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GEOTHERMAL RESOURCE AREA 11

Clark County

MASTER

Area Development Plan

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SUMMARY

Geothermal Resource Area 11 includes all of the land in Clark County, Nevada. Within this area are nine geothermal anomalies: Moapa Area, Las Vegas Valley, Black Canyon, Virgin River Narrows, Roger's Springs, Indian Springs, White Rock Springs, Brown's Spring, and Ask Creek Spring.

All of the geothermal resources in Clark County have relatively low temperatures. The highest recorded temperature is 145° F. at Black Canyon. The temperatures of the other resources range from 70° F. to 90° F. Because of the low temperature of the resources and, for the most part, the distance of the resources from any population base, the potential for the development of the resources are considered to be somewhat limited.

SUMMARY OF FINDINGS AT EACH RESOURCE SITE

Moapa Area

This low temperature resource (80° to 90° F.) may hold potential for recreation and for small, low temperature agricultural applications such as aquaculture, animal husbandry, and greenhousing.

Las Vegas Valley

Because of the urbanized character of this resource area only the greenhousing type of agricultural applications are considered feasible. Existing wells could practically be retrofitted for the use of heat pumps for space heating or cooling.

Black Canyon

The Black Canyon geothermal resource (148° F.) is the highest temperature resource known in Clark County. Because of its remote location in very rugged terrain no development is foreseen in the near future.

Virgin River Narrows

The Virgin River Narrows geothermal anomaly has a temperature of 80° F. Remote location and poor access limits development of this site.

Roger's Springs

Roger's Springs have a maximum temperature of 86° F. Recreation is believed to have the highest development potential. Such development could possibly be implemented in conjunction with the Valley of Fire State Park.

Indian Springs

Various uses of the warm (79° F.) water from these springs should be considered when developing the new state prison facility in this area.

White Rock Springs--Brown's Springs--Ash Creek Spring

No feasible applications known at this time.

I. INTRODUCTION

Geothermal Resource Area II encompasses all of Clark County, Nevada. There are numerous geothermal anomalies within the area and the six that are considered major are evaluated in this document: Moapa Area, Las Vegas Valley, Black Canyon, Virgin River Narrows, Roger's Springs, and Indian Springs. Several smaller springs are briefly discussed.

It is the purpose of this document to provide public and private decision makers with information that will facilitate the development of the various geothermal resources found in Clark County. To further this goal, this Area Development Plan was prepared to provide information concerning the geothermal resources, the physical and socio-economic setting of Clark County, and the potential for developing various uses of this so far underutilized resource.

This report has been divided into three major sections to enable the reader to interpret the information presented more easily. The first section describes the physical and socio-economic characteristics of Clark County. The second section describes the area's geothermal resources. The third section describes several potential uses for the resources in the county.

FIGURE 1

FIGURE 2
TOPOGRAPHICAL
AND PHYSICAL
FEATURES OF
CLARK COUNTY

II. THE AREA

A. Physical Characteristics

1. Location and Relief

Clark County encompasses a total land area of 8,084 square miles which makes it the sixth largest of Nevada's 17 counties with about eight percent of the state's total land area. Clark County is located in southern Nevada and is bordered on the north and west by Lincoln and Nye Counties, and on the east and south by the States of California and Arizona.

Clark County is essentially mountainous with interspersed low valleys. The more notable of the mountain ranges include the Pintwater Range, Desert Range, Sheep Range, Las Vegas Range, Arrow Range, McCullough Range, El Dorado Range, Newberry Range, Muddy Mountains, Virgin Mountains, and the Spring Mountains. The major valleys include the Las Vegas Valley, El Dorado Valley, Paiute Valley, and Dry Lake Valley. Elevations in Clark County range from a high of 11,918 feet at Mount Charleston in the Spring Mountains to a low of 500 feet found at the southern most tip of the state.

2. Climatic Conditions(20, 21)

The climatic conditions found in Clark County are quite variable because of the large physical size and the great relief of the area. Detailed climatic information for the study area is available only at two recording stations: McCarran International Airport in Las Vegas at an elevation of 2,162 feet, and Boulder City at an elevation of 2,525 feet. See Tables 1 and 2 for detailed climatological summaries.

The four seasons are fairly well defined in Clark County. Summers are typically hot with maximum temperatures in the 100's

LATITUDE 36° 05' N
LONGITUDE 115° 10' W
ELEV. (GROUND) 2162 Feet

TABLE 1
CLIMATOLOGICAL SUMMARY

STATION Las Vegas, Nevada

MEANS AND EXTREMES FOR PERIOD 1937-1968

Month	Temperature (°F)							** Mean degree days	Precipitation Totals (Inches)							Mean number of days					Month	
	Means			Extremes					Mean	Greatest daily	Year	Snow, Sleet					Precip. 10 inch or more	Temperatures				
												Max.	Min.									
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year							Mean	Maximum monthly	Year		Greatest daily	Year	90° and above		32° and below
(a)	29	29	29	32		32		#	29	32		29	32		32		29	29	29	29	29	
Jan.	56.6	30.7	43.8	76	1948	8	1963	688	.48	.71	1952	.7	16.7	1949	5.0	1949	1	0	*	19	0	Jan.
Feb.	61.9	35.6	48.7	82	1954	17	1938	487	.34	1.01	1940	*	4.1	1939	4.1	1939	1	0	0	10	0	Feb.
Mar.	68.9	40.8	54.8	91	1966	19	1939	335	.42	.79	1938	T	T	1963+	T	1946+	1	0	0	3	0	Mar.
Apr.	79.1	49.9	64.5	99	1946+	31	1955+	111	.29	.97	1965	T	T	1964+	T	1964+	1	5	0	*	0	Apr.
May	88.5	50.8	73.2	109	1951	38	1942	6	.08	.31	1965	T	T	1954	T	1954	*	16	0	0	0	May
Jun.	98.3	66.5	82.4	116	1940	48	1939	0	.03	.39	1955	T	T	1955	T	1955	*	26	0	0	0	Jun.
Jul.	105.0	73.4	89.2	117	1942	56	1940+	0	.47	1.18	1954	0	0	----	0	----	1	31	0	0	0	Jul.
Aug.	102.7	71.8	87.3	116	1950	54	1937	0	.44	2.58	1957	0	0	----	0	----	1	31	0	0	0	Aug.
Sep.	95.7	63.5	79.6	113	1950	43	1948+	0	.37	1.09	1939	0	0	----	0	----	1	24	0	0	0	Sep.
Oct.	82.5	51.6	67.1	100	1947	32	1949	78	.26	1.08	1947	T	T	1956	T	1956	1	8	0	*	0	Oct.
Nov.	67.0	38.5	52.4	84	1941	15	1938	387	.38	1.09	1965	*	4.0	1964	3.0	1964	1	*	0	6	0	Nov.
Dec.	58.7	32.8	45.8	78	1940	14	1945	617	.38	.87	1947	T	2.0	1967	2.0	1967	1	0	0	16	0	Dec.
Year	80.4	51.1	65.7	117	Jul 1942	8	Jan. 1963	2709	3.94	2.58	Aug. 1957	.7	16.7	Jan. 1949	5.0	Jan. 1949	10	141	*	54	0	Year

