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OPEN-FILE REPORT NO. 81-3

APPENDICES OF AN APPRAISAL FOR THE USE OF GEOTHERMAL ENERGY IN STATE-OWNED BUILDINGS IN COLORADO

Section A: Alamosa
Section B: Buena Vista
*Section C: Burlington
Section D: Durango
Section E: Glenwood Springs
Section F: Steamboat Springs

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DISCLAIMER

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FIGURES

BURLINGTON

The State Highway Department Building in Burlington has been evaluated in this geothermal energy appraisal. While there is no known geothermal resource at Burlington, a shallow water aquifer - Ogallala Aquifer - does exist beneath Burlington at depths of 200 to 300 feet. One particular water well is reported to be producing water at 59°F to 63°F at 800 to 1000 gpm. Therefore, the Ogallala is being considered as a source of warm water for the use of water-to-air heat pumps for space heating of the Highway Department Building.

The geothermal energy economics are evaluated for two options: (1) a new water well drilled on the site of the Highway Department Building and (2) the purchase of warm water from an existing City of Burlington water well. The latter option is evaluated only for the 12 percent/9 percent (through 1984/ through 2000) natural gas price escalation case, whereas the former option is evaluated for both the 15 percent and the 12 percent/9 percent schedules.

The results of the economic evaluations generally indicate that heat pumps would not be economically competitive, particularly if the State purchased City water at the current water rates. Fuel price escalation rates greater than 15 percent per year can shift the heat pump/shallow well option to a marginal position.

The principal institutional/environmental issue to be addressed for the Burlington facility is an existing ordinance which only allows the City to drill water wells within the City. The City would either have to grant an exception for a State well or the City would own the well and sell the water to the State.

Resource Assessment for Burlington

There are absolutely no indicators of anomalous geothermal heat in the subsurface beneath Burlington, Colorado. There are no hot springs, alteration zones, sinter deposits, mappable fracture zones or volcanics within 78 miles of the town.

A water well in the Burlington area is reported to be 327 feet deep, with water being pumped from the 200-foot level in the Ogallala Aquifer. The well is producing at 800 to 1000 gpm with surface temperature of 59°F to 63°F.

If temperature gradient data from the nearest control point, an oil well 15 miles away, are applied to a 63°F well at 200 feet, then depths in excess of 5,600 feet would be required to encounter 150°F temperatures in the Burlington area.

Because there are no indicators of geothermal heat at Burlington, this site is used to study the heat pump potential only.

On-site drilling of a warm water well to 200 feet deep and a well drilling cost of $5,000 are assumed for the Highway Department Building.

Building Retrofit Engineering for State Highway Department Building

The following engineering design specifications are prescribed for the Highway Department Building in Burlington. The proposed heat pump engineering schematic is provided in Figure 19.

Present Conventional Fuel Heating System

Building	Square Footage	Fuel	Heating Equipment	Peak Heat Load (Btu/hr)
Office	800	Natural gas	Forced air furnace	100,000
Garage	4,000	Natural gas	Overhead furnace	104,000
				204,000

