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**Microclimates of the
Arid Lands Ecology Reserve
1968 - 1975**

April 1977

Battelle
Pacific Northwest Laboratories

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1968 - 1975**

**J. M. Thorp
W. T. Hinds**

April 1977

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SUMMARY

The climatology of the ALE Reserve does not end, of course, with this report. As this goes to press the arid lands of eastern Washington are experiencing the driest winter in 65 years of record. Even without including this winter's (1976-77) data in our summaries here, we have been fortunate to have had a very dry winter (1972-73) and a very wet winter (1973-74) occur within our first 8 years of climatological measurements on the Reserve.

Our primary purpose with this report has been to analyze the first 8 years of climatological measurements from the ALE Reserve and to identify persistent spatial variations between stations or groups of stations. From these variations we have been able to recognize several distinct, but related microclimates occurring within the Reserve. Secondly, we have shown that significant correlations exist between each microclimate on the Reserve and that of the Hanford Meteorological Station nearby. These correlations, coupled with the 30-year weather record at the HMS and possibly with the 32-year (1912-1944) record at the Hanford townsite, allow ALE Reserve temperature and precipitation estimates to be made for years prior to the ALE climatology program.

ACKNOWLEDGMENTS

Many people have contributed directly and indirectly to the preparation of this report; we regret being unable to acknowledge each one. We especially thank Dr. B. E. Vaughan and Dr. W. H. Rickard of the Ecosystems Department, and C. L. Simpson and Dr. C. E. Elderkin of the Atmospheric Sciences Department for their sustained interest, guidance and support of this project.

This work has been performed under Contract EY-76-C-06-1830 with the Division of Biomedical and Environmental Research, Energy Research and Development Administration.

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MICROCLIMATES OF THE ARID LANDS ECOLOGY RESERVE — 1968-1975

INTRODUCTION

Microclimatic observations on the Arid Lands Ecology (ALE) Reserve began in mid-1968 (temperature) and spring 1969 (precipitation). The ALE Reserve is 300 km² of shrub-steppe and grassland in semi-arid southcentral Washington, a portion of the Energy Research and Development Administration's Hanford Works that was set aside in 1968 specifically for ecological studies.

Twenty-six locations on five elevational transects were established on the ALE Reserve in 1968. The basic microclimatological measurements at these stations include monthly precipitation and monthly maximum and minimum temperature at 0.3 m above ground. Continuous soil temperatures and/or air temperature, and relative humidity at standard height (about 1.2 m) have been measured at seven stations since 1972. The Hanford Meteorology Station (HMS), a Class A weather station with continuous records of wind velocity, air temperature, relative humidity, soil temperature, solar radiation and precipitation is located about 7 km from the northeastern boundary of the ALE Reserve.

This report describes the physiography and climatology of the Reserve. Statistical and multivariate analyses identify microclimatic regions on the Reserve and test for meaningful correlations between the ALE stations and the Hanford Meteorology Station. Correlations among the ALE stations themselves come as fringe benefits.

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GEOGRAPHY AND CLIMATOLOGY OF THE HANFORD REGION

With more than half its area once covered by conifer forests, Washington State deserves its name, "Evergreen State." Visitors familiar only with western Washington greenery are often surprised to find an area in the southeastern quarter of the state with a climate much too arid to support trees. This arid steppe land of more than 6,000,000 hectares (24,000 square miles)¹ slopes gently north to south from about 610 m* (2,000 feet) near Grand Coulee Dam to about

120 m (400 feet) at the confluence of the Yakima, Snake, and Columbia Rivers at Tri-Cities, Washington. Commonly called the Lower Columbia Basin, it lies in the rain shadow of the Cascade Mountains 160 km (100 miles) west (Figure 1). The Cascades annually receive 350 to 450 cm of precipitation whereas 100 km to the east, the Lower Columbia Basin averages only 15 to 25 cm.² This drastic reduction of precipitation can occur in less than 70 km, depending on topographic details.

*All elevations referenced to mean sea level.

Figure 1. Map of Washington State Showing Cascade Mountains, Columbia Basin and the Hanford Reservation.

At the southern end of the Lower Columbia Basin lies the U.S. Energy Research and Development Administration's Hanford Reservation, with the Columbia River on the north and east and the Yakima River to the south (Figure 2). Established in 1943, the Hanford Reservation, a national security area and now a National Environmental Research Park, was closed at that time to agriculture, grazing and

unofficial travel. In 1965, state Highway 240 was completed through the Reservation via Cold Creek Valley, a dry creek bed trending northwest-southeast at the base of the Rattlesnake Hills. In 1968, the Atomic Energy Commission (now ERDA) set aside a portion of the Reservation south of Highway 240 as an ecological study area called the Arid Lands Ecology (ALE) Reserve (Figure 3).

Figure 2. The Hanford Reservation Includes the Arid Lands Ecology Reserve.

Figure 3. The Arid Lands Ecology Reserve Showing Microclimatological Stations and Road Network.

The most striking topographic feature of the Reservation is Rattlesnake Mountain which bounds the ALE Reserve on the southwest. For 5 km, the uniform crest of this mountain is 1100 m high, dropping on its southeastern end to 125 m at the water gap of the Yakima River. Northwest of this long crest, a jumbled topography much less than 1000 m in elevation merges with the northwest continuation of the Rattlesnake Hills.³

The gently sloping south side of Rattlesnake Mountain, outside the Hanford Reservation, supports dryland wheat farming at the higher elevations. By contrast, the north slope, on the ALE Reserve, drops steeply (about 25°) to 650 m elevation, then eases to 7° down to about 350 m, and finally slopes ever more gently to the Cold Creek Valley at 150 m. North of Cold Creek Valley (150 to 200 m), the land surface rolls gently while rising to about 225 m on the crest of a

broad ridge. The Hanford Meteorology Station is located at 223 m elevation near the center of the Hanford Reservation on this intermediate upland.

Prior to the establishment of the HMS in 1944, U.S. Weather Bureau (now National Weather Service) cooperative observers made climatological observations from April 1912 until March 1943 at the old Hanford townsite on the Columbia River.⁴ From December 1943, to May 1944, Weather Bureau observations were made at Richland, 40 km southeast of the HMS site. Hourly observations on a continuous basis commenced at the HMS on December 7, 1944, and have continued to date (1977). Summarizations of Hanford area climatological data from all three locations have been published by Stone et al.⁴ Relevant updated tables extracted from this document are found in Appendix B.

The climate of the Hanford area is greatly influenced by the Cascade Mountain Range to the west, which forms a barrier to moisture-laden winter storms moving eastward from the Pacific Ocean. The moist air within these frontal storm systems rises to clear the mountain obstruction, producing copious precipitation over the mountains. As these storms continue eastward, the resultant moisture-depleted air is warmed and further dried by descent down the eastern slopes of the Cascade Mountains. This produces a dramatic decrease in annual precipitation eastward from the Cascades.

Annual precipitation at the HMS averages 16.5 cm (~6.5 inches), but it has ranged from about 7 to 30 cm during the past 30 years.⁴ On the average, 60% of this precipitation falls between October and February (Figure 4). Precipitation decreases after the

Figure 4. Average Monthly Precipitation (Vertical Bars) and Average Hours Per Month Precipitation Observed at Hanford Meteorological Station (1912-1970).

three wettest months of November, December and January, but increases again to a secondary maximum in June. The climate of the Hanford region can thus be described as having hot, dry summers and moderately cold winters. July is the hottest and driest month while January is the wettest and coldest month (Figure 5).

The HMS climatological data are representative of the entire Hanford Reservation.⁶ However, a large portion of the ALE Reserve is on the northeast-facing slope of the Rattlesnake Hills, which rise to about 1100 m. Diverse microclimates result from combinations of slope, exposure and elevation encountered in this uplift.

Figure 5. Average Monthly Temperature and Average Monthly Precipitation at the Hanford Meteorology Station (1912-1970).

THE ALE RESERVE MICROCLIMATOLOGICAL NETWORK

To measure and identify microclimatic variations on the ALE Reserve, we established a network of stations in 1968 to measure maximum/minimum temperatures and precipitation. To minimize disturbance, the stations were selected along existing roads; thus, the transects are irregular (Figure 6). Where not restricted by topography, the station locations were selected on five transects to provide data in or near major ecological study plots, or within areas of similar vegetation.

The **Snively Transect** lies at the western end of the ALE Reserve, with four stations oriented

nearly north-south. It begins in the Cold Creek Valley at 200 m and terminates in an old field at 530 m, approximately 13 km uphill. The field was abandoned about 35 years ago and has remained undisturbed.

Five km east, the **Benson Transect** contains eight climatological stations spaced over about 8 km. It starts in another abandoned field at 190 m (in Cold Creek Valley) and terminates at 940 m, against the edge of cultivated wheat fields at the crest of the Rattlesnake Hills. This transect also lies north-south.

Figure 6. Five Transects of Microclimatological Stations on the ALE Reserve.

For several kilometers eastward from the Benson Transect the upper slopes of Rattlesnake Mountain become quite steep; even sheepherder roads reach no higher than 400 m on the mountain. The **Central Transect** begins on the floor of Cold Creek Valley at 160 m, 8 km east of the Benson Transect, rises to near the base of the steep slopes, then jumps to three closely-spaced stations across the crest of the mountain at 1080 m. It is about 9.5 km in length, oriented northeast-southwest.

Some 3.5 km further eastward is the **Winterfat Transect** with only three stations spaced over about 8 km. It commences at 206 m, just above an ecotone between *Artemisia tridentata* and

Eurotia lanata communities and terminates just over the southeast shoulder of Rattlesnake Mountain at 950 m. Its orientation is also northeast-southeast.

At the southeastern corner of the ALE Reserve, the **Blacktop Transect** begins in Cold Creek Valley at barely 135 m and climbs for 10 km nearly due westward via a blacktop road to 755 m on the southeastern shoulder of Rattlesnake Mountain. There are six stations on this transect.

Table 1 catalogs the ALE stations. A detailed description of each station and its individual microclimatic correlation with the HMS is found

Table 1

Arid Lands Ecology Reserve Microclimatological Station Descriptions

STATION NUMBER	STATION NAME	ELEV, m	SLOPE,°	EXPOSURE	COVER TYPE	SOIL* TYPE
	<u>SNIVELY TRANSECT</u>					
01	UPPER COLD CREEK	204	0	--	A/P	Qu
02	RATTLESNAKE SPRINGS	210	0	--	S/D	He
03	LOWER SNIVELY	323	2.3	N	A/A	Wa
04	UPPER SNIVELY	533	3.4	NE	A/A	Ri
	<u>BENSON TRANSECT</u>					
05	BENSON RANCH	189	0	--	A/P	Qu
06	UPPER BENSON RANCH	234	2.9	N	A/P	Wa
07	ALLUVIAL FAN	347	4.8	NE	A/A	Sc
08	LOWER LARK SPUR	488	9.5	NE	A/A	Ls
09	LARK SPUR	588	0	NE	A/A	Ls
10	BENSON BASIN	744	6.3	N	A/A	Ls
11	ANDERSON RIM	884	4.5	NE	A/A	Ls
12	ANDERSON FIELD	939	2.3	S	A/A	Ls
	<u>CENTRAL TRANSECT</u>					
13	HOPSAGE	158	0	--	At/P	Qu
14	TELEMETER	366	4.5	NE	A/A	Ri
15	RATTLESNAKE CREST NE	1020	18.4	NE	A/A	Ls
16	RATTLESNAKE CREST	1079	0	--	E/P	Ls
17	RATTLESNAKE CREST SW	1067	8.1	SW	E/P	Ls
	<u>WINTERFAT TRANSECT</u>					
18	WINTERFAT	206	3.8	NE	Eu/P	Wa
19	CALOCHORTUS	381	4.1	NE	A/A	Ri
20	BEETLE PLOT 7	954	8.1	SE	A/A	Ls
	<u>BLACKTOP TRANSECT</u>					
21	LOWER COLD CREEK	134	0	--	A/P	El
22	BEETLE PLOT 3	192	2.2	E	A/P	Wa
23	BEETLE PLOT 4	286	1.9	E	A/A	Wa
24	E.R.C. (Y)	329	2.2	NE	A/A	Wa
25	BEETLE PLOT 5	448	5.2	NE	A/A	Ri
26	BEETLE PLOT 6	756	9.4	NE	A/A	Ls
622	HANFORD METEOROLOGY STATION	223	0	--	A/P	Ba

*See Appendix A for soil type legend

in Appendix A. Figure 7 portrays the distribution of the ALE stations with elevation. The IBP site shown between the Winterfat and Blacktop

Transects is a Grasslands Biome study site for the U.S. International Biological Program. A full discussion centered on this site is available.