TABLE 2

CLIMATOLOGICAL SUMMARY

STATION Boulder City, Nevada

LATITUDE 35° 59' N
LONGITUDE 114° 51' W
ELEV. (GROUND) 2525

MEANS: 1936-1965
MEANS AND EXTREMES FOR PERIOD Extremes: 1936-1968

Month	Temperature (°F)							Mean degree days	Precipitation Totals (Inches)							Mean number of days					Month		
	Means			Extremes					Mean	Greatest daily	Year	Snow, Sleet					Precip. 10 inch or more	Temperatures					
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year					Mean	Maximum monthly	Year	Greatest daily	Year		90° and above	Max.			Min.	
																			32° and below	32° and below		0° and below	0° and below
(a)	30	30	30	33		33		##	30	33		30	33		33		30	30	30	30	30		
Jan	53.8	38.1	46.0	74	1964	11	1937	608	.65	.86	1945	1.3	27.5	1949	12.5	1949	2	0	*	6	0	Jan	
Feb	58.9	41.5	50.2	80	1954	21	1949	445	.48	.86	1958	*	5.5	1939	3.0	1939	1	0	0	3	0	Feb	
Mar	66.2	45.9	56.1	91	1964	25	1964	288	.58	1.66	1952	*	7.0	1945	7.0	1945	1	0	0	1	0	Mar	
Apr.	76.4	54.3	65.4	97	1949	31	1963	93	.45	1.05	1965	0	T	1944	T	1944	1	2	0	0	0	Apr	
May	85.6	61.7	73.7	106	1951	38	1964	12	.17	1.08	1958	0	T		0		*	*	11	0	0	0	May
Jun	95.3	69.8	82.6	114	1954	48	1955	0	.06	.70	1964	0	0		0		*	23	0	0	0	0	Jun
Jul	101.2	76.4	88.8	117	1964	65	1965	0	.48	1.89	1936	0	0		0		1	30	0	0	0	0	Jul
Aug	98.9	74.9	86.9	112	1938	59	1957	0	.62	1.92	1957	0	0		0		2	30	0	0	0	0	Aug
Sep	92.7	69.0	80.9	110	1950	46	1965	0	.49	1.65	1952	0	0		0		1	21	0	0	0	0	Sep
Oct	79.7	58.5	69.1	97	1964	37	1953	53	.41	1.02	1958	0	0		0		1	3	0	0	0	0	Oct
Nov	64.1	46.3	55.2	82	1962	28	1958	312	.46	1.92	1960	*	3.0	1958	3.0	1958	1	0	0	*	0	0	Nov
Dec	54.0	40.6	47.3	73	1958	22	1968	530	.57	.96	1940	*	2.5	1945	5.5	1932	2	0	0	2	0	0	Dec
Year	77.2	56.4	66.9	117	July 1964	11	Jan 1937	2341	5.42	1.92	Aug 1957	1.3	27.5	Jan 1949	12.5	Jan 1949	12	115	0	12	0	0	Year

Estimated from monthly means using Weather Bureau Formula

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

+ Also on earlier dates, months, or years.

* Less than one half.

(F.). Nights tend to be relatively cool with temperatures between 70° and 75° F. There is typically about a two week period in the summer when warm, moist air from tropical marine areas dominates the area. This causes scattered thundershowers which can be quite severe and a greatly elevated relative humidity.

Winters are usually mild and pleasant. Daytime temperatures average near 60° (F.) with mostly clear skies. The fall and spring seasons are generally ideal with average temperatures in the high 60's (F.) and low 70's (F.).

Temperature characteristics at other locations in Clark County may be inferred by applying the environmental lapse rate of 3-1/2° F. per 1,000 vertical feet lower or higher than the recording station. Care must be taken, however, when using these calculated temperatures as local conditions may greatly influence exact temperature readings.

The Sierra Nevada Mountains of California act as an effective barrier to moisture-laden storms moving eastward from the Pacific Ocean. Rainy days average from less than one in June to three per month in winter. Snow rarely falls except at higher elevations. Any snow in the lower valleys melts as soon as it falls or shortly thereafter.

Strong winds, associated with major storms, usually blow through the area from the southwest in the winter months. During summer thunderstorms, winds of over 50 miles per hour are not uncommon.

3. Geologic Setting(15, 17)

Clark County is located in the Basin and Range Geomorphic Province. The county has a geologic structure more or less typical of the province with elongate mountains separated by long alluvial filled valleys.

Rocks exposed at various places around Clark County include igneous, metamorphic, and sedimentary types ranging in age from Precambrian to Recent. Precambrian rocks consist mostly of

schists, gneisses, and amphibolites which have been intruded by coarse-grained granite rocks. Sedimentary rocks of the Paleozoic are widespread in all but the southern portion of the county where Precambrian and Tertiary Rocks predominate. Limestone and dolomite form 75 to 80 percent of the Paleozoic strata with sandstone and shale forming the remainder. Mesozoic rocks consist mostly of sandstone and shale. Tertiary deposits are generally fresh-water clastic and chemical sediments. The youngest Quaternary and Recent rocks consist primarily of alluvial and lacustrine sediments filling most of the valley floors.

The Basin and Range topography which is characteristic to Clark County has been developed on all of these rock types. This topography has developed because of the characteristic fault block structure caused by normal faulting. It is expressed as long north-south trending mountains and valleys. With the exception of that portion of the area that drains into the Colorado River the region is characterized by internal drainage and large ephemeral lakes.

The geothermal resources in the study area are associated with the long north-south trending normal faults characteristic to the Basin and Range Province. Water, originating as rainfall, sinks deep into the earth where it is heated by contact with a geothermal heat source. This heat source may be either a cooling magmatic body or just rock heated by the earth's geothermal gradient. The heated water then rises toward the surface along the deep faults which offer permeable conduits for fluid movement. If these faults cut the earth's surface, hot springs and other surface manifestations of geothermal energy may appear. It should be noted that geothermal resources may be present without such surface indications. One of the goals of modern exploration geology is to locate these "hidden" resources.

4. Hydrology(7, 8)

Clark County lies in portions of two hydrographic regions: the Central Region and the Colorado River Basin.

Most of the western portion of Clark County is in the Central Region. The area is characterized by long, narrow valleys with small, intermittent streams emptying into the valley bottoms where the flows evaporate. The perennial streams are usually only a few miles long. There are no standing bodies of water even though the area is characterized by interior drainage. Following storms, playa bottoms may be covered with water although this quickly evaporates.

Most of the eastern portion of Clark County is in the Colorado River Basin. This area is similar to the Central Region except that all of the area, with three exceptions, drains into the Colorado River which eventually flows into the Pacific Ocean. These three exceptions--Garrett Valley, Hidden Valley, and Lake Valley--are characterized by internal drainage. They are included in the Colorado River Basin because they are completely surrounded by basins contributing to the Colorado River.

The hydrology of the study area is typical of that occurring in a desert environment. Precipitation is very seasonal, occurring primarily in the winter as rain at lower elevations and as snow in the higher elevations. Summer precipitation is in the form of sudden, sometimes violent, thunderstorms. Streamflows are equally seasonal with peak flows occurring in the spring. Under uncontrolled conditions, runoff reaches a peak flow in late spring and an annual low flow in late summer or early fall. Exceptions are the exceedingly large flows due to severe thunderstorms which can occur any time during the summer. These flash floods are unpredictable and last only a few hours. This wide range in stream flow creates multiple problems. Seasonal high flows often result in flood damage with serious erosion and sedimentation occurring.

Low flows limit agricultural production and tend to cause high water temperatures. Both sedimentation and high water temperatures impact adversely on fish life and general water quality.

