12/16/77

NUBETH JOINT VENTURE

ENVIRONMENTAL REPORT
SUPPORTIVE INFORMATION
TO

APPLICATION FOR
SOURCE MATERIAL LICENSE

IN SITU SOLUTION MINING TEST SITE
SUNDANCE PROJECT
CROOK COUNTY
WYOMING

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1.0 PROPOSED ACTIVITIES

1.1 INTRODUCTION

The Joint Venture is in the process of evaluating recovery of uranium with regard to economic and environmental factors involved in the in situ solution mining of uranium. A single-hole, slug-type, (push-pull) in situ leach test was performed in September, 1976. The test showed that the technique was feasible for extracting uranium by lixiviation from the mineralized formation, the leachate being brought to the surface and a total weight of approximately seven pounds of yellowcake being made from the leachate. Data from the study also showed that formation water can be restored to near its original chemical and physical condition. (Enclosure 1)

On the basis of the push-pull test, Nubeth is optimistic that uranium can be economically extracted from the formation and desires to evaluate the in situ leaching and recovery techniques further and for this purpose proposes to perform in situ leaching of uranium from a limited volume of mineralized formation (less than two acres) using multiple holes, and to operate a small uranium extraction pilot plant with a maximum input capacity of 90 gpm (gallons per minute).

ENCLOSURE 1

In Situ Leaching for Uranium, Push-Pull Test, Nubeth Joint Venture
Sundance Project, Crook County, Wyoming, Summary

Refers to section 1.1 Introduction

ENCLOSURE 1

In-situ Leaching for Uranium, Push-Pull Test, Nubeth Joint Venture, Sundance Project, Crook County, Wyoming. - Summary.

General Description

The test was performed from August 20 to August 30, 1976 on drill hole 758R, situated approximately 1000 feet north of Oshoto Reservoir. The drill hole was cased from the surface to a depth of 416 feet. Below this depth it was perforated through 30 feet of mineralized lower Lance-Fox Hills formation. The test was designed by Geoffrey G. Hunkin, P.E., Mining Engineer, Consultant, Littleton, Colorado, who was present during part of the test. The intent was to determine leachability of uranium in situ, with a bulk test, and to provide a bulk sample of leachate for the purpose of obtaining preliminary recovery information and data in processing for yellow cake. The test may be generally described as follows:

1) Five thousand gallons of formation water were withdrawn from the mineralized formation and were stored in a plastic tank on the surface (pH 8.25).

2) Sodium bicarbonate and ammonium hydroxide were added and mixed with the 5000 gallons collected (pH 8.1).

3) The mixture was passed through a filter and hydrogen peroxide was added as 3800 gallons of the leachant were injected back through the well into the formation under a pressure head of approximately 70 feet over the piezometric head of the formation.

4) After injection, the well was undisturbed for 7 days following which recovery commenced.

5) Approximately 4000 gallons of leachate were air-lifted from the well to the surface into the plastic storage tank. From the tank the leachate passed through a filter, into a small resin ion exchange column, from which the barren solution (as indicated by systematic sampling and analyses) passed to a separate plastic lined tank.

Results

The ion exchange column with resin was shipped to Bethlehem Steel Holmer Reserch Laboratory (Bethlehem, Pennsylvania) where approximately 7 pounds of U_3O_8 yellow cake powder was recovered. Analysis of the powder generally met or was superior to marketing specifications for yellow cake.

Formation Water Restoration

Following the leachate withdrawal phase described above which was completed on August 28, 1976, a program of pumping and chemical analyses was conducted to restore formation water to acceptable conditions. Five periods of pumping, commencing on September 13, 1976, and terminating April 27, 1977, extracted a total of 72,000 gallons of water from the well.

The results of chemical analyses from samples taken during the pumping periods are presented on the attached table, which shows that the quiescent period between pumping periods allowed chemical reactions to resume. More effective restoration may have been achieved by pumping continuously, until the affected zone approached equilibrium. A range of base line analyses for this test had not been obtained from multiple sampling; only a single reference point had been obtained from a set of analyses of one pre-test sample. Accordingly, an average base line condition was not known,

and the restoration target was assumed to be that of the single sample. More water samples gathered over an extended period of time from a given well or wells should be collected and analyzed prior to future tests to establish a base line (seasonal variations if any included) for restoration programs.

Stripped solution from the test was disposed of by evaporation, dilution and surface storage. A portion of the water pumped during the restoration process was stored in lined ponds and the remainder discharged on the surface. No salts accumulated and no anomalous radioactivity was noted in any of the water so wasted. Vegetation thrived where the water was discharged.

The above information and data has been turned over to the Wyoming Department of Environmental Quality, as originally arranged.

GKBiemesderfer:bac
8/16/77

				Pre-Test 8/4/76	Push-Pull Test 8/20 to 8/29/76	Samples taken after "x... First Clean Up 9/13/76 4000 g	5000 g	6000 g	Start...
SODIUM	(Na)	mg/l		489		560	630	620	642
POTASSIUM	(K)	"		6		8.7	9.1	9.0	8
CALCIUM	(Ca)	"		11		8.9	9.3	6.7	8
MAGNESIUM	(Mg)	"		4		2.6	2.2	2.0	4
SULFATE	(SO_4)	"		525		800	700	1000	740
CHLORIDE	(Cl)	"		20		14	12	12	16
CARBONATE	(CO_3)	"		84		85	18	26	60
BICARBONATE	(HCO_3)	"		488		960	670	590	671
TOTAL DISSOLVED SOLIDS		"		1379		1590	1750	1740	1808
AMMONIA NITROGEN	(N)	"		0.33		201	66	50	52
pH UNITS				8.6					8.3
URANIUM	(U_3O_8)	mg/l		0.19					7.3
NITRATE	(N)			8.3		11	2.5	1.4	0.1
SPEC. CONDUCTANCE-MICROMHOS				2275		3250	2940	2870	2500
ARSENIC	(As)	mg/l	(ND0.01)	ND		.08	0.2		.02
BORON	(B)	"		0.45		0.4	0.2	0.2	.8
BARIUM	(Ba)	"	(ND0.005)	ND		<0.1	<0.1	<0.1	ND
CADMIUM	(Cd)	"	(ND0.002)	ND		ND	ND	ND	ND
CHROMIUM	(Cr)	"	(ND0.01)	ND		ND	ND	ND	ND
COPPER	(Cu)	"		0.01		.016	<.002	<.002	ND
LEAD	(Pb)	"	(ND0.05)	ND		<.01	<.01	<.01	ND
MANGANESE	(Mn)	"	(ND0.01)	ND		.02	.02	.01	.02
MERCURY	(Hg)	"	(ND0.001)	ND		ND	ND	ND	ND
MOLYBDENUM	(Mo)	"	(ND0.05)	ND		1.8	3.4	2	.7
SELENIUM	(Se)	"	(ND0.01)	ND		0.2	0.2	.15	.0
SILVER	(Ag)	"	(ND0.02)	ND		ND	ND	ND	ND
ZINC	(Zn)	"		0.33		13	.06	.06	.6
VANADIUM	(V_2O_5)	"	(ND0.05)	ND		24			.20
URANIUM	(U)	"					70	28	
VANADIUM	(V)	"				.08	1.4	1.1	
RADIUM p Ci/l				36± 6		50± 16	92± 20	53± 16	36±
GROSS ALPHA p Ci/l				340±20		14300±300	41100±500	19800±400	3000±1
GROSS BETA p Ci/l				33±33		4390±130	12100±200	5850±170	3720±
ANALYST				(1)		(2)	(2)	(2)	(1)

(1) CHEMICAL & GEOLOGICAL LABORATORIES, BOX 2794, CASPER, WYOMING.

(2) SKYLINE LABS, INC., 12090 WEST 50TH PLACE, WHEAT RIDGE, COLORADO.

(3) ACCU-LABS, 11485 W. 48th AVENUE, WHEAT RIDGE, COLORADO.

APERTURE CARD

NUBETH JOINT VENTURE

ANALYSES OF WATER SAMPLES FROM PUSH-PULL TEST WELL NO. 738 R

Also Available on Aperture Card

llons pumped

Second Clean-Up 11/23/76			Third Clean-Up 3/15/77					Fourth Clean-Up 4/13/77		Fifth Clean-Up 4/27/77	
7000 g	8000 g	9000 g	10000 g	11000 g	Start	12000 g	16000 g	21000 g	36000 g	56000 g	72[illegible] g
679	671	703	723	703	805	975	880	828	828	820	826
8	8	8	8	8	6	6.1	5.5	5.4	5.1	4.8	4.3
9	5	5	4	5	8.8	9.2	7.1	7.7	8.6	9.2	9.4
4	3	2	2	2	3.6	3.6	2.8	3.0	3.1	3.4	3.5
740	690	900	925	900	814	903	941	824	983	840	828
18	18	16	16	16	10	14	14	8	10	11	10
108	96	72	96	60	0	0	0	0	0	0	0
671	720	586	561	610	695	676	622	577	583	582	684
1896	1846	1995	2052	1994	1850	1940	1940	1820	1780	1880	1858
32	36	29	26	23	16	16	14	7.6	5.6	4.1	2.1
8.6	8.5	8.5	8.6	8.5	7.7	8.2	8.1	7.2	7.3	7.3	7.4
36	19	7.9	5.2	3.45	3.2	18	4.8	2.4	0.57	0.39	0.32
.08	.03	0.14	.09	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2550	2500	2550	2500	2500	2710	2620	2810	2880	2770	2800	2778
.07	.08	.05	.04	.08	0.03	0.10	0.07	0.06	0.05	0.04	0.02
.70	.75	.61	.68	.70	0.3	0.3	0.4	0.4	0.4	0.4	0.4
ND	ND	ND	ND	ND	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5
ND	ND	ND	ND	ND	0.004	0.004	0.007	0.004	0.005	0.004	0.005
ND	ND	ND	ND	ND	0.01	0.005	0.005	<0.005	<0.005	<0.005	<0.005
ND	ND	ND	ND	ND	<0.005	0.005	<0.005	0.005	0.005	0.005	0.005
ND	ND	ND	ND	ND	0.04	0.02	0.02	0.02	0.02	0.02	0.02
.01	ND	ND	ND	ND	0.08	0.02	0.01	0.02	0.01	0.01	0.01
ND	ND	ND	ND	ND	Tr	Tr	Tr	Tr	Tr	Tr	Tr
1.85	1.10	.70	.55	.40	.26	.44	.19	<0.1	<0.1	<0.1	<0.1
0.20	0.01	.01	ND	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
ND	ND	ND	ND	ND	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
0.09	0.10	.09	.08	.03	0.95	0.10	0.11	0.09	0.13	0.11	0.13
0.60	0.50	0.45	.40	.40	0.02	0.17	0.13	0.33	0.28	0.056	0.040
81± 16	60± 14	45± 8	40± 7	33± 7	23± 4	33± 6	36± 5	38± 7	41± 7	43± 6	44± 7
25400±600	5300±200	2200±100	1180± 60	1200±80	1100±100	21000±500	1400±100	1360±100	490±40	470±40	260±30
13900±200	5200±200	1800±100	1300±100	790±60	600± 50	5100±200	700± 50	470± 50	190±40	150± 4	170±40
(1)	(1)	(1)	(1)	(1)	(3)	(3)	(3)	(1)	(1)	(1)	(1)

9811120207-01

1.2 DESCRIPTION OF THE PROPOSED PROJECT

In situ leaching is basically a simple process. Injection wells and recovery wells arranged in a predetermined pattern are drilled into the uranium bearing ore zone. Leachant solution (chemically-treated formation water) from a mixing tank on the surface is pumped under slight pressure into the ore zone via cased injection wells. Through appropriate perforations in the well casings the leaching solution enters the ore zone where it dissolves the uranium. Under suction, the adequately cased and perforated recovery wells gather the solution containing weakly diluted uranium or leachate. The leachate is pumped from the recovery wells to a surge or storage tank at the surface plant.

At the surface plant leachate from the surge tank is delivered to the ion exchange resin towers, where a special resin selectively extracts the uranium from the leachate which now, devoid of uranium, is piped as barren solution to a mixing tank where proper amounts of sodium carbonate-bicarbonate and hydrogen peroxide or oxygen as oxidizers are again added and the regenerated leaching solution is reinjected into the ground to repeat the cycle. When uranium (uranyl ion) eventually saturates the ion exchange resin the latter is removed from the leachate circuit. Saturated ion exchange resin is stripped of uranyl ion with sodium carbonate. The stripping agent, now rich in uranium is piped to a precipitation plant where additional chemicals (sulfuric acid and hydrogen peroxide) cause the uranium to precipitate into fine solid particles of "yellowcake" (uranium oxide). Excess water is decanted and a water slurry of "yellowcake" is the product of the solution mining process. Minor amounts of surface plant effluent are properly disposed of in adequate solar evaporation storage ponds.

Before the leaching operation is commenced, a baseline for water quality of the aquifers will be established. After the

leaching operation is terminated restoration techniques specific to the test site will be applied in order to restore the aquifer to acceptable baseline water quality level.

The entire process is designed to conform with the requirements of the Nuclear Regulatory Commission, the Environmental Protection Agency and the State of Wyoming Department of Environmental Quality.

1.3 PROJECT SCHEDULE

The pilot test is scheduled to start in the Spring of 1978. Conclusion of the pilot test and aquifer restoration is expected to take place on or about December, 1979.

1.4 PROJECT ORGANIZATION

The project organization is shown in Figure 1. As indicated the Operations Manager will be responsible to Nuclear Dynamics, Inc. - Nubeth Joint Venture.

1.4.1 Minimum Technical Qualifications Required of Operations Supervisory Personnel - Item 10, Form AEC-2

The Operations Manager minimum qualifications will be: a Bachelor's degree in Science or Engineering in the Earth Sciences or directly related fields; eight years experience in uranium and mineral production, with at least three years supervisory experience in mineral production.

Intermediate management positions for Metallurgical Plant and Well Field operation require a Bachelor's degree in Science or Engineering in the appropriate or closely related fields with not less than five years professional experience; for the Chemical Laboratory Supervisor, the requirements would be Bachelor's degree in Chemistry or Chemical Engineering or equivalent with three years of applicable professional experience.

The Resident Geologist and Safety and Licensing Engineer will require Bachelor's degrees in Science or Engineering in the appropriate field with at least two years of professional experience. The Safety and Licensing Engineer will be responsible for the radiation safety program; general health and safety; and licensing.

The Accounting Supervisor will be required to have an accredited college or business school degree in accounting or the equivalent and three years professional experience.

Nuclear Dynamics
Nubeth Join

Operations

Safety & Licensing
(Engineer)

Resident Geologist
(Geologist)

Well Field Supt.
(Mining Engineer)

Technicians

(M

Figur

Proposed Organ

Sundance

In Situ Solutio

APERTURE
CARD

Also Available on
Aperture Card

Manager for
/enture

nager

t. Plant Supt.
allurgical Eng.)

Shift Foremen

Chemical Lab. Supt.
(Chemist)

Technicians

Accounting Supervisor

Clerks

1
ation Chart
oject
Mining Test

9811120207-02

1.5 UNITED STATES PRODUCTION CAPABILITY AND REQUIREMENTS

Production capability and domestic requirements of U_3O_8 for the United States are extensively reviewed in several governmental publications, which, in general predict a deficit in supply beginning in about 1980.

Production from the proposed In Situ Solution Mining Test will not significantly effect supply/demand relationships in the United States. However, if commercial and environmental aspects of the test prove acceptable, then subsequent production will constitute a valuable contribution to the United States domestic energy requirements.

2.0 THE SITE

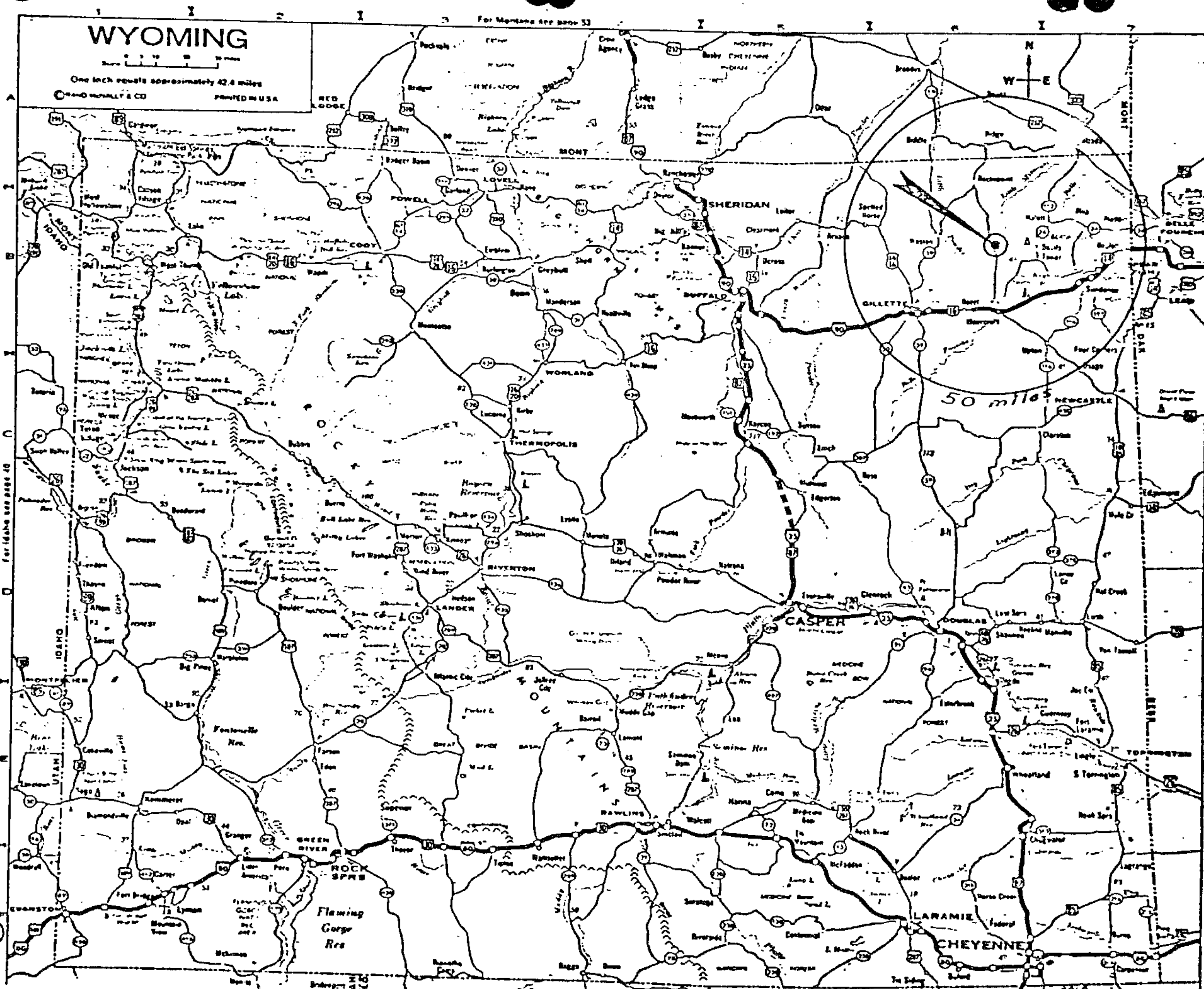
2.1 SITE LOCATION

The proposed test site is located in northeastern Wyoming, approximately 24 miles north of the town of Moorcroft. Figures 2 and 3 show the general location and access to the test area. For reference purposes, the area of interest is referred to as the "Sundance Project." The site is located in Sections 18 and 19, T. 53 N., R. 67 W., 6th P.M. Crook County, Wyoming. Access to the site is by a graded county road, and by approximately one-quarter mile of maintained oil field access road, as shown on Plate 1 (pocket). The mineral rights for the test site are controlled by the Nubeth Joint Venture.

The surface area where the test will be conducted involves approximately five acres. The subsurface area to be leached may involve up to two acres. The proposed plant is a movable type of installation with enclosure for winter operation, which will cover approximately 4800 square feet of the site. Solar evaporation storage ponds will cover approximately an additional 1.2 acres. The well field and parking lot and a minimum of well field access roads constitute the balance of surface installations at the site.

WYOMING
Population: 332,416
(1970 Census)
Area: 97,914 Sq. Miles
Capital: Cheyenne

ties and Towns



⊙ Test Site

FIGURE 2.

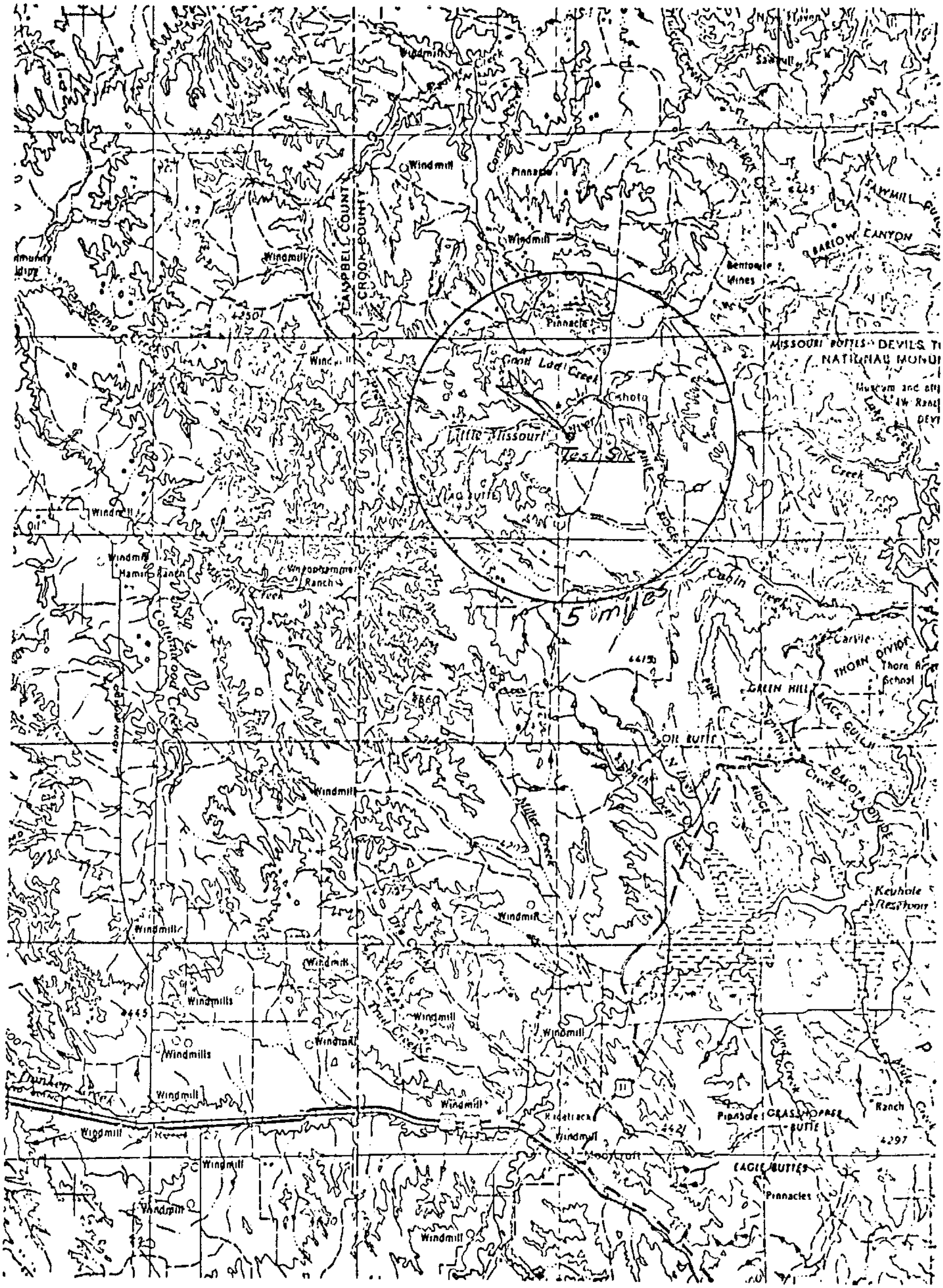


Figure 3. Access Map - from U. S. Geological Survey Topographic Sheet NL 13-11, Gillette, 1:250,000

2.2 REGIONAL DEMOGRAPHY AND LAND USES

Shown on Figure 2 is a 50-mile radius circle centered on the site. The following towns are found within the area covered by the circle:

Moorcroft, (pop. 1,150, 1977, Enclosure 2) and Sundance (pop. 2,500, 1977, Enclosure 2) both of which are in Crook County (area 2,819 square miles, pop. 5,050, Enclosure 2).

Gillette, which is the largest community (pop. 11,200, 1977, Enclosure 2) is in Campbell County (area 4,742 square miles, pop. 20,900).

A portion of the Black Hills National Forest, Devil's Tower National Monument (11 miles east of site) and Keyhole Reservoir and State Park on the Belle Fourche River are found within the 50-mile radius. (Figure 3)

Except for the lands occupied by the National Forest (situated to the east of the National Monument) the area is typical of the northern High Plains rolling grasslands. The land is used principally for grazing cattle and sheep. Some of the land is farmed for wheat, oats, alfalfa and feed grains (Enclosure 2). Mineral production includes coal, oil, gas, bentonite, rock sand and uranium (Enclosure 2 and Ref. 1).

Figure 3 shows a five-mile radius circle centered on the site of the proposed test operation. Approximately 15 persons live within The five-mile radius in various ranch houses. The nearest habitation (2 persons) to the test site is approximately one mile from the site.

The principal land uses for a five-mile radius around the test site are petroleum production and grazing. Burlington Northern, Inc., the petroleum producer in the area, has been informed of our intention to conduct an in situ leach test. By using existing roads and previously disturbed areas, the test will have little impact on grazing. No other minerals of economic value are known to be present in the formations involved in test operations.

ENCLOSURE 2

Moorcroft, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Sundance, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Gillette, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Refers to section 2.2 Regional Demography and Land Uses

(Also sections 2.5.1, 2.5.2)

ENCLOSURE 2

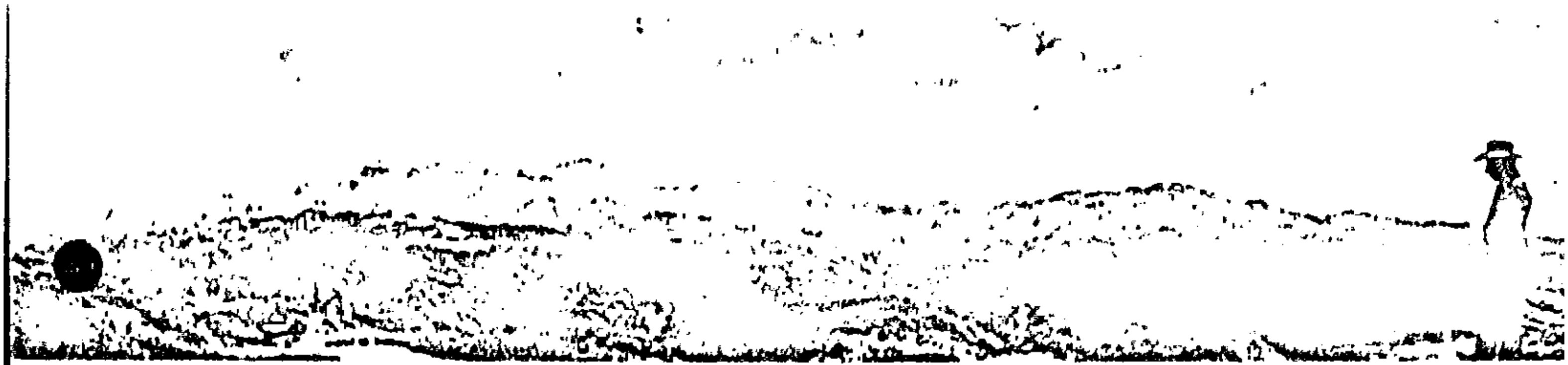
Moorcroft, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Sundance, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Gillette, Wyoming, Community Profile, 1977, Industrial Development Division Department of Economic Planning and Development, Barrett Building, Cheyenne, Wyoming

Refers to section 2.2 Regional Demography and Land Uses

(Also sections 2.5.1, 2.5.2)



MOORCROFT WYOMING
1977 COMMUNITY PROFILE

INDUSTRIAL DEVELOPMENT DIVISION — DEPARTMENT OF ECONOMIC PLANNING AND DEVELOPMENT

Population

	City	County
1970	926	4,535
1975	1,030	4,883
1977 (est.)	1,150	5,050

Climate

Mean daily maximum temperature in:
January 30.3° July 85.9°
Mean monthly temperature in:
January 20.4° July 72.2°

Mean annual precipitation: 10.79 in.
Mean annual snowfall: 40.0 in.

Average annual wind velocity: 8 mph
Average annual relative humidity: 50%
Elevation: 4,206 feet

Civic and Municipal Data

GOVERNMENT
Mayor-Council System
In city limits: 640 acres
Undeveloped: 67% of acreage.
Available for industrial development 300 acres in and around Moorcroft.
Recreational parks - 12.

POLICE FORCE
Police force staff - 3 full time, one part-time. Protection provided to areas outside the city limits by the County Sheriff's office, staff - 3.

ZONING
Planning board recently formulated.

STREETS
26% paved of which 50% have sidewalks and 100% have gutters.

CHURCH
Protestant - 3 Catholic - 1

FIRE DEPARTMENT
28-man volunteer fire department. Outlying areas within 25-mile radius are served by all equipment. Moorcroft fire insurance rating - 9.

HOUSING

No. of Housing Units	County
Single Family	1,219
Multi-Family	66
Mobile Homes	553
Total	1,838
No. Housing Units in Town	362

The estimated cost of a new 3-bedroom home (1,100 sq. ft.), unfinished basement, 1-car garage, located in an area of comparable homes is approximately: $42,500
Average monthly rental (3 bdrm.): $250

RETAIL AND WHOLESALE TRADE — COUNTY
No. of retail establishments: 100
No. of wholesale establishments: 8
Net collection of retail/wholesale sales tax: $24,130

EDUCATION - SCHOOLS

	No. of Schools	No. of Pupils
High School	1	109
Jr. High	1	104
Elementary	1	226
Other	—	—

Sheridan Junior College (131 miles), enrollment - 720.

LIBRARIES
Two with a total of 12,000 volumes.

MEDICAL
Doctors - 2 Medex - 1
Memorial Hospital of Campbell County in Gillette (27 miles west) 31-beds, occupancy rate - 57%.

Moorcroft City Ambulance available.
Crook County Memorial Hospital in Sundance (33 miles), 16 bed, occupancy rate - 7%.
Mental Health Center of Northern Wyoming.

NEWS MEDIA
Newspaper: Moorcroft Leader, weekly, circulation - 550.
Radio: No local broadcasting station. Numerous channels available. KIML (Gillette) KASL (Newcastle) KOLL (Gillette)
Television: No lacal broadcasting statio. Channels available from Casper and Rapid City, S.D. Cable T.V. - summer 1977.

HOTELS AND MOTELS
Hotels: 0 No. of rooms: 0
Motels: 5 No. of rooms: 63

CONVENTION FACILITIES
One convention facility in town with a capacity for 100.

Tax Structure

Assessed Valuation

City	$1,186,149
County	$46,400,074

Tax Levy (in mills)

	1976	1975	1974
City	8.00	8.00	8.00
County	11.79	8.94	10.46
School	44.39	43.03	43.41
Total	64.19	60.01	61.88

Bonded Indebtedness
School - $674,000
City - 115,500
County - 69,000

Net collection of sales tax in county - $459,-394

Total amount of revenue collected by the city in 1976 - $151,868.

Total amount of taxes levied by Crook County for all purposes in 1976 - $2,644,927.

Ratio of assessed valuation to true value - 10%

Wyoming has no state, corporate or individual income tax.

Financial Institutions

BANKS - One
Deposits: $3,490,000
Moorcroft State Bank
Financing for industrial facilities is available through local banks and Wyoming industrial development corporations.

Major Firms

Name	Product	Emp.
Ture Oil Co.	oil	50
Dick's Hot Oil	oil & gas	5
Updike Bros..	oil & gas	25
Texaco, Inc.		20
Atlantic Richfield		20
Nuclear Dynamics		5

Transportation

HIGHWAYS
Federal I 90, US 16, US 14
State Wyo 14, Wyo 16

MOTOR FREIGHT
Ross Transfer, Inc.
Salt Creek Freightways
United Buckingham Freight Lines

RAILROADS
Days goods are in transit to:

Chicago	5	Minneapolis	4
Cleveland	6	New York	8
Dallas	5	Salt Lake City	3
Denver	2	San Francisco	5
Seattle	3	Los Angeles	6
Omaha	3	Kansas City	3

Six trips/day with Burlington Northern. Reciprocal switching is available.

AIR
Nearest airport: Gillette (28 miles)
Runway length: 5,500 feet, asphalt
Commercial service - Trans-American Airways, Dutton Aviation, Star Aviation, Coe-Aire Wyoming

Utilities

MUNICIPAL WATER SOURCE

5 wells
Source capacity: 300,000 gal/day
Peak demand: 216,000 gal/day
Storage capacity: 300,000 gallons
Transmission capacity: 150 gal/min.
Treatment: No treatment required.
Rates
First 2,000 gal/mo. - $4.00/mo.
Next 8,000 gal/mo. - .80/1,000 gal/mo.
Additional - .50/1,000 gal/mo.

SANITATION

Method of disposal: Sanitary landfill
Charge: Residential $2.50/mo.
commercial varies.
Sewer: Lagoon system, single cell.
Rate: Residential - $2.00/mo.
Commercial - First 10,000 - $1.80
based on water usage.

NATURAL GAS

Supplied by: Petrolane-Wyoming Gas Co.

*Rates - Residential & Commercial per therms	per mcf/per month
First 6 therms	$3.55
Next 44	.22
Next 50	.209
Next 100	.19
Next 800	.165
All over 1,000	.146

ELECTRIC POWER

Supplied by: Tri-County Electric Assn.
*Rates - Residential & Commercial

kwh per mo.	per kwh
First 100	5.0¢
Next 900	2.0¢
Next 500	1.5¢
Over 1,500	1.0¢

*Other rate schedules are available.

Labor Market Analysis

LABOR SUPPLY - COUNTY

Labor Force 2,268
Male 1,865 Female 603
Unemployed 63
Male 42 Female 210
Unemployment rate 2.8%

DISTRIBUTION OF LABOR FORCE - COUNTY

	No. of Units	No. of Employees
Agriculture Forestry & Services	27	67
Mining	18	243
Construction	19	194
Manufacturing	9	151
Trans., Commun. & Utilities	8	107
Wholesale Trade	4	8
Retail Trade	48	235
Finance, Ins. & Real Estate	51	26

WAGE RATES (WEEKLY)

	Co. Avg. Wage	State Wage
Agriculture & Forestry	$ 118.93	$ 134.45
Mining	221.69	301.60
Construction	180.89	243.66
Manufacturing	168.03	231.82
Trans., Commun. & Utilities	222.03	244.73
Wholesale Trade	182.27	215.50
Retail Trade	86.18	109.63
Finance, Ins. & Real Estate	148.98	175.28
Services		135.00

TOTAL PAYROLL

April - June 1976

	County
Agriculture Forestry & Services	$ 98,335
Mining	604,456
Construction	301,104
Manufacturing	328,400
Trans., Commun. & Utilities	304,040
Wholesale Trade	15,008
Retail Trade	228,949
Finance, Ins. & Real Estate	47,776

Source: Employment Security Commission

Recreation

CULTURAL ATTRACTIONS
Jubilee Days (July)
Playday (August), rodeos, concerts.

SPORTS
Basketball, tennis, swimming, camping, snowmobiling, boating, fishing, roping, hunting, bowling, skating, and softball.

PUBLIC RECREATION AREAS

Noonan Park	2 acres
Robinson Park	¼ acre
River Park	10 acres
Municipal Swimming Pool	
Keyhole Reservoir	5 miles N
Devils Tower Nat'l Monument	25 miles N

County Resources

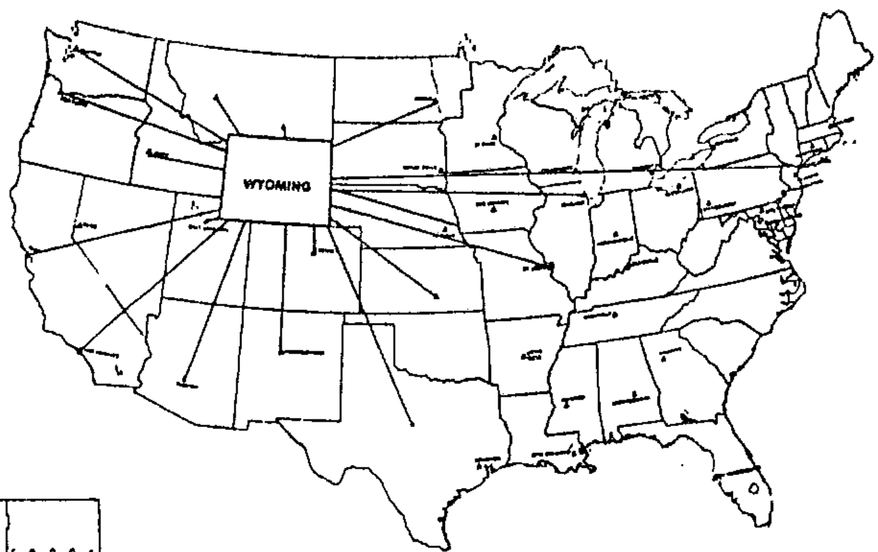
Crook County
MINERALS-oil, bentonite, gas, rock, sand, uranium
Value of net production $25,376,020
FOREST LAND No. of acres: 200,000
MAJOR AGRICULTURAL PRODUCTS-timber, wheat, oats, cattle, alfalfa, barley, sheep
TOTAL NUMBER OF ACRES IN COUNTY: 1,804,338 2,819 sq. miles

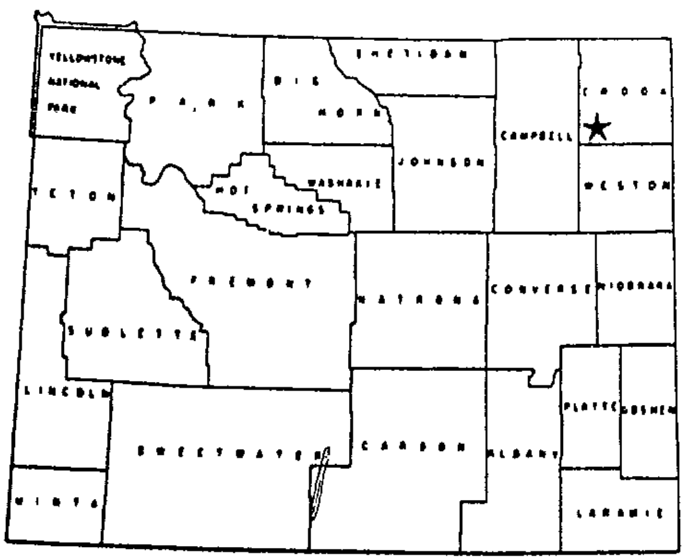
FOR FURTHER INFORMATION CONTACT

Moorcroft Development Corporation
Moorcroft, WY 82721

Industrial Development, DEPAD
Barrett Bldg., Cheyenne, WY 82002
(307) 777-7284

MOORCROFT





Distance in miles from: Moorcroft: to:	
Chicago	1,000
Billings	267
Denver	366
Omaha	759
Seattle	1,100
Casper	192
New York	2,000
Kansas City	900
Los Angeles	1,200
St. Louis	1,000
Salt Lake City	599
Cheyenne	266

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SUNDANCE WYOMING
1977 COMMUNITY PROFILE

INDUSTRIAL DEVELOPMENT DIVISION — DEPARTMENT OF ECONOMIC PLANNING AND DEVELOPMENT

Population

	City	County
1970	1,056	4,535
1975	1,282	4,883
1977 (est.)	2,500	5,050

Climate

Mean daily maximum temperature in:
January 31.1° July 82.8°
Mean monthly temperature in:
January 19.9° July 70.2°

Mean annual precipitation: 14.91 in.
Mean annual snowfall: 77.0 in.