Figure 7. Distribution of the ALE Microclimatological Stations with Elevation. Horizontal spacing is relative but not to scale.

MICROCLIMATES ON THE ALE RESERVE

The purpose of the ALE Reserve microclimatological program has been twofold: 1) to identify and describe microclimates within the Reserve, and 2) to test for correlations of temperatures and precipitation at each ALE station with those at the Hanford Meteorology Station. These correlations should make the longer record at HMS useful to ALE investigators.

TEMPERATURE PATTERNS

Figures 8a,b and 9a,b show contours of the average extreme maxima and minima in January and

July for 1968-1975. A uniform decrease of extreme maxima occurs with elevation both in January and July, though the range of temperature differences in July is greater than in January (10°C versus 6°C). In January, the rate of change with elevation of extreme temperature is near the normal lapse rate ($6^{\circ}\text{C}/\text{km}$). But, in July, the difference is $10.4^{\circ}\text{C}/\text{km}$, which is very close to the dry adiabatic lapse rate for ascending unsaturated air (Figure 10). Perhaps the July profile of extreme maxima is indeed largely the result of convective mixing. However, in January the upper reaches of Rattlesnake Mountain lie hidden in shadows nearly all day. Convective

Figure 8a. Average January Extreme Maximum Temperature ($^{\circ}\text{C}$) on the ALE Reserve (1968-1975).

Figure 9a. Average January Extreme Minimum Temperature (°C) on the ALE Reserve (1968-1975).

It must be remembered that all these data, maxima and minima, represent the averages of January and July extreme temperatures over the 8 years of record. There is no assurance that the individual station values occurred even on the same days of the month, much less the same hour. Thus, it cannot be assumed that these profiles of temperatures represent specific situations.

PRECIPITATION PATTERNS

With precipitation, we are on firm ground using a monthly statistic. Figures 12, 13 and 14 show the distribution of precipitation on the ALE Reserve for three ecologically important time periods: the wet season, the bioyear, and the dry season.

The Wet Season

The precipitation which falls between November and February (Figure 12) makes up the wet season. Normally, this is the most important source of water for the ensuing growing season. Daily-hourly precipitation records at the HMS show that precipitation during these months is usually light ($\leq .25$ cm/hr), but average hours of precipitation per month range from 57 in February to 96 in January.⁴ These long precipitation events, coupled with high average relative humidity (70 to 80%), and low radiative loads⁵ (200 Langley's day⁻¹), reduce evapotranspirational losses greatly. Most of the precipitation penetrates and remains in the soil mantle.

Figure 9b. Average July Extreme Minimum Temperature ($^{\circ}\text{C}$) on the ALE Reserve (1968-1975).

Figure 10. Average Extreme Maximum Temperatures Versus Elevation for January and July (1968-1975). Major Arid Lands investigative plots are at the levels indicated.

Figure 11. Average Extreme Minimum Temperatures Versus Elevation for January and July (1968-1975). Major ALE investigative plots are at the levels indicated.

Figure 12. Average November Through February (Wet Season) Precipitation (cm) on the ALE Reserve (1968-1975).

Figure 13. Average October Through May (Bioyear) Precipitation (cm) on the ALE Reserve (1968-1975).

Exceptions occur when warm, snow-melting Chinook winds or warm rains arrive after a period of consistent sub-freezing temperatures. In these circumstances, much of the melting snow (and precipitation) may run off the frozen soil.

The maximum amount of November-February precipitation on the ALE Reserve falls on the upper slopes of Rattlesnake Mountain, near 900 m, decreasing up on the wind-swept crest of the mountain and down on the flats of Cold Creek Valley. The high elevation reduction is no doubt due, in part, to wind effects on the rain gauge. The decrease in Cold Creek Valley is likely a rain shadow effect of the mountain,

since it is oriented across most of the moisture-laden winds.

The Bioyear Precipitation (October-May)

Bioyear precipitation is that amount which is most pertinent to annual vegetative growth and reproduction. Figure 13 and Table 2 show these averages range from 24 cm just below the crest of Rattlesnake Mountain (at Station 10) to only 14 cm on the crest itself, at the low southeastern end of the mountain, and out in the Basin proper at HMS. Surely considerable precipitation fails to get measured at the crest, Station 16, because of wind errors. The vegetation at and near the crest indicates that

Figure 14. Average July Through September (Dry Season) Precipitation (cm) on the ALE Reserve (1968-1975).

there are very significant interactions among precipitation gradient, wind exposure, and soil depth, in a very short distance from the crest of the mountain.

The Dry Season

July, August, and September are the three driest months of the year, and July and August are the hottest (Figures 4 and 5). The basic elevational pattern for the bioyear and the wet season precipitation is repeated during the summer, (Figure 14), but the amounts are reduced by an order-of-magnitude from the bioyear totals. Clearly, the summer months would be a time of stress for non-adapted species. Only in rare instances (1973-74, for example) are winter and

spring moisture accumulations sufficient to provide a carryover of available soil water through the summer months.⁵

The mean monthly values of extreme temperatures and precipitation, and their standard deviations, are shown in Table 3. The annualized standard deviation of mean monthly maximum temperature is about 3°C greater than that of minimum temperature throughout the elevational range on the ALE Reserve, (Figure 15). This indicates that extreme maximum temperatures have a greater range, annually, than do extreme minima. A single station (near Station 19), using daily data, showed that winter temperatures are consistently more variable than the maxima,

Table 2

Average Monthly Extreme Maximum and Minimum Temperature and Average Bioyear and Calendar Year Precipitation at ALE Reserve Microclimatological Stations (1968-1975)
Arranged by Decreasing Elevation.

STATION	STATION NAME	ELFV. m	1968 - 1975					
			AVERAGE MONTHLY MAX TEMPERATURE		AVERAGE MONTHLY MIN. TEMPERATURE		AVERAGE PRECIPITATION	
			JAN	JUL	JAN	JUL	OCT-MAY	JAN-DEC
16	RATTLESNAKE CREST	1079	7.0	36.5	-17.5	4.5	14.1	16.5
17	RATTLESNAKE CREST SW	1067	7.5	37.5	-17.5	4.5	14.3	16.6
15	RATTLESNAKE CREST NE	1021	7.0	35.5	-16.5	4.0	21.5	24.6
20	BEETLE PLOT 7	954	10.0	39.5	-18.0	4.5	20.5	23.5
12	ANDERSON FIELD	939	9.0	40.0	-17.0	4.0	19.8	22.5
11	ANDERSON RIM	884	8.0	38.0	-20.5	2.0	23.9	27.2
26	BEETLE PLOT 6	756	10.0	40.0	-14.5	8.0	18.9	21.6
10	BENSON BASIN	744	10.0	40.0	-16.5	5.0	24.1	27.2
09	LARK SPUR	588	11.5	41.5	-17.5	6.5	22.9	25.3
04	UPPER SNIVELY	533	11.5	43.0	-17.0	6.0	22.5	24.8
08	LOWER LARK SPUR	488	12.5	43.5	-14.5	8.0	21.8	24.3
25	BEETLE PLOT 5	448	12.0	43.0	-15.5	7.5	19.8	22.5
19	CALOCHORTUS	381	12.5	43.0	-16.0	8.5	22.4	24.6
14	TELEMETER	366	13.0	43.5	-16.0	9.5	22.7	24.7
07	ALLUVIAL FAN	347	12.5	44.0	-16.0	8.5	20.6	22.4
24	ERC Y	329	12.5	43.5	-17.0	6.0	18.9	21.1
03	LOWER SNIVELY	323	12.5	44.5	-15.5	8.5	19.5	21.3
23	BEETLE PLOT 4	286	14.0	46.5	-17.0	6.0	18.6	20.8
06	UPPER BENSON	234	14.5	44.5	-15.5	9.5	16.7	18.7
02	RATTLESNAKE SPRINGS	210	12.5	44.5	-17.5	7.0	14.8	16.3
18	WINTER FAT	206	14.0	44.5	-17.0	8.5	17.5	19.3
01	UPPER COLD CREEK	204	14.0	47.0	-20.0	6.5	14.1	15.6
22	BEETLE PLOT 3	192	14.0	46.5	-17.0	7.5	17.7	19.9
05	BENSON RANCH	189	13.5	45.5	-20.0	3.5	15.0	16.9
13	HOPSAGE	158	14.0	44.5	-20.0	5.5	15.4	17.1
21	LOWER COLD CREEK	134	14.5	45.5	-19.5	5.0	16.4	18.4

because of an occasional influx of cold arctic air. Apparently, monthly minima, especially during winter months, exhibit more variability than the maxima while remaining within a lesser annual range.

Neither bioyear nor annual precipitation totals show a linear relationship with height (Figure 16). The greatest amount of measurable precipitation occurs between 750 and 900 m on all transects except Blacktop. The six stations on the Blacktop transect have a different

elevational relationship than do the other transects. We have long felt that this transect is not representative of the other portions of the ALE Reserve due to its position along the edge of the mountain.⁵

Rotenberry et al.,⁶ have begun study of microclimates on the ALE Reserve using pairwise cluster analyses of correlation coefficients between variables of temperature extremes and precipitation. Figure 17 portrays the various groups and subgroups of similar microclimates.

Table 3

Average Monthly Values of Extreme Maximum and Extreme Minimum Temperatures and Average Monthly Precipitation at ALE Microclimatological Stations with the Standard Deviation of Each Parameter (1968-1975).

STATION	STATION NAME	ELEVATION, m	MEAN MONTHLY VALUES					STANDARD DEVIATION cm
			MAXIMUM TEMPERATURE °C	STANDARD DEVIATION °C	MINIMUM TEMPERATURE °C	STANDARD DEVIATION °C	PCPN cm	
011	UPPER COLD CREEK	204	31.0	12.3	-6.4	8.8	1.28	1.40
021	RATTLESNAKE SPRINGS	210	28.9	11.6	-4.0	8.5	1.33	1.54
031	LOWER SNIVELY	323	28.5	11.8	-1.7	8.5	1.74	1.94
041	UPPER SNIVELY	533	27.0	11.4	-4.1	7.9	2.04	2.12
051	BENSON RANCH	189	30.0	11.9	-7.6	8.3	1.36	1.53
061	UPPER BENSON RANCH	234	30.0	11.4	-1.8	8.6	1.52	1.71
071	ALLUVIAL FAN	347	28.5	11.7	-2.1	8.5	1.84	2.03
081	LOWER LARK SPUR	488	26.6	11.8	-1.5	7.8	2.13	2.11
091	LARK SPUR	588	26.7	11.4	-3.4	8.2	2.07	2.23
101	BENSON BASIN	744	25.1	10.9	-3.9	7.7	2.23	2.26
111	ANDERSON RIM	884	23.5	11.2	-6.6	7.8	2.22	2.27
121	ANDERSON FIELD	939	25.1	11.3	-4.7	7.2	1.84	1.88
131	HOPSAGE	158	30.0	11.4	-6.7	8.7	1.39	1.58
141	TELEMETER	366	28.0	11.5	-2.5	8.6	2.01	2.32
150	RATTLESNAKE CREST NE	1020	22.0	10.2	-4.3	7.5	2.02	2.13
160	RATTLESNAKE CREST	1079	22.3	10.8	-4.7	7.7	1.33	1.50
170	RATTLESNAKE CREST SW	1067	23.0	11.0	-5.0	7.5	1.36	1.45
181	WINTERFAT	206	29.2	11.3	-3.0	8.7	1.57	1.81
191	CALOCHORTUS	381	27.7	11.5	-2.3	8.4	2.01	2.21
201	BEEBLE PLOT 7	954	25.0	10.9	-4.9	7.5	1.93	1.95
211	LOWER COLD CREEK	134	30.1	11.3	-7.1	8.4	1.50	1.67
221	BEEBLE PLOT 3	192	30.8	11.8	-3.4	8.5	1.62	1.83
231	BEEBLE PLOT 4	286	30.6	12.0	-4.2	8.2	1.70	1.92
241	E. R. C. (Y)	329	28.2	11.4	-3.7	8.2	1.73	1.89
251	BEEBLE PLOT 5	448	27.1	11.5	-2.1	8.0	1.85	1.89
260	BEEBLE PLOT 6	756	24.8	11.1	-1.2	7.9	1.77	1.81
622	HANFORD METEOROLOGICAL STATION*	223	26.9	10.2	-2.7	9.0	1.37	1.42

* FOR THE SAME PERIOD OF RECORD

DATA CORRELATIONS BETWEEN ALE RESERVE STATIONS AND THE HMS

The ALE microclimatology program has now yielded a data set for each station which can be correlated with the Hanford Meteorology Station, which has a 30-year record of climatic measurements. The ALE data have been regressed on the appropriate HMS data to provide a variety of equations with differing characteristics.