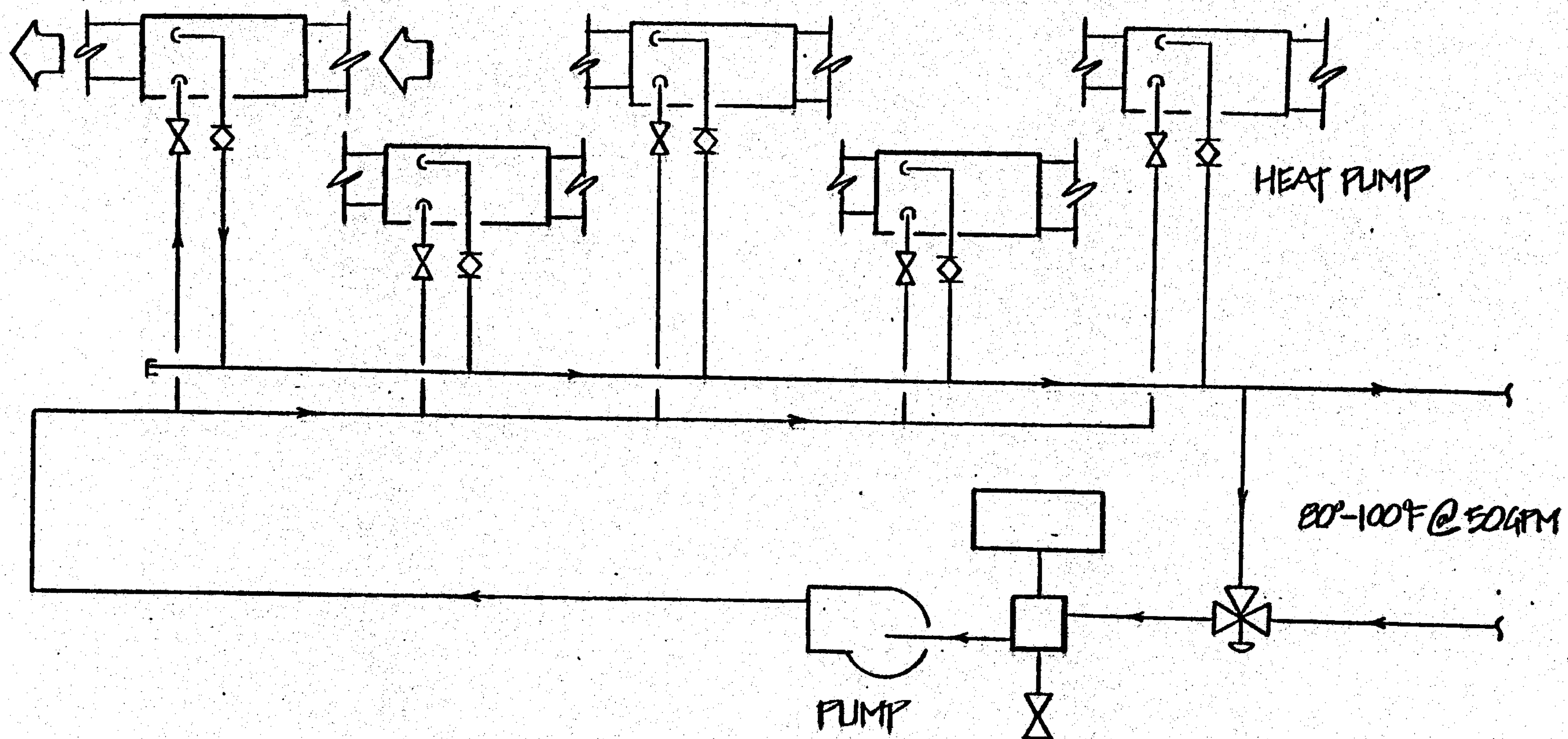
Geothermal System Design Specifications

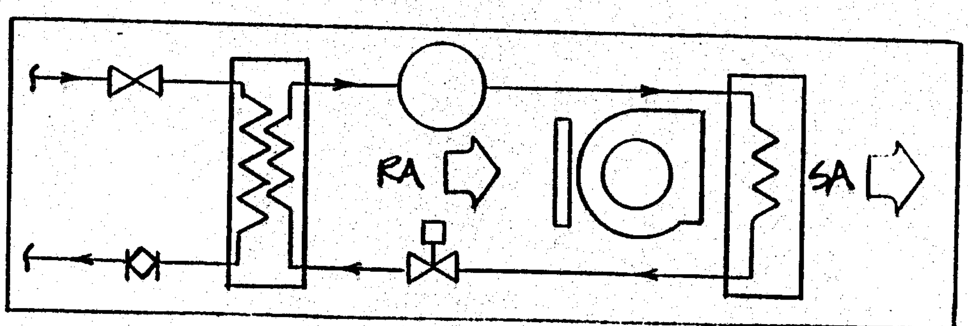
Proposed System and Modifications:

1. Retrofit to utilize shallow aquifer as source for water-to-air heat pumps.
2. Replace gas furnace in office and gas unit heaters in garage with water-to-air heat pumps.
3. Existing air distribution will remain; however, additional sheet metal is required.
4. Circulating pump is required.
5. Air separator and expansion tank are required.
6. Distribution piping to heat pumps is required.
7. 3-way diverting valve is required.
8. More sophisticated temperature control is required.

Engineering Design:

Design heating can be accomplished with water-to-air heat pumps, utilizing a 60°F to 80°F direct warm water source at 30 gpm and $\Delta T = 15^{\circ}F$. Four 52,000 Btu/hr heat pumps (COP = 4.0) are used.