Average annual wind velocity: 7 mph
Average annual relative humidity: 50%
Elevation: 4,750 feet

Average growing season: 110 days

Civic and Municipal Data

GOVERNMENT
Mayor-Council Government
In city limits: 400 acres.
Undeveloped: 20 acres.
Approximately 20 acres available for industrial development in town.

Recreational parks - 2 acres.

POLICE FORCE
Police force staff - 4. Protection provided to areas outside the city limits by the County Sheriff's Office - staff of 4.

ZONING
Territory covered. Municipality Act administered by city council. Industry regulated by classification listing.

STREETS
10% paved all with sidewalks and gutters.

CHURCH
Protestant - 9 Roman Catholic - 1

FIRE DEPARTMENT
15-man volunteer fire dept. Outlying areas served by one pumper truck. Sundance fire insurance rating - 8.

HOUSING

No. of Housing Units	County
Single Family	1,219
Multi-Family	66
Mobile Homes	553
Total	1,838
No. Housing Units in Town	444

The estimated cost of a new 3-bedroom home (1,100 sq. ft.), unfinished basement, 1-car garage, located in an area of comparable homes is approximately: $36,000-38,000
Average monthly rental (3 bdrm.): $200

RETAIL AND WHOLESALE TRADE
No. of retail establishments: 55
No. of wholesale establishments: 8 (county)
Net collection of retail/whls. sales tax (co.) $24,130

EDUCATION - SCHOOLS

No. of Schools		No. of Pupils
High School	1	145
Jr. High	1	133
Elementary	1	247
Other	—	—

Ratio of pupils/teachers: 14.3
Total expended/pupil: $1,901
Sheridan Junior College in Sheridan (164 miles) enrollment - 720.
Black Hills State College (33 miles)

LIBRARIES
One in town

MEDICAL
Doctors - 2 Dentists - 1 Medex - 1
Crook County Memorial Hospital - 16 bed occupancy rate 7%.

Mental Health Center of Northern Wyoming.

NEWS MEDIA
Newspaper: Sundance Times, weekly circulation - 1,659.
Radio: No local broadcasting station. Numerous channels available.
Television: No local broadcasting station. Three channels available.

HOTELS AND MOTELS
Hotels: 1 No. of rooms: 14
Motels: 6 No. of rooms: 106

CONVENTION FACILITIES
Nothern Hills Convention Center - 35 miles. Three located in Newcastle (46 miles) with capacities of 2,000, 1,500 and 400.

Tax Structure

Assessed Valuation
City $1,680,220
County $46,400,074

Tax Levy (in mills)

	1976	1975	1974
City	14.68	19.00	19.51
County	11.79	8.97	9.63
School	44.39	43.03	43.41
Total	70.87	71.01	73.40

Total amount of taxes levied by Crook County for all purposes in 1976 - $2,644,927.

Net collection of sales tax in county - $459,-394.

Ratio of assessed valuation to true value - 25%

Ratio of assessment to actual value for manufacturing plants - 30%.

Wyoming has no state, corporate or individual income tax.

Financial Institutions

BANKS - One
Deposits: $18,449,000
Sundance State Bank

SAVINGS & LOAN ASSOCIATIONS
Plans for one.
Financing for industrial facilities is available through local banks and Wyoming industrial development corporations.

Major Firms

Name	Product	Emp.
Roberts Const. Co.	ready-mix concrete	5-10
Champion Const.	construction	5-10
Sundance Times	newspaper	5
Tri-County Electric Association	power service	37

Transportation

HIGHWAYS
Federal I-90 and US-14
State Wyo 585 and Wyo 116

MOTOR FREIGHT
Salt Creek Freightways
Barber Transport

RAILROADS
Days goods are in transit to:

Chicago	5	Minneapolis	4
Cleveland	6	New York	8
Dallas	5	Salt Lake City	3
Denver	1	San Francisco	5
Seattle	3	Los Angeles	6
Omaha	3	Kansas City	3

Rail service is not available in Sundance Burlington Railroad Serreo Moorcroft (33 miles) and Upton (28 miles).Reciprocal switching is available.

AIR
Airport: Private
Runway length: 2,300 feet, asphalt
Commercial service available in Gillette (60 miles) and Spearfish S.D.(33 miles).

Utilities

MUNICIPAL WATER SOURCE
Well - 2
Source capacity: 706,000 gal/day
Peak demand: 600,000 gal/day
Storage capacity: 315,000 gallons
Transmission capacity: 1,000 gal/min.
Treatment: Chlorination

RATES
First 2,000 gal/mo. - $4.00/mo.
Next 2,000 gal/mo. - 2.50/mo.
Next 15,000 gal. - 60¢/1,000
All add'l gal. - 45¢/1,000

SANITATION
Method of disposal: Sanitary landfill.
Charge: Res,d. - $$5.00
Comm. - $10.00-$15.00
Sewage: Lagoon treatment facility
Rates - Res,d. - $4.00/mo.
Comm. - $4.00 - 6.00/mo.

NATURAL GAS
Natural gas is not available in Sundance. Sources of fuel include propane,fuel oil, coal and electric power.

ELECTRIC POWER
Supplied by: Tri-County Electric Association, Inc.
*Rates - General Service
Demand - over 20 kw billng demand/mo. $1.50/kw
Energy (commercial)
First 100 kwh/mo. - $5.0¢/kwh
Next 100 kwh/mo. - 2.0¢/kwh
Next 1,000 kwh/mo. - 1.75¢/kwh
Next 2,000 kwh/mo. - 1.0¢/kwh

Residential Rates plus 31%
First 100 kwh/mo. - .5¢/kwh
Next 400 kwh/mo. - 1.75¢/kwh
Next 500 kwh/mo - 1.5¢/kwh
All over¢/kwh
plus 31%

*Other rate schedules are available.

Industrial Property

Former Air Force Radar Station - over 40 acres with 70 available buildings, including auditorium and gymnasium. Has its own water supply, sewage system, all utilities and paved roads. 27 houses on station being rented or sold.

Labor Market Analysis

LABOR SUPPLY - COUNTY
Labor Force 2,268
Male 1,865 Female 603
Unemployed 63
Male 42 Female 21
Unemployment rate 2.8%

DISTRIBUTION OF LABOR FORCE - COUNTY

	No. of Units	No. of Employees
Agriculture Forestry & Services	27	67
Mining	18	243
Construction	19	194
Manufacturing	9	151
Trans., Commun. & Utilities	8	107
Wholesale Trade	4	6
Retail Trade	487	235
Finance, Ins. & Real Estate	5	26

WAGE RATES (WEEKLY)

	Co. Avg. Wage	State Wage
Agriculture & Forestry	$ 118.93	$ 134.45
Mining	221.69	301.60
Construction	180.89	243.66
Manufacturing	168.03	231.82
Trans., Commun. & Utilities	222.03	244.73
Wholesale Trade	182.27	215.50
Retail Trade	86.18	109.63
Finance, Ins. & Real Estate	148.98	175.28
Services		135.00

TOTAL PAYROLL
April - June 1976

	County
Agriculture Forestry & Services	$ 98,335
Mining	648,456
Construction	391,164
Manufacturing	328,400
Trans., Commun. & Utilities	304,040
Wholesale Trade	15,008
Retail Trade	228,949
Finance, Ins. & Real Estate	47,776

Source: Employment Security Commission

Recreation

CULTURAL ATTRACTIONS
Devils Tower - geological monument.
Custers expedition Trail
Crook Co. Museum

SPORTS
Golfing, fishing, hunting, boating, swimming, skating, backpacking, camping, and snowmobiling.

PUBLIC RECREATION AREAS
Washington Park (in city)
City Park 2 acres
Golf course - 9 holes, grass greens
Keyhole State Park,
Black Hills National Forest
Bear Lodge Mountain Drive

County Resources

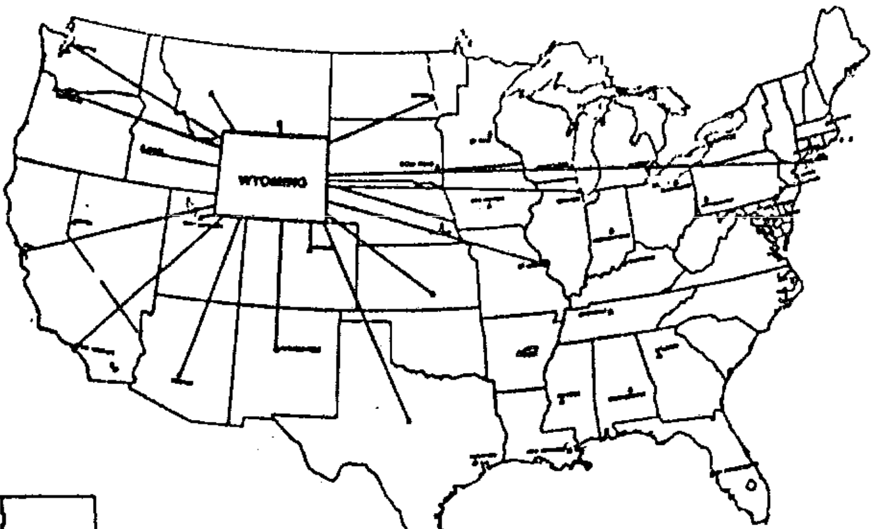
~~Carbon~~ Crook County

MINERALS- oil, bentonite, gas, rock, sand, and uranium
Value of net production $25,376,020
FOREST LAND No. of acres: 200,000
MAJOR AGRICULTURAL PRODUCTS
timber, grains, alfalfa, sheep, beef, and swine
TOTAL NUMBER OF ACRES IN COUNTY: 1,804,338 2,819 sq. miles

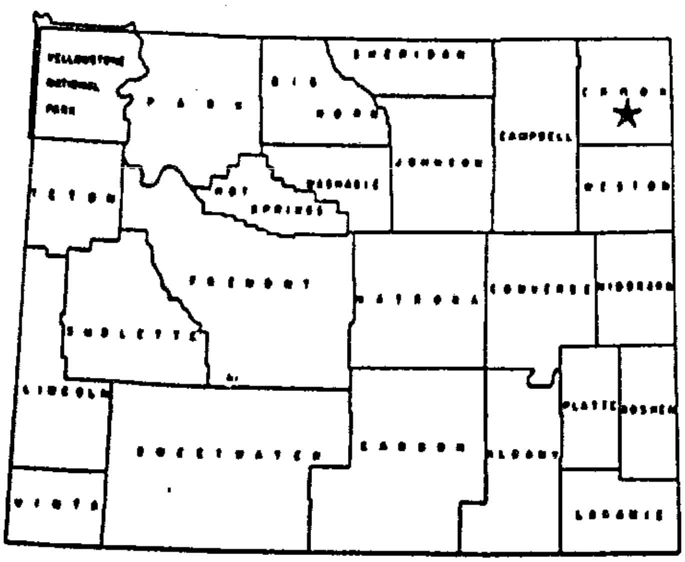
FOR FURTHER INFORMATION CONTACT

Sundance Commercial Club
Sundance, Wyoming 82729

Industrial Development, DEPAD
Barrett Bldg., Cheyenne, WY 82002
(307) 777-7284



SUNDANCE



Distance in miles from: Sundance to:

Chicago	1,046
Billings	300
Denver	366
Omaha	650
Seattle	1,010
Casper	187
New York	1,985
Kansas City	804
Los Angeles	1,359
St. Louis	1,103
Salt Lake City	609
Cheyenne	269

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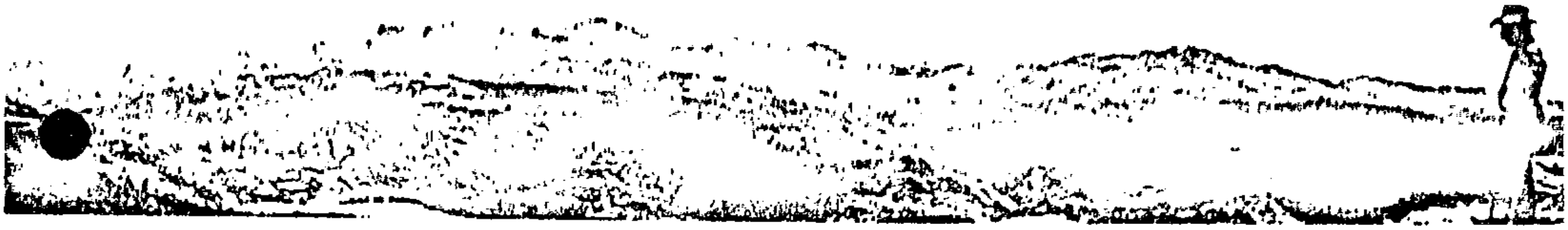


GILLETTE WYOMING

1977 COMMUNITY PROFILE

INDUSTRIAL DEVELOPMENT DIVISION — DEPARTMENT OF ECONOMIC PLANNING AND DEVELOPMENT

Population

	City	County
1970	7,194	12,957
1975	8,215	13,090
1977 (est.)	11,200	20,900

Climate

Mean daily maximum temperature in:
January 32.7° July 87.8°
Mean monthly temperature in:
January 21 5° July 71.7°

Mean annual precipitation: 16.4 in.
Mean annual snowfall: 47.8 in.

Average annual wind velocity: 8 mph
Average annual relative humidity: 45%
Elevation: 4,544 feet

Average growing season: 127 days

Civic and Municipal Data

GOVERNMENT

Mayor-Council System
In city limits: 3,010 acres
Undeveloped - 35% of acreage
Industrial - 160 acres
Commercial (approx.) - 117.2 acres
Numerous acres in an around city available for industrial development.

POLICE FORCE

Police force staff - 42, police officers - 30. Protection provided to areas outside the city limits by the County Sheriff's office, staff - 22.

ZONING

Territory covered by municipality, county with 5 x 6 mile area - county wide subdivision ordinance. Act administered by City-County Joint Planning Commission.

STREETS

75% paved and improved of which 50% have sidewalks and 75% gutters.

CHURCH

Protestant - 15 Catholic - 1 Other - 3

FIRE DEPARTMENT

29-man volunteer fire department (25 volunteer, 4 professionals). Outlying areas served by Campbell County fire department. Gillette fire insurance rating - 7.

HOUSING

No. of Housing Units	City	County
Single Family	1,497 (41%)	1,998
Multi-Family	650 (17%)	665
Mobile Homes	1,416 (39%)	2,384
Total	3,575	5,047

The estimated cost of a new 3-bedroom home (1,100 sq. ft.), unfinished basement, 1-car garage, located in an area of comparable homes is approximately: $45,000
Average monthly rental (3 bdrm.): $375
Eight housing projects planned or already under construction.

RETAIL AND WHOLESALE TRADE

No. of retail establishments: 450 (est.)
Amount of retail sales: $92 million (est.)
No. of wholesale establishments: 10
Net collection of retail/wholesale sales tax (co.): $290,696

EDUCATION - SCHOOLS

	No. of Schools	No. of Pupils
High School	1	784
Jr. High	1	937
Elementary	7	2,032
Other	Gillette Day Training Center	85

ENCLOSURE 2c

Ratio of pupils/teachers: 13.3
Total expended/pupil: $2,716
Sheridan Junior College (103 miles), enrollment 720

LIBRARIES
One library with a total of 31,000 volumes.
Permanent art collection.
Inter-library service.

MEDICAL
Physicians-12 Dentists-4 Optometrists-3
Memorial Hospital - 31 bed, occupancy rate - 57%.
Pioneer Manor Nursing Home - 120-bed, occupancy rate - 90%.

NEWS MEDIA
Newspaper: Gillette News Record, daily (Mon.-Fri.), circulation - 5,200. The Advertiser, weekly, circulation - 10,000
Radio: KIML - 6am - 12midnight
KOLL - FM - 24 hr/day
Television: KTWO (Casper) KOTA & KEVN (Rapid City, S.D.). No local broadcasting station.

HOTELS AND MOTELS
Hotels: 3 No. of rooms: 59
Motels: 12 No. of rooms: 433

CONVENTION FACILITIES
Five convention facilities with a capacity of largest three: 400, 250, 100.

Tax Structure

Assessed Valuation
City $13,503,334
County $304,739,720

Tax Levy (in mills)

	1976	1975	1974
City	7.50	7.50	8.00
County	14.68	10.77	16.26
School	44.96	35.33	38.05
Total	67.15	53.60	62.31

Bonded Indebtedness
County - $ 28,000.00
School - 7,220,000.00
City - 2,491,828.28
Campbell County
Hospital District - 8,850,000.00

Total amount of revenue collected by the city in 1976 - $4,003,366.93
Taxes only - $101,000.00
Total amount of revenue collected by the county in 1976 - $16,688,044.37
Property tax balance: minerals 80% services 5% city property 4% and rural property 11%
Local tax revenue per capita - $841.53
Wyoming has no state, corporate or individual income tax.

Financial Institutions

BANKS - Three
Deposits: $104,699,087
Total Assets: $112,897,761

SAVINGS & LOAN ASSOCIATIONS -Two
Deposits - $5,665,000 (est.)

Financing for industrial facilities is available through local banks and Wyoming industrial development corporations.

Major Firms

Name	Product	Emp.
Exeter Drilling	well drilling	200-250
Amax Coal Co.	coal	240
Getter Trucking	oil field service	85
Kerr-McGee Coal Corp.	coal	88
Morrison-Knudson	construction	175-200
Wyodak & Black Hills Power & Light	coal & electricity	65
Thunder Basin	coal	54
Carter Mining	coal	79
Farmers Co-Op	Range feed	53
Cordero	coal	81
Dunbar Well Service	oil field service	55

Transportation

HIGHWAYS
Federal Interstate 90 U.S. 14 & 16
State Wyo 59 and Wyo 50

MOTOR FREIGHT
BN Transport
Ross - Nebraska
Barber Transportation
International Transport
Salt Creek Freightways
United Buckingham Freightways

RAILROADS
Days goods are in transit to:

Chicago	5	Minneapolis	4
Cleveland	8	New York	8
Dallas	5	Salt Lake City	3
Denver	2	San Francisco	5
Seattle	3	Los Angeles	6
Omaha	3	Kansas City	3

Burlington Northern Railroad - 2 trips per day.
Other
Continental Trailways Bus, United Parcel Service

AIR
Airport: Gillette Campbell County Airport

Runway length: 5,500 feet, asphalt
Commercial service: Trans-American Airways, Dutton Aviation, Star Aviation, Coe-Aire Wyoming

Industrial Property

100 acre area in town available for industrial development.
150 acre site outside city limits.

Utilities

MUNICIPAL WATER SOURCE
28 Wells

Source capacity: 3.0 million gal/day (est.)
Peak demand: 3.0 million gal/day
Storage capacity: 6 million gallons
Transmission capacity: 2.5 million gal/day
Treatment: Lime softening, electrodialyosis
Hardness: 150 milograms/liter
Rates:
Residential
First 3,000 gals - $4.00
Next 7,000 gals - .75/1000
Next 10,000 gals - .70/1000
Next 10,000 gals - .65/1000
Over 30,000 gals - .60/1000
Industrial
First 3,000 gals - $6.00
Next 7,000 gals - .80/1000
Next 20,000 gals - .75/1000
Next 20,000 gals - .70/1000
Over 50,000 gals - .55/1000

SANITATION

Method of disposal: Landfill
Charge: $4.00 - 88./mo.
Sewer: Activated sludge treatment
Present Load: 1.5 million gal./day
Usage charge: $2.00/mo.

NATURAL GAS

Supplied by: Petrolane-Wyoming Gas Service
Supply unlimited 10.5 - 11 BTU/Cu. ft.
*Monthly Rate (1 therm =11,040 BTU/cu.ft.)

	average cost/therm
First 6	$4.02
Next 44	.243
Next 50	.240
Next 100	.219
Next 800	.20
Next 1,000	.168

Fuel oils - #1 fuel oil - 44.7¢/gal.
Propane gas - available for bulk - 26¢/gal (est. 1976)

ELECTRIC POWER

Supplied by Black Hills Power & Light
City of Gillette serves as City Utility Co.

*Monthly Rates - Residential	
First 10 kwh	$1.00
Next 90 kwh	4.0¢/kw
All add'l kwh	3.25¢/kw
Commercial Rate	
20 kwh	$1.00
Next 480	4¢/kwh
Next 2,000	3¢/kwh
All add'l	2.25¢/kwh

*Other rate schedules are available.

Labor Market Analysis

LABOR SUPPLY - COUNTY

Labor Force 7,916
Male 5,911 Female 2,005
Unemployed 268
Male 159 Female 84
Unemployment rate 3.4%

DISTRIBUTION OF LABOR FORCE - COUNTY

	No. of Units	No. of Employees
Agriculture Forestry & Services	124	865
Mining	104	1601
Construction	152	1757
Manufacturing	9	93
Trans., Commun. & Utilities	54	479
Wholesale Trade	40	225
Retail Trade	122	1392
Finance, Ins. & Real Estate	26	183

WAGE RATES (WEEKLY)

	Co. Avg. Wage	State Wage
Agriculture & Forestry	$ 157.95	$ 134.45
Mining	316.18	301.60
Construction	261.34	243.66
Manufacturing	240.33	231.82
Trans., Commun. & Utilities	274.84	244.73
Wholesale Trade	246.07	215.50
Retail Trade	121.08	109.63
Finance, Ins. & Real Estate	175.70	175.28
Services		135.00

TOTAL PAYROLL

April - June 1976	County
Agriculture Forestry & Services	$ 1,692,374
Mining	6,245,012
Construction	5,432,490
Manufacturing	291,611
Trans., Commun. & Utilities	1,700,738
Wholesale Trade	698,449
Retail Trade	2,078,368
Finance, Ins. & Real Estate	402,020

Source: Employment Security Commission

Recreation

CULTURAL ATTRACTIONS

Gillette Cowboy Days Rodeo, County Museum, Community Concerts, Little Levi Rodeo, Campbell County Fair, Weltner's Wonder Museum and Buffalo Ranch, Community Theatre & Rockpile Museum.

SPORTS

County Recreation Department provides: basketball, swimming, baseball, tennis, archery, gymnastics, bowling, football and skiing. Hunting , fishing, snowmobiling, horse back riding, camping and skating.

PUBLIC RECREATION AREAS

Fishing Park	59 acres
Tennis, Baseball Parks	32 acres
City Park	2.2 acres
Municipal Swimming Pool	outdoor
County Recreation Center	indoor swimming pool
Key Hole State Park	40 miles E
Big Horn Nat'l Forest	75 miles W
Undeveloped Park Lands	61.6 acres
Bicentennial Park	68 acres

County Resources

Campbell County

MINERALS- oil, coal, gas

Value of net production $241,758,637

MAJOR AGRICULTURAL PRODUCTS- cattle, sheep, wheat, alfalfa, feed grains

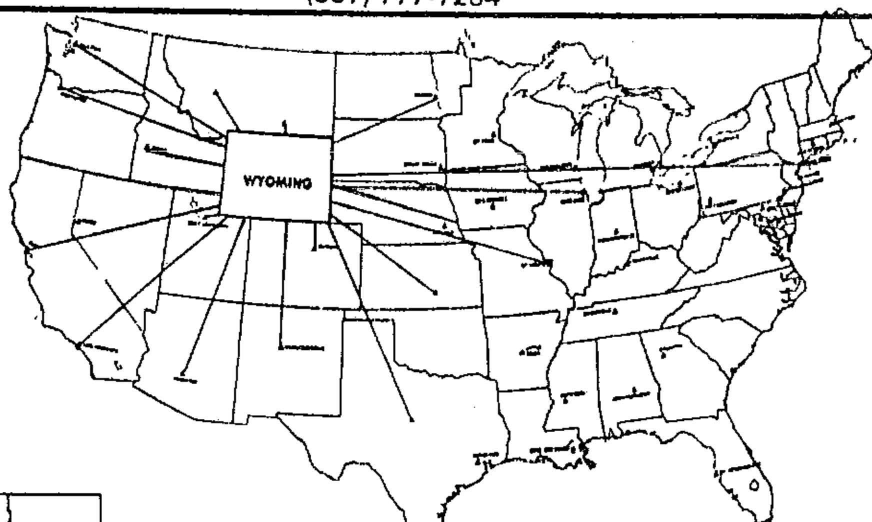
TOTAL NUMBER OF ACRES IN COUNTY: 3,034,614 4,742 sq. miles

FOR FURTHER INFORMATION CONTACT

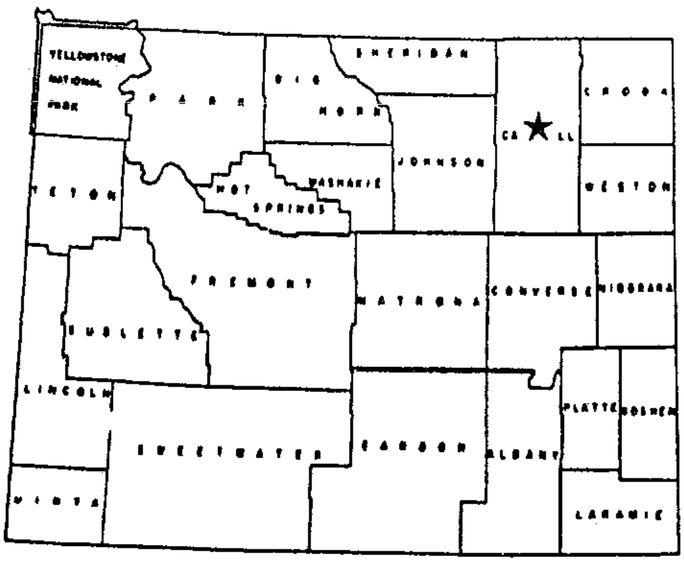
Campbell County Chamber of Commerce
Box 1006, Gillette, WY 82716
(307) 682-3673

City-County Department of Planning and Development
Box 540, Gillette, WY 82716
(307) 686-2222 ext. 44

Industrial Development, DEPAD
Barrett Bldg., Cheyenne, WY 82002
(307) 777-7284



GILLETTE



Distance in miles from: Gillette to:

Chicago	1,147
Billings	239
Denver	339
Omaha	737
Seattle	1,085
Casper	130
New York	1,887
Kansas City	892
Los Angeles	1,284
St. Louis	1,142
Salt Lake City	535
Cheyenne	239

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2.3 REGIONAL HISTORIC, SCENIC, CULTURAL AND NATURAL LANDMARKS

According to the Wyoming State Archives and Historical Department, the site location will not adversely affect any historic sites in the area. The Texas Trail which is the general route that was followed by cattle herds from Texas in the 1880's lies well to the south from the site (Enclosure 3, correspondence and map.).

No prehistoric or historical cultural remains are known to exist at the site. If any cultural or significant paleontological evidence is exposed during any excavation or other similar work at the site, such activity will be delayed until a qualified archaeologist has examined the evidence.

There are no Scenic or Natural Landmarks at the proposed site.

ENCLOSURE 3

Letter and map from John C. Paige, Senior Historian,
Historical Research and Publications Division,
State of Wyoming

Refers to section 2.3 Regional Historic, Scenic,
Cultural and Natural Landmarks

ENCLOSURE 3

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming State Archives and Historical Department

HISTORICAL RESEARCH AND PUBLICATIONS

BARRETT BUILDING CHEYENNE, WYOMING 82002

KATHERINE A. HALVERSON
DIVISION DIRECTOR

WILLIAM H. WILLIAMS
DIRECTOR

November 18, 1977

Ms. Sue McCullough
Nuclear Dynamics
P.O. Box 20766
Phoenix, Arizona 85036

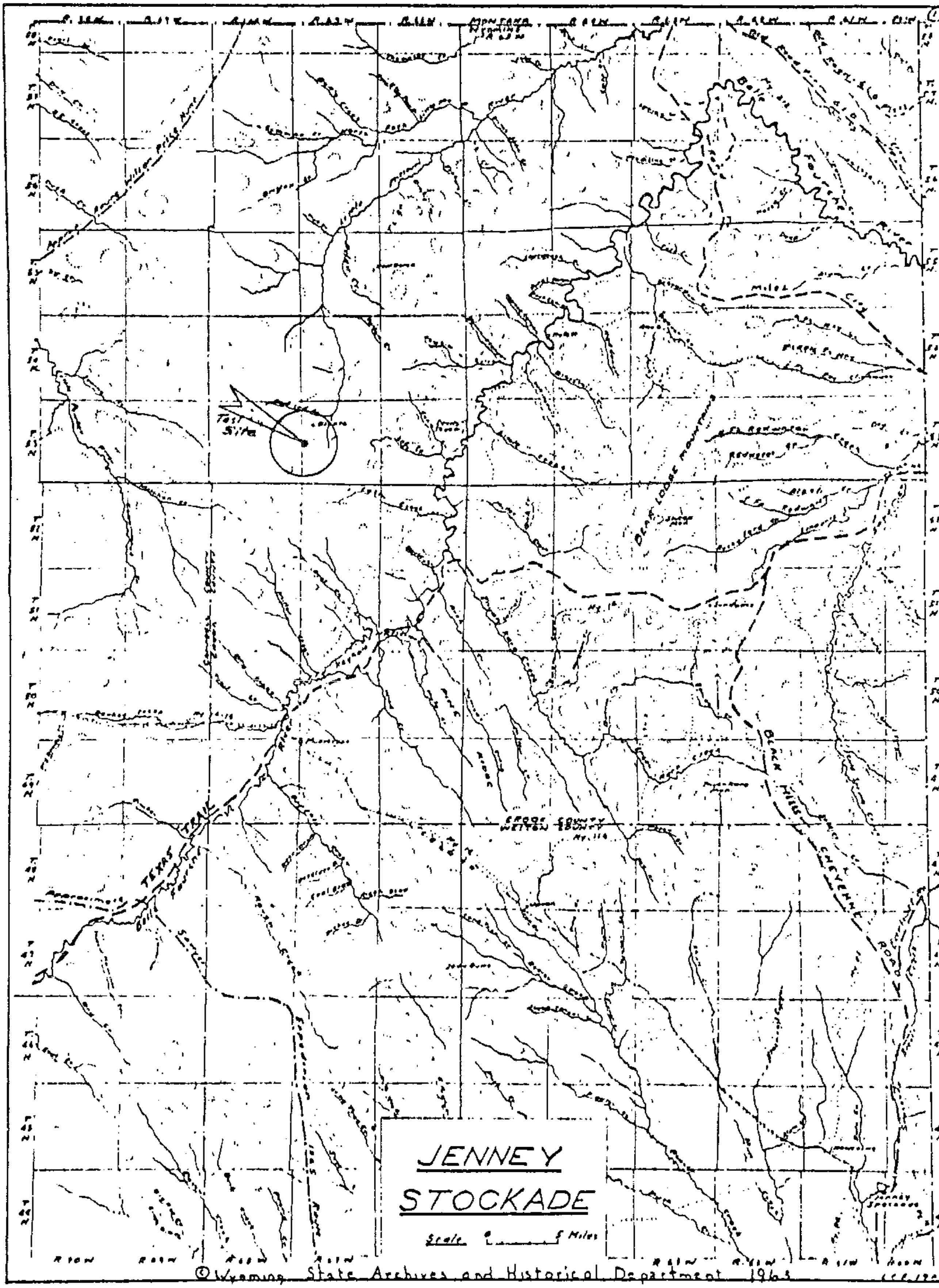
Dear Ms. McCullough:

According to our records the proposed exploration work in the area of Township 50-55 North and Ranges 67-69 West will not adversely affect any historic sites or trails in the area with the possible exception of the Texas Trail.

Sincerely,

John C. Paige
Senior Historian,
Historical Research
and Publications Division

JCP:bp


JENNEY
STOCKADE
Scale
5 Miles
Test Site
TEXAS TRAIL
BLACK HILLS CHEYENNE ROAD
BEAR LODGE MOUNTAINS
CROOK COUNTY
WESTON COUNTY
Jenney Stockade

2.4 ECOLOGY

A study of vegetation and animal life at the test site area was conducted by Camp Dresser & McKee Inc., Environmental Sciences Division, 11455 West 48th Avenue, Wheatridge, Colorado 80033 (Enclosure 4).

2.4.1 Vegetation

The test site is in an area typical of rolling upland grasslands in the northern Great Plains. The elevation at the test site is approximately 4,240 feet and maximum relief in the area is approximately 300 feet. Soil types in the area are sand, sandy loam and clay.

Vegetation consists mostly of Junegrass, Blue Grama, Buffalo Grass, with Prairie Sandreed, Silvery Lupine on moister slopes and Needle-and-thread, Red Three-awn on some drier slopes and Wheatgrasses and Bluegrasses scattered throughout with or without Sagebrush. Approximately 70-85 per cent of the area is covered with this type of vegetation and the remainder with wet lowland or disturbed area vegetation. (Enclosure 4)

2.4.2 Wildlife

Animal species of the area are typical of the mixed grass prairie environment.

Birds observed include sparrows, larks, blackbirds, doves, swallows, nighthawk; various falcons and hawks (Enclosure 4). Also seen in the area are golden eagles, great horned owls and, rarely, bald eagles.

Mammals observed are typical of the environment and include jackrabbits, cottontails, ground squirrels, foxes, badgers and skunks (Enclosure 4). In addition pronghorn antelope, deer, Ref. 2) coyotes and various field mice, gophers, shrews and bats are known to occur in the general area. (Enclosure 5)

A small livestock watering dam known as Oshoto Reservoir which is located approximately 3000 feet north of the test site collects intermittent runoff and provides a habitat for waterfowl such as mallards, teals, grebes, pintails and herons as well as frogs (Enclosure 4) and other amphibians and reptiles. No fish are understood to be present.

ENCLOSURE 4

Report, Uranium Test Site Near Moorcroft, Wyoming -
Camp Dresser & McKee Inc., Environmental Engineers,
Scientists, Planners and Management Consultants

Refers to sections 2.4, 2.4.1, 2.4.2

environmental engineers, scientists, planners and management consultants

11455 West 48th Avenue
Wheat Ridge, CO 80033
(303) 422-0469

August 8, 1977

Al Stoick
Nuclear Dynamics
200 South Lowell
Casper, Wyoming 82601

Dear Mr. Stoick:

Enclosed is the report resulting from my recent field trip to your uranium test site near Moorcroft, Wyoming. Although no one-time species list can ever be considered complete, I feel confident that few species -- and certainly no major ones -- were overlooked.

Based on my previous conversations with the WDEQ, these data should be more than adequate to accompany your present permit application. If and when additional studies are required, such as vegetation maps, Based on my previous conversations with the WDEQ, these data should be more than adequate to accompany your present permit application. If and when additional studies are required, such as vegetation maps, plant productivity, animal breeding densities, etc., please contact either David White or me.

We have enjoyed working with you and look forward to future involvement on this or other Nuclear Dynamics projects.

Sincerely,

Allen B. Crockett

Allen B. Crockett, Ph.D.

ABC/kt

Enclosure

The Nuclear Dynamics test site is located in the northeastern Powder River Basin, approximately 24 miles north of Moorcroft, Crook County, Wyoming (Section 18 and 19, T 53 N, R 67 W). In general, the site is in an area of gently rolling uplands underlain by Upper Cretaceous Lance strata. The uplands are dissected by small drainages which are tributaries to Oshoto Reservoir.

The vegetation of the site is typical of western high plains mixed-grass prairie of the region. Uplands, especially hilltops, were dominated by Prairie Junegrass (*Koeleria cristata*), Blue Grama (*Bouteloua gracilis*), and Buffalo Grass (*Buchloe dactyloides*) turf interspersed with a variety of common forbs, such as Yellow Owl-clover (*Orthocarpus luteus*), Purple Prairie-clover (*Dalea purpurea*), Blazing Star (*Liatris punctata*), Golden-aster (*Heterotheca villosa*), Ironplant Goldenrod (*Haplopappus spinulosus*), Purple-headed Coneflower (*Echinacea angustifolia*), Prairie Coneflower (*Ratibida columnifera*), Yarrow (*Achillea lanulosa*), Silver Scurfpea (*Psoralea argophylla*), Milkvetch (*Astragalus* cf. *bisulcatus*), Silver Loco (*Oxytropis* cf. *sericea*), Winter or Prairie Sage (*Artemisia frigida*), and a variety of less abundant species (see complete species list appended to this report).

Apparently slightly less severe sites, perhaps in areas of snow accumulation or greater shade, were similar to hilltops but varied by having increased abundance of Prairie Sandreed (*Calamovilfa longifolia*), Green Needlegrass (*Stipa viridula*), Bluegrass (*Poa canbyi* and *Poa secunda*), Slimflower Scurf-pea (*Psoralea tenuiflora*), Silvery Lupine (*Lupinus argenteus*), Goldenrod (*Solidago* spp.), and Pasture Sage (*Artemisia ludoviciana*).

Apparently slightly more severe sites, with southwesterly exposures, greater drainage, or sandier substrata, varied from hilltops in having Needle-and-thread (*Stipa comata*), Indian Ricegrass (*Oryzopsis hymenoides*), Red Three-awn (*Aristida longiseta*), Plains Muhly (*Muhlenbergia cuspidata*), Skeletonweed (*Lygodesmia juncea*), Globe Mallow (*Sphaeralcea coccinea*), and Cut-leaf Evening Primrose (*Oenothera coronopifolia*).

In addition were scattered occurrences throughout the three above-mentioned upland mixed-grass areas of Big Sagebrush (Artemisia tridentata), Gardner Saltbrush (Atriplex gardneri), Rubber Rabbitbrush (Chrysothamnus nauseosus), Broom Snakeweed (Gutierrezia sarothrae), Small Soapweed (Yucca glauca), Prickly Pear (Opuntia polycantha), Greasewood (Sarcobatus vermiculatus), and Silver Sagebrush (Artemisia cana). The latter two species were generally restricted to arroyos or other drainages.

Also present throughout the mixed-grass areas, but nowhere abundant, were Montana Wheatgrass (Agropyron albicans), Desert Wheatgrass (Agropyron desertorum), Western Wheatgrass (Agropyron smithii), Slender Wheatgrass (Agropyron trachycaulum and Agropyron trachycaulum ssp. majus), and Bearded Wheatgrass (Agropyron trichophorum).

Wetlands were of three basic types: grass/sedge, forb/shrub, and rooted aquatics. The grass/sedge wetlands were variously dominated by Big Bluestem (Andropogon gerardii), Timothy (Phleum pratense), Alkali Muhly (Muhlenbergia asperifolia), Nuttall Alkaligrass (Puccinellia nuttalliana), Redtop (Agrostis cf. gigantea), Northern Reedgrass (Calamagrostis cf. inexpansa), Smooth Brome (Bromus inermis), Threadleaf Sedge (Carex filifolia), Sedge (Carex xerantica), Rush (Juncus interior), American Bulrush (Scirpus americanus), and Longstem Spikerush (Eleocharis macrostachya). A variety of forbs were present but never dominant. These included Harebell (Campanula rotundifolia) and Clover (Trifolium sp.)