The Nevada State Water Engineer's Office has defined five designated groundwater basins in Clark County out of a total of 17 basins. These basins are those in which the allocated water is believed to exceed the annual recharge into the basin as can occur in populated areas. The Division of Water Resources has special regulations and permitting procedures which apply to applications to appropriate water from these designated basins. Table 3 shows these designated groundwater basins and the associated order number designating these basins.

Table 3

DESIGNATED GROUNDWATER BASINS IN CLARK COUNTY

<u>Designated Basin</u>	<u>Basin Number</u>	<u>Order Number</u>	<u>Date</u>
Las Vegas Artesian	212	175	3-10-41
Pahrump Artesian	162	176	3-11-41
Muddy River Springs Area	219	392	7-14-71
Mesquite Valley (Sandy Valley)	163	701	1-05-78
Indian Springs Valley	161	728	8-10-79

Because the study area's geothermal resources are the water dominated type, any use of those resources may affect the local groundwater conditions. This may impact historical use of groundwater in those areas and cause difficulties to arise concerning

water rights and water allocation although geothermal energy development is considered to be a preferred use. These problems may be especially severe in designated groundwater basins. Any developer of geothermal energy resources is encouraged to contact the State Water Engineer early in the project's planning process to insure that all such water related questions are answered.

B. Land Ownership and Land Uses(12)

Clark County totals nearly 8,084 square miles in size which makes it approximately eight percent of the total land area of the State of Nevada. Table 4 shows the basic land ownership pattern found in Clark County.

Table 4

LAND OWNERSHIP PATTERNS IN CLARK COUNTY

	Acres	Percent
Public Land		
Federal	4,608,889	89.09
State	46,178	0.90
County	4,582	0.09
Other	23,504	0.45
Total Public	4,683,153	90.52
Private Land		
Indian	1,197	0.02
Tax Roll	489,411	9.48
Total Private	490,608	9.48

Existing land use patterns in Clark County are based primarily on the proximity of the area to the major population center of Las Vegas and other smaller population centers. Away from these centers the land has historically been used for agriculture, ranching, mining, wildlife management, and open space. The Bureau of Land Management has classified most of the 2,960,133 acres of

public land it administers as being for multiple use. The exception are those units being studied as potential wilderness areas. This multiple use classification includes all types of uses from recreation, wildlife management, watershed management, and livestock grazing, to timber production on the more heavily forested portions of the land. Other federal agencies managing land in Clark County, such as the U.S. Forest Service and the Bureau of Reclamation, are also utilizing the multiple use concept wherever possible. Some federal land in Clark County, notably that on the Nevada Test Site and Nellis Gunnery Range, is closed to all public uses.

There are two BLM Wilderness Study Areas in Clark County: Pine Creek and Mount Stirling. These study areas are those which the BLM believes meets the following criteria:(19)

1. Size--must have at least 5,000 or more acres of contiguous public land or be of a size to make practical its preservation and use in an unimpaired condition;
2. Naturalness--must be substantially natural or generally appear to have been affected primarily by the forces of nature with the imprint of man's work substantially unnoticeable.
3. Outstanding solitude or recreation--must have either outstanding opportunities for solitude or a primitive and unconfined type of recreation;
4. Supplemental values--must have supplemental values, which include ecological, geological, or other natural features of scientific, educational, scenic, or historical value.

These two Wilderness Study Areas will continue to be managed under special guidelines directed by Congress to preserve the wilderness values until a final determination of wilderness suitability is made. There are no known geothermal resources within the boundaries of any of the potential wilderness areas. Should any be located in the future, the development of those resources will be subject to the BLM Wilderness Area Management Policy.

The larger urban communities have developed zoning classifications which control land uses within the community. Such uses include: residential, commercial, governmental/institutional, various types of industrial, and agricultural. Geothermal development must be compatible with existing development in these zoned areas.

C. Population(16)

The population of Clark County has steadily increased over the past century. In the 56 year period between 1920 and 1976 the population increased from only 4,649 persons to 343,400 persons. This is over a 6,900 percent growth rate. The years 1940 through 1960 saw the largest percentage growth of the county. However, the years 1960 to 1976 showed the largest increase in actual number of persons. Table 5 illustrates the past and projected growth trend in Clark County.

The existing population of Clark County is not evenly distributed around the entire county but is localized into distinct population centers with only scattered persons in the rural areas. The largest of these population centers is the Las Vegas/North Las Vegas/Henderson metropolitan area located in the Las Vegas Valley. Other communities in Clark County with populations of over 1,000 persons are Boulder City and Overton. Smaller communities include: Indian Springs, Logandale, Blue Diamond, Bunkerville, Goodsprings, Jean, Searchlight, Charleston Peak, Mesquite, and Nelson.

The State Planning Coordinator's Office anticipates that all communities in Clark County will continue growing to the year 2000. The Las Vegas metropolitan area is anticipated to increase in size by several times. Table 6 graphically illustrates the projected growth for the various communities in Clark County.

As the population of the study area grows, geothermal development should be encouraged to help supply energy needs of new residents. Such development could, in addition, supply new jobs and provide a broadened economic base for the study area.

Table 5(16)

PAST AND PROJECTED POPULATION TREND IN CLARK COUNTY

<u>Year</u>	<u>Clark</u>	<u>Year</u>	<u>Clark</u>
1920	4,859	1973	295,800
1930	8,532	1974	321,100
1940	16,414	1975	330,700
1950	48,289	1976	345,302
1960	126,016	1977	359,814
1961	135,605	1978	376,815
1962	150,922	1979	393,816
1963	169,855	1980	410,817
1964	189,389	1981	434,043
1965	201,984	1982	457,268
1966	212,623	1983	480,494
1967	218,928	1984	503,719
1968	233,899	1985	526,945
1969	267,720	1990	659,600
1970	273,288	1995	757,000
1971	286,700	2000	866,900
1972	295,800		

Table 6
POPULATION PROJECTIONS FOR THE MAJOR COMMUNITIES
IN CLARK COUNTY TO THE YEAR 2020

City	1980	1990	2000	2010	2020
Las Vegas	1165,000	187,000	208,130	231,000	255,000
Henderson	21,500	43,000	81,000	105,300	121,000
North Las Vegas	41,390	51,000	60,360	70,000	77,500
Las Vegas Valley- Unincorporated	163,800	331,900	483,200	628,000	697,000
Las Vegas Valley- Total	402,300	626,000	848,000	1,053,000	1,171,000
Boulder City	10,100	13,100	16,100	18,500	20,400
Indian Springs	930	960	1,000	1,020	1,040
Logandale	740	810	880	900	920
Overton	1,140	1,260	1,370	1,490	1,600
Blue Diamond	250	260	270	280	300
Bunkerville	420	430	450	460	470
Goodsprings	230	250	270	290	310
Jean	200	300	400	500	600
Searchlight	450	470	500	530	550
Charleston Peak	150	170	190	210	230
Mesquite	830	860	900	930	970
Nelson	110	120	130	140	150

D. Transportation Facilities(4, 5, 6)

Three major national highways pass through Clark County. U.S. 93 is a major north-south highway connecting the towns of Jackpot, Wells, Ely, Pioche, Caliente, and Las Vegas.

U.S. 95 is the second major route. It connects the western part of the state by passing through the towns of McDermitt, Winnemucca, Lovelock, Fernley, Fallon, Hawthorne, Tonopah, Goldfield, Beatty, and Las Vegas.