Precipitation is commonly treated as a monthly statistic by all scientists. Thus, the task of

correlating our monthly precipitation records at each ALE station with HMS is straightforward.

Our temperature data are not so readily interpreted for comparing the ALE temperature data with HMS values. For example, the schedule of ALE climatology observations is monthly. Thus, our monthly maxima and minima are the **extremes** for the month, **not** the

Figure 15. Annualized Standard Deviations of Mean Monthly Precipitation and Mean Monthly Extreme Maximum and Minimum Temperature on the ALE Reserve Versus Elevation. Solid points are Blacktop Transect stations (1968-1975).

monthly average maxima and monthly average minima. The average maximum and minimum temperature data from ALE shown in Table 2 and Appendix A are the averages then of the **monthly** extremes over the 8 years of record and constitute a small sample for statistical purposes.

Now, the question arises whether it is possible to identify an ecologically significant temperature with relatively few monthly values of temperature extremes as base data? Following a suggestion by Daubenmire⁷ that the average value of maximum temperature can be more ecologically influential than either the mean temperature or the extreme maximum, Hinds and Rotenberry⁸ have shown that statistically significant correlations exist between the extremes and averages of maximum and minimum temperatures at any given station. Significant correlations also exist between the extreme temperature values at individual ALE

Figure 16. Average Annual and Bioyear Precipitation on the ALE Reserve as a Function of Elevation (1968-1975).

stations and corresponding extremes from the HMS. Thus, it is also possible to estimate temperature variations within ALE microclimates for the years prior to 1968, using the HMS data.

TEMPERATURE CORRELATIONS

The extreme maximum temperatures at ALE stations correlate very well with the extreme monthly maxima at HMS: the correlation coefficient (r) exceeds 0.98 for all stations. Minimum temperature extremes are slightly less similar, with values of r from 0.956 to 0.988. The coefficient of determination, r^2 , may be a more useful statistic here, as it provides a measure of that part of the variation in the ALE temperatures attributable to the HMS measurements (Table 4). Values of r^2 for both maxima and minima have been plotted on a vertical plan of the ALE network and then isoplethed to give a pattern of the degree of correlation reliability (Figures 18a and

**A. MONTHLY MAXIMUM TEMPERATURES,
MAJOR CLUSTERS**

**D. MONTHLY MINIMUM TEMPERATURES,
MAJOR CLUSTERS AND "FROST POCKETS"**

**B. MONTHLY MAXIMUM TEMPERATURES,
LOWER ELEVATION SUBGROUPS**

**E. MONTHLY PRECIPITATION,
MAJOR CLUSTERS**

**C. MONTHLY MAXIMUM TEMPERATURES,
HIGHER ELEVATION SUBGROUPS**

**F. MONTHLY PRECIPITATION, LOWER
ELEVATION SUBGROUPS**

Figure 17. Results of Independent Cluster Analyses of Each Microclimatic Variable.

18b). As one would expect, the stations at or near the 223 m elevation of the HMS show the highest dependence with decreasing values above 400, and below 200 m. All values of r^2 , however, are greater than 0.9, indicating a high degree of similarity between the extreme temperatures at the ALE stations and HMS. Turbulent mixing of the lower levels of the atmosphere during daytime is probably a significant factor in the higher correlation between maxima. Elevation is obviously an important factor in similarity distribution for both maxima and minima.

A difference (significant at the 0.01 level) between the slopes of maximum and minimum temperature regressions is detectable. All slopes for maxima (except the frequently anomalous Station 15) are greater than 1.0, whereas for the

minima, all are less than 0.95. Also, the range of slopes is slightly greater for the maxima.

At eight of the ALE stations, thermographs with 2 to 3 years of record at 1.2 m height permit correlation of extreme monthly maximum and minimum temperatures with the average monthly maxima and minima. Hinds and Rotenberry⁸ have performed bivariate regression analyses on these data and their results show a good correlation between the means and extremes of maximum and minimum temperatures; $r^2 = 0.95$ for maximum temperatures and 0.90 for the minima. Regression slopes averaged 0.9 for the maxima and 0.8 for the minima, but the range of slopes varied from 0.7 to 1.0. This variety of regression slopes may indicate that considerable diversity exists at different ALE stations.

Figure 18a. Coefficient of Determination, r^2 , of Extreme Mean Monthly Maximum Temperature at ALE Stations on Extreme Mean Monthly Maximum Temperature at HMS (1968-1975).

Figure 18b. Coefficient of Determination, r^2 , of Extreme Mean Monthly Minimum Temperature at ALE Stations on Extreme Mean Monthly Minimum Temperature at HMS (1968-1975).

PRECIPITATION CORRELATIONS

As with temperature, the coefficient of determination, r^2 , has been calculated (Table 4) and plotted (Figure 19) to show the covariability between monthly precipitation totals at each ALE station and that at HMS. At each station, r^2 for the precipitation data is less than those for temperature. Below 400 m elevation, a decrease in r^2 with height appears to be related to an increase in elevation. Above 400 m, the stations on the Central and Benson Transect show the

greatest independence. Their correlations are not much changed by elevation increases. Except for five stations very near the same elevation as the HMS, the intercepts are all positive, indicating that most of the ALE Reserve receives precipitation at times when the HMS does not. The topographic influence of Rattlesnake Mountain is very likely the major factor in this, as it is not uncommon for observers at the HMS to report visible showers over the ALE Reserve near the mountain at times when none falls at their location.

Table 4

Regression Coefficients and Dependency Statistic, r^2 , of ALE Monthly Precipitation (cm)
and Extreme Monthly Maximum and Minimum Temperatures ($^{\circ}\text{C}$)
Regressed on the Hanford Meteorology Station (1968-1975).

STATION NUMBER	ELEV, m	MAXIMUM TEMPERATURE			MINIMUM TEMPERATURE			PRECIPITATION		
		r^2	SLOPE	INTERCEPT	r^2	SLOPE	INTERCEPT	r^2	SLOPE	INTERCEPT
01	204	0.968	1.177	-0.824	0.954	0.946	-4.019	0.904	0.930	0.010
02	210	0.983	1.122	-1.474	0.971	0.925	-1.648	0.899	1.017	-0.060
03	323	0.982	1.141	-2.423	0.958	0.912	0.548	0.873	1.267	0.009
04	533	0.973	1.095	-2.611	0.953	0.848	-1.928	0.841	1.355	0.196
05	189	0.973	1.130	-0.424	0.933	0.882	-5.424	0.896	1.012	-0.014
06	234	0.979	1.096	0.385	0.957	0.932	0.509	0.867	1.112	0.001
07	347	0.981	1.128	-2.018	0.961	0.916	0.156	0.805	1.270	0.109
08	488	0.978	1.131	-3.513	0.955	0.874	0.927	0.788	1.246	0.355
09	588	0.974	1.099	-3.017	0.959	0.905	-1.293	0.808	1.401	0.162
10	744	0.972	1.051	-3.301	0.939	0.841	-1.982	0.802	1.412	0.302
11	884	0.964	1.073	-5.561	0.932	0.850	-4.613	0.813	1.430	0.271
12	939	0.941	1.069	-4.009	0.914	<u>0.776</u>	-3.086	0.846	1.209	0.190
13	158	0.981	1.099	0.282	0.961	0.942	-4.218	0.881	1.035	-0.017
14	366	0.982	1.116	-2.165	0.966	0.934	-0.130	0.761	1.412	0.087
15	1021	0.954	<u>0.995</u>	-5.403	0.938	0.813	-2.697	0.759	1.298	0.250
16	1079	0.967	1.039	-5.752	0.933	0.821	-2.747	0.786	0.915	0.139
17	1067	0.963	1.062	-5.561	0.932	0.801	-2.952	0.777	0.890	0.156
18	206	0.976	1.1	-0.378	0.977	<u>0.949</u>	-0.517	0.851	1.163	-0.014
19	381	0.976	1.113	-2.248	0.976	0.911	-0.048	0.785	1.366	0.143
20	954	0.957	1.039	-3.121	0.937	0.802	-2.904	0.871	1.273	0.194
21	134	0.969	1.083	0.849	0.929	0.897	-4.835	0.876	1.092	0.013
22	192	0.978	1.140	-0.055	0.965	0.924	-1.056	0.887	1.202	-0.017
23	286	0.975	1.153	-0.631	0.958	0.886	-2.000	0.852	1.238	0.011
24	329	0.977	1.1	-1.546	0.966	0.890	-1.501	0.850	1.218	0.068
25	448	0.971	1.105	-2.629	0.966	0.866	0.071	0.841	1.209	0.199
26	756	0.975	1.068	-3.878	0.949	0.846	0.934	0.874	1.178	0.165

Figure 19. Coefficient of Determination, r^2 , of Mean Monthly Precipitation at ALE Stations on Mean Monthly Precipitation at HMS (1968-1975).

VEGETATIVE COVER TYPES ON THE ALE RESERVE

The ALE Reserve is classified as semi-arid shrub-steppe⁹ characterized by widely distributed shrubs and perennial grasses in addition to a few annual and many perennial herbs. Trees cannot exist except in the few habitats where springs or groundwater occur. The major kinds of shrub-steppe communities identified by the most conspicuous or most abundant plant species are:

- *Artemisia/Poa* (Sagebrush/sandberg bluegrass)
- *Artemisia/Agropyron* (Sagebrush/blue-bunch wheatgrass)
- *Atriplex/Poa* (Hopsage/sandberg bluegrass)
- *Sarcobatus/Bromus-Distichlis* (Grease-wood/cheatgrass-saltgrass)

- *Eurotia/Poa* (Winterfat/sandberg bluegrass)
- *Eriogonum/Poa* (Thyme buckwheat/sandberg bluegrass)
- *Salix-Populus* (Willow-cottonwood)

Smaller islands of contrasting vegetation types appear within these major designations. The following sections describe the various vegetation-types and some of their important variations.¹⁰

ARTEMISIA/POA (A/P)

Up to about 250 m elevation on the ALE Reserve, most of the landscape is taken up by a "short grass shrubland," *Artemisia tridentata/Poa sandbergii* (Figure 20). Variants of this type occupy regions that have been disturbed by fire,

Figure 20. *Artemisia/Poa* Stand at Station 06.

overgrazing or cultivation. Below 200 m, the introduced annual grass *Bromus tectorum* is more evident than the perennial native, *Poa sandbergii*, especially in disturbed areas. Other variants include *Artemisia tridentata*-*Purshia tridentata*/*Poa sandbergii* and *Artemisia tridentata*-*Atriplex spinosa*/*Bromus tectorum*. Old fields pre-dating the Hanford Reservation fall within this broadly distributed vegetation-. Such areas generally have been invaded by tumbleweed, *Salsola kali* and cheatgrass.

Microclimatological Stations 01, 05, 06, 21 and 22 are in the A/P cover type and its variants.

ARTEMISIA/AGROPYRON (A/A)

The *Artemisia tridentata*/*Agropyron spicatum* vegetation-type (Figure 21) and its variants generally occur above 250 m and on the Hanford

Reservation is mostly confined to the ALE Reserve. Variants of this "tall grass shrubland" include:

- *Agropyron spicatum* (resulting from temporary elimination of the *Artemisia* by fire) Figure 22.
- *Artemisia tripartita*/*Agropyron spicatum*
- *Agropyron spicatum* - *Festuca idahoensis*
- Old (abandoned) agricultural fields.

The shrub *Artemisia* was burned from substantial areas by wild fires in 1957 and 1973. The surviving grasslands will be slow to return to their former composition because *Artemisia* is a non-sprouter and when consumed by fire, it must re-establish itself by invasion from

Figure 21. *Artemisia*/*Agropyron* Stand at Station 23.

Figure 22. *Agropyron* Grassland Resulting from Elimination of the Shrub *Artemisia* by Fire. Near Station 19.

surrounding unburned areas. The perennial bunchgrass generally survives fire, perhaps in better condition than before the fire.¹¹ The *A. tripartita*/*Agropyron* variant is found in restricted high elevation habitats with mesic conditions, and the *Agropyron-Festuca* variant only occurs on steep north-facing slopes above 750 m on the Rattlesnake Ridge. Abandoned fields in the A/A cover occur on gentle terrain in the southwestern corner of the Reserve between 500 and 600 m. Stations 03, 04, 07, 08, 09, 10, 11, 12, 14, 15, 19, 20, 23, 24, 25 and 26 are located within this widespread cover type and its variants.