Forb/shrub wetlands generally were comprised of Western Snowberry (Symphoricarpos occidentalis), Wild Rose (Rosa sp.), Poison Ivy (Toxicodendron radicans), Curly-leaf Dock (Rumex crispus), Horsemint (Monarda fistulosa var. menthaefolia), Field Mint (Mentha arvensis), Milkweed (Asclepias speciosa and Asclepias pumila), Sunflower (Helianthus maximiliani and Helianthus rigidus var. subrhomboideus), Blue Lettuce (Lactuca tataria ssp. pulchella), Canada Thistle (Cirsium arvense), Bull Thistle (Cirsium vulgare), Yellow Thistle (Cirsium ochrocentrum), Wild Licorice (Glycyrrhiza lepidota), and Cocklebur (Xanthium strumarium), in addition to various wetland graminiforms. One lone Chokeberry (Prunus virginiana

var. *melanocarpa*) was present on the site.

Rooted aquatics included Cattail (*Typha latifolia*) and Arrow-head (*Sagittaria* cf. *latifolia*) along the reservoir itself, or in isolated puddles in adjacent tributaries.

Disturbed areas were dominated by weedy forbs and grasses, such as Ragweed (*Ambrosia psilostachya* and *Ambrosia trifida*), Pigweed (*Amaranthus retroflexus*), Lambsquarters/Goosefoot (*Chenopodium album*, *Chenopodium incanum* and *Chenopodium leptophyllum*), Russian-thistle (*Salsola iberica*), Fireweed Summer-cypress (*Kochia scoparia*), Knotweed (*Polygonum aviculare* and *Polygonum ramossisimum*), Black Medic (*Medicago lupulina*), Buttonweed Mallow (*Malva neglecta*), Prickly Lettuce (*Lactuca serriola*), Common Sunflower (*Helianthus annus*), Curlycup Gumweed (*Grindelia squarrosa*), Salsify (*Tragopogon* sp.), Dandelion (*Taraxacum officinale*), Plantain (*Plantago patagonica*), and a variety of mustards (*Allyssum*, *Lepidium*, *Sisymbrium*, and *Thlaspi*), as well as the thistles (*Cirsium*) listed above. Weedy grasses were Foxtail Barley (*Hordeum jubatum*), especially in moister sites, and Cheatgrass or Downy Brome (*Bromus tectorum*) and Japanese Brome (*Bromus japonicus*), especially on drier sites. Disturbed areas were primarily restricted to roads, buildings, or old drill sites and comprised a small percentage of the total area.

Domestic species whose presence probably is related, at least originally, to revegetation efforts included Yellow Sweetclover (*Melilotus officinalis*), Alfalfa (*Medicago sativa*), and Smooth Brome (*Bromus inermis*). These species were scattered throughout the site but were never dominant.

In summary, most of the site was covered by a well-developed turf of Junegrass, Blue Grama, and Buffalo Grass, with Prairie Sandreed and Silvery Lupine dominant on moister slopes, with Needle-and-thread and Red Three-awn dominant on some drier slopes, and with Wheatgrasses and Bluegrasses scattered throughout. This broad vegetation type, with or without Sagebrush, comprised 70 - 85 percent of the rolling landscape. The remaining 15 - 30 percent was divided between wet lowlands with grass/sedge, forb/shrub, or rooted aquatic dominants, and weedy disturbed areas.

Animals of the site were typical of mixed grass prairie and included Brewer's Sparrow (Spizella breweri), Vesper Sparrow (Pooecetes gramineus), Lark Sparrow (Chondestes grammacus), Savannah Sparrow (Passerculus sandwichensis), Le Conte's Sparrow (Passerherbulus caudacutus), Lark Bunting (Calamospiza melanocorys), Horned Lark (Eremophila alpestris), Western Meadowlark (Sturnella neglecta), Sage Thrasher (Oreoscoptes montanus), Mourning Dove (Zenaidra macroura), and Brewer's Blackbird (Euphagus cyanocephalus) in grasslands; Red-winged Blackbird (Agclaius phoeniceus), Song Sparrow (Melospiza melodia), and common Yellowthroat (Geothlypis trichas) in wetlands; Great Blue Heron (Ardea herodias), Mallard (Anas platyrhynchos), Pintail (Anas acuta), Gadwall (Anas strepera), American Widgeon (Anas americana), Blue-winged Teal (Anas discors), Green-winged Teal (Anas carolinensis), and Horned Grebe (Podiceps auritus) in standing water; and Cliff Swallow (Petrochelidon pyrrhonota), Barn Swallow (Hirundo rustica), Common Nighthawk (Chordeiles minor), Eastern Kingbird (Tyrannus tyrannus), Say's Phoebe (Sayornis saya), Loggerhead Shrike (Lanius ludovicianus), American Kestrel (Falco spaverius), Prairie Falcon (Falco mexicanus), Rough-legged Hawk (Buteo lagopus), Red-tailed Hawk (Buteo jamaicensis), and Marsh Hawk (Circus cyaneus) across the site. In addition, numerous shorebirds, primarily Tringa and Calidris species were present in migratory flocks.

Mammals observed were White-tailed Jackrabbit (Lepus townsendii), Cottontail (Sylvilagus sp.), Thirteen-lined Ground Squirrel (Spermophilus tridecemlineatus), Red Fox (Vulpes vulpes), Badger (Taxidea taxus), and Striped Skunk (Mephitis mephitis). Shrews, bats, gophers, mice, voles, coyotes, deer, and pronghorn antelope are presumed to occur as well but were not seen.

The only amphibian seen was the Leopard Frog (Rana pipiens); numerous reptiles and other amphibians undoubtedly are present also. The ichthyofauna of water bodies was not surveyed.

Table 1 - Vegetation by Life-form of the Nuclear Dynamics Test Site, July 1977

ANNUAL FORBS

Scientific Name	Common Name
Alyssum desertorum	Desert Alyssum
Amaranthus retroflexus	Redroot Pigweed
Ambrosia psilostachya	Ragweed
Ambrosia trifida	Giant Ragweed
Chenopodium album	Lambsquarters
Chenopodium incanum	Goosefoot
Chenopodium leptophyllum	Narrowleaf Goosefoot
Cleome serrulata	Rocky Mountain Beeplant
Helianthus annus	Common Sunflower
Kochia scoparia	Fireweed Summer-cypress
Lactuca serriola	Prickly Lettuce
Lepidium densiflorum	Prairie peppergrass
Malva neglecta	Buttonweed
Medicago lupulina	Black Medic
Orthocarpus luteus	Yellow Owl-clover
Plantago patagonica	Wooly Plantain
Polygonum aviculare	Prostrate Knotweed
Polygonum ramossisimum	Upright Knotweed
Salsola iberica	Russian-thistle
Sisymbrium altissimum	Tumbling Hedgemustard
Thlaspi arvense	Pennycress
Xanthium strumarium	Cocklebur

ANNUAL GRAMINIFORMS

Bromus japonicus	Japanese Brome
Bromus tectorum	Downy Brome, Cheatgrass

Table 1 - Vegetation by Life-form of the Nuclear Dynamics Test Site, July 1977, Continued

BIENNIAL FORBS

Scientific Name	Common Name
Cirsium arvense	Canada Thistle
Cirsium ochrocentrum	Yellow Thistle
Cirsium vulgare	Bull Thistle
Erigeron strigosus	Daisy Fleabane
Grindelia squarrosa	Curlycup Gumweed
Melilotus officinalis	Yellow Sweetclover
Tragopogon sp.	Salsify

PERENNIAL FORBS

Scientific Name	Common Name
Achillea l. nulosa	Yarrow
Antennaria	Pussytoes
Arnisa fulgens	Arnica
Artemisia frigida	Winter or Prairie Sage
temisia ludoviciana	Pasture Sage
Asclepias pumi a	Low Milkweed
Asclepias specios	Showy Milkweed
Aster commutatus	Aster
Aster ericoides	Aster
Astragalus sp.	Milkvetch
Astragalus cf. *bisulcatus*	Milkvetch
Campanula rotundifolia	Harebell or Bluebell
Dalea purpurea	Purple Prairie-clover
Echinacea angustifolia	Purple-headed Coneflower
Erigeron pumilus	Low Daisy
Eriogonum alatum	Buckwheat
Glycyrrhiza lepidota	Wild Licorice
Gutierrezia sarothrae	Broom Snakeweed
Haplopappus spinulosus var. *spinulosus*	Ironplant Goldenrod
Helianthus maximiliani	Sunflower
Helianthus rigidus var. *subrhomboideus*	Sunflower

Table 1 - Vegetation by Life-form of the Nuclear Dynamics Test Site, July 1977, Continued

PERENNIAL FORBS (cont.)

Scientific Name	Common Name
Heterotheca villosa	Golden-aster
Lactuca tataria ssp. *pulchella*	Large-flowered Blue Lettuce
Linum lewisii	Wild Blue Flax
Lupinus argenteus	Silvery Lupine
Lygodesmia juncea	Skeletonweed
Medicago sativa	Alfalfa
Melandrium drummondii	Drummond Campion
Mentha arvensis	Field Mint
Monarda fistulosa var. *menthaefolia*	Pink Bergamot or Horsemint
Oenothera coronopifolia	Cut-leaf Evening Primrose
Oxytropis sericea	Silver Loco
Oxytropis cf. *lagopus*	Haresfoot Loco
Phlox hoodii	Hood's Phlox
Potentilla arguta ssp. *arguta*	White Cinquefoil
Psoralea argophylla	Silver Scurfpea
Psoralea tenuiflora	Slimflower Scurfpea
Ratibida columnifera	Prairie Coneflower
Rumex crispus	Curly-leaf Dock
Rumex triangulivalvis	Dock
Sagittaria cf. *latifolia*	Arrow-head
Solidago missouriensis	Missouri Geldenrod
Solidago mollis	Goldenrod
Solidago nana	Goldenrod
Sphaeralcea coccinea	Globe Mallow
Taraxacum officinale	Dandelion
Trifolium sp.	Clover
Yucca glauca	Small Soapweed Yucca

Table 1 - Vegetation by Life-form of the Nuclear Dynamics Test Site, July 1977, Continued

PERENNIAL GRAMINIFORMS

Scientific Name	Common Name
Agropyron albicans	Montana Wheatgrass
Agropyron desertorum	Desert Wheatgrass
Agropyron smithii	Western Wheatgrass
Agropyron trachycaulum	Slender Wheatgrass
Agropyron trachycaulum ssp. *majus*	Compact Slender Wheatgrass
Agropyron trichophorum	Bearded Wheatgrass
Agrostis cf. gigantea	Redtop
Andropogon gerardii	Big Bluestem
Aristida longiseta	Red Three-awn
Bouteloua gracilis	Blue Grama
Bromus inermis	Smooth Brome
Buchloe dactyloides	Buffalo Grass
Calamagrostis cf. inexpansa	Northern Reedgrass
Calamovilfa longifolia	Prairie Sandreed
Carex filifolia	Threadleaf Sedge
Carex xerantica	Sedge
Eleocharis macrostachya	Longstem Spikerush
Hordeum jubatum	Foxtail Barley
Juncus interior	Rush
Koeleria cristata	Prairie Junegrass
Muhlenbergia asperifolia	Alkali Muhly
Muhlenbergia cuspidata	Plains Muhly
Oryzopsis hymenoides	Indian Ricegrass
Phleum pratense	Timothy
Poa canbyi	Canby Bluegrass
Poa secunda	Sandberg Bluegrass
Puccinellia nuttalliana	Nuttall Alkaligrass
Scirpus americanus	American Bulrush
Stipa comata	Needle-and-thread Grass
Stipa viridula	Green Needlegrass
Typha latifolia	Cattail

Table 1 - Vegetation by Life-form of the Nuclear Dynamics Test Site, July 1977, Continued

Scientific Name	Common Name
SHRUBS	
Artemisia cana	Silver Sagebrush
Artemisia tridentata	Big Sagebrush
Atriplex gardneri	Gardner Saltbrush
Chrysothamnus nauseosus	Rubber Rabbitbrush
Prunus virginiana var. *melanocarpa*	Chokecherry
Rosa sp.	Wild Rose
Sarcobatus vermiculatus	Greasewood
Symphoricarpos occidentalis	Western Snowberry
Toxicodendron radicans	Poison Ivy
CACTI	
Opuntia polycantha	Prickley Pear
LICHENS	
Parmelia chlorochroa	Lichen

ENCLOSURE 5

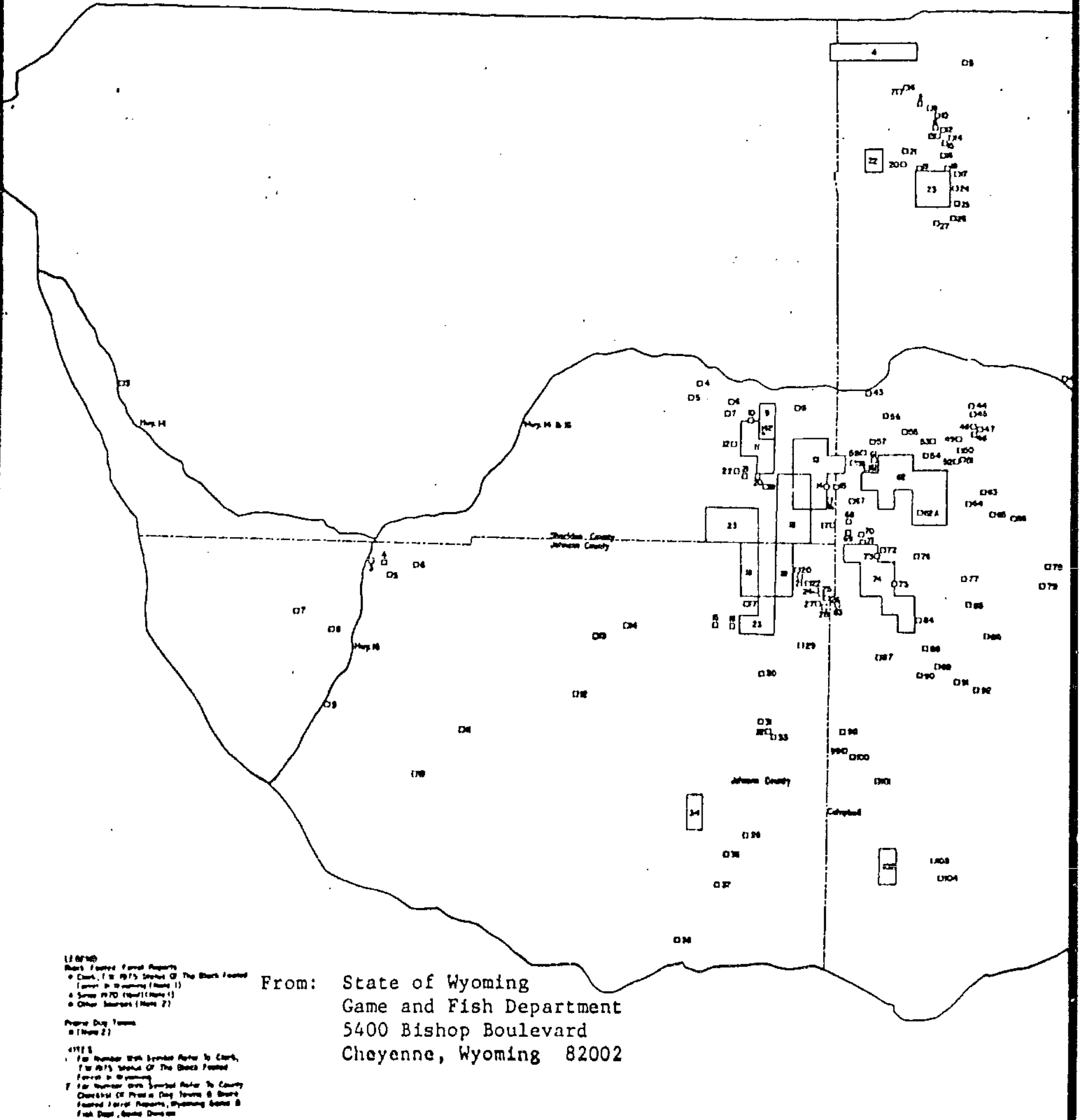
Wildlife Distribution Maps, State of Wyoming Game & Fish Dept.
5400 Bishop Boulevard, Cheyenne, Wyoming: White Tailed
Deer, Mule Deer, Prairie Dog and Black Footed Ferred

Refers to section 2.4.2

GUIDELINES FOR MAPPING WILDLIFE DISTRIBUTION

TYPE	DESCRIPTION	SYMBOL
Summer	The general geographic area occupied by a migratory herd during summer months. (Approximately June 1 - October 31)	——— S
Winter	The general geographic area occupied by a migratory herd during winter months. (Approximately November 1 - May 31)	——— W
Migration Routes	Definable route followed during seasonal movements year after year. a. General area of movement b. Specific movement corridors	Mr →→— → → →
Parturition Areas	Geographic area consistently used for birth of young.	·······- P
Breeding Areas	Geographic area consistently used for breeding by the majority of a population.	-·---- B
Display Areas	Sites consistently used by the male segment of game bird populations during courtship (e.g., strutting grounds, dancing grounds, drumming sites, etc.) a. censused b. uncounted c. abandoned	 ● ⦶ ✕
Year-long	Geographic area occupied by all or a portion of the population for the entire year.	——— Y
Combination	Range where animals occur during more than one season.	——— S/Y ——— W/Y
Critical	That range that is present in minimum amounts and is the determining factor in the potential for population maintenance and/or growth. This will usually be represented by a winter concentration where most members of a population are forced during periods of maximum snow cover each year or where most members of a population are concentrated during periodic severe winters. The critical range may also be represented by late fall water source or other resources in short supply (e.g., cover for breeding, nesting, fawning, etc.). The degree of criticalness is related to a specific herd and is not related to the density of animals relative to any other herd.	(////)

From: State of Wyoming
Game and Fish Department
5400 Bishop Boulevard
Cheyenne, Wyoming 82002



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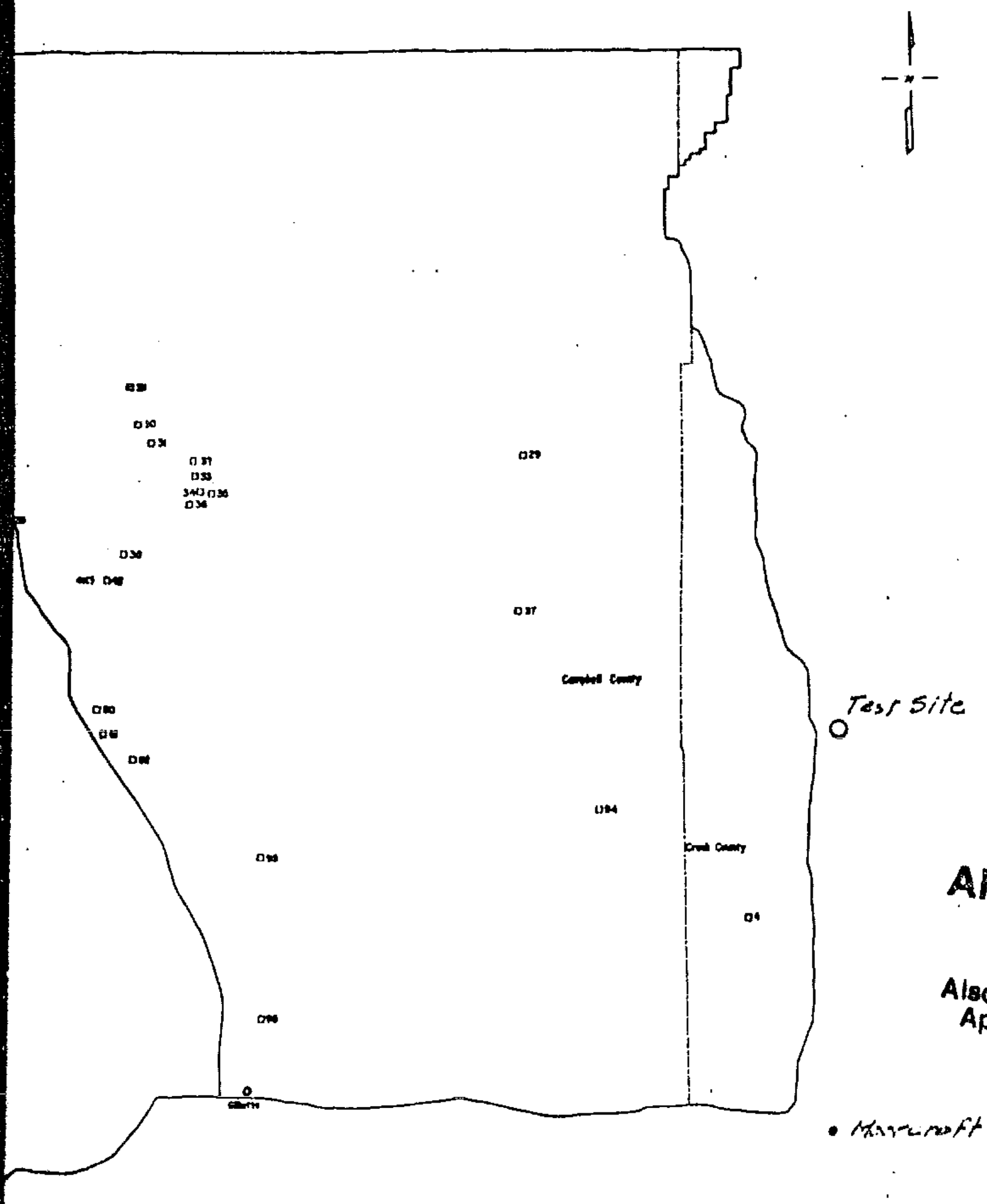
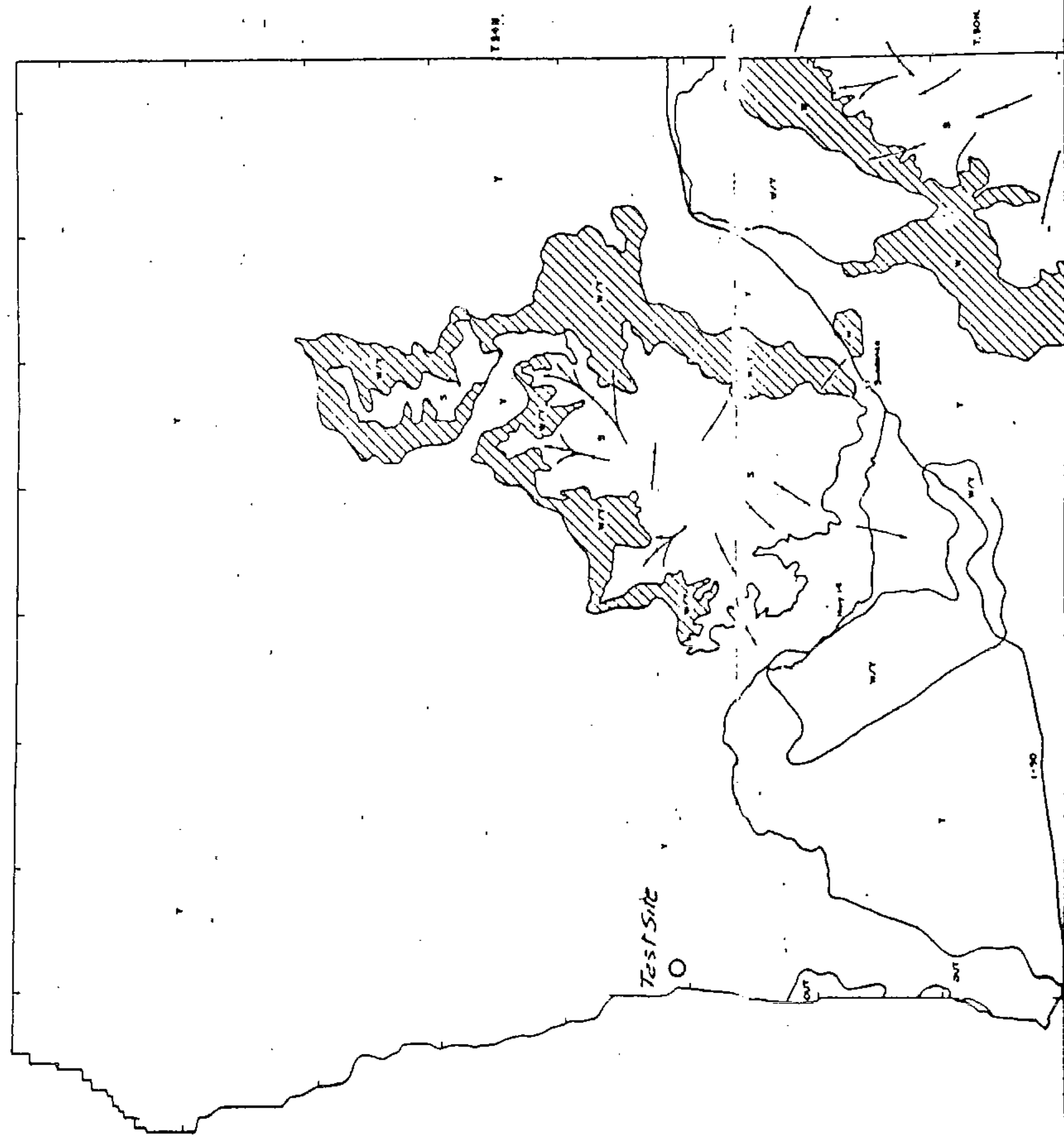
Game and Fish Department
5400 Bishop Boulevard
Cheyenne, Wyoming 82002



PRAIRIE DOG AND BLACK FOOTED FERRET



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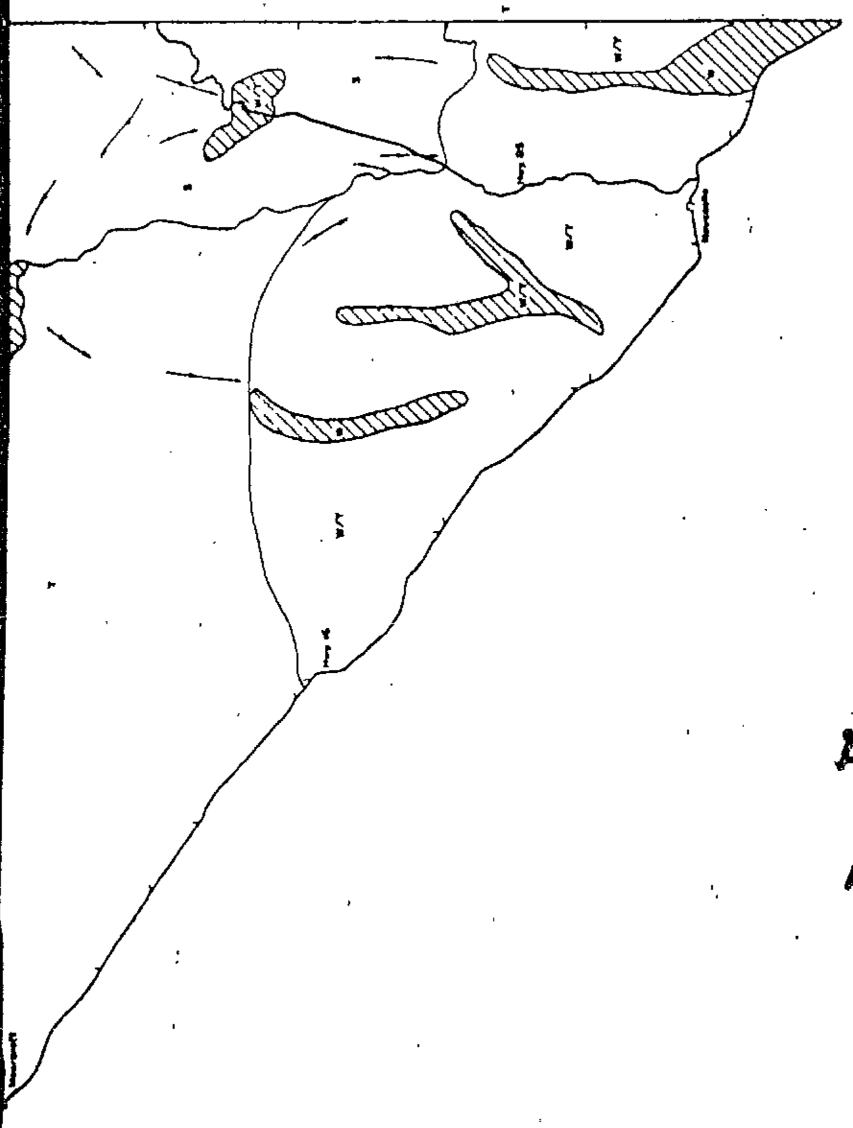
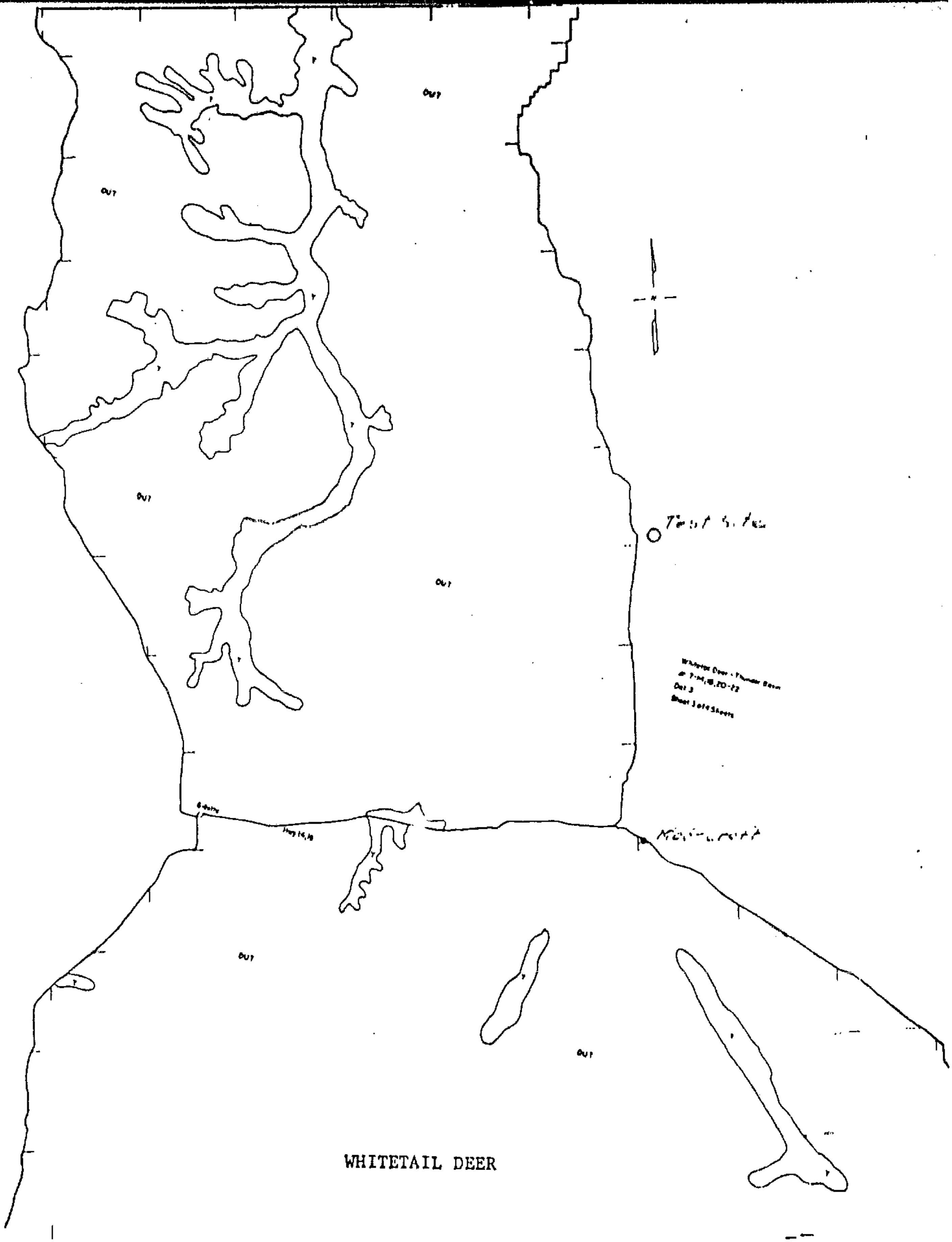
Game and Fish Department
5400 Bishop Boulevard
Cheyenne, Wyoming 82002

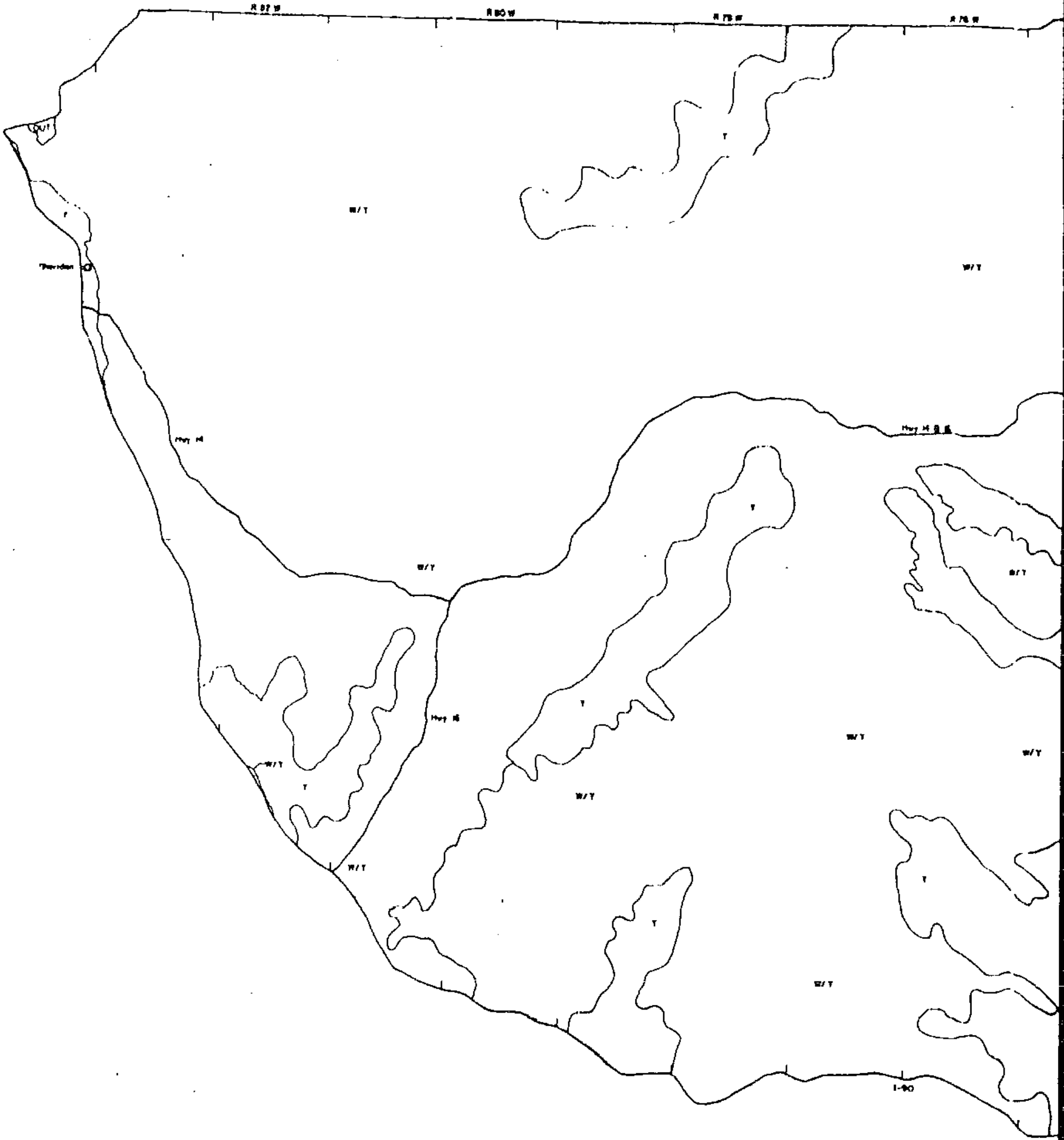


WHITE-TAILED DEER - BLACK HILLS WHITETAILS

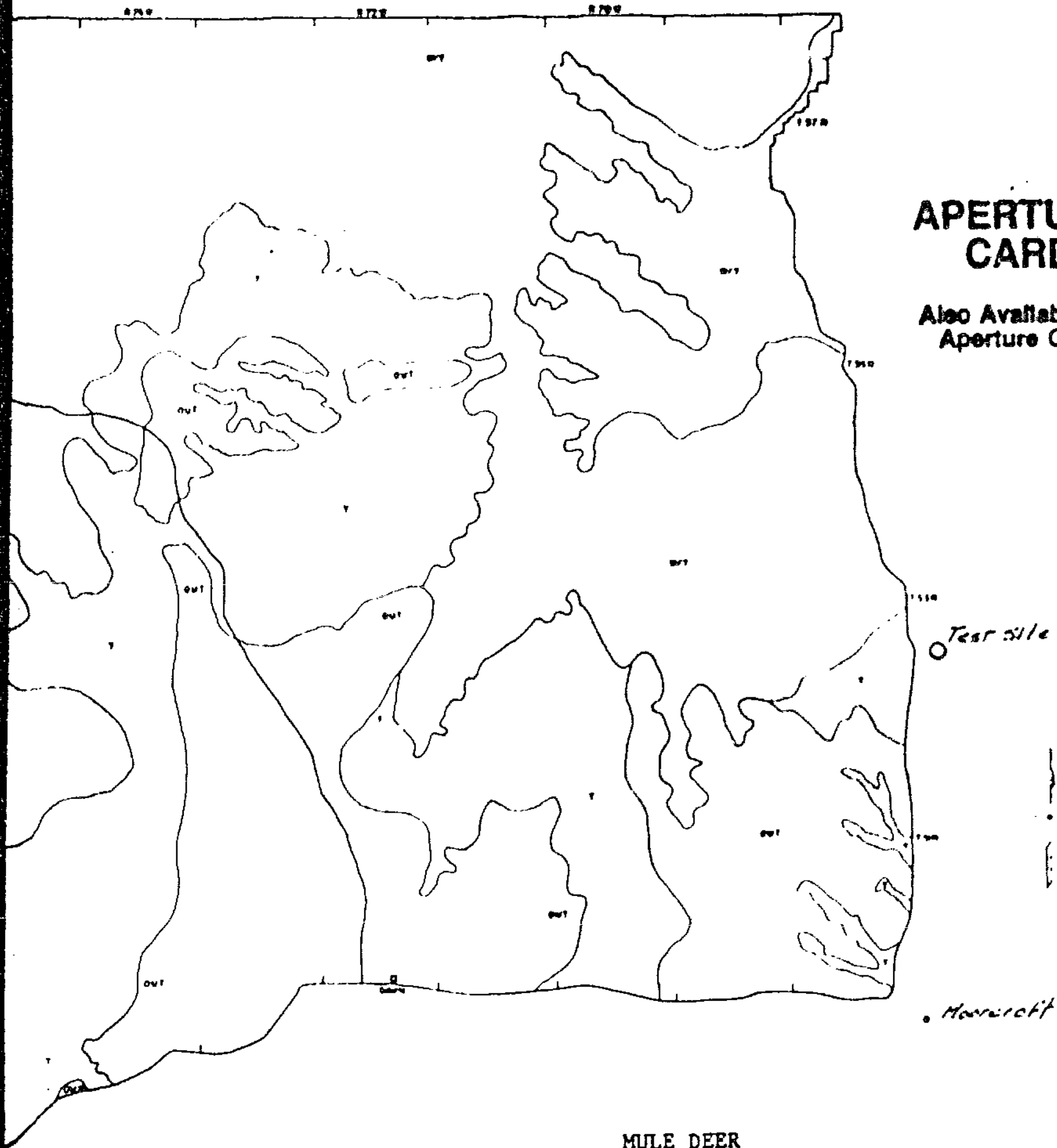


WHITETAIL DEER

From: State of Wyoming
Game and Fish Department
5400 Bishop Boulevard
Cheyenne, Wyoming 82002



From: State of Wyoming
Game and Fish Department
5400 Bishop Boulevard
Cheyenne, Wyoming 82002



APERTURE CARD

Also Available on Aperture Card

MULE DEER

2.5 METEOROLOGY

Climatological information has been obtained from Climatological Data, Annual Summary, Wyoming, a publication of the United States Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service (Enclosure 6) and from various maps from the Climatological Atlas of the United States published by the same office (Ref. 3) The data originates from reporting weather stations located in the vicinity (13 to 32 miles) of the test site.