The third major route is Interstate 15. I-15 is one of 12 interstate routes across the United States. It crosses through the southern part of the state connecting Mesquite, Glendale, Logandale, Moapa, Las Vegas, Goodsprings and Jean.

Clark County has a total of 4,970 miles of roadway. There are 922 miles of road on the federal aid system, 108 miles on the state aid system, 3,274 miles on the county system, and 667 miles on city or local systems. The county has 2,927 miles of unpaved road and 2,043 miles of roadway paved to various standards.

Clark County has very good transportation facilities in the Las Vegas Valley area. Outside of this particular region transportation services may be very primitive. There is one major airport facility in Clark County and three additional landing strips for small aircraft. McCarren International Airport in Las Vegas is the regional airport for southern Nevada. It serves not only Clark County but many of the surrounding counties in Nevada, Arizona, and California. Currently seven commercial airlines service McCarren International Airport with passenger and freight service. Charter service is available through approximately 20 different private airlines. Thirty-four interstate trucking lines service the Clark County area and most have terminal facilities in Las Vegas. The Union Pacific supplies railway freight needs to the community and AMTRAK supplies railway passenger needs. Seven bus lines and 12 taxicab companies assist in passenger transportation with charter bus service also available.

FIGURE 4

**MAJOR
TRANSPORTATION
FACILITIES IN
CLARK COUNTY**

- ✈
 Commercial Airport
- ✚
 Landing Strip

E. Economic Activities

1. Background(12)

The area now known as Clark County was originally a part of the New Mexico Territory. It then became part of the Arizona Territory and eventually in 1867 Nevada's southern boundaries were extended to include this area. At that time it became part of Lincoln County.

The railroad city of Las Vegas became the population and business center of Lincoln County after 1905. Eventually, the citizens of Las Vegas petitioned the Nevada Legislature to form a new county. The reasons for the petition were that the county seat was over two hundred miles away and there was a major slump in Lincoln County causing a financial drain on the City of Las Vegas. Clark County became a legal entity on July 1, 1909.

Today the main economic and population growth of Clark County is centered in the Las Vegas Valley, which is defined as the Las Vegas Standard Metropolitan Area. Clark County's development has been stimulated by many sources:

1. The construction of Hoover Dam
2. The development of the Lake Mead National Recreation Area
3. The establishment of World War II defense industries
4. The development of railroad services
5. The establishment of space industries
6. The development of the Nevada Test Site
7. The development of the tourist industry
8. The development and growth of agriculture
9. The rapid growth in population

Clark County continues to be one of the fastest growing areas in the state.

2. Employment and Income(10)

Although more diversified than many other counties in Nevada, Clark County's economy is by service industries which accounted for 45 percent of the county employment in 1979. The second and

Table 7

1979 EMPLOYMENT PATTERNS -- CLARK COUNTY(10)

Industry	Number of Firms	Number of Employees	Percent of Employees	Total Wages	Percent of Wages
Mining	24	372	<1	6,141,436	<1
Construction	1,292	15,509	8	302,644,629	11
Manufacturing	305	6,882	3	110,504,714	4
Trans., Comm., and Util.	305	11,992	6	196,866,850	7
Wholesale & Retail Trade	3,010	43,331	21	445,473,986	17
Fin., Ins., and Real Estate	966	9,249	4	117,877,441	4
Service Industries*	3,487	93,176	45	1,119,111,248	42
Government	93	25,200	12	369,617,734	14
TOTAL	9,482	205,711	100	2,668,823,038	100

*Includes Agricultural Services and Firms not Elsewhere Classified

third largest employers, trade and government, represented 21 percent and 12 percent of total employment respectively (Table 7).

Unemployment rates have fluctuated greatly averaging between five and nine percent.

Clark County enjoyed the state's third highest per capita income in 1977--\$7,959--a 42 percent increase from 1973.

F. Design Information(1)

The engineering design characteristics for the urban community of Las Vegas are as follows:

Latitude-----36°05'

Longitude-----115°10'

Elevation-----2,162 feet

Winter Design Dry

Bulb Temperature

99%-----25° F.

97.5%-----28° F.

Summer Design Dry-Bulb

and Mean Coincident Wet-

Bulb Temperature

1%-----108°/66° F.

2.5%-----106°/65° F.

5%-----104°/65° F.

Mean Daily Temperature

Range-----30° F.

Design Wet-Bulb

Temperature

1%-----71° F.

2.5%-----70° F.

5%-----69° F.

Degree-Heating Days-----2,709

Degree-Cooling Days-----2,942

Additional degree-heating and degree-cooling information is available at the following recording stations in Clark County:

	Elevation	Degree-Heating Days	Degree-Cooling Days
Boulder City	2,525 feet	2,341	3,020
Searchlight	3,540 feet	2,707	1,233

G. Energy Information(16)

The energy situation in Geothermal Resource Area 11 is typical of that occurring in southern Nevada. Electricity and natural gas are the prime sources of energy used in the urban area with electricity, propane, and distillate fuels being the primary source of energy in the rural area. These fuels are supplemented with small quantities of coal, wind, hydro, and other alternative energy resources.

Four different certificated utilities supply the electrical needs of most of Clark County: Nevada Power Company, C.P. National, the Overton Power District, and the Valley Electric Association. There are areas, however, that have no electrical services available. Users in these areas must generate their own electricity.

Nevada Power Company is the primary electrical supplier, selling directly to customers throughout much of central Clark County, and indirectly to C.P. National for resale to their customers. Several years ago, Nevada Power made the conversion to coal for their generating fuel. The cost of coal generated electricity is much less than oil or natural gas generated electricity. For this reason, the electrical costs to consumers being supplied directly or indirectly by Nevada Power Company are much less than found in other areas of the state.

The Overton Power District in northeast Clark County obtains much of its electrical energy from hydroelectric projects along the Colorado River. Because the power districts were treated as preferred customers, when projects such as the Hoover Dam and Powerhouse were constructed and placed on line, the power district was able to obtain electricity at very reasonable rates. There are two primary reasons for this inexpensive electricity: The power projects were constructed at a time when labor and building

costs were low; and today, hydroelectric power is less expensive to produce because there are no costs for high priced fossil fuels.

Valley Electric Association supplies electrical energy to a portion of western Clark County. The source of much of the electrical energy is hydroelectric projects on the Colorado River. For the same reasons as above, the costs of this electrical energy are relatively low.

Southwest Gas supplies natural gas to the Las Vegas area and to the southern tip of Nevada. A major pipeline connects these two areas. The company also has the authority to service areas within one mile of this transmission line. The costs of natural gas obtained through Southwest Gas in Southern Nevada are steadily rising although not at the same rate as found in northern Nevada. With the anticipated deregulation of natural gas prices, these costs will continue escalating in cost.

Consumers in areas not having access to natural gas must rely on electricity to satisfy their energy demands. In remote rural areas the costs of importing these fuels can become extremely expensive. Energy costs for petroleum products have more than doubled in the last few years.

Coal is another energy source that has seen only limited use in the study area. The amount in relation to other energy sources is believed very small and consists mostly of residential applications and electrical generation.

Other potential alternative energy sources that have some development possibilities in the near future include solar and wind systems. The Nevada Department of Energy is actively encouraging these as well as all types of geothermal development.

