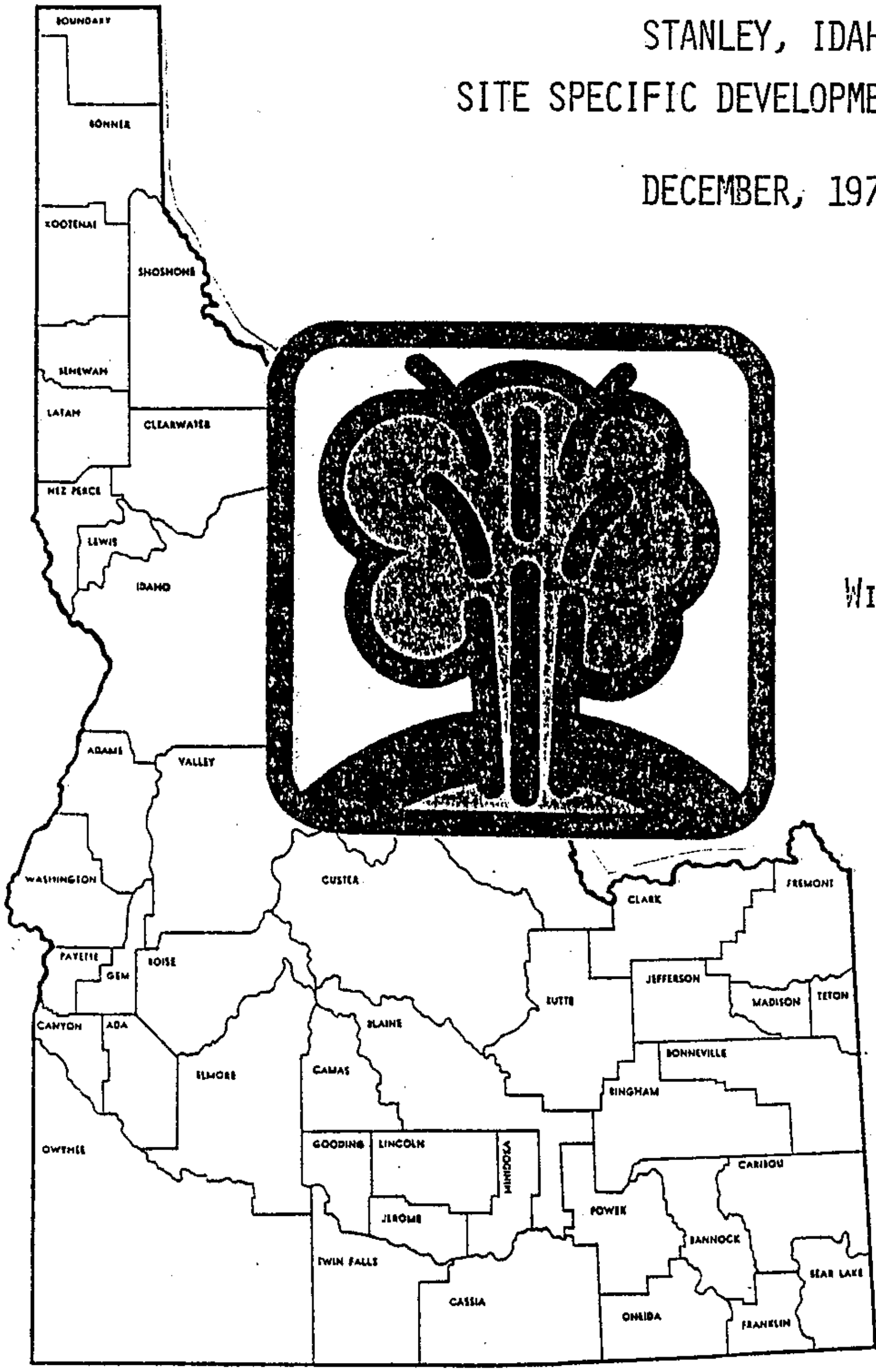
Idaho Geothermal Report

STANLEY, IDAHO

SITE SPECIFIC DEVELOPMENT ANALYSIS

DECEMBER, 1979



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Prepared for the United States Department of Energy, Division of Geothermal Energy
Idaho Falls Operations Office-DOE/ID/12010-8

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STANLEY, IDAHO

SITE SPECIFIC DEVELOPMENT ANALYSIS

Preface:

Stanley is an isolated mountain community in interior regions of Idaho's Sawtooth Mountains. The community is located at an elevation of 1,903 meters (6,260 ft.) and has 10,739 heating degree days. A significant hot springs with a surface temperature of 41° C (105° F) is located within one kilometer (.6 mi.) of the community. The community of Stanley is interested in developing this geothermal prospect for space heating.

The Stanley Hot Springs geothermal prospect was selected for site specific development analysis because: the site has high heating degree days; the city has requested assistance from the Idaho Office of Energy, and the site can be considered a "type example" of the geothermal development potential which is typical of Idaho's intermountain communities.

1.0 Introduction

A site specific development analysis is a qualitative and quantitative analysis of technical, economic, environmental, and institutional factors which influence the scale and timing of geothermal development. The analysis is based on current information available in the literature and reflects the intent of public and private development interest in the Stanley area. Resource data for the Stanley Basin was provided by the Idaho Department of Water Resources, the U.S. Geological Survey, the University of Utah Research Institute, and Boise State University.

A review of current available socio-economic data and technical papers on geothermal space heating was conducted to determine the scale and cost of a district heating system. Federal, State, and local planning reports were reviewed to determine the institutional factors affecting development.

The Stanley Site Specific Development Analysis describes the institutional, logistical, and economic parameters which will affect the development of a geothermal district heating system which could service the community of Stanley. The development concept involves locating a production well at Stanley Hot Springs and distributing hot water for space heating to all major buildings in the community of Stanley.