2.5.1 Climate, Temperature, Frost and Soil Temperature

The climate is cold and dry. For Moorcroft the mean monthly temperatures in January and July are 20.4° F and 72.2° F (Enclosure 2; for greater detail see Enclosure 6; shown graphically in Figures 4 and 5). Frost can be expected between September 15th and May 30th (Ref. 3).

Soil temperatures recorded monthly at Gillette 2E Station (sandy loam with native range cover) for depths ranging from two and one quarter inches to forty inches for 1976 are given in Enclosure 6. The data shows that in 1976 at the 40 inch depth the minimum soil temperature of 35° F was attained during the months of February and March. However, a review of the data for previous years (Ref. 6) indicates that 31° temperatures have been recorded on several occasions.

2.5.2 Precipitation, Humidity and Evaporation

For Moorcroft, the mean annual precipitation is 10.79 inches of rain and 40.0 inches of snow. (Enclosure 2) For the year 1976, the total precipitation was 16.44 inches, most of which was recorded from April through September (12.97 inches). June was the wettest month with 4.30 inches recorded (Enclosure 6).

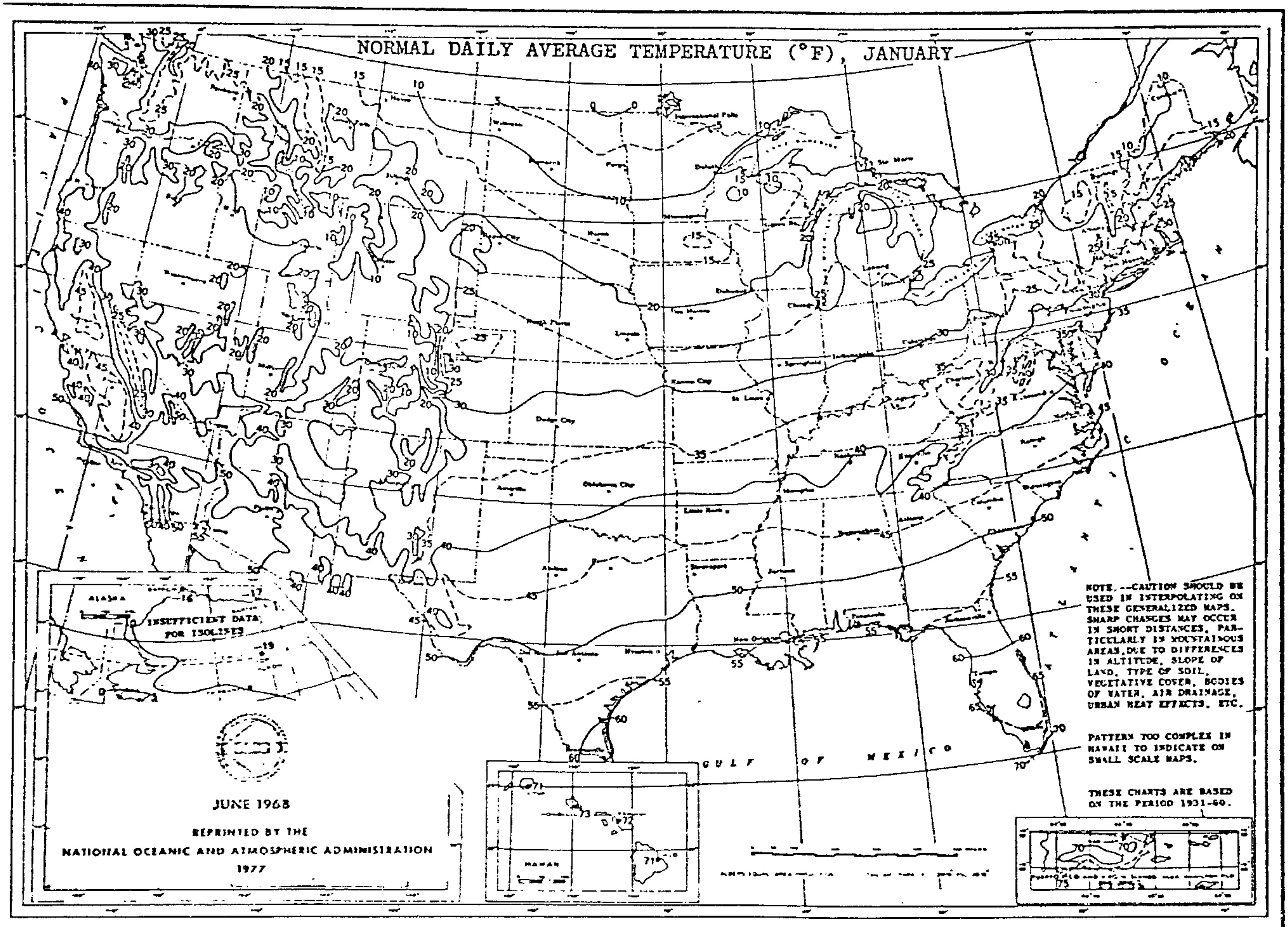


Figure 4. Normal Daily Average Temperatures (°F) January

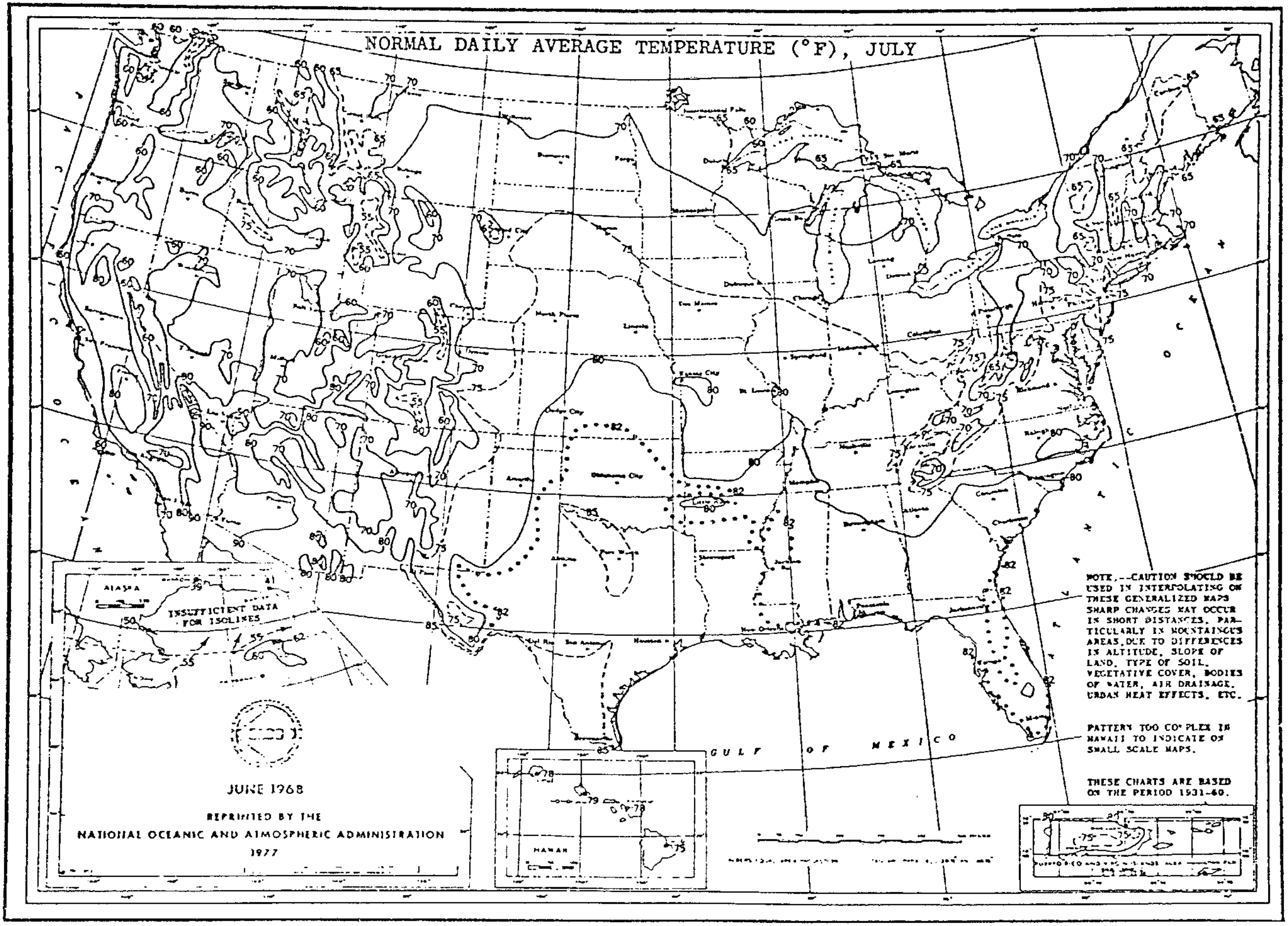


Figure 5. Normal Daily Average Temperatures (°F) July

The mean monthly relative humidity for the area ranges approximately from 55% in July and August to 65% in November through March (Ref. 3).

The mean annual Pan Evaporation for the area is approximately 60 inches (Ref. 3). For the year 1976 the total Pan Evaporation at the Gillette 2E Station was 50.68 inches recorded in the months of April (4.33 inches) through October (3.72 inches). The high of 10.26 inches was recorded for the month of July. No significant evaporation was recorded from November through March (Enclosure 6).

2.5.3 Wind

The test site and vicinity are in the topographically unobstructed plains area. The wind blows with some persistence generally from the west. On a monthly basis the prevailing westerly winds have an average velocity of eight miles per hour except during the early Spring months when they average ten miles per hour (Ref. 3). High wind velocities in gusts are not uncommon.

2.5.4 Inversions and High Air Pollution Potential

Because topographically the area is open, there is little opportunity for the entrapment and growth of atmospheric inversion layers.

Pollution potential is relatively low because of the extremely low density in population of the general area. Dust sources are restricted to scattered country dirt roads and to relatively minor farming activities.

2.5.5 Meteorological Monitoring

The following are the weather data reporting stations in the near vicinity around the test site, listed in clockwise order, at their respective approximate distances and orientation from the site (Fig. 6, Map of Wyoming Stations, 1976).

Devil's Tower No. 2	E	12 miles
Sundance	ESE	31 miles
Moorcroft	S	22 miles
Gillette 2	SW	33 miles
Weston	WNW	19 miles
Oshoto 15	NNW	15 miles

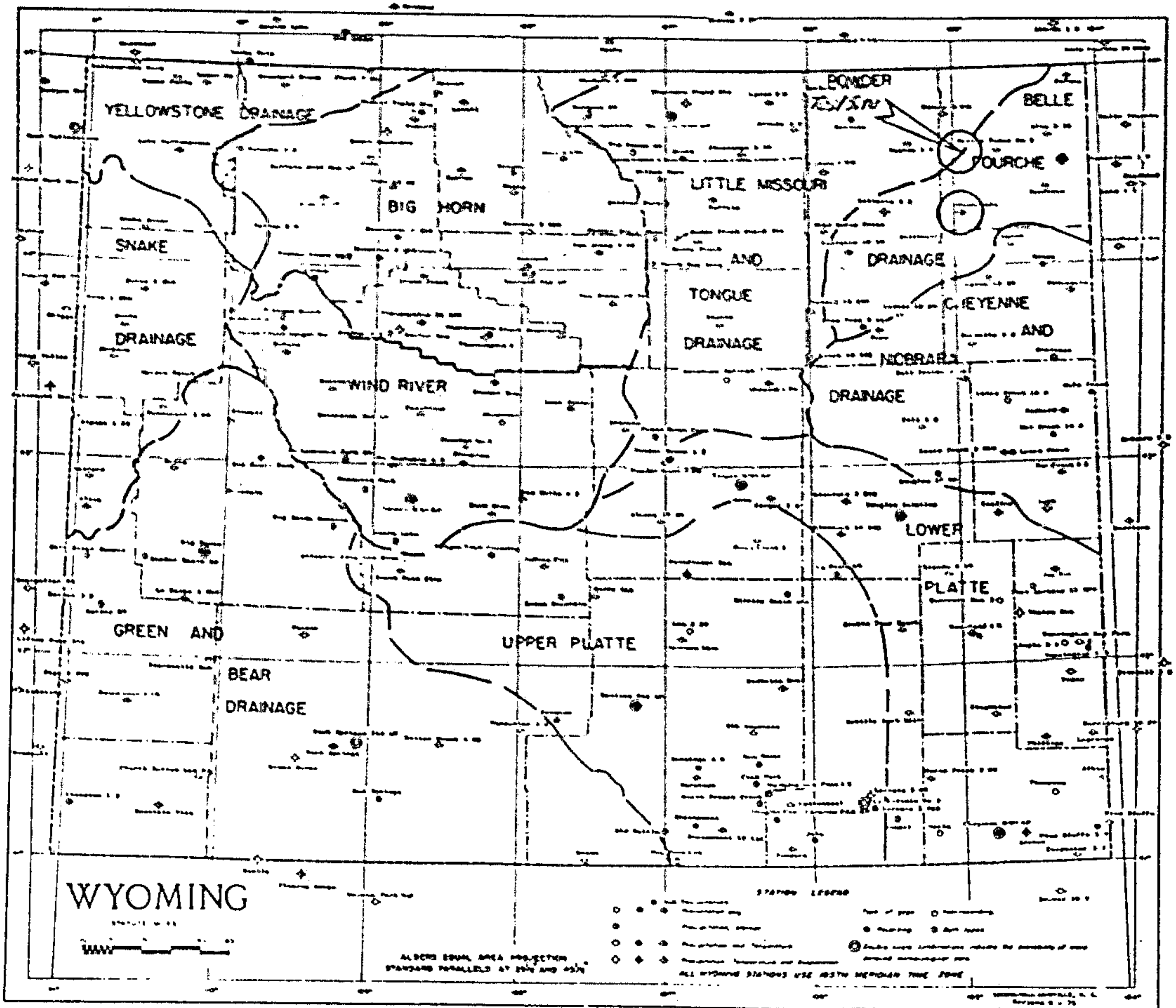


Figure 6. Map of Wyoming Weather Stations

ENCLOSURE 6

Climatological Data Annual Summary, Wyoming 1976, Vol. 85, No. 13, (Excerpts): National Oceanic & Atmospheric Administration Environmental Data Service, National Climatic Center, Asheville, North Carolina

Refers to sections 2.5, 2.5.1 and 2.5.2

ENCLOSURE 6

VOLUME 85 NUMBER 13

CLIMATOLOGICAL DATA

ANNUAL SUMMARY

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★

WYOMING

1976

"I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AND IS COMPILED FROM INFORMATION RECEIVED AT THE NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA 28801."

Daniel B. Mitchell

DIRECTOR
NATIONAL CLIMATIC CENTER

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA SERVICE / NATIONAL CLIMATIC CENTER ASHEVILLE, N.C.

AVERAGE TEMPERATURES AND DEPARTURES FROM NORMAL

Station	January Temperature	January Departure	February Temperature	February Departure	March Temperature	March Departure	April Temperature	April Departure	May Temperature	May Departure	June Temperature	June Departure	July Temperature	July Departure	August Temperature	August Departure	September Temperature	September Departure	October Temperature	October Departure	November Temperature	November Departure	December Temperature	December Departure	Annual Temperature	Annual Departure
GILLETTE 18 SW	22.0		30.3		30.2		43.7		53.6		59.7		71.6		68.4		59.3		44.0		31.4		26.4		45.2	
MOORCROFT	19.0		29.4		30.7		44.2		-		M		M		68.9		62.2		44.7		-		23.1		-	
SUNDANCE	20.7	.4	27.7	3.8	29.2	-.2	44.5	3.0	52.4	1.3	61.2	1.1	69.0	.2	66.9	-1.0	59.9	2.7	43.2	-3.0	29.6	-2.5	22.4	-.3	44.0	.4
DIVISION	21.0	.2	30.1	3.8	30.3	.3	44.8	2.3	53.4	.9	61.6	.6	71.0	1.1	68.1	-.2	60.1	2.8	43.3	-4.1	30.0	-2.8	24.3	-.3	44.9	.3
CHEYENNE AND NIOBRARA DRAINAGE 07																										
DULL CENTER 1 SE	24.1	1.0	31.6	3.0	33.7M	1.9	46.1M	1.6	55.1M	1.5	65.0M	.4	76.9M	3.2	71.9M	.9	62.1M	2.4	44.8	-3.9	33.7M	-1.1	26.9M	2.5	47.9M	1.2
HAT CREEK 3 E	22.9		32.8		32.1		43.3		53.6		63.3		73.8		70.3		61.1		43.4		32.6		25.8		46.3	
LANCE CREEK 3 WNW	23.1		33.8		33.1		43.7		57.9		63.2M		73.9		71.0		59.8		43.3		32.6		25.8		46.8M	
LAWVER 10 SW	24.2		32.1M		30.3M		M		54.6M		M		72.0M		M		-		44.0M		33.2M		27.1M		-	
LUSK	24.3	.4	33.2	3.4	34.1	1.8	45.9	2.3	55.8	.9	60.8	-1.2	70.6	.8	67.0M	-1.5	57.9	-.1	43.9	-3.7	32.5	-1.7	28.8	2.0	46.1M	.3
MORRISSEY	24.0	.7	32.0	3.9	34.0M	.5	47.0	1.2	56.0M	1.1	65.4	.8	76.0	1.9	72.9	-.4	64.2	2.0	M		33.9	-1.7	25.9	-.6	-	
NEWCASTLE	21.4M	-1.3	29.4	2.5	32.3	.2	46.2	1.9	56.7	1.6	65.0	.9	74.8	1.8	69.9	-1.7	61.3M	1.8	44.3	-4.9	30.5	-4.1	23.8	-2.5	46.3M	-.4
REDBIRD	23.8		33.1		32.9		47.9		56.2		64.2		74.6		69.5		60.5		42.6		30.9		24.9		46.6	
RENO	M		26.9M		29.8M		43.3M		54.9M		60.6M		74.0M		70.2		61.3M		46.2M		M		-		-	
ROCHELLE 3 E	20.1	-.8	30.3	4.8	29.1	-1.3	42.4M	.0	53.3	.1	62.0	-.9	69.9	-2.2	67.9	-1.8	59.2	1.0	43.1	-4.0	30.8	-3.1	20.6	-3.4	44.1M	-1.1
UPTON	14.6		23.5		29.2		44.4		53.8M		61.9		71.6		68.8		59.8		42.9		29.7		20.7		43.3M	
DIVISION	22.2	.8	31.0	4.0	33.0	.4	45.6	1.0	54.8	1.2	62.9	.3	73.3	1.6	69.6	-.4	60.7	1.8	43.9	-4.1	32.0	-1.7	25.8	.7	46.2	.6
LOWER PLATTE 08																										
ALBIN	26.2	-.2	34.9	3.4	34.4M	1.9	45.1M	1.6	53.6	.4	62.0	.1	71.9M	.8	68.0	-1.5	60.4	.4	46.2	-2.9	35.5M	-2.5	31.1	1.2	47.3M	.5
ALCOVA 17 NW	20.1M		29.2M		29.4M		40.8M		51.7M		57.3		69.5M		65.6M		54.0M		43.7M		33.6M		23.5M		43.1M	
ARCHER	29.7M		34.0M		33.1		44.9		53.1		62.1		71.2		67.1M		60.4		45.4		34.2M		31.6		47.2M	
CARPENTER 3 E	26.4		36.0M		34.3		45.3		54.0		62.6M		71.7		68.1		60.7M		44.2M		34.1		32.8		47.6M	
CASPER 3 E	28.1		34.6		35.3		47.3		56.1		63.7		74.3		69.6		61.2		48.3		34.0		31.7		48.6	
CASPER WSO AP	23.0	-.2	30.2	3.4	32.0	1.0	44.0	1.3	53.6	.9	60.7	-1.2	72.8	1.8	68.4	-1.4	59.2	.5	43.8	-3.9	30.3	.6	28.8	2.1	45.9	.6
CHEYENNE WSO AP	26.9	.7	32.9	3.9	30.9	-.7	42.7	.0	51.1	-1.3	59.7	-1.6	69.2	.2	65.0	-2.6	57.7	-.8	43.4	-4.9	33.9	-2.0	30.6	1.4	45.3	-.6
CHUGWATER	28.4	.8	34.2	6.0	34.3	1.8	45.3	1.8	55.6	.5	61.6	.1	71.4	2.5	66.9	-.8	61.9	.8	46.7	-1.3	34.1	-1.3	31.7	1.7	47.6	.9
DOUBLE FOUR RANCH	24.3		30.1		33.8		44.8		52.9		59.8		69.8		64.2		57.1		41.8		32.7		27.7		44.9	
DOUGLAS AVIATION	23.0		32.4		32.4		44.6		54.2		60.8		72.3M		68.3		58.2		42.8		31.9		27.9		45.7M	
GLENDO 4 SW	-		34.0		34.1		44.1		53.1		60.6		71.6		68.0		58.1		42.6		30.6		26.2		-	
GLENROCK 5 ESE	24.6	.8	34.7	3.2	34.4	.7	46.9	1.8	56.6	2.2	63.8	-.7	-		70.9	-.1	62.0M	3.1	43.6	-3.9	35.4	-1.1	32.5	3.4	-	
GLENROCK 14 SSE	22.7		27.6		M		41.0M		50.2		58.1M		67.7		63.6		-		-		-		29.6		-	
HORSE CREEK 2 NW	26.2M		31.6		31.6		42.4		51.3		58.8		68.5		65.6		58.6		46.1		34.7		31.9		45.7M	
KEELINE	M		30.1M		31.4		43.0M		51.6		59.6		72.1M		66.7		58.2		41.6M		30.7M		26.7M		-	
LAGRANGE	26.1	-7.2	33.5	1.7	28.7	-6.7	41.3	-3.0	50.3	-4.7	58.4	-6.6	-		65.6	-3.3	56.7M	-3.8	39.7	-10.0	28.9	-8.0	27.4	-2.3	-	
PHILLIPS	28.0		33.3		33.7		44.8		55.0M		62.8		72.3		68.4		60.7		45.0		35.3		33.3M		48.3M	
SYBILLE RESEARCH UNIT	25.8		32.2		32.9		44.6		52.5		60.5		70.3		67.3		60.2		46.4		35.6		30.6		46.6	
TORRINGTON EXP FARM	25.2	-1.6	37.2	5.9	36.8	1.2	48.1	1.4	57.2	.9	65.3	.1	74.8	2.6	70.6	.2	62.0	1.6	45.1	-4.3	32.1	-4.8	31.7	2.7	48.8	.3
WHALEN DAM	23.9		36.0		34.5		47.3		55.4		64.1		74.8		70.7		61.3		44.6		33.7M		29.6		48.0M	
WHEATLAND 4 N	29.2	.8	31.8	3.8	36.1	.8	47.1	.9	55.9	-.1	63.8	-.8	75.1	.2	68.6	-2.0	59.9	-1.7	46.0M	-4.9	35.3	-1.2	32.9	1.2	48.6M	-.3
YODER	27.4	.0	37.3	6.8	39.4	4.0	49.2	2.6	56.0	.1	64.3	-.3	74.8	2.2	71.7	1.4	-		M		34.3	-1.5	33.4	3.3	-	
DIVISION	25.7	-.2	33.2	4.1	33.7	1.0	44.9	1.0	53.7	.8	61.3	-1.0	71.7	1.2	67.6	-1.4	59.4	.4	44.3	-4.2	33.6	-3.1	29.9	1.8	46.6	.1
WIND RIVER 09																										
BOYSEN DAM	12.5M		28.6M		35.3		48.8		60.0		66.4M		77.6		71.1		-		-		33.2		25.6M		-	
BURRIS	27.4		30.0		29.0		41.5		52.4M		57.0		67.6		61.7M		50.3M		46.1M		37.1M		31.3		44.9M	
DIVERSION DAM	25.5	2.3	29.1	2.7	33.6	1.9	44.0	1.0	55.4	3.3	60.0	.0	70.4	2.4	64.0	-2.2	58.0	1.3	44.2M	-2.2	33.7	3.3	30.0M	5.8	45.7M	1.7
DUBOIS	25.3M	4.0	M		24.5M	-2.7	M		M		52.5M	-.4														
FORT WASHAKIE 1 SE	16.5		26.4		31.3		48.8		51.5		58.1		69.7		65.9		57.1		27.7M		31.6		22.6		42.2M	
GAS HILLS 4 E	19.9		23.9		27.5		41.3M		52.5M		56.6		71.3M		65.7M		55.4M		43.7M		33.6M		26.3M		41.4M	
LANDER WSO AP	19.2	-.8	27.1	1.6	33.6	1.6	46.0	1.1	56.6	1.8	60.6	-.8	72.8	1.6	67.8	-2.2	59.7	1.2	43.6	-3.2	33.7	1.2	23.4	2.4	43.0	.6
LOST CABIN	15.5		24.0		31.0		44.0		53.1		59.9		77.2		67.0		59.2		42.0M		29.6		21.9		43.2M	
PAVILLION	21.7	1.2	28.1M	-1.8	34.5M	1.8	45.4M	1.0	55.5M	1.9	61.2M	-.8	73.0	2.3	65.5	-2.4	58.8M	.2	43.3M	-4.1	33.0M	2.9	24.8M	3.3	43.6M	.7
RIVERTON	10.6	-6.4	22.1	-1.0	33.3	.8	46.1	.2	55.2	1.8	60.7	-1.3	73.6	3.4	65.7	-2.2	57.7	.3	41.1	-4.5	30.6	.7	20.1	1.2	43.0	.4
SAND DRAW	23.6		27.3		32.6M		46.2		-		-		-		67.1		59.6		-		-		M		-	
DIVISION	19.6	-.8	26.7	1.3	31.6	.1	43.9	1.6	54.8	2.3	59.3	-.3	71.0	3.1	65.9	-1.0	58.3	1.4	43.2	-3.2	33.1	1.8	23.3	2.0	44.5	.7
UPPER PLATTE 10																										
BATES CREEK 2	23.2		29.0		31.0		44.0		53.4		60.4		71.1		65.9		59.6		44.4		32.1		26.8		45.2	
ELK MOUNTAIN	23.1		28.7		27.3		39.7M		48.8		56.8		66.3		61.6		54.8		41.2		32.1M		28.6		42.3M	
ENCAMPMENT 10 ESE	21.8	-.2	28.2	4.4	26.9	-1.1	39.2	-.2	48.5	-.9	55.0	-1.6	64.8	.4	59.1	-3.1	52.3M	-2.6	39.6	-3.6	30.0	-2.6	25.6	-1.6	40.7M	-1.3
LARAMIE 2	24.7		33.1																							
LARAMIE FAA AP	19.7	-1.0	27.9	4.1	26.7	-.8	39.1	1.3	47.6	-.3	56.5	-.4	66.1	1.0	61.4	-1.2	53.2	-.2	39.2	-4.1	29.0	-1.4	23.9	.6	40.8	.1
LARAMIE 2 NW	20.6		27.3		29.3M		39.2		47.1M		56.7		66.6		60.6		54.3		39.3		29.8M		23.6		41.3M	
MEDICINE BOW	21.2M		27.1		27.1		41.0M		49.7		56.3		66.8		60.3M		53.3M		37.8		29.2M		22.8		41.0M	
MUDDY GAP	21.3		24.7		32.0		43.5M		53.6M		58.8M															
PATHFINDER DAM	M		28.3M	2.9	33.3	2.3	44.7	2.5	55.2M	2.8			73.3	2.6	69.8	-.2	61.3M	2.3	47.2M	-.9	35.4M	1.0	29.1M	3.1		
RAWLINS FAA AP	21.0		28.1		28.3		40.6		51.0		56.8		69.2		65.1		55.8		41.7		29.3		24.0		42.3	
SARATOGA	22.0	.8	28.6	3.8	30.3	1.2	41.3	2.2	51.6	1.6	58.3	.1	69.7M	2.7	65.4	-.8	58.2	1.3	43.4	-2.1	30.4	-1.3	26.3	.8	43.2M	.7
SEMINOE DAM	20.5	-.6	26.5	2.2	29.0	.3	42.4	2.0	53.1	2.6	59.0	.6	71.0	2.2	66.4	-.5	58.3	1.8	44.3	-3.2	32.6	.8	26.2	2.8	44.2	1.0
SOUTH PASS CITY	15.3M		17.1M		17.9		33.2M		44.5		48.3M		59.1		56.4		48.3		36.0		26.7		19.7		34.9M	
DIVISION	21.2	.7	27.1	4.0	28.2	1.0	40.7	1.1	50.6	1.6	56.6	-.2	67.8	2.6	62.2	-.9	55.3	1.2	41.2	-2.9	30.7	.0	24.8	1.3	42.2	1.0

See Reference Notes Following Station Index

TABLE 2

TOTAL PRECIPITATION AND DEPARTURES FROM NORMAL

WYOMING
1976

STATION	JANUARY PRECIP	JANUARY DEPARTURE	FEBRUARY PRECIP	FEBRUARY DEPARTURE	MARCH PRECIP	MARCH DEPARTURE	APRIL PRECIP	APRIL DEPARTURE	MAY PRECIP	MAY DEPARTURE	JUNE PRECIP	JUNE DEPARTURE	JULY PRECIP	JULY DEPARTURE	AUGUST PRECIP	AUGUST DEPARTURE	SEPTEMBER PRECIP	SEPTEMBER DEPARTURE	OCTOBER PRECIP	OCTOBER DEPARTURE	NOVEMBER PRECIP	NOVEMBER DEPARTURE	DECEMBER PRECIP	DECEMBER DEPARTURE	ANNUAL PRECIP	ANNUAL DEPARTURE
DEVILS TOWER 2	.76		.42		.54		2.99		2.78		6.42		1.63		1.43		.45		.49		1.57		.00		19.73	
DILLINGER	.36	.04	.46	.01	.70-	.29	2.18	.49	2.22-	.17	3.44	.33	1.51	.06	1.42	.35	.40-	.77	.17-	.15	.05	.34	.17-	.24	13.80	.47
GILLETTE 2 E	.64-	.02	.33-	.28	.59-	.33	2.10	.23	2.68	.18	5.09	1.03	1.29	.05	1.41	.34	.32-	.49	.48	.10	.84	.03	.31-	.31	16.99	1.17
GILLETTE 18 SW	.72		.53		.90		2.70		3.45		3.31		.48		.42		1.01		.93		1.13		.13		15.39	
MOORCROFT	.47		.43		.25		1.45		2.33		4.30		2.37		1.22		1.17		.00		1.18		.21		16.55	
SUNDANCE	.12-	.10	1.06	.41	.10-	.45	2.91	.79	3.96	.88	6.21	3.46	1.83	.16	1.20-	.15	.40-	1.09	.34-	.21	1.09	.20	.64	.05	19.32	1.91
DIVISION	.56	.02	.60	.00	.38-	.31	2.34	.01	3.41-	.27	5.34	2.24	1.90	.11	1.25-	.02	.43-	.78	.40-	.27	1.09	.34	.36-	.12	17.96	1.67
CHEYENNE AND NIOBRARA DRAINAGE 07																										
BILL											2.37		.74				1.29		.91				.89			
DULL CENTER 1 SE	.15-	.12	.66	.19	.70-	.76	2.45	1.19	3.02	.76	2.33-	.17	.78-	.01	.54-	.42	.37-	.42	.77-	.12	.67	.39	.21-	.03	12.26	.29
HAT CREEK 3 E	1.11		.71		.36		3.13		4.41		3.29		1.41		.06		.40		.43		.74		.08		16.73	
LANCE CREEK 3 WNW	.19		.41		.37		3.41		3.14		4.33		3.70		.90		1.33		.37		.40		.09		16.22	
LAWVER 10 SW	.20		.49		T		2.75		3.88		2.80		.62		.67		.45		.96		.57		.21		11.14	
LUSK	1.11	.53	.55	.03	.73-	.18	2.14	.09	4.04	1.41	3.08	.02	.97-	.74	.09-	.48	.57-	.56	.15-	.32	.77	.17	.26-	.24	16.99	1.26
MCKINNEY	.57	.22	.71	.30	.27-	.48	1.97	.19	3.46	.15	2.85	.51	.42-	1.31	.70-	.11	.46-	.22	.37-	.29	.48	.04	.11-	.17	14.01-	1.94
NEWCASTLE	.40	.42	1.36	.42	.30-	.38	1.11-	.12	2.75-	.25	3.72	.78	1.04	1.21	1.19-	.19	.34-	.46	.22-	.23	.42	.47	.03	.13	15.18	1.06
REDBIRD	.36	.05	.55	.20	.44-	.35	2.52	1.53	3.32	.30	2.81-	.16	1.25-	.43	4.79	1.73	1.01-	.04	.76	.04	.17-	.10	.43-	.29	17.09	4.11
RENO	.20		.59		.37		1.45		2.76		2.06		.17		.08		.62		.74		1.05		.34		10.81	
ROCHELLE 3 E	.24	.04	.68	.19	.37-	.34	3.21	.56	4.59	2.29	2.03-	.62	2.46	.76	2.39	1.21	.56-	.34	.47-	.04	.43	.05	.12-	.19	16.81	3.74
UPTON	.39		.30		.45		2.79		3.40		3.69		5.14		.53		.47		.00		1.05		.31		18.39	
UPTON 13 SW	.77		.49		.16		2.41		2.69		3.50		.91		.72		.63		.70		.67		.33		12.23	
DIVISION	.15	.11	.63	.21	.36-	.37	2.53	.71	3.38	.87	2.96	.23	1.61-	.06	1.00-	.08	.69-	.33	.52-	.24	.83	.17	.23-	.16	14.84	1.06
LOWER PLATTE 08																										
ALBIN	1.27	.74	.61-	.02	.48-	.02	2.95	.61	2.21-	.84	1.06-	1.98	2.44	.51	2.20	.78	.44-	.74	.30-	.77	.39-	.40	.11-	.50	14.65-	3.57
ALCOVA 17 NW	.72		1.07		.18		1.69		1.66		1.23		.39		.57		1.05		.75		T		.25		10.34	
ARCHER	.42	.50	.47	.12	.51-	.38	1.64	.12	1.67-	1.06	.43-	1.37	2.37	.50	1.43	.35	1.56	.02	.51-	.80	.22-	.29	.07-	.21	11.39-	1.96
CARPENTER 3 E	.41		.24		.70		1.24		2.13		.77		2.21		.42		1.23		.12		.10		T		9.61	
CASPER 2 E	.36-	.22	.42	.01	.13-	.49	2.25	.47	2.66	.25	1.98	.13	.43	.05	.38-	.17	.61-	.38	1.39	.21	.13-	.79	.21-	.39	11.89-	1.52
CASPER WSO AP //R	.44-	.08	.49	.39	.50-	.41	1.92	.07	2.40	.75	1.66	.22	1.07	.12	.31-	.28	1.15	.78	1.21	.29	.09-	.59	.34-	.11	11.91	.09
CHEYENNE WSO AP //R	.32-	.14	.71	.25	.32-	.73	1.79	.22	2.07-	.43	.66-	1.73	2.39	.57	1.40-	.05	.77-	.28	.15-	.00	.28-	.30	.10-	.25	10.94-	3.67
CHUGWATER	.72	.14	.62	.04	.56-	.93	1.67-	.23	2.93-	.03	3.18-	.72	1.07-	.59	.64-	.78	.73-	.78	.60-	.46	.50-	.14	.77-	.38	13.16-	4.22
DOUBLE FOUR RANCH	.78	.31	.36-	.06	.75-	.47	2.76	1.07	2.13-	.45	.73-	3.01	3.78	1.06	4.01	2.87	1.06-	.05	.58-	.21	.19-	.49	.36	.20	16.15	1.30
DOUGLAS AVIATION	.30		.88		.36		3.43		3.11		1.67		.40		.10		1.49		.73		.20		.14		12.47	
FT LARAMIE 11 NNW	.09-	.24	.03-	.34	.71-	.49	1.94	.12	1.93	.47	1.50-	1.38	2.33	.41	.37-	.66	.27-	.88	.52-	.48	.08-	.34	.70-	.13	10.10-	3.65
GLENDO 6 SW	.28		.66		.21		4.46		3.44		1.53		2.55		.19		1.65		.45		.13		.16		14.04	
GLENROCK 5 ESE	.15-	.35	.39-	.05	.70-	.40	3.19	1.62	3.84	1.47	1.17-	.76	.53-	.36	.12-	.88	1.70	.49	1.50	.48	.09-	.47	.08-	.13	13.59	.88
GLENROCK 14 SSE	.46		.66		.66		7.13		1.81		3.01		1.35		.17		1.26		1.49		1.52		.28		16.78	
GUERNSEY DAM 2	.59		.12		.15		2.69		3.01		1.41		1.27		.22		.23		.57		.10		.05		10.45	
HECLA	.35-	.19	.41	.08	.57-	.64	1.97-	.04	1.69-	1.07	1.13-	.43	1.93-	.09	1.29-	.07	.77-	.12	.40-	.71	.29-	.35	.17-	.27	11.31-	4.32
HORSE CREEK 2 NW	.96		.78		.35		1.97		3.15		1.88		2.04		3.32		1.05		.77		.23		.52		13.54	
KEELINE	.13-	.59	.13-	.37	.10-	.93	1.07	1.26	3.77	1.39	1.13-	.81	.19-	.12	1.64	.85	3.14	.03	.43	.04	.22-	.36	T -	.46	14.19	.07
LAGRANGE	1.11	.47	.38-	.01	.36-	.57	2.03	.30	2.60-	.78	1.01-	1.08	1.46-	.21	1.19-	.10	.76-	.33	.29-	.49	.56	.27	.09-	.39	11.99-	3.57
LINGLE 4 S	.78		.12		.23		2.98		3.57		1.92		1.72		1.15		.90		.78		.21		.07		12.30	
PHILLIPS	.57		.32		.31		1.57		2.41		.87		1.09		2.51		.78		.86		.13		.13		10.32	
SYBILLE RESEARCH UNIT	.58		.49		.36		1.91		2.80		1.90		1.03		1.10		.27		.97		.10		.42		11.49	
TINNYSON	.81	.33	.63	.16	.51-	.47	3.97	.79	3.36-	.79	.60-	2.81	.68-	1.47	.99-	.90	.76-	.90	.90-	.78	.35-	.22	T -	.43	16.19-	6.00
TORRINGTON EXP FARM	.33-	.05	.10-	.22	.44-	.26	2.72	.56	3.16	.40	2.74-	.27	3.14	1.44	.16-	.11	.63-	.39	.17-	.57	.00-	.41	.00-	.40	13.34-	.19
WHALEN DAM	.64		.71		.30		2.47		3.11		1.43		1.39		.33		1.17		.53		.04		.16		11.68	
WHEATLAND 4 N	.08-	.16	.32	.03	.29-	.43	3.19	.70	3.62	.64	.36-	3.15	1.62	.42	.44-	.47	.50-	.47	.33-	.42	.05-	.35	.05-	.28	8.91-	3.56
YODER	.68	.42	.70-	.08	.25-	.42	3.43	1.89	3.51	.67	.55-	3.32	.73-	.09	1.26	.72	.24-	.77	.29-	.63	.08-	.30	T -	.73	10.74-	3.09
DIVISION	.58	.09	.55	.13	.33-	.93	2.26	.61	2.69	.11	1.42-	1.28	1.98	.04	1.18	.08	.67-	.19	.39-	.53	.24-	.32	.16-	.29	12.39-	1.88
WIND RIVER 09																										
BOYSEN DAM	.30		.18		.22		1.41		1.49		2.93		T		1.34		.73		1.43		.06		.02		10.77	
BURRIS	T		.33		.68		2.28		2.13		1.22		.37		2.23		.70		T		T		.07		9.16	
DIVERSION DAM	T -	.21	.70	.02	.22-	.78	.99-	.13	3.77	.38	2.34	.26	.33-	.91	3.41	2.09	1.55	.10	.10-	.52	.00-	.43	.00-	.80	11.11	1.65
DUBOIS	T -	.37	.26-	.03	.57	.00	2.56	1.48	1.03-	.35	1.40	.15	.40-	.43	-		-		-		-		-		-	
FORT WASHAKIE 1 SE	.13-	.19	.59	.29	.06-	.74	1.14-	.59	2.42-	.62	.93-	1.25	.11-	.44	1.91	1.02	.79-	.35	1.10	.12	.19-	.50	.22-	.10	9.59	2.79
GAS HILLS 4 E	.81		.34		.22		1.49		1.58		2.08		1.20		.88		.19		1.12		.42		.21		10.60	
LANDER WSO AP //R	.27-	.73	.32	.16	.43-	.75	1.17-	1.19	2.09-	.52	1.47	.04	1.05	.44	.60-	.02	.56-	.92	1.47	.42	.40-	.47	.20-	.75	11.01-	2.83
LOST CABIN	.10		.15		.15		.71		2.27		1.93		.28		1.39		.99		.79		.07		.04		8.63	
PAVILLION	.03-	.16	.25	.09	.04-	.43	.40-	.49	1.40-	.27	1.16-	.44	.00-	.69	1.02	1.12	.60-	.02	.16-	.52	T -	.38	T -	.10	6.36-	2.44
RIVERTON	.12-	.07	.31	.10	.07-	.42	.90-	.37	1.00-	.42	1.43-	.21	.20-	.41	1.56	1.70	.23-	.12	.92	.05	T -	.44	.08-	.13	6.00-	1.74
SAND DRAW	.15		.18		.10		.92		1.58		1.65		.88		.95		.46		-		-		-		-	
SHOSHONI	.07		.33		.04		.90		1.13		1.37		.58		1.27		.63		.49		.00		.08		6.29	
DIVISION	.37-	.14	.39	.02	.25-	.43	1.31-	.23	1.77-	.21	1.80-	.00	.66-	.20	1.55	1.02	.60-	.20	.65-	.02	.13-	.40	.09-	.21	9.39-	1.17
UPPER PLATTE 10																										
ATLANTIC CITY ORE MINE	1.41		2.31		.54		1.09		1.58		2.06		.73		1.16		.29		2.32		.06		.23		13.83	
BATES CREEK 2	.57		.77		.69		3.59		1.26		2.29		1.40		1.17		.07		1.29		.06		.13		13.99	
ELK MOUNTAIN	.05-	.15	1.19	.56	.54-	.28	1.43	.03	.01-	.78	1.20-	.33	.66-	.28	1.31	.43	.33-	.75	.74-	.99	.17-	.43	.41-	.11	9.79-	1.09
ENCAMPMENT 10 ESE	.37-	.47	1.32	.55	1.30	.20	1.69-	.08	1.41-	.36	1.89	.21	1.40	.24	1.20-	.43	.30-	.09	.40-	.40	.20-	.71	.19-	.28	11.46-	3.06
LARAMIE 2	.12		1.20		-		-		-		-		-		-		-		-		-		-		-	
LARAMIE FAA AP	.13-	.39	.33	.12	.30-	.21	.70-	.15	.82-	.47	.79-	.57	1.73	.75	1.15	.03	.09-	.79	.37-	.39	.14-	.35	.14-	.18	6.94-	3.20
LARAMIE 2 NW	.12		.19		.42		1.21		1.00		1.26		2.27		2.20		.33		.46		.15		.13		9.76	
LEO 6 SW	.35-	.23	1.06	.39	.51-	.49	2.12	.77	1.34-	.27	.88-	.66	.77	.10	.10-	.36	.18-	.59	.52-	.46	.13-	.36	.19-	.35	8.35-	2.65
MEDICINE BOW	1.10		.85		.30		1.41		.94		1.10		.28		1.13		.14		.37		.16		.48		8.08	
MUDDY GAP	.49		.66		.25		.65		.70		1.09		.78		-		-		-		-		-		-	
PATHFINDER DAM	.39	.08	.26-	.06	.14-	.51	1.96	.85	1.16-	.47	1.42-	.09	.09	.35	.36-	.33	.96	.19	.65-	.29	.07-	.37	.14-	.22	8.50-	1.01
RAWLINS FAA AP	.16		.75		.44		1.49		.30		1.09		.43		.21		.22		.58		.03		.09		5.96	
SARATOGA	.05-	.49	.53	.12	.60-	.32	1.16	.10	1.76	.55	1.46	.27	1.44	1.75	.52-	.44	.44-	.45	.33-	.78	T -	.31	.33-	.23	9.21-	.37
SEMINOE DAM	.36-	.05	.93	.11	.25-	.41	1.00	.37	2.08-	.11	1.33-	.24	1.32	.43	.41-	.08	.20-	.42	.47-	.10	.26-	.30	.17-	.44	10.47-	1.32
SOUTH PASS CITY	.80-	.45	2.27	1.45	.99-	.63	1.30-	.07	1.87	.39	1.99	.18	1.30	.69	1.21	.57	.15-	.78	1.43	.13	T -	1.09	.14-	.98	13.34-	.39
DIVISION	.43-	.25	.81	.22	.94-	.43	1.99	.25	1.17-	.34	1.45-	.07	1.01	.25	1.01	.02	.38-	.29	.93-	.40	.12-	.57	.26-	.39	8.65-	1.30