Given a mix of energy resources that are presently used it is obvious that the potential for developing geothermal energy is very good. In order to assess the extent of the role that geothermal energy can play in supplying energy requirements in the study area, the NDOE has been working with the New Mexico Energy Institute (NMEI) to evaluate the potential of geothermal energy development through the year 2020. Using a computer model devel-

oped by NMEI, projections have been made of the amount of geothermal energy that can be economically developed through the next 40 year period. Two primary classes of development are evaluated: residential and industrial applications by municipal developers and residential and industrial applications by private developers. Tables 8 and 9 show the projections that were developed. For comparison, the amount of geothermal energy which could be developed is shown in BTUs and in the equivalent amount of oil and electricity.

Based on these projections, it is estimated that by the year 1990 5.23×10^{11} BTUs of energy could be economically developed by either private or municipal developers. By 2000, the amount of energy increases to 6.28×10^{11} BTUs and by 2019 it increases to 7.42×10^{11} BTUs for private developers and 7.78×10^{11} BTUs for municipal developers.

It should be noted that these projections represent an idealized situation where all the resources are developed to their maximum economic potential. Due to the location and physical characteristics of the resources in the study area, it is unlikely that development will occur at the projected levels.

It has been estimated, using data from the publication Energy in Nevada, that total anticipated energy consumption for non-transportation needs in 1990 would be 1.25×10^{14} BTUs. In 2000 it would be about 1.59×10^{14} BTUs. These figures indicate that, under ideal conditions, approximately 0.4 percent of the energy demand in the study area could be met by geothermal energy in the year 1990 and 0.39 percent could be met by 2000. Because of the location of the population base in relation to the geothermal resources found in the study area, it is not anticipated that the resources will be developed to their greatest potential in this time period. However, if only a portion of the resources were developed, there could be a significant impact on the consumption of fossil fuels, new industry development, and new jobs for the people living in the study area.

Energy costs for fossil fuels such as natural gas and oil are going to continue to rise in the foreseeable future. This is primarily due to two factors. First, the source of much of this

energy is outside of the United States and hence beyond the physical control of the country. Second, domestic sources of energy will be deregulated in cost by 1985. Both of these factors make coal and geothermal energy attractive alternatives to existing energy sources. Coal, one of the major non-renewable energy resources found in abundance in the United States, can be processed into synthetic fuels. The cost of this coal, whether for production of synthetic fuels or for combustion in an electrical powerplant, is also high. Additionally, strip mining of coal and the air pollution created when it is burned pose serious environmental questions.

Geothermal energy offers an attractive alternative to these non-renewable energy resources. It is relatively clean, less expensive to use, and attractive to many types of developers. Geothermal technology is becoming more available to manage geothermal reservoirs to obtain maximum production over the longest period of time and to make use of very difficult fluid types. Thus, the development of the geothermal resources in Clark County should be encouraged wherever and whenever possible. This development would benefit both Nevada's citizens and industries, and would assist in the development of an energy independent United States.

Table 8

NEW MEXICO ENERGY INSTITUTE--GEOTHERMAL DIRECT USE ENERGY PROJECTIONS--
 COMBINED INDUSTRIAL AND RESIDENTIAL APPLICATION WITH PRIVATE
 DEVELOPER -- CLARK COUNTY

Year	Geothermal energy	Equivalent Gallons of oil	Equivalent Kilowatt hours of electricity
1980	-0-	-0-	-0-
1981	-0-	-0-	-0-
1982	-0-	-0-	-0-
1983	-0-	-0-	-0-
1984	-0-	-0-	-0-
1985	-0-	-0-	-0-
1986	-0-	-0-	-0-
1987	-0-	-0-	-0-
1988	-0-	-0-	-0-
1989	-0-	-0-	-0-
1990	5.23 x 10 ¹¹	3,789,855	1.53 x 10 ⁸
1991	5.36 x 10 ¹¹	3,884,058	1.57 x 10 ⁸
1992	5.49 x 10 ¹¹	3,978,261	1.61 x 10 ⁸
1993	5.63 x 10 ¹¹	4,079,710	1.65 x 10 ⁸
1994	5.77 x 10 ¹¹	4,181,159	1.69 x 10 ⁸
1995	5.91 x 10 ¹¹	4,282,609	1.73 x 10 ⁸
1996	5.98 x 10 ¹¹	4,333,333	1.75 x 10 ⁸
1997	6.06 x 10 ¹¹	4,391,304	1.78 x 10 ⁸
1998	6.13 x 10 ¹¹	4,442,029	1.80 x 10 ⁸
1999	6.20 x 10 ¹¹	4,492,754	1.82 x 10 ⁸
2000	6.28 x 10 ¹¹	4,550,725	1.84 x 10 ⁸
2001	6.35 x 10 ¹¹	4,601,449	1.86 x 10 ⁸
2002	6.43 x 10 ¹¹	4,659,420	1.88 x 10 ⁸
2003	6.51 x 10 ¹¹	4,717,391	1.91 x 10 ⁸
2004	6.58 x 10 ¹¹	4,768,116	1.93 x 10 ⁸
2005	6.66 x 10 ¹¹	4,826,087	1.95 x 10 ⁸
2006	6.74 x 10 ¹¹	4,884,058	1.97 x 10 ⁸
2007	6.82 x 10 ¹¹	4,942,029	2.00 x 10 ⁸
2008	6.91 x 10 ¹¹	5,007,246	2.02 x 10 ⁸
2009	6.99 x 10 ¹¹	5,065,217	2.05 x 10 ⁸
2010	6.66 x 10 ¹¹	4,826,087	1.95 x 10 ⁸
2011	6.74 x 10 ¹¹	4,884,058	1.97 x 10 ⁸
2012	6.82 x 10 ¹¹	4,942,029	2.00 x 10 ⁸
2013	6.91 x 10 ¹¹	5,007,246	2.02 x 10 ⁸
2014	6.99 x 10 ¹¹	5,065,217	2.05 x 10 ⁸
2015	7.07 x 10 ¹¹	5,123,188	2.07 x 10 ⁸
2016	7.16 x 10 ¹¹	5,188,406	2.10 x 10 ⁸
2017	7.24 x 10 ¹¹	5,246,377	2.12 x 10 ⁸
2018	7.33 x 10 ¹¹	5,311,954	2.12 x 10 ⁸
2019	7.42 x 10 ¹¹	5,376,811	2.17 x 10 ⁸

Table 9

NEW MEXICO ENERGY INSTITUTE--GEOTHERMAL DIRECT USE ENERGY PROJECTIONS--
 COMBINED INDUSTRIAL AND RESIDENTIAL APPLICATION WITH MUNICIPAL
 DEVELOPER -- CLARK COUNTY