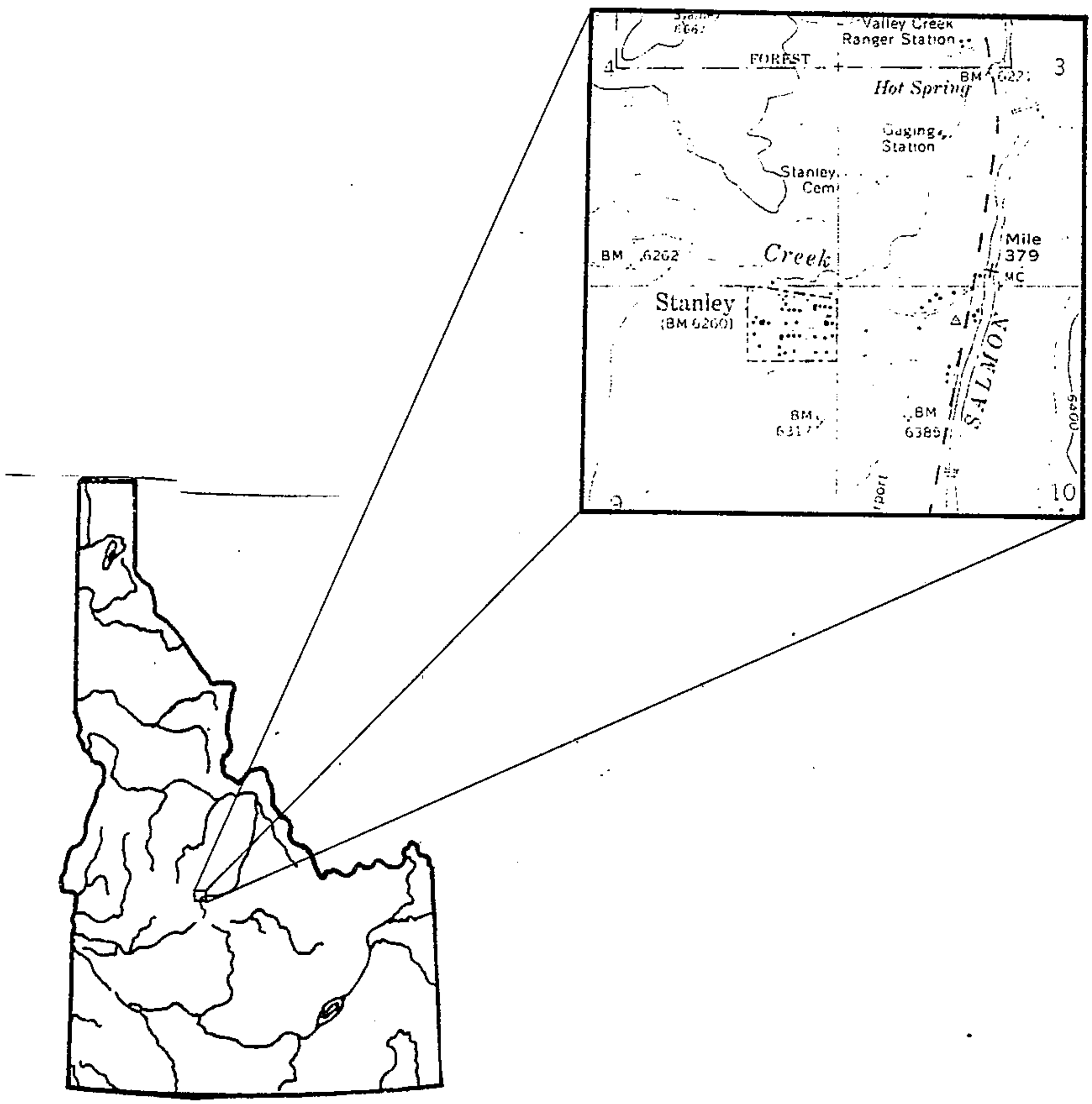
The resource temperatures are expected to range from a minimum to 41° C (105° F) to a maximum of 75° C (167° F). The higher temperature is based on geochemical thermometry. A realistic temperature of 60° C (140° F) could be expected from a 100 to 200 m (328 - 656 ft.) deep well.

Stanley is a small community with a population of approximately 70 year-round residents. The community is the only incorporated town in the Sawtooth National Recreation Area (see Figure 1.0). This small community is service area for the recreation area. The community consists of several service oriented small businesses such as: service stations, cafes, hotels and motels, a grocery store, and post office.

The principal energy supplies for Stanley are electricity, number two fuel oil, propane, and firewood. Monthly heating bills for commercial buildings in Stanley can be as high as $1,000 per month in the winter.

Figure 1.0

Location of Stanley, Idaho



2.0 Site Description

2.1 Location

Stanley, Idaho is located within the boundaries of the Sawtooth National Recreation Area in Custer County at the junction of U.S. Highway 93 and State Highway 21. The community has an elevation of 1,908 meters (6,260 ft.) and is located in an intermountain basin which is surrounded by mountains of the Sawtooth and White Clouds ranges.

Stanley Basin is a large fault controlled basin which is filled to an undetermined depth with alluvium. The basin is a major water shed of the Salmon River.

Stanley Hot Springs is located along the Salmon River, one kilometer (.6 mi.) north of Stanley at the confluence of Valley Creek and the Salmon River. Figure 1.0 shows the location of Stanley Hot Springs and the City of Stanley. The topography of the hot springs and community is relatively level. The City of Stanley is 12 meters (40 ft.) higher than the hot springs. Stanley Hot Springs is located in Section 3, T. 10 N. R. 13 E., Boise Meridian.

2.2 Demographics

The City of Stanley has an estimated, 1979, population of 70 persons. The community has experienced a steady increase in population since 1970. If the current immigration continues the population of Stanley will reach 100 by 1985. Table 2.2 lists the state population and employment forecast of Custer County and its communities. These forecasts are based on historical trends and do not consider the prospects of new employment trends.

Renewed interest in mining activity north of Stanley may cause a substantial immigration into the Stanley Basin. A Los Angeles based firm, Cyprus Mines Corporation, is considering establishing an openpit molybdenum mine and mill complex in Custer County on Thompson Creek, approximately 40 kilometers (25 mi.) northeast of Stanley. A decision to develop the mine will be made in 1980 and depends on approval of a number of operation permits. If all permits are approved in a timely manner, production could commence by 1983.

Anticipated total project employment will be nearly 550 people. Secondary impact could mean an increase of over 2,000 people in the region. Operational plans currently call for the majority of these people to live in the community of Challis which is located 60 kilometers (37 mi.) northeast of the mine site. Some population overflow is expected to impact Stanley.

TABLE 2.2

DEMOGRAPHICS AND EMPLOYMENT

CUSTER COUNTY

County's population as percentage of the State total - 1976: 0.39%

	1950	1960	1970	1976
Population	3,318	2,996	2,967	3,300
Percent of population change			12.4%	12.4%
Percent change (Idaho)			16.5%	16.5%
Population per square mile	0.7	0.6	0.6	0.7

Percent of 1970 population:	Rural farm	22.5%
	Rural non-farm	77.5%
	Urban	0

CITY POPULATION

	Census 1970	Estimate 1975	Percent Change
Challis (County Seat)	784	953	2.16
Clayton	36	35	-2.8
Lost River	40	41	2.5
Mackay	539	615	14.1
Stanley	47	67	42.6

TABLE 2.2 - Continued

Employment Summary

	1972	1975	1980	1985	1990	1995	2000
Agriculture	405	402	384	366	348	334	321
Mining	42	98	110	124	135	144	150
Construction	2	2	2	2	3	3	3
Wood Products	8	6	6	7	8	9	10
Other Manufacturing	10	4	4	5	6	7	7
Trans. Comm. and Utils	55	44	51	56	62	68	75
Whsle and Retail Trade	244	237	259	271	285	299	315
Finance, Ins. Real Est	42	46	48	50	52	54	56
Services and Misc.	188	154	208	248	294	348	412
State and Local Govt.	226	249	282	308	338	369	404
Federal Government	110	144	151	163	175	184	195
Total	1332	1386	1511	1606	1710	1823	1953

Forecast Summary

	1970	1975	1980	1985	1990	1995	2000
Total Population	2960	3240	3740	4020	4290	4410	4580
Total Employment*	1330	1380	1510	1600	1710	1820	1950
Labor Force	1320	1400	1530	1630	1730	1840	1970

*Source: Idaho Dept. of Water Resources, Population and Employment Forecast - State of Idaho, 1978.

2.3 Economy of Site Area

Custer County's economic activities were analyzed to provide a working knowledge of the present and past economic base as well as to provide insight as to the type of future activities which could occur. Custer County has had a stable but stagnant economy in terms of total employment and per capita income for the past five years. The county has not experienced any significant growth since 1970. Table 2.3 lists the major elements of Custer County's economy.

The Stanley area's economy depends primarily on tourism. Unemployment is high during the winter months when tourism is restricted to winter sports. In the recent past, the major contributors to the City of Stanley's economic base were livestock, timber, and mining activities. These activities are currently restricted and will be maintained at a low level on Federal lands because of the National Recreation Area designation.

Opportunities for economic growth in Custer County are currently tied to opportunities of new mining activities and increased tourism. New mining operations are expected to center their base of operations in the Challis area which is the main service center in Custer County. At full operation, in 1983, the Cyprus Mining Company expects to have a local payroll of approximately eight million dollars. The opening of this new mine will bring a growth boom to Custer County which could darw approximately 2,000 new residents into the county.

