Hire	8,000
	Supplies	11,000
	Breeding/Veterinarian	17,000
	Fuel, Gas, Oil	33,000
	Property Taxes	12,300
	Insurance	4,700
	Natural Gas	5,100
	Utilities	24,125
	Depreciation	59,000
	Total Expenses	**795,925**
NET INCOME		**60,575**