ATRIPLEX/POA (At/P)

This cover type is mostly confined to the floor of the Cold Creek Valley. There is a lack of other species in this association; often, only the annual, cheatgrass (*Bromus tectorum*) occurs. Hopsage, *Atriplex spinosa*, accumulates potassium and magnesium in its deciduous foliage and over a period of years builds up a soil concentration of these elements around its base. Interestingly, Daubenmire¹ (p. 64) mentions not finding a single *A. spinosa* shrub in Washington State with fewer than 16 xylem layers. *Atriplex spinosa*, unlike *Artemisia tridentata*, probably

Figure 23. *Atriplex/Poa* Stand at Station 13.

adds more than one layer annually; even so, the study would indicate a remarkable paucity of young hopsage specimens. Station 13 is located in a pure stand of this species (Figure 23).

SARCOBATUS/DISTICHLIS (S/D)

On the ALE Reserve, this cover type, (Figure 24) is found in a small area (about 100 acres) near the eastern base of Yakima Ridge where a perched water table occurs 5 to 15 m below the ground surface.¹² The annual grass *Bromus tectorum* has invaded this cover type and is commonly the dominant understory at present. Station 02 is located within this cover type.

EUROTIA/POA (Eu/P)

The *Eurotia lanata/Poa sandbergii* cover type occupies several thousand acres near the center

of the ALE Reserve between 200 and 300 m elevation on the gentle lower northeast slope of Rattlesnake Mountain (Figure 25). It does not appear to overlap into the regions where *Agropyron* appears, but in some areas it has merged with *Artemisia tridentata*. Station 18 is located in the *Eurotia/Poa* cover type.

ERIOGONUM/POA (E/P)

Along the high rocky crest of the Rattlesnake Hills above about 1000 m, the *Eriogonum thymoides/Poa sandbergii* cover type (Figure 26) is rooted in a shallow lithosol. The vegetation here is subjected to pruning by strong winds which frequently sweep the ridge crests. The flowering perennials *Penstemon gairdnerii*, *Phlox hoodii*, *Crepis modocensis*, *Haplopappus stenophyllus*, the endangered endemic, *Balsamorhiza rosea* and the shrub

Figure 24. *Sarcobatus*/*Distichlis* Stand at Station 02.

Figure 25. *Eurotia*/*Poa* Stand at ALE Station 18.

Figure 26. *Eriogonum/Poa* Vegetation Near Station 16.

Salvia dorii, are established in numbers great enough to provide a strikingly alpine floral display early in most summers. Stations 16 and 17 are located in this cover type.

RIPARIAN (R) (SALIX - POPULUS)

In the western reaches of the ALE Reserve, there are several springs with surface flows for as far as 3 km; vegetative response to the underground

water can be observed to greater distances. The only trees on the ALE Reserve are found in these mesic habitats. The most common species are *Populus trichocarpa*, *Populus tremuloides*, and *Salix amyglodes*. *Populus alba*, an introduced tree, is found at abandoned ranch house sites. The flora is a complex mixture of species from contiguous dryland communities as well as truly riparian taxa. There are no climatological stations within this restricted cover type.

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APPENDIX A

DESCRIPTION OF THE ALE RESERVE MICROCLIMATOLOGICAL STATIONS

INSTRUMENTATION
STATION NUMBERING
MONTHLY AVERAGES
SITE DESCRIPTIONS
CLIMATOLOGICAL SCATTERGRAMS

APPENDIX A

DATA TABLES, DESCRIPTIONS AND CORRELATION SCATTERGRAMS OF THE TWENTY-SIX ALE STATIONS

INSTRUMENTATION

Standard instrumentation at each of the twenty-six stations is a Six-type (U-shaped) maximum/minimum thermometer mounted horizontally on the north side of a 6 x 6-inch wooden post set in concrete, with the thermometer bulb 30 cm above ground surface

(Figure A-1). Horizontal mounting prevents thermometer-index creep caused by possible vibration of the shelter during high winds. Wind speeds can exceed 50 mps near the crest of Rattlesnake Mountain and 25 mps at all stations. The thermometers are shielded from direct sunlight by a shallow box-like cover attached to the top of the 6 x 6-inch post. This shelter is open

Figure A-1. Shelter for Mounting Maximum/Minimum Thermometers and 5-inch Capacity Rain Gauge at ALE Stations.

on the bottom and on the north and is painted white. Double tops with an air space between were added in late 1976 to minimize conductive heating from the sun. A bracket on the side of the thermometer shelter holds a plastic rain gauge of 5-inch capacity. A film of oil several millimeters thick is used in the gauge as an evaporation suppressant and in winter the gauges are additionally charged with 2.5 to 4 cm of ethylene glycol antifreeze. Where soil consistency permits, a metal tube has been driven vertically into the ground and a mercury-in-glass thermometer is suspended in the tube with its bulb 60 cm below ground surface. A cork seals the exposed end of the tube to prevent

water from entering and to inhibit air circulation within the tube.

Continuous recording instruments at or near selected ALE stations are housed in a standard National Weather Service shelter (Stevenson screen), Figure A-2, with air temperature and relative humidity sensors about 1.2 m above ground surface. Soil temperatures at these stations are generally measured at 10 cm and 40 cm below surface. However, at the IBP site 1.9 km southeast of Station 19, soil probes are at 5, 10, 20, and 60 cm below surface. Periodic summaries of these daily ALE data will be published in future reports.

Figure A-2. Standard Weather Service Instrument Shelter and 8-inch Diameter Precipitation Gauge in use at ALE Stations.

STATION NUMBERING

Each station is assigned a three-digit number, i.e., 011, 260, etc. The first two digits are the station number; the third digit is an indicator of

the type of instrumentation in use. The third digit instrumentation code is explained below:

Code	Type of Instrumentation	Type of Record
0	Maximum/Minimum Thermometer 2-inch Diameter Raingauge	Monthly Monthly
1	Maximum/Minimum Thermometer 2-inch Diameter Raingauge Soil Thermometer at 60 cm	Monthly Monthly Monthly
2	8-inch Diameter Precipitation Gauge	Monthly
3-6	Hygrothermograph and/or Soil Thermograph -10 and -40 cm	Daily Daily

MONTHLY AVERAGES

The monthly maximum and minimum temperature, and the total monthly precipitation have been recorded for the ALE microclimatological stations since October 1968. Tables A-1, A-2 and A-3 summarize average monthly values of these parameters.

STATION DESCRIPTIONS AND CLIMATOLOGICAL SCATTERGRAMS

The following sets of facing pages describe, in numerical order, the location, topography, and climatic correlation with the Hanford Meteorology Station of each of the 26 ALE Reserve microclimatological stations. Corresponding photographs depict vegetation and terrain of each station. Stations start with 01, Upper Cold Creek, at the lower end of the Snively Transect located near the western edge of the ALE Reserve, and end with 26, Beetle Plot 6, at the upper end of the Blacktop Transect (Figures 6 and 7, pp. 8 and 10). Data for these

pages are from 1968-1975 for most stations, and are ongoing at the majority of sites.

The slope of each station has been determined by clinometer. In general, the average slope, 50 to 100 m on each side of the climatological station is considered even though the instrument shelter may be located on a bit of level terrain within the slope. This situation occurs at Stations 08, 10 and 26. The exposure of a station indicates the direction towards which the slope faces.

The vegetative cover type for each station is that which characterizes the undisturbed region immediately surrounding the station. In some instances, for example Stations 04, 05 and 21, agricultural or other disturbance by man, has altered the original vegetation resulting in an invasion of introduced species; the indicated cover type for these stations is that of the native vegetation near by.

Soil types and descriptions are taken from the soil map by Hajek (Figure A-3).

Table A-1

**Arid Lands Ecology Reserve Monthly Maximum Temperatures
(Celsius) Sorted by Station Number**

STATION	STATION NAME	ELEV. M	AVERAGE VALUES (1968-1975)											
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
01	UPPER COLD CREEK	204	30.5	18.5	15.5	14.0	19.5	24.0	30.5	39.5	45.0	47.0	45.5	41.0
02	RATTLESNAKE SPRINGS	210	28.5	16.5	14.5	12.5	18.0	22.5	29.0	36.0	41.5	44.5	43.0	38.5
03	LOWER SNIVELY	323	28.0?	15.5	14.0	12.5	16.5	21.5	29.0	36.5	41.5	44.5	42.5	38.0
04	UPPER SNIVELY	533	27.5	15.5	12.5	11.5	16.0	21.0	26.0	33.5	39.5	43.0	41.5	37.0
05	BENSON RANCH	199	29.0	18.0	15.5	13.5	19.0	24.0	30.0	37.5	43.5	45.5	44.0?	40.0
06	UPPER BENSON RANCH	234	29.5	17.0	15.5	14.5	19.5	24.5	31.0	38.0	42.5	44.5	43.5	39.5
07	ALLUVIAL FAN	347	28.0	15.5	14.0	12.5	17.0	21.5?	29.0	36.5	41.5	44.0	42.0	38.5
08	LOWER LARK SPUR	498	27.5?	14.0	12.0	12.5	16.0	21.0	27.0	34.5	39.0	43.5?	42.5	37.0
09	LARK SPUR	588	26.5	14.5	11.5?	11.5	15.0	21.0	27.0	34.0	40.0	41.5	40.5	36.5
10	BENSON BASIN	744	26.0	14.0	10.5?	10.0	13.5?	19.5	25.5	32.0	37.0	40.0	38.5	34.5
11	ANDERSON RIM	884	24.5	13.0	8.5?	9.0	12.0?	17.5	23.0	30.0	35.5	38.0	37.5	33.0
12	ANDERSON FIELD	939	27.0	14.0	11.0?	9.0?	13.0?	19.0	23.5	30.0	37.0	40.0	39.0	35.0
13	HOPSAGE	158	30.0	17.5	15.5	14.0	18.5	24.5	30.5	37.5	42.5	44.5	44.0	39.5?
14	TELEMETER	366	27.5	15.0	13.0	13.0	16.0	22.5	28.5	35.5	40.5	43.5	42.0	37.5
15	RATTLESNAKE CREST NE	1020	22.0	11.5	8.0?	7.0?	10.5?	15.5	20.5	27.0	33.0	35.5	34.0	30.5
16	RATTLESNAKE CREST	1079	23.5?	12.0?	9.0?	7.0	11.0	16.5	22.0	28.5	34.0	36.5	35.5	31.5
17	RATTLESNAKE CREST SW	1067	25.0	13.0	8.5?	7.5	11.5	17.0	22.5	29.0	35.0	37.5	37.0	32.5
18	WINTERFAT	206	29.5	16.5	14.5	14.0	19.0	24.0	30.0	36.5	42.0	44.5	43.0?	38.5?
19	CALOCHORTUS	341	29.0	15.0	13.0	12.5	16.5	22.0	28.0	35.5	40.5	43.0	42.0	37.5
20	BEEFLE PLOT 7	954	26.5	15.0	10.0?	10.0	14.0	20.0	26.0	30.5	36.0	39.5	39.5	34.0
21	LOWER COLD CREEK	134	30.0	19.5	16.0	14.5	19.5	24.0	29.5	38.0	43.0	45.5	43.5	39.5
22	BEEFLE PLOT 3	192	30.5	17.5	15.0	14.0	19.5	25.5	31.5	38.5	43.5	46.5	44.5	40.5
23	BEEFLE PLOT 4	286	30.5	19.0	14.5	14.0	19.0	25.0	31.0	38.5	44.0	46.5	44.5	40.5
24	E.R.C. (Y)	329	28.0	15.5	13.0	12.5	17.0	23.0	28.5	36.0	41.0	43.5	42.0	37.5
25	BEEFLE PLOT 5	448	27.0	15.5	12.0	12.0	15.5	22.0	27.5	34.5	40.0	43.0	40.5	36.5
26	BEEFLE PLOT 6	756	26.0	14.5	10.0?	10.0	14.0	19.0	25.0	31.5	37.0	40.0	38.5	34.0
622	MET. TOWER 3 FT LEVEL	223	26.5	16.5	14.5	13.5	17.0	20.5	27.5	33.5	38.0	41.0	40.0	35.0