Year	Geothermal energy	Equivalent Gallons of oil	Equivalent Kilowatt hours of electricity
1980	-0-	-0-	-0-
1981	-0-	-0-	-0-
1982	-0-	-0-	-0-
1983	-0-	-0-	-0-
1984	-0-	-0-	-0-
1985	-0-	-0-	-0-
1986	1.41 x 10 ¹¹	6,876,811	2.78 x 10 ⁷
1987	2.88 x 10 ¹¹	2,086,957	8.44 x 10 ⁷
1988	4.43 x 10 ¹¹	3,216,145	1.30 x 10 ⁸
1989	5.10 x 10 ¹¹	3,695,652	1.49 x 10 ⁸
1990	5.23 x 10 ¹¹	3,789,855	1.53 x 10 ⁸
1991	5.36 x 10 ¹¹	3,884,058	1.57 x 10 ⁸
1992	5.49 x 10 ¹¹	3,978,261	1.61 x 10 ⁸
1993	5.63 x 10 ¹¹	4,079,710	1.65 x 10 ⁸
1994	5.77 x 10 ¹¹	4,181,159	1.69 x 10 ⁸
1995	5.91 x 10 ¹¹	4,282,609	1.73 x 10 ⁸
1996	5.98 x 10 ¹¹	4,333,333	1.75 x 10 ⁸
1997	6.06 x 10 ¹¹	4,391,304	1.78 x 10 ⁸
1998	6.13 x 10 ¹¹	4,442,029	1.80 x 10 ⁸
1999	6.20 x 10 ¹¹	4,492,754	1.82 x 10 ⁸
2000	6.28 x 10 ¹¹	4,550,725	1.84 x 10 ⁸
2001	6.35 x 10 ¹¹	4,601,449	1.86 x 10 ⁸
2002	6.43 x 10 ¹¹	4,659,420	1.88 x 10 ⁸
2003	6.51 x 10 ¹¹	4,717,391	1.91 x 10 ⁸
2004	6.58 x 10 ¹¹	4,768,116	1.93 x 10 ⁸
2005	6.66 x 10 ¹¹	4,826,087	1.95 x 10 ⁸
2006	6.74 x 10 ¹¹	4,884,058	1.97 x 10 ⁸
2007	6.82 x 10 ¹¹	4,942,029	2.00 x 10 ⁸
2008	6.91 x 10 ¹¹	5,007,246	2.02 x 10 ⁸
2009	6.99 x 10 ¹¹	5,065,217	2.05 x 10 ⁸
2010	7.07 x 10 ¹¹	5,123,188	2.07 x 10 ⁸
2011	7.16 x 10 ¹¹	5,188,406	2.10 x 10 ⁸
2012	7.24 x 10 ¹¹	5,246,377	2.12 x 10 ⁸
2013	7.33 x 10 ¹¹	5,311,594	2.15 x 10 ⁸
2014	7.42 x 10 ¹¹	5,376,812	2.17 x 10 ⁸
2015	7.51 x 10 ¹¹	5,442,029	2.20 x 10 ⁸
2016	7.60 x 10 ¹¹	5,507,246	2.23 x 10 ⁸
2017	7.69 x 10 ¹¹	5,572,464	2.25 x 10 ⁸
2018	7.78 x 10 ¹¹	5,637,681	2.28 x 10 ⁸
2019	7.87 x 10 ¹¹	5,702,899	2.31 x 10 ⁸

III. THE RESOURCE

A. General Information

There are approximately nine geothermal anomalies currently known in Clark County. The hottest of these resources is 145° F. The majority of them range in temperature between 75° F. and 90° F.

The Clark County area has a high annual mean ambient air temperature. This 60° F. temperature must be considered as an important factor in the reported spring and well temperatures. Taking this into consideration there are several springs and wells in the study area that have anomalous temperatures. The following portion of this report includes a discussion of several geothermal areas in Clark County with a brief description of the known characteristics of each resource.

Evaluation of the geothermal reservoir associated with each of the resources is difficult because of the limited information currently available. The size of the reservoir was determined by referring either to the U.S.DOE publication Geothermal Direct Heat Use Market Potential/Penetration or U.S.G.S. Circular 790. The heat energy stored in the reservoir was determined according to standard U.S.G.S. methodology. Using this methodology, the potential heat energy found in a geothermal reservoir is calculated using known factors such as: the surface area of the reservoir, the depth of the reservoir, the temperature of the reservoir, and the specific heat of rock. The formula used for this calculation is:(25)

$$q_r = p_c \times a \times d \times (t - t_{ref})$$

where:

q_r = reservoir thermal energy in BTU's

p_c = volumetric specific heat of rock plus water 40.284 BTU/f

a = reservoir area

$t^3/^{\circ}F$

d = reservoir thickness

t = reservoir temperature

t_{ref} = reference temperature (59° F.)

FIGURE 5

LOCATIONS OF

GEO THERMAL

RESOURCES IN

CLARK COUNTY

- **Single Spring**
- **Cluster of Geothermal Thermal Wells or Springs**

Existing technology is not capable of extracting all of the energy from the geothermal reservoir. To give a more realistic value to the energy obtainable using existing technology, an assumption of 25 percent total reservoir capacity is used.

It should be emphasized that the information presented about each geothermal reservoir is based on the best information currently available. The actual conditions in the reservoir may be considerably different than indicated. Any party investigating the development of any of these resources is urged to contact the Division of Earth Sciences of the Environmental Resource Center for additional resource information and to engage the services of a reputable consulting firm which has experience in assessing and developing geothermal reservoirs.

B. Moapa Area

1. Description(11)

Six warm springs and four warm wells have been reported about six miles northwest of the community of Moapa at the head of the Muddy River. These springs and wells all have temperatures averaging near 90° F. The springs flow out of alluvium. Water is believed to be transmitted through Paleozoic carbonate rocks which are exposed to the vicinity. Iverson's Warm Springs has been used extensively for irrigation and has been developed into a thriving recreational area drawing visitors primarily from the Las Vegas area.

2. The Reservoir

The following parameters are believed to describe the geothermal resource located in the Moapa area:

Volume(23)

0.24 cubic mile

Temperature (11)

Clarence Lewis well-----80° F.
Woodruff and Perkins well-----82° F.
"well"-----90° F.
Muddy River Springs-----90° F.
Peterson Spring-----90° F.
Iverson's Warm Springs-----90° F.

Discharge (11)

Clarence Lewis well-----360 gallons per minute
Woodruff and Perkins well-----285 gallons per minute
Muddy River Springs-----3,240 gallons per minute
Iverson's Warm Springs-----1,696 gallons per minute

Water Chemistry(11)

Examples of four water chemistry analyses are reproduced in Appendix 1. These samples indicate that the water from the Moapa area geothermal resource area meets all standards for safe drinking water except the total dissolved solids. The total dissolved solids is almost double the amount allowed for potable water.

Energy Content(25)

Potential heat energy found in the reservoir----- 4.4×10^{13} BTUs
Heat energy extractable with existing technology----- 1.1×10^{13} BTUs

C. Las Vegas Valley

1. Description(11)

Warm springs and warm wells in the Las Vegas Valley are concentrated primarily in three areas: the Kyle Springs area, the Las Vegas Springs area, and the Warm Springs Ranch area. The Kyle Springs area is located in S15, T20S, R16E. The Spring has a reported temperature of 79° F. Several warm wells in the same area

indicate that their source is also related to the spring. It is believed that these higher than normal water temperatures indicate that the water in this area has circulated to greater depths than the rest of the valley.

Las Vegas Springs are located in S30 and 31, T20S, R61E. These springs are located about three miles west of downtown Las Vegas. Temperatures of up to 79° F. have been reported. These springs have now gone dry, probably due to utilization of the water for irrigation and for domestic water supplies for the residents of Las Vegas. The springs originally flowed at 2,567 gallons per minute. They appear to be along a fault that displaces basin alluvium deposits.

There are more than 20 warm wells in the Warm Springs Ranch area of S10, T22S, R61E. Water temperatures at reported wells near this site are 90° F. Water temperatures of 79° F. and 84° F. are encountered in wells up to one and one-half miles west of the ranch. A well about one mile southwest of the ranch has a reported temperature of 106° F.

There are several other warm wells in the Las Vegas Valley. These, however, do not show any particular clustering. One well drilled in 1957 for oil encountered 137° F. water. This well, located in C NW/4 NW/4 S24, T21S, R61E was later plugged below 6,050 feet. It is believed that the hot water energy point was about 5,210 feet in the Permian Kaibab Limestone.