WATER TO AIR HEAT PUMP

Figure 19

BURLINGTON HIGHWAY DEPT.

Equipment Components and Cost Estimates:

Component	Specifications	Quantity	Unit Cost	Total Cost
Heat Pump	52,000 Btu/hr	4	$1,250	$ 5,000
Sheet Metal				1,000
Circulation Pump				1,000
Air Separator and Expansion Tank				1,200
Distribution Piping		200'	16	3,200
Insulation		200'	6	1,200
Temperature Controller				630
		Subtotal		$13,230
		Contingency (10%)		1,323
	Total			$14,553

Economic Evaluations

On the following pages are presented the itemized geothermal capital improvement costs, the annual operating and maintenance costs for both the geothermal system and the conventional fuel system, and the results of the calculations of the four economic measures for the heat pump/shallow well option for the State Highway Department at Burlington; not included are the details for the heat pump option using purchased city water.

The heat pump capital improvement cost is estimated as $23,597 for the heat pump/shallow well case and as $32,948 for the heat pump/purchased water case. The cost difference is attributable to the costs of installing a moderate length (estimated at 500 feet) supply and return pipeline to a new city water well and/or main lines. The first year operating and maintenance costs are approximately equal at $1,600 for both the heat pump/shallow well system and the existing natural gas heating system. The purchase of city water at current rates increases the first year operating and maintenance costs to $5,900 for that heat pump option.

The calculated economic measures (assuming fuel price escalation of 15% per annum) are summarized as follows:

	Heat Pump/Shallow Well System
Simple Payback Period:	16 years
Total Annualized Cost:	
Geothermal:	$ 5,757
Conventional:	$ 4,779
Total Undiscounted Savings:	$62,852
Total Present Value Savings:	$14,425

The heat pump/shallow well option is not economically competitive with the natural gas heating system for the given set of assumptions; it might become marginally competitive if natural gas prices increased more than 15 percent per year.

CAPITAL COSTS

Location: Burlington   Facility: Highway Department Building

Geothermal Option: Heat Pump with Shallow Well

		Costs
A. Production Well System		
Exploration		$ N.R.
Reservoir Engineering		N.R.
Wells 1 @ $ 5,000		5,000
Well Pumps (1)	30gpm, 240 ft-hd, 3.2 HP	1,000
Valves and Controls		500
Contingency Funds (10%)		Included
Subtotal		6,500
Engineering Design Fee (10%)		Included
Total		$ 6,500
B. Transmission Line System		
Piping (50 ft.)		1,100
Pumps ( )	gpm, ft-hd, HP	N.R.
Contingency (10%)		110
Subtotal		1,210
Engineering Design Fee (10%)		121
Total		$ 1,331

C. Central Distribution System

Heat Exchanger, or	
Heat Pump	N.A.
Auxiliary Building	
Valves and Controls	
Piping	
Circulation Pumps ( ) gpm, ft-hd, HP	
Miscellaneous	
Contingency (10%)	
Subtotal	
Engineering Design Fee (10%)	
Total	$ -0-

D. Building(s) Retrofit HVAC System

Heating Units 4 Heat Pumps @ $1,250	5,000
Retrofit Plumbing	6,600
Valves and Controls	630
Contingency (10%)	1,223
Subtotal	13,453
Engineering Design Fee (10%)	1,345
Total	$ 14,798

E. Reinjection/Disposal System - Surface

Reinjection Well(s): wells @ $	N.R.
Piping (100 ft.)	800
Pumps ( )	N.R.
Controls and Valves	N.R.
Contingency (10%)	80
Subtotal	880
Engineering Design Fee (10%)	88
Total	$ 968

F. Grand Total $23,597

ANNUAL OPERATING AND MAINTENANCE COSTS

(1980 Dollars)

Location: Burlington Facility: Highway Department Building

Geothermal Option: Heat Pump with Shallow Well

Geothermal System

Cost Item	Electricity Cost	Maintenance Cost/ (% of C. C.)
A. Production Well System		130 (2%)
Pump electricity 3.2 H P	$ 462	
B. Transmission Line System	-	13 (1%)
C. Central Distribution System		
Heat Pump electricity	-	-
Circ. Pump electricity	-	
D. Building(s) Retrofit HVAC System	726	296 (2%)
E. Reinjection/Disposal System	-	10 (1%)
Total	$ 1,188	$ 449