See Reference Notes Following Station Index

Table 3

TEMPERATURE EXTREMES AND FREEZE DATA

WYOMING 1974

Station	Highest	Date	Lowest	Date	Last spring minimum of 16° or below Date	Temp.	20° or below Date	Temp.	24° or below Date	Temp.	28° or below Date	Temp.	32° or below Date	Temp.	First fall minimum of 32° or below Date	Temp.	28° or below Date	Temp.	24° or below Date	Temp.	20° or below Date	Temp.	16° or below Date	Temp.	Number of days between dates 16° or below	20° or below	24° or below	28° or below	32° or below
• • •																													
BELLE FOURCHE DRAINAGE 06																													
ALVA 5 SE	96	9- 6	-29	1- 8	3- 2	16	5- 3	17	5- 7	22	5-16	25	6-19	31	8-28	32	9- 9	26	9-20	24	10-15	13	10-15	13	166	165	134	116	70
COLONY	107	9- 6	-19	1- 8	3-13	14	3-16	20	5- 2	21	5- 3	28	5- 7	29	9-27	31	10- 5	27	10-15	23	10-16	19	11-11	10	245	214	166	139	143
DEVILS TOWER 2	98	9- 6	-26	1- 8	3-31	15	5- 3	20	5- 7	23	5-16	27	6-18	31	9- 9	27	9- 9	27	10- 5	20	10- 5	20	10-15	17	198	135	151	116	83
DILLINGER	102	7- 9	-32	2- 6	3-31	11	5- 2	18	5- 2	19	5-16	26	5-18	26	9- 9	26	9- 9	26	10- 5	23	10-15	13	10-15	13	198	169	156	116	116
GILLETTE 2 E	100	7-11	-19	1- 8	3-15	16	3-29	20	5- 2	24	5- 2	24	5-18	31	9- 9	32	10- 5	28	10-13	22	10-19	9	10-19	9	218	204	166	156	116
GILLETTE 18 SW	99	7-11	-18	1- 8	4- 3	13	4- 3	15	5- 2	24	5- 2	24	6-18	32	9-27	31	10-15	19	10-15	19	10-15	19	10-19	7	199	195	166	166	101
MOORCROFT	96	9- 6	-20	2- 6+	3-29	15	3-31	20	-		-		6-15	30	9- 9	32	10- 5	27	10-13	20	10-13	20	11- 7	12	223	198	-	-	86
SUNDANCE	93	9- 6+	-20	1- 8	3-22	16	5- 2	20	5- 2	20	5- 2	20	6-16	32	9- 9	30	10- 5	25	10-15	16	10-15	16	10-15	16	207	166	166	156	87
• • •																													
CHEYENNE AND NIOBRARA DRAINAGE 07																													
BULL CENTER 1 SE	104	7- 9	-24	2- 6	3-29	15	4- 6	19	4- 5	23	5- 3	27	5- 7	32	9- 9	29	9-28	27	10-15	22	10-16	18	10-19	10	204	195	193	148	125
HAT CREEK 5 E	98	7-12+	-19	1- 7	4- 3	14	4- 3	14	4- 5	22	5- 2	26	6-14	32	9-28	28	9-28	28	10-15	19	10-15	19	10-19	9	199	195	193	149	106
LANCE CREEK 3 WNW	107	7-11	-19	2- 7	4- 4	14	4- 4	14	4- 6	23	5- 4	28	5- 9	32	9- 9	28	9- 9	28	10-15	20	10-15	20	10-16	14	195	194	193	128	123
LAWVER 10 SW	-	-	-15	11-27+	-		4- 5	20	-		5- 3	26	5-16	30	-		-		-		-		10-19	15	-	-	-	-	-
LUSK	98	7- 9	-13	1- 7	4- 3	15	4- 6	20	5- 8	24	5- 8	24	6-14	32	9- 2	32	9- 9	20	9- 9	20	9- 9	20	10-16	14	196	158	124	124	80
MORRISEY	102	7-17	-18	2- 6	3-13	15	4- 3	19	4- 3	19	4-20	28	5- 3	32	10- 5	29	-		-		-		-		-	-	-	-	155
NEWCASTLE	101	7- 9	-17	1- 8	3-16	14	4- 3	18	4- 3	18	5- 3	28	5-16	31	9- 9	32	10- 5	24	10- 5	24	10-15	20	10-19	17	217	195	185	155	116
REDBIRD	102	7-11	-30	2- 6	3-31	12	4- 3	20	4-20	24	5- 6	27	5-17	32	8-28	32	9- 9	21	9- 9	21	10-19	11	10-19	11	202	197	142	126	103
RENO	99	7- 9		-	4- 3	15	4-30	20	5- 3	21	5- 3	21	5- 8	29	9-27	31	10-19	21	10-15	21	10-18	16	10-18	16	198	171	165	165	142
ROCHELLE 3 E	101	7- 9	-34	2- 6	3-20	16	4-20	19	5- 7	24	5- 9	28	6-16	31	8-27	31	9- 9	21	9- 9	21	10-17	8	10-17	8	211	180	125	121	70
UPTON	97	7-12+	-28	2- 6	3-29	14	5- 2	20	5- 3	23	5-16	27	6-18	31	8-27	32	9- 9	27	10- 5	24	10-15	17	10-19	11	204	168	155	116	70
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LOWER PLATTE 08																													
ALBIN	97	7- 9	-18	11-27	3-16	16	4- 3	19	4- 4	23	5- 3	28	5-17	29	9-28	31	10- 7	24	10- 7	24	10-16	20	10-19	12	217	196	186	157	134
ALCOVA 17 NW	90	7- 9	-27	3-13	4- 2	15	4- 2	15	4-22	23	6-23	28	6-26	32	10- 5	32	10- 7	22	10- 7	22	10-18	19	10-19	14	200	199	169	104	101
ARCHER	98	7-10	-17	11-27	3-30	15	4- 3	20	4-20	24	5-17	28	5-17	28	9-28	30	10- 7	21	10- 7	21	10-16	16	10-18	16	200	196	170	163	134
CARPENTER 3 E	101	7-10+	-14	11-27	4- 3	16	4- 3	16	4- 4	23	5-17	26	5-17	26	9-28	30	10- 7	23	10- 7	23	10-16	20	10-19	10	199	196	186	143	134
CASPER 2 E	100	7- 9	-17	11-27	3-15	16	4- 3	18	4- 4	23	4-20	26	5-16	31	9- 9	31	10- 7	18	10-16	21	10-19	20	11-12	8	242	199	193	170	116
CASPER WSO AP	99	7- 9	-14	2- 5	4- 3	15	4- 3	15	4- 5	24	4-30	28	5-16	29	9- 9	31	10- 7	27	10-15	24	10-16	19	11-12	5	223	196	193	160	116
CHEYENNE WSO AP	94	7-10+	-13	11-27	3-30	15	3-31	19	3-31	19	4-20	26	5-17	32	9-28	30	10- 7	23	10- 7	23	10-16	19	10-19	13	207	199	190	179	134
CHUGWATER	100	7-12	-26	11-27	4- 3	9	4- 5	20	4- 5	20	5-17	28	6-19	31	9- 9	27	9- 9	27	10-15	18	10-15	18	10-19	10	199	193	193	115	82
DOUBLE FOUR RANCH	99	7-12	-19	2- 6	3-13	14	4- 5	20	5-17	23	5-17	23	5-17	23	8-27	30	9- 9	26	10- 7	21	10-15	20	10-16	14	217	193	143	119	102
DOUGLAS AVIATION	99	7- 8	-22	1- 3	4- 3	12	4- 3	12	4- 5	23	4-20	25	5-16	31	9- 9	30	9-28	27	10-15	24	10-18	20	10-19	7	199	198	193	161	116
GLENDO 4 SW	99	7- 9		-	4- 6	15	4- 6	19	4-20	23	5-16	27	6-19	31	8-28	30	9- 9	25	9-28	21	10-15	20	10-16	12	199	192	161	118	70
GLENROCK 5 ESE	94	8-25+	-14	11-27	3-12	3	4- 3	17	4- 6	22	4-20	26	5- 3	32	9- 9	32	10- 7	28	10-16	20	10-16	20	11-12	5	245	198	193	170	129
GLENROCK 14 SSE		-		-	3-13	12	4-20	19	4-24	23	5-16	26	6-27	31	8-27	30	9- 9	25	10- 7	21	10-15	14	10-15	14	214	176	166	110	61
HORSE CREEK 2 NW	92	7-12+	-10	11-28+	3-30	16	4- 4	20	4-17	22	5-15	27	6-26	31	9- 9	32	9-28	28	10-15	20	10-15	20	10-19	16	203	194	141	116	75
KEELINE	98	7- 9+	-20	11-27	4- 3	13	4- 3	13	5- 6	24	5- 6	24	6-26	32	8-27	31	9-28	27	10- 5	24	10-15	19	10-18	16	198	195	132	149	62
LAGRANGE		-	-26	11-27	4- 3	13	4- 4	19	4-20	24	5- 2	28	5-19	30	9- 9	29	9-28	25	10- 7	23	10-15	18	10-16	17	196	194	170	149	113
PHILLIPS	100	7- 9	-20	11-27	4- 3	15	4- 3	15	4- 3	15	4-25	28	5-17	32	9- 9	31	9-28	27	10- 7	24	10-15	20	10-16	11	196	195	187	156	115
SYBILLE RESEARCH UNIT	92	7-12+	-11	11-27+	4- 3	14	4- 3	14	4- 3	14	4-30	26	6-14	31	8-28	31	10- 7	26	10-13	17	10-13	17	10-19	15	199	195	195	167	106
TORRINGTON EXP FARM	103	7- 8	-21	11-27	4- 3	16	4- 3	16	4- 3	16	4-30	19	5-18	32	9- 9	29	9-28	28	10-16	18	10-16	18	10-19	10	199	196	196	161	114
WHALEN DAM	106	7-10	-12	1- 3	3-31	18	4- 3	18	4- 3	18	4-20	28	5- 3	32	9-10	32	9-28	28	10-16	22	10-19	12	10-19	12	202	199	196	161	130
WHEATLAND 4 N	102	7- 9	-22	2- 6	4- 3	15	4- 6	19	4- 6	19	4-20	28	5-16	31	9-28	29	9-28	25	10- 7	23	10-19	20	10-19	8	199	194	186	161	139
YODER	104	7- 9+	-22	1- 7+	3-12	7	4- 3	16	4- 4	22	5- 1	28	5-14	31	-		-		-		-		-		-	-	-	-	-
• • •																													
WIND RIVER 09																													
BOYSEN DAM	100	7-26+	-21	2- 7+	3-12	10	3-29	20	3-30	22	5-15	25	5-15	25	-		-		-		11-12	20	11-13	19	246	228	-	-	-
BURRIS	91	7-11+	-23	2- 6+	4- 3	13	4- 3	13	4-30	23	4-10	23	6-14	32	9- 9	30	10- 5	26	10- 7	23	10-15	20	10-16	16	198	185	160	158	87
DIVERSION DAM	97	7-10+	-28	2- 7	4- 3	9	4- 3	9	4-24	23	4-24	23	6-15	30	9- 9	30	10- 9	28	10- 7	24	-		-		-	-	166	164	86
DUBOIS	-		-		4-28	15	4-28	15	5-14	23	5-14	23	6-24	32	-		-		-		-		-		-	-	-	-	-
FORT WASHAKIE 1 SE	94	7-10	-27	2- 6	4- 7	15	4-27	20	4-27	20	6-14	28	6-24	32	8-26	31	9- 9	28	10- 7	21	10-16	20	10-19	16	195	172	163	87	63
GAS HILLS 4 E	95	7-10+	-18	1- 3	3-30	14	4-27	20	5- 7	24	6-14	28	6-28	32	10- 5	30	10- 7	26	10-13	22	10-16	13	11-12	16	227	174	161	119	101
LANDER WSO AP	97	7-10+	-21	2- 6	3-13	12	3-30	18	4- 3	21	4-27	26	6-14	32	10- 6	32	10- 7	26	10-16	22	10-16	13	11-12	16	244	201	196	163	114
LOST CABIN	98	7-11+	-32	2- 6	4- 3	15	5-15	20	5-15	20	5-13	20	6-25	30	8-27	31	9- 9	28	10- 7	23	10-16	16	10-16	16	194	154	145	117	63
PAVILLION	97	7-10	-21	2- 6	3-29	16	4- 3	18	-		4-24	25	6-14	32	10- 5	31	10- 7	24	10- 7	24	10-19	18	11-13	6	229	193	-	166	113
RIVERTON	101	7-11+	-32	2- 6	4- 3	16	4- 3	16	4-24	22	5- 1	26	6-13	31	9- 9	30	10- 9	27	10- 8	23	10-13	20	10-19	13	199	195	167	137	86
SAND DRAW	-		-		-		-		-		-		-		9- 9	30	-		-		-		-		-	-	-	-	-
• • •																													
UPPER PLATTE 10																													
BATES CREEK 2	95	7-11+	-13	2- 6	4- 3	15	4- 3	15	4- 3	15	5-16	28	6-14	32	9-27	27	9-27	27	10-15	23	10-16	19	10-19	16	196	196	195	134	105
ELK MOUNTAIN	90	7-11	-19	11-27	3-30	10	4-27	20	5-16	22	6-14	26	6-18	31	8-27	31	9-28	26	10- 7	17	10- 7	17	10-15	16	199	163	144	104	70
ENCAMPMENT 10 ESE	88	7-11	-24	11-27	4-27	15	4-27	15	5-15	23	6-14	23	6-27	32	8-27	31	9-26	28	9-28	20	9-28	20	10- 7	16	163	154	106	104	61
LARAMIE 2																													
LARAMIE FAA AP	91	7- 9	-21	11-27	4- 3	14	5- 1	19	5- 7	22	6-14	27	6-24	32	9- 9	24	9- 9	24	9- 9	24	9-28	16	10-16	16	196	150	130	87	77
LARAMIE 2 NW	97	7- 9	-24	11-27	4- 3	11	6-14	20	6-14	20	6-24	28	6-24	28	9-11	28	9- 1	28	9-28	16	9-28	16	9-28	16	178	106	106	69	69
MEDICINE BOW	94	7-12+	-26	11-27	4- 4	13	4- 3	19	5-19	23	6-14	28	6-30	32	8-27	30	8-25	28	9- 9	23	9-28	16	9-28	16	177	176	119	79	58
MUDDY GAP	-		-		3-30	13	3-30	15	3-30	15	5-16	24	6-14	32	-		-		-		-		-		-	-	-	-	-
PATHFINDER DAM	97	7-11	-20	2- 6	4-16	16	4-16	16	4-18	16	4-20	27	-		10- 5	32	10- 7	27	10-16	24	10-19	18	11-12	7	208	184	181	170	-
RAWLINS FAA AP	93	7- 9	-19	2- 6	4- 3	15	4- 4	18	6-27	24	6-14	28	6-14	28	9- 9	28	9-28	20	9-28	20	10- 7	16	[illegible]	[illegible]	167	177	154	87	87
SARATOGA	98	7-12	-16	11-27	3-30	12	4- 3	19	5-16	24	6-14	26	6-14	26	8-27	32	9-24	23	10- 7	23	10-15	19	10-18	16	200	195	144	106	74
SEMINOE DAM	97	7-11	-11	2- 6+	3-30	14	3-30	14	4- 3	22	5-16	29	6-14	29	9-27	32	10- 7	24	10- 7	24	10-18	19	11-12	8	227	207	187	144	105
SOUTH PASS CITY	88	7-10	-25	11-27	4-25	15	6-15	19	6-28	24	6-28	24	6-29	32	7- 3	32	8- 4	28	8-17	21	9- 9	16	9- 9	16	137	86	60	41	4

SOIL TEMPERATURES

Station	Depth (IN)	Time	January Average	January Extremes	February Average	February Extremes	March Average	March Extremes	April Average	April Extremes	May Average	May Extremes	June Average	June Extremes	July Average	July Extremes	August Average	August Extremes	September Average	September Extremes	October Average	October Extremes	November Average	November Extremes	December Average	December Extremes	Annual Average	Annual Extremes
ARCHER																												
	2.25		32.6	35 24	35.3	45 31	40.8	60 32	52.7	68 39	62.4	84 41	75.6	97 52	80.9	102 59	74.5	94 59	68.5	98 45	52.4	76 32	40.4	56 21	32.2	43 17	53.9	102 17
	4		34.1	38 30	37.0	49 32	42.4	61 32	53.9	67 40	62.9	84 42	75.4	95 52	80.1	98 61	74.9	90 61	68.8	90 48	53.7	72 39	42.4	56 30	34.2	43 21	54.9	98 21
	8		33.1	35 31	34.8	41 31	39.9	52 32	50.9	60 41	58.4	72 46	69.9	83 58	76.0	90 65	71.9	79 60	65.9	78 49	52.4	66 41	41.8	49 33	34.3	42 27	52.3	90 27
	20	8PM	36.4	37 36	36.4	38 34	38.9	43 37	47.9	50 43	55.7	59 46	63.5	67 59	68.6	70 65	66.5	68 62	63.7	69 58	54.0	60 48	45.2	48 41	38.4	41 36	51.1	70 36
	40	8PM	43.0	44 42	42.0	42 42	42.9	45 42	48.5	51 45	53.0	56 49	60.6	66 56	65.1	67 63	65.8	67 65	64.8	67 62	58.7	62 55	51.8	54 49	45.8	48 44	53.5	67 42
CASPER WSO AP																												
	2.25		-	- -	33.7	44 31	40.2	53 32	51.6	63 38	62.7	78 46	72.3	95 50	83.0	97 63	80.6	96 65	69.1	92 48	50.8	71 37	40.4	51 31	32.4	38 27	-	97 -
	4		-	- -	33.3	40 32	39.4	49 33	50.5	58 43	61.0	72 47	70.3	82 53	80.6	91 65	78.2	89 67	68.1	85 51	50.7	67 40	41.0	49 33	33.0	37 30	-	91 -
	8		-	- -	32.0	36 31	36.9	42 32	47.4	52 41	57.8	68 46	67.1	75 54	77.7	83 66	75.6	83 62	66.7	83 53	49.9	62 41	40.1	46 33	32.2	35 30	-	83 -
	20	5PM	-	-	34.0	35 34	36.8	40 34	45.6	48 41	54.2	59 47	63.0	67 59	72.5	75 67	72.5	74 71	67.2	73 59	53.3	61 47	44.1	48 40	36.5	39 35	-	75 -
	40	5PM	-	-	36.3	37 36	37.3	40 36	44.2	46 40	51.3	55 44	59.3	61 55	67.0	70 63	69.5	70 69	67.1	71 63	57.0	63 51	48.1	51 45	41.2	44 39	-	71 -
GILLETTE 2 E																												
	2.25		31.9	33 28	31.6	35 28	37.6	55 31	50.4	- 35	61.3	80 43	71.4	89 52	81.0	94 69	78.0	92 61	-	- -	47.9	72 31	36.6	47 25	33.4	35 30	-	94 25
	4		34.4	35 31	34.0	36 31	39.5	54 34	52.6	- 38	62.8	78 47	72.9	87 57	82.7	92 73	79.4	89 64	-	- -	50.8	70 39	39.8	49 30	36.5	38 32	-	92 30
	20	VAR	33.3	34 32	31.9	33 31	34.7	40 32	45.1	- 40	55.9	59 48	64.1	69 60	72.7	75 67	71.7	74 70	-	- -	50.2	60 39	40.0	45 36	35.8	37 33	-	75 31
	40	VAR	37.7	39 36	35.3	36 35	36.7	40 35	44.6	- 40	51.7	56 45	61.5	64 57	69.3	72 64	70.7	72 70	-	- -	56.6	63 50	46.0	50 43	40.8	42 39	-	72 35
POWELL FIELD STATION																												
	2.25		23.0	27 19	26.7	35 18	32.7	47 24	48.4	58 37	58.7	69 44	61.9	73 49	74.6	83 65	70.3	78 60	60.7	74 51	45.2	59 38	36.5	45 30	27.7	31 24	47.2	83 18
	4		24.3	27 22	27.8	34 20	33.4	45 25	48.9	56 39	59.4	67 46	63.1	71 51	75.4	88 65	71.7	77 64	62.4	75 54	46.8	59 40	38.1	46 32	29.4	32 26	48.4	88 20
	8		24.4	27 21	27.1	35 21	32.3	39 26	45.8	50 39	55.2	61 45	59.1	64 52	70.7	76 65	68.2	72 64	60.9	72 54	46.1	55 41	38.3	46 31	29.9	32 28	46.4	76 21
	20	5PM	32.5	34 32	33.6	36 31	37.5	42 34	48.3	51 43	56.3	62 48	61.6	64 59	70.9	73 65	70.8	72 69	66.2	72 61	54.6	62 50	46.1	50 41	38.5	41 36	51.4	73 31
	40	5PM	35.9	38 35	34.8	36 34	36.3	39 35	42.8	45 39	48.6	53 45	54.6	56 53	60.4	64 56	63.9	65 63	63.2	65 60	55.4	60 51	48.2	51 43	41.2	44 39	48.8	65 34
RIVERTON 2																												
	2.25		15.3	18 8	22.4	31 16	30.6	40 17	43.8	64 34	65.8	86 41	70.4	95 45	84.6	109 64	77.0	94 57	69.5	93 47	48.2	73 30	34.0	49 16	19.6	28 9	48.2	109 8
	4		18.3	22 13	24.5	32 20	34.3	43 19	46.8	59 37	63.4	79 46	70.0	87 46	82.9	100 68	76.4	92 62	69.7	88 56	50.1	67 37	36.6	47 23	22.2	28 12	49.6	100 12
	8		20.9	22 18	25.2	32 18	37.0	48 29	48.9	56 39	61.3	77 48	68.9	80 57	80.9	85 73	75.3	84 68	68.6	78 58	51.6	65 42	38.0	46 25	25.1	28 20	50.1	85 18
	20	8AM	46.1	48 43	41.1	44 38	38.9	40 38	42.3	45 40	-	- -	52.9	55 50	-	- -	-	- -	-	- -	-	- -	-	- -	-	- -	-	- 38
	40	8AM	45.8	48 43	41.0	44 34	38.9	40 38	42.8	45 40	-	- -	52.9	55 50	57.7	60 55	-	- -	-	- -	-	- -	-	- -	-	- -	-	60 34

See Reference Notes Following Station Index

Table 4

TOTAL EVAPORATION AND WIND MOVEMENT

WYOMING
1976

Station		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
• • • BIG HORN 04														
ANCHOR DAM	EVAP	-	-	-	-	-	6.48B	8.06	7.49	4.96	-	-	-	-
	WIND	-	-	-	-	-	884	711	866	595	-	-	-	-
	MAX	-	-	-	-	-	74.4	83.8	76.3	68.9	-	-	-	-
	MIN	-	-	-	-	-	49.9	57.3	52.7	47.2	-	-	-	-
HEART MOUNTAIN	EVAP	-	-	-	-	6.32	5.46	7.32	6.35	3.50	-	-	-	-
	WIND	-	-	-	-	1002B	442	163	-	197	-	-	-	-
	MAX	-	-	-	-	76.5	83.7	93.2	84.7	71.2	-	-	-	-
	MIN	-	-	-	-	47.7	53.0	59.7	53.4	46.3	-	-	-	-
• • • POWDER, LITTLE MO. & TONGUE DRAINAGE 05														
SHERIDAN FIELD STA	EVAP	-	-	-	-	6.89	7.83	10.84B	10.00B	5.91B	-	-	-	-
	WIND	-	-	-	-	2850B	2264	2099B	2500	1565	-	-	-	-
	MAX	-	-	-	-	71.0	76.8	89.4	83.2	73.3	-	-	-	-
	MIN	-	-	-	-	45.0	51.1	57.8	54.6	47.2	-	-	-	-
• • • BELLE FOURCHE DRAINAGE 06														
GILLETTE 2 E	EVAP	-	-	-	4.33B	6.83B	8.61B	10.26B	9.99B	6.94B	3.72B	-	-	-
	WIND	-	-	-	2143	1555	1032	1364	1641B	1278	1359	-	-	-
	MAX	-	-	-	63.4	75.7	84.9	90.9	84.0	76.5	58.2	-	-	-
	MIN	-	-	-	39.3	46.1	54.4	60.4	56.3	49.1	37.8	-	-	-
• • • LOWER PLATTE 08														
WHALEN DAM	EVAP	-	-	-	4.56	7.18	9.63	11.53	9.60	6.69	4.68B	-	-	-
	DEP	-	-	-	-	.20	.37	1.05	.37	.12	.02	-	-	-
	WIND	-	-	-	-	2198B	1911	1426	1311	1105	-	-	-	-
	MAX	-	-	-	-	71.6	79.5	88.2	82.8	73.1	-	-	-	-
	MIN	-	-	-	-	44.8	50.8	59.9	55.8	47.5	-	-	-	-
• • • WIND RIVER 09														
BOYSEN DAM	EVAP	-	-	-	-	-	7.94B	9.89	7.65	-	-	-	-	-
	DEP	-	-	-	-	-	1.67	1.33	2.54	-	-	-	-	-
	WIND	-	-	-	-	-	1122	947	847	-	954B	-	-	-
	MAX	-	-	-	-	-	76.3	88.1	84.9	-	-	-	-	-
	MIN	-	-	-	-	-	55.5	61.7	57.4	-	-	-	-	-
• • • UPPER PLATTE 10														
LARAMIE 2 NW	EVAP	-	-	-	-	7.14B	9.64B	10.88B	9.02	6.66	-	-	-	-
	WIND	-	-	-	-	3697	3126	1724	2767	2221	2653	-	-	-
	MAX	-	-	-	-	65.5	75.9	84.3	77.7	69.7	-	-	-	-
	MIN	-	-	-	-	37.8	42.7	52.1	45.6	41.5	-	-	-	-
PATHFINDER DAM	EVAP	-	-	-	5.73B	8.37B	-	11.91	11.54	7.61	5.20B	-	-	-
	DEP	-	-	-	-	2.57	-	2.36	2.76	1.07	-	-	-	-
	WIND	-	-	4170	3075	2456B	-	2294B	2658	2224	-	2487	-	-
	MAX	-	-	-	-	73.9	-	86.4	80.3	73.2	60.6	-	-	-
	MIN	-	-	-	-	44.2	-	56.8	52.8	47.7	36.8	-	-	-

See Reference Notes Following Station Index

2.6 BACKGROUND RADIATION

Natural background radiation consists of cosmic radiation and radiation from natural terrestrial radioactivity. Tables I and II, (taken from "Radiological Quality of the Environment in the U. S., 1977," U. S. Environmental Protection Agency, Office of Radiation Programs) give the estimated average annual exposure to cosmic and gamma rays respectively, per person in each State in the United States, expressed in milliroentgens equivalent man per year per person (mrem/year/person).

The cosmic radiation figure for Wyoming is 130 mrem/year/person, which is approximately three times the average for the United States. The high topographic elevation of the State is the reason for the higher than average cosmic radiation. The terrestrial radioactivity (90 mrem/year/person) is 50% above the national average.

Readings of the total gamma ray radioactivity at selected locations at the site and vicinity are being taken to establish a local background value, as well as any significant range in diurnal, weekly and monthly fluctuations.

A portable scintillation counter of adequate sensitivity is used for the measurements.

TABLE I

Estimated annual cosmic-ray whole-body doses *(2.10)*
(mrem/person)

Political Unit	Average Annual Dose
Alabama	40
Alaska	45
Arizona	60
Arkansas	40
California	40
Colorado	120
Connecticut	40
Delaware	40
Florida	35
Georgia	40
Hawaii	30
Idaho	85
Illinois	45
Indiana	45
Iowa	50
Kansas	50
Kentucky	45
Louisiana	35
Maine	50
Maryland	40
Massachusetts	40
Michigan	50
Minnesota	55
Mississippi	40
Missouri	45
Montana	90
Nebraska	75
Nevada	85
New Hampshire	45

Political Unit	Average Annual Dose
New Jersey	40
New Mexico	105
New York	45
North Carolina	45
North Dakota	60
Ohio	50
Oklahoma	50
Oregon	50
Pennsylvania	45
Rhode Island	40
South Carolina	40
South Dakota	70
Tennessee	45
Texas	45
Utah	115
Vermont	50
Virginia	45
Washington	50
West Virginia	50
Wisconsin	50
Wyoming	130
Canal Zone	30
Guam	35
Puerto Rico	30
Samoa	30
Virgin Islands	30
District of Columbia	40
Total United States	45

TABLE II

Estimated annual external gamma whole-body doses from natural terrestrial radioactivity *(2.10)* (mrem/person)

Political Unit	Average Annual Dose
Alabama	70
Alaska	60*
Arizona	60*
Arkansas	75
California	50
Colorado	105
Connecticut	60
Delaware	60*
Florida	60*
Georgia	60*
Hawaii	60*
Idaho	60*
Illinois	65
Indiana	55
Iowa	60
Kansas	60*
Kentucky	60*
Louisiana	40
Maine	75
Maryland	55
Massachusetts	75
Michigan	60*
Minnesota	70
Mississippi	65
Missouri	60*
Montana	60*
Nebraska	55
Nevada	40
New Hampshire	65

*Assumed to be equal to the United States average.

Political Unit	Average Annual Doses
New Jersey	60
New Mexico	70
New York	65
North Carolina	75
North Dakota	60*
Ohio	65
Oklahoma	60
Oregon	60*
Pennsylvania	55
Rhode Island	65
South Carolina	70
South Dakota	115
Tennessee	70
Texas	30
Utah	40
Vermont	45
Virginia	55
Washington	60*
West Virginia	60*
Wisconsin	55
Wyoming	90
Canal Zone	60*
Guam	60*
Puerto Rico	60*
Samoa	60*
Virgin Islands	60*
District of Columbia	55
Others	60*
Total United States	60

2.7 SEISMOLOGY

The comparative seismic risk at the test site and in the general area is indicated in Figures 7, 8, and 9, adapted from Seismic Risk Studies of the United States, a publication of the Environmental Science Services Administration (Ref. 6). A computer printout (Fig. 11) was obtained from the Earthquake Data File, National Geophysical and Solar Terrestrial Data Center, (Enclosure 7) which gives information on earthquakes which occurred within a 200-mile radius of Moorcroft, Wyoming from 1895 through 1976. Earthquakes of Intensity IV or higher are plotted on Figure 10.

An inspection of the above data indicates that the test site area lies in a zone of low seismic activity and risk.

The pilot plant is semi-movable, low relief in design (modular). It will be enclosed in a Butler type housing structure (structurally flexible). Erection will be in compliance with local building codes.

