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IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW MEXICO

UNITED STATES OF AMERICA and ZUNI INDIAN TRIBE, Plaintiffs, -v- STATE OF NEW MEXICO, ex rel. STATE ENGINEER, et al., Defendants.	07cv00681-BB ZUNI RIVER BASIN ADJUDICATION **Subproceeding 1** **Zuni Indian Claims**

ZUNI INDIAN TRIBE'S RULE 26(a)(2) DISCLOSURES CONCERNING CLAIMS BASED ON EVIDENCE OF PAST OR PRESENT IRRIGATION BY MEANS OF PERMANENT IRRIGATION WORKS

Pursuant to the Special Master's September 24, 2008 *Scheduling Order* (Doc. No. 264) and Fed.R.Civ.P. 26(a)(2), the Zuni Indian Tribe hereby discloses the enclosed report entitled Crop Reference Evapotranspiration, Nutria Irrigation Project, Zuni Pueblo, New Mexico from its retained expert Stetson Engineers Inc., along with other statements required by Fed.R.Civ.P. 26(a)(2)(iv)-(vi). The report is available on CD-ROM upon request.

Dated: March 12, 2009

Jane Marx

Jane Marx
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Covina and Bakersfield, California • Mesa, Arizona • Centennial, Colorado • Diamondhead, Mississippi

1634 March 12, 2009 San Rafael

Jane Marx
Jane Marx, Attorney at Law, P.C.
2825 Candelaria Road NW
Albuquerque, New Mexico 87107

Re: Crop Reference Evapotranspiration, Nutria Irrigation Project, Zuni Pueblo, New Mexico

Dear Ms. Marx:

Enclosed is our report entitled *Crop Reference Evapotranspiration, Nutria Irrigation Project, Zuni Pueblo, New Mexico* dated March 12, 2009. My Statement of Qualifications is enclosed and the professional compensation required for the report was $25,000. Our contact information is:

Stetson Engineers Inc.
2171 E. Francisco Blvd., Suite K
San Rafael, CA 94901

415-457-0701 (office)
415-457-1638 (fax)

If you have any questions, please feel free to contact me at the number above.

Sincerely,

Joe DeMaggio, P.E.
Stetson Engineers Inc.

Enclosures

CROP REFERENCE EVAPOTRANSPIRATION
NUTRIA IRRIGATION PROJECT
ZUNI PUEBLO, NEW MEXICO

PREPARED FOR THE
ZUNI TRIBE

MARCH 12, 2009

STETSON
ENGINEERS INC.

WATER RESOURCE PROFESSIONALS
SERVING CLIENTS SINCE 1957

◈ BAKERSFIELD, COVINA AND SAN RAFAEL, CALIFORNIA ◈
◈ MESA, ARIZONA ◈ CENTENNIAL, COLORADO ◈

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1.0 INTRODUCTION

The quantification of a tribal water right for irrigated agriculture begins with the estimation of crop water requirements. Calculation of the crop water requirements begins with the estimation of the crop reference evapotranspiration. The crop reference evapotranspiration was estimated by Natural Resources Consulting Engineers (NRCE) in Section 4 of a report entitled *Zuni Indian Reservation Identification of Lands and Estimation of Water Requirements for Past and Present Irrigated Lands Served by Permanent Irrigation Works,* dated November 3, 2008.

Stetson Engineers reviewed NRCE's report and analysis focusing on the Nutria Irrigation Project area as a test case to determine if an appropriate method was used for calculating the crop reference evapotranspiration. As described in detail below, Stetson's independent analysis of the Nutria Irrigation Project area confirms the propriety of the method NRCE used to arrive at the crop reference evapotranspiration values essential to the determination of crop water requirements, as well as NRCE's results.

1.1 PURPOSE AND SCOPE

The purpose of this report is to document the technical approach Stetson used to calculate the crop reference evapotranspiration (ET_{ref}) for the Nutria Irrigation Project located on the Zuni Indian Reservation in New Mexico. Available climatic data was input to the ASCE Penman-Monteith equation for calculating the ET_{ref}. Climatic data were collected from nearby stations and filled/extended to reduce missing values.

This report addresses the following:

1) Climatic data available
2) Method for extending and filling missing climate data
3) Regional/Climatic data used for elevation adjustments
4) ASCE Penman-Monteith equation
5) Aridity effects
6) Summary of ET_{ref}

1.2 SUMMARY OF CONCLUSION

The average crop reference evapotranspiration calculated by NRCE for the Nutria Irrigation Project is 48.56 inches per year (NRCE, 2008). Using well-accepted methodologies to determine crop reference evapotranspiration, Stetson's calculation of the average crop reference evapotranspiration for the Nutria Irrigation Project is 50.76 inches per year. Stetson' estimation is approximately 4.5 percent higher than NRCE's number, an acceptable margin of difference. The methods used by NRCE, which are similar to those used by Stetson, are appropriate for the calculation of the crop reference evapotranspiration. The small difference between NRCE's and Stetson's numbers may result from minor differences in filling of missing data, dew point temperature elevation adjustment, use of total sky cover data and slightly different period of record. In summary Stetson agrees with NRCE's method of analysis and supports NRCE's results.

The calculated crop reference evapotranspiration of 50.76 inches per year is based on average climate data. A water rights claim needs to take into consideration variations in climate conditions that occur that will influence the amount of water a crop needs to obtain desired crop yield. Stetson also calculated the crop reference evapotranspiration that would occur during the hottest year during the period of record from 1949 to 2008 and the coolest year during the same period. The high temperature crop reference evapotranspiration is 55.87 inches per year and the low temperature crop reference evapotranspiration is 46.29 inches per year. The high temperature ET_{ref} is 10 percent higher than the average and the low temperature ET_{ref} is 9 percent lower than the average. In order for a farmer's crop to use the average crop water requirements, more than the average will be used during the hot years and less than the average will be used during the cool years. Therefore a water rights claim should not be limited to the average water requirements.

2.0 CLIMATIC DATA

The climatic inputs for the ET_{ref} calculations are constructed based on the historical climatic data. The historical climatic data used in this report were obtained from the National Climatic Data Center (NCDC) Summary of the Day (SD) and Surface Airways (SA) databases.

Climate data needed for calculation of the crop reference evapotranspiration using the ASCE Penman-Monteith equation includes daily data for the following: maximum temperature (*Tmax)*, minimum temperature (*Tmin)*, average temperature (*Tavg)*, dew point temperature (*Tdew)*, total sky cover (*Tskc)* and wind speed (*Wind)*.

The NCDC SD database contains daily records of *Tmax,* and *Tmin.* The NCDC SA database contains hourly and daily records of *Tdew, Tskc,* and *Wind.* Three Climate Stations' data was collected. The McGaffey 5SE station is located about 10 miles north east of the Nutria Irrigation Project. The Gallup station is located about 20 miles north of the project. The Albuquerque Station is located about 100 miles east of the project. The climatic stations used are listed in Table 2-1.

Table 2-1: Summary of Climate Stations and Data Availability

Station Name	ID	Elevation (ft)	Latitude	Longitude	Available Data	Period of Record
McGaffey 5 SE	5560	8,000	N35:20:00	W108:27:00	*Tmax, Tmin*	1949-2008
Gallup	23081	6,466	N35:31:00	W108:47:00	*Tdew* *Tskc* *Wind*	1973-2008 1973-2000 1973-2008
Albuquerque	23050	5,310	N35:03:00	W106:37:00	*Tdew* *Tskc* *Wind*	1949-2008 1949-1996 1949-2008

3.0 FILLING OF MISSING DATA/RECORD EXTENSION

Based on the review of available data, the following conclusions can be made:

- The complete data sets for *Tmax,* and *Tmin* for the McGaffey 5 SE, can be developed for calendar years 1949-2008.
- The complete data sets for *Tdew, Tskc* and *Wind* for the Gallup station can be developed for the period from 1949 to 2008.
- The complete data sets for *Tdew, Tskc* and *Wind* for the Albuquerque station can be developed for the period from 1949 to 2008.

Filling/extension of the climate data was performed using the method shown as follows:

3.1 AIR TEMPERATURE

Missing daily maximum and minimum temperature data accounts for about 4% of the whole period record of 1949 through 2008. The missing data was filled using the daily average data for the month with the missing data.

3.2 DEW POINT TEMPERATURE

The daily dew point temperature record for the Gallup station was filled/extended using data from the Albuquerque station.

Filling/extension of the Gallup dew point temperature data was performed using the linear regression method. In this method, the missing data at station Y ("filled station") is filled/extended using the data from station X ("filling station") using the equation $y = a + bx$, where x is the data at the station X; y is the estimate for the missing data at station Y; $b = S_{xy} / S_{xx}$; $a = \bar{y} - b\bar{x}$; $\bar{x}$ and $\bar{y}$ are the means of x and y, respectively, during the common period of record of stations X and Y; $S_{xx} = \sum_{i=1}^{n} (x_i - \bar{x})^2$; $S_{xy} = \sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})$; and n is the number of days on the common period of record of stations X and Y. Table 3-1 presents the filling/extension summary for the dew point temperature data.

Table 3-1: Summary of Filling/Extension of the Gallup Dew Point Temperature Data

Filled Station	Filling Station	Intercept *a*	Slope *b*	R^2	Days Filled by Regression	Days Filled by Interpolation	Total Days Filled
23081	23050	0.947	0.860	0.830	9,274	0	9,274

3.3 TOTAL SKY COVER

The daily total sky cover record for the Gallup station was filled/extended using data from the Albuquerque station.

Extension of the daily Gallup total sky cover record for the period 1949 through 1999 was performed using the linear regression method described in Section 3.2. Extension of the record for years 2000 to 2008 was performed using the daily average of the available data. Table 3-2 presents the filling/extension summary for the total sky cover data.

Table 3-2: Summary of Filling/Extension of the Gallup Daytime Total Sky Cover Data

Filled Station	Filling Station	*a*	*b*	R^2	Days Filled by Regression	Days Filled by Monthly Avg.	Total Days Filled
23081	23050	0.811	6.783	0.66	8,956	3,379	12,335

3.4 WIND SPEED

The daily wind speed records for the Gallup station were filled/extended using data from the Albuquerque station.

The filling/extension of the wind speed data was performed using the method of ratio of monthly means (RMM). In this method, the missing data at station Y ("filled station") in month *m* is filled using the data from station X ("filling station") using the equation $y = b_m x$; where x is the data at the station X; y is the estimate for the missing data at station Y; $b_m = \bar{y}_m / \bar{x}_m$; and $\bar{x}_m / \bar{y}_m$ are the monthly means of x and y, respectively, during the common period of record of stations X and Y in month *m*. Subsequently, several missing days in the daytime record were filled by linear interpolation. Table 3-3 presents the filling/extension summary for the wind speed data.

Table 3-3: Summary of Filling/Extension of the Gallup Wind Speed Data Using the Albuquerque Wind Speed Data

Ratios of Monthly Means												Days Filled by RMM	Total Days Filled by Linear Interpolation	Total Days Filled
Jan b_1	Feb b_2	Mar b_3	Apr b_4	May b_5	Jun b_6	Jul b_7	Aug b_8	Sep b_9	Oct b_{10}	Nov b_{11}	Dec b_{12}			
0.657	0.737	0.839	0.853	0.848	0.807	0.767	0.740	0.757	0.714	0.727	0.674	8860	0	8860

For the calculation of ET_{ref}, wind speed at 2 meters above the surface is required and the wind speed data was measured at 10 meters above the surface, therefore, it must be adjusted with the following equation:

$$u_2 = u_z \frac{4.87}{\ln(67.8z - 5.42)}$$

where: u_2 = wind speed at 2 meters above ground surface (mph)

u_z = wind speed measured at z in meters above ground surface (mph)

In = natural log

z = distance above ground (meters)

4.0 REGIONAL ANALYSIS OF LONG-TERM CLIMATIC DATA

Since the maximum air temperature, minimum air temperature, and dew point temperature generally exhibit strong dependencies on elevation, these dependencies should be taken into account.

The elevation adjustment factors ("lapse rates") for the maximum air temperature and minimum air temperature were developed through regional analysis by Natural Resources Consulting Engineers (NRCE, 2008) and the lapse rates determined from the regional analysis described above are:

- Maximum temperature lapse rate is -3.743 degrees Fahrenheit per 1,000 feet.
- Minimum temperature lapse rate is -4.205 degrees Fahrenheit per 1,000 feet.

The climatic inputs for the air temperature for the Nutria Irrigation Project area located at 6,800 feet elevation were developed by performing elevation adjustments of the air temperature recorded at the McGaffey 5E climatic station located at 8,000 feet elevation. The climatic inputs for the dew point temperature for the Nutria Irrigation Project area were developed by performing elevation adjustments of the dew point temperature data recorded at the Gallup station located at 6,466 feet elevation. Based on maps of mean wind speed and of mean total sky cover percentage (sunrise to sunset) for the contiguous United States, these variables do not exhibit clear elevation dependencies (NCDC, 2002). Therefore, the total sky cover and wind speed data from the Gallup station were applied to the Nutria Irrigation Project without elevation adjustments. The methodology for calculation of the elevation-adjusted climatic inputs is described in the following sections.

4.1 AIR TEMPERATURE

The maximum and minimum daily air temperature for the study area (the Nutria Irrigation Project area) is calculated as the sum of the daily data recorded at the climatic station and the appropriate regional lapse rate (with a negative sign) times the elevation difference between the mean elevation of the Nutria Irrigation Project area and the elevation of the climate station. This is accomplished using the following equations:

$$T\max(t) = T\max_{station}(t) - 0.003743(Z - Z_{station}),$$

$$T\min(t) = T\min_{station} - 0.004205(Z - Z_{station})$$

where $T\max(t)$ and $T\min(t)$ are the maximum and minimum daily air temperatures for the study area, in degrees Fahrenheit, $T\max_{station}(t)$ and $T\min_{station}(t)$ are the maximum and minimum daily air temperatures at the climatic station, in degrees Fahrenheit, Z is the mid-elevation of the study area, in feet, and $Z_{station}$ is the elevation of the climatic station, in feet.

The average daily air temperature is calculated as the mean of the maximum and minimum daily air temperatures:

$$T(t) = \frac{1}{2}\left[T\max(t) + T\min(t)\right]$$

4.2 DEW POINT TEMPERATURE

The daily dew point temperature is calculated as:

$$Tdew(t) = Tdew_{station}(t) + Tdew_{adjust} ,$$

where $Tdew(t)$ is the daily dew point temperature for the Nutria Irrigation Project area, $Tdew_{station}(t)$ is the daily dew point temperature data at the climatic station, and $Tdew_{adjust}$ is the dew point temperature elevation adjustment, all in degrees Fahrenheit.

The dew point temperature elevation adjustment $Tdew_{adjust}$ is calculated as:

$$Tdew^{C}_{adjust} = \frac{\frac{(Z - Z_{station})}{128780}(237.3 + \overline{Tdew_{station}})}{\frac{(Z - Z_{station})}{128780} + \frac{237.3}{(237.3 + \overline{Tdew_{station}})}}, \quad Tdew_{adjust} = \frac{9}{5} Tdew^{C}_{adjust}$$

where $Tdew^{C}_{adjust}$ is the dew point temperature elevation adjustment in degrees Celsius, and $\overline{Tdew_{station}}$ is the long-term average dew point temperature at the station, in degrees Celsius.

The above equation for the dew point temperature elevation adjustment was derived based on the following relationship between the actual vapor pressure and elevation, as reported by Reitan (1963):

$$\frac{e(Z)}{e(Z_{station})} = \exp\left[-\frac{(Z - Z_{station})}{7457}\right]$$

where exp is the exponential function e^{x}.

The following standard equation for the actual vapor pressure (ASCE, 2005) was also used in the derivation:

$$e = 0.6108 \exp\left[\frac{17.27 Tdew}{Tdew + 237.3}\right],$$

where e is the vapor pressure in kilopascals (kPa) and $Tdew$ is the dew point temperature in degrees Celsius.

5.0 CROP REFERENCE EVAPOTRANSPIRATION

The daily crop reference evapotranspiration *(ET_{ref})* was calculated as a function of the solar radiation (general land surface), maximum air temperature, minimum air temperature, dew point temperature, total sky cover, and wind speed using the ASCE Penman-Monteith equation for the reference crop of clipped, cool season grass (ASCE, 2005).

The ASCE Penman-Monteith equation is:

$$ET_{ref} = \frac{0.408\Delta(R_n - G) + \gamma \frac{C_n}{T+273} u_2 (e_{sat} - e)}{\Delta + \gamma(1 + C_d u_2)} ,$$

where: ET_{ref} = reference ET (mm/day),

Δ = slope of the saturation vapor pressure versus temperature curve (kPa/°C)

R_n = net radiation at the crop surface (MJ/m^2/day),

G = soil heat flux density at the soil surface (MJ/m^2/day),

γ = psychrometric constant (kPa/°C),

C_n = constant for short reference crop type and daily time step, use 900

T = mean daily air temperature at 2 meter height (°C),

u_2 = mean daily wind speed at 2 meter height (m/s),

e_{sat} = mean saturation vapor pressure at 2 meter height (kPa),

e = mean actual vapor pressure at 2 meter height (kPa),

C_d = constant for short reference crop type and daily time step, use 0.34

Equations used in calculating the required inputs into the ASCE Penman-Monteith equation are provided below.