Conventional Fuel System

Type of System: Natural Gas Fired Furnace and Unit Heaters

Fuel Cost	
Total Annual Fuel Load	430×10^6 Btu/yr
1980-81 Estimated Fuel Price	$3.00/$10^6$ Btu
1980-81 Estimated Total Annual Fuel Cost	$ 1,290

Maintenance Cost	
Percent of Associated Capital Costs	2%
Estimated Capital Costs	$15,000
Estimated Maintenance Cost	$ 300

Electricity Cost	
1980-81 Estimated Total Annual Electricity Cost	$ -0-

ECONOMIC EVALUATIONS

Location: Burlington Facility: Highway Department Building

Geothermal Option: Heat Pump with Shallow Well

A. Simple Payback Calculation

Current Annual Conventional System Cost	
Natural Gas	$ 1,290
Electricity	-
Maintenance	300
Total	$ 1,590

Geothermal System Cost	
Capital Cost (1980 Dollars)	$ 23,597
First Year Operating Cost	1,188
First Year Maintenance Cost	449
Total	$ 25,234

Simple Payback Period: $\frac{\text{Total Geothermal System Cost}}{\text{Total Conventional System Cost}}$ = 16 years

B. Annual Cost Comparison

(Assume 20-Year Life and 10% per Annum Cost of Capital)

Cost Item	Conventional System Annualized Cost	Geothermal System Annualized Cost
Capital Investment	$ -	$ 2,772
Electricity (9%/yr. escalation)	-	2,330
Maintenance (10%/yr. escalation)	438	655
Conventional Fuel (15%/yr. escalation)	4,341	-
Total Annualized Cost	$ 4,779	$ 5,757

ECONOMIC EVALUATIONS (cont'd)

Location: Burlington

Facility: Highway Department Building

Geothermal Option: Heat Pump with Shallow Well

C. Total Savings and Payback Period

Year	Conventional System			Geothermal System		End of Year	Annual Savings	Present Value (i = 10%)
	Fuel (15%)	Elect. (9%)	Maint. (10%)	Elect. (9%)	Maint. (10%)			
1980						0		
1981	$1,290	-	$300	$1,188	$449	1	($ 47)	($ 43)
1982	1,484		330	1,295	494	2	25	21
1983	1,706		363	1,411	543	3	115	86
1984	1,962		399	1,538	598	4	225	154
1985	2,256		439	1,677	657	5	361	224
1986	2,595		483	1,828	723	6	527	297
1987	2,984		531	1,992	795	7	728	374
1988	3,431		585	2,172	875	8	969	452
1989	3,946		643	2,367	962	9	1,260	534
1990	4,538		707	2,580	1,058	10	1,607	619
1991	5,219		778	2,812	1,164	11	2,021	708
1992	6,002		856	3,066	1,280	12	2,512	800
1993	6,902		942	3,341	1,408	13	3,095	897
1994	7,937		1,036	3,642	1,549	14	3,782	996
1995	9,128		1,139	3,970	1,704	15	4,593	1,100
1996	10,497		1,253	4,327	1,875	16	5,548	1,207
1997	12,071		1,378	4,717	2,062	17	6,670	1,319
1998	13,882		1,516	5,141	2,268	18	7,989	1,437
1999	15,964		1,667	5,604	2,495	19	9,532	1,558
2000	18,359		1,834	6,108	2,745	20	11,340	1,685
Totals							$62,852	$14,425

Capital Investment $23,597

	Undiscounted	Present Value (discounted at 10%)
Total 20-Year Savings	$62,852	$14,425
Payback Period	16-17 years	>20 years

Institutional Requirements

In Burlington, since a ground water heat pump system is proposed, two approaches are technically possible: an on-site shallow (200 feet) well or purchase of City water. The City charge for water is $9.50/month for the first 5,000 gallons and $0.60 per thousand gallons thereafter. Wells other than wells drilled by the City are prohibited within the City. Presumably, there are provisions for exceptions such that a waiver for drilling a well for nonconsumptive use could be obtained. If this is the case, the water can be returned to the City, after removing the heat. If City water is to be purchased, an application is submitted to the City Clerk. No other City permits are indicated. (Phyllis Collins and Les McClain, pers. comm., 1980).

Environmental Considerations

At Burlington, the water that would be used in the heat pump system is the same water as that used in the City's domestic water system. As such, no environmental problems would be posed beyond those common to any domestic water system.