? INCLUDES ESTIMATED DATA

Table A-2

**Arid Lands Ecology Reserve Monthly Minimum Temperatures
(Celsius) Sorted by Station Number**

STATION	STATION NAME	ELEV. M	AVERAGE VALUES (1968-1975)											
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
01	UPPER COLD CREEK	204	-10.0	-9.5	-17.0	-20.0	-14.0	-8.5	-9.0	-3.5	3.5	6.5	5.5	-2.0
02	RATTLESNAKE SPRINGS	210	-5.5	-6.5	-14.5	-17.5	-11.5	-6.0	-5.0	-0.5	4.0	7.0	7.5	1.5
03	LOWER SNIVELY	323	-2.5	-4.0	-13.0	-15.5	-9.5	-3.0	-2.0	1.5	5.5	8.5	9.5	4.0
04	UPPER SNIVELY	533	5.5	-5.5	-14.5	-17.0	-11.0	-5.5	-4.5	-1.0	4.0	6.5	6.5	0.5
05	BENSON RANCH	199	-9.5	-10.5	-18.0	-20.0	-14.0	-10.0	-9.0	-4.0	0.5	3.5	4.0	-3.0
06	UPPER BENSON RANCH	234	-4.0	-4.5	-12.5	-15.5	-9.5	-4.0	-3.0	2.0	6.5	9.5	9.5	3.5
07	ALLUVIAL FAN	347	-3.5	-5.0	-13.5	-16.0	-9.5	-4.0	-3.0	2.0	5.0	8.5	8.5	4.0
08	LOWER LARK SPUR	498	2.0	-3.5	-10.0	-14.5	-8.5	-3.0	-2.0	2.5	6.5?	8.0	9.0	4.5
09	LARK SPUR	588	-4.5	-6.0	-14.5?	-17.5	-9.0	-5.0	-4.5	0.0	4.5	6.5	7.5	2.0
10	BENSON BASIN	744	-5.0	6.0	-14.5?	-16.5	-9.5	-5.5	-5.5	-1.0	3.5	5.0	6.5	1.0
11	ANDERSON RIM	884	-8.5	-8.5	-17.0?	-20.5	-12.0	-7.5	-8.0	3.5	1.0	2.0	4.5	-7.0
12	ANDERSON FIELD	939	-5.5	-6.5	-15.0?	-17.0?	-9.5?	-6.0	-6.0	-2.0	1.5	4.0	5.0	0.5
13	HOPSAGE	158	-9.5	9.5	-17.0	-20.0	-14.0	-8.5	-7.5	-3.0	1.5	5.5	5.0	-2.0
14	TELEMETER	366	-4.0	-5.0	-13.5?	-16.0	-10.0	-4.5	-3.0	1.0	5.0	9.5	8.5	3.0
15	RATTLESNAKE CREST NE	1020	4.5	-6.0	-15.5?	-17.5	-12.0?	-6.5?	-5.0	-2.0	1.5	4.0	5.5	1.5
16	RATTLESNAKE CREST	1079	-5.0	-6.0?	-15.5?	-17.5	-11.5	-6.0	5.5	-2.5	2.0	4.5	6.0	0.5
17	RATTLESNAKE CREST SW	1067	-6.0	-7.0	-16.5?	-19.0?	-12.0	-7.5	-6.5	-3.5	1.0	3.0	4.0	0.0
18	WINTERFAT	206	-5.0	-5.5	-14.0	-17.0	-10.5	5.5	-3.5	1.0	5.0	8.5	9.5	2.5
19	CALOCHORTUS	341	-3.5	-5.0	-13.5	-16.0	-10.0	-4.5	-3.0	1.5	5.0	8.5	8.5	3.5
20	BEEFLE PLOT 7	954	-5.5	-6.5	-15.0?	-18.0	-11.0	-6.0	-5.5	-1.5	2.5	4.5	4.5	1.0
21	LOWER COLD CREEK	134	10.5	-10.5	-17.5	-19.5	-13.5	-8.5	9.0	-3.5	2.0	5.0	4.0	-2.5
22	BEEFLE PLOT 3	192	-6.0	6.5	-14.0	-17.0	-10.5	-5.5	-4.5	0.5	5.5	7.5	8.5	1.5
23	BEEFLE PLOT 4	286	-7.0	6.5	-14.5	-17.0	-11.0	-6.5	-5.0	-1.0	4.0	6.0	7.0	1.5
24	E.R.C. (Y)	329	-5.5	6.0	-14.5	-17.0	-11.0	-6.0	-4.5	0.0	4.5	6.0	7.5	1.5
25	BEEFLE PLOT 5	448	-2.5	4.5	-13.0	-15.5	-9.5	-4.0	-3.0	1.5	5.0	7.5	8.0	3.5
26	BEEFLE PLOT 6	756	-1.0	3.5	-12.0?	-14.5	-8.5	-2.5	-2.0	2.0	6.0	8.0	9.0	5.0
622	MET. TOWER 3 FT LEVEL	223	-4.5	5.5	-14.5	-17.0	-11.0	-5.5	-3.0	2.0	6.0	9.5	8.5	3.5

? INCLUDES ESTIMATED DATA

Table A-3

Arid Lands Ecology Reserve Monthly Precipitation
(Centimeters) Sorted by Station Number

STATION	STATION NAME	ELEV. M	AVERAGE VALUES (1968-1975)												TOTAL OCT-MAY	TOTAL JAN-DEC
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP		
01	UPPER COLD CREEK	204	1.22	2.02	3.32	3.12	1.42	1.12	0.72	1.32	0.42	0.22	0.62	0.4	1.32	15.6
02	RATTLESNAKE SPRINGS	210	1.32	2.4	3.32	3.52	1.32	1.12	0.82	1.12	0.42	0.22	0.6	0.4	1.32	16.3
03	LOWER SNIVELY	323	1.72	3.0	4.62	4.22	1.92	1.52	1.02	1.52	0.62	0.22	0.52	0.62	1.82	21.3
04	UPPER SNIVELY	533	2.02	3.5	5.02	4.62	2.32	2.12	1.32	1.92	0.82	0.42	0.52	0.82	2.12	24.8
05	BENSON RANCE	199	1.22	2.42	3.42	3.52	1.32	1.12	0.92	1.32	0.52	0.32	0.62	0.52	1.32	16.9
06	UPPER BENSON RANCE	234	1.4	2.5	3.92	3.92	1.52	1.32	0.92	1.22	0.62	0.42	0.52	0.5	1.5	19.7
07	ALLUVIAL FAN	347	1.62	3.1	5.02	4.52	2.02	1.92	1.22	1.62	0.62	0.32	0.4	0.6	1.92	22.4
08	LOWER LARK SPUR	488	1.3	2.9	5.32	4.52	2.22	2.42	1.22	1.92	0.72	0.52	0.9	0.62	1.6	21.8
09	LARK SPUR	588	1.6	3.7	5.42	4.52	2.52	2.12	1.42	1.62	0.72	0.32	0.5	0.9	1.8	22.9
10	BENSON BASIN	744	1.9	3.7	5.32	4.82	2.72	2.32	1.52	2.02	1.02	0.62	0.6	0.9	2.0	24.1
11	ANDERSON RIM	894	2.2	3.9	5.12	4.72	2.62	2.12	1.42	2.02	1.02	0.62	0.72	1.0	2.3	23.9
12	ANDERSON FIELD	939	1.7	3.42	4.12	3.12	2.02	1.62	1.12	1.82	0.92	0.52	0.62	0.8	1.92	19.9
13	HOPSAGE	158	1.2	2.3	3.42	3.62	1.52	1.22	0.92	1.32	0.62	0.32	0.52	0.42	1.3	17.1
14	TELEMEETER	366	1.6	3.5	5.12	4.92	2.62	2.22	1.22	1.42	0.82	0.22	0.52	0.5	1.8	22.7
15	RATTLESNAKE CREST NE	1020	1.6	3.1	4.22	5.32	2.32	1.92	1.32	1.92	1.32	0.52	0.7	0.8	1.7	21.5
16	RATTLESNAKE CREST	1079	0.9	2.4	2.92	3.22	1.22	1.42	0.62	1.42	0.82	0.42	0.9	0.5	1.2	14.1
17	RATTLESNAKE CREST SW	1067	1.2	2.5	2.62	2.92	1.22	1.32	0.92	1.62	1.02	0.32	0.6	0.5	1.3	14.3
18	WINTERFAT	206	1.3	2.9	4.12	3.92	1.72	1.52	0.92	1.32	0.62	0.32	0.42	0.52	1.4	17.5
19	CALOCHORTUS	391	1.62	3.52	5.02	4.92	2.32	2.42	1.32	1.52	0.92	0.22	0.62	0.52	1.72	22.4
20	PEFTLE PLOT 7	954	1.7	3.4	4.02	4.02	1.92	2.02	1.42	2.12	1.12	0.42	0.7	0.8	1.9	20.5
21	LOWER COLD CREEK	134	1.2	2.5	3.72	3.72	1.62	1.42	1.02	1.42	0.92	0.42	0.4	0.4	1.3	16.4
22	BEEFLE PLOT 3	192	1.3	3.0	4.02	3.92	1.72	1.52	1.12	1.32	1.02	0.32	0.32	0.5	1.4	17.7
23	BEEFLE PLOT 4	296	1.5	3.1	3.92	4.12	1.92	1.92	1.02	1.32	0.92	0.42	0.52	0.5	1.6	19.6
24	E. R. C. 1Y1	329	1.4	3.1	4.22	4.02	1.92	1.92	1.02	1.32	0.92	0.32	0.52	0.6	1.5	18.9
25	BEEFLE PLOT 5	448	1.5	3.1	4.02	4.22	1.92	2.12	1.22	1.92	1.02	0.42	0.52	0.92	1.7	19.3
26	BEEFLE PLOT 6	756	1.5	3.1	3.92	4.02	1.72	1.92	1.22	1.82	1.12	0.42	0.6	0.7	1.6	18.9
622	MET, TOWER 3 FT LEVEL	223	1.2	2.2	3.2	2.7	1.3	0.9	0.9	1.6	0.5	0.4	0.9	0.6	1.4	14.0

? INCLUDES ESTIMATED DATA

The graph at the top of each lefthand page (pp. 40-90) shows the monthly average maximum temperature, monthly average minimum temperature, and average monthly precipitation. The mean monthly standard deviations for the maximum and minimum temperature (Table 3) are drawn at the positions of the means. Note that the year starts with October, the beginning of the bioyear (October - May), a time period more significant to plant communities than the Julian calendar year.

On the facing page of each pair are the regression plots of monthly maximum/minimum temperature, and monthly precipitation for each ALE station against the analogous value for the Hanford Meteorological Station. Temperatures are in °C and precipitation in cm of water. The regression curves, with their standard errors, have been calculated and drawn on each of the scattergrams. A box on each scattergram lists the pertinent statistical data. Individual values used in these diagrams are found in Tables A-1, A-2 and A-3.

Figure A-3. Soil Types Found on the Hanford Reservation (After Hajek, 1966, BNWL-243).

Station—**HANFORD METEOROLOGY
STATION**

Number—**622**

Elevation—**223 m**

Transect—

Slope—**0°**

Exposure—

Cover Type—**Artemisia/ Poa**

Soil Type—**Ba**

Instrumentation—

**Hourly temperature, wind
speed, wind direction at 1, 15
30, 61, 91 and 122 meters.
Daily-hourly soil temperature
at 0.1, 3.8 and 9.1 dm and
precipitation, hourly relative
humidity, solar radiation,
atmospheric pressure, dew
point temperature
Period of record 12/44 - 12/75**

Station—UPPER COLD CREEK

Number—01

Elevation—204 m

Transect—Snively

Slope—0°

Exposure—

Cover Type—*Artemisia*/*Poa*

Soil Type—Qu

Instrumentation—

Monthly maximum, minimum
temperature, precipitation

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—RATTLESNAKE SPRINGS

Number—02

Elevation—210 m

Transect—Snively

Slope—0°

Exposure—

Cover Type—*Sarcobatus*/*Distichlis*

Soil Type—He

Instrumentation—

Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 12/75

Continuous temperature and
relative humidity 9/71 - 8/75

Station—**LOWER SNIVELY**

Number—**03**

Elevation—**323 m**

Transect—**Snively**

Slope—**2°**

Exposure—**North**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Wa**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

**Continuous temperature and
relative humidity 1/73 - 12/75**

**Continuous 1 dm and 4 dm
soil temperature 9/71 - 12/75**

Station—UPPER SNIVELY

Number—04

Elevation—533 m

Transect—Snively

Slope—3°

Exposure—Northeast

Cover Type—Artemisia/Agropyron

Soil Type—Ri

Instrumentation—

Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 12/75

Continuous temperature and
relative humidity 9/71 - 12/75

Continuous 1 dm and 4 dm
soil temperature 9/71 - 12/75

Station— **BENSON RANCH**

Number— **05**

Elevation— **189 m**

Transect— **Benson**

Slope— **0°**

Exposure—

Cover Type— **Artemisia/ Poa**

Soil Type— **Qu**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

**Continuous temperature and
relative humidity 9/71 - 8/75**

**Continuous 1 dm and 4 dm
soil temperature 11/71 - 8/75**

Station—UPPER BENSON

Number—06

Elevation—234 m

Transect—Benson

Slope—3°

Exposure—North

Cover Type—Artemisia/Poa

Soil Type—Wa

Instrumentation—

Monthly maximum, minimum
temperature, precipitation

10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 12/75

Station—**ALLUVIAL FAN**

Number—**07**

Elevation—**347 m**

Transect—**Benson**

Slope—**5°**

Elevation—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Sc**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