The **slope of the saturation vapor pressure versus temperature curve**, Δ (kPa/°C), is calculated as:

$$\Delta = \frac{2503 \exp\left(\frac{17.27 T_{avg}}{T_{avg} + 237.3}\right)}{(T_{avg} + 237.3)^2} ,$$

where $T_{avg} = (T_{max} + T_{min})/2$, equals daily mean air temperature in degrees Celsius, T_{max} = daily maximum air temperature in degrees Celsius, T_{min} = daily minimum air temperature in degrees Celsius, and exp = e^x

The **net radiation**, R_n (in MJ/(m^2 day)), is then calculated as:

$$R_n = (1-\alpha)R_s + R_{nl} ,$$

where α is albedo, set to 0.23 for general land surfaces,
where R_{nl} = net long-wave radiation, adjusted to account for the effect of the cloud cover, is given by:

$$R_{nl} = R_{nlo}\left(1.35\frac{R_s}{R_{so}} - 0.35\right),$$

where R_{nlo} = net clear sky long-wave radiation in (MJ/(m^2 day)), is calculated as:

$$R_{nlo} = -\varepsilon\sigma\frac{(T^K_{\max})^4 + (T^K_{\min})^4}{2},$$

where $T^K_{\max}$ and $T^K_{\min}$ are the maximum and minimum absolute daily temperatures in degrees Kelvin and $\sigma = 4.903\times10^{-9}$ MJ/(m^2 day KE) is the Stefan-Boltzmann constant. Degrees Kelvin = degrees Celsius + 273.16,
where R_s is the short wave solar radiation in MJ/(m^2 day) and R_{so} is the short wave solar radiation for clear skies in MJ/(m^2 day)). Using the relationship:

$$R_s / R_{so} = 1 - A(C/100)^2,$$

where C is the total sky cover expressed in percent. This relationship was determined empirically by the Tennessee Valley Authority (TVA, 1972), in which they determined the coefficient A equals 0.65,
where ε is the net emissivity between the atmosphere and the ground and is calculated from the actual vapor pressure as:

$$\varepsilon = 0.34 - 0.14\sqrt{e},$$

where e is the mean actual vapor pressure in (kPa), is calculated from the dew point temperature as:

$$e = 0.608\exp\left[\frac{17.27T_{dew}}{T_{dew} + 237.3}\right]$$

where T_{dew} is the dew point temperature in degrees Celsius and exp = e^x ,
the clear sky solar radiation, R_{so}, is calculated as:

$$R_{so} = \left(0.75 + 2x10^{-5} z\right)R_a$$

where z = elevation above sea level in meters.
where the extraterrestrial radiation, R_a, is calculated as:

$$R_a = \frac{24}{\pi}G_{sc}d_r\left[\omega_s\sin(\varphi)\sin(\delta) + \cos(\varphi)\cos(\delta)\sin(\omega_s)\right],$$

where:

R_a = extraterrestrial radiation (MJ m^{-2} d^{-1}),
G_{sc} = Solar Constant (4.92 MJ m^{-2} h^{-1}),
d_r = inverse relative distance factor (squared) for earth-sun (unit less),
ω_s = sunset hour angle (radians),
φ = latitude (radians),

δ = solar declination (radians),

where the conversion from decimal degrees to radians is given by:

$$Radians = \frac{\pi}{180}(decimal \deg rees) ,$$

where the inverse relative distance factor, d_r, is calculated as:

$$d_r = 1 + 0.033\cos\left(\frac{2\pi}{365}J\right) ,$$

where the sunset hour angle, ω_s, is calculated as:

$$\omega_s = \frac{latitude * \pi}{180} ,$$

where latitude is in degrees north of the equator,

where the solar declination, δ, is calculated as:

$$\delta = 0.409\sin\left(\frac{2\pi}{365}J - 1.39\right) ,$$

where J is the number of the day in the year between 1 (1 January) and 365 or 366 (31 December).

Where the **soil heat flux density at the soil surface**, $G(MJ / m^2 / day)$ is approximated from the average air temperature as:

$$G = 0.38(T_{avg} - T_{avg}^{prev}) ,$$

where T_{avg} is the average daily temperature in degrees Celsius, which is calculated as the arithmetic average of the maximum and minimum temperatures,

where T_{avg}^{prev} is the average air temperature (in degrees Celsius or Kelvin) for the previous day. For calculation with daily data, G can be ignored and assumed to be zero.

Where the **psychrometric constant**, γ (kPa/°C), is calculated as:

$$\gamma = \frac{C_p P}{0.622\lambda} = 0.000665P ,$$

where C_p =0.001013 MJ/(kg KE) is the specific heat of air at constant pressure and P is the atmospheric pressure in kPa where the latent heat of vaporization, λ is 2.45 MJ/kg and KE indicates Kelvin degrees.

P is approximately constant in time for a given elevation and is calculated as:

$$P = 101.3\left(\frac{293 - 0.0065Z}{293}\right)^{5.26} ,$$

where Z = weather site elevation above mean sea level, in meters,

where the mean daily air temperature, T, degrees Celsius.

$$T = (T_{max} + T_{min})/2 \ ,$$

where T = daily mean air temperature in degrees Celsius, Tmax = daily maximum air temperature in degrees Celsius, Tmin = daily minimum air temperature in degrees Celsius.

Where the **mean saturated vapor pressure**, e_{sat} (kPa), is calculated from the maximum and minimum daily temperatures as:

$$e_{sat} = \frac{e_{sat}^{T_{max}} + e_{sat}^{T_{min}}}{2}$$, where $e_{sat}^{T_{max}}$ and $e_{sat}^{T_{min}}$, both in kPa, are given by:

$$e_{sat}^{T_{max}} = 0.6108 \exp\left[\frac{17.27 T_{max}}{T_{max} + 237.3}\right] \ , \ e_{sat}^{T_{min}} = 0.6108 \exp\left[\frac{17.27 T_{min}}{T_{min} + 237.3}\right]$$

where T_{max} and T_{min} are the maximum and minimum daily temperatures in degrees Celsius.

The constants $\mathbf{C_n}$ **and** $\mathbf{C_d}$ are provided as 900 and 0.34, respectively, for a short (0.12m) reference crop and calculations performed on a daily time-step.

6.0 ARIDITY EFFECTS

ASCE defines reference evapotranspiration as "the ET rate from a uniform surface of dense, actively growing vegetation having a specified height and surface resistance, not short of soil water, and representing an expanse of at least 100 m of the same or similar vegetation" (ASCE, 2005). They also state: "weather data should be measured at stations that are located in open, well-watered, vegetated settings (preferably grass)." "Humidity, temperature, and wind speed variables change when entering an irrigated field surrounded by dry or poorly irrigated fields. It is important, when making calculations of ET_{ref}, that weather measurements are accurate and that weather measurements reflect the environment that is defined by the reference surface." FAO-56 (1998) presents procedures for evaluating and adjusting humidity and air temperature data for the effects of aridity, i.e., non-reference conditions, at the weather station site. These procedures were used to evaluate and adjust the dew point temperature and air temperature inputs to the ET_{ref} calculations for the Nutria Irrigation Project.

6.1 ADJUSTMENTS OF T_{max}, T_{min} AND T_{dew}

The empirical method described herein intends to correct the observed temperatures, T_{max} and T_{min} in proportion to the difference (T_{max} - T_{min}), which works as an indicator of the overestimation of the temperature difference between non-reference sites and reference sites. Since T_{dew} defines the actual vapor pressure ($e_a = e^o(T_{dew})$), correcting T_{dew} also provides an adjustment for vapor pressure deficit (VPD).

The method used follows:

1. Compare $T_{min} - T_{dew}$ (T_{dew} measured or computed from e_a using equations (11) or (12) in Annex 3 of FAO No. 56 (FAO, 1998) from a non reference site with those from a reference site. Daily or monthly data are utilized to compute $T_{min} - T_{dew}$.

   When differences Tmin - Tdew for the non reference site are systematically higher than about 2°C relative to the reference site, then compute the average differences

   $$\Delta T = T_{\min} - T_{dew} \qquad \text{Equation (1)}$$

   for the months which require correction.

   Or, if comparing $T_{min} - T_{dew}$ from the non reference site to $T_{min} - T_{dew}$ from the reference site, then calculate ΔT as:

   $$\Delta T = \left(T_{\min} - T_{dew}\right)_{n/ref} - \left(T_{\min} - T_{dew}\right)_{ref} \qquad \text{Equation (2)}$$

2. Correct temperatures for each month (or day) by:

$$(T_{\max})_{cor} = (T_{\max})_{obs} - \left(\frac{\Delta T - K_o}{2}\right)$$

$$(T_{\min})_{cor} = (T_{\max})_{obs} - \left(\frac{\Delta T - K_o}{2}\right)$$

for $\Delta T > K_o$, where subscripts *cor* and *obs* refer to corrected and observed values, respectively. K_o is a "conservative" factor equal to 2°C when the non-reference station is not compared to a reference station (ΔT is from Equation (1)). $K_o = 0$ when ΔT is from Equation (2).

3. Correct T_{dew} for the same months or days as:

$$(T_{dew})_{cor} = (T_{dew})_{obs} + \left(\frac{\Delta T - K_o}{2}\right)$$

where K_o has the same value as for the two Equations in 2, and utilizing the observed values for T_{dew}. The user should always insure that $(T_{\min})_{cor} \geq (T_{dew})_{cor}$.

4. Compute ET_{ref} with the corrected values for T_{max}, T_{min} and T_{dew}.

7.0 SUMMARY OF ET_{REF}

The average daily ET_{ref} is calculated using the average daily climate data for the period of 1949 through 2008 and then the average monthly ET_{ref} is calculated by adding daily ET_{ref} together for each month. Table 7-1, Table 7-2 and Figure 7-1 show the results without and with aridity effects.

Table 7-1: Monthly ET_{ref} without aridity effects
(inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.60	2.16	3.67	5.34	7.19	8.41	7.93	6.74	5.57	3.99	2.32	1.56	56.49

Table 7-2: Monthly ET_{ref} with aridity effects
(inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1.60	2.14	3.26	4.32	5.88	6.95	7.22	6.68	5.27	3.65	2.22	1.56	50.76

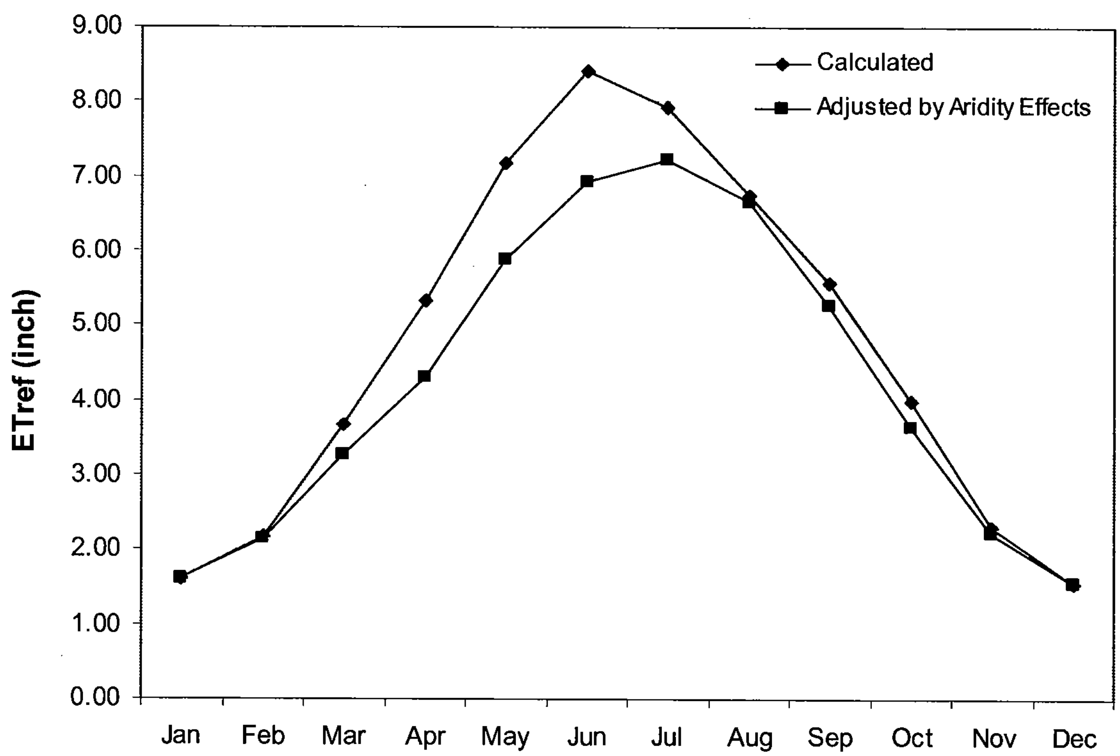

Figure 7-1: Monthly *ETref* showing Aridity Effects

The calculated crop reference evapotranspiration of 50.76 inches per year is based on average climate data. A water rights claim needs to take into consideration variations in climate conditions that occur that will influence the amount of water a crop needs to obtain desired crop yield. Stetson also calculated the crop reference evapotranspiration that would occur during the hottest year during the period of record from 1949 to 2008 and the coolest year during the same period. The high temperature crop reference evapotranspiration is 55.87 inches per year and the low temperature crop reference evapotranspiration is 46.29 inches per year. The high temperature ET_{ref} is 10 percent higher than the average and the low temperature ET_{ref} is 9 percent lower than the average. In order for a farmer's crop to use the average crop water requirements, more than the average will be used during the hot years and less than the average will be used during the cool years. Therefore a water rights claim should not be limited to the average water requirements. The monthly high, low and average crop reference evapotranspiration are shown on Table 7-3.

Table 7-3: Hot, Average and Cool Temperature Monthly ET_{ref} with Aridity Effects
(inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Temp.
2.63	3.65	5.41	6.02	6.87	7.23	7.05	4.80	4.93	3.79	2.07	1.42	55.87	Hot
1.60	2.14	3.26	4.32	5.88	6.95	7.22	6.68	5.27	3.65	2.22	1.56	50.76	Average
1.43	1.60	2.88	3.94	5.67	7.09	6.32	6.43	4.25	3.52	1.96	1.19	46.26	Cool

8.0 ABBREVIATIONS AND ACRONYMS

Δ	Slope of the saturation vapor pressure versus temperature curve (kPa/°C)
γ	Psychrometric constant (kPa/°C),
ASCE	American Society of Civil Engineers
C	Degrees Celsius
C_n, C_d	Constants for reference type and calculation time step
E	Mean actual vapor pressure at 2 meter height (kPa)
E	Vapor Pressure
e_{sat}	Mean saturation vapor pressure at 2 meter height (kPa)
ET_{ref}	Crop reference evapotranspiration
exp	Exponential function
FAO	Food and Agricultural Organization
ft	Feet
G	Soil Heat Flux
G	Acceleration due to Gravity 9.81 m/s^2
Grad	Solar Radiation
ID	Identification Number
K	Kilo
KE	Kelvin Degrees
kPa	Kilopascals
LT	Lapserate for saturated air
M	Meters
MJ	Megajoule
Mm	Millimeters
mph	Miles per hour
NCDC	National Climate Data Center
NRCE	Natural Resources Consulting Engineers
Pa	Pascal's
R	Specific Gas Constant 287 S/(KgKE)

RMM	Ratio of monthly means
R_n	Net radiation
R_s	Short wave solar radiation
S	Second
SA	Surface airways
SD	Summary of the day
SE	Southeast
T	Mean daily air temperature at 2 meter height (°C)
Tavg	Average temperature
Tdew	Dew point temperature
Tmax	Maximum temperature
Tmin	Minimum temperature
Tskc	Total sky cover
TVA	Tennessee Valley Authority
U_2	Mean daily wind speed at 2 meter height (m/s)
VPD	Vapor pressure deficit
Wind	Wind speed
Z	Mid elevation of study area or elevation in meters

9.0 REFERENCES

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APPENDIX A: CLIMATIC DATA FILLING/EXTENION

Appendix A shows raw daily climatic data (maximum and minimum air temperature, dew point temperature, average wind speed, and total sky cover) for the period of record (1949 through 2008) and the filled and extended data for the period of record (1949 through 2008) using the month of July as a sample. Data for the other 11 months is available upon request.