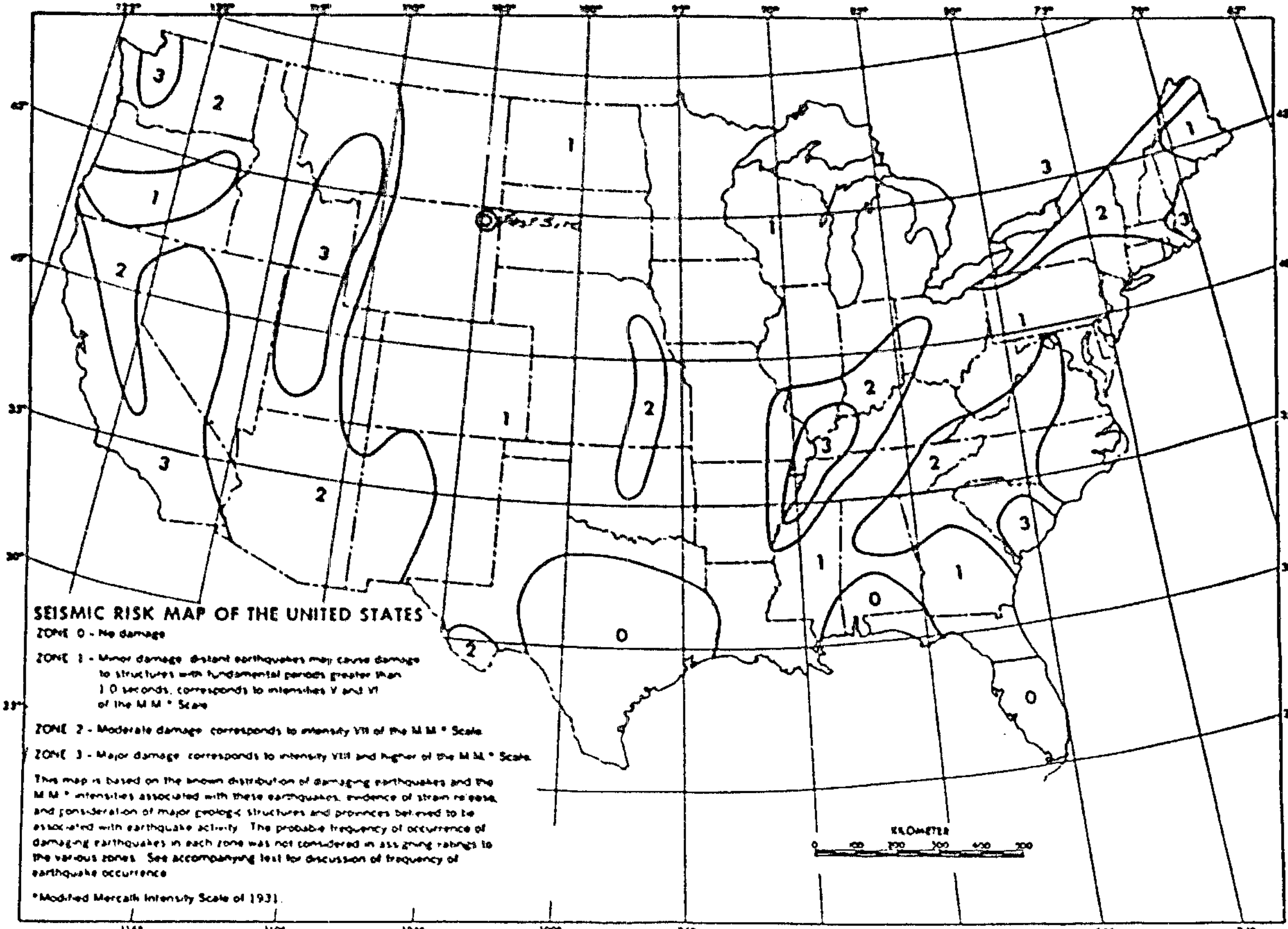


Figure 7. Seismic Risk Map of the United States; after Algermissen

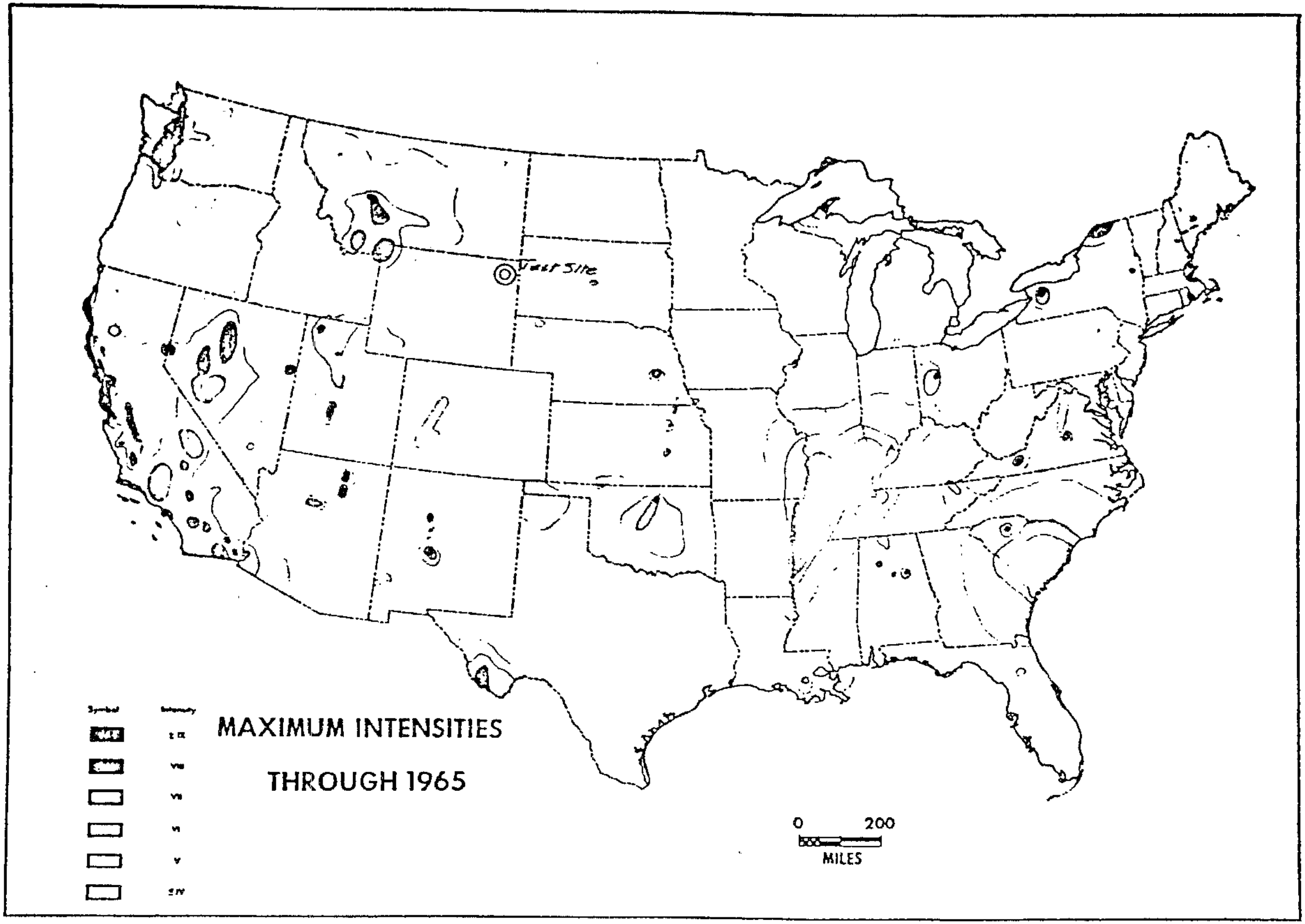


Figure 8. Maximum Modified Mercalli intensities throughout the United States - all historical data through 1965; after Algermissen

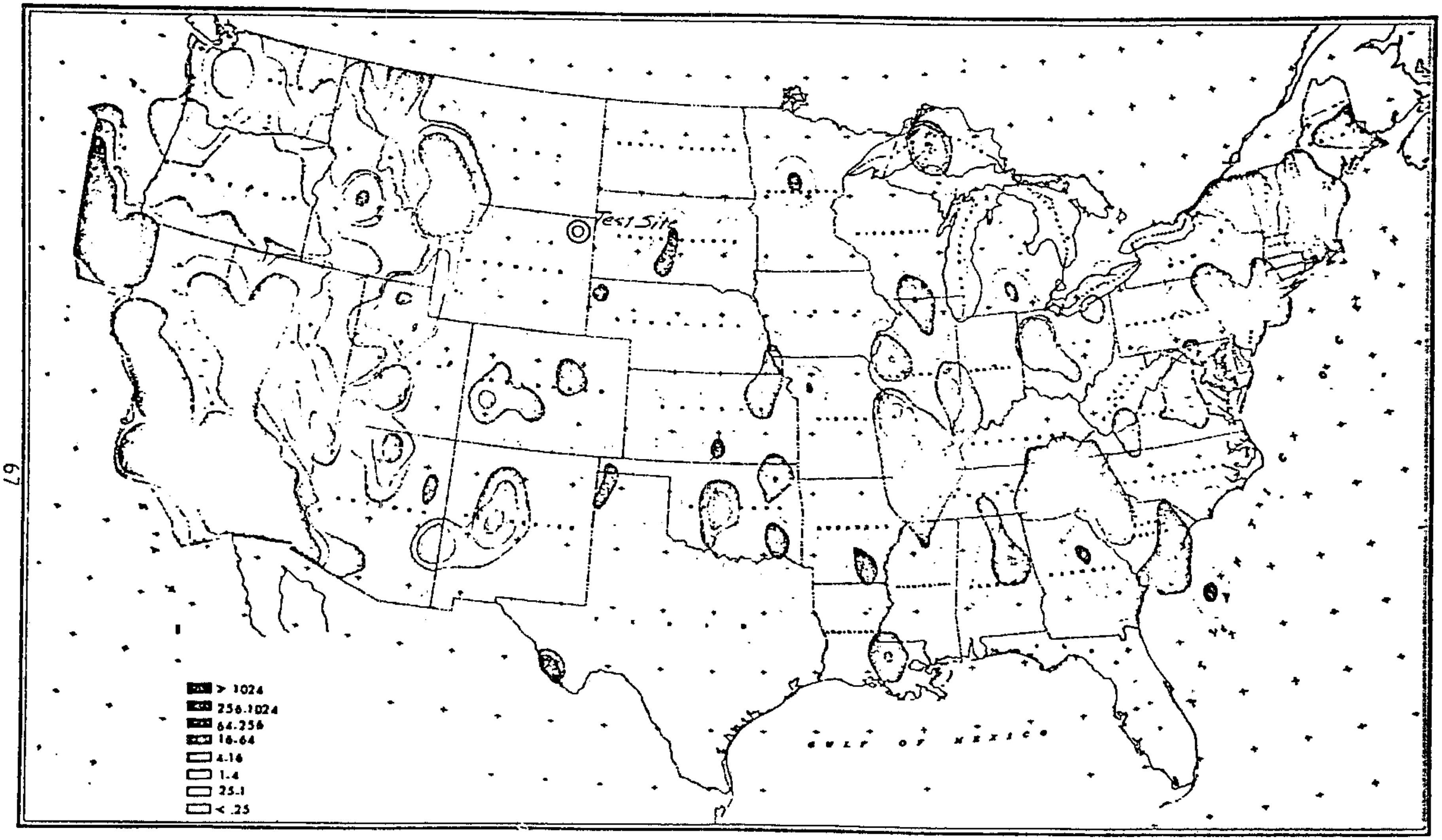


Figure 9. Strain Release in the United States, 1900 to 1965 experssed as the equivalent number of magnitude IV earthquakes; after Algermissen

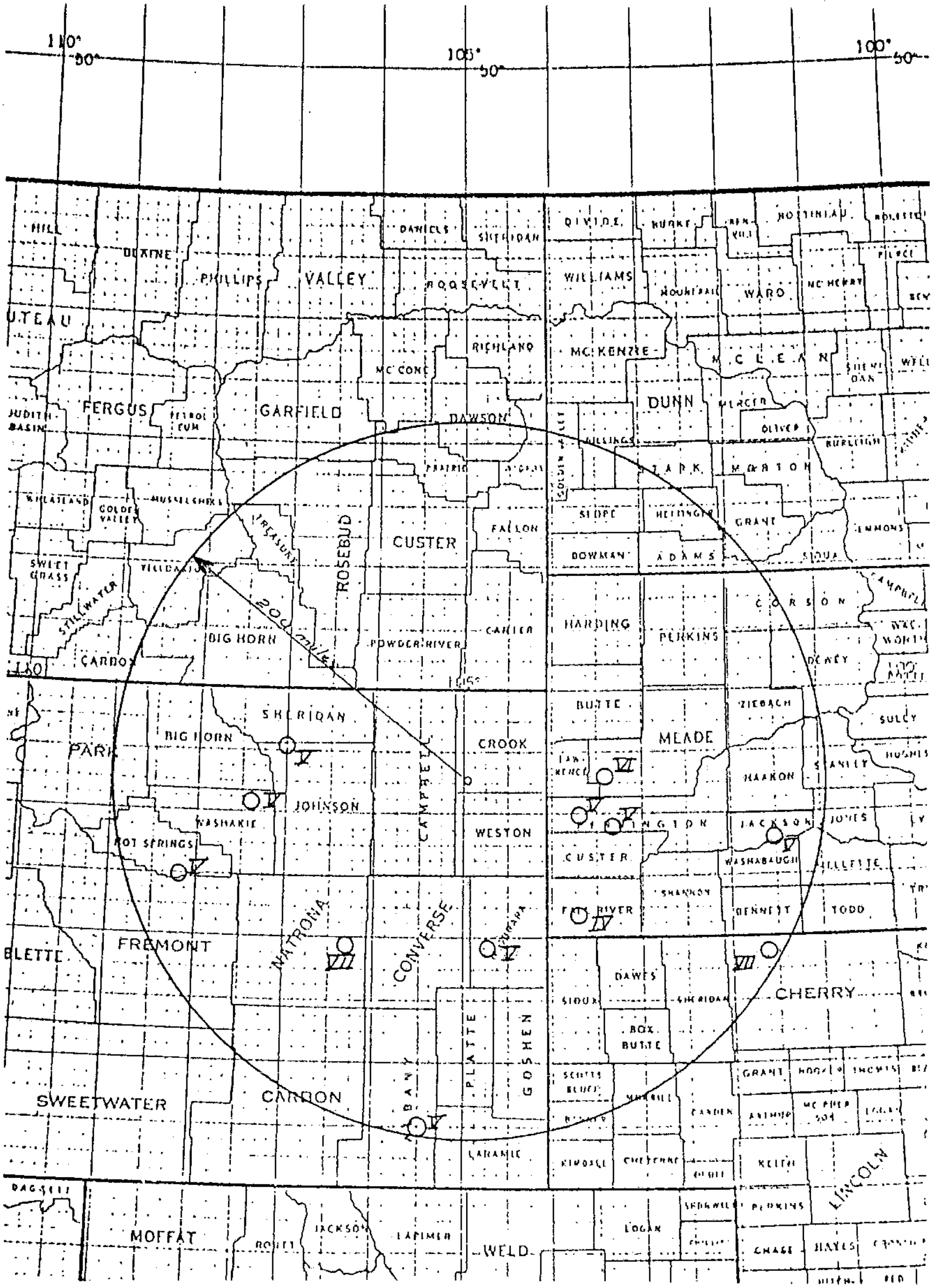


Figure 10. Location of Earthquakes of Intensity IV or higher that took place within 200 miles of Moorcroft, Wyoming between 1895 and 1977. From Earthquake Data File Computer Printout. National Geophysical and Solar-Terrestrial Data Centers; Environmental Data Service; National Oceanic & Atmospheric Administration. (11/23/77)

SOURCE	YEAR	MO DA HR MN SEC	LAT	LONG	DEPTH (KM)	MAGNITUDES BODY	LOCAL	INT MAP	INT MAX	PHENOM DISGND	AN CC	Q/S	MAP CG	DIST (KM)
EGM	1935	[illegible]	[illegible]	[illegible]					V		[illegible] F		155 53	138
EGM	1937	11 1[illegible]	[illegible]	[illegible]					VII		[illegible]		155 26	167
EGM	[illegible]	[illegible]	[illegible]	[illegible]					V		[illegible] F		155 31	281
EQH	[illegible]	[illegible]	[illegible]	[illegible]					V		[illegible] F		155 47	167
USE	[illegible]	[illegible]	[illegible]	[illegible]					V		[illegible] F		155 38	274
USE	[illegible]	[illegible]	[illegible]	[illegible]							[illegible] F		[illegible]	274
USE	[illegible]	[illegible]	[illegible]	[illegible]					V		[illegible] F		155 43	[illegible]
USE	[illegible]	[illegible]	[illegible]	[illegible]					V		[illegible] F		[illegible] 15	311
USE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		USE	VII		[illegible]		155 21	[illegible]
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]		155 21	[illegible]
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			V		[illegible] F	007	155 24	153
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	005	155 32	226
CGS	1965	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	011	[illegible]	145
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	006	[illegible] 47	172
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			VI		[illegible]	007	155 43	[illegible]
CGS	1967	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
CGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	229
[illegible]	[illegible]	12 12 15 57 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	016	155 37	210
ERL	1971	[illegible]	[illegible]	[illegible]	[illegible]						[illegible] F	[illegible]	[illegible]	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	010	155 45	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	019	[illegible]	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	155 27	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	155 16	[illegible]
ERL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
ERL	1973	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	241
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				C	[illegible]	013	155 16	298
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				C	[illegible]	[illegible]	155 16	[illegible]
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	155 16	[illegible]
GS	[illegible]	11 1[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]
GS	[illegible]	11 21 22 [illegible]	[illegible]	[illegible]	[illegible]					C	[illegible]	[illegible]	[illegible]	[illegible]
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					C	[illegible]	010	[illegible] 47	191
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					C	[illegible]	[illegible]	155 26	[illegible]
GS	1974	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			V		[illegible] F	[illegible]	155 47	[illegible]
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			II		[illegible] F	22	155 26	[illegible]
GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				IV		452 F	17	155 33	153
GS	1975	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	11	155 16	[illegible]
GS	1975	12 19 23 24 [illegible]	[illegible]	[illegible]	[illegible]		[illegible]				[illegible]	17	155 27	[illegible]
GS	[illegible]	12 [illegible] 23 12 [illegible]	[illegible]	[illegible]	[illegible]						[illegible]	14	155 27	[illegible]
GS	[illegible]	[illegible] 27 [illegible]	[illegible]	[illegible]	[illegible]						[illegible] F	14	155 17	217
GS	1976	05 1[illegible] 13 54 57.5	[illegible]	[illegible]	[illegible]		3.40ML GS				456	13	155 56	153
GS	1975	[illegible] 03 [illegible] 16.2	[illegible]	105.15[illegible]	[illegible]	4.9 MB	4.20ML GS				450 F	30	155 46	99

Intensity
Appendix 5

Distance in km. between
earthquake location and
Moorcroft

THIS RUN CONTAINS 44 HITS

PREPARED BY THE NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER

ENVIRONMENTAL DATA SERVICE——NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

11/23/77 PAGE 1

Figure 11. Earthquake Data File Computer Printout; Earthquakes within 200-mile radius around Moorcroft, Wyoming

APPENDIX 5

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like a passing truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage *negligible* in buildings of good design and construction; *slight* to *moderate* in well-built ordinary structures; *considerable* in poorly bui or badly designed structures; some chimneys broken. Noticed by persons driving motorcars.

VIII. Damage *slight* in specially designed structures; *considerable* in ordinary substantial buildings, with partial collapse; *great* in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed.

IX. Damage *considerable* in specially designed structures; well-designed frame structures thrown out of plumb; *great* in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with their foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

Figure 12. Modified Mercalli intensity scale 1931 - From Earthquake Data File Summary

APPENDIX 5 (Cont.)

XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage *total*. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into air.

USA Modified Mercalli, 1931 (MM)	Japanese, 1950 (JMA)	Rossi-Forel, 1873 (RF)	European (Mercalli-Cancani-Sieberg), 1917
I	0	I	I
II	I	I-II	II
III	II	III	III
IV	II-III	IV-V	IV
V	III	V-VI	V
VI	IV	VI-VII	VI
VII	IV-V	VIII-	VII
VIII	V	VIII+ - IX-	VIII
IX	V-VI	IX+	IX
X	VI	X	X
XI	VII		XI
XII			XII

Figure 13. Modified Mercalli intensity scale, 1931 - (continued)

ENCLOSURE 7

Earthquake Data File Summary, Key to Geophysical Records Documentation, Appendices 3, 4, and 6, from; National Oceanic and Atmospheric Administration, Environmental Data Services, National Geophysical and Solar-Terrestrial Data Center, Boulder, Colorado

Refer to section 2.7

APPENDIX 3

DATA FORMAT--PRINTOUTS

Field	*Description**	*Tape Position***
SOURCE	Data source (appendix 4).	6-8
YEAR, MO, DA	Date (UT/GMT).	10-17
HR, MN, SEC	Origin time (UT/GMT). Letter or symbol following time is quality and code for time and coordinates.	18-24, 77
LAT, LONG	Geographic latitude and longitude.	25-37
DEPTH	A, G, D, or N following value designates depth control factor.	38-40, 73
MAGNITUDES	Body- and surface- (SURF.) wave values as determined by PDE programs. Authority for other magnitudes and local magnitudes according to source codes (appendix 4).	41-43, 59-60, 66-68, 78-80
INT MAP	Isoseismal map published.	46-48
INT MAX	Maximum intensity (appendix 5).	49
PHENOM DTSVNO	Associated phenomena: Diastrophism, Tsunami, Seiche, Volcanism, Nontectonic, and Waves Generated.	50-55
RN	Flinn-Engdahl geographic region number (appendix 7).	56-58
CE	Cultural effects.	64
Q/S	Quality/number of stations.	74-76
MAR DG	Marsden (10°) square and (1°) subsquare number (appendix 6).	1-5
DIST	On radius searches, the distance in km between the earthquake location and the designated point.	-

---

*See Data Format--Magnetic Tape (appendix 1) for detailed description.

**The programmed format used in the Earthquake Data File printouts incorporates decimal points in the origin time and coordinates and is designed to present the data in a readable style.

APPENDIX 4

CODES FOR DATA SOURCES

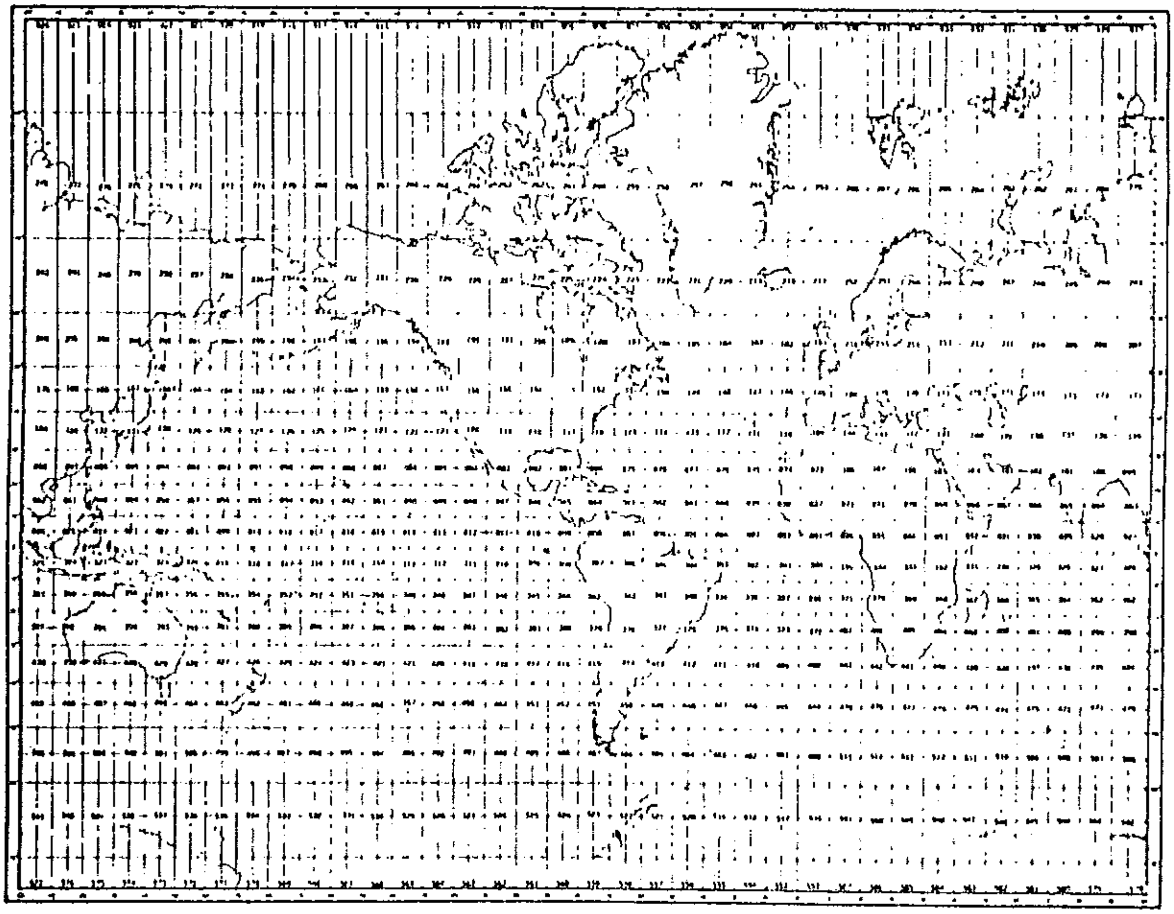
ADK Adak, AK, USA
AEC U.S. Atomic Energy Commission
AGS Alaska Seismic Studies, USGS-NCER, Menlo Park, CA, USA
ALG Algiers, Algeria
ALI Alicante, Spain
ALM Almeria, Spain
ALQ Albuquerque, NM, USA
APA Apatity, RSFSR, USSR
API Apia, Samoa Is.
ATH Athens Observatory, Greece
BCI Bureau Central International de Séismologie, Strasbourg, France
BLA Blacksburg, VA, USA
BNS Bensberg, Federal Republic of Germany
BOG Bogota, Colombia
BRA Bratislava, Czechoslovakia
BRK Berkeley (Haviland), CA, USA
BSS *Bulletin of the Seismological Society of America*
BUC Bucharest, Romania
BUL Bulawayo, Rhodesia
CAN Canberra, Australian Capital Territory, Australia
CAR Caracas, Venezuela
CFR Charles F. Richter (see Richter, 1958, in References)
CGS Coast and Geodetic Survey
CHC Chapel Hill, NC, USA
CLL Collmberg, German Democratic Republic
DJA Djakarta, Java, Indonesia
EQH *Earthquake History of the United States* (see References)
ERL Environmental Research Laboratories
GIA Geophysical Institute, University of Alaska, Fairbanks, AK, USA
G-R Gutenberg-Richter (see Gutenberg and Richter, 1954, in References)
GOL Golden (Bergen Park), CO, USA
GS U.S. Geological Survey, Denver, CO, USA
HEL Helsinki, Finland
HRB Hurbanovo, Czechoslovakia
HVO Hawaiian Volcano Obsy., Hawaii National Park, HI, USA
ISK Istanbul-Kandilli, Turkey
ISS International Seismological Summary, Kew, England, UK
IST Istanbul, Turkey
JER Jerusalem, Israel
JMA Japan Meteorological Agency, Tokyo, Japan
JOH Johannesburg, South Africa
KAR Karachi, Pakistan
KEW Kew, England, UK
KIR Kiruna, Sweden
LEM Lembang, Java, Indonesia
LIS Lisbon, Portugal
LJU Ljubljana, Yugoslavia
LWI Lwiro, Zaire
MAL Malaga, Spain
MAN Manila, Philippines
MAT Matsushiro, Honshu, Japan
MER Merida, Mexico
MOS Moscow, RSFSR, USSR
MOX Moxa, German Democratic Republic
NCE National Center for Earthquake Research (NCER), Menlo Park, CA, USA
NES Northeastern Seismological Association, Weston, MA, USA
NOS National Ocean Survey
NOU Noumea, New Caledonia
NRR North Reno, NV, USA
OAX Oaxaca, Mexico
OBM Ulan Bator, Mongolia
OTT Ottawa, Ontario, Canada
OXF Oxford, MS, USA
PAL Palisades, NY, USA
PAS Pasadena, CA, USA
PDE *Preliminary Determination of Epicenters*
PEK Peking, China
PET Petropavlovsk, RSFSR, USSR
PMG Port Moresby, Papua

APPENDIX 4 (Cont.)

PMR Palmer, AK, USA
PRA Praha (Prague), Czechoslovakia
PRU Pruhonice, Czechoslovakia
QUE Quetta, Pakistan
RAC Raciborz, Poland
REY Reykjavik, Iceland
RIV Riverview, New South Wales, Australia
RMP Rome (Monte Porzio Catone), Italy
ROM Rome, Italy
SAN Santiago, Chile
SEA Seattle, WA, USA
SHI Shiraz, Iran
SHL Shillong, India
SLM St. Louis, MO, USA
SNM Socorro, NM, USA
SSS San Salvador, El Salvador
STR Strasbourg, France
STU Stuttgart, Federal Republic of Germany
SYK Sykes (see References)
TAC Tacubaya, Mexico
TEH Teheran, Iran
TOC Tocklai, India
TRI Trieste, Italy
TRN Trinidad, Trinidad, W.I.
TUL Tulsa, OK, USA
UCC Uccle, Belgium
UGL Uglegorsk, RSFSR, USSR
UPP Uppsala, Sweden
USE *United States Earthquakes*
VIC Victoria, British Columbia, Canada
WAR Warsaw, Poland
WEL Wellington, New Zealand
YSS Yuzhno-Sakhalinsk, RSFSR, USSR
ZUR Zurich, Switzerland

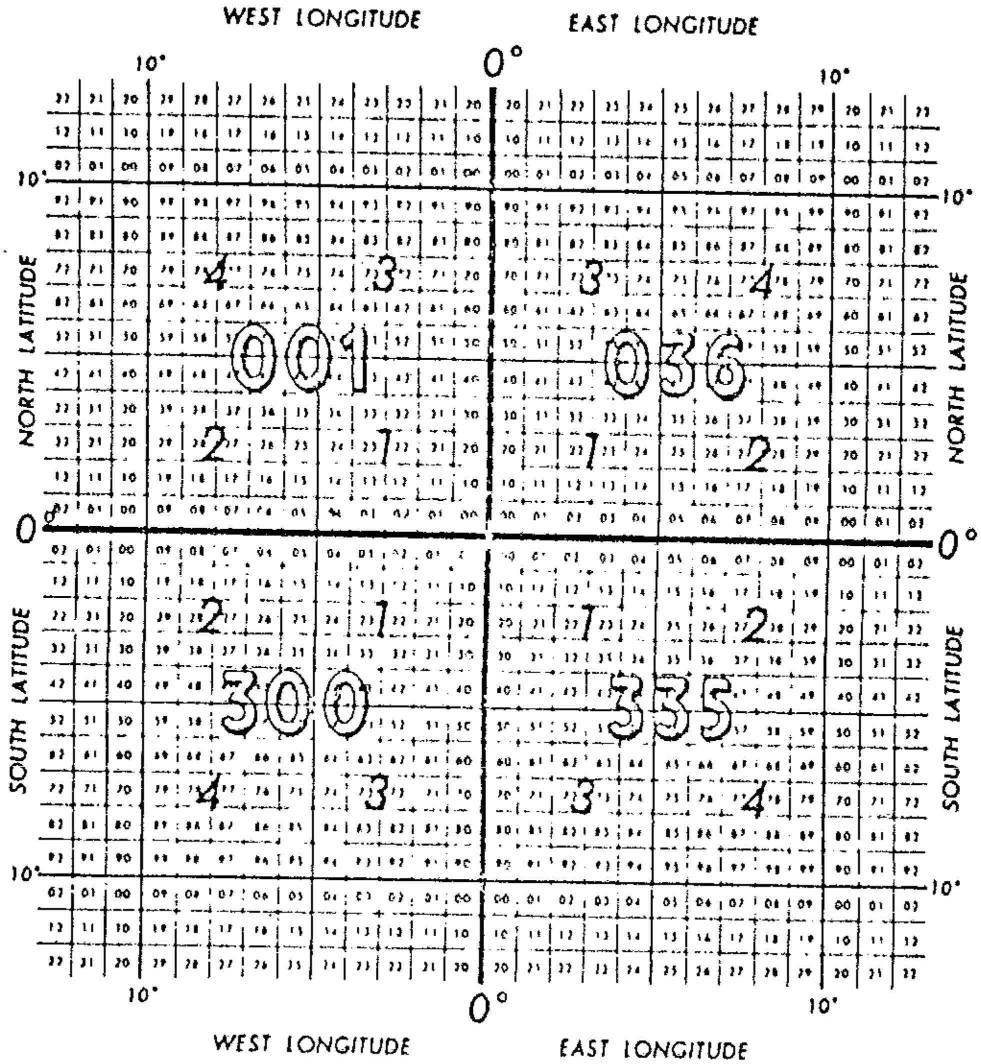
APPENDIX 6. MARSDEN SQUARE CHARTS

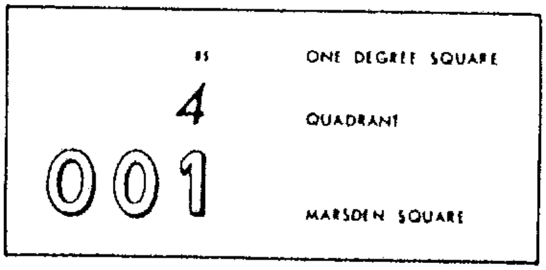
10° MARSDEN SQUARE CHART



APPENDIX 6 (Cont.)

1° MARSDEN SQUARE CHART





2.8 GEOLOGY

The structural and topographic Powder River Basin is bounded on the west by the Bighorn Mountains, on the southwest by the Casper arch, on the east by the Black Hills, and on the south by the Laramie Range and Hartville uplift. The northern limit of the basin is the Miles City arch in Montana. The basin is asymmetric, with its deepest part on the west side roughly parallel to the Bighorn Mountains. The west side of the basin is strongly deformed, with beds dipping from 30° to vertical, while the east side is characterized by shallow dips of from 3° to 5°. A maximum of 18,000 feet of Cambrian to Holocene sediments fill the basin. (Reference 7).

The area of the test site is on the northeast side of the basin where the beds dip gently to the west. The general geology of this area is shown in Figure 14. The underlying formation pertinent to this application is the Upper Cretaceous Pierre Shale, which consists of from 2000 to 3000 feet of impervious marine shales, sandy shales, and bentonite beds intercalated with some sandstones. (Ref. 7) Overlying the Pierre Shale is the Fox Hills Sandstone, a regressional sequence of marginal marine, estuarine and tidal flat deposits ranging from zero to 200 feet in thickness. The Fox Hills Sandstone is gradational into the overlying Late Cretaceous Lance Formation, which is predominantly fresh-water deltaic deposits of fine- to medium-grained sandstone, sandy shale and claystone, with a total thickness of 500 to 1000 feet. Figure 15 provides a description of these units and their hydrologic characteristics. (Ref. 7, 8).

Uranium mineralization averaging less than 0.1 per cent U_3O_8 occurs in the Lance Formation and possibly in the Fox Hills Sandstone in fine- to medium-grained sands, containing carbonaceous material interbedded with thin shales and mudstones. Plates 3 and 4 illustrate north-south and east-west geologic cross sections through the test site area. Figure 16 is a plan map showing the drill hole locations for the geologic sections.

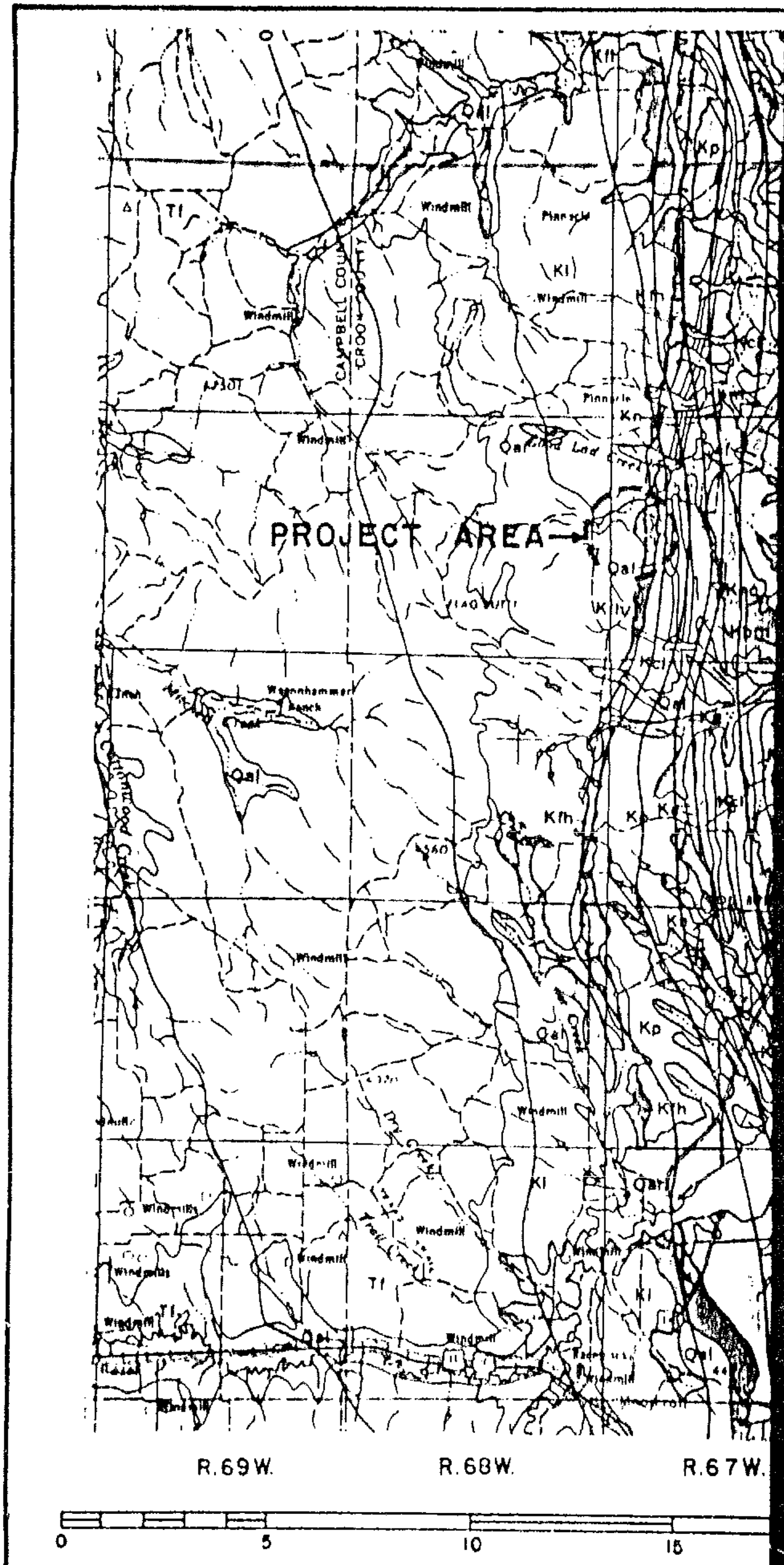
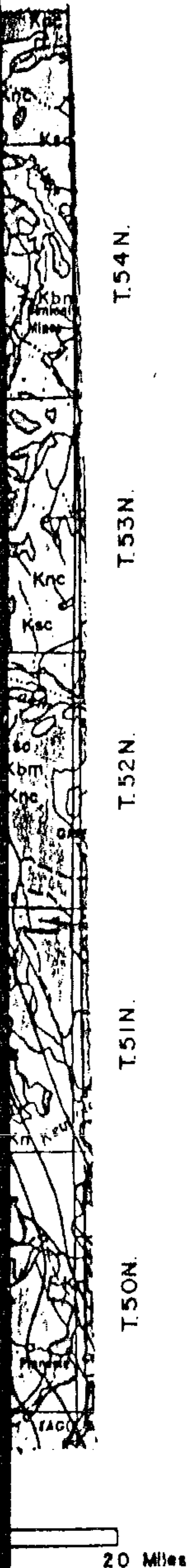


FIGURE 14. GEOLOGIC MAP OF AREA CONTAINING TEST



Pleistocene and Holocene

Qal — Alluvium

Qls — Landslide deposits

Qs — Windblown sand

Pleistocene

Qg — Glacial deposits

Oligocene Miocene

Taw, Twr — Arikaree and White River Formations
Twr, *White River Formation*

Eocene

Twm, Tw, Twk — Wasatch Formation
Twm, *Moncrief Member*
Twk, *Kingsbury Conglomerate Member*

Paleocene

Tf — Fort Union Formation

Pliocene ?