MONTHLY AVERAGES (1968-1975)

Station—**LOWER LARK SPUR**

Number—**08**

Elevation—**488 m**

Transect—**Benson**

Slope—**10°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
12/69 - 12/75**

**Monthly 6 dm soil temperature
1/72 - 12/75**

**Continuous temperature and
relative humidity 10/71 - 8/75**

**Continuous 1 dm soil
temperature 11/71 - 8/75**

**Continuous 4 dm soil
temperature 7/72 - 8/75**

Station—**LARK SPUR**

Number—**09**

Elevation—**588 m**

Transect—**Benson**

Slope—**0°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**BENSON BASIN**

Number—**10**

Elevation—**744 m**

Transect—**Benson**

Slope—**6°**

Exposure—**North**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**
10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 12/75

Station—**ANDERSON RIM**

Number—**11**

Elevation—**884 m**

Transect—**Benson**

Slope—**4°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

**Continuous temperature and
relative humidity 9/71 - 8/75**

Continuous 1 dm soil

temperature 11/71 - 8/75

Continuous 4 dm soil

temperature 7/72 - 8/75

Station—**ANDERSON FIELD**

Number—**12**

Elevation—**939 m**

Transect—**Benson**

Slope—**2°**

Exposure—**South**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**HOPSAGE**

Number—**13**

Elevation—**158 m**

Transect—**Central**

Slope—**0°**

Exposure—

Cover Type—**Atriplex/Poa**

Soil Type—**Qu**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

**Monthly 6 dm soil temperature
1/72 - 12/75**

Station—TELEMETER

Number—14

Elevation—366 m

Transect—Central

Slope—4°

Exposure—Northeast

Cover Type—*Artemisia/Agropyron*

Soil Type—Ri

Instrumentation—

Monthly maximum, minimum
temperature, precipitation

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**RATTLESNAKE CREST NE**

Number—**15**

Elevation—**1020 m**

Transect—**Central**

Slope—**18°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—
**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

Station— RATTLESNAKE CREST

Number—16

Elevation—1079 m

Transect—Central

Slope—0°

Exposure—

Cover Type—Eriogonum/Poa

Soil Type—Ls

Instrumentation—

Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75

Continuous temperature and
humidity 5/72 - 12/75
2.1 km SE

Station—**RATTLESNAKE CREST SW**

Number—**17**

Elevation—**1067 m**

Transect—**Central**

Slope—**8°**

Exposure—**Southwest**

Cover Type—**Eriogonum/ Poa**

Soil Type—**Ls**

Instrumentation—
**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

Station—WINTERFAT

Number—18

Elevation—206 m

Transect—Winterfat

Slope—4°

Exposure—Northeast

Cover Type—Eurotia/Poa

Soil Type—Wa

Instrumentation—

Monthly maximum, minimum
temperature, precipitation

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**CALOCHORTUS**

Number—**19**

Elevation—**381 m**

Transect—**Winterfat**

Slope—**4°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ri**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

**Monthly 6 dm soil temperature
1/72 - 12/75**

**Continuous temperature and
humidity (1.9 km SE)
9/71 - 12/75**

**Continuous 0.5, 1, 2, 6 dm
soil temperature (1.9 km SE)
9/71 - 12/75**

Station—**BEETLE PLOT 7**

Number—**20**

Elevation—**954 m**

Transect—**Winterfat**

Slope—**8°**

Exposure—**Southeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

9/71 - 12/75

Station—**LOWER COLD CREEK**

Number—**21**

Elevation—**134 m**

Transect—**Blacktop**

Slope—**0°**

Exposure—

Cover Type—**Artemisia/Poa**

Soil Type—**E1**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**BEETLE PLOT 3**

Number—**22**

Elevation—**192 m**

Transect—**Blacktop**

Slope—**2°**

Exposure—**East**

Cover Type—**Artemisia/Poa**

Soil Type—**Wa**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation
10/68 - 12/75**

**Monthly 6 dm soil temperature
9/71 - 12/75**

Station—**BEETLE PLOT 4**

Number—**23**

Elevation—**286 m**

Transect—**Blacktop**

Slope—**2°**

Exposure—**East**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Wa**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**

10/68 - 12/75

Monthly 6 dm soil temperature

9/71 - 12/75

Station—ERC Y

Number—24

Elevation—329 m

Transect—Blacktop

Slope—2°

Exposure—Northeast

Cover Type—*Artemisia*/*Agropyron*

Soil Type—Wa

Instrumentation—

Monthly maximum, minimum
temperature, precipitation

10/68 - 12/75

Monthly 6 dm soil temperature

1/72 - 12/75

Station—**BEETLE PLOT 5**

Number—**25**

Elevation—**448 m**

Transect—**Blacktop**

Slope—**5°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ri**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**
10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 12/75

Station—**BEETLE PLOT 6**

Number—**26**

Elevation—**756 m**

Transect—**Blacktop**

Slope—**9°**

Exposure—**Northeast**

Cover Type—**Artemisia/Agropyron**

Soil Type—**Ls**

Instrumentation—

**Monthly maximum, minimum
temperature, precipitation**
10/68 - 12/75

Monthly 6 dm soil temperature
1/72 - 5/72

APPENDIX B

NORMALS, AVERAGES AND EXTREMES OF CLIMATIC ELEMENTS OF THE HANFORD AREA

COMPOSITE RECORD OF MONTHLY, ANNUAL, AND BIOYEAR
PRECIPITATION AT HANFORD TOWNSITE AND HMS (1912-1975)
AVERAGE MONTHLY MAXIMUM AND MINIMUM TEMPERATURES (°F)
AT HMS (1945-1975)
NORMAL AND EXTREME DAILY TEMPERATURES AT HANFORD
NARRATIVE CLIMATOLOGICAL SUMMARY OF
THE HANFORD AREA

Table B-1.

Averages and Extremes of Climatic Elements at Hanford^a
(Based on all available records to and including the year 1975)

	TEMPERATURE (°F)												DEGREE DAYS (BASE 65°F)												PRECIPITATION (INCHES)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
	1912-1975 AVERAGES						1912-1975 EXTREMES						HEATING 1945-1975 TOTALS						COOLING 1960-1975 TOTALS						1912-1975 TOTALS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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	DAILY MAXIMUM	DAILY MINIMUM	MONTHLY	HIGHEST MONTHLY	YEAR	LOWEST MONTHLY	YEAR	RECORD HIGHEST	RECORD LOWEST	RECORD HIGHEST	RECORD LOWEST	RECORD HIGHEST	RECORD LOWEST	RECORD HIGHEST	RECORD LOWEST	MEAN MONTHLY	MAXIMUM MONTHLY	MINIMUM MONTHLY	MEAN MONTHLY	MAXIMUM MONTHLY	MINIMUM MONTHLY	 

EXTREME AVERAGES OR TOTALS AND YEAR OR SEASON OF OCCURRENCE

1912-1975 TEMPERATURE AVERAGES (°F)

HIGHEST ANNUAL	56.2	1958
LOWEST ANNUAL	50.2	1929
HIGHEST WINTER (D-J-F)	41.1	1933-34
LOWEST WINTER	24.2	1948-49
HIGHEST SPRING (M-A-M)	50.2	1947
LOWEST SPRING	48.0	1955
HIGHEST SUMMER (J-J-A)	78.2	1958
LOWEST SUMMER	70.3	1954
HIGHEST FALL (S-O-N)	56.6	1963
LOWEST FALL	49.6	1946

1912-1975 PRECIPITATION TOTALS (IN.)

GREATEST ANNUAL	11.45	1950
LEAST ANNUAL	3.26	1967
SNOW, ICE PELLETS (SLEET)		
GREATEST SEASONAL	43.6	1915-16
LEAST SEASONAL	0.3	1957-58

1945-1975 WIND SPEED AVERAGE (mph)

HIGHEST ANNUAL	8.3	1968
LOWEST ANNUAL	6.3	1957

1946-1975 RELATIVE HUMIDITY AVERAGE (%)

HIGHEST ANNUAL	57.9	1950
LOWEST ANNUAL	49.4	1967

1946-1975 SKY COVER AVERAGES (SUNRISE TO SUNSET, SCALE 0-10)

HIGHEST ANNUAL	6.4	1966
LOWEST ANNUAL	5.1	1949

1953-1975 SOLAR RADIATION AVERAGE DAILY TOTAL (LANGLEYS)

HIGHEST ANNUAL	390	1973
LOWEST ANNUAL	357	1967

Table B-2

Averages and Extremes of Climatic Elements at Hanford (Continued)
(Based on all available records to and including the year 1975)

		NUMBER OF DAYS (1945-1975) **																													
		CLEAR				PTLY CLOUDY	CLOUDY				THUNDERSTORMS				HEAVY FOG (VIS. 1/4 MI. OR LESS)				PRECIP. INCH OR MORE				SNOW 1.0 INCH OR MORE								
		MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR					
Jan.	4	7	1963	0	1955+	7	20	27	1969	17	1963	0	0	-----	0	-----	5	14	1965	0	1949	3	0	1972+	2	10	1950	0	1947		
Feb.	5	9	1968+	1	1972+	7	17	26	1958	12	1964	0	1	1972+	0	1975+	3	11	1963	0	1971+	2	5	1961+	0	1972+	2	4	1975+	0	1964
Mar.	6	12	1965+	2	1961	9	15	22	1968	9	1965	0	1	1969+	0	1975+	1	5	1951	0	1975+	2	8	1957	0	1973+	0	2	1957+	0	1915
Apr.	7	12	1962	1	1963	11	13	21	1963	6	1956	1	3	1948	0	1975+	0	1	1975+	0	1974+	1	5	1958	0	1973+	0	0	-----	0	-----
May	9	14	1973	2	1960	11	11	19	1960	6	1958	2	7	1956	0	1974+	0	1	1958	0	1975+	2	4	1967+	0	1968+	0	0	-----	0	-----
June	10	21	1961	5	1972+	10	10	15	1973+	5	1960+	3	8	1972+	0	1963+	0	1	1971	0	1975+	2	3	1960+	0	1973+	0	0	-----	0	-----
July	20	26	1960	13	1974	7	3	9	1974	1	1961	2	7	1975	0	1973+	0	0	-----	0	-----	1	3	1974+	0	1973+	0	0	-----	0	-----
Aug.	19	30	1955	11	1968	7	4	13	1968	0	1955	2	8	1953	0	1974+	0	1	1959	0	1975+	1	4	1975	0	1974+	0	0	-----	0	-----
Sept.	15	27	1975	8	1969	8	7	13	1969	1	1975	1	4	1959	0	1975+	0	1	1957	0	1975+	1	5	1959	0	1975+	0	0	-----	0	-----
Oct.	10	14	1970	1	1975	8	13	22	1973	9	1970	0	1	1975+	0	1974+	0	6	1962	0	1974+	2	3	1950	0	1972+	0	1	1973	0	1975+
Nov.	4	10	1957	1	1973+	6	19	25	1973+	15	1961	0	0	-----	0	-----	6	13	1965	0	1960	3	10	1973	0	1967	0	6	1955	0	1949+
Dec.	3	7	1972+	1	1962+	6	22	29	1962	18	1967+	0	1	1971	0	1975+	8	17	1950	2	1968+	3	9	1964	0	1949+	2	6	1964	0	1949+
Year	112	30	1955	0	1955+	97	154	23	1962	0	1969+	11	8	1972+	0	-----	24	17	1950	0	-----	23	9	1969	0	1975+	6	10	1950	0	-----