Table A-1: Daily Maximum Temperature (Tmax) Raw Data (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	84	82	81	79	79	78	77	84	82	67	79	72	78	84	83	88	86	87	80	79	79	73	72	74	74	78	79	82	85	85	84	88	67	80
1950	87	87	86	83	78	72	72	73	75	79	76	81	85	83	78	78	75	75	76	82	79	76	78	71	73	79	80	81	79	78	79	87	71	79
1951	85	85	85	85	83	86	92	90	88	85	83	76	76	80	82	86	86	87	85	85	87	81	80	76	77	81	85	80	81	87	81	92	76	83
1952	83	84	87	81	78	73	77	75	69	80	80	81	83	84	83	81	82	84	83	85	86	82	84	83	85	83	81	76	79	76	77	87	69	81
1953	85	89	88	88	90	82	87	88	81	82	82	74	78	81	82	76	70	78	78	78	72	78	83	85	87	85	87	85	78	75	76	90	70	82
1954	78	74	75	75	82	84	80	78	84	84	86	83	84	80	82	81	75	78	80	85	80	76	72	74	79	77	84	80	85	87	87	87	72	80
1955	69	77	78	80	78	81	82	84	85	85	80	77	72	76	83	74	76	75	73	75	77	79	80	70	80	77	78	80	73	77	69	85	69	77
1956	77	76	77	79	78	87	85	88	87	90	89	85	77	70	81		88	80	71	81	82	83	75	76		77	76	72	72	71	71	90	70	79
1957	89	92	94	91	92	89	86	77	80	77	77	80	80	82	84	80	82	73	74	80	83	81	80	74	62	63	75	78	81	83	85	94	62	81
1958	80	80	80	80	80	80	84	87	88	91	92	93	93	91	91	90	89	79	80	83	83	85	86	83	90	76	79	80	80	81	81	93	76	84
1959	79	83	83	82	84	85	85	83	85	85	88	88	87	85	82	77	80	85	82	85	85	86	86	86	86	85	87	87	87	77	83	88	77	84
1960	87	87	80	78	75	76	83	83	83	79	84	87	90	87	87	87	88	85	83	88	86	86	86	89	91	94	96	99	99	88	84	99	75	86
1961	89	75	72	74	78	80	74	79	90	91	86	87	82	85	88	89	89	90	88	90	84	89	82	84	86	90	85	80	81	81	78	91	72	84
1962	84	89	83	83	85	83	83	78	81	85	85	84	80	86	88	82	83	83	85	92	90	87	80	80	78	76	82	82	84	82	79	92	76	83
1963	85	89	90	85	84	88	90	86	80	81	82	77	79	79	81	84	85	85	86	82	82	87	84	89	89	89	88	86	83	86	88	90	77	85
1964	89	87	86	83	84	89	84	85	85	82	80	82	82	81	84	79	80	85	85	90	86	85	86	83	75	74	75	73	84	78	85	90	73	83
1965	80	82	83	84	85	82	80	84	82	79	78	85	83	80	76	74	76	78	76	80	82	84	80	77	73	74	76	78	78	78	79	85	73	80
1966	78	83	81	88	88	89	90	90	88	90	88	85	85	88	84	86	86	82	77	76	79	85	85	82	85	85	84	88	75	78	82	90	75	84
1967	84	86	87	90	88	89	86	85	83	76	77	79	73	74	76	70	69	74	78	80	78	81	80	78	79	80	80	74	74	78	72	90	69	79
1968	80	80	78	74	70	70	75	78	75	80	84						86	84	86	84	82	83	84	82	80	84	82	84	79	75	74	86	70	80
1969	90	89				90	88	91	84	77	77	76	88	85	84	80	74	74	78	80	78	78	79	80	80	80	78	80	78	80	80	91	74	81
1970	90	82	80	80	83	78	78	74	76	78	78	80	82	89	88	88	86	88	86	84	80	81	69	75	77	79	80	76	75	82		90	69	81
1971	83	80	76	80	81	83	72	75	79	80	86	90	92	90	90	88	87	86	88	82	80	79	75	78	80	84	82	85	87	84	82	92	72	83
1972	86	88	88	84	86	82	80	80			80	79	84	82	90	91	86	79	75	76	75	78	80	79	71	70	77	82	84	85	89	91	70	82
1973	87	85	87	88	89	89	90	86	79	80	78	77	79	75	74	72	65	68	69	74	76	74	72	78	79	80		78	74	77	76	90	65	79
1974	88	86	87	84	80	81	77	75	76	78	77	80	82	85	69	70	76	74	72	69	69	71	76	75	76	79	76		78	79	82	88	69	78
1975	85	86	74	78	79		78	82	77	78	78	74	69	71	75	79	73	70	76	78	79	82	82	79		81	75	77	76	66		86	66	77
1976	82	80	80	81	82	84	83	80	84	83	85	85	84	79	75	79		80	81	70	74	75	76	77	67	66	72	70	79	80		85	66	78
1977			84	86	68	75	80	84	85	86	87	72	83	75	76	77	79	80	82	79	75	76	74	78	76	70	78	77	80	82	86	87	68	79
1978		80	84	83	80	82	80	84		84	84	80	82	83	87			88	84	88	85	82	85	70	72	76	82	80	85	89		89	70	82
1979	81	73	76	69	76	80	79	82	86	88		85	87	88	86	87	81	77	78	76	77	78	80	82	85	86	89	88	85	78		89	69	81
1980	87	78		79	85	88	76	80	85	88	87	82	71	81	84	88	87		84	81	82	80	79	80	84	85	86	80	82	80	84	88	71	83
1981	73	65	77		85	85	87	85	79	66	68	78	75	75	75	73	71	70	79	82	84	85	86		79	80	78	76	78	79	81	87	65	78
1982	73	74	76	78	76	73	74	76	78	84	87	84	85	87	85	84	82	81	78	83	83	80	78	79	78	78	76	75	72	72	72	87	72	79
1983	79	79	80	80	86	88	85	80	82	82	82	79	79	82	80	80	82	83	84	80	82	77	75	77	75	75	75	69	75	79	75	88	69	80
1984	83	78	81	85	85	86	84	80	81	82	78	78	75	72	82	78	79	79	77	80	84	80	80	72	77	78	76	78	78	79	77	86	72	79
1985	80	84	83	81	87	89	89	87	86	85	83	85	87	87	84	79	80	84	79	73	77	72	71	72	76	74	74	75	77	73	70	89	70	80
1986	73	76	77	81	80	72	75	72	78	75	76	80	84	82	76	76	65	70	73	74	63	71	70	68	75	79	79	78	83	84	85	85	63	76
1987	82	79	82	80	80	80	81	84	83	82	80	80	82	83	85	84	77	70	74	77	78	81	80	83	80	77	73	72	70	72	74	85	70	79
1988	73	77	78	77	76	72	78	79	78	73	74	76	77	82	80	80	83	80	83	79	76	78	82	83	84	80	76	75	78	80	75	84	72	78
1989	85	86	90	92	93	93	92	89	90	85	87	80	81	86	88	87	88	86	91	92	87	88	81	75	74	78	69	73	70	70	75	93	69	84
1990	85	86	78	79	78	72	74	77	72	69	73	71	76	75	69	75	76	73	78	80	80	81	78	79	73	76	78	82	81	84	77	86	69	77
1991	83	84	85	87	82	77	82	83	80	80	78	80	76	77	80	75	76	81	82	77	78	79	80	74	74	73	75	77	80	78	79	87	73	79
1992	79	73	75	80	85	87	87	82	81	80	75	69	65	72	74	75	79	78	78	82	82	83	80	74	69	72	77	80	82	83	80	87	65	78
1993	79	85	86	78	76	79	82	84	85	83	84	85	87	77	80	81	80	79	80	84	82	78	79	78	79	80	82	85	80	83	82	87	76	81
1994	92	86	85	85	85	83	82	84	83	88	90	88	87	90	88	90	87	83	81	80	85	79	80	79	83	86	84	86	82	81	80	92	79	85
1995	80	76	70	76	75	80	87	83	84	88	86	86	84	80	72	70	68	70	67	76	80	81	80	78	84	87	90	91	94	89	88	94	67	81
1996	78	80	85	86	89	86	86	80	79	77	79	85	84	70	80	78	70	76	80	83	90	89	91	90	88	85	86	81	85	82	85	91	70	83
1997	82	85	88	84	86	84	82	81	77	84	80	86	84	85	87	88	90	87	85	80	81	75	78	82	86	86	85	78	68	66	64	90	64	82
1998	90	91	88	79	82	75	73	70	68	67	81	88	89	86	87	86	86	85	87	88	87	87	80	74	70	77	80	71	78	80	77	91	67	81
1999	88	90	78	83	80	78	72	76	74	76	69	76	80	78	75	80	70	64	70	69	70	73	76	77	80	78	80	80	77	77	79	90	64	77
2000	80	82	79	83	84	80	86	90	85	75	80	85	83	86	88	84	76	78	83	75	82	89	80	81	83	85	89	90	82	84	82	90	75	83
2001	87	90	86	88	82	88	88	94	82	80	79	80	82	86	87	80	81	80	81	78	76	80	82	83	81	80	74	82	84	80	73	94	73	82
2002	92	93	91	80	82	79	83	88	81	80	78	87	88	90	88	87	78	77	71	76	75	84	75	80	78	80	74	77	85	82	85	93	71	82
2003	88	90	91	92	88	92	90	91	92	96	95	98	92	94	96	90	85	86	87	90	94	88	90	85	86	90	88	80	77	78	80	98	77	89
2004	81	84	82			80	83	85	86	84	82	80	87	80		81	80		85	83	80	90	78	70	74		70	75	77	81	86	90	70	81
2005	87	85	86	88	86	85	87	86	87	88	90	88	88	90	87	92	91	92	88	90	89	88	82	80	81	77	75	75	86	82	80	92	75	86
2006	80	85	80	77	75	68	67	70	74	80	81	80	82	84	84	80	90	87	80	86	82	84	80	88	85	80	80	74	70	74	69	90	67	79
2007	95	92	92	85	82	80	85	82	88	87	80	81	82	86	90	91	87	87	89	84	86	82	80	81	80	81	76	80	80	80	78	95	76	84
2008	85	80	84	86	85	85	83	84	74	83	76	72	74	70	70	85	84	83	76	80	75	76	85	84	81	85	76	77	88	89	89	89	70	81

Table A-2: Daily Maximum Temperature (Tmax) Filled (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	84	82	81	79	79	78	77	84	82	67	79	72	78	84	83	88	86	87	80	79	79	73	72	74	74	78	79	82	85	85	84	88	67	80
1950	87	87	86	83	78	72	72	73	75	79	76	81	85	83	78	78	75	75	76	82	79	76	78	71	73	79	80	81	79	78	79	87	71	79
1951	85	85	85	85	83	86	92	90	88	85	83	76	76	80	82	86	86	87	85	85	87	81	80	76	77	81	85	80	81	87	81	92	76	83
1952	83	84	87	81	78	73	77	75	69	80	80	81	83	84	83	81	82	84	83	85	86	82	84	83	85	83	81	76	79	76	77	87	69	81
1953	85	89	88	88	90	82	87	88	81	82	82	74	78	81	82	76	70	78	78	78	72	78	83	85	87	85	87	85	78	75	76	90	70	82
1954	78	74	75	75	82	84	80	78	84	84	86	83	84	80	82	81	75	78	80	85	80	76	72	74	79	77	84	80	85	87	87	87	72	80
1955	69	77	78	80	78	81	82	84	85	85	80	77	72	76	83	74	76	75	73	75	77	79	80	70	80	77	78	80	73	77	69	85	69	77
1956	77	76	77	79	78	87	85	88	87	90	89	85	77	70	81	82	88	80	71	81	82	83	75	76	79	77	76	72	72	71	71	90	70	79
1957	89	92	94	91	92	89	86	77	80	77	77	80	80	82	84	80	82	73	74	80	83	81	80	74	62	63	75	78	81	83	85	94	62	81
1958	80	80	80	80	80	80	84	87	88	91	92	93	93	91	91	90	89	79	80	83	83	85	86	83	90	76	79	80	80	81	81	93	76	84
1959	79	83	83	82	84	85	85	83	85	85	88	88	87	85	82	77	80	85	82	85	85	86	86	86	86	85	87	87	87	77	83	88	77	84
1960	87	87	80	78	75	76	83	83	83	79	84	87	90	87	87	87	88	85	83	88	86	86	86	89	91	94	96	99	99	88	84	99	75	86
1961	89	75	72	74	78	80	74	79	90	91	86	87	82	85	88	89	89	90	88	90	84	89	82	84	86	90	85	80	81	81	78	91	72	84
1962	84	89	83	83	85	83	83	78	81	85	85	84	80	86	88	82	83	83	85	92	90	87	80	80	78	76	82	82	84	82	79	92	76	83
1963	85	89	90	85	84	88	90	86	80	81	82	77	79	79	81	84	85	85	86	82	82	87	84	89	89	89	88	86	83	86	88	90	77	85
1964	89	87	86	83	84	89	84	85	85	82	80	82	82	81	84	79	80	85	85	90	86	85	86	83	75	74	75	73	84	78	85	90	73	83
1965	80	82	83	84	85	82	80	84	82	79	78	85	83	80	76	74	76	78	76	80	82	84	80	77	73	74	76	78	78	78	79	85	73	80
1966	78	83	81	88	88	89	90	90	88	90	88	85	85	88	84	86	86	82	77	76	79	85	85	82	85	85	84	88	75	78	82	90	75	84
1967	84	86	87	90	88	89	86	85	83	76	77	79	73	74	76	70	69	74	78	80	78	81	80	78	79	80	80	74	74	78	72	90	69	79
1968	80	80	78	74	70	70	75	78	75	80	84	81	82	82	82	82	86	84	86	84	82	83	84	82	80	84	82	84	79	75	74	86	70	80
1969	90	89	82	82	82	90	88	91	84	77	77	76	88	85	84	80	74	74	78	80	78	78	79	80	80	80	78	80	78	80	80	91	74	81
1970	90	82	80	80	83	78	78	74	76	78	78	80	82	89	88	88	86	88	86	84	80	81	69	75	77	79	80	76	75	82	79	90	69	81
1971	83	80	76	80	81	83	72	75	79	80	86	90	92	90	90	88	87	86	88	82	80	79	75	78	80	84	82	85	87	84	82	92	72	83
1972	86	88	88	84	86	82	80	80	82	81	80	79	84	82	90	91	86	79	75	76	75	78	80	79	71	70	77	82	84	85	89	91	70	82
1973	87	85	87	88	89	89	90	86	79	80	78	77	79	75	74	72	65	68	69	74	76	74	72	78	79	80	80	78	74	77	76	90	65	79
1974	88	86	87	84	80	81	77	75	76	78	77	80	82	85	69	70	76	74	72	69	69	71	76	75	76	79	76	79	78	79	82	88	69	78
1975	85	86	74	78	79	82	78	82	77	78	78	74	69	71	75	79	73	70	76	78	79	82	82	79	79	81	75	77	76	66	79	86	66	77
1976	82	80	80	81	82	84	83	80	84	83	85	85	84	79	75	79	80	80	81	70	74	75	76	77	67	66	72	70	79	80	79	85	66	78
1977	83	83	84	86	68	75	80	84	85	86	87	72	83	75	76	77	79	80	82	79	75	76	74	78	76	70	78	77	80	82	86	87	68	79
1978	83	80	84	83	80	82	80	84	82	84	84	80	82	83	87	82	80	88	84	88	85	82	85	70	72	76	82	80	85	89	79	89	70	82
1979	81	73	76	69	76	80	79	82	86	88	81	85	87	88	86	87	81	77	78	76	77	78	80	82	85	86	89	88	85	78	79	89	69	81
1980	87	78	82	79	85	88	76	80	85	88	87	82	71	81	84	88	87	80	84	81	82	80	79	80	84	85	86	80	82	80	84	88	71	82
1981	73	65	77	82	85	85	87	85	79	66	68	78	75	75	75	73	71	70	79	82	84	85	86	79	79	80	78	76	78	79	81	87	65	78
1982	73	74	76	78	76	73	74	76	78	84	87	84	85	87	85	84	82	81	78	83	83	80	78	79	78	78	76	75	72	72	72	87	72	79
1983	79	79	80	80	86	88	85	80	82	82	82	79	79	82	80	80	82	83	84	80	82	77	75	77	75	75	75	69	75	79	75	88	69	80
1984	83	78	81	85	85	86	84	80	81	82	78	78	75	72	82	78	79	79	77	80	84	80	80	72	77	78	76	78	78	79	77	86	72	79
1985	80	84	83	81	87	89	89	87	86	85	83	85	87	87	84	79	80	84	79	73	77	72	71	72	76	74	74	75	77	73	70	89	70	80
1986	73	76	77	81	80	72	75	72	78	75	76	80	84	82	76	76	65	70	73	74	63	71	70	68	75	79	79	78	83	84	85	85	63	76
1987	82	79	82	80	80	80	81	84	83	82	80	80	82	83	85	84	77	70	74	77	78	81	80	83	80	77	73	72	70	72	74	85	70	79
1988	73	77	78	77	76	72	78	79	78	73	74	76	77	82	80	80	83	80	83	79	76	78	82	83	84	80	76	75	78	80	75	84	72	78
1989	85	86	90	92	93	93	92	89	90	85	87	80	81	86	88	87	88	86	91	92	87	88	81	75	74	78	69	73	70	70	75	93	69	84
1990	85	86	78	79	78	72	74	77	72	69	73	71	76	75	69	75	76	73	78	80	80	81	78	79	73	76	78	82	81	84	77	86	69	77
1991	83	84	85	87	82	77	82	83	80	80	78	80	76	77	80	75	76	81	82	77	78	79	80	74	74	73	75	77	80	78	79	87	73	79
1992	79	73	75	80	85	87	87	82	81	80	75	69	65	72	74	75	79	78	78	82	82	83	80	74	69	72	77	80	82	83	80	87	65	78
1993	79	85	86	78	76	79	82	84	85	83	84	85	87	77	80	81	80	79	80	84	82	78	79	78	79	80	82	85	80	83	82	87	76	81
1994	92	86	85	85	85	83	82	84	83	88	90	88	87	90	88	90	87	83	81	80	85	79	80	79	83	86	84	86	82	81	80	92	79	85
1995	80	76	70	76	75	80	87	83	84	88	86	86	84	80	72	70	68	70	67	76	80	81	80	78	84	87	90	91	94	89	88	94	67	81
1996	78	80	85	86	89	86	86	80	79	77	79	85	84	70	80	78	70	76	80	83	90	89	91	90	88	85	86	81	85	82	85	91	70	83
1997	82	85	88	84	86	84	82	81	77	84	80	86	84	85	87	88	90	87	85	80	81	75	78	82	86	86	85	78	68	66	64	90	64	82
1998	90	91	88	79	82	75	73	70	68	67	81	88	89	86	87	86	86	85	87	88	87	87	80	74	70	77	80	71	78	80	77	91	67	81
1999	88	90	78	83	80	78	72	76	74	76	69	76	80	78	75	80	70	64	70	69	70	73	76	77	80	78	80	80	77	77	79	90	64	77
2000	80	82	79	83	84	80	86	90	85	75	80	85	83	86	88	84	76	78	83	75	82	89	80	81	83	85	89	90	82	84	82	90	75	83
2001	87	90	86	88	82	88	88	94	82	80	79	80	82	86	87	80	81	80	81	78	76	80	82	83	81	80	74	82	84	80	73	94	73	82
2002	92	93	91	80	82	79	83	88	81	80	78	87	88	90	88	87	78	77	71	76	75	84	75	80	78	80	74	77	85	82	85	93	71	82
2003	88	90	91	92	88	92	90	91	92	96	95	98	92	94	96	90	85	86	87	90	94	88	90	85	86	90	88	80	77	78	80	98	77	89
2004	81	84	82	82	82	80	83	85	86	84	82	80	87	80	82	81	80	80	85	83	80	90	78	70	74	80	70	75	77	81	86	90	70	81
2005	87	85	86	88	86	85	87	86	87	88	90	88	88	90	87	92	91	92	88	90	89	88	82	80	81	77	75	75	86	82	80	92	75	86
2006	80	85	80	77	75	68	67	70	74	80	81	80	82	84	84	80	90	87	80	86	82	84	80	88	85	80	80	74	70	74	69	90	67	79
2007	95	92	92	85	82	80	85	82	88	87	80	81	82	86	90	91	87	87	89	84	86	82	80	81	80	81	76	80	80	80	78	95	76	84
2008	85	80	84	86	85	85	83	84	74	83	76	72	74	70	70	85	84	83	76	80	75	76	85	84	81	85	76	77	88	89	89	89	70	81