2.4 Land Use Considerations

The City of Stanley consists of approximately 124.8 hectares (308.5 acres). Approximately 78.9 hectares (195) acres of 63% of the land within the city limits are currently vacant land. An additional 25% of the total land area, 27.1 hectares (67 acres) is used for municipal and civic purposes such as the school, clinic, airport, and sewer lagoons. Current residential land use accounts for only 8% of the total land use. This residential land use is concentrated in 1.0 hectares (2.5 acres) area. Commercial land use, 6.8% of the total land area, is concentrated along the main streets and intersections and accounts for less than 8.5 hectares (21 acres).

Year-round residential occupancy in Stanley is low. Most residential use occurs during the summer and is related to the increase in tourism. Summer population of Stanley can exceed 250 residents. Some commercial businesses are also seasonal and close during the winter months. Present commercial activities are merchandizing, hotels, motels, restaurants, and service stations. These commercial activities are located along the highway areas and in the center of the residential area.

Stanley's major land use concern is the allocation of land uses in such a way as to provide for private and public needs while still maintaining the community's historic setting.

Stanley is in an unusual land use planning position. It is unique by being surrounded by federally controlled lands and by being affected by Federal legislation (P.L. 92-400) concerning land use on private land within the Sawtooth National Recreation Area.

TABLE 2.3

Economy:

Percent of average monthly unemployment - 1976:

Jan.	11.0%	Feb.	13.6%	Mar.	11.6%	Apr.	8.9%	May	4.3%	Jun.	3.8%
Jul.	3.8%	Aug.	3.7%	Sep.	4.7%	Oct.	4.8%	Nov.	8.0%	Dec.	9.7%

Percent of labor force unemployed: 1970:5.0% 1972:8.7% 1975:7.6% 1976:7.0%

Month and percentage of highest unemployment: 1975: Feb.-15.3%
1976: Feb.-13.6%

Month and percentage of lowest unemployment: 1975: Sep.- 3.1%
1976: Aug.- 3.7%

Percent of females (16+) in labor force: 1960 (14+): 30.6% 1970: 37.3%

Employment (B.E.A. data)	1967	1970	1974	1975
Total employment	1,210	1,248	1,377	1,393
Farm proprietors	278	247	237	235
Non-Farm proprietors	194	227	247	247
Wage and salary employment:				
Federal civilian	122	107	153	144
Military	--	--	--	--
State & local	164	207	234	249
Manufacturing	24	(D)	17	10
Mining	64	84	71	99
Construction	23	(D)	5	(D)
Trans., Comm. & Pub. Util.	41	37	45	43
Trade	91	106	110	103
Finance, Insurance & Real Estate	16	19	19	18
Services	74	95	32	95
Other	--	--	--	(D)
Farm	119	108	107	149

(D) Not shown to avoid disclosure of confidential information.

Average Idaho tax return (county) - 1976: $232

Average Idaho tax return (State) - 1976: $396

Total assessed valuation: 1975*: $7,290,547 1976: $7,676,434
*1974 subsequent rolls, 1975 real and personal rolls, and 1975 utilities

Average levy county-wide paid per $100 assessed valuation:
1973: $8.21 1974: $7.25 1975: $7.14 1976: $7.43

Sales tax: 1974*: $159,886 1975*: $168,543 1977*: $171,818
*Fiscal Year

TABLE 2.3 - Continued

Property tax as percent of full value: County-1976: 1.01%
State -1976: 1.55%

Per capita income:	1970 $2,500	1974 $3,551	1975 $3,435
% of national average:	1970 63.0%	1974 65.2%	1975 58.2%
% of state average:	1970 76.0%	1974 72.2%	1975 66.4%

Median family income - 1969: $7,063

Median family income* - 1976: $8,625
*HUD estimate

Transfer payments (thousands of dollars - county):
1970 $960 1974 $1,785 1975 $2,185

Number of business establishments - 1974: 68

All housing units 1,320

Number of vacant - seasonal and migratory units 163

Number of mobile homes or trailers 111

Population per occupied unit 3.0

Section 4 of P.L. 92-400 states:

> "The Secretary shall make and publish regulations setting standards for the use, subdivision, and development of privately owned property within the boundaries of the recreation area. Such regulations shall be generally in furtherance of the purposes of this Act and shall have the object of assuring that the highest and best private use, subdivision, and development of such privately owned property is consistent with the purposes of the Act and with overall general plan of the recreation area..."

All Development in Stanley, including building design, must comply with the regulations set forth in the Sawtooth National Recreation Area Act.

Figure 2.4 shows the major surface landowners in the Stanley area. The Stanley town site is the area with the highest density of commercial and residential structures. In recent years, commercial development has grown along the highway rights. New subdivisions have been partially developed, but very few residential structures have actually been built. New residential growth is expected to concentrate north of Valley Creek and within the old Stanley town site.

2.5 Climate

The Stanley Basin has an extremely cool climate. Located in a high intermountain valley the area has cool summer evenings and cold winters with heavy snowfalls. The average frost free period for the area is 15 days. Table 2.5 summarizes the climatic data for the Stanley Basin.

3.0 Resource Evaluation

3.1 Description of Springs

Stanley Hot Springs is located in Section 3, T. 10 N., R. 13 E., Boise Meridian, in Custer County, Idaho. The spring discharges from quartenary alluvium near Cretaceous granitic rocks. The discharge area is a gravel bar which separates the mouth of Valley Creek from the Salmon River. Several thermal seeps and springs discharge into both the Salmon River and Valley Creek from both sides of the gravel bar along a 400 meter (1,312 ft.) long area.