		NUMBER OF DAYS			
		MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY
CLEAR 10-3 TENTHS SKY COVER, SR TO SS1					
GREATEST ANNUAL (1946-75)		141	1951		
LEAST ANNUAL (1946-75)		85	1966		
CLOUDY (8-10 TENTHS SKY COVER, SR TO SS1)					
GREATEST ANNUAL (1946-75)		181	1969+		
LEAST ANNUAL (1946-75)		84	1949		
THUNDERSTORMS					
GREATEST ANNUAL (1945-75)		23	1948		
LEAST ANNUAL (1945-75)		3	1949		
HEAVY FOG (VIS. 1/4 MILE OR LESS)					
GREATEST ANNUAL (1945-75)		42	1950-51		
LEAST ANNUAL (1945-75)		9	1948-49		
PRECIPITATION 0.10 INCH OR MORE					
GREATEST ANNUAL (1946-75)		39	1950		
LEAST ANNUAL (1946-75)		10	1965		
SNOW 1.0 INCH OR MORE					
GREATEST ANNUAL (1946-75)		15	1955-56		
LEAST ANNUAL (1946-75)		0	1957-58		
3 IN. OR MORE SNOW ON GROUND					
GREATEST ANNUAL (1946-75)		40	1964-65		
LEAST ANNUAL (1946-75)		0	1966-67		
PEAK GUST 40 MPH OR GREATER					
GREATEST ANNUAL (1945-75)		41	1961		
LEAST ANNUAL (1945-75)		13	1958		
MAX. TEMPERATURE 90 OR ABOVE					
GREATEST ANNUAL (1912-75)		85	1940+		
LEAST ANNUAL (1912-75)		31	1964		
MAX. TEMPERATURE 100 OR ABOVE					
GREATEST ANNUAL (1912-75)		32	1942		
LEAST ANNUAL (1912-75)		1	1954		
MAX. TEMPERATURE 32 OR BELOW					
GREATEST ANNUAL (1912-75)		53	1955-56		
LEAST ANNUAL (1912-75)		1	1937-38		
MIN. TEMPERATURE 32 OR BELOW					
GREATEST ANNUAL (1912-75)		141	1916-17		
LEAST ANNUAL (1912-75)		75	1957-58		
MIN. TEMPERATURE 0 OR BELOW					
GREATEST ANNUAL (1912-75)		18	1949-50		
LEAST ANNUAL (1912-75)		0	1974-75		

REFERENCE NOTES

- * CALORIES/cm²
- ** SKY COVER AND PRECIPITATION OBSERVATIONS NOT BEGUN UNTIL 1960
- † LESS THAN 1/2
- ALSO ON EARLIER YEARS

LOCATION AND HISTORY

PRESENT LOCATION 25 MILES NW OF RICHLAND, WASHINGTON
LATITUDE 46°34' N; LONGITUDE 119°36' W ELEVATION 733 FEET
OBSERVATIONS FROM 1912 TO 1944 WERE BY UNITED STATES WEATHER BUREAU COOPERATIVE OBSERVERS AT A SITE ABOUT 10 MILES ENE OF PRESENT LOCATION. SINCE 1944 OBSERVATIONS HAVE BEEN MAINTAINED ON A 24 HOUR-A-DAY BASIS BY THREE DIFFERENT ERDA CONTRACTORS.

Table B-3

Composite Record of Monthly, Annual and Bioyear (October-May) Precipitation (Inches)
at Hanford Townsite (Near) and HMS (1912-1975).

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL TOTAL	BIOYEAR TOTAL
1912	--	--	--	--	0.93	0.22	0.09	0.93	0.04	0.55	1.19	0.48	(4.41)	
1913	1.39	0.16	0.05	0.16	0.61	1.11	0	T	0.03	1.42	0.75	0.76	5.44	4.57
1914	1.12	1.15	T	0.54	0.60	0.29	0.73	0	0.32	1.75	0.58	0.74	7.82	6.34
1915	0.65	0.61	0.58	0.39	0.90	0.76	0.21	T	T	0.20	1.56	1.10	6.96	6.20
1916	0.69	1.54	0.55	0.77	0.01	--	--	0	0.02	0	1.20	0.87	5.65	6.42
1917	1.00	0.28	0.31	0.72	0.57	0.09	T	0	0.07	0	0.81	0.50	4.35	4.95
1918	0.63	0.50	0.22	0	0.34	0.68	0.28	0.38	0.15	0.54	0.69	0.49	4.90	3.00
1919	1.04	1.09	0.38	0.32	0.64	0	T	T	0.74	0.21	0.88	1.00	6.30	5.19
1920	1.46	T	T	0.78	0.05	0.69	T	<u>1.18</u>	0.75	0.51	0.99	1.22	7.63	4.38
1921	0.36	1.25	T	0.60	0.33	0.12	T	0.14	0.06	0.29	1.61	0.69	5.45	5.28
1922	0.37	0.45	0.26	0.14	T	0.65	0	0.26	0.26	0.72	0.28	1.03	4.42	3.81
1923	0.37	0.40	0.05	0.85	0.27	1.11	0.33	T	0.43	1.03	0.06	0.56	5.46	3.97
1924	1.02	0.78	0.10	0.01	T	0.14	0.37	0.17	0.83	0.77	1.36	1.16	6.71	3.56
1925	0.66	0.70	0.06	0.80	0.87	0.34	0	T	0.49	0.07	0.96	0.66	5.61	6.38
1926	0.93	0.57	0.08	0.04	0.26	0.80	0	0.10	0.30	0.40	<u>3.05</u>	0.78	7.31	3.57
1927	1.29	0.77	0.45	0.03	0.09	T	T	0.29	1.14	0.62	<u>1.26</u>	0.40	6.34	6.66
1928	1.34	0.09	0.63	0.71	0.12	0.12	0.08	0.15	0.05	0.01	0.49	1.33	5.58	5.17
1929	1.37	0.07	0.02	0.05	0.25	0.89	T	0.07	0.15	0.07	T	0.84	3.78	3.59
1930	0.58	0.78	0.14	0.24	0.43	0.09	T	0.06	0.40	0.04	0.32	0.30	3.38	3.08
1931	1.35	0.17	0.99	0.11	0	0.51	0.19	0	0.16	0.47	1.15	<u>2.53</u>	7.63	3.28
1932	1.52	0.15	0.63	0.96	0.29	0.06	0.03	0.10	T	0.77	0.65	<u>0.24</u>	6.40	7.70
1933	0.86	0.50	0.43	0	1.06	0.17	0.10	0.13	0.44	0.59	0.48	1.20	5.96	4.51
1934	0.41	0.10	0.57	0.29	1.56	0.12	0	0.45	0.71	0.74	1.05	0.50	6.50	5.20
1935	0.41	0.31	0.05	0.08	0.13	0.37	0.46	0	0.05	0.39	0.30	0.87	3.42	3.27
1936	1.54	0.65	0	0.35	0.33	0.50	0.04	0.01	0.28	0.06	T	0.98	4.74	4.43
1937	0.80	0.63	0.76	0.73	0.01	1.09	0.24	0.06	0.16	0.39	1.84	1.08	7.79	3.97
1938	0.35	0.77	1.15	0.18	0.11	1.78	0.06	0.14	0.02	0.79	0.67	0.71	6.73	5.87
1939	0.59	0.80	0.52	T	0.07	0.07	0	0.28	0.11	0.25	T	1.69	4.38	4.15
1940	0.84	<u>3.08</u>	0.47	0.26	0.28	0.11	0.34	0	0.88	2.03	1.45	1.52	11.26	6.87
1941	1.82	0.85	0.16	0.31	0.83	1.16	0.08	0.59	0.57	0.41	0.46	0.40	7.44	8.77
1942	0.46	0.47	0	0.20	1.02	1.28	0.02	0	T	0.54	1.34	1.19	6.52	3.42
1943	0.40	0.37	0.33	--	--	--	--	--	--	--	--	0.23	(1.33)	(4.17)
1944	0.39	0.56	0.03	0.77	--	--	--	--	--	--	--	--	(1.75)	--
1945	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1946	--	--	--	--	--	--	0.15	0.35	0.52	0.65	0.66	<u>0.11</u>	(2.44)	--
1947	0.32	0.27	0.42	0.70	0.02	1.07	0.71	0.68	<u>1.34</u>	2.20	0.81	0.75	9.29	3.15
1948	1.36	0.69	0.07	0.95	1.71	1.47	0.40	0.39	0.16	0.45	0.95	1.11	9.71	8.54
1949	0.13	0.68	1.12	0.02	0.16	0.01	0.01	0.03	0.23	0.10	1.47	0.16	4.12	4.62
1950	1.80	1.06	0.87	0.47	0.27	<u>2.92</u>	0.07	T	0.01	2.46	0.55	0.97	<u>11.45</u>	6.20
1951	0.84	0.51	0.46	0.53	0.43	1.38	0.37	0.15	0.10	0.71	0.82	0.70	7.00	6.75
1952	0.65	0.50	0.06	0.13	0.58	1.07	T	0.08	0.08	0.04	0.20	0.77	4.16	4.15
1953	2.16	0.25	0.17	0.77	0.28	0.55	T	0.96	0.13	0.20	0.96	0.49	6.92	4.64
1954	1.48	0.28	0.59	0.07	0.41	0.10	0.22	0.42	0.51	0.42	0.86	0.35	5.71	4.48
1955	0.56	0.22	0.17	0.40	0.59	0.28	0.57	0	0.77	0.40	1.54	2.03	7.53	3.57
1956	1.71	0.56	0.10	T	0.22	0.86	T	0.38	0.01	1.03	0.15	0.58	5.60	6.56
1957	0.48	0.23	<u>1.86</u>	0.38	0.82	0.47	0.05	0.02	0.34	<u>2.72</u>	0.39	0.53	8.29	5.53
1958	1.74	1.48	0.46	0.64	0.74	0.81	0.02	T	0.05	0.19	0.77	1.84	8.74	8.70
1959	2.05	1.17	0.40	0.20	0.50	0.23	T	0.03	1.26	0.56	0.41	0.26	7.07	7.12
1960	0.51	0.58	0.67	0.53	0.71	0.14	T	0.28	0.23	0.23	0.92	0.64	5.42	4.23
1961	0.33	2.10	1.02	0.48	0.80	0.42	0.15	0.09	T	0.07	0.49	0.88	6.83	6.52
1962	<u>0.13</u>	0.90	0.14	0.34	1.35	0.12	T	0.50	0.38	0.95	0.62	0.60	6.03	4.30
1963	0.95	0.69	0.53	1.17	0.43	0.28	0.31	0.01	0.02	0.04	0.74	1.14	6.31	5.94
1964	0.37	0.01	0.03	0.11	0.04	0.90	0.04	0.24	0.09	0.28	0.94	2.34	5.39	2.48
1965	0.93	0.14	0.03	0.09	0.15	0.49	0.11	0.03	0.11	0.01	1.17	0.39	<u>3.15</u>	4.90
1966	0.68	0.03	0.39	0.03	0.05	0.43	<u>0.81</u>	T	0.27	0.39	2.25	0.60	5.93	2.75
1967	0.32	T	0.14	0.90	0.56	0.57	T	T	0.05	0.13	0.16	0.43	3.26	5.16
1968	0.88	0.58	0.02	0.01	0.06	0.19	0.04	0.51	0.25	0.93	1.23	1.25	5.95	<u>2.27</u>
1969	1.24	0.54	0.10	<u>1.22</u>	0.51	0.75	T	T	0.48	0.10	0.13	1.29	6.36	7.02
1970	<u>2.47</u>	0.75	0.27	0.45	0.54	0.25	0.01	T	0.03	0.24	0.71	0.61	6.33	8.00
1971	0.78	0.10	1.02	0.07	0.56	0.71	0.13	0.09	1.13	0.18	0.46	1.07	6.30	4.09
1972	0.19	0.27	0.58	0.10	<u>2.03</u>	0.66	0.16	0.56	0.02	T	0.55	1.27	6.39	4.88
1973	0.90	0.21	0.08	T	0.24	0.01	T	0.02	0.43	1.72	2.64	2.02	8.27	3.25
1974	0.90	0.41	0.52	0.46	0.28	0.12	0.71	T	0.01	0.21	0.71	0.97	5.30	<u>8.95</u>
1975	1.43	0.98	0.33	0.42	0.38	0.24	0.32	1.16	0.03	0.87	0.60	0.70	7.46	5.43
AVG	0.92	0.60	0.37	0.38	0.47	0.55	0.15	0.20	0.30	0.58	0.86	0.89	6.27	5.07
*NORMAL	0.97	0.58	0.38	0.44	0.53	0.70	0.15	0.21	0.30	0.61	0.80	0.81	6.48	5.12

THE HIGHEST, AND IF MEASURABLE, THE LOWEST TOTALS IN EACH COLUMN
ARE UNDERScoreD

T DENOTES A TRACE, AN AMOUNT TOO SMALL TO MEASURE

() DENOTES AN INCOMPLETE ANNUAL TOTAL

* NORMALS ARE AVERAGES FOR THE PERIOD 1941-1970
THE BIOYEAR IS DEFINED AS OCTOBER THROUGH MAY

Table B-4

Average Monthly Maximum and Minimum Temperatures (°F) at HMS (1945-1975)