Table A-3: Daily Minimum Temperature (Tmin) Raw Data (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	53	50	43	45	45	42	43	41	50	51	51	50	51	45	43	43	50	51	54	49	46	45	49	48	52	48	44	44	43	44	50	54	41	47
1950	51	44	42	46	56	50	49	50	49	51	48	51	53	47	50	42	45	52	42	46	43	42	43	49	51	50	51	49	49	49	52	56	42	48
1951	54	57	45	45	47	49	45	46	45	61	63	59	60	46	45	42	49	52	55	47	46	46	45	49	46	50	50	49	51	50	45	63	42	50
1952	40	43	41	51	51	52	45	50	45	42	44	43	44	47	50	51	50	54	47	48	49	59	48	46	48	46	47	45	42	46	47	59	40	47
1953	53	45	40	50	42	40	45	48	49	50	49	48	52	49	47	50	50	46	48	46	45	47	45	50	55	54	40	45	45	44	45	55	40	47
1954	52	43	40	45	45	42	48	45	44	48	45	48	45	45	48	49	46	49	51	54	49	51	53	43	45	46	48	49	51	45	47	54	40	47
1955	32	40	44	49	47	39	41	49	51	45	45	44	45	49	50	42	44	42	44	49	48	44	45	53	45	48	45	50	49	50	42	53	32	45
1956	47	44	38	38	38	40	42	43	48	44	49	49	45	51	47	80	46	48	42	44	47	46	51	43	46	43	45	49	45	49	52	80	38	46
1957	43	43	48	53	54	50	47	51	53	49	52	46	43	44	43	45	47	47	43	43	42	41	44	48	53	52	50	47	47	47	48	54	41	47
1958	49	45	44	42	42	42	40	46	46	49	47	46	45	45	45	47	47	49	47	47	40	41	41	46	43	47	45	44	45	46	46	49	40	45
1959	46	45	46	44	46	46	46	48	46	46	42	42	43	53	52	48	48	50	54	50	50	44	41	50	50	51	50	43	46	53	46	54	41	47
1960	42	47	46	47	46	45	43	40	43	45	45	45	48	40	40	40	44	44	42	44	40	42	43	43	43	42	47	45	45	52	49	52	40	44
1961	44	44	52	47	49	44	52	47	48	48	47	41	45	47	47	44	50	51	55	50	44	44	41	45	46	45	47	53	46	43	45	55	41	47
1962	44	44	45	45	48	42	40	40	40	40	40	37	35	40	39	36	47	45	45	43	45	42	49	54	45	45	45	44	47	43	42	54	35	43
1963	38	38	42	43	46	47	46	44	42	46	49	50	52	52	50	47	47	47	49	46	45	46	46	48	49	48	46	46	43	47	46	52	38	46
1964	45	42	43	45	48	48	49	42	40	42	46	50	48	44	44	47	47	47	45	45	45	42	42	41	42	45	45	50	52	51	45	52	40	45
1965	38	42	41	40	44	46	46	44	44	46	41	42	43	46	44	44	45	47	47	47	43	46	45	45	49	49	48	48	40	42	36	49	36	44
1966	42	41	44	44	42	43	43	45	50	50	48	44	44	45	46	46	48	50	51	47	48	48	50	50	50	50	51	51	52	54	50	54	41	47
1967	43	45	45	46	49	48	45	48	48	55	60	50	52	50	52	49	54	58	53	50	44	49	51	52	53	50	52	54	52	50	49	60	43	50
1968	36	38	41	38	38	44	41	45	42	44	46						42	44	50	48	46	47	46	46	42	44	46	48	45	45	44	50	36	44
1969	37	45				41	40	41	41	50	50	48	50	49	50	54	52	51	48	52	49	52	49	50	54	54	50	51	50	51	50	54	37	49
1970	38	46	48	49	53	51	52	48	46	48	45	50	44	47	48	48	48	48	48	46	48	50	52	50	50	46	49	50	46	47		53	38	48
1971	42	51	39	41	42	51	45	42	43	49	44	46	51	52	50	56	46	46	51	49	49	50	49	50	44	52	47	48	46	46	40	56	39	47
1972	42	45	41	42	54	50	43	50			44	49	44	44	47	57	50	48	44	48	46	48	49	52	52	45	47	53	52	50	48	57	41	48
1973	46	49	52	49	47	48	57	48	48	55	51	45	49	47	47	49	51	50	43	42	40	40	38	41	48	43		45	44	43	45	57	38	47
1974	46	52	44	57	49	45	48	46	44	45	42	45	48	51	52	52	45	46	45	45	47	45	45	46	47	48	48		49	48	47	57	42	47
1975	40	45	46	49	45		44	48	51	50	49	51	44	46	47	52	47	48	43	54	45	49	46	45		42	45	49	52	45		54	40	47
1976	45	46	43	40	43	45	46	48	48	44	44	43	44	51	46	43		48	54	47	50	47	45	49	50	46	45	46	46	50		54	40	46
1977			50	48	52	42	43	43	42	45	46	42	45	50	48	52	48	46	48	48	50	46	52	50	47	46	49	48	45	47	44	52	42	47
1978		39	40	42	41	38	40	48		47	48	45	47	52	50			45	48	49	53	43	51	50	47	47	47	49	48	58		58	38	47
1979	45	43	40	39	41	46	41	43	42	40		41	43	45	48	57	52	46	43	49	44	42	39	43	44	45	47	57	50	42		57	39	45
1980	47	43		42	41	51	44	46	53	44	44	50	42	45	46	44	56		48	46	49	54	46	48	52	50	56	48	49	50	51	56	41	48
1981	52	44	47	45		48	51	51	52	55	49	51	45	46	48	46	49	47	48	46	47	48	53		49	48	48	46	47	45	54	55	44	48
1982	40	35	36	38	44	37	48	43	40	39	44	41	43	44	45	47	49	48	45	54	54	46	46	45	49	47	52	50	51	52	45	54	35	45
1983	38	36	44	41	52	49	46	49	46	47	46	44	43	44	47	45	45	54	47	48	47	45	46	49	47	45	49	49	49	50	54	54	36	46
1984	47	46	45	41	47	48	48	55	51	48	50	49	52	49	50	56	47	49	47	44	45	48	47	42	54	46	48	45	47	46	44	56	41	48
1985	41	50	42	45	48	51	49	51	45	48	45	41	49	48	48	50	51	48	50	45	45	47	48	46	40	46	51	47	48	48	47	51	40	47
1986	50	48	48	48	40	41	52	50	49	47	44	43	46	51	46	47	46	45	48	51	46	42	46	44	45	42	39	37	40	43	44	52	37	45
1987	38	33	35	38	34	35	38	40	43	40	38	41	42	41	42	45	40	38	39	42	55	43	40	49	50	49	49	48	50	47	51	55	33	42
1988	46	46	45	49	46	48	49	50	51	43	42	42	43	52	46	45	47	47	46	48	47	47	44	43	46	48	46	49	47	48	46	52	42	47
1989	40	43	38	44	48	50	51	48	47	44	45	42	51	46	45	48	47	45	56	52	49	48	47	45	43	45	40	47	48	47	49	56	38	46
1990	48	52	50	46	40	48	47	45	44	48	53	52	48	47	43	44	48	46	49	52	44	40	45	49	47	46	41	40	39	41	41	53	39	46
1991	44	40	43	46	46	44	49	49	45	41	42	41	42	48	46	50	47	51	49	47	52	45	46	48	45	45	42	46	44	48	47	52	40	46
1992	49	28	35	34	42	45	50	45	47	49	50	51	44	46	38	41	48	43	40	43	46	45	50	54	52	45	42	40	45	46	46	54	28	44
1993	42	43	50	44	41	42	43	44	46	45	46	54	47	44	45	46	48	39	41	43	38	36	37	40	39	42	39	48	51	46	54	54	36	44
1994	46	46	44	42	41	40	39	40	42	43	46	44	42	43	45	42	48	50	42	47	53	47	46	45	50	46	44	44	44	43	48	53	39	45
1995	37	34	30	35	30	35	45	46	53	45	44	42	42	40	43	51	50	48	50	42	51	45	37	35	40	41	37	50	52	49	45	53	30	43
1996	46	48	50	46	48	49	50	50	49	47	49	48	55	47	48	53	51	48	46	44	48	45	49	44	48	46	51	44	47	48	48	55	44	48
1997	36	33	31	35	38	41	40	45	47	44	40	35	37	41	40	42	45	44	42	48	50	52	48	42	48	45	43	41	50	51	49	52	31	43
1998	44	44	45	44	52	50	52	54	50	47	45	46	45	47	48	48	46	44	48	47	45	45	46	48	46	51	47	51	47	46	50	54	44	47
1999			45	45	49	47		48	49	50	48	49		44	46	47	52	50	44	48	50	51	46	49	50	48		51		48	50	52	44	48
2000	40	43			42	44	50	45	39	35	38	39	40	42	44	42	40	43		44	41	40	41	42	40		47	57	43	59	47	59	35	43
2001	44	48	46	44	49		45	44	50	44	40	41	48	53	46	44	48	45	46	51	53	56	50	47	48	49	45		47	48	50	56	40	47
2002	45	47	52	43	50	52	51	50	52	48	50	48	50	48	49	46	47	46	46	52	48	51	53	49	47	52	47	45	49	50	46	53	43	49
2003	44	42	40	42	40	53	45	40	40	46	50	52	50	49	52	50	50	49	47	48	50	46	50	51	52	53	50	53	50	49	48	53	40	48
2004	32	35	37			39	40	40	44	46	46	50	45	54		47	44		48	43	51	52	50	44	40		50	42	40	42	47	54	32	44
2005	41	40	46	42	38	42	43	45	43	40	46	44	53	46	50	47	50	51	50	49	50	53	45	52	50	54	44	43	50	48	45	54	38	46
2006	53	50	48	52	47	50	47	50	46	47	48	45	46	45	42	50	55	52	47	48	56	50	48	50	40	50	48	46	50	54	51	56	40	49
2007	43	48	48	52	54	51	48	50	47	50	52	48	47	50	48	50	51	51	48	52	50	48	47	50	47	46	54	50	54	50	52	54	43	50
2008	45	46	47	48	47	42	43	50	44	47	46	45	52	52	53	47	52	48	53	49	52	47	48	48	45	46	48	46	48	54	55	55	42	48