Ti — Intrusive rocks

Upper Cretaceous

Kl — Lance Formation

Kfh — Fox Hills Sandstone
Lewis Shale included along west side of basin

Kp — Pierre Shale

9811120207-06

T.R. CRUMP 28 SEPT 77

SITE.

Reproduced from U.S. Geol. Survey Hydrological

GEOLOGIC FORMAT

ERA	SYSTEM	SERIES	Geologic Unit	Lithology, Thickness, and Distr
CENOZOIC	TERTIARY	Paleocene	Fort Union Formation	Sandstone, fine-grained, and interbedded shale and coal. Thickness about 2,270 fe basin (Dobbin, Kramer, and Horn, 1957) an southwest part (Horn, 1955), and about 3, northwest part (Hose, 1955, pl. 8). Outc Union encircles most of basin; the beds d into the subsurface.
MESOZOIC	CRETACEOUS	Upper Cretaceous	Lance Formation	Sandstone, fine-to medium-grained, and i shale and claystone. Thickness increases east side of basin from about 500 feet i Campbell County to about 1,600 feet in no County (Robinson and others, 1964, p. 98 about 2,500 feet in Niobrara County (Whi p. 23) to as much as 3,000 feet in south County (Rapp, 1953, table 1). On west s thickness increases southward from about southern Montana (Thom and others, 1935, about 2,000 feet near Buffalo (Mapel, 19 and to about 2,400 feet in southern John (Horn, 1955).
			Fox Hills Sandstone	Predominantly sandstone, fine-to medium- thin beds of sandy shale; thickness rang to 250 feet in Crook and Weston Countie others, 1964, p. 95), and from about 400 Niobrara County (Whitcomb, 1965, p. 19). about 700 feet in southwest part of basi but has not been differentiated, if pres overlying Lance Formation in west and no of basin (Hose, 1955, p. 65; Mapel, 1959
			Pierre Shale	Pierre Shale--Shale, some sandy shale a and many beds of bentonite (Robinson an p. 77). Contains Groat Sandstone Bed o Ferruginous Member in Crook and Weston Gill and Cobban (1961, p. D190) report thicker and coarser grained toward west thickens southward from about 2,100 fee most Crook County to about 2,900 feet i County (Robinson and others, 1964, fig. much as 3,100 feet in Niobrara County (table 3). Present on east side of basi ward in subsurface into Lewis Shale, Me Formation, and upper part of Cody Shale of basin.

bac
7/29/77

Figur
Stratigrap

...NS AND POTENTIAL WATER ...

...ution	Availability and Chemical Quality of Ground Water
...hale, carbonaceous ...t in east part of ... 2,900 feet in ...50 feet in ...op of Fort ...p basinward	Yields water from fine-grained sandstone, jointed coal, and clinker beds. Maximum yields are about 150 gpm. Average specific capacity of four wells in southwest Crook County was 0.3 gpm per foot of drawdown (Whitcomb and Morris, 1964, table 3 and p. 40). Well 50-72-22 cac near Gillette had a specific capacity of 0.7 gpm per foot of drawdown (Littleton, 1950, p. 14). Average specific capacity for 85 wells in Sheridan County computed from yield-drawdown data from drillers' logs was 0.42 gpm per foot of drawdown (Lowry and Cummings, 1966, p. 21). Dissolved solids range from about 200 to more than 3,000 mg/l, but commonly range between 500 and 1,500 mg/l. Water type is mostly sodium bicarbonate, and to a lesser extent sodium sulfate.
...terbedded sandy ... southward on ... northeast ...rthern Weston ..., and from ...comb, 1965, ...rn Converse ...de of basin, ...600 feet in ...p. 61) to ...9, p. 60) ...on County	Generally yields less than 20 gpm, but yields of several hundred gallons per minute may be possible from the complete section of the formation. Most wells have been drilled in outcrops of the Lance for domestic and stock purposes and tap only a small part of the formation. The specific capacity of three wells in Crook County ranged from 0.4 to 1.7 gpm per foot of drawdown (Whitcomb and Morris, 1964, p. 15). Dissolved solids range from about 200 to more than 2,000 mg/l, but commonly range between 500 and 1,500 mg/l. No dominant water type is prevalent.
...grained, containing ...es from about 125 ... (Robinson and ... to 500 feet in ... Thickness is ...n (Horn, 1955), ...ent, from the ...rthwest parts ..., p. 59).	Yield of as much as 200 gpm are available from sandstone beds in east part of basin. Several wells south of Rozet produce about 200 gpm from the Fox Hills for water flooding. Well 56-71-15dd, Campbell County, flows 75 gpm from a depth of about 2,000 feet, and has a shut-in pressure of 54 psi (pounds per square inch) at the surface. Maximum yields in west part of basin will probably be less than 100 gpm. Well 40-78-15abb, Natrona County, had a specific capacity of only 0.37 gpm per foot of drawdown (Crist and Lowry, 1972, p. 61). Dissolved solids are mostly less than 1,000 mg/l in east part of basin, but generally range between 1,000 and 2,000 mg/l in west part. No dominant water type is prevalent.
...d sandstone, ... others, 1964, ... the Gammon ...Counties that ...becomes ... Formation ... in northern- ... central Weston ...5), and to as ...Whitcomb, 1965, ...l grade west- ...saverde ... on west side	Pierre Shale, Niobrara Formation, Carlile Shale, Greenhorn Formation, and Belle Fourche Shale--Sequence of rocks is predominantly shale with only local lenses of sand from which small amounts of water can be expected. The Groat Sandstone Bed might be an exception, but yields of 10 to 20 gpm would probably be maximum.

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2.9 HYDROLOGY

2.9.1 Surface Water

The test site lies in an area of grasslands with rolling topography and small drainages which are intermittent tributaries to the Little Missouri River and the Belle Fourche River. A small livestock watering dam known as the Oshoto Reservoir is located approximately 3000 feet north of the test site. This shallow reservoir (0 to 20 feet deep, 3500 feet long and 300 feet wide) is located on the Little Missouri River and collects intermittent runoff. (Plate 1, pocket) The plant site is topographically over 100 feet higher in elevation than the top of the reservoir dam.

The reservoir is the only body of surface water in the vicinity of the test site.

2.9.2 Groundwater

Extensive hydrologic tests were conducted in August, 1977. Interpretation of the results are provided in Enclosure 8 in a report by Paul A. Manera, Manera and Associates, Consultants in Water Resources, Phoenix, Arizona.

In the test-site area, the 550 foot thickness of the combined lower Lance Formation and Fox Hills Sandstone (where present) contains three aquifers between the ground surface and the top of the impervious Pierre Shale (Plate 5, pocket). The aquifers, from top to bottom, are described as follows:

2) Established the hydraulic confinement of the "B zone" aquifer containing the mineralization.

3) Determined (subject to additional confirmatory data in process) the rate of movement of water in the "B zone" aquifer as less than one foot per year, and the direction to the WNW.

2.9.3 Baseline Water Quality - Surface Water

Samples for baseline water quality purposes have been collected from various sources beginning in 1976.

Surface waters and private well sources within a radius of three miles from the test site are listed in Table III (additional baseline water quality data beyond the three mile radius is available). Locations for water samples are shown on Plate 1 (pocket), and the analyses are given on Table IV. Oshoto Reservoir and three selected wells (marked with an asterisk, Table IV) will continue to be sampled and analyzed on an approximately seasonal interval for as long as is deemed necessary.

A common factor with the majority of the analyses shown, which include Oshoto Reservoir, is the high content of combined alkalies present, principally sodium which generally exceeds the limits of Wyoming DEQ secondary criteria for Irrigation Water Quality as shown in Table IV. Potassium ranges from 4 to 32 mg/l only. (Enclosure 9)

2.9.4 Baseline Water Quality - Ground Water

Nubeth drill holes located between 500 and 7,000 feet from the test site which have been sampled and analyzed at various times since 1976 are indicated on Plate 1 and 2, and are listed as follows:

1) The "surface aquifer" or water table aquifer which extends to a depth of 150 to 250 feet approximately. The static head of the "water table" aquifer stands from 7 to 13 feet above the piezometric head of "A zone" aquifer below.

2) The "A zone" aquifer which lies between approximately 250 feet to 430 ± feet from the ground surface, is a non-flowing artesian aquifer. The piezometric head of the "A zone" aquifer stands from 40 to 46 feet above the piezometric head of the "B zone" aquifer below.

3) The "B zone" aquifer, from 445 ± feet to 550 ± feet is a non-flowing artesian aquifer. As indicated above, its piezometric head is lower than "A zone" aquifer. The "B zone" aquifer is hydraulically confined and separated from the "A zone" above by a 10 to 20 foot thick clay aquiclude. The continuity and impermeability of this aquiclude were confirmed by the hydrologic tests. Confining the "B zone" aquifer underneath is the impervious Pierre Shale. The "B zone" aquifer contains the uranium mineralization.

To the west from the test site, the Lance Formation dips very gently westward and very gradually attains a thickness of approximately 1000 feet, while to the east the Lance Formation and the Fox Hills Sandstone eventually outcrop and terminate on the northeast monoclinal flank of the Powder River Basin.

The principal results attained from the hydrologic tests follow:

1) Determination of transmissivity, hydraulic conductivity, direction of flow (subject to additional confirmatory data in process) and storage coefficient for the "B zone" aquifer, plus other related information.

TABLE III
WATER SAMPLES WITHIN A THREE-MILE
RADIUS OF THE TEST SITE

WELL NO.	PROPERTY	WYOMING COORDINATES (APPROX.)	SEC.-TWP.-RGE.	TYPE OF WELL	DEPTH	WELL BOTTOM FORMATION	DATE SAMPLED
100	Elmo Wesley House, Oshoto, Wyo.	1428900 N. 559700 E.	8-53 N.-67 W.	House/Elec. Pump	185'-200'	Fox Hills (?)	9/18/76
101	Oshoto Reservoir	1426700 N. 556100 E.	18-53 N.-67 W.	Reservoir		Alluvium	9/18/76
102	Harry Berger, Windmill	1425000 N. 558500 E.	17-53 N.-67 W.	Windmill/Pasture	180'-200'	Fox Hills	9/18/76
103	Elmo Wesley, Windmill	1428000 N. 557800 E.	18-53 N.-67 W.	Windmill/Pasture	130'	Fox Hills	12/9/76
104	Grace Reynolds House Well	1413500 N. 552600 E.	25-53 N.-68 W.	House/Windmill	286'	Lance (?)	1/25/77
105	Elmo Wesley Pasture Well	1430500 N. 558000 E.	7-53 N.-67 W.	Elec. Pump N.W. of House	130'	Lance (?)	12/9/76
106	Ray Robinson House Well	1422800 N. 559300 E.	20-53 N.-67 W.	Elec. Pump(?)/House		Fox Hills (?)	1/25/77
108	Elmo Wesley Well-Pasture	1426200 N. 559900 E.	17-53 N.-67 W.	Elec. Pump	±200'	Fox Hills	5/16/77
109	Harry Berger Well-Pasture	1428400 N. 560000 E.	18-53 N.-67 W.	Elec. Pump	Shallow Unknown	Fox Hills	5/16/77
110	Oshoto Reservoir	1426700 N. 556100 E.	18-53 N.-67 W.	Reservoir at Dam		Alluvium	5/16/77
111	Gene Berger Ranch	1433700 N. 560400 E.	8-53 N.-67 W.	Elec. Pump	Shallow Unknown	Fox Hills	5/16/77
112	Well in Pasture	1433800 N. 559490 E.	5-53 N.-67 W.	Elec. Pump	Shallow Unknown	Fox Hills	5/16/77
113	Well in Pasture	1438500 N. 557700 E.	6-53 N.-67 W.	Windmill	Shallow Unknown	Lance	5/16/77
117	Reynolds Windmill	1419800 N. 553800 E.	19-53 N.-67 W.	Windmill	Shallow Unknown	Lance	5/17/77
119	Burch Ranch Well in Pasture	1437200 N. 549900 E.	1-53 N.-68 W.	Elec. Pump	±100'	Lance	5/17/77
120	Burch Ranch Windmill-Pasture	1435100 N. 552700 E.	1-53 N.-68 W.	Windmill	±100'	Lance	5/17/77
122	Jim Hahn Ranch House	1425000 N. 545100 E.	14-53 N.-68 W.	Elec. Pump/House	Shallow Unknown	Lance	5/17/77
123	Jim Hahn Windmill	1425000 N. 545100 E.	14-53 N.-68 W.	Windmill/Barn	Shallow Unknown	Lance	5/17/77
125	Windmill	1422470 N. 551090 E.	24-53 N.-68 W.	Windmill	Shallow Unknown	Lance	5/17/77
126	Well in Pasture	1417072 N. 557217 E.	30-53 N.-67 W.	Elec. Pump	120'	Lance	6/12/77

TABLE IV

Major Constituents of Water Samples Taken from Sources

Located Within a 3-Mile Radius of Test Site

(All values mg/l except conductivity which is in micromhos and Radium 226, Gross Alpha and Gross Beta which are in pCi/l)

Property No.	Combined Na and K	Combined Ca and Mg	CO_3^{--}	HCO_3^-	SO_4^{--}	Cl^-	B	TDS	Cond.	Ra 226	Gross Alpha	Gross Beta	As	Se
100	574	20	72	732	544	8	.006	1579	1750	0.2 ± 0.2	0.3 ± 1.5	3 ± 15	< 0.01	< 0.01
Oshoto R. 101*	316	32	240	329	97	8	.020	855	1150	0.4 ± 0.4	11.6 ± 3.2	9 ± 10	< 0.01	< 0.01
102*	1179	49	36	1074	1620	12	.008	3475	3325	0.4 ± 0.3	10.4 ± 4.5	0 ± 20	< 0.01	< 0.01
103	213	65	36	464	208	8	ND	760	975	0.8 ± 0.4	11.4 ± 4.2	7 ± 13	< 0.01	< 0.01
104	318	4	48	512	176	10	.008	808	1150	0.8 ± 0.5	10.3 ± 4.5	16 ± 15	< 0.01	< 0.01
105	385	220	0	866	752	10	ND	1794	2000	0.9 ± 0.5	2.1 ± 2.6	57 ± 31	< 0.01	< 0.01
106	360	268	0	573	1090	34	.018	2034	2225	0.3 ± 0.3	21 ± 5	39 ± 31	< 0.01	< 0.01
108	767	26.4	0	768	707	6	.005	1700	2795				< 0.01	< 0.005
109	252	160	0	510	329	39	.016	893	1410	0.0 ± 0.4	10.2 ± 3.4	5 ± 11	< 0.01	< 0.005
Oshoto R. 110*	263.6	37	17	438	84	32	.022	617	1080	0.0 ± 0.4	11.3 ± 3.2	7 ± 11	< 0.01	< 0.005
111	130.4	155	0	497	120	35	.037	739	989	0.0 ± 0.5	10.1 ± 2.9	0 ± 9	< 0.01	< 0.005
112	192	11.5	20	350	6	30	.007	390	665	0.5 ± 0.6	3.3 ± 2.0	[illegible] ± 9	< 0.01	< 0.005
113	45	116	0	372	38	37	.022	395	753	0.0 ± 0.4	3.5 ± 2.1	6 ± 8	0.02	< 0.005
117*	166.2	37	0	392	24	30	.008	434	763	0.0 ± 0.4	2.1 ± 1.5	0 ± 9	< 0.01	< 0.005
119*	45	118	0	399	26	30	.007	409	722	0.0 ± 0.4	< 0 ± 0.8	0 ± 7	< 0.01	< 0.005
120	62	99	0	392	10	32	.029	372	715	0.0 ± 0.3	0.0 ± 0.8	0 ± 7	< 0.01	
122	214	375	0	342	824	76	.088	1770	2375	0.0 ± 0.4	22 ± 5	1 ± 17	< 0.01	< 0.005
123	221	39	0	470	60	17	.007	586	925	0.0 ± 0.5	3.0 ± 1.8	1 ± 8	0.02	< 0.005
125	130.9	80	0	418	43	9	.037	507	818	0.0 ± 0.4	27 ± 4	15 ± 11	< 0.01	< 0.005
126	132.8	45	0	397	40	3	.005	392	652				< 0.01	< 0.005
EPA (1)		Alkalinity naturally occurring 400 mg/l as $CaCO_3$		150	250	250		1900		5			0.05	0.01
DEQ (2)														

Residual Class Limits of Na_2CO_3 for Irrigation Water Quality - Secondary Criteria (7/8/77)

Class	Milliequivalents/liter	Description
1	Below 1.25	Safe
2	1.25 to 2.50	Marginal
3	over 2.50	Not Suitable

Property 113 has 1.3 milliequivalents/liter Na_2CO_3 - Windmill/Pasture

Property 110 has 11.1 milliequivalents/liter Na_2CO_3 - Oshoto Reservoir

Property 102 has 50.7 milliequivalents/liter Na_2CO_3 - Windmill Pasture

(1) Wyoming DEQ - Compiled Primarily by Water Quality Division - DEQ (7/8/77) from EPA Proposed Water Quality Criteria - Public Water Supply Category.

(2) Wyoming DEQ (7/8/77) Irrigation Water Quality - Secondary Criteria.

* Sites designated for baseline water sampling.

790-V	Surface aquifer	sampled on 7-77
796-V	Surface aquifer	sampled on 7-77
* 3-V	"A zone"	sampled on 7-77
758-R	"B zone"	sampled on 4-76, 9-76
* 788-V	"B zone"	sampled on 8-77
789-V	"B zone"	sampled on 8-77
791-V	"B zone"	sampled on 7-77
829-R	"B zone"	sampled on 4-76, 12-76, 7-77

Two wells selected from the above list (marked with an asterisk), of wells already drilled and, two new wells yet to be designated, will be sampled and analyzed once every two months as long as deemed necessary in accordance with NRC and DEQ.

Table V gives a comprehensive list of analyses for water constituents analyzed for baseline quality purposes in summary form, along with corresponding EPA Proposed Quality Criteria as obtained from the Water Quality Division, Wyoming DEQ.

Additional data will be forthcoming for the "surface aquifer," "A zone" and for "B zone" from wells drilled recently and from wells yet to be drilled within 500 to 7000 feet from the test site. Location and sampling data from these wells will be provided to NRC and DEQ as it becomes available, especially wells located downflow from the test site.

Monitor wells located within 200 feet of the perimeter of the leach module (see 3.2.1) were drilled for the purpose of monitoring "B zone" and "A zone" within and around the leaching operation. These will be sampled every two weeks to obtain sufficient data to establish natural variations of critical parameters as follows: sodium, total dissolved solids, uranium, arsenic, selenium and radium 226. A complete suite of analyses (Table V) will be run on a monthly basis. The acceptable range for these parameters will be determined by mutual agreement with NRC and DEQ.

TABLE V

PRELIMINARY BASELINE WATER CHEMISTRY

as of 8-77

(All values mg/l except conductivity which is in micromhos and Radium 226, Gross Alpha and Gross Beta which are in pCi/l)

	Surface Aquifer Two wells Min.	Surface Aquifer Two wells Max.	"A zone" One well	"B zone" Five wells Min.	"B zone" Five wells Max.	EPA[1] Public Water Supply	EPA[1] Livestock	EPA[1] Irrigation
Ca	17	18	7.8	6.0	20.5			
Na	66	205	325	320	700		2000	
Na milliequiv/l	2.87	8.9	14.1	13.9	30.4			1.25[2]
K	2.5	4.0	7.3	2	7.9			
Mg	9.6	11	1.5	1.8	16			
Cl^-	9.0	9.0	12	10	21.3	250	2000	100
CO_3^-	0.0	9.2	74	0.0	120			
HCO_3^-	188	411	374	321	643	150		
SO_4^{--}	14.0	129	202	106	880	250	3000	200
NH_3	.1	.3	1.8	.1	1.48			
TDS	288	559	917	939	1860	1000	5000	500-5000
Cond.	368	957	1320	1190	2580			
U	.006	.01	< .002	.012	.85			
B	< .01	< .1	.24	.2	.8	1	5	.75-2
Cu	< .005	< .005	.04	< .005	.04	1	.5	.2-5
Zn	< .009	< .03	.02	.002	.58	5	25	2-10
Pb	< .002	< .01	< .002	.002	.05	.05	.1	5-10
Mo	< .01	< .01	.02	< .01	.03			.01-.05
V	.004	< .004	.011	< .002	.006		.1	.1
Se	.003	.008	.005	.003	.22	.01	.05	.02
Ag	.001	< .002	.001	< .002	.008	.05		
Cd	.002	< .002	.01	< .002	.008	.01	.05	.01-.05
Mn	.002	.01	.03	.004	.08	.05	10	.02-10
Ba	.5	< .5	.05	< .005	.5	1		
Hg	< .0001	< .0001	< .0001	< .0001	.001	.002	.01	
Fe	.11	.40	1.0	.05	.4	.3		.5-20
As	.01	< .04	.02	< .01	.02	.05	.2-1.0	.1-2.0
Cr	< .005	.01	.04	< .005	.32	.05	1	.1-1.0
NO_3^-	.05	3.54	.85	< .05	8.3	10 (as N)	100	
pH	7.7	8.4	9.4	7.7	8.6	4.5-9.0	6.0-9.0	4.5-9.0
Ra 226	0.0 ± 0.6	0.4 ± 0.3	0.0 ± 0.7	0.4 ± 0.4	100 ± 15	5		
Gross Alpha	3.5 ± 1.7	12.2 ± 3.0	4.4 ± 2.4	14.4 ± 4.0	380 ± 20			
Gross Beta	0 ± 7	3.0 ± 11.0	37.0 ± 12	0 ± 22	740 ± 20			

(1) Wyoming DEQ - Compiled Primarily by Water Quality Division - DEQ (7/8/77) from EPA Proposed Water Quality Criteria

(2) Wyoming DEQ (7/8/77) Irrigation Water Quality - Secondary Criteria.

If sufficient data is collected which shows that a parameter (or parameters) does not vary significantly between consecutive analyses, the frequency of analysis of the parameter in question should be reduced with the approval of NRC and DEQ.

For more detailed information on wells within the perimeter of the leach module which will also be used for baseline water quality determinations, please refer to 3.2.2 and 3.2.4.

ENCLOSURE 8

Aquifer Analysis Near Oshoto Reservoir Crook County, Wyoming
for Nuclear Dynamics, Inc. - Paul A. Manera

In Back Pocket

ENCLOSURE 9

EPA Proposed Quality Criteria

ENCLOSURE 9

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

LAND QUALITY DIVISION

STATE OFFICE BUILDING TELEPHONE 307-777-7756 CHEYENNE, WYOMING 82002

November 8, 1977

Mr. Al Stoick
Nuclear Dynamics Corp.
200 South Lowell
Casper, WY 82601

Dear Al:

Enclosed please find a list of proposed EPA Water Quality Criteria as you requested by telephone today.

Sincerely,

Dan Herlihy
Hydrogeologist

DH:dlh
Enclosure

EPA PROPOSED WATER QUALITY CRITERIA (1)

(Compiled Primarily by Water Quality Division - DEQ)

Parameter	Irrigation	Livestock	Aquatic Life	Public Water Supply
Acidity				
Alkalinity			Not more than 25% reduction from natural level (4)	Naturally occurring 400 mg/l as $CaCO_3$ (4)
Aluminum	5.0-20. mg/l	5.0 mg/l		
Ammonia			.02 mg/l	.5 mg/l
Arsenic	.10 - 2.0 mg/l	0.2 mg/l ** 1.0 mg/l*	1.0 mg/l*	.05 mg/l*
Barium				1.0 mg/l
Beryllium	.1 mg/l	6000 mg/l*	28.5 mg/l*	
Bicarbonate			40 - 180 mg/l*	0 - 150 mg/l*
BOD				
Boron	.75 - 2.0 mg/l	5.0 mg/l		1.0 mg/l
Cadmium	.01 - .05 mg/l	50.0 ug/l	.03 - .004 mg/l	.01 mg/l
Carbon adsorbable				.3 mg/l CCE & 1.5 CAE
Chloride	100 mg/l*	2000 mg/l ** 1500 mg/l*		250 mg/l
Chlorine	0 - 50 mg/l*		.05 - .003 mg/l	0 - 2.0mg/l*
Chromium	.1 - 1.0 mg/l	1.0 mg/l	.05 mg/l	.05 mg/l
Cobalt	.05 - 5.0 mg/l	1.0 mg/l	1.0 mg/l*	.1 - .25 mg/day*
Color				75 pcu [15 col... unit...]
Copper	.2 - 5.0 mg/l	.5 mg/l	.1 - .2 mg/l	1.0 mg/l
Cyanide			.005 mg/l	.2 mg/l
Detergents			.2 mg/l	
Dissolved Oxygen			6 mg/l	
Dissolved Solids	2000 - 5000 or 500-1000 mg/l	5000 mg/l ** 2500 mg/l*	2000 mg/l*	1000 mg/l*
Floride	2.0 - 15.0 mg/l	2.0 mg/l ** 1.0 mg/l*	1.5 mg/l*	.6 - 1.7 mg/l (3) .7 - 1.2 mg/l*
Florine		2.0 mg/l		

** Present limit accepted by Land Quality, DEQ for Wildlife & Livestock Impoundments: Guideline No. 4

* Taken from McKee and Wolf (ed.), 1963, Water Quality Criteria (2nd ed.): The Resources Agency of California, State Water Quality Control Board Publication No. 3-A

Parameter	Irrigation	Livestock	Aquatic Life	Public Water Supp
Foaming agents				.5 mg/l
Hardness				
Hydrogen Sulfide			.002 mg/l	.05 mg/l (2)
Iron	.5 - 20. mg/l		.3 - .7 mg/l*	.3 mg/l
Lead	5.0 - 10. mg/l	.1 mg/l	.03 mg/l	.05 mg/l
Lithium	.075 - 2.5 mg/l			5 mg/l*
Manganese	.02 - 10. mg/l	10.0 mg/l*	1.0 mg/l*	.05 mg/l
Mercury(inorganic		.01 mg/l ** 1.0 ug/l	.2 ug/l	.002 mg/l
Mercury (organic)			.2 ug/l	
Molybdenum	.01 - .05 mg/l (5)			
Nickel	.2 - 2.0 mg/l		.030 - .4 mg/l	1.0 mg/l*
Nitrates		NO4 + NO3 100 mg/l	(as N) 4.2 - .9 mg/l*	(as N) 10 mg/l
Nitrilotriacetate				
Nitrites		10.0 mg/l		1.0 mg/l
Oil				
Oil & Grease	10 mg/l*	10 mg/l*	10 mg/l*	
Odor				absent 3-Threshold odor No. absent
pH	4.5 - 9.0	6.0 -9.0 **	6.0 - 9.0	6.5 - 8.5 (2) 5.0 - 9.0
Phenolic Compounds			.1 mg/l	
Phenols	40 - 50 mg/l*		1.0 mg/l*	1.0 ug/l
Phthalate Esters			.3 ug/l	
Phosphate	6 - 50 mg/l*			
Polychlorinated Biphenyls			.002 ug/l	
Radioactivity				5 pCi/l
Salinity		3000 mg/l		500 mg/l*
Selenium	.02 mg/l	.05 mg/l		.01 mg/l

** Present limit accepted by Land Quality, DEQ for Wildlife & Livestock Impoundments: Guideline No. 4

* Taken from McKee and Wolf (ed.), 1963. Water Q...

Parameter	Irrigation	Livestock	Aquatic Life	Public Water Suppl
Silver			.033 - .0048 mg/l*	.05 mg/l
Sodium		2000 mg/l (7)		
Sulfate	200 mg/l*	3000 mg/l** 500 mg/l*		250 mg/l
Sulfide			.002 mg/l	
Suspended Solids	240 mg/l*		25 - 80 mg/l	.1 mg/l*
Temperature				
Turbidity			200 Units*	.1 - 5 Units*
Vanadium	.1 mg/l*	.1 mg/l		
Zinc	2 - 10 mg/l*	25.0 mg/l	.87 - 33 mg/l	5.0 mg/l

** Present limit accepted by Land Quality, DEQ for Wildlife & Livestock Impoundments: Guideline No. 4

* Taken from McKee and Wold (ed.), 1963, Water Quality Criteria (2nd ed.): The Resourc Agency of California, State Water Quality Control Board Publication No. 3-A.

(See footnotes on last page)

Radionuclides: Additional Notes - - - Drinking Water Standards (Information taken from (1) Page 85)

(A) Gross Alpha Radioactivity

1. Investigation levels keyed to Ra-226.

Gross Alpha Concentration	Required Action
a) Not exceeding 0.5 pci/liter	None
b) Greater than .5; less than 5 pci/liter	Radiochemical analysis for Ra-226
c) Greater than 5 pci/liter	Comprehensive radiochemical analys

(B) Gross Beta Radioactivity

1. Investigation levels keyed to Strontium-90.
2. Other beta-emitters Pb-210, Ra-228 (usually present in insignificant amounts)

Gross Beta Concentration (excluding K-40)	Required Action
a) Not greater than 5 pci/l	None (if no Pb-210 & Ra-226 are abse
b) Greater than 5, but not less than 50 pCi/liter	Analysis of Strontium -90, Iodine 1 Iodine 131
c) Greater than 50 pCi/liter	Comprehensive radiochemical analys

(C) Additional information, see footnote (6)

(7/8/77)

IRRIGATION WATER QUALITY & SECONDARY CRITERIA

Agricultural Engineering FACT SHEET

TABLE 1 -- Boron Class Limits

Class	Limits -- parts per million			Description
	Sensitive crops	Semi-tolerant crops	Tolerant crops	
1	Below 0.33	Below 0.67	Below 1.00	Very low. No effect on crops.
2	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00	Low. Very slight effect on crops.
3	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00	Moderate. Significant yield depression.
4	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75	High. Large yield depression anticipated.
5	Over 1.25	Over 2.50	Over 3.75	Very high. Non-usable.

TABLE 2 -- Selenium Class Limits

Class	Limits -- parts per million	Description
1	0.00 to 0.10	Low. No plant toxicity anticipated.
2	0.11 to 0.20	Medium. Usable -- possible long-term accumulation under particular conditions and should be watched.
3	0.21 to 0.50	High. Doubtful -- probably toxic accumulation in plants except under especially favorable conditions.
4	Over 0.50	Very high. Non-usable under any conditions.

TABLE 3 -- Residual Class Limits of Sodium Carbonate

R.C. = (Σ HCO₃ + Σ CO₃) − (Σ Ca + Σ M[illegible]) expressed in meq/l

Class	Limits -- milliequivalents per liter	Description
1	Below 1.25	Safe. No augmented alkali problems over those listed under alkali rating.
2	1.25 to 2.50	Marginal. Possibility of some increases in alkali over those listed under alkali rating.
3	Over 2.50	Not suitable. Considered non-usable for irrigation under most circumstances.

WATER QUALITY STANDARD SUMMARY

<table>
<tr><th rowspan="2"></th><th colspan="3">CLASS</th></tr>
<tr><th>I</th><th>II</th><th>III</th></tr>
<tr><td>Fecal Coliform Geometric Mean</td><td>May 1 through September 30
200/100ml* primary contact
1000/100ml secondary contact</td><td>May 1 through September 30
200/100ml* primary contact
1000/100ml secondary contact</td><td>May 1 thru September 30
1000/100ml</td></tr>
<tr><td>Dissolved Oxygen</td><td>6.0 mg/l</td><td>5.0 mg/l</td><td>None</td></tr>
<tr><td>Floating Solids</td><td colspan="3">Free from</td></tr>
<tr><td>Oil and Grease</td><td colspan="3">10 mg/l (maximum)</td></tr>
<tr><td>pH</td><td colspan="3">6.5 - 8.5 units</td></tr>
<tr><td>Radioactive Material</td><td colspan="3">BPT and 3 pCi/l Ra^{226}, 10 pCi/l Sr^{90} (maximum)</td></tr>
<tr><td>Settleable Solids</td><td colspan="3">Free from</td></tr>
<tr><td>Taste, Odor, and Color</td><td>Free from</td><td>Free from</td><td>None</td></tr>
<tr><td>Temperature</td><td>Warm water fish 90°F (max.)
Cold water fish 78°F (max.)
2°/4° maximum increase</td><td>Warm water fish 90°F (max.)
Cold water fish 78°F (max.)
2°/4° maximum increase</td><td>None</td></tr>
<tr><td>Toxic Materials</td><td colspan="3">Free from</td></tr>
<tr><td>Turbidity</td><td>10 JTU (maximum increase)</td><td>10 JTU (maximum increase)</td><td>None</td></tr>
<tr><td>Total Gas Pressure</td><td colspan="3">110% of atmosphere</td></tr>
</table>

* Applies to all still water bodies, and certain streams.

Footnotes

(1) Committe of Water Quality Criteria, 1972, Water Quality Criteria, Environmental Studies Board: National Academy of Scienc - National Acadamy of Engineering, Washington, D.C.

(2) Environmental Protection Agency, March 31, 1977, National Secondary Drinking Water Standards (40 CFR Part 143) Proposed Regulations: Federal Register, Volume 42, No. 62, p. 17143-17146.

(3) U.S. Public Health Service, March 6, 1962, Drinking Water Standards (42 CFR, Ch. 1, Part 72): Federal Register 2152

(4) Environmental Protection Agency (not published as of July, 1977), Quality Criteria for Water: Washington, D.C.

(5) Environmental Protection Agency, (undated), Comparison of NTAC, NAS, and Proposed EPA Numerical Criteria for Water Quality: Washington, D.C., 12 pp.

(6) Environmental Protection Agency, July 9, 1976, Promulgation of Regulations on Radionuclides (40 CFR, Ch. 1, Part 141): Federal Register, Vol. 41, No. 133, p. 28402-28409.

(7) Wyoming Department of Agriculture, April 9, 1973, Division of Laboratories (table not published).

3.0 THE PROCESS AND PLANT

3.1 PROCESS CHEMISTRY AND PLANT DESIGN

The process description, pilot plant flow sheet and materials balance is given in Enclosure 10, prepared by Hazen Research, Inc., Golden, Colorado.

Laboratory studies of drill core and analyses of ground water indicate that the subject system has the following characteristics:

1. High sodium sulfate and bicarbonate content
2. Low calcium content
3. Low concentration of sulfide minerals - predominantly pyrite
4. Carbonaceous material present in moderate amounts
5. Uranium present as very fine-grained uraninite and possibly other unidentified minerals.

As a result of laboratory leach tests and the single-hole push-pull test discussed in Enclosure 1, the lixiviant planned for dissolving the uranium will be formation water to which sodium carbonate-bicarbonate and oxidizer (oxygen or hydrogen peroxide) will be added. The following reactions take place:

$$2UO_2 + O_2 = 2UO_3$$

$$UO_3 + Na_2CO_3 + 2NaHCO_3 = Na_4UO_2(CO_3)_3 + H_2O$$

The stable and soluble uranyl tricarbonate ion formed can then be pumped to surface and removed in an ion exchange system. The use of sodium carbonate-bicarbonate for dissolution of uranium and subsequent elution is chosen because it is compatible with the formation water. In the event that the method planned does not work efficiently, an ammonium carbonate-bicarbonate method may

become advisable. If this should become apparent, prompt notification will be given to the United States Nuclear Regulatory Commission (NRC) and the State of Wyoming Department of Environmental Quality (DEQ).

Uranium precipitation using hydrogen peroxide will produce a clean $UO_4 \cdot n\ H_2O$ slurry, which will be sealed in drums and shipped to a convenient uranium mill (or buyer).

Due to the low concentration of calcium, molybdenum and vanadium in the leachate (as indicated in the push-pull test) it is not anticipated that substantial buildup of these elements will occur in the system during test operations. In the event that some calcium buildup does occur in the leach solution cycle, plugging could occur in wells, filters, etc., and IX resins would foul. Various corrective measures, mechanical as well as chemical in nature would then be used as necessary. Should resin efficiency drop prematurely, regeneration with sodium hydroxide could be employed. The waste products from these and other possible side processes will be stored in a suitable solar evaporation storage pond or ponds (six months to one year storage capacity) for appropriate interim disposal with the final disposition being established by NRC and DEQ regulations.

Because the volume of leachate from the recovery well processed in the pilot plant will exceed the volume of leachant re-injected into the formation by 4 to 6 per cent, provision is made to store this excess barren solution in a suitable solar evaporation storage pond (six months to one year storage capacity).

The solar evaporation storage pond design shown in Figure 8 will be typical of such ponds which will be constructed in accordance with NRC and DEQ standards and requirements (lining, freeboard, leak detection, etc.).

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May 19, 1977

ENCLOSURE 10

Nubeth Pilot Plant Process Description
(Mario Carrasco and A. V. Henrickson)

This pilot plant will be designed and constructed to test the recovery of uranium from an underground uranium ore deposit by in situ leaching with a weak sodium bicarbonate solution containing a chemical oxidizing agent. The leaching circuit will utilize injection and recovery wells designed to give a controllable flow pattern through a section of the ore bed to give maximum uranium recovery. The uranium which is dissolved by the sodium bicarbonate solution will, in turn, be recovered by the following process steps.

1. Ion exchange of the uranyl tricarbonate complex on a strong base resin.

2. Elution of the uranium from the resin with a one-molar sodium bicarbonate solution.

3. Acidification of the uranium rich eluant with sulfuric acid to pH 4 to destroy the carbonate and to release the uranium.

4. Precipitation of the uranium with hydrogen peroxide to form a $UO_4 \cdot x H_2O$ yellow cake product.

Leach Field

The leach field will consist of a center well encircled by four or more periphery wells. In normal operation, the leach solution will be injected in the center well and recovered from the periphery wells at controlled rates so that the enriched solution will not migrate significantly beyond the pumping radium of the recovery wells. Alternately, the flow may be reversed with the outside wells becoming the injection wells and the center well becoming the recovery well.

The field operating setup will contain a makeup and storage tank for the lean leach solution, an injection pump, a production well pump, a rich leach solution storage tank, and a piping system with appropriate controls to give the desired distribution of solutions.

Chemically, the leaching process involves dissolving the uranium by forming the soluble U(VI) tricarbonate complex ion $[UO_2(CO_3)_3]^{-4}$. Carbonate is supplied by the bicarbonate leach solution. A chemical oxidant is required because the uranium is predominantly present as the reduced U(IV) which does not form a stable carbonate complex except in solutions containing a large excess of carbonate or bicarbonate.

Ion Exchange System

The ion exchange circuit for recovery of the uranium from the leach solution is a standard three-column stationary bed system. Each column is 36" diameter x 90" high containing 30 cubic feet of a strong base resin. During operation, two columns are on the loading cycle and one column is on the washing elution, and backwash cycle. The barren raffinate discharged from the second loading column is returned to the makeup and storage tank for the lean leach solution in the leach field injection system. Solution is fed to the two IX loading columns until uranium breaks through the first column. This column is then put on the elution cycle and the flow shifted to return the freshly eluted column to the loading section. The columns are manually operated by valves on the feed and discharge solution manifolds.