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1945	39.0	28.5	47.4	30.1	52.0	32.5	62.9	37.7	74.2	49.2	80.5	54.4	93.5	62.5	92.3	62.6	78.0	51.1	70.1	42.7	48.8	32.4	38.3	26.9
1946	43.0	25.7	50.1	29.1	56.5	34.6	66.7	40.7	78.9	49.3	79.6	54.0	91.4	61.0	91.2	61.9	77.1	50.3	61.3	37.6	44.7	27.0	42.7	26.9
1947	36.6	18.2	51.1	28.9	62.4	36.8	69.9	42.3	83.5	53.8	90.5	55.2	89.9	60.6	86.2	57.4	79.1	51.8	62.4	44.3	48.9	33.5	38.6	27.6
1948	39.5	24.5	40.4	23.1	52.0	30.6	61.0	37.8	69.5	58.4	95.7	59.3	87.3	58.2	85.8	57.8	78.7	50.1	64.2	37.7	49.7	31.9	34.8	18.9
1949	23.5	04.6	41.5	22.2	56.5	34.9	70.8	40.3	81.1	67.0	94.4	54.2	90.2	59.6	90.0	59.6	81.9	54.7	63.5	36.9	53.7	36.8	43.5	26.7
1950	20.2	04.1	38.5	22.9	62.4	32.3	61.9	37.3	73.9	59.1	79.4	53.7	91.6	59.3	92.2	60.6	83.7	51.3	60.3	42.0	48.0	33.3	41.1	31.4
1951	39.9	26.2	46.1	27.7	53.6	27.7	69.3	39.0	76.2	61.1	83.9	55.0	93.5	59.8	89.9	58.5	82.3	51.4	63.1	39.8	48.2	30.8	34.2	20.5
1952	31.5	18.9	45.2	28.2	55.5	32.7	70.4	40.1	76.8	62.7	80.8	53.5	93.4	60.7	90.1	57.9	85.3	52.6	73.5	44.5	42.0	26.0	39.5	30.2
1953	50.4	34.7	51.1	31.3	52.3	34.0	63.0	39.0	72.0	58.0	76.1	49.8	92.2	59.4	88.5	59.4	84.1	51.6	69.3	41.5	53.5	33.2	46.5	28.7
1954	36.1	21.8	46.2	32.4	50.5	29.7	64.5	38.2	77.0	62.9	78.9	52.1	89.6	58.2	85.3	57.6	78.2	52.0	63.6	39.1	53.9	38.1	40.6	27.5
1955	34.6	25.4	44.8	25.9	50.3	28.5	60.0	35.1	69.7	44.4	84.9	55.4	86.9	59.0	91.4	59.6	80.1	52.6	64.7	42.0	39.4	23.3	35.5	23.2
1956	38.3	25.4	33.0	18.1	54.2	38.3	70.2	42.3	78.6	52.0	79.2	52.3	94.3	63.5	89.7	60.9	82.6	52.0	63.2	41.1	43.6	29.7	41.3	27.9
1957	24.1	08.9	43.3	25.0	53.2	34.8	67.5	42.8	78.3	53.5	84.6	56.9	88.6	59.9	86.4	59.4	83.9	54.1	59.9	41.5	49.9	30.8	45.8	31.1
1958	43.8	30.5	52.0	37.0	54.5	32.5	63.2	39.3	82.9	53.3	87.6	60.3	96.5	66.0	96.0	62.9	79.1	52.1	68.3	40.5	49.5	31.8	40.3	30.1
1959	39.1	25.0	43.6	27.4	57.3	33.0	67.6	40.7	70.7	44.3	82.2	55.1	93.3	62.2	86.8	56.9	74.5	50.6	65.5	41.2	47.4	25.5	39.8	26.4
1960	30.6	16.0	47.0	27.7	56.7	33.5	65.5	39.8	71.7	45.2	85.6	54.7	98.2	65.4	85.5	57.4	81.9	53.6	67.3	41.6	50.6	31.8	34.4	23.5
1961	41.3	28.7	52.3	35.1	56.1	36.1	65.0	39.7	72.8	47.3	89.7	58.2	94.7	64.1	95.6	64.7	77.3	50.4	64.3	38.9	45.5	25.1	41.2	26.3
1962	38.9	20.8	45.3	27.9	53.5	31.6	70.1	41.2	68.5	45.3	83.3	53.4	91.1	60.8	86.1	57.8	82.1	52.2	63.3	41.9	51.8	34.6	42.5	31.1
1963	34.0	16.8	46.7	29.9	58.1	34.8	60.5	39.1	75.7	47.7	82.7	56.1	86.3	58.5	91.0	60.4	86.0	56.2	68.3	43.7	51.2	34.3	35.0	25.5
1964	43.6	27.6	50.1	26.0	55.7	31.9	63.8	36.7	73.6	45.8	80.9	54.5	70.2	58.9	84.5	55.1	77.9	48.2	66.5	40.1	44.4	32.1	32.9	18.0
1965	38.5	26.2	50.6	30.4	55.7	30.1	68.0	41.7	74.6	46.4	93.3	55.3	92.0	60.9	88.5	60.9	77.2	47.5	70.8	43.4	50.2	36.0	40.9	25.2
1966	41.2	26.9	49.6	30.3	57.6	33.2	68.7	40.5	78.6	47.8	80.5	53.3	87.6	58.9	90.2	61.1	83.1	54.6	66.2	40.5	52.8	34.6	44.9	31.5
1967	48.6	31.1	55.7	31.7	56.6	32.0	59.8	35.4	74.3	46.6	86.9	58.1	94.6	62.5	98.7	64.2	87.5	55.9	67.9	42.4	51.5	31.6	40.9	25.2
1968	44.4	27.1	52.0	31.6	60.7	37.2	65.0	37.6	76.2	48.6	83.5	56.2	95.3	64.1	84.6	58.5	80.9	52.7	61.7	38.9	48.8	34.6	37.5	23.6
1969	25.9	13.7	38.9	24.7	58.6	33.1	64.5	40.0	79.2	50.0	89.0	61.3	91.7	60.4	89.5	56.2	81.3	53.6	63.5	38.5	48.9	31.4	39.3	30.0
1970	36.7	24.7	48.9	32.4	56.9	33.1	61.6	36.3	76.1	46.9	88.3	58.9	94.5	62.8	92.9	59.8	75.4	48.2	64.2	37.6	48.7	30.8	38.5	23.1
1971	45.0	26.6	49.7	28.5	52.1	29.3	65.4	38.6	77.9	50.2	78.7	51.8	94.6	62.7	96.6	64.3	75.4	47.6	64.6	38.8	49.3	31.5	38.0	23.2
1972	39.2	21.8	44.0	25.7	59.5	34.4	62.9	36.2	77.9	50.7	93.2	56.3	91.2	61.1	92.9	62.3	76.6	46.2	66.0	38.5	46.5	33.4	35.9	18.7
1973	37.0	21.2	46.8	30.2	59.7	35.1	68.4	38.9	78.7	47.6	83.5	53.8	94.3	62.2	90.3	57.5	79.2	52.2	63.5	41.3	44.7	32.1	44.3	31.8
1974	38.3	20.5	50.3	31.5	56.9	33.6	64.6	41.2	71.5	44.2	89.0	56.3	89.4	59.6	91.5	59.5	84.1	51.9	66.7	38.4	49.8	33.5	44.4	27.9
1975	40.0	25.0	42.2	25.2	53.1	31.8	60.6	35.8	75.0	45.5	81.3	53.2	94.7	64.4	85.4	56.7	84.1	51.9	63.5	41.5	50.0	29.1	41.8	27.1
AVG	37.5	22.5	46.6	28.3	55.8	33.1	65.3	39.1	75.7	51.1	93.2	55.2	92.0	61.2	89.9	59.6	80.6	51.6	65.2	40.6	48.6	31.6	39.8	26.0

Figure B-1. Normal and Extreme Daily Temperatures at Hanford.

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NARRATIVE CLIMATOLOGICAL SUMMARY OF THE HANFORD AREA*4

The Hanford Meteorology Station is situated on a plateau in southcentral Washington. The plateau slopes downward toward the Columbia River about 10 miles north of the station and upward to the foothills of the Rattlesnake Mountains about 10 miles south. Elevation of the station is 733 feet, which is roughly 300 feet above the Columbia River to the north. Both the Rattlesnake Mountains south and southwest of the station and the Yakima Ridge to the west rise to more than 3500 feet, while the Saddle Mountains beyond the Columbia River to the north rise to more than 2500 feet.

Greatly affecting the climate of the Hanford area, although not visible from the meteorology station, are the Cascade Mountains beyond Yakima to the west. Since Hanford is in the rain shadow of these mountains, precipitation totals only 6.28 inches annually. The 3 months November-through-January contribute 43% of this total, while the 3 months July-through-September contribute only 10%. On the average there are only two occurrences per year of 24-hour amounts of 0.50 inch or more, while occurrences of 24-hour amounts of 1.00 inch or more number only 2 in the entire 25 years of record (1946-1975). One of these was the record storm of October 1-2, 1957, in which rainfall totaled 1.08 inches in 3 hours, 1.68 inches in 6 hours, and 1.88 inches in 12 hours. At the other extreme, there have been 81 consecutive days without measurable rain (June 22-September 10, 1967), 139 days with only 0.18 inch (June 22-November 7, 1967) and 172 days with only 0.32 inch (February 24-August 13, 1968).

About 39% of all precipitation during the months December-through-February is in the form of snow. However, only one winter in eight can expect an accumulation of as much as 6 inches on the ground. The average seasonal number of such days is four, although the 1964-65 winter had 35, 32 of which were consecutive.

By serving as a source of cold air drainage, the Cascade Mountains also have considerable effect on the wind regime at Hanford. This drainage (gravity) wind, plus topographic channeling, causes a considerable diurnal range of speed during summer. In July, hourly average speeds range from a low of 5.2 mph from 9 to 10 a.m. to a high of 13.0 mph from 9 to 10 p.m. In contrast, the corresponding speeds for January are 5.5 and 6.3 mph.

Although the gravity wind occurs with regularity in summer, it is seldom strong unless reinforced by frontal activity. In June, the month of highest average speed, there are fewer instances of hourly averages exceeding 31 mph than in December, the month of lowest average speed. It is also notable that, although channeling results in a prevailing west-northwest or northwest wind the year around, the strongest speeds are from the southwest directions.

Atmospheric stagnation is an important factor in Hanford's wind regime. December, for example, has an average of 10 days with a peak gust under 13 mph. By contrast, only once in 7 years does June have even **one** such day.

*Based on records kept at the Hanford Meteorology Station from 1945-1975 and supplemented with precipitation and temperature data taken by U.S. Weather Bureau cooperative observers at a site about 10 miles east-northeast of the present station location during the period 1912-1944.

Temperatures at Hanford are colder in winter and warmer in summer than would be the case without the Cascades. However, other mountain ranges shield the area from many of the arctic surges and half of all winters are free of temperatures as low as 0°. However, six winters in 63 of record have contributed a total of 16 days with temperatures -20° or below and in January-February, 1950, there were four consecutive such days. There are 10 days of record when even the **maximum** temperature failed to get above zero. At the other extreme, in the winter of 1925-26, the lowest temperature all season was +22°.

Although winter minima have varied from -27° to +22°, summer maxima have varied only from 100° to 115°. However, there is considerable variation in the **frequency** of such maxima. In 1954, for example, there was only 1 day with a maximum as high as 100°. On the other hand, there have been two summers (1938 and 1967) when the temperature went to 100° or above for 11 consecutive days.

Although temperatures reach 90°F or above an average of 56 days a year, minimum temperatures 70°F or above occur only an average of 8 days a year. The usual cool nights are a result of the gravity wind mentioned earlier.

Thunderstorms have been observed at the station in every month except November and January and one occurred at Richland (about 25 miles southeast) on January 18, 1953. Although severe ones are rare, lightning strikes have occasionally ignited grass fires which burned thousands of acres of the Hanford project land and resulted subsequently in considerable wind erosion. The most notable of these occurrences were in August 1961, July 1965, and July 1970.

On June 16, 1948 a tornado was observed near the east end of Rattlesnake Mountain about 10 miles south of HMS. It was over barren country and no damage resulted. There have been two funnel clouds observed in 31 years (1945-75) of observations. However, the nearest reported tornado damage has been at Yakima, about 45 miles west (April 30, 1957), and at Wallula Junction, about 50 miles southeast (June 26, 1958). Damage from these included moving a double garage off its foundation into a field 20 feet away, and lifting an 800-pound boat across a road.