Table A-4: Daily Minimum Temperature (Tmin) Filled (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	53	50	43	45	45	42	43	41	50	51	51	50	51	45	43	43	50	51	54	49	46	45	49	48	52	48	44	44	43	44	50	54	41	47
1950	51	44	42	46	56	50	49	50	49	51	48	51	53	47	50	42	45	52	42	46	43	42	43	49	51	50	51	49	49	49	52	56	42	48
1951	54	57	45	45	47	49	45	46	45	61	63	59	60	46	45	42	49	52	55	47	46	46	45	49	46	50	50	49	51	50	45	63	42	50
1952	40	43	41	51	51	52	45	50	45	42	44	43	44	47	50	51	50	54	47	48	49	59	48	46	48	46	47	45	42	46	47	59	40	47
1953	53	45	40	50	42	40	45	48	49	50	49	48	52	49	47	50	50	46	48	46	45	47	45	50	55	54	40	45	45	44	45	55	40	47
1954	52	43	40	45	45	42	48	45	44	48	45	48	45	45	48	49	46	49	51	54	49	51	53	43	45	46	48	49	51	45	47	54	40	47
1955	32	40	44	49	47	39	41	49	51	45	45	44	45	49	50	42	44	42	44	49	48	44	45	53	45	48	45	50	49	50	42	53	32	45
1956	47	44	38	38	38	40	42	43	48	44	49	49	45	51	47	80	46	48	42	44	47	46	51	43	46	43	45	49	45	49	52	80	38	46
1957	43	43	48	53	54	50	47	51	53	49	52	46	43	44	43	45	47	47	43	43	42	41	44	48	53	52	50	47	47	47	48	54	41	47
1958	49	45	44	42	42	42	40	46	46	49	47	46	45	45	45	47	47	49	47	47	40	41	41	46	43	47	45	44	45	46	46	49	40	45
1959	46	45	46	44	46	46	46	48	46	46	42	42	43	53	52	48	48	50	54	50	50	44	41	50	50	51	50	43	46	53	46	54	41	47
1960	42	47	46	47	46	45	43	40	43	45	45	45	48	40	40	40	44	44	42	44	40	42	43	43	43	42	47	45	45	52	49	52	40	44
1961	44	44	52	47	49	44	52	47	48	48	47	41	45	47	47	44	50	51	55	50	44	44	41	45	46	45	47	53	46	43	45	55	41	47
1962	44	44	45	45	48	42	40	40	40	40	40	37	35	40	39	36	47	45	45	43	45	42	49	54	45	45	45	44	47	43	42	54	35	43
1963	38	38	42	43	46	47	46	44	42	46	49	50	52	52	50	47	47	47	49	46	45	46	46	48	49	48	46	46	43	47	46	52	38	46
1964	45	42	43	45	48	48	49	42	40	42	46	50	48	44	44	47	47	47	45	45	45	42	42	41	42	45	45	50	52	51	45	52	40	45
1965	38	42	41	40	44	46	46	44	44	46	41	42	43	46	44	44	45	47	47	47	43	46	45	45	49	49	48	48	40	42	36	49	36	44
1966	42	41	44	44	42	43	43	45	50	50	48	44	44	45	46	46	48	50	51	47	48	48	50	50	50	50	51	51	52	54	50	54	41	47
1967	43	45	45	46	49	48	45	48	48	55	60	50	52	50	52	49	54	58	53	50	44	49	51	52	53	50	52	54	52	50	49	60	43	50
1968	36	38	41	38	38	44	41	45	42	44	46	46	46	47	47	48	42	44	50	48	46	47	46	46	42	44	46	48	45	45	44	50	36	44
1969	37	45	44	44	45	41	40	41	41	50	50	48	50	49	50	54	52	51	48	52	49	52	49	50	54	54	50	51	50	51	50	54	37	48
1970	38	46	48	49	53	51	52	48	46	48	45	50	44	47	48	48	48	48	48	46	48	50	52	50	50	46	49	50	46	47	47	53	38	48
1971	42	51	39	41	42	51	45	42	43	49	44	46	51	52	50	56	46	46	51	49	49	50	49	50	44	52	47	48	46	46	40	56	39	47
1972	42	45	41	42	54	50	43	50	46	46	44	49	44	44	47	57	50	48	44	48	46	48	49	52	52	45	47	53	52	50	48	57	41	48
1973	46	49	52	49	47	48	57	48	48	55	51	45	49	47	47	49	51	50	43	42	40	40	38	41	48	43	47	45	44	43	45	57	38	47
1974	46	52	44	57	49	45	48	46	44	45	42	45	48	51	52	52	45	46	45	45	47	45	45	46	47	48	48	47	49	48	47	57	42	47
1975	40	45	46	49	45	45	44	48	51	50	49	51	44	46	47	52	47	48	43	54	45	49	46	45	47	42	45	49	52	45	47	54	40	47
1976	45	46	43	40	43	45	46	48	48	44	44	43	44	51	46	43	48	48	54	47	50	47	45	49	50	46	45	46	46	50	47	54	40	46
1977	44	44	50	48	52	42	43	43	42	45	46	42	45	50	48	52	48	46	48	48	50	46	52	50	47	46	49	48	45	47	44	52	42	47
1978	44	39	40	42	41	38	40	48	46	47	48	45	47	52	50	48	48	45	48	49	53	43	51	50	47	47	47	49	48	58	47	58	38	47
1979	45	43	40	39	41	46	41	43	42	40	47	41	43	45	48	57	52	46	43	49	44	42	39	43	44	45	47	57	50	42	47	57	39	45
1980	47	43	44	42	41	51	44	46	53	44	44	50	42	45	46	44	56	48	48	46	49	54	46	48	52	50	56	48	49	50	51	56	41	48
1981	52	44	47	45	45	48	51	51	52	55	49	51	45	46	48	46	49	47	48	46	47	48	53	47	49	48	48	46	47	45	54	55	44	48
1982	40	35	36	38	44	37	48	43	40	39	44	41	43	44	45	47	49	48	45	54	54	46	46	45	49	47	52	50	51	52	45	54	35	45
1983	38	36	44	41	52	49	46	49	46	47	46	44	43	44	47	45	45	54	47	48	47	45	46	49	47	45	49	49	49	50	54	54	36	46
1984	47	46	45	41	47	48	48	55	51	48	50	49	52	49	50	56	47	49	47	44	45	48	47	42	54	46	48	45	47	46	44	56	41	48
1985	41	50	42	45	48	51	49	51	45	48	45	41	49	48	48	50	51	48	50	45	45	47	48	46	40	46	51	47	48	48	47	51	40	47
1986	50	48	48	48	40	41	52	50	49	47	44	43	46	51	46	47	46	45	48	51	46	42	46	44	45	42	39	37	40	43	44	52	37	45
1987	38	33	35	38	34	35	38	40	43	40	38	41	42	41	42	45	40	38	39	42	55	43	40	49	50	49	49	48	50	47	51	55	33	42
1988	46	46	45	49	46	48	49	50	51	43	42	42	43	52	46	45	47	47	46	48	47	47	44	43	46	48	46	49	47	48	46	52	42	47
1989	40	43	38	44	48	50	51	48	47	44	45	42	51	46	45	48	47	45	56	52	49	48	47	45	43	45	40	47	48	47	49	56	38	46
1990	48	52	50	46	40	48	47	45	44	48	53	52	48	47	43	44	48	46	49	52	44	40	45	49	47	46	41	40	39	41	41	53	39	46
1991	44	40	43	46	46	44	49	49	45	41	42	41	42	48	46	50	47	51	49	47	52	45	46	48	45	45	42	46	44	48	47	52	40	46
1992	49	28	35	34	42	45	50	45	47	49	50	51	44	46	38	41	48	43	40	43	46	45	50	54	52	45	42	40	45	46	46	54	28	44
1993	42	43	50	44	41	42	43	44	46	45	46	54	47	44	45	46	48	39	41	43	38	36	37	40	39	42	39	48	51	46	54	54	36	44
1994	46	46	44	42	41	40	39	40	42	43	46	44	42	43	45	42	48	50	42	47	53	47	46	45	50	46	44	44	44	43	48	53	39	45
1995	37	34	30	35	30	35	45	46	53	45	44	42	42	40	43	51	50	48	50	42	51	45	37	35	40	41	37	50	52	49	45	53	30	43
1996	46	48	50	46	48	49	50	50	49	47	49	48	55	47	48	53	51	48	46	44	48	45	49	44	48	46	51	44	47	48	48	55	44	48
1997	36	33	31	35	38	41	40	45	47	44	40	35	37	41	40	42	45	44	42	48	50	52	48	42	48	45	43	41	50	51	49	52	31	43
1998	44	44	45	44	52	50	52	54	50	47	45	46	45	47	48	48	46	44	48	47	45	45	46	48	46	51	47	51	47	46	50	54	44	47
1999	44	44	45	45	49	47	46	48	49	50	48	49	46	44	46	47	52	50	44	48	50	51	46	49	50	48	47	51	47	48	50	52	44	48
2000	40	43	44	44	42	44	50	45	39	35	38	39	40	42	44	42	40	43	47	44	41	40	41	42	40	47	47	57	43	59	47	59	35	44
2001	44	48	46	44	49	45	45	44	50	44	40	41	48	53	46	44	48	45	46	51	53	56	50	47	48	49	45	47	47	48	50	56	40	47
2002	45	47	52	43	50	52	51	50	52	48	50	48	50	48	49	46	47	46	46	52	48	51	53	49	47	52	47	45	49	50	46	53	43	49
2003	44	42	40	42	40	53	45	40	40	46	50	52	50	49	52	50	50	49	47	48	50	46	50	51	52	53	50	53	50	49	48	53	40	48
2004	32	35	37	44	50	39	40	40	44	46	46	50	45	54	47	47	44	48	48	43	51	52	50	44	40	47	50	42	40	42	47	54	32	45
2005	41	40	46	42	38	42	43	45	43	40	46	44	53	46	50	47	50	51	50	49	50	53	45	52	50	54	44	43	50	48	45	54	38	46
2006	53	50	48	52	47	50	47	50	46	47	48	45	46	45	42	50	55	52	47	48	56	50	48	50	40	50	48	46	50	54	51	56	40	49
2007	43	48	48	52	54	51	48	50	47	50	52	48	47	50	48	50	51	51	48	52	50	48	47	50	47	46	54	50	54	50	52	54	43	50
2008	45	46	47	48	47	42	43	50	44	47	46	45	52	52	53	47	52	48	53	49	52	47	48	48	45	46	48	46	48	54	55	55	42	48

Table A-5: Daily Dew Point Temperature (Tdew) Raw Data (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
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1973	47.0	42.0	47.0	48.0	42.0	44.0	52.0	56.0	54.0	54.0	50.0	50.0	55.0	55.0	55.0	55.0	56.0	54.0	48.0	42.0	42.0	43.0	37.0	37.0	39.0	46.0	45.0	51.0	51.0	49.0	47.0	56.0	37.0	48.2
1974	36.0	39.0	32.0	28.0	42.0	49.0	50.0	45.0	37.0	27.0	25.0	28.0	45.0	54.0	55.0	55.0	54.0	50.0	50.0	51.0	54.0	50.0	50.0	46.0	46.0	45.0	46.0	46.0	45.0	49.0	49.0	55.0	25.0	44.5
1975	32.0	51.0	49.0	47.0	48.0	52.0	52.0	53.0	54.0	58.0	57.0	56.0	55.0	54.0	53.0	54.0	55.0	51.0	47.0	47.0	47.0	48.0	42.0	45.0	47.0	47.0	47.0	52.0	54.0	49.0	45.0	58.0	32.0	49.9
1976	47.0	33.0	25.0	30.0	33.0	38.0	39.0	41.0	42.0	43.0	47.0	49.0	55.0	51.0	47.0	52.0	50.0	53.0	57.0	52.0	49.0	50.0	48.0	49.0	52.0	53.0	52.0	51.0	51.0	55.0	54.0	57.0	25.0	46.7
1977	44.0	41.0	46.0	55.0	49.0	39.0	30.0	34.0	41.0	42.0	48.0	49.0	51.0	49.0	50.0	50.0	52.0	53.0	54.0	55.0	56.0	57.0	56.0	57.0	54.0	53.0	51.0	50.0	44.0	47.0	37.0	57.0	30.0	48.2
1978	19.0	15.0	17.0	19.0	20.0	12.0	29.0	44.0	45.0	46.0	50.0	45.0	42.0	45.0	43.0	42.0	45.0	48.0	46.0	42.0	44.0	35.0	48.0	52.0	51.0	48.0	42.0	44.0	42.0	43.0	43.0	52.0	12.0	38.9
1979	45.0	42.0	39.0	33.0	34.0	37.0	37.0	31.0	20.0	21.0	19.0	24.0	29.0	35.0	40.0	49.0	53.0	50.0	47.0	49.0	50.0	42.0	30.0	37.0	31.0	34.0	44.0	47.0	48.0	37.0	35.0	53.0	19.0	37.7
1980	49.0	42.0	36.0	24.0	24.0	36.0	48.0	51.0	43.0	48.0	47.0	49.0	51.0	43.0	38.0	30.0	35.0	43.0	50.0	47.0	45.0	46.0	47.0	49.0	49.0	49.0	43.0	48.0	51.0	51.0	48.0	51.0	24.0	43.9
1981	56.0	49.0	44.0	39.0	39.0	42.0	50.0	54.0	58.0	58.0	57.0	57.0	57.0	55.0	57.0	54.0	54.0	52.0	49.0	40.0	45.0	46.0	50.0	52.0	54.0	49.0	47.0	47.0	43.0	45.0	54.0	58.0	39.0	50.1
1982	45.0	32.0	31.0	36.0	38.0	33.0	47.0	46.0	40.0	34.0	38.0	33.0	32.0	35.0	40.0	50.0	55.0	55.0	51.0	52.0	50.0	52.0	50.0	46.0	49.0	52.0	56.0	57.0	56.0	56.0	49.0	57.0	31.0	45.0
1983	24.0	25.0	28.0	35.0	44.0	46.0	49.0	55.0	52.0	51.0	48.0	47.0	44.0	42.0	45.0	42.0	42.0	52.0	53.0	53.0	53.0	55.0	55.0	58.0	55.0	55.0	55.0	54.0	53.0	55.0	54.0	58.0	24.0	47.7
1984	48.0	46.5	37.7	31.0	35.5	42.3	46.6	48.3	47.3	47.1	49.3	52.9	55.4	50.1	51.5	56.0	52.6	48.6	49.5	49.9	49.2	53.4	55.1	49.7	46.5	43.8	47.1	49.3	51.9	47.8	43.9	56.0	31.0	47.9
1985	25.0	31.6	32.9	28.8	28.7	34.8	39.4	40.8	41.5	44.5	47.6	45.3	46.3	47.3	49.3	52.4	53.0	52.5	54.5	52.3	51.9	54.9	54.2	46.5	45.2	46.5	47.8	54.3	54.0	54.7	50.8	54.9	25.0	45.5
1986	50.2	47.8	49.3	55.8	46.1	37.9	45.4	52.3	52.4	43.7	37.9	41.3	40.3	49.0	54.5	55.4	51.6	53.5	54.5	53.8	52.5	52.7	52.3	46.1	43.5	40.5	34.1	30.6	35.1	37.0	39.8	55.8	30.6	46.4
1987	21.8	16.1	17.8	20.2	19.3	24.3	26.6	23.8	28.5	24.9	25.3	29.9	36.5	37.7	37.2	48.3	39.1	36.7	33.6	45.3	53.3	48.8	36.6	47.8	52.3	51.8	55.4	56.8	58.2	57.0	57.8	58.2	16.1	37.7
1988	50.3	49.2	48.4	45.6	50.3	46.7	42.0	46.8	50.0	45.0	48.7	45.8	36.8	44.8	43.9	42.1	44.3	43.7	43.7	47.7	43.3	41.9	38.5	42.4	44.2	44.5	46.7	49.0	52.0	52.0	54.2	54.2	36.8	46.0
1989	19.0	18.5	18.5	17.7	30.5	37.2	33.6	27.0	40.5	47.9	49.8	43.4	36.8	31.6	30.5	44.0	42.9	27.8	38.8	44.7	44.3	50.2	56.2	54.8	52.5	52.7	54.3	52.5	51.3	50.8	54.0	56.2	17.7	40.5
1990	35.6	40.9	48.8	49.2	55.7	52.7	55.3	55.1	55.2	54.9	55.9	50.1	52.8	56.5	46.7	47.5	50.5	50.2	53.0	50.8	47.1	41.4	45.8	49.7	46.2	40.7	34.0	30.6	38.4	41.4	40.3	56.5	30.6	47.5
1991	27.4	32.4	37.7	43.6	41.5	41.9	47.7	50.8	44.0	41.2	43.0	47.5	45.1	46.9	49.6	49.8	51.6	53.1	53.5	53.4	52.8	50.3	50.4	51.4	51.9	47.9	43.5	43.7	46.1	48.6	53.9	53.9	27.4	46.5
1992	24.3	23.2	21.8	29.5	29.8	33.1	44.0	47.5	47.6	51.4	53.0	52.3	47.2	45.5	41.0	39.1	45.2	44.3	46.3	42.0	43.3	47.3	55.0	56.5	56.5	50.6	43.0	42.2	45.4	42.8	45.6	56.5	21.8	43.1
1993	30.7	33.3	41.0	40.0	33.4	35.3	31.0	33.4	39.0	45.0	44.2	49.1	48.4	44.0	35.6	45.4	31.9	29.9	33.3	31.3	23.3	28.8	30.5	30.4	28.5	25.3	26.5	35.1	48.6	50.8	45.5	50.8	23.3	36.4
1994	36.9	39.7	34.8	26.6	29.8	25.5	19.0	26.0	28.3	28.0	27.8	19.3	20.5	21.9	16.6	18.9	36.0	46.8	46.3	44.2	48.9	48.4	50.9	50.6	52.2	46.7	47.6	46.2	48.1	52.3	50.6	52.3	16.6	36.6
1995	36.0	31.0	26.0	37.0	27.3	23.8	30.4	34.0	31.3	30.1	25.5	27.8	45.4	47.8	44.7	53.0	53.2	54.3	50.3	41.4	40.8	26.5	17.7	21.9	22.3	20.2	24.1	25.0	27.4	33.2	36.1	54.3	17.7	33.7
1996	44.9	43.7	44.4	43.5	44.2	46.5	52.4	55.2	55.5	53.0	51.2	52.9	55.3	48.9	53.3	57.8	53.1	45.5	38.0						39.5	45.7	46.5	50.4	47.8	47.8	43.3	57.8	38.0	48.5
1997	21.5	23.9	23.9	25.9	28.5	25.0	27.4	38.7	35.7	36.9	37.3	28.4	23.7	28.0	33.9	36.5	39.7	45.0	50.0	51.4	50.1	53.9	51.9	42.6	43.1	52.3	55.4	52.8	55.8	56.5	53.6	56.5	21.5	39.7
1998	32.5	40.8	47.4	49.8	53.3	58.2	59.3	58.5	58.2	52.8	48.9	49.2	42.3	39.2	41.0	46.9	46.7	46.1	45.7	47.9	52.0	55.1	55.0	55.5	52.9	55.7	54.5	54.1	52.2	48.1	53.5	59.3	32.5	50.1
1999	34.6	39.0	48.6	46.8	51.0	54.8	52.3	53.3	54.6	52.6	40.9	42.3	45.0	55.5	53.8	51.4	51.2	56.2	49.5	49.2	53.7	57.1	57.6	53.4	52.5	52.9	53.8	55.4	56.5	51.9	51.4	57.6	34.6	50.9
2000																																		
2001	41.8	43.1	44.1	40.0	38.0	50.3	51.1	50.0	48.9	50.3		50.3	52.9	51.6	52.9	42.9	47.7	47.2	43.7	49.0	48.8	40.6	39.0	44.8	49.2	54.0	45.3	44.4	48.4	52.7	54.1	54.1	38.0	47.2
2002	30.0	28.6	37.8	31.2	33.1	39.5	44.2	47.9	32.2	51.7	48.7	40.4	37.5	42.8	46.6	48.3	50.3	53.0	50.9	50.3	42.6	52.0	53.1	51.8	51.2	53.5	56.0	46.8	38.8	40.0		56.0	28.6	44.4
2003	26.1	25.0	25.0	25.3	27.4	27.2	25.6	24.8	24.9	27.1	38.0	38.5	37.4	36.3	39.8	41.6	39.2	45.8	46.5	50.3	50.2	44.5	46.0	47.4	47.4	50.3	55.9	54.2	48.5	52.0	52.6	55.9	24.8	39.4
2004	11.9	8.5	8.8	10.6	16.5	22.0	21.4	28.7	40.2	39.9	39.6	45.3	47.4	49.4	49.0	50.1	47.7	46.0	45.9	43.9	38.2	39.8	48.1	46.5	43.6	47.0	49.0	44.8	40.2	33.4	35.1	50.1	8.5	36.7
2005	11.4	15.7	19.1	17.4	19.3	23.1	26.4	32.9	27.1	20.0	19.4	24.2	35.9	34.6	36.5	39.7	42.5	35.1	36.8	38.7	39.5	44.6	49.5	52.3	57.6	47.8	49.0	43.9	40.7	42.1	46.0	57.6	11.4	34.5
2006	38.8	40.8	43.4	42.0	49.4	53.8	55.9	54.8	53.6	46.5	42.1	37.7	31.7	25.7	35.6	37.4	41.8	44.0	48.3	45.3	49.8	51.1	45.8	47.4	49.2	53.7	51.7	52.4	53.8	57.5	57.1	57.5	25.7	46.4
2007	9.0	5.8	10.5	28.5	42.1	48.7	41.7	35.0	29.4	35.7	44.6	47.4	41.3	39.1	39.3	41.0	41.2	45.7	48.4	51.1	52.8	56.8	54.4	50.7	49.5	52.3	53.8	54.5	53.3	54.3	53.3	56.8	5.8	42.3
2008	39.4	37.3	36.9	41.5	45.2	49.0	46.6	40.4	45.7	46.1	56.0	55.4	53.2	55.8	54.4	51.5	48.4	45.7	50.4	54.4	55.3	55.6	56.9	52.1	52.2	57.0	58.0	51.5	42.7	42.8	41.8	58.0	36.9	49.0