The ion exchange process involves the absorption of the $[UO_2(CO_3)_3]^{-4}$ by the strong base resin and elution with strong $NaHCO_3$ solution. This reaction can be represented by the following equation:

$$4\ R_2\ CO_3 + [UO_2(CO_3)_3]^{-4} \rightleftharpoons R_4UO_2(CO_3)_3 + 4\ CO_3^{=}$$

This reaction is reversible and the uranium can be eluted from the resin by increasing the $CO_3^{=}$ concentration and shifting the reaction to the left.

Yellow Cake Precipitation

All of the U_3O_8 rich eluate produced in the ion exchange system during one eluting cycle is collected in a 6' x 6' (1,269-gallon) tank. It is first mixed thoroughly by recycling with a centrifugal pump. Then it is measured, sampled, and transferred to an 8' x 8' (3,008-gallon) precipitation tank. Yellow cake is precipitated by first destroying the HCO_3^- in solution by additon of sulfuric acid to pH 4 and then adding 30% hydrogen peroxide. The uranium precipitates as $UO_4 \cdot x H_2O$. This reaction can be represented by the following equation:

$$UO_2^{++} + H_2O_2 + x H_2O \rightarrow UO_4 \cdot x H_2O + 2H^+$$

Complete precipitation occurs in about two hours at 50°C. The entire slurry of precipitated yellow cake is then transferred to a cone-bottom decantation tank and allowed to settle. After settling, the supernatant solution is decanted off through a series of discharge valves installed on the side of the tank and the settled yellow cake is transferred from the cone-bottom by a diaphragm pump into shipping containers.

Tailings

Potentially, there will be two major sources of solutions from the operation which will require disposal in the tailings area. These are:

1. Excess solution to be pumped from the leach field to prevent migration of leach solution. Assuming that this amount is 5% and that 90 gpm is pumped from the production wells, 4.3 gpm (6,192 gallon/day) of IX raffinate will have to be discarded.

2. Yellow cake decant solution at a feed rate of 90 gpm containing 100 ppm U_3O_8 to IX, the amount of eluate which will be produced at 10 g/l will be approximately 1,300 gallon/day. This amount will require disposal to tailings or in the yellow cake slurry.

Recycling the decant solution for IX eluant is not chemically feasible because of the sulfate buildup. Sulfate concentrations in excess of 100 g/l interferes seriously with uranium precipitation with hydrogen peroxide.

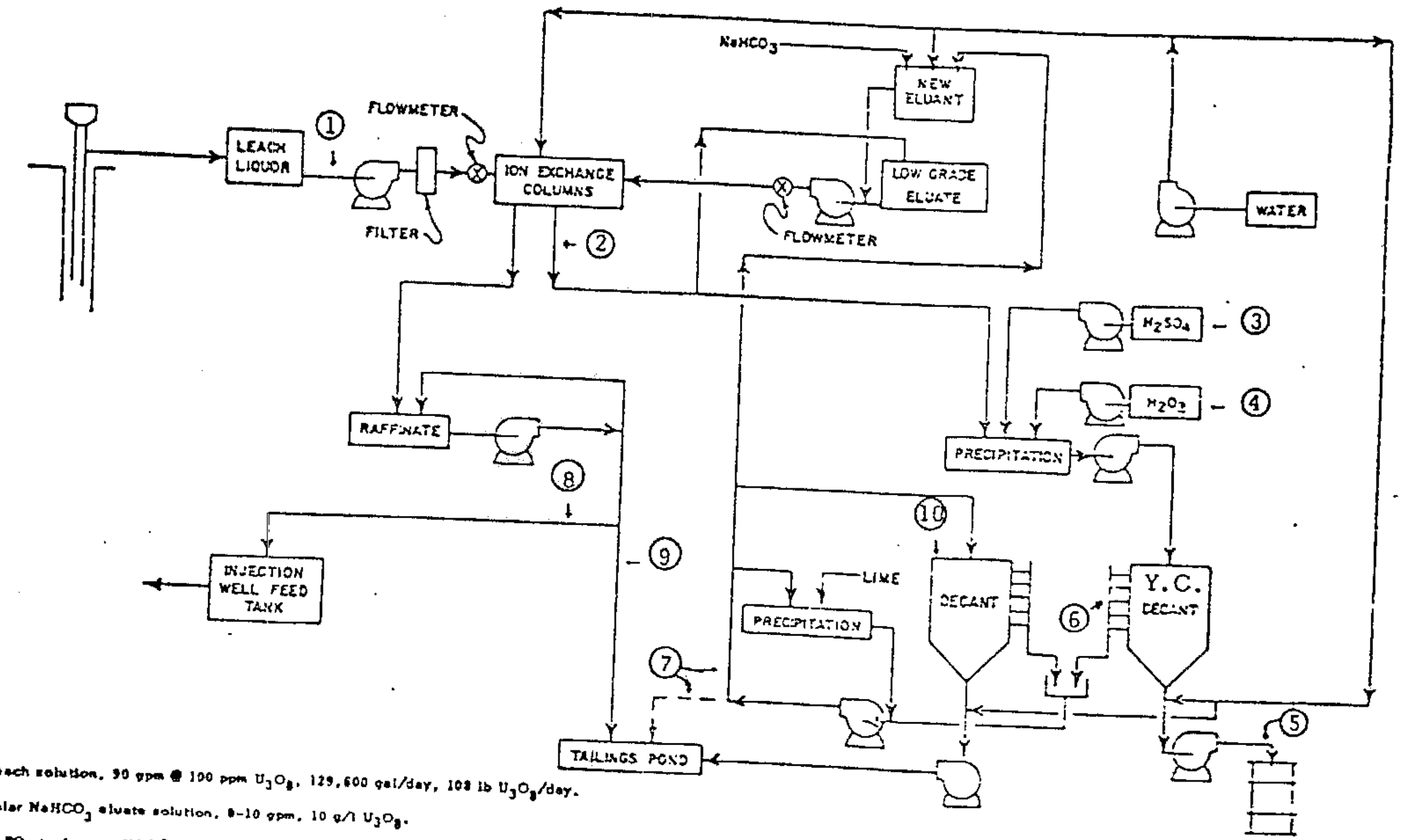
An alternate procedure which can be used is precipitation of the sulfate from the yellow cake decant solution with lime and discarding the precipitated calcium sulfate to tails. Provision has been made in the equipment which is installed so that this can be done.

Reagent Requirements

Assumed feed rate = 90 gpm @ 100 ppm U_3O_8

	lb/day	Ton/year
Sodium bicarbonate	892	163
Sulfuric acid	520	95
Hydrogen peroxide 30%	16.2 (100%)	
	54 (30%)	
	6 gallon	2,190 gallon
Sodium sulfate produced	(754)	(138)

Note: If lime is used to precipitate sulfate from the yellow cake decant solution, an amount equivalent to the sulfuric acid added will be required. In addition, CO_2 equivalent to the lime used will be required to convert the NaOH which is produced to sodium bicarbonate.



① Rich leach solution, 90 gpm @ 100 ppm U_3O_8, 129,600 gal/day, 108 lb U_3O_8/day.

② 1.0 molar $NaHCO_3$ eluate solution, 8-10 gpm, 10 g/l U_3O_8.

③ 93% H_2SO_4 to destroy HCO_3^- to pH 4, 93 gal/day, 520 lb/day.

④ 30% H_2O_2 to precipitate yellow cake, 16 lb H_2O_2/day, 6 gal/day.

⑤ Yellow cake slurry 108 lb U_3O_8/day, 20-40 gal H_2O/day. PRODUCT $$

⑥ Yellow cake decant system, 0.11 lb U_3O_8/day, 754 lb Na_2SO_4/day.

⑦ Yellow cake decant solution, 1236 gal/day.

⑧ Ion exchange raffinate, 90 gpm return to leach feed tank.

⑨ Raffinate discard to tails.

⑩ Optional sulfate removal as $CaSO_4$.

Nucoth Pilot Plant Schematic Flowsheet	
NTS	5/3/77
1SO4	4257

hrl

3.2 WELL FIELD DESIGN, FORMATION RESTORATION AND SCHEDULE OF OPERATIONS

The in situ leach mining pilot tests will be performed in two phases on a small, low-grade ore pod of uranium oxide limited to less than two acres (approximate dimensions: 600 feet long; 100 to 150 feet wide; from 5 to 12 feet thick; grade in the order of .05% U_3O_8). Phase I will be limited to the western end of the ore pod only and will supply and operate the pilot plant at approximately 10 per cent its full rated capacity of 90 gpm. Subject to governmental approvals, the leaching operation of Phase I is expected to start early in the Spring of 1978. After two to three months, Phase I leaching operations will end and restoration of this area will be initiated. Data and knowledge gained in Phase I will be used in design and preparation of Phase II which will take place as restoration of Phase I proceeds (see 3.2.5 Restoration). Relevant data generated during operations will be furnished on a quarterly or semiannual basis to NRC and DEQ. After restoration of Phase I has been demonstrated, Phase II, which is an expansion of Phase I, will commence and eventually encompass the entire ore pod, (of less than 2 acres) supplying the pilot plant up to (but not over) its maximum rated capacity of 90 gpm. Upon termination of leaching the balance of the ore pod, which is expected to occur in mid-1979, restoration will proceed until the entire leach module is restored to NRC and DEQ requirements. Restoration is expected to be completed or be nearly completed by December, 1979. This plan has been reviewed with DEQ.

3.2.1 Phase I - Well Field Design

The well field module for Phase I will leach the mineralized portion of the "B zone" and will consist of a single recovery well surrounded by four leachant injection wells on an approximate 40-foot radius circle. (Figure 17a) An observation well will monitor the "A zone" which lies above the "B zone" (the "B zone" aquifer

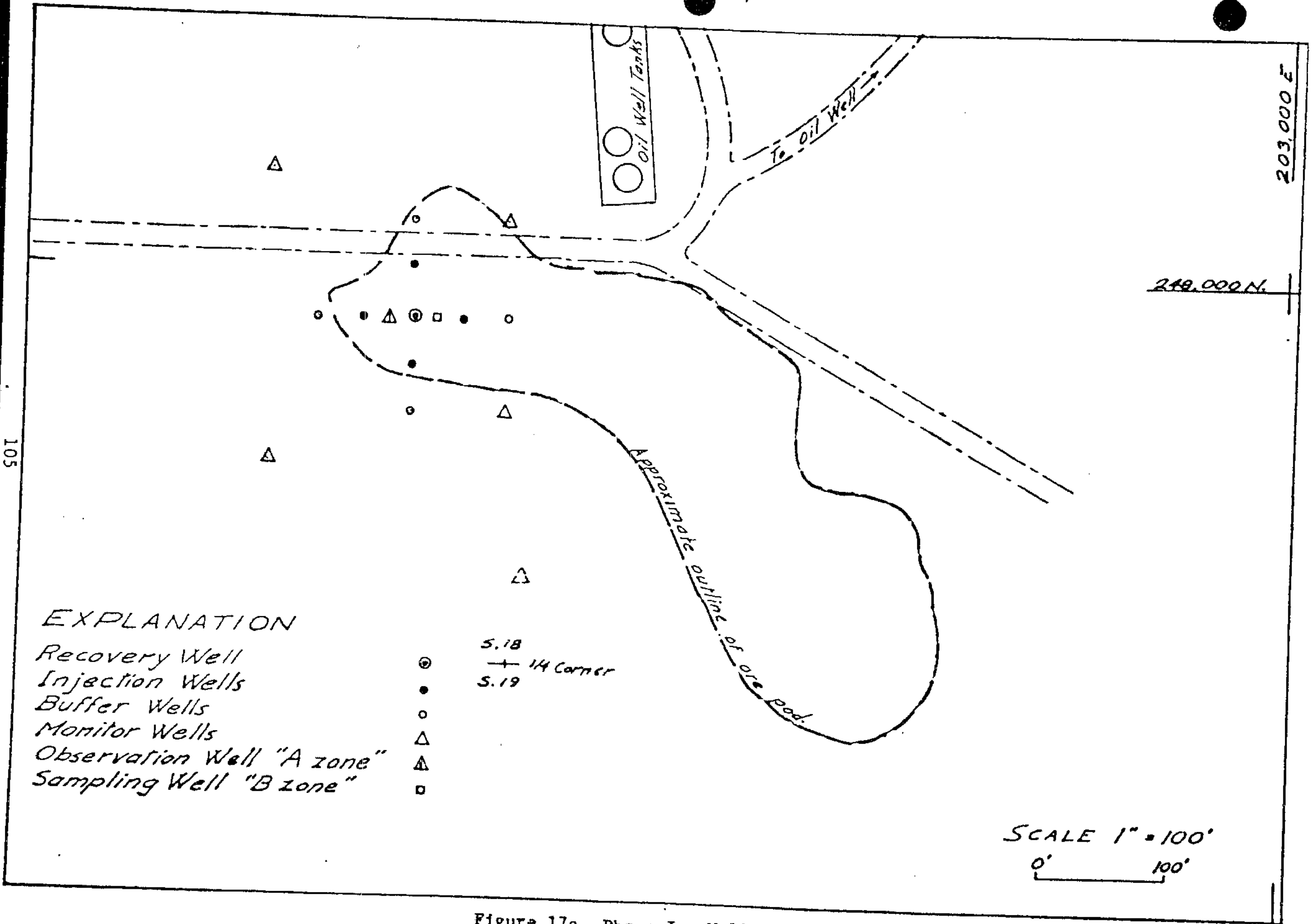


Figure 17a. Phase I - Well Field

is approximately 100 feet thick; see 2.9.2 Groundwater and Enclosure 8). The observation well will be located within the circle and on a line between the recovery well and an injection well. A leachate sampling well in the mineralized portion of the "B zone" will be similarly located between the recovery well and another injection well.

Concentrically around this leach module on approximately a 75-foot radius circle, there will be four fresh formation water injection buffer wells, which will create an opposing pressure barrier of formation water around the leachant (see Figure 17a). Purpose of the pressure barrier is to contain the leachant and prevent its outward excursion. Formation water for the buffer wells will be obtained from the "B zone" hydrological test pumping well, which is far enough away (approximately 700 to 800 feet) so as not to disturb the leach module flow pattern.

Encircling beyond the buffer wells at a distance from the central recovery well ranging from 100 to 160 feet there will be four wells monitoring the quality of the formation water in the "B zone."

Flow rate from the recovery well will be controlled to exceed total leachant injected (four wells) by four to six per cent. Cumulative flow meters on the recovery and injection wells will be read and recorded at least twice daily during leaching operations, (and less frequently as necessary during restoration) as well as injection pressure which will be kept at a minimum compatible with maintaining the desired hydrological flow pattern and flow rate. It is expected that this pressure will range between 30 and 100 psi above the normal static water level. The four to six per cent excess volume flow will be bled off at the surface pilot plant as barren solution and stored in solar evaporation storage ponds (Figure 18).

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Fresh formation water injected into the buffer wells will be controlled to flow at a minimal rate which approximates the leachant injection rate. Injection pressure measuring devices and cumulative flow meters on each of these four wells will be read and recorded concurrently with leachant injection readings. It is expected that a small portion of buffer well water will mix with injected leachant encountered and be drawn into the recovery well. The bulk of the buffer well water will gradually build and maintain the pressure barrier. The remainder of the fresh formation water will diffuse into the formation.

Well completion techniques used will be similar for injection, recovery, sampling, observation, and monitoring wells with some variations in materials and procedures, and will meet NRC and DEQ requirements.

3.2.2 Phase I - Sampling

The "A" aquifer observation well within the leach module and the four monitor wells in the "B" aquifer will be sampled and static water levels recorded prior to leaching operations for water baseline purposes (analyses per Table V) at reasonable time intervals. During leach operations these wells will have static level recorded and be sampled every two weeks and analyzed for sodium, total dissolved solids, uranium, arsenic, selenium and radium 226. The "A zone" observation well located within the leach module will have the static water level recorded daily. A full suite of analyses will be run from the four "B zone" monitor wells on a monthly basis.

For water baseline analysis purposes, samples will be taken at reasonable time intervals prior to leaching operations from the central recovery well, leachate sampling well and leachant injection wells. These same wells will also be sampled during the restoration process as necessary.

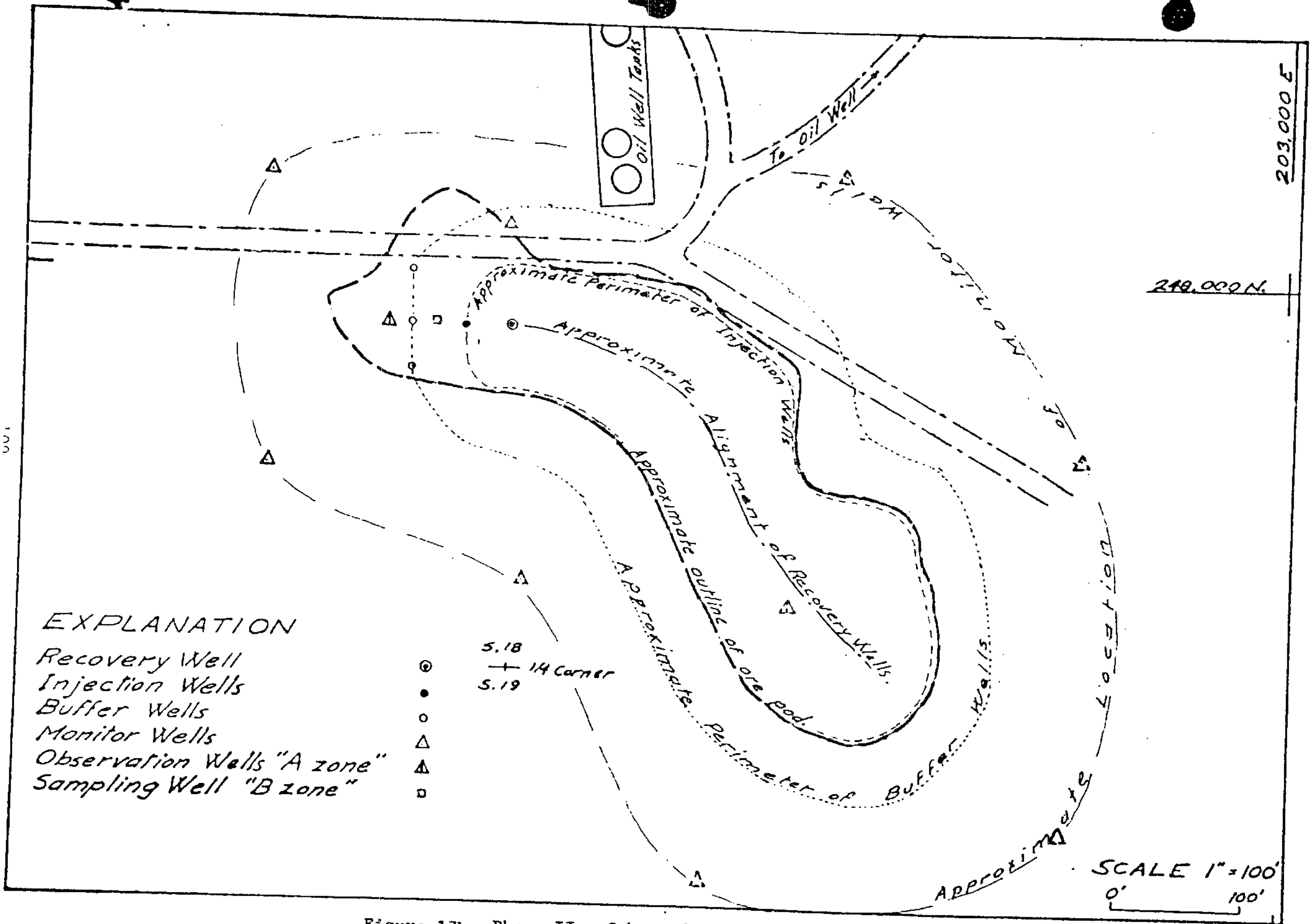

Figure 17b. Phase II - Schematic Layout of Well Field

During leaching operations, process-control and quality control sampling and water level recording will routinely be performed at leachant injection, recovery and the "B zone" leachate sampling wells.

Sampling methods will be employed which are in compliance with Baseline and Monitor Sampling procedures for collection, preservation and analysis of baseline water quality determination and monitoring as required by the NRC and DEQ. (Ref. 9)

3.2.3 Phase II - Field Design

The well field module for Phase II is an expansion of Phase I module to encompass the entire ore pod covering less than two acres. Because its final planning is purposely to be established on the basis of results from Phase I, only a generalized plan can be outlined at this time, as follows.

Phase II well field module would consist of a single row of suitably spaced recovery wells along the central longitudinal axis of the ore pod, flanked by injection holes along each side and ends of the ore pod. Distance between recovery and leachant injection wells is expected to range from 40 to 70 feet. Distances between recovery wells are expected to range from 30 to 60 feet and between leachant injection wells 30 to 60 feet. Within the perimeter of leachant injection wells there will be one, possibly two, "A zone" observation wells as in Phase I and for the same purpose. (Figure 17b)

Surrounding the perimeter of leachant injection wells (which delineates the Phase II leach module) at 35 to 70 feet out from the perimeter there will be a ring of fresh formation water buffer injection wells for the purpose of creating an untreated formation water pressure barrier just sufficient to contain the leach module and prevent excursion of leachant.

Encircling around and beyond the buffer well perimeter at a distance not to exceed 200 feet from the perimeter there will be approximately seven wells monitoring the quality of the formation water in the "B zone" (with emphasis on the downflow side). Two of these wells are monitor wells utilized in Phase I which, because of their location, will also be useful for the same purpose in Phase II.

Cumulative flow rate from recovery wells on stream at any one time during Phase II may reach but will not exceed the pilot plant maximum designed (input) flow rate of 90 gpm. Cumulative flow from recovery wells will exceed leachant injection rate by a percentage similar to Phase I and dictated by the knowledge gained therefrom, this excess to be bled off and stored in the manner described for Phase I. Cumulative flow meters on recovery and injection wells as well as pressure devices will be read and handled as described under Phase I.

Fresh formation water injected into the buffer wells will be controlled to inject at a minimal rate which shall achieve the desired pressure buffering effect. This total injection rate is expected to be somewhat under the total leachant injection rate. The purpose, effect and control of the buffer zone are the same as that for Phase I. Source of the untreated formation water will continue to be the "B zone" hydrological test pumping well which, as mentioned under Phase I, is sufficiently far away that it will not disturb the flow pattern of the leach module.

Well completion techniques will meet NRC and DEQ requirements.

3.2.4 Phase II - Sampling

Procucedures, frequency of sampling, parameters recorded and analyzed as performed under Phase I, will be continued and extended as applicable to the newly added "A zone" observation wells within the leach module and to the seven previously described monitor wells in the "B zone".

For baseline water quality purposes samples and recordings will be taken at reasonable time intervals prior to Phase II leaching operations from approximately every third recovery well, every third leachant injection well and all leachate sampling wells. The above mentioned wells plus the balance of the recovery wells will also be sampled during the restoration process as necessary.

During leaching operations, process-control and quality control sampling and water level recording will routinely be performed at recovery wells, "B zone" leachate sampling wells (if any) and at the leachant service tank.

Sampling methods will be employed which are in compliance with Baseline and Monitor Sampling procedures for collection preservation and analysis of baseline water quality determination and monitoring as required by the NRC and DEQ (Enclosure 9).

3.2.5 Restoration

Development and evaluation of aquifer restoration techniques specific to the test site are an important objective of the pilot test program.

Upon termination of a leaching operation, either Phase I or II, injection of leachant will cease. Fresh untreated formation water will continue to be injected into the buffer wells while the recovery well or wells continue to be pumped. This will create a formation water drive which encroaches in on all sides toward the recovery well. After the encroaching front has advanced inward past the idled leachant injection wells (and tests from these show that the formation water is approaching acceptable standards) then injection of untreated formation water into the former leachant injection wells will be gradually started, while injection into the buffer wells will be gradually decreased and will eventually cease. This procedure will accelerate flushing out of all chemicals through the central recovery well or wells until restoration to approach acceptable baseline water quality is achieved. Recovery well water will be processed through the pilot plant to remove uranium while gradual thinning out of chemicals takes place by dilution and removal procedures. In order to accelerate restoration of recovery well water to acceptable levels a volume of up to one pore volume of the leach module may be stored in the solar evaporation storage ponds. Radioactive waste materials, if any, will be disposed of in accordance with NRC and DEQ regulations.

The NRC and DEQ will be informed of the status of water quality parameters at each stage of the restoration procedures, semi-annually as a minimum. It is anticipated that one or more wells within the test site will be retained for periodic sampling (monthly or every two months as indicated by plot of data) until two consecutive samplings in agreement indicate that baseline levels have been satisfactorily achieved. The remaining wells will be sealed, in compliance with NRC and DEQ requirements, unless they are needed for further testing or other necessary use.

3.2.6 Surface Reclamation

Surface reclamation of drill sites, pilot test site and pond areas, will be accomplished in a manner consistent with our previously State-approved drill site and access road procedures. Surface soils will be replaced and graded. Appropriate grass seed mix will be planted during the designated Spring or Fall periods.

The solar evaporation storage ponds' evaporate will be collected and disposed of in an approved NRC and DEQ manner, dependent upon its chemical composition and radioactivity.

3.2.7 Sanitary and Other Plant Wastes

Sewage will be handled by portable type latrines in compliance with State of Wyoming regulations. Emergency shower, wash bowl and laboratory effluent will be handled in a storage tank in accordance with NRC and DEQ regulations.

3.2.8 Status of Permits and Bonds

The following permits and bonds related to in situ research and other activities have been issued and/or approved by the State of Wyoming:

1. License to Explore with Dozer No. 19, Dated August 19, 1976.
   Includes authorization for two push-pull Leach Tests. Only one was used. Renewal applied for on October 24, 1977.

2. Reclamation Bond.

3. General Performance Bond.

The following permit has been applied for:

1. Water Well Permit Applications, Dated March 14, 1977, relating to Hydrologic Test Wells.

The following permits will be secured prior to in situ solution mining tests.

1. Authorization from the State of Wyoming Department of Environmental Quality to operate in situ solution mining tests.

2. State Engineer's Construction Permit for Solar Evaporation Storage Ponds, consistent with NRC requirements.

3. Permit to construct - Waste Water Facility (Water Treatment Permit - State of Wyoming).

4. Other applicable state and federal permits which may be required for in situ solution mining tests, and related operations. (NPDES, etc.)

3.3 EXTERNAL APPEARANCE OF THE PROPOSED PLANT

The ion exchange plant and ancillary facilities (which include an office, partial storage space, wash and emergency facilities) will be housed in an approximately 40 feet wide by 40 feet long Butler type building of sufficient height to provide the clearance required by the ion exchange towers which is in the order of 15 feet. Attached end to end, will be a similar Butler type building of the same width and approximately 80 feet in length, but of lesser height, to house the surge and service tanks required in the leaching process. The overall picture will be that of a housing structure approximately 40 feet wide by 120 feet long with a stepped low relief roofline.

A trailer-laborat y will be located adjacent to the main housing structure ab .

In addition there will be separate ancillary small storage housing structures. A fence will protect the facilities and a suitable parking lot will be provided.

4.0 ENVIRONMENTAL EFFECTS

4.1 SITE PREPARATION AND PLANT CONSTRUCTION

Effects on the environment will be temporary in duration and limited in scope.

Erection time for the pilot plant will be in the order of two months. Well field drilling activities will precede each of Phases I and II. Preparation time for Phase I will be relatively short; Phase II well field preparation may extend over a period of several months.

4.1.1 Effects at the Site

Plant erection will require a minimum of ground levelling and excavation for a light foundation for installation of a light Butler type building for enclosure of the ion exchange plant, surge, and service tanks. Because the various units are of pre-assembled modular type and are generally skid mounted, no extensive slabs of concrete will be required. Impervious plastic type of linings will be used extensively over a packed and suitably levelled ground floor within the building (wherever concrete slabs are not used) to keep dust down and to collect and facilitate clean up of spillage if any.

Solar evaporation storage ponds will require a certain amount of levelling and excavation in their construction. Well field leachant, leachate and buffer water lines for Phase II will probably be buried below the soil freeze for winterizing (2.5.1). A soil trenching machine will probably be used for this excavation. Noise from these activities is not unusually loud and should not be audible at the nearest habitation one mile away (2.2). Equipment used during construction will be located at the site or nearby.

Well field site preparation involving the drilling and finishing of holes and laying of lines will involve a minimum of surface disturbance. Affected areas will be restored in accordance with previously approved State of Wyoming drill site and access road procedures.

Sanitary wastes will be taken care of in portable chemical toilets. Trash and wastes from construction activities will be hauled away for proper disposal.

4.1.2 Effects Off-site

The plant will be close if not adjacent to an established access road and in the vicinity of an oil well pad and oil tank farm (Plate II). Established roads will be used for access to the site. Increase in traffic will take place during construction and settle down after construction is completed.

4.2 RESOURCES EXPENDED

Irretrievable resources used in the construction will be those which cannot be recycled after the eventual dismantling of the facility; for example, fuel, chemicals, paint, waste, contaminated material or equipment which cannot be reclaimed, etc.

5.0 ENVIRONMENTAL EFFECTS OF PROPOSED OPERATIONS

5.1 HEALTH AND SAFETY EFFECTS OF PROPOSED OPERATIONS - RADIOLOGICAL IMPACT - Item 11, Form AEC-2

The greater part of radioactivity generated in naturally occurring uranium ores originates from the daughter products derived from the radioactive disintegration of uranium itself. In conventional uranium mining, the bulk of exposure to radioactivity is caused by daughter products associated with mining and milling of the ore and disposal of mill tailings. A fortunate aspect of in situ solution mining is that the great majority of daughter products are not leached but remain underground.

As a result, what radioactivity is brought to the surface is quite low level in the very dilute leachate recovered. Therefore, in the surface plant the radioactivity levels normally encountered during conventional mining and/or milling are approached only in the precipitation and slurry dewatering circuits. In the proposed pilot plant because the final product is in slurry form, no radioactive dust conditions will develop such as may exist when a yellowcake powder is the product. It is evident that radiation is minimal and exposure hazards associated with the processes are insignificant.

5.1.1 Radioactive Effluents

Liquid waste products from the pilot plant will have a very low level of radioactivity, as explained above. This type of waste will be stored in a suitable solar evaporation storage pond or ponds for appropriate interim disposal with the final disposition being established by NRC and DEQ regulations (see 3.1 Process Chemistry and Plant Design). There are no radioactive gaseous effluents resulting from the process. (Nevertheless air monitoring devices are included, see section 5.1.3).

5.1.2 Radioactivity Monitoring and Safety Program - Item 12c, Form AEC-2

Radiation monitoring and a safety training program will be implemented by the plant contractor Hazen Research, Inc., Golden, Colorado, or an equivalent independent consulting organization. The program will instruct management personnel and all operators on monitoring and safety procedures as part of the plant start-up operations. Hazen Research, Inc. (or equivalent organization) will check the operation frequently until such time as the Safety-Licensing engineer is ,ualified to perform such duties. Hazen will be on call in the event of any operating or radiological problem.

5.1.3 Equipment and Facilities For Protection From and Monitoring of Radioactivity - Items 11(a), 11(b), 11(c), 12(a), 12(b), 12(c), Form AEC-2

The radiation safety program outlined under section 5.1.2 will be instituted to monitor the health and safety effects of the proposed operations. The equipment, instrumentation and facilities will include beta-gamma dose rate meters or equivalent, alpha radiation meter or equivalent, film badges for operating personnel, plus ordinary first aid facilities including quick acting shower (for chemicals). Calibration and maintenance of equipment will conform with procedures required by NRC and MESA.

Because of the rigorous winters encountered in this area, the surface plant will be enclosed. Suitable exhaust ventilators will be installed to forestall any possible accumulation of radon ga or carbon dioxide.

Points of radioactivity level sampling will be: 1) Leachate surge tank, 2) leachate filters, 3) raffinate service tank (barren solution from IX towers); bleed to solar evaporation storage pond,

4) uranium precipitation decant solution bleedoff to second solar evaporation storage pond. Other points in the entire circuit and within the enclosing structure will be checked as part of the plant evaluation as may be recommended by Hazen Research, Inc. or equivalent independent consultant. A list of checkpoints will be established and will be checked and recorded at daily intervals and made available to NRC and DEQ.

The test facility, including the solar evaporation storage ponds will be fenced, and, where applicable, will be posted with approved signs warning of the presence of significant radioactive material.

5.1.4 Safety Features and Procedures to Protect Health and Avoid Non-Nuclear Accidents in Source Material Storage and Processing Areas - Item 12, Form AEC-2

Accepted standard industrial safe working practices will be followed to prevent accidents to life and property. Because of the water-base nature of the plant processes, and because the necessity for solid liquid or gaseous combustible materials is minimal, the fire and explosion hazards connected with the operation will be very low.

LPG for heating purposes will be stored outside the building. Sulfuric acid and hydrogen peroxide will be stored away from each other and away from yellowcake slurry storage areas. Yellowcake slurry will be packaged in drums and stored to avoid or minimize accidents caused by weather, fire and mobile equipment. The packaging will comply with U. S. Department of Transportation regulations for storage and transport, as well as with NRC.

5.2 CHEMICAL EFFLUENTS - NON-RADIOACTIVE

Plant waste effluents (liquid, non-radioactive) not suitable for regeneration or re-use will be stored in the same manner as with low-level radioactive effluents.

Barren leachate bleedoff (very weak sodium bicarbonate water solution) will be stored in a suitable solar evaporation storage pond. (see 3.1 Process Chemistry and Plant Design)

5.3 ATMOSPHERIC RELEASES

In the yellowcake precipitation circuit of the plant, carbon dioxide is released upon acidification of the eluate, prior to precipitation with hydrogen peroxide (Enclosure 10). The carbon dioxide will be removed by an exhaust ventilation system. No other significant gas or vapor release will result from the proposed process. Should the necessity arise to change the process as discussed in 3.1 (bottom of page) any release of ammonia vapors will be properly handled by the exhaust system.

No significant radon gas release is expected in the process. Nevertheless a monitoring system will maintain surveillance. The exhaust system will remove all gases, vapors and fumes within the building enclosure.

Liquified Petroleum Gas (LPG) or fuel oil is planned as fuel for heating purposes although electricity, (and possibly coal) may be used if advantageous. The BTU requirements are not expected to be high for plant process use as some heat is generated in the process itself.

5.4 SANITARY AND RELATED WASTE

Trash and garbage will be collected in suitable receptacles and hauled away for disposal at an approved location. Sewage will be disposed of through a portable latrine service. Chemical laboratory wastes and wash bowl and emergency shower effluents will all go to a plant effluent solar evaporation storage pond.

6.0 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PRE-OPERATIONAL STUDIES AND MONITORING

6.1.1 Demography and Land Use

Data and other local information and sources are given and discussed in section 2.2.

6.1.2 Historical and Cultural Studies

Sources (Wyoming State Archives and Historical Department) and data are given and discussed in section 2.3.

6.1.3 Ecological Studies

Data from Wyoming State Game and Fish Department, and study by Camp Dresser & McKee, Inc., Environmental Sciences Division are given in sections 2.4, 2.4.1, and 2.4.2.

6.1.4 Meteorological Studies

Data principally from the National Oceanic and Atmospheric Administration, U. S. Department of Commerce is given and described in sections 2.5, 2.5.1, 2.5.2, 2.5.3, 2.5.4, and 2.5.5.

6.1.5 Background Radiation Studies

The pre-operational monitoring program is described in section 2.6.

6.1.6 Seismological Studies

Data on seismic risk and history of tremors that occurred within 200 miles of Moorcroft are given and discussed in section 2.7; the sources of data are various offices of the National Oceanic and Atmospheric Administration.

6.1.7 Geological Studies

The information and data is given and discussed in section 2.8.

6.1.8 Hydrological Studies

The information, data, sampling, results and sources are described and given in sections 2.9, 2.9.1, 2.9.2, 2.9.3 and 2.9.4; also in sections 3.2.2 and 3.2.4.

6.2 PROPOSED OPERATIONAL MONITORING PROGRAMS

Monitoring programs and practices for hydrological, radiological (safety) and effluent disposal purposes are discussed in the following sections.

6.2.1 Hydrological Monitoring - Operational

Monitoring of aquifers during operations and restoration periods has been described in sections 2.9.3, 3.2.2, 3.2.4 and 3.2.5.

6.2.2 Radioactivity Monitoring - Operational

The program has been described in sections 5.1.2 and 5.1.3.

6.2.3 Chemical Effluent Monitoring - Operational

No chemical effluent will be released into the environment. Effluents from the plant will be discharged into solar evaporation storage ponds as described in section 3.1 page . As shown in Figure 17 the design of the pond provides for a leak detection device in the form of drains. These will be monitored regularly twice a week.

7.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 EMERGENCY PROCEDURES IN THE EVENT OF ACCIDENTS WHICH MIGHT INVOLVE SOURCE MATERIAL - Item 12-b, Form AEC-2

Because the highest level of radioactivity involved at any point in the operations is very low (as explained under 4.1) the danger of grave hazards from radioactive causes is fortunately insignificant.

In the event of ruptures in plant components, the impervious construction around and under tanks and similar equipment containing process solutions would drain and collect spillage into sump areas designed for this event. The spillage would be pumped to the solar evaporation storage ponds, or into standby storage tanks available for the purpose as applicable.

For the unlikely event of a fire, (scarcity of combustible material) adequate fire extinguishers will be stationed throughout the building structures. In addition, the fresh water makeup tank with its service pump and line and outlets constantly under pressure will supply water pressure for fire hoses stored at strategic locations ready for emergency use.

7.2 TRANSPORTATION ACCIDENTS

Yellowcake uranium oxide slurry obtained in the R. and D. pilot scale plant will be packaged in drums in compliance with NRC regulations and other applicable Federal and State of Wyoming regulations. The drums will be properly secured and blocked on the transport trucks before leaving the plant.

In the unlikely event that a truck accident should take place and that some of the drums become ruptured, any spillage of the

contents would not travel any great distance because of the high specific gravity of the yellowcake. Because it is in slurry form no yellowcake dust would become wind blown. Any spillage would be physically recovered, along with contaminated dirt, soil, or mud.

8.0 RESTORATION AND RECLAMATION

These activities were described in sections 3.2.5 and 3.2.6 respectively.

9.0 ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

Construction and operation of the pilot scale R. and D. plant will create approximately 15 temporary jobs of about 18 months duration with a payroll of approximately $600,000.

The short duration of the construction and operation period should not result in any economic or social hardship on surrounding communities.

Capital costs relating to the proposed pilot scale operations are estimated at about $200,000. Operation and maintenance costs should approximate $800,000.

External costs associated with the construction and operation of the proposed operations are expected to be minimal due to the short duration of the test and the limited number of employees involved. Little or no impact should be felt on city, county, or state agencies and services in the area.

10.0 ALTERNATIVES

The low uranium content, depth and configuration of the mineralized zone in the test site area precludes economic recovery using conventional open pit or underground mining methods. The application of in situ leach mining technology appears to offer the only means by which this resource can be recovered. On the basis of preliminary studies, in situ leach mining would result in minimal environmental impact on the surface and subsurface of the site involved. The alternatives to continuing the program would be delaying further evaluation or abandoning the resource, both of which would entail not only considerable financial loss to the venture but also the delay or loss of a valuable domestic asset to the national energy requirements of the United States.

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APPLICATION FOR
SOURCE MATERIAL LICENSE

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