2. The Resource

Because of the character of the resource found in the Las Vegas Valley it is not possible to give definite parameters for the reservoir characteristics. The springs and wells may or may not be part of a single reservoir. Based on information currently available, the following summarizes the known characteristics of the Las Vegas Valley geothermal resource:

Volume (23)

Estimated volume 2.4 cubic miles

Temperature (11)

Kyle Spring-----75° F.
Las Vegas Springs-----79° F.
James Filbey well-----79° F.
I.M. Pinjuv well-----73° F.
R.J. Bond well-----81° F.
Henry Wick well-----84° F.
Gladstone Corporation well-----91° F.
"well"-----106° F.

Discharge(11)

Las Vegas Springs
(Joe Brown Well)-----950-1700 gallons per minute
Las Vegas Springs-----2600 gallons per minute

Water Chemistry(11)

Examples of eight water chemistry analyses from wells in the Las Vegas Valley are reproduced in Appendix 1. These analyses indicate that most of the wells in the valley violate the Nevada Standards for Safe Drinking Water in one or more of the pollutant categories. Sulfate and total dissolved solids are the most commonly violated standards.

Energy Content(25)

Potential heat energy found in the reservoir----- 6.7×10^{14} BTUs
Heat energy extractable with existing technology----- 1.7×10^{14} BTUs

D. Black Canyon and Other Warm Springs in Clark County(11)

Several warm springs are found in Arizona and Nevada along the Black Canyon portion of the Colorado River. These springs, located approximately seven miles east of Boulder City, have temperatures ranging from 78° F. to 148° F., and discharges ranging up to 224 gallons per minute.

There are several springs in the narrows of the Virgin River with slightly anomalous temperatures. These springs have temperatures ranging from 75° F. to 80° F. and a discharge of 270 gallons per minute.

Roger's Springs near the Valley of Fire State Park, have a reported temperature of 86° F. and a discharge of up to 900 gallons per minute. Indian Springs are located in the immediate proximity of the small community of Indian Springs and the Indian Springs Auxillary Air Base. These springs have a temperature of 79° F. and flows up to 500 gallons per minute. White Rock Springs are located along the base of La Madre Mountain about 15 miles west of Las Vegas in the Red Rock Canyon Recreation Lands. These springs have temperatures of 78° F. and discharges of up to 1400 gallons per minute. No water right claims have yet been filed on these springs. Two other springs in the Clark County area are reported to have slightly elevated temperatures: Brown's Spring--temperature 75° F.; and Ash Creek Spring--temperature 72° F.

For calculation purposes all seven of the springs listed above are defined as having a reservoir volume of 0.24 cubic mile each.

1. Black Canyon

Energy Content(25)

Potential heat energy found in the reservoir----- 1.3×10^{14} BTUs

Heat energy extractable with existing technology---- 3.2×10^{13} BTUs

2. Virgin River Narrows

Energy Content(25)

Potential heat energy found in the reservoir----- 3.0×10^{13} BTUs

Heat energy extractable with existing technology---- 7.5×10^{12} BTUs

3. Rodger's Springs

Energy Content(25)

Potential heat energy found in the reservoir----- 3.8×10^{13} BTUs

Heat energy extractable with existing technology---- 9.6×10^{12} BTUs

4. Indian Springs

Energy Content(25)

Potential heat energy found in the reservoir----- 2.8×10^{13} BTUs

Heat energy extractable with existing technology---- 7.1×10^{12} BTUs

5. White Rock Springs

Energy Content(25)

Potential heat energy found in the reservoir----- 2.8×10^{10} BTUs

Heat energy extractable with existing technology---- 7.1×10^{12} BTUs

6. Brown Springs

Energy Content(25)

Potential heat energy found in the reservoir----- 2.3×10^{13} BTUs

Heat energy extractable with existing technology---- 5.7×10^{12} BTUs

7. Ash Creek Springs

Energy Content(25)

Potential heat energy found in the reservoir----- 1.9×10^{13} BTUs

Heat energy extractable with existing technology---- 4.6×10^{12} BTUs

IV. THE USES

A. General Information

Uses for geothermal energy fall into two broad categories: electrical generation and direct use of the hot water. Electrical generation on a practical commercial scale requires both a high temperature resource and a large geothermal reservoir. It appears that none of the known geothermal areas in Clark County meet these criteria.

Direct uses of the geothermal energy are more varied and can economically use both lower temperature and less extensive resources. In addition, hot water from a high temperature application can be used for lower temperature applications after it's initial use. Figure 6 illustrates the various types of uses for geothermal energy and the temperature requirement for each use. Several of these types of applications may be feasibly developed in Clark County.

B. Moapa Area

The geothermal resource in the Moapa area is represented by several springs and wells with temperatures ranging up to about 90° F. Several options are available to developers of resources with temperatures in this range. These include recreation, the aquacultural raising of fish and prawns if the flows are sufficient to maintain the ponds at a year around temperature of 85° F., space heating and cooling using heat pumps, and similar applications. The resources in the Moapa area have been used for irrigation. One spring (Iverson's Warm Spring) has been developed into a popular recreational area for people in the surrounding communities as far away as Las Vegas.

The Moapa Valley area is historically an agricultural region. Approximately two miles to the southeast of the known spring area is the Moapa Indian Reservation. The development of some type of

FIGURE 6

GEOTHERMAL USE TEMPERATURES IN CLARK COUNTY

* Temperatures indicated are based
in part on various geothermometers.

application that can tie these two factors together holds some potential. In developing this resource the economic situation of the tribe and the community of Moapa could be greatly enhanced. Such development may include: greenhousing, aquaculture, or animal husbandry activities. Although the temperature of the resource is somewhat low, it must be remembered that the Moapa Valley area of Clark County is located in a desert environment. Summertime temperatures are frequently greater than 100° F. Wintertime temperatures, though occasionally cold, are usually pleasant. These factors could work together to give added incentive to geothermal energy developers in the Moapa Valley area.

C. Las Vegas Valley

Development of the geothermal resources in the Las Vegas Valley does hold some potential at this time. Existing wells could be retrofitted to make use of heat pumps to assist in the heating and cooling of private homes and small commercial establishments. The 400 to 600 foot depth of the wells needed and the low temperature of the fluid obtained from those wells may be a limiting factor on new development of either large or small scale space conditioning systems. The economics of developing these resources may not be practical at this time. Other potential low temperature applications such as in the agricultural industry are also hampered by these problems plus the fact that the known warm spring and well areas are located in the urbanized portion of the Las Vegas Valley.

D. Black Canyon and Other Warm Springs in Clark County

With the exception of the Black Canyon warm springs all other known springs in Clark County have temperatures of less than 80° F. This factor reduces the potential for development of these springs. Primary types of applications in this temperature range would include recreation and space heating using heat pumps. Agricultural applications using this temperature would be limited to soil warming and conventional irrigation.

Roger's Springs have been developed into a primitive recreation area. Many people from the Las Vegas area include a stop at this area for a swim before or after visiting the Valley of Fire State Park.

Indian Springs lie in the area where a new state prison facility will soon be built. Although the temperatures are low, there would be some possibility of using this water for domestic water or boiler water preheat. The development of small greenhouses at the prison to use this water could also be an advantageous application.

The other springs in the Clark County area probably hold only potential for development under existing circumstances. If, however, the nation's energy situation changes, or technology is developed to use the lower temperature fluids, these springs should be carefully examined as a potential source of low level energy.