Table A-5: Daily Dew Point Temperature (Tdew) Filled (F), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	42.2	37.9	33.6	38.8	43.1	47.4	47.4	39.6	47.4	51.7	50.8	50.8	50.0	48.2	47.4	48.2	47.4	44.8	46.5	50.8	49.1	49.1	49.1	50.0	49.1	46.5	43.9	43.9	44.8	45.7	44.8	51.7	33.6	46.1
1950	40.5	36.2	39.6	44.8	45.7	48.2	51.7	51.7	49.1	49.1	50.0	48.2	46.5	43.9	43.9	41.4	41.4	45.7	42.2	40.5	46.5	45.7	45.7	46.5	44.8	45.7	47.4	44.8	44.8	46.5	48.2	51.7	36.2	45.4
1951	38.8	30.2	20.7	32.8	36.2	31.9	32.8	26.7	22.4	29.3	32.8	42.2	48.2	47.4	44.8	41.4	42.2	41.4	44.8	42.2	41.4	45.7	47.4	47.4	47.4	45.7	44.8	41.4	42.2	45.7	49.1	49.1	20.7	39.6
1952	39.6	35.3	43.9	47.4	46.5	50.8	50.0	43.1	47.4	45.7	42.2	43.1	44.8	47.4	46.5	44.8	37.1	37.9	42.2	37.1	38.8	40.5	43.9	44.8	42.2	45.7	41.4	47.4	45.7	44.8	45.7	50.8	35.3	43.7
1953	41.4	40.5	46.5	43.1	42.2	44.8	43.9	42.2	44.8	42.2	45.7	49.1	46.5	42.2	43.9	50.0	50.8	53.4	52.5	47.4	44.8	44.8	43.1	43.1	43.1	45.7	45.7	43.9	46.5	47.4	50.8	53.4	40.5	45.6
1954	43.1	44.8	46.5	43.1	41.4	38.8	43.9	49.1	45.7	40.5	42.2	37.9	35.3	37.1	37.1	39.6	42.2	45.7	49.1	47.4	48.2	50.8	50.8	50.0	45.7	43.1	43.9	43.1	46.5	43.1	47.4	50.8	35.3	44.0
1955	20.7	20.7	28.5	42.2	42.2	43.9	41.4	33.6	37.9	42.2	48.2	50.0	49.1	44.8	41.4	45.7	45.7	42.2	42.2	46.5	49.1	51.7	50.8	48.2	49.1	50.0	54.3	50.8	49.1	50.0	46.5	54.3	20.7	43.8
1956	39.6	43.1	35.3	28.5	35.3	37.1	33.6	31.9	37.9	38.8	40.5	43.9	43.9	45.7	43.1	40.5	43.1	43.9	48.2	43.9	42.2	39.6	43.9	42.2	42.2	41.4	42.2	47.4	48.2	48.2	50.8	50.8	28.5	41.5
1957	33.6	29.3	34.5	36.2	46.5	38.8	40.5	44.8	38.8	39.6	44.8	46.5	46.5	46.5	50.0	49.1	45.7	49.1	50.0	50.8	43.9	47.4	50.0	50.8	51.7	52.5	50.8	47.4	48.2	48.2	48.2	52.5	29.3	45.2
1958	43.1	44.8	42.2	33.6	37.9	42.2	36.2	38.8	36.2	33.6	35.3	43.1	33.6	36.2	40.5	49.1	48.2	47.4	43.1	31.9	31.0	31.9	29.3	40.5	42.2	44.8	38.8	45.7	48.2	45.7	39.6	49.1	29.3	39.8
1959	42.2	43.9	47.4	41.4	37.9	40.5	46.5	43.1	40.5	40.5	40.5	37.9	37.9	41.4	43.9	43.1	40.5	41.4	43.1	41.4	43.1	43.9	44.8	43.9	43.9	45.7	47.4	47.4	48.2	47.4	47.4	48.2	37.9	43.2
1960	40.5	37.9	39.6	43.1	48.2	50.0	49.1	51.7	52.5	47.4	40.5	41.4	43.9	45.7	43.9	40.5	37.9	37.9	38.8	39.6	39.6	43.1	41.4	43.9	46.5	45.7	43.1	37.9	43.9	51.7	52.5	52.5	37.9	43.9
1961	43.1	44.8	45.7	46.5	42.2	43.9	45.7	47.4	49.1	50.0	45.7	43.9	43.1	39.6	40.5	36.2	37.9	37.1	39.6	40.5	41.4	40.5	41.4	37.9	37.9	43.9	43.9	46.5	42.2	39.6	43.1	50.0	36.2	42.6
1962	44.8	42.2	43.1	43.9	49.1	50.0	45.7	47.4	46.5	39.6	40.5	48.2	42.2	26.7	24.2	37.9	43.9	43.9	47.4	46.5	50.0	48.2	48.2	47.4	46.5	46.5	43.1	43.9	47.4	47.4	48.2	50.0	24.2	44.2
1963	36.2	37.1	41.4	47.4	45.7	43.9	45.7	50.0	48.2	46.5	46.5	44.8	37.9	37.1	33.6	41.4	43.9	43.1	44.8	47.4	42.2	40.5	40.5	37.9	41.4	40.5	37.1	42.2	43.9	42.2	43.1	50.0	33.6	42.4
1964	37.1	32.8	31.9	32.8	35.3	34.5	40.5	46.5	47.4	45.7	50.0	50.0	46.5	46.5	43.9	44.8	46.5	43.9	45.7	46.5	43.9	45.7	49.1	46.5	44.8	48.2	48.2	48.2	50.0	50.0	50.8	50.8	31.9	44.3
1965	43.9	39.6	41.4	38.8	36.2	39.6	43.1	43.9	38.8	43.1	45.7	44.8	43.9	46.5	48.2	48.2	45.7	46.5	46.5	45.7	48.2	43.9	45.7	42.2	44.8	50.0	48.2	49.1	47.4	45.7	48.2	50.0	36.2	44.6
1966	44.8	41.4	36.2	31.9	38.8	38.8	38.8	39.6	39.6	46.5	47.4	46.5	46.5	48.2	48.2	50.0	50.0	48.2	49.1	52.5	49.1	43.9	48.2	46.5	45.7	49.1	51.7	50.8	50.8	50.8	48.2	52.5	31.9	45.8
1967	32.8	38.8	40.5	37.1	37.1	40.5	43.1	43.1	37.9	40.5	41.4	43.9	40.5	37.9	37.1	43.9	46.5	41.4	44.8	43.9	45.7	44.8	42.2	45.7	48.2	50.0	45.7	46.5	48.2	46.5	47.4	50.0	32.8	42.7
1968	19.0	43.9	46.5	48.2	48.2	49.1	48.2	43.9	46.5	47.4	44.8	43.1	41.4	38.8	34.5	28.5	29.3	37.9	44.8	44.8	45.7	47.4	51.7	52.5	53.4	50.8	49.1	50.0	48.2	47.4	51.7	53.4	19.0	44.4
1969	43.9	39.6	36.2	38.8	38.8	41.4	41.4	39.6	50.0	49.1	50.0	48.2	45.7	44.8	45.7	49.1	50.8	48.2	48.2	44.8	46.5	47.4	47.4	48.2	51.7	48.2	48.2	44.8	42.2	43.9	48.2	51.7	36.2	45.5
1970	46.5	43.9	43.1	43.1	37.1	42.2	50.0	48.2	46.5	42.2	39.6	38.8	37.1	40.5	46.5	47.4	44.8	45.7	49.1	51.7	51.7	50.8	51.7	51.7	50.8	48.2	48.2	52.5	50.8	44.8	48.2	52.5	37.1	46.2
1971	45.7	45.7	37.9	29.3	30.2	37.9	41.4	45.7	43.9	37.1	35.3	33.6	31.9	31.0	30.2	36.2	35.3	35.3	43.9	50.0	50.8	49.1	49.1	46.5	44.8	46.5	48.2	44.8	43.9	46.5	47.4	50.8	29.3	41.1
1972	35.3	32.8	38.8	46.5	46.5	43.9	38.8	39.6	42.2	43.9	41.4	42.2	38.8	36.2	44.8	44.8	42.2	46.5	45.7	44.8	47.4	46.5	47.4	48.2	50.0	48.2	45.7	40.5	46.5	38.8	35.3	50.0	32.8	42.9
1973	47.0	42.0	47.0	48.0	42.0	44.0	52.0	56.0	54.0	54.0	50.0	50.0	55.0	55.0	55.0	55.0	56.0	54.0	48.0	42.0	42.0	43.0	37.0	37.0	39.0	46.0	45.0	51.0	51.0	49.0	47.0	56.0	37.0	48.2
1974	36.0	39.0	32.0	28.0	42.0	49.0	50.0	45.0	37.0	27.0	25.0	28.0	45.0	54.0	55.0	55.0	54.0	50.0	50.0	51.0	54.0	50.0	50.0	46.0	46.0	45.0	46.0	46.0	45.0	49.0	49.0	55.0	25.0	44.5
1975	32.0	51.0	49.0	47.0	48.0	52.0	52.0	53.0	54.0	58.0	57.0	56.0	55.0	54.0	53.0	54.0	55.0	51.0	47.0	47.0	47.0	48.0	42.0	45.0	47.0	47.0	47.0	52.0	54.0	49.0	45.0	58.0	32.0	49.9
1976	47.0	33.0	25.0	30.0	33.0	38.0	39.0	41.0	42.0	43.0	47.0	49.0	55.0	51.0	47.0	52.0	50.0	53.0	57.0	52.0	49.0	50.0	48.0	49.0	52.0	53.0	52.0	51.0	51.0	55.0	54.0	57.0	25.0	46.7
1977	44.0	41.0	46.0	55.0	49.0	39.0	30.0	34.0	41.0	42.0	48.0	49.0	51.0	49.0	50.0	50.0	52.0	53.0	54.0	55.0	56.0	57.0	56.0	57.0	54.0	53.0	51.0	50.0	44.0	47.0	37.0	57.0	30.0	48.2
1978	19.0	15.0	17.0	19.0	20.0	12.0	29.0	44.0	45.0	46.0	50.0	45.0	42.0	45.0	43.0	42.0	45.0	48.0	46.0	42.0	44.0	35.0	48.0	52.0	51.0	48.0	42.0	44.0	42.0	43.0	43.0	52.0	12.0	38.9
1979	45.0	42.0	39.0	33.0	34.0	37.0	37.0	31.0	20.0	21.0	19.0	24.0	29.0	35.0	40.0	49.0	53.0	50.0	47.0	49.0	50.0	42.0	30.0	37.0	31.0	34.0	44.0	47.0	48.0	37.0	35.0	53.0	19.0	37.7
1980	49.0	42.0	36.0	24.0	24.0	36.0	48.0	51.0	43.0	48.0	47.0	49.0	51.0	43.0	38.0	30.0	35.0	43.0	50.0	47.0	45.0	46.0	47.0	49.0	49.0	49.0	43.0	48.0	51.0	51.0	48.0	51.0	24.0	43.9
1981	56.0	49.0	44.0	39.0	39.0	42.0	50.0	54.0	58.0	58.0	57.0	57.0	57.0	55.0	57.0	54.0	54.0	52.0	49.0	40.0	45.0	46.0	50.0	52.0	54.0	49.0	47.0	47.0	43.0	45.0	54.0	58.0	39.0	50.1
1982	45.0	32.0	31.0	36.0	38.0	33.0	47.0	46.0	40.0	34.0	38.0	33.0	32.0	35.0	40.0	50.0	55.0	55.0	51.0	52.0	50.0	52.0	50.0	46.0	49.0	52.0	56.0	57.0	56.0	56.0	49.0	57.0	31.0	45.0
1983	24.0	25.0	28.0	35.0	44.0	46.0	49.0	55.0	52.0	51.0	48.0	47.0	44.0	42.0	45.0	42.0	42.0	52.0	53.0	53.0	53.0	55.0	55.0	58.0	55.0	55.0	55.0	54.0	53.0	55.0	54.0	58.0	24.0	47.7
1984	48.0	46.5	37.7	31.0	35.5	42.3	46.6	48.3	47.3	47.1	49.3	52.9	55.4	50.1	51.5	56.0	52.6	48.6	49.5	49.9	49.2	53.4	55.1	49.7	46.5	43.8	47.1	49.3	51.9	47.8	43.9	56.0	31.0	47.9
1985	25.0	31.6	32.9	28.8	28.7	34.8	39.4	40.8	41.5	44.5	47.6	45.3	46.3	47.3	49.3	52.4	53.0	52.5	54.5	52.3	51.9	54.9	54.2	46.5	45.2	46.5	47.8	54.3	54.0	54.7	50.8	54.9	25.0	45.5
1986	50.2	47.8	49.3	55.8	46.1	37.9	45.4	52.3	52.4	43.7	37.9	41.3	40.3	49.0	54.5	55.4	51.6	53.5	54.5	53.8	52.5	52.7	52.3	46.1	43.5	40.5	34.1	30.6	35.1	37.0	39.8	55.8	30.6	46.4
1987	21.8	16.1	17.8	20.2	19.3	24.3	26.6	23.8	28.5	24.9	25.3	29.9	36.5	37.7	37.2	48.3	39.1	36.7	33.6	45.3	53.3	48.8	36.6	47.8	52.3	51.8	55.4	56.8	58.2	57.0	57.8	58.2	16.1	37.7
1988	50.3	49.2	48.4	45.6	50.3	46.7	42.0	46.8	50.0	45.0	48.7	45.8	36.8	44.8	43.9	42.1	44.3	43.7	43.7	47.7	43.3	41.9	38.5	42.4	44.2	44.5	46.7	49.0	52.0	52.0	54.2	54.2	36.8	46.0
1989	19.0	18.5	18.5	17.7	30.5	37.2	33.6	27.0	40.5	47.9	49.8	43.4	36.8	31.6	30.5	44.0	42.9	27.8	38.8	44.7	44.3	50.2	56.2	54.8	52.5	52.7	54.3	52.5	51.3	50.8	54.0	56.2	17.7	40.5
1990	35.6	40.9	48.8	49.2	55.7	52.7	55.3	55.1	55.2	54.9	55.9	50.1	52.8	56.5	46.7	47.5	50.5	50.2	53.0	50.8	47.1	41.4	45.8	49.7	46.2	40.7	34.0	30.6	38.4	41.4	40.3	56.5	30.6	47.5
1991	27.4	32.4	37.7	43.6	41.5	41.9	47.7	50.8	44.0	41.2	43.0	47.5	45.1	46.9	49.6	49.8	51.6	53.1	53.5	53.4	52.8	50.3	50.4	51.4	51.9	47.9	43.5	43.7	46.1	48.6	53.9	53.9	27.4	46.5
1992	24.3	23.2	21.8	29.5	29.8	33.1	44.0	47.5	47.6	51.4	53.0	52.3	47.2	45.5	41.0	39.1	45.2	44.3	46.3	42.0	43.3	47.3	55.0	56.5	56.5	50.6	43.0	42.2	45.4	42.8	45.6	56.5	21.8	43.1
1993	30.7	33.3	41.0	40.0	33.4	35.3	31.0	33.4	39.0	45.0	44.2	49.1	48.4	44.0	35.6	45.4	31.9	29.9	33.3	31.3	23.3	28.8	30.5	30.4	28.5	25.3	26.5	35.1	48.6	50.8	45.5	50.8	23.3	36.4
1994	36.9	39.7	34.8	26.6	29.8	25.5	19.0	26.0	28.3	28.0	27.8	19.3	20.5	21.9	16.6	18.9	36.0	46.8	46.3	44.2	48.9	48.4	50.9	50.6	52.2	46.7	47.6	46.2	48.1	52.3	50.6	52.3	16.6	36.6
1995	36.0	31.0	26.0	37.0	27.3	23.8	30.4	34.0	31.3	30.1	25.5	27.8	45.4	47.8	44.7	53.0	53.2	54.3	50.3	41.4	40.8	26.5	17.7	21.9	22.3	20.2	24.1	25.0	27.4	33.2	36.1	54.3	17.7	33.7
1996	44.9	43.7	44.4	43.5	44.2	46.5	52.4	55.2	55.5	53.0	51.2	52.9	55.3	48.9	53.3	57.8	53.1	45.5	38.0	41.7	36.7	38.3	42.0	42.1	39.5	45.7	46.5	50.4	47.8	47.8	43.3	57.8	36.7	47.1
1997	21.5	23.9	23.9	25.9	28.5	25.0	27.4	38.7	35.7	36.9	37.3	28.4	23.7	28.0	33.9	36.5	39.7	45.0	50.0	51.4	50.1	53.9	51.9	42.6	43.1	52.3	55.4	52.8	55.8	56.5	53.6	56.5	21.5	39.7
1998	32.5	40.8	47.4	49.8	53.3	58.2	59.3	58.5	58.2	52.8	48.9	49.2	42.3	39.2	41.0	46.9	46.7	46.1	45.7	47.9	52.0	55.1	55.0	55.5	52.9	55.7	54.5	54.1	52.2	48.1	53.5	59.3	32.5	50.1
1999	34.6	39.0	48.6	46.8	51.0	54.8	52.3	53.3	54.6	52.6	40.9	42.3	45.0	55.5	53.8	51.4	51.2	56.2	49.5	49.2	53.7	57.1	57.6	53.4	52.5	52.9	53.8	55.4	56.5	51.9	51.4	57.6	34.6	50.9
2000	48.1	43.5	39.6	29.5	32.6	38.7	41.4	44.1	46.1	44.5	45.1	48.8	48.3	50.7	45.0	44.1	45.1	43.8	43.5	40.6	41.5	39.6	41.5	39.8	41.2	46.4	44.6	42.1	45.2	44.1	42.2	50.7	29.5	42.9
2001	41.8	43.1	44.1	40.0	38.0	50.3	51.1	50.0	48.9	50.3	43.4	50.3	52.9	51.6	52.9	42.9	47.7	47.2	43.7	49.0	48.8	40.6	39.0	44.8	49.2	54.0	45.3	44.4	48.4	52.7	54.1	54.1	38.0	47.1
2002	30.0	28.6	37.8	31.2	33.1	39.5	44.2	47.9	32.2	51.7	48.7	40.4	37.5	42.8	46.6	48.3	50.3	53.0	50.9	50.3	42.6	52.0	53.1	51.8	51.2	53.5	56.0	46.8	38.8	40.0	41.0	56.0	28.6	44.3
2003	26.1	25.0	25.0	25.3	27.4	27.2	25.6	24.8	24.9	27.1	38.0	38.5	37.4	36.3	39.8	41.6	39.2	45.8	46.5	50.3	50.2	44.5	46.0	47.4	47.4	50.3	55.9	54.2	48.5	52.0	52.6	55.9	24.8	39.4
2004	11.9	8.5	8.8	10.6	16.5	22.0	21.4	28.7	40.2	39.9	39.6	45.3	47.4	49.4	49.0	50.1	47.7	46.0	45.9	43.9	38.2	39.8	48.1	46.5	43.6	47.0	49.0	44.8	40.2	33.4	35.1	50.1	8.5	36.7
2005	11.4	15.7	19.1	17.4	19.3	23.1	26.4	32.9	27.1	20.0	19.4	24.2	35.9	34.6	36.5	39.7	42.5	35.1	36.8	38.7	39.5	44.6	49.5	52.3	57.6	47.8	49.0	43.9	40.7	42.1	46.0	57.6	11.4	34.5
2006	38.8	40.8	43.4	42.0	49.4	53.8	55.9	54.8	53.6	46.5	42.1	37.7	31.7	25.7	35.6	37.4	41.8	44.0	48.3	45.3	49.8	51.1	45.8	47.4	49.2	53.7	51.7	52.4	53.8	57.5	57.1	57.5	25.7	46.4
2007	9.0	5.8	10.5	28.5	42.1	48.7	41.7	35.0	29.4	35.7	44.6	47.4	41.3	39.1	39.3	41.0	41.2	45.7	48.4	51.1	52.8	56.8	54.4	50.7	49.5	52.3	53.8	54.5	53.3	54.3	53.3	56.8	5.8	42.3
2008	39.4	37.3	36.9	41.5	45.2	49.0	46.6	40.4	45.7	46.1	56.0	55.4	53.2	55.8	54.4	51.5	48.4	45.7	50.4	54.4	55.3	55.6	56.9	52.1	52.2	57.0	58.0	51.5	42.7	42.8	41.8	58.0	36.9	49.0