Figure 2.4 Surface Ownership

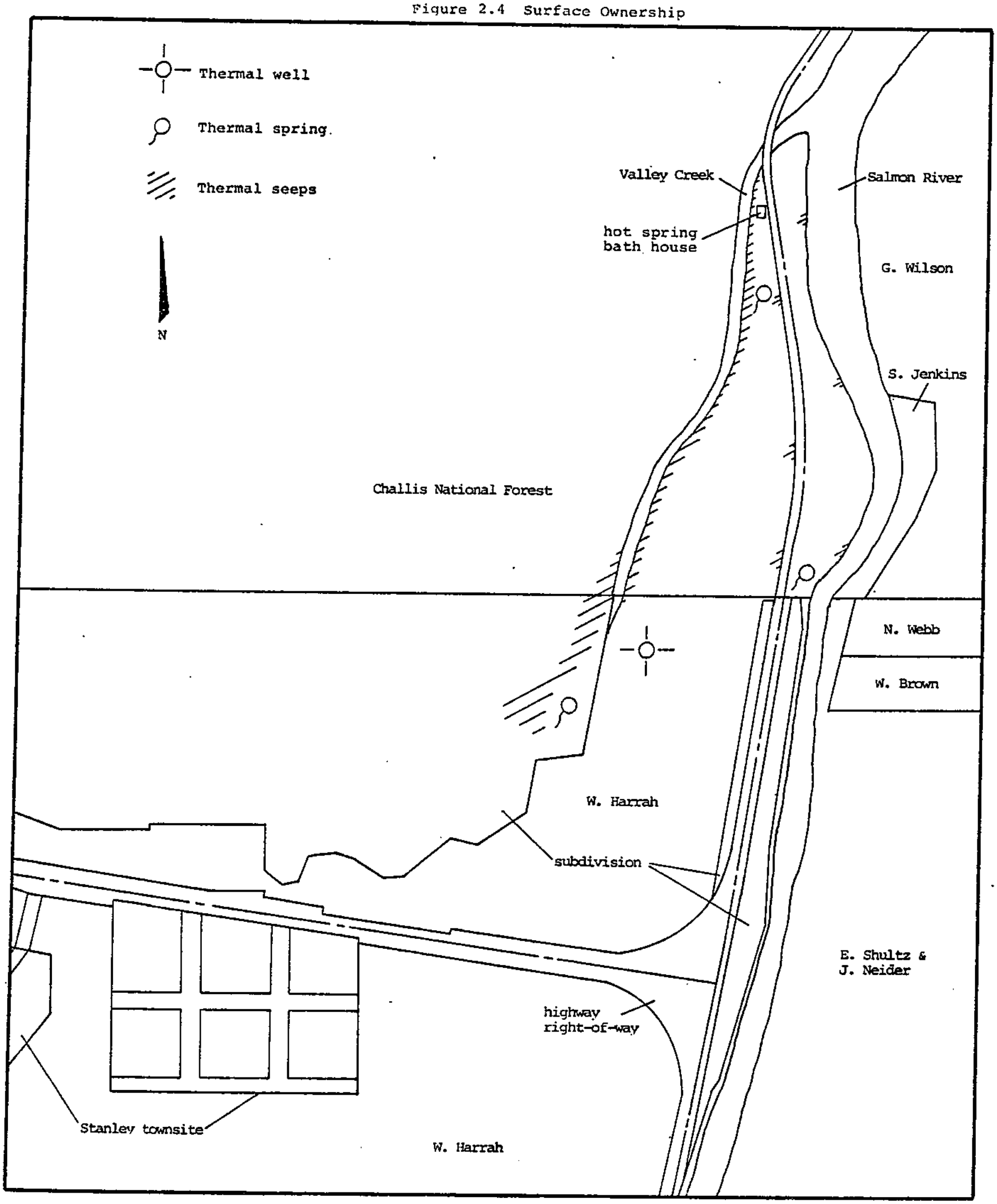


TABLE 2.5

CLIMATOLOGICAL DATA FOR STANLEY, IDAHO

Elevation: 1,926 meters (6,230 ft.)

Years of Record: 19

Mean Daily Temperature

January Minimum: $-18^{o}C$ ($-.7^{o}F$)
January Maximum: $-3.2^{o}C$ ($26.2^{o}F$)

July Minimum: $1.05^{o}C$ ($33.9^{o}F$)
July Maximum: $25.6^{o}C$ ($78.1^{o}F$)

Lowest Temperature of Record: $-45.5^{o}C$ ($-50^{o}F$)

Highest Temperature of Record: $35.5^{o}C$ ($96^{o}F$)

Average Annual Days

Maximum of $32^{o}C$ ($90^{o}F$): 3 days
Minimum of $0^{o}C$ ($32^{o}F$) or less: 310 days

Growing Season (Average Freeze Free Period): 15 days

Average Precipitation

Annual Precipitation: 41.2 cm (16.23 in.)
Annual Snow Fall: 238.5 cm (93.9 in.)

January Precipitation: 4.52 cm (1.78 in.)
July Precipitation: 1.50 cm (.61 in.)

Average Annual Number of Days with Precipitation

.25 cm (.10 in.) or more: 53
1.27 cm (.50 in.) or more: 7

Heating Degree Days: 10,739

Source: Idaho Climatological Summary Data by Counties. National Weather Service Climatology in Cooperation with the Idaho Department of Commerce and Development, Boise, Idaho. October 1971.

3.1 Description of Springs - Continued

The discharge of the spring area is estimated to be between (400 and 600 l/min. (150 and 160 GPM). The surface discharge temperature of the thermal water ranges from 31° C to 41° C (88° F to 106°F). Reliable geochemical thermometers indicate subsurface temperatures of 90° C (194° F) to 110° C (230° F). The springs are located 400 meters (1,312 ft.) north and 12 meters (40 ft.) lower in elevation than the city of Stanley.

3.2 General Physiography and Geology

The Stanley Basin is the upper water shed of the Salmon River. The Salmon River flows out of the southeastern side of the basin into the narrow canyon of the Salmon River near Stanley. Valley Creek, which drains the northwest half of the basin, is the major tributary of the Salmon River. The confluence of Valley Creek and the Salmon River occurs at the City of Stanley. Stanley Hot Springs is located at this confluence which is the lowest point in the Stanley Basin.

The mountains of the Sawtooth Range and the White Clouds Range are the prominent features in the landscape of the Stanley Basin. Elevations range from 1,896 meters (8,120 Ft.) at Stanley Hot Springs to over 3,000 meters (9,840 ft.) in the Sawtooth Mountains. The Stanley Basin is a broad structurally controlled intermountain valley. The strong northwest trend of this valley parallels the northern front of the Sawtooth Range.

There is very little detailed knowledge available about the structural geology of the Stanley Basin. Remker and Bennett (1979) have mapped a major inferred fault along the base of the Sawtooth Mountains which forms the western margin of the Stanley Basin. Aerial photo data shows a strong structural linear trending northwest from the Snake River Plain near Hailey, Idaho. This large structural trend is topographically expressed in the Wood River Valley and the Sawtooth Valley. Stanley Basin is located in the center of what is known as the Sawtooth Valley.

The Sawtooth Valley, in the vicinity of the Stanley Basin, separates two distinct lithologies. Cretaceous granite of the Idaho Batholith outcrops along the eastern margin of the valley. Late Eocene pink granites of the Sawtooth Batholith outcrop along the western margin of the valley. The structural control of this valley is probably related to the contact between these two batholiths.

The Sawtooth Valley is filled to an undetermined depth with glacial alluvium. Quarternery glacial till forms the foothills along the Sawtooth Mountain front. Quarternary terrace gravels and alluvium fill the broad flat basin around the City of Stanley and Stanley Hot Springs.

An east trending fault has been mapped by Remker and Bennett (1979) at the location of Stanley Hot Springs. This fault controls the course of the Salmon River Canyon to the east of the Stanley Basin. Several hot springs are located in the Salmon River Canyon along this east trending fault. This series of thermal springs is known as the Sunbeam Hot Springs District. Tscharz, Killsgaard and Seeland (1974) named this sheer zone the Mormon Bend Fault.

3.2 General Physiography and Geology - Continued

Stanley Hot Springs is located along the trace of this east trending fault where the fault intersects the northern margin of the Stanley Basin. The thermal waters of Stanley Hot Springs are discharging from a lobe of quarternary terrace gravels which separate the confluence of Valley Creek from the Salmon River. Cretaceous granite outcrops near these terrace gravels.

3.3 Well Data

A limited number of shallow water wells have been drilled near Stanley Hot Springs. Water wells drilled within 200 meters (656 ft.) of the hot spring normally encounter bedrock within 50 meters (164 ft.) of the surface. A well drilled into the terrace gravel deposit, from which the hot springs are discharging, encountered thermal mud at a depth of 30 meters (98 ft.). A shallow water well drilled 100 meters (328 ft.) north of the hot springs and along the margin of the basin, encountered less than 10 meters (33 ft.) of terrace gravels and was abandoned at a depth of 30 meters (98 ft.) in weathered and altered granite. Wells drilled south of the hot springs in the City of Stanley are less than 50 meters (164 ft.) deep and do not encounter bedrock.

3.4 Seismic Data

Relatively little is known about the seismicity of southwest Idaho. Previous knowledge has been limited to felt reports, temporary microseismic networks and seismic monitoring by instruments relatively distant from the area.