The Black Canyon geothermal anomaly has temperatures up to about 145° F. This greatly enlarges the field of potential applications that could be developed at these springs. The problem is that these springs are located in extremely rugged terrain with no road access. These factors limit the types of potential applications and probably make any development of this resource impractical at this time.

V. CONCLUSION

The potential for geothermal development in Clark County is not great. There are relatively few known geothermal anomalies in the area and these have low temperatures. Except for those springs located in the Moapa area or Las Vegas Valley, all are remotely located with only fair to poor road access.

Based on the information presented in this Area Development Plan the sites in the study area most appropriate for each general category of geothermal energy development were determined. These are:

Electrical Generation

None

Residential-Commercial Space Conditioning

Potentially several of the existing wells in the Las Vegas Valley and Moapa area could be retrofitted with heat pumps.

District Space Heating

None

Recreation

Iverson's Hot Springs
Roger's Springs

Industrial Process Heat

None

Greenhousing

Very small scale greenhousing may be developed with the Indian Springs Prison Facility.
Moapa area.

Aquaculture

Moapa Area

Animal Husbandry

Moapa Area

VI. Additional Information

Additional information on the occurrence, character, or development of Nevada's geothermal resources may be obtained by writing, calling, or visiting any of the following:

Nevada Bureau of Mines and Geology
University of Nevada-Reno
Reno, Nevada 89557
(702) 784-6691

Nevada Department of Conservation
and Natural Resources
Division of Water Resources
201 South Fall Street
Carson City, Nevada 89710
(702) 885-4380

Nevada Department of Energy
400 West King Street, Room 106
Carson City, Nevada 89710
(702) 885-5157

University of Nevada, Las Vegas
Division of Earth Sciences
Environmental Resource Center
Museum of Natural History
255 Bell
Reno, Nevada 89503
(702) 784-6151

U.S. Bureau of Land Management
Room 3008, Federal Building
300 Booth Street
Reno, Nevada 89509
(702) 784-5748

U.S. Geological Survey
District Geothermal Office
4600 Kietzke Lane
Reno, Nevada 89502
(702) 784-5676

VII. BIBLIOGRAPHY

1. ASHRAE Handbook and Product Directory - 1977 Fundamentals.
New York: American Society of Heating Refrigeration,
and Air Conditioning Engineers, Inc. 1977.
2. Department of Economic Development. Clark County - Datafile.
1976.
3. Department of Economic Development. Nevada Industrial Directory. 1978.
4. Department of Highways. Nevada Federal And State Systems-
Description and Index. 1978.
5. Department of Highways. Non-Federal Aid State Aid Routes.
1978.
6. Department of Transportation. Status of Road Systems.
1979.
7. Division of Water Resources. Alternative Plans for Water
Resource Use--Area 4. 1974.
8. Division of Water Resources. Alternative Plans for Water
Resource Use--Area 5. 1974.
9. EG&G, Inc. Nevada Hydrothermal Commercialization Baseline.
1979.
10. Employment Security Department. Nevada Employment and Pay-
rolls. 1976, 1977, 1978, 1979.
11. Garside, Larry J., and Schilling, John H. Thermal Waters of
Nevada. Mackay School of Mines. Bulletin 91. 1979.
12. Governor's Office of Planning Coordination. The Comprehen-
sive Economic Development Plan. Vol. 1, 2, and 3.
1980.
13. Governor's Office of Planning Coordination. Directory of
Local Planning Organizations. 1979.
14. Hammer, Gay; Esposito, Louis; and Montgomery, Martin. Idaho
Geothermal Handbook. The Idaho Office of Energy.
1979.
15. Longwell, C.R., et. al. Geology and Mineral Resources of
Clark County, Nevada. Nevada Bureau of Mines and Geolo-
gy, Bulletin 62. 1965.
16. Nevada Department of Energy. Energy in Nevada. 1980.

17. Stewart, John H. Geology of Nevada. Nevada Bureau of Mines and Geology, 1980. Special Publication #4.
18. Thornbury, William D. Regional Geomorphology of the United States. New York: John Wiley and Sons, Inc. 1965.
19. United States Bureau of Land Management. Wilderness Study Area Decisions. 1980.
20. United States Department of Commerce, Climatological Summary - Boulder City. 1936 to 1965.
21. United States Department of Commerce, Climatological Summary - Las Vegas. 1937 to 1968.
22. United States Department of Energy. Environmental Development Plan - Geothermal Energy Systems. 1979.
23. United States Department of Energy. Geothermal Direct Heat Use Market Potential/Penetration Analysis for Nevada, DOE Region IX. 1979.
24. United States Department of Energy. Nevada Southwest Regional Geothermal Development Operations Research Project. Appendix 8. January, 1979.
25. United States Geological Survey. Assessment of Geothermal Resources of the United States. Circular 790. 1978.
26. United States Geological Survey. Methodology for Determining the Accessable Resource Base of Identified Hydrothermal Convection Systems. Open File Report 78-1003. 1978.

VIII. Appendix 1 -- Water Chemistry Analysis
Clark County

Identification	pH	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
<u>MOAPA AREA</u>															
"well"	7.7	-	-	65	27	-	-	265	-	186	64	-	-	-	-
Muddy River Springs	7.7	31	-	65	28	99	10	288	0	174	60	2.4	2.3	0.3	985
Peterson Spring	7.9	245	.01	75	26	107	8.8	284	0	189	59	2.1	1.9	-	854
Iverson's Spring	7.5	29	-	70	26	101	11	274	0	179	64	2.3	2.2	0.3	620
<u>INDIAN SPRINGS AREA</u>															
Indian Springs	7.4	13	0	5	20	4.5	1.1	238	0	16	3.7	0.1	1.1	0.1	335
<u>ROGERS SPRING AREA</u>															
Rogers Spring	7.5	18	<.02	430	128	284	18	170	0	1747	328	1.5	1.3	-	3040
<u>LAS VEGAS VALLEY</u>															
Kyle Spring	-	8	.01	53	27	26		251	-	33	55	-	2	-	258
Joe Brown Well	7.4	14	.05	48	25	8.1	3.6	222	-	51	6.5	0.2	1.0	-	266
Tollackson Well	-	-	-	64	30	11		223	-	107	6	0.3	3.0	-	332
J.R. Bond Well	-	25	-	110	50	29		215	tr	327	20	-	-	-	715
U.G. Campbell Well	-	12	-	110	42	18		160	0	315	20	-	-	-	602
Nevada Safe Drinking Water Standards			.03		125					250	250				500

VIII. Appendix 1 -- Water Chemistry Analysis
Clark County - continued

Identification	pH	SiO ₂	Fe	Ca	Mg	Na	K	HCO ₃	CO ₃	SO ₄	Cl	F	NO ₃	B	TDS
L.H. Irvin well	-	-	-	134	57		2.3	198	0	353	30	-	-	-	775
Henry Wick well	-	-	-	158	53		0.7	176	9	441	.5	-	-	-	838
Gladstone Corporation well	-	30	-	155	50	15		205	0	405	35	-	-	-	857
<u>Black Canyon Area</u>															
spring	8.2	45	.01	200	4.5	480	12	84	0	780	480	4.1	-	1.0	-
spring	8.2	54	.01	140	10	290	10	136	0	610	180	4.1	-	.66	-
Nevada Safe Drinking Water Standards			.03		125					250	250				500