Table A-7: Daily Total Sky Cover (Tskc) Raw Data (%), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
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1973	30.0	40.0	50.0	20.0	10.0	60.0	80.0	70.0	30.0	50.0	40.0	40.0	80.0	90.0	80.0	100.0	100.0	80.0	20.0	10.0	10.0	10.0	0.0	0.0	10.0	30.0	50.0	80.0	40.0	60.0	30.0	100.0	0.0	45.2
1974	20.0	20.0	20.0	20.0	40.0	50.0	90.0	50.0	20.0	10.0	20.0	40.0	70.0	80.0	90.0	90.0	70.0	50.0	50.0	60.0	80.0	40.0	50.0	40.0	30.0	60.0	60.0	50.0	30.0	30.0	60.0	90.0	10.0	48.1
1975	10.0	60.0	40.0	60.0	60.0	70.0	50.0	70.0	80.0	70.0	80.0	70.0	60.0	50.0	50.0	90.0	60.0	30.0	20.0	60.0	20.0	30.0	20.0	40.0	20.0	30.0	40.0	80.0	80.0	30.0	10.0	90.0	10.0	49.7
1976	40.0	10.0	0.0	30.0	20.0	60.0	30.0	50.0	30.0	50.0	50.0	50.0	80.0	70.0	20.0	60.0	40.0	60.0	80.0	50.0	70.0	70.0	50.0	50.0	70.0	70.0	50.0	40.0	30.0	30.0	70.0	80.0	0.0	47.7
1977	70.0	30.0	80.0	90.0	70.0	30.0	10.0	30.0	20.0	40.0	90.0	80.0	60.0	80.0	60.0	70.0	50.0	70.0	50.0	70.0	80.0	80.0	60.0	90.0	50.0	60.0	40.0	40.0	40.0	40.0	30.0	90.0	10.0	56.8
1978	0.0	0.0	0.0	10.0	0.0	0.0	30.0	70.0	60.0	70.0	60.0	50.0	40.0	60.0	50.0	50.0	50.0	60.0	50.0	50.0	80.0	40.0	80.0	80.0	60.0	30.0	40.0	40.0	30.0	30.0	40.0	80.0	0.0	42.3
1979	50.0	30.0	60.0	40.0	20.0	40.0	10.0	40.0	20.0	10.0	30.0	10.0	10.0	30.0	50.0	70.0	50.0	70.0	20.0	70.0	50.0	30.0	0.0	40.0	0.0	20.0	40.0	70.0	60.0	10.0	20.0	70.0	0.0	34.5
1980	70.0	20.0	0.0	0.0	0.0	70.0	70.0	40.0	60.0	70.0	20.0	40.0	50.0	20.0	10.0	10.0	20.0	30.0	60.0	60.0	40.0	60.0	70.0	50.0	50.0	60.0	70.0	70.0	60.0	50.0	40.0	70.0	0.0	43.2
1981	70.0	20.0	20.0	0.0	10.0	30.0	50.0	80.0	80.0	80.0	60.0	90.0	70.0	60.0	70.0	50.0	50.0	20.0	10.0	20.0	40.0	70.0	70.0	40.0	40.0	60.0	30.0	40.0	40.0	50.0	90.0	90.0	0.0	48.7
1982	20.0	0.0	0.0	40.0	40.0	60.0	70.0	30.0	30.0	10.0	20.0	10.0	10.0	0.0	30.0	50.0	80.0	60.0	50.0	80.0	70.0	60.0	40.0	40.0	60.0	60.0	70.0	80.0	80.0	70.0	30.0	80.0	0.0	43.5
1983	40.0	40.0	20.0	0.0	40.0	30.0	40.0	70.0	50.0	60.0	30.0	20.0	30.0	30.0	20.0	0.0	40.0	50.0	30.0	40.0	60.0	60.0	70.0	60.0	60.0	70.0	90.0	60.0	50.0	70.0	70.0	90.0	0.0	45.2
1984	80.0	50.0	20.0	0.0	30.0	50.0	60.0	70.0	70.0	70.0	70.0	90.0	90.0	70.0	50.0	70.0	50.0	30.0	30.0	30.0	40.0	80.0	90.0	60.0	70.0	60.0	40.0	40.0	70.0	30.0	30.0	90.0	0.0	54.5
1985	0.0	20.0	0.0	20.0	30.0	30.0	70.0	80.0	70.0	40.0	50.0	50.0	60.0	70.0	50.0	90.0	80.0	60.0	80.0	60.0	40.0	70.0	60.0	40.0	30.0	30.0	50.0	80.0	70.0	60.0	80.0	90.0	0.0	52.3
1986	60.0	40.0	60.0	90.0	50.0	30.0	90.0	70.0	60.0	40.0	0.0	20.0	40.0	80.0	70.0	100.0	70.0	60.0	60.0	100.0	80.0	80.0	80.0	20.0	20.0	20.0	50.0	20.0	20.0	0.0	20.0	100.0	0.0	51.6
1987	60.0	0.0	0.0	0.0	20.0	0.0	30.0	20.0	50.0	10.0	20.0	10.0	40.0	30.0	30.0	80.0	30.0	10.0	0.0	60.0	60.0	50.0	10.0	60.0	60.0	40.0	60.0	70.0	90.0	70.0	80.0	90.0	0.0	37.1
1988	90.0	70.0	60.0	50.0	70.0	30.0	40.0	50.0	90.0	40.0	40.0	30.0	40.0	50.0	30.0	30.0	70.0	70.0	50.0	60.0	20.0	20.0	60.0	90.0	40.0	60.0	90.0	80.0	90.0	80.0	90.0	90.0	20.0	57.4
1989	0.0	0.0	10.0	0.0	20.0	30.0	20.0	20.0	50.0	50.0	60.0	20.0	50.0	20.0	40.0	40.0	20.0	10.0	40.0	40.0	50.0	60.0	90.0	50.0	50.0	90.0	80.0	60.0	60.0	40.0	60.0	90.0	0.0	39.7
1990	20.0	60.0	70.0	50.0	100.0	100.0	70.0	70.0	90.0	50.0	80.0	30.0	60.0	90.0	40.0	50.0	50.0	60.0	30.0	40.0	50.0	20.0	50.0	70.0	20.0	0.0	10.0	30.0	40.0	40.0	30.0	100.0	0.0	50.6
1991	0.0	10.0	0.0	20.0	20.0	30.0	70.0	60.0	30.0	30.0	50.0	50.0	30.0	40.0	60.0	60.0	60.0	60.0	80.0	70.0	80.0	60.0	70.0	70.0	50.0	50.0	20.0	40.0	70.0	80.0	80.0	80.0	0.0	48.4
1992	0.0	0.0	50.0	20.0	0.0	10.0	70.0	80.0	60.0	90.0	90.0	80.0	30.0	60.0	60.0	30.0	50.0	50.0	30.0	40.0	20.0	50.0	90.0	100.0	90.0	40.0	20.0	20.0	30.0	50.0	60.0	100.0	0.0	47.4
1993	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	20.0	20.0	40.0	80.0	60.0	30.0	20.0	40.0	10.0	40.0	60.0	30.0	10.0	10.0	10.0	0.0	0.0	20.0	0.0	40.0	60.0	60.0	60.0	80.0	0.0	23.5
1994	90.0	60.0	10.0	30.0	10.0	20.0	0.0	20.0	30.0	30.0	20.0	0.0	10.0	10.0	30.0	60.0	90.0	80.0	40.0	20.0	80.0	80.0	60.0	80.0	90.0	70.0	60.0	60.0	50.0	50.0	80.0	90.0	0.0	45.8
1995	50.0	50.0	40.0	30.0	0.0	20.0	50.0	40.0	30.0	10.0	10.0	40.0	60.0	90.0	70.0	100.0	90.0	100.0	60.0	30.0	60.0	0.0	0.0	0.0	0.0	10.0	10.0	30.0	60.0	60.0	50.0	100.0	0.0	40.3
1996	30.0	40.0	40.0	30.0	30.0	50.0	70.0	80.0	80.0	70.0	50.0	70.0	80.0	40.0	80.0	80.0	50.0	20.0	20.0	20.0	40.0	10.0	10.0	30.0	60.0	60.0	90.0	90.0	50.0	80.0	70.0	90.0	10.0	52.3
1997	0.0	10.0	10.0	10.0	10.0	20.0	20.0	70.0	60.0	50.0	60.0	0.0	10.0	40.0	40.0	60.0	70.0	70.0	90.0	80.0	80.0	90.0	50.0	30.0	80.0	100.0	90.0	100.0	100.0	100.0	60.0	100.0	0.0	53.5
1998																																		
1999	10.0	70.0	70.0	60.0	40.0	50.0	60.0	80.0	90.0	90.0	30.0	60.0	80.0	90.0	70.0	40.0	90.0	100.0	80.0	40.0	100.0	90.0	80.0	50.0	50.0	60.0	60.0	70.0	70.0	40.0	50.0	100.0	10.0	65.2
2000	60.0	80.0	30.0	10.0	10.0	40.0	70.0	70.0	70.0	70.0	70.0	80.0	80.0	90.0	90.0	80.0	30.0	20.0	40.0	40.0	30.0	20.0	30.0	60.0	60.0	80.0	70.0	40.0	30.0	30.0	20.0	90.0	10.0	51.6
2001																																		
2002																																		
2003																																		
2004																																		
2005																																		
2006																																		
2007																																		
2008																																		