An earthquake swarm occurred near Stanley in 1963 (Dewey, et. al., 1972). Over 50 events were reported in one month by the U.S. Coast and Geodetic Survey. Several events were of magnitude 4 and larger. In 1964, reconnaissance microearthquake investigations (Westphal and Lange, 1966) located several events roughly 25 kilometers (15.5 mi.) east of Stanley. Focal depths of the seismic events were determined to range from 14.5 kilometers (9 mi.) to 29.1 kilometers (18 mi.). In 1972, 40 microearthquakes were recorded in eight days by Pennington (1974). Pennington's report states:

> " All of the events in the Stanley area occurred in the uppermost part of the crust, with focal depths of less than 6 kilometers. A single focal mechanism cannot be determined by a composite plot of first motions. The events cluster in space and time, suggesting earthquake swarm developments perhaps associated with the geothermal activity of the Sunbeam Hot Springs District."

Eighteen of these events were located. Five events occurred in a 24-hour period within 3 milometers (1.8 mi.) of Stanley. All five events exhibited first motions which were consistently compressional for rays leaving upward and to the east. Seven additional events occurred in another 24-hour period. Located very near Stanley, the first motions of these events were inconsistent. All the events near Stanley were shallow (Pennington, et. al., 1974).

3.4 Seismic Data - Continued

Focal mechanism studies of the largest earthquakes in the 1963 swarm show normal faulting on a fairly steep dipping east, trending fault plane (Smith and Sbar, 1974). Pennington (1974) points out that microearthquake data indicates a more northerly striking fault plane. The discrepancy may be due to the epicenter of the 1963 event being 25 kilometers (15.5 mi.) east of the 1972 activity which suggests that several active seismic systems are evident in the Stanley area.

During 1976 and 1977, Boise State University's Department of Geology and Geophysics operated a network of three radiotelemetry seismographs in the Boise area. Over 800 seismic events were recorded. Although epicenters locate throughout central Idaho, the seismic events most frequently occur near Stanley and west of Challis in Custer County. Vincent and Applegate (1978) report nineteen seismic events located near Stanley appear to be associated with the eastern boundry of the Sawtooth Mountains. Six additional events align with the western boundary of the Sawtooth Mountains. The magnitude of the Stanley seismic cluster range from 1.3 to 4.0 and were most frequently between 1.9 to 3.0. The majority of these events were located within a 15 mile radius of the Stanley basin.

Earthquake swarms like the 1963 Stanley Swarm are often indicative of hydrothermal, volcanic or magmatic activity (Sykes, 1970). Shallow swarms have been observed in geothermal areas associated with fissure systems (Ward and Bjornsson, 1971). The seismic activity in the Stanley-Sunbeam area may be related to geothermal or perhaps magmatic activity (Pennington, et. al., 1974).

3.5 Aeromagnetic Data

The aeromagnetic map of Idaho (See Figure 3.5 USGS, 1978) shows the Stanley Basin (See Figure 3.5) to be a magnetic low anomaly of 880 to 900 gammas contrasted to highs in the neighboring Sawtooth and White Cloud Ranges of 1,040 to 1,220 gammas. The basin is controlled by north trending faults against the Sawtooth Batholith on the west and the Idaho Batholith on the east. The high magnetic gradient between the valley and ranges to the east and west is indicative of fault control. The lowest magnetic values are in the south and central portions of the basin, indicating that the sedimentary fill is deepest south of Stanley.

3.6 Geochemical Analysis

The geochemistry of Stanley Hot Springs (Mitchell and Anderson, 1979) is listed in Table 3.6.1. This spring has the low total dissolved solids and is relatively "clean" water. The hot spring does have high fluoride content (14 mg/l) which may pose disposal problems. Safe drinking water standards for fluoride are 2 mg/l. Stanley Hot Springs have an anomalously low potassium (.5 mg/l) compared to other hot springs in the area. The low potassium levels have a significant affect on the geochemical thermometry used to predict aquifer temperatures. Stanley Hot Springs has a potassium count which is 80% lower than the other hot springs in the area.

Figure 3.5 Aeromagnetic Map

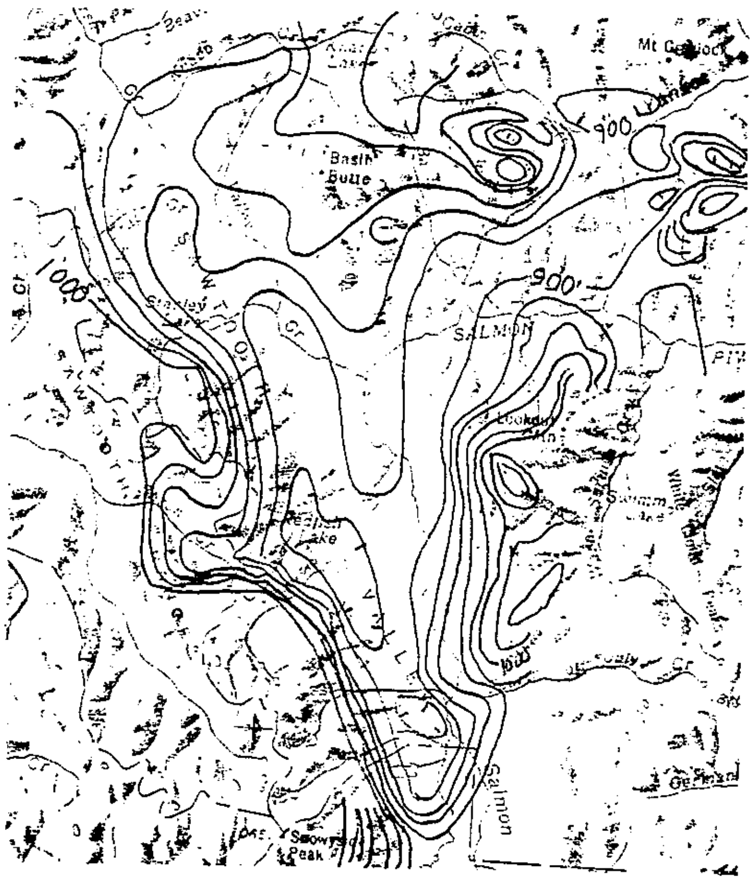


TABLE 3.6.1

CHEMICAL ANALYSIS OF STANLEY HOT SPRINGS
(Chemical Constituents in milligrams per liter)

Sample Collection Data	Discharge (GPM)	Temperature (OC)	Silica (Si)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (P)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	TDS	pH
7-12-72	110	41	55	2.2	0.10	60	0.50	30	28	31	0.01	5.0	14	.05	71	8.8

Source: Idaho Department of Water Resources Bull. 30, Part 9, 1979.

TABLE 3.6.2

Geothermometer Temperatures

Springs or Well Identification	Discharge l/m	Known Temp. °C	Aquifer Temperature Predicted by Geochemical Thermometry °C*							
			T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Stanley Hot Springs 10 n, 13 E, 3 caa	110	41	106	106	-10	75	47	47	6	47
Elkhorn H. S. 11 N 13 E, 36 baa	13	57	121	119	- 3	93	137	37	83	137
Basin Creek H.S. 11 N 14 E, 21 aab	7	60	131	127	11	104	144	44	102	144
Sunbeam H. S. 11 N 15 E, 19 cba	444	78	131	128	12	104	129	129	72	129
Robinson Bar H.S. 11 N 15 E, 26 ddc	40	49	125	122	6	97	148	148	109	148

T_1 = Silica temperature assuming quartz equilibrium and conductive cooling (no steam loss)
T_2 = Silica temperature assuming quartz equilibrium and adiabatic expansion at constant enthelpy (Maximum steam loss)
T_3 = Silica temperature assuming equilibrium with amorphous silica
T_4= Silica temperature assuming equilibrium with chalcedony and conductive cooling (no steam loss)
T_5= Na-K-Ca temperature
T_6= Na-K-Ca temperature corrected for PCO_2
T_7= Na-K-Ca temperature corrected for Mg
T_8= Na-K temperature

Source: Idaho Department of Water Resources Bull. 30, Part 9, 1979.

3.6 Geochemical Analysis - Continued

Aquifer temperatures predicted by geochemical thermometry are listed in Table 3.6.2 for several hot springs located near Stanley in the Sunbeam Hot Springs belt. The lower potassium count is reflected in the lower Na-K-Ca temperature thermometers for the spring.

In this case the most reliable geochemical thermometer is probably the Silica temperature assuming equilibrium with chalcedony. This geochemical thermometer predicts an aquifer temperature of 75° C (167° F). Exploration wells drilled in other locations throughout Idaho have not encountered temperatures which exceed the Silica with chalcedony equilibrium geochemical thermometers. This geochemical thermometer is considered to be a reliable measure of upper temperature limits which can be expected for low temperature resources.

3.7 Reservoir Potential

The reservoir area has significant potential for production of large amounts of thermal water. The U.S. Geological Survey (Tschanz, Killsgaard and Seeland, 1974) estimated the reservoir size by using magnetic surveys, structural interpretation and surface area influenced by past and present discharge. The USGS reports that Stanley Hot Springs District with an estimated reservoir size of 15.2 hectares (38 acres), with significant permeability and fluid content.

3.8 Potential Applications of the Resource

Commercial interests have considered developing a spa - bathhouse complex on private land adjacent to the hot springs. Such a complex would take advantage of large volume of tourist traffic which passes through the Sawtooth National Recreation Area during summer and fall months. Two attempts at this endeavor have failed in recent years due to a lack of investment capital. The concept of a spa is currently being considered by the Stan Harrah Company which is the largest landowner in Stanley. Stan Harrah Company operates a large motel and several large major commercial buildings in Stanley. A spa complex could attract winter tourism and increase the visitor rate during the winter months.

Both the City of Stanley and Stan Harrah Company are interested in developing the thermal water for space heating. Currently, the community depends upon electricity, propane, and wood for space heating. The community has over 300 days per year when the temperature falls below 0° C (32° F). Because Stanley has a high space heating demand and is co-located with the hot springs, space heating of commercial and residential buildings in Stanley appears to be the most realistic development scenario. Rising energy cost has created a growing awareness in Stanley of the need for alternative energy forms and the potential for geothermal space heating. The potential for development of Stanley Hot Springs for space heating the City of Stanley is analyzed in the following section.

4.0 Site Specific Application

The development of Stanley Hot Springs for a district heating system capable of heating the residential and commercial buildings in the City of Stanley is estimated to cost $111,164. This cost estimate includes capital investment required for production and transmission systems. The following economic analysis represents a preliminary examination of the economic viability of geothermal space heating at Stanley, Idaho. Table 4.0 details the estimated capital investment required to develop such a system.

TABLE 4.0

Capital Cost Breakdown

I. Transmission Systems:		$90,674
Main to City	$75,004	
Connectors	15,760	
II. Supply System:		
A. Supply Well 1 well @ 152 m (500 ft.)		7,400
B. Supply Pump 1 @ 30 HP		13,000
III. Disposal System		
No extra facilities needed	——	
Total Capital Investment		$111,164

4.1 Considerations for a Heating System

Before potential cost savings from a geothermal space heating system can be considered in detail, it is necessary to examine both demand and supply for space heat in Stanley to determine whether a proposed well of a given temperature is capable of supplying the heat demand both in peak periods and on an annual basis. This analysis contains some projections of heating demand, but it is based on actual fuel bills wherever it was possible to obtain such information.

4.2 Heat Demand

Stanley has approximately 10,000 heating degree days and minimum temperatures often reach -34° C (-30° F), which generates a design temperature difference of 35° C (95° F), 18° C (65°F) to -34° C (-30° F).

4.2 Heat Demand - Continued

Stanley has a large commercial complex (consisting of gas stations, restaurant, bar, supermarket, and lodge) belonging to the Harrah estate; an elementary school, a hotel, two stores, two bars, a post office, a laundromat, and approximately 36 residences.

Actual power bills for 1978 - 1979 were received from the Harrah complex, the hotel, and the laundromat, probably the three biggest heat consumers in Stanley. These bills were converted to units of fuel purchased and thence to BTUs. Thus it was possible to get a good picture of total yearly demand as well as monthly peak demand.

For other heat customers average energy usage was assumed based on EG & G's Rules of Thumb publication and EG & G's cost simulation model for space heating installations. Total yearly demand and peak demand estimates are detailed in Table 4.2.1. Both yearly and hourly peak heat requirements are well within the amounts of heat available from the projected 1894 liter/min. (500 GPM) well.

4.3 Heat Available

Economical temperature drop across a heat exchanger is given by the equation:

$$t = (.6 \times \text{temperature}) - 70 \ \text{F}$$

With 75° C (167° F) water this gives a temperature drop (Δt) of 30° F. The quantity of heat available from a single 500 GPM well is given by the equation:

$$Q = 500 \ (\Delta t) \ w,$$

Q = quantity of heat in BTU/hr.
t = temperature drop
w = flow in gallons per minute

$$Q = 500 \ (30) \ (500 \ \text{GPM})$$
$$7.5 \times 10^6 \ \text{BTU/hr.}$$

This represents the peak heat available in a given hour from the projected well.

Multiplying this figure by 8,760 (the number of hours in a year) gives a figure of 6.57×10^{10} BTUs, the total heat available over a whole year. Assuming a household uses $.2 \times 10^9$ BTU per year, the projected well could serve 328 residential customers.

Comparison of the heat demand figures in Table 4.2.1 with the heat available indicates that 4.75×10^{10} BTUs per year or 2.65×10^6 BTU/hr. are surplus heat capacity available for possible use beyond present needs. This excess capacity could be used for additional space heating in Stanley , or a pipeline could be run to Lower Stanley which would service customers there but probably at a prohibitive cost due to the length of pipe required.

TABLE 4.2.1

Stanley Heat Demand

	Yearly Demand (BTUs)	Peak Demand (BTU/hr.)
Harrah Complex:		
Gas	3.08×10^9	3.94×10^5
Electric	4.45×10^9	5.67×10^5
Hotel		
Gas	5.12×10^8	9.80×10^4
Electric	2.97×10^8	3.90×10^4
Laundromat		
Gas	5.31×10^8	2.85×10^4
Residences	7.20×10^9	2.85×10^6
School	1.20×10^9	4.75×10^5
Other Commercial Establishments	1.00×10^9	3.95×10^5
Totals	1.817×10^{10}	4.85×10^6

Notes:

For Harrah Complex, hotel, laundromat, derivation of figures is as follows:

Yearly demand derived by dividing electric bills by 1.7¢ Kwh and multiplying by 3,413 BTU/Kwh, dividing gas (propane) bills by 57.9¢/gal. and multiplying by 91,500 BTU/Gal. Peak demand derived by applying same procedure outlined above to peak monthly bills (January - February), then dividing by 720 to reduce the monthly figure to BTUs per hour. Laundromat peak demandis in August, so the January figure was used. For other users, the following assumptions were made:

Each of 36 residences assumed to use $.2 \times 10^9$ BTU per year. Dividing annual heat load by 2.52×10^3 (the product of 8,760 hours and an annual utilization factor of .28839) gives a design heat load or peak demand figure of 7.92×10^4 BTU/hr. per house. The school is assumed to be 5,000 $ft.^2$, with a design temperature difference of 95° F (65° F - (-30° F)) and a heat load of 1 BTU/hr./ft. per F. This gives a design heat load of 4.75×10^5 BTU/hr. which is projected to yearly heat load using the above annual utilization factor. Four other commercial establishments are assumed to have annual heat load of $.25 \times 10^9$ BTU each which is divided as for residences to give a design heat load.

4.3 Heat Available - Continued

Another use of hot water from the projected well would be a public spa or hot springs pool. Interest in such a facility has been expressed by several parties over the past few years and the Forest Service is said to be receptive to construction of such a facility in the Sawtooth National Recreation Area (SNRA). Heavy use of the area in summer by tourists also allows the possibility of a hot shower facility for campers, either separate or in combination with a spa. Conversion of the surplus BTUs listed above into flow rates indicates that about 662 liter/min (175 GPM) may be available for uses other than meeting present demand.

4.4.0 Proposed Facilities

4.4.1 Transmission System

Water would be pumped straight east to the Highway (U.S. 75), south along the highway approximately 400 meters (a quarter mile) and thence west on Idaho 21 for approximately 800 meters (half a mile). Two lateral lines would extend south into the heart of town. (See Figure 4.4.1).

A 15 cm (6 in.) pipe would extend a total of 1346 meters (4,412 ft.) from the wellhead to the western boundary of the pipeline, at a cost of $5.18/meter ($17 per foot). The two lateral connecting lines would be 5 cm (2 in.) pipe, costing $3.05/meter ($10 per foot) and extending 480 meters (1,576 ft).

All pipe would be Bonstrand 1600 series RTRP pipe in a PVC jacket with polyurethane foam insulation supplied by Rovanco Company. The pipe would be buried to a depth of one meter (3 ft.) and located on the edge of the roads to minimize surface restoration cost.

4.4.2 Supply System

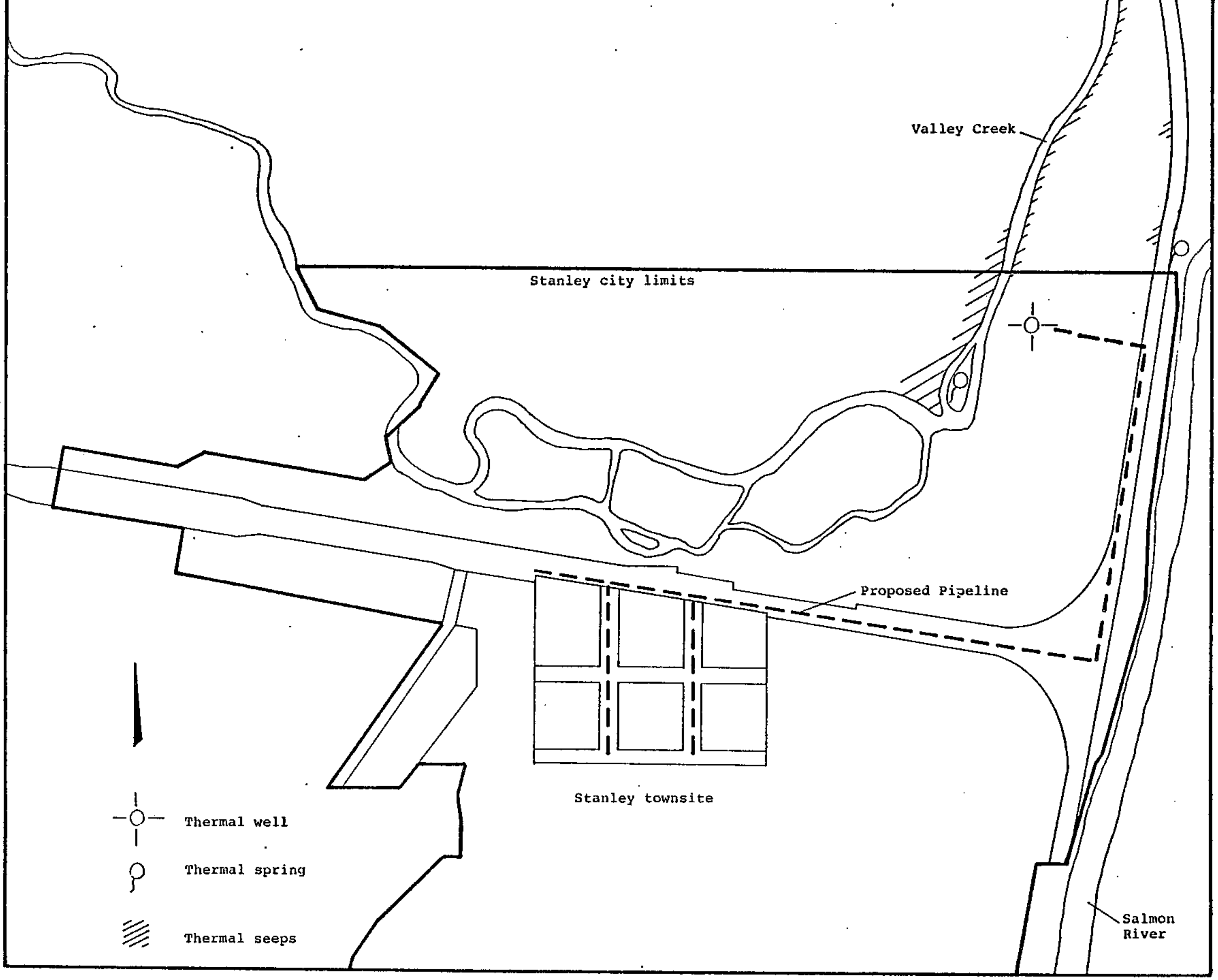
A. Supply well

A single 1,894 liter/min (500 GPM) well would be drilled between Valley Creek and Highway 95 (see Figure 4.4.1) to a depth of 152 meters (500 ft.). A 25 cm (10 in.) hole would be drilled to 12 meters (40 ft.) and a 20 cm (8 in.) casing set. Then drilling would proceed 140 meters (460 ft.) with a 20 cm (8 in.) hole. The entire 152 meters (500 ft.) would be cased to the surface with 15 cm (6 in.) casing. Cost figures of $0.39 per cm ($1 per ft.) of diameter per .304 meters (one ft.) of depth were used for both drilling and casing, for an overall well cost of about $49 per meter ($15 per ft.).

B. Supply pump

A vertical turbine downhole pump set for 152 meters (500 ft.) lift would pump the geothermal fluid from the well into Stanley. A three stage 30 HP pump, using a maximum of $3,920 per year in electric power at a rate of 2¢ per Kwh would cost about $13,000 including main valves and installation costs.

Figure 4.4.1 Stanley Geothermal Transmission System



4.4.3 Disposal System

Spent geothermal fluids would be voided directly into the city sewer system rather than injected. It is felt at this time that the comparatively small amount of water involved would be handled by the newly-installed sewer lagoon system and might have the added benefit of promoting evaporation and chemical changes in the sewage lagoon. At the present the lagoon is frozen over for extended periods. Addition of hot water may enhance the performance of this sewage treatment system. An engineering analysis is needed to accurately assess the capacity for geothermal fluid disposal into the sewer system.

4.5 Cost Analysis

A 20-year cost comparison of propane with geothermal heat is shown in Table 4.5.1. The cost of propane is derived by taking an annual heat load of 1.342 X 10^{10} BTU (total demand of 1.817 X 10^{9} BTUs from Table 4.2.1 minus electricity usage of .475 X 10^{9} BTU), dividing by91,500 BTUs per gallon to convert to gallons of propane then multiplying by the price of propane. This cost rises over time as propane prices rise at the rates projected by Dames and Moore. Electricity cost represents maximum yearly usage for the pump required to produce the geothermal water. Maintenance costs are estimated at 2% of capital cost. Annual savings represent what would have been spent for propane minus actual operating expenses with geothermal. The annual savings streams were then discounted at 10% and 20% to convert these future amounts to their present worth. In both cases the savings streams and payback periods are substantial with respect to the projected investment.

Table 4.5.2 presents price projections for conventional fuel sources, in billing terms and converted to millions of BTUs for easier comparison. These prices have been adjusted for conversion efficiency so that final prices are for millions of usable BTUs. (Electricity is assumed to be 100% efficient, gas and propane 80% efficient, and oil 70%). All prices in Table 4.5.2, plus all other energy prices in the overall analysis, have been escalated at rates given in the Dames and Moore study prepared in late 1977 for the Idaho Public Utilities Commission. There is considerable reason now to believe that these projections are too low but in the absence of a more comprehensive set of projections we will continue to use them.

Keep in mind that is a case for geothermal heat can be made with these rates of increase for conventional fuel alternatives, which we know are conservative, actual increases beyond these conservative projections only serve to enhance the competitiveness of geothermal heat.

Estimates of future fuel prices from Table 4.5.2 along with estimates of geothermal prices from Table 4.5.3 are found in graphical form in Figure 4.5.4.

TABLE 4.5.1
20-YEAR OPERATING COST SAVING FROM GEOTHERMAL HEAT

(1) PROPANE Cost	(2) GEO ELECTRICITY Cost	(3) GEO MAINTENANCE Cost	(4) ANNUAL SAVING	(5) PRESENT WORTH (10%)	(6) PRESENT WORTH (20%)
84,939	3,920	2,223	78,796	71,633	65,163
90,630	4,277	2,378	83,974	69,400	58,315
96,702	4,666	2,545	89,491	67,236	52,049
103,181	5,025	2,723	95,433	65,182	46,023
109,166	5,412	2,914	100,740	62,552	40,485
115,497	5,829	3,118	106,550	60,145	35,683
122,196	6,278	3,336	112,582	57,772	31,420
129,283	6,761	3,570	118,952	55,492	27,664
136,782	7,349	3,820	125,613	53,272	24,345
144,305	7,989	4,087	132,229	50,979	21,355
152,242	8,684	4,373	139,188	48,785	18,733
160,615	9,439	4,679	146,497	46,678	16,431
169,449	10,260	5,007	154,182	44,661	14,410
178,769	11,153	5,357	162,259	42,728	12,638
188,601	12,123	5,732	170,746	40,875	11,082
198,974	13,178	6,133	179,663	39,100	9,718
209,917	14,324	6,563	189,030	37,399	8,520
221,463	15,571	7,022	198,870	35,764	7,470
233,643	16,925	7,514	209,204	34,207	6,548
246,494	18,398	8,040	220,056	32,710	5,740
				TOTAL 1,016,561	TOTAL 514,262
				Payback Period 1.6 Years	Payback Period 2.0 Years

(1) Yearly heat demand of 1.342 X 10^{10} BTU converted to propane cost at 57.9¢ per gal. and 91,500 BTUs per gal.
(2) Projected to increase at Dames & Moore rates.
(3) Estimated at 2% of capital cost, increasing 7% per year.
(4) Annual cost of propane (1) - operating cost of geothermal (2) & (3).
(5) & (6) Years savings converted to present value.

TABLE 4.5.2

FUEL PRICES - PROJECTED 20 YEARS

	1 Electricity		2 Gas		3 #2 Fuel Oil		4 Propane		5 Geothermal
	$/Kwh	$/10^6 BTU	$/Therm	$/10^6 BTU	$/Gal.	$/10^6 BTU	$/Gal.	$/10^6 BTU	$/10^6 BTU
1979	.0293	8.585	.382	4.776	.739	7.610	.579	7.961	1.002
1980	.0319	9.347	.409	5.115	.789	8.127	.618	8.498	1.029
1981	.0349	10.226	.438	5.478	.843	8.680	.659	9.061	1.058
1982	.0380	11.134	.469	5.867	.900	9.270	.703	9.666	1.087
1983	.0410	12.013	.506	6.284	.961	9.901	.744	10.230	1.117
1984	.0441	12.921	.544	6.730	1.027	10.574	.787	10.821	1.150
1985	.0475	13.918	.586	7.208	1.097	11.293	.833	11.454	1.185
1986	.0512	15.001	.632	7.720	1.171	12.061	.881	12.114	1.223
1987	.0551	16.144	.680	8.268	1.251	12.881	.932	12.815	1.267
1988	.0599	17.551	.733	8.855	1.338	13.783	.984	13.530	1.315
1989	.0651	19.074	.789	9.483	1.432	14.748	1.038	14.272	1.366
1990	.0708	20.744	.850	10.157	1.532	15.780	1.095	15.056	1.422
1991	.0770	22.561	.915	10.878	1.640	16.885	1.155	15.881	1.483
1992	.0837	24.524	.986	11.650	1.754	18.066	1.219	16.761	1.548
1993	.0909	26.634	1.061	12.477	1.877	19.331	1.286	17.683	1.619
1994	.0989	28.978	1.143	13.363	2.009	20.684	1.356	18.645	1.696
1995	.1075	31.498	1.231	14.312	2.149	22.132	1.431	19.676	1.779
1996	.1168	34.222	1.326	15.328	2.300	23.681	1.510	20.763	1.869
1997	.1270	37.211	1.428	16.416	2.461	25.339	1.593	21.904	1.966
1998	.1380	40.434	1.538	17.582	2.633	27.113	1.680	23.100	2.071

1 Electric power projected to increase at Dames & Moore rates, 9.1% through 1982, 7.7% through 1987, 8.7% thereafter
2 Gas price " " " " " " " " " " " " " " " 7.1% 7.7% 7.1%
3 Oil price " " " " " " " " " " " " " " " 6.8% 7.5% 7.0
4 Propane (LPG) " " " " " " " " " " " " " 6.7% 5.8% 5.5%
5 Derived from Table 4.3.4

20 YEAR PROJECTION OF GEOTHERMAL COSTS

TABLE 4.5.3

	(1) Amortization	(2) Maintenance	(3) Electric Power	(4) Total Geothermal Cost	(5) Cost/100 ft.^{3}	(6) Cost/10^6 BTU
1979	12,870	2,223	3,920	19,013	.188	1.002
1980	12,870	2,379	4,277	19,526	.193	1.029
1981	12,870	2,545	4,666	20,081	.199	1.058
1982	12,870	2,723	5,025	20,618	.204	1.087
1983	12,870	2,914	5,412	21,196	.210	1.117
1984	12,870	3,118	5,829	21,817	.216	1.150
1985	12,870	3,336	6,278	22,484	.223	1.185
1986	12,870	3,570	6,761	23,201	.230	1.223
1987	12,870	3,820	7,349	24,039	.24	1.267
1988	12,870	4,087	7,989	24,946	.247	1.315
1989	12,870	4,373	8,684	25,927	.257	1.366
1990	12,870	4,679	9,439	26,988	.267	1.422
1991	12,870	5,007	10,260	28,137	.289	1.483
1992	12,870	5,357	11,153	29,380	.291	1.548
1993	12,870	5,732	12,123	30,725	.304	1.619
1994	12,870	6,133	13,178	32,181	.319	1.696
1995	12,870	6,563	14,325	33,758	.334	1.779
1996	12,870	7,022	15,571	35,463	.351	1.869
1997	12,870	7,514	16,925	37,309	.370	1.966
1998	12,870	8,040	18,398	39,308	.389	2.071

(1) Capital cost of $111,164 amortized at 10% for 20 years
(2) Estimated at 2% of capital cost, rising 7% per year
(3) Projected to rise at Dames & Moore rates, 9.1% until 1982, 7.7% through 1987, 8.7% thereafter
(4) Total of (1) & (2) & (3)
(5) Total cost from column (4) divided by yearly water use of 10,093,650 ft.^{3}
(6) Total cost from column (4) divided by yearly therms available, 187,762, multiplied by 10 to convert to millions of BTUs.