Table A-8: Daily Total Sky Cover (Tskc) Filled (%), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	31.1	23.0	23.0	31.1	39.2	63.6	39.2	31.1	79.8	87.9	79.8	79.8	63.6	31.1	23.0	14.9	47.3	47.3	55.4	47.3	55.4	63.6	55.4	39.2	63.6	23.0	23.0	6.8	14.9	47.3	55.4	87.9	6.8	44.7
1950	87.9	47.3	63.6	47.3	71.7	79.8	79.8	71.7	55.4	71.7	79.8	23.0	63.6	23.0	47.3	39.2	55.4	55.4	23.0	23.0	39.2	55.4	47.3	79.8	63.6	63.6	47.3	39.2	79.8	87.9	63.6	87.9	23.0	57.3
1951	14.9	6.8	6.8	23.0	47.3	31.1	31.1	14.9	47.3	39.2	47.3	63.6	79.8	63.6	39.2	14.9	23.0	71.7	79.8	39.2	39.2	71.7	55.4	47.3	39.2	55.4	31.1	39.2	55.4	47.3	71.7	79.8	6.8	43.1
1952	14.9	39.2	55.4	63.6	63.6	63.6	79.8	63.6	79.8	39.2	23.0	14.9	31.1	55.4	47.3	23.0	23.0	31.1	14.9	14.9	23.0	39.2	23.0	31.1	31.1	14.9	31.1	39.2	39.2	39.2	63.6	79.8	14.9	39.2
1953	31.1	47.3	47.3	39.2	47.3	71.7	31.1	31.1	39.2	23.0	47.3	71.7	31.1	39.2	39.2	55.4	79.8	55.4	31.1	39.2	23.0	63.6	14.9	14.9	14.9	23.0	23.0	23.0	47.3	55.4	79.8	79.8	14.9	41.3
1954	47.3	55.4	55.4	23.0	39.2	23.0	55.4	71.7	47.3	14.9	39.2	39.2	31.1	47.3	55.4	47.3	47.3	63.6	55.4	71.7	79.8	79.8	71.7	47.3	23.0	39.2	39.2	23.0	31.1	31.1	39.2	79.8	14.9	46.3
1955	6.8	14.9	31.1	47.3	23.0	47.3	31.1	6.8	31.1	39.2	71.7	55.4	63.6	39.2	31.1	47.3	39.2	31.1	63.6	63.6	55.4	39.2	71.7	55.4	63.6	71.7	79.8	55.4	63.6	31.1	23.0	79.8	6.8	45.0
1956	47.3	47.3	14.9	14.9	14.9	23.0	6.8	14.9	23.0	31.1	55.4	55.4	23.0	39.2	47.3	55.4	47.3	47.3	71.7	31.1	39.2	71.7	79.8	31.1	31.1	39.2	47.3	79.8	63.6	55.4	87.9	87.9	6.8	43.1
1957	14.9	14.9	31.1	47.3	71.7	23.0	31.1	47.3	39.2	55.4	55.4	63.6	63.6	39.2	63.6	55.4	47.3	47.3	71.7	55.4	6.8	39.2	71.7	71.7	79.8	63.6	39.2	14.9	39.2	55.4	63.6	79.8	6.8	47.9
1958	63.6	47.3	23.0	23.0	39.2	23.0	6.8	6.8	6.8	14.9	6.8	14.9	14.9	23.0	55.4	63.6	63.6	63.6	55.4	6.8	39.2	14.9	23.0	63.6	71.7	71.7	31.1	47.3	79.8	63.6	39.2	79.8	6.8	37.7
1959	31.1	31.1	55.4	63.6	31.1	31.1	55.4	23.0	39.2	23.0	14.9	39.2	47.3	55.4	55.4	47.3	14.9	23.0	31.1	23.0	31.1	39.2	31.1	31.1	47.3	63.6	31.1	39.2	39.2	47.3	23.0	63.6	14.9	37.4
1960	23.0	23.0	71.7	71.7	87.9	87.9	79.8	79.8	47.3	55.4	14.9	31.1	31.1	31.1	31.1	14.9	31.1	31.1	23.0	6.8	14.9	23.0	63.6	55.4	14.9	23.0	23.0	31.1	71.7	71.7	55.4	87.9	6.8	42.6
1961	39.2	63.6	47.3	63.6	71.7	47.3	55.4	39.2	39.2	23.0	23.0	23.0	39.2	39.2	23.0	14.9	39.2	63.6	23.0	47.3	47.3	6.8	14.9	31.1	23.0	14.9	39.2	39.2	23.0	23.0	39.2	71.7	6.8	36.3
1962	31.1	31.1	39.2	71.7	87.9	63.6	39.2	63.6	47.3	39.2	47.3	71.7	55.4	23.0	14.9	23.0	55.4	39.2	55.4	39.2	63.6	71.7	79.8	47.3	47.3	39.2	31.1	63.6	71.7	79.8	63.6	87.9	14.9	51.5
1963	14.9	39.2	39.2	63.6	39.2	31.1	55.4	63.6	71.7	47.3	47.3	47.3	23.0	23.0	23.0	31.1	23.0	63.6	71.7	47.3	14.9	23.0	14.9	31.1	47.3	31.1	79.8	63.6	14.9	14.9	31.1	79.8	14.9	39.7
1964	23.0	14.9	14.9	31.1	14.9	31.1	31.1	47.3	79.8	63.6	87.9	79.8	23.0	23.0	55.4	39.2	55.4	39.2	63.6	47.3	47.3	39.2	55.4	39.2	39.2	71.7	55.4	63.6	55.4	55.4	71.7	87.9	14.9	47.1
1965	63.6	47.3	31.1	14.9	31.1	47.3	79.8	55.4	31.1	63.6	39.2	39.2	71.7	63.6	71.7	63.6	39.2	31.1	31.1	47.3	31.1	79.8	55.4	39.2	47.3	63.6	79.8	79.8	47.3	6.8	63.6	79.8	6.8	50.2
1966	14.9	23.0	23.0	14.9	14.9	47.3	63.6	55.4	39.2	87.9	79.8	79.8	55.4	39.2	39.2	31.1	31.1	55.4	55.4	79.8	39.2	31.1	47.3	31.1	55.4	71.7	79.8	79.8	71.7	63.6	63.6	87.9	14.9	50.5
1967	6.8	23.0	14.9	47.3	55.4	63.6	71.7	63.6	63.6	63.6	47.3	71.7	55.4	31.1	39.2	87.9	79.8	14.9	31.1	31.1	31.1	47.3	39.2	71.7	55.4	71.7	71.7	71.7	63.6	55.4	71.7	87.9	6.8	52.0
1968	6.8	55.4	71.7	87.9	87.9	79.8	47.3	71.7	39.2	39.2	39.2	31.1	55.4	63.6	6.8	14.9	23.0	31.1	39.2	14.9	31.1	71.7	71.7	71.7	63.6	47.3	47.3	39.2	23.0	39.2	87.9	87.9	6.8	48.4
1969	47.3	14.9	23.0	39.2	31.1	23.0	23.0	63.6	87.9	71.7	63.6	63.6	39.2	47.3	55.4	71.7	79.8	87.9	47.3	55.4	63.6	71.7	55.4	63.6	71.7	63.6	55.4	39.2	23.0	63.6	63.6	87.9	14.9	53.9
1970	79.8	55.4	47.3	63.6	31.1	71.7	79.8	79.8	47.3	23.0	31.1	39.2	6.8	23.0	47.3	55.4	31.1	39.2	71.7	39.2	87.9	71.7	71.7	71.7	71.7	47.3	63.6	71.7	63.6	23.0	39.2	87.9	6.8	53.1
1971	63.6	71.7	14.9	14.9	63.6	87.9	79.8	79.8	39.2	31.1	39.2	14.9	6.8	23.0	23.0	55.4	23.0	47.3	71.7	79.8	71.7	63.6	47.3	23.0	47.3	39.2	23.0	6.8	14.9	39.2	39.2	87.9	6.8	43.4
1972	23.0	31.1	14.9	55.4	55.4	39.2	63.6	55.4	63.6	47.3	23.0	31.1	14.9	6.8	31.1	79.8	63.6	71.7	71.7	71.7	55.4	79.8	47.3	39.2	71.7	31.1	39.2	6.8	14.9	63.6	63.6	79.8	6.8	46.0
1973	30.0	40.0	50.0	20.0	10.0	60.0	80.0	70.0	30.0	50.0	40.0	40.0	80.0	90.0	80.0	100.0	100.0	80.0	20.0	10.0	10.0	10.0	0.0	0.0	10.0	30.0	50.0	80.0	40.0	60.0	30.0	100.0	0.0	45.2
1974	20.0	20.0	20.0	20.0	40.0	50.0	90.0	50.0	20.0	10.0	20.0	40.0	70.0	80.0	90.0	90.0	70.0	50.0	50.0	60.0	80.0	40.0	50.0	40.0	30.0	60.0	60.0	50.0	30.0	30.0	60.0	90.0	10.0	48.1
1975	10.0	60.0	40.0	60.0	60.0	70.0	50.0	70.0	80.0	70.0	80.0	70.0	60.0	50.0	50.0	90.0	60.0	30.0	20.0	60.0	20.0	30.0	20.0	40.0	20.0	30.0	40.0	80.0	80.0	30.0	10.0	90.0	10.0	49.7
1976	40.0	10.0	0.0	30.0	20.0	60.0	30.0	50.0	30.0	50.0	50.0	50.0	80.0	70.0	20.0	60.0	40.0	60.0	80.0	50.0	70.0	70.0	50.0	50.0	70.0	70.0	50.0	40.0	30.0	30.0	70.0	80.0	0.0	47.7
1977	70.0	30.0	80.0	90.0	70.0	30.0	10.0	30.0	20.0	40.0	90.0	80.0	60.0	80.0	60.0	70.0	50.0	70.0	50.0	70.0	80.0	80.0	60.0	90.0	50.0	60.0	40.0	40.0	40.0	40.0	30.0	90.0	10.0	56.8
1978	0.0	0.0	0.0	10.0	0.0	0.0	30.0	70.0	60.0	70.0	60.0	50.0	40.0	60.0	50.0	50.0	50.0	60.0	50.0	50.0	80.0	40.0	80.0	80.0	60.0	30.0	40.0	40.0	30.0	30.0	40.0	80.0	0.0	42.3
1979	50.0	30.0	60.0	40.0	20.0	40.0	10.0	40.0	20.0	10.0	30.0	10.0	10.0	30.0	50.0	70.0	50.0	70.0	20.0	70.0	50.0	30.0	0.0	40.0	0.0	20.0	40.0	70.0	60.0	10.0	20.0	70.0	0.0	34.5
1980	70.0	20.0	0.0	0.0	0.0	70.0	70.0	40.0	60.0	70.0	20.0	40.0	50.0	20.0	10.0	10.0	20.0	30.0	60.0	60.0	40.0	60.0	70.0	50.0	50.0	60.0	70.0	70.0	60.0	50.0	40.0	70.0	0.0	43.2
1981	70.0	20.0	20.0	0.0	10.0	30.0	50.0	80.0	80.0	80.0	60.0	90.0	70.0	60.0	70.0	50.0	50.0	20.0	10.0	20.0	40.0	70.0	70.0	40.0	40.0	60.0	30.0	40.0	40.0	50.0	90.0	90.0	0.0	48.7
1982	20.0	0.0	0.0	40.0	40.0	60.0	70.0	30.0	30.0	10.0	20.0	10.0	10.0	0.0	30.0	50.0	80.0	60.0	50.0	80.0	70.0	60.0	40.0	40.0	60.0	60.0	70.0	80.0	80.0	70.0	30.0	80.0	0.0	43.5
1983	40.0	40.0	20.0	0.0	40.0	30.0	40.0	70.0	50.0	60.0	30.0	20.0	30.0	30.0	20.0	0.0	40.0	50.0	30.0	40.0	60.0	60.0	70.0	60.0	60.0	70.0	90.0	60.0	50.0	70.0	70.0	90.0	0.0	45.2
1984	80.0	50.0	20.0	0.0	30.0	50.0	60.0	70.0	70.0	70.0	70.0	90.0	90.0	70.0	50.0	70.0	50.0	30.0	30.0	30.0	40.0	80.0	90.0	60.0	70.0	60.0	40.0	40.0	70.0	30.0	30.0	90.0	0.0	54.5
1985	0.0	20.0	0.0	20.0	30.0	30.0	70.0	80.0	70.0	40.0	50.0	50.0	60.0	70.0	50.0	90.0	80.0	60.0	80.0	60.0	40.0	70.0	60.0	40.0	30.0	30.0	50.0	80.0	70.0	60.0	80.0	90.0	0.0	52.3
1986	60.0	40.0	60.0	90.0	50.0	30.0	90.0	70.0	60.0	40.0	0.0	20.0	40.0	80.0	70.0	100.0	70.0	60.0	60.0	100.0	80.0	80.0	80.0	20.0	20.0	20.0	50.0	20.0	20.0	0.0	20.0	100.0	0.0	51.6
1987	60.0	0.0	0.0	0.0	20.0	0.0	30.0	20.0	50.0	10.0	20.0	10.0	40.0	30.0	30.0	80.0	30.0	10.0	0.0	60.0	60.0	50.0	10.0	60.0	60.0	40.0	60.0	70.0	90.0	70.0	80.0	90.0	0.0	37.1
1988	90.0	70.0	60.0	50.0	70.0	30.0	40.0	50.0	90.0	40.0	40.0	30.0	40.0	50.0	30.0	30.0	70.0	70.0	50.0	60.0	20.0	20.0	60.0	90.0	40.0	60.0	90.0	80.0	90.0	80.0	90.0	90.0	20.0	57.4
1989	0.0	0.0	10.0	0.0	20.0	30.0	20.0	20.0	50.0	50.0	60.0	20.0	50.0	20.0	40.0	40.0	20.0	10.0	40.0	40.0	50.0	60.0	90.0	50.0	50.0	90.0	80.0	60.0	60.0	40.0	60.0	90.0	0.0	39.7
1990	20.0	60.0	70.0	50.0	100.0	100.0	70.0	70.0	90.0	50.0	80.0	30.0	60.0	90.0	40.0	50.0	50.0	60.0	30.0	40.0	50.0	20.0	50.0	70.0	20.0	0.0	10.0	30.0	40.0	40.0	30.0	100.0	0.0	50.6
1991	0.0	10.0	0.0	20.0	20.0	30.0	70.0	60.0	30.0	30.0	50.0	50.0	30.0	40.0	60.0	60.0	60.0	60.0	80.0	70.0	80.0	60.0	70.0	70.0	50.0	50.0	20.0	40.0	70.0	80.0	80.0	80.0	0.0	48.4
1992	0.0	0.0	50.0	20.0	0.0	10.0	70.0	80.0	60.0	90.0	90.0	80.0	30.0	60.0	60.0	30.0	50.0	50.0	30.0	40.0	20.0	50.0	90.0	100.0	90.0	40.0	20.0	20.0	30.0	50.0	60.0	100.0	0.0	47.4
1993	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	20.0	20.0	40.0	80.0	60.0	30.0	20.0	40.0	10.0	40.0	60.0	30.0	10.0	10.0	10.0	0.0	0.0	20.0	0.0	40.0	60.0	60.0	60.0	80.0	0.0	23.5
1994	90.0	60.0	10.0	30.0	10.0	20.0	0.0	20.0	30.0	30.0	20.0	0.0	10.0	10.0	30.0	60.0	90.0	80.0	40.0	20.0	80.0	80.0	60.0	80.0	90.0	70.0	60.0	60.0	50.0	50.0	80.0	90.0	0.0	45.8
1995	50.0	50.0	40.0	30.0	0.0	20.0	50.0	40.0	30.0	10.0	10.0	40.0	60.0	90.0	70.0	100.0	90.0	100.0	60.0	30.0	60.0	0.0	0.0	0.0	0.0	10.0	10.0	30.0	60.0	60.0	50.0	100.0	0.0	40.3
1996	30.0	40.0	40.0	30.0	30.0	50.0	70.0	80.0	80.0	70.0	50.0	70.0	80.0	40.0	80.0	80.0	50.0	20.0	20.0	20.0	40.0	10.0	10.0	30.0	60.0	60.0	90.0	90.0	50.0	80.0	70.0	90.0	10.0	52.3
1997	0.0	10.0	10.0	10.0	10.0	20.0	20.0	70.0	60.0	50.0	60.0	0.0	10.0	40.0	40.0	60.0	70.0	70.0	90.0	80.0	80.0	90.0	50.0	30.0	80.0	100.0	90.0	100.0	100.0	100.0	60.0	100.0	0.0	53.5
1998	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
1999	10.0	70.0	70.0	60.0	40.0	50.0	60.0	80.0	90.0	90.0	30.0	60.0	80.0	90.0	70.0	40.0	90.0	100.0	80.0	40.0	100.0	90.0	80.0	50.0	50.0	60.0	60.0	70.0	70.0	40.0	50.0	100.0	10.0	65.2
2000	60.0	80.0	30.0	10.0	10.0	40.0	70.0	70.0	70.0	70.0	70.0	80.0	80.0	90.0	90.0	80.0	30.0	20.0	40.0	40.0	30.0	20.0	30.0	60.0	60.0	80.0	70.0	40.0	30.0	30.0	20.0	90.0	10.0	51.6
2001	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2002	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2003	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2004	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2005	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2006	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2007	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3
2008	35.9	30.7	28.1	27.4	27.8	37.4	48.9	54.8	53.0	47.4	45.9	44.8	51.1	54.4	50.4	61.1	56.3	52.6	45.6	49.3	53.3	49.6	50.0	49.6	45.2	49.6	51.1	56.3	55.6	49.6	52.2	61.1	27.4	47.3

Table A-9: Daily Average Wind Speed (Wind) Raw Data (mph), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949																																		
1950																																		
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1973	6.2	3.5	8.3	5.2	2.3	8.3	7.6	5.8	5.5	7.8	7.2	8.8	6.3	6.8	6.6	4.9	7.6	6.0	5.6	7.0	10.2	7.8	7.8	5.2	3.7	8.3	6.5	6.8	5.2	7.9	6.5	10.2	2.3	6.6
1974	11.5	14.1	8.1	6.9	12.1	6.6	5.8	8.2	7.0	10.1	7.5	9.1	7.8	5.8	5.3	5.3	5.8	5.9	6.9	4.2	2.3	4.6	4.3	4.7	3.7	3.2	5.2	7.0	6.6	6.5	6.9	14.1	2.3	6.7
1975	6.6	7.0	4.2	7.8	6.2	6.0	6.3	3.9	5.8	5.8	3.3	2.4	5.0	2.9	7.8	4.3	5.2	4.5	3.2	5.9	2.9	4.5	5.2	7.0	6.6	5.8	7.2	4.3	5.5	5.5	5.0	7.8	2.4	5.3
1976	6.8	10.5	9.1	6.2	8.5	8.9	4.3	7.5	8.5	7.8	8.1	9.1	7.8	5.8	6.2	9.6	5.3	9.8	6.3	7.6	6.6	8.9	9.2	6.2	8.1	5.6	4.0	5.8	4.9	10.5	6.3	10.5	4.0	7.4
1977	10.8	9.2	7.3	7.6	7.2	4.9	5.8	7.9	14.0	9.9	8.9	5.9	7.8	9.4	7.0	6.9	5.3	10.2	9.1	5.3	10.4	7.5	5.8	3.9	7.3	8.2	1.4	8.6	3.2	4.0	4.7	14.0	1.4	7.3
1978	7.2	9.6	13.7	9.9	12.1	7.9	8.9	8.3	6.5	5.2	4.6	7.0	6.3	8.1	6.9	8.5	7.9	7.0	7.0	9.4	8.1	4.0	7.6	5.9	5.5	4.9	4.2	6.3	7.8	7.5	7.5	13.7	4.0	7.5
1979	9.5	6.8	4.3	3.5	5.3	7.8	7.9	6.8	3.5	6.0	5.2	6.8	6.6	6.0	4.9	7.9	11.1	3.5	6.6	8.1	7.9	5.0	5.0	3.5	3.6	4.7	6.6	7.8	9.1	7.6	6.5	11.1	3.5	6.3
1980	10.2	6.5	6.3	5.5	3.9	7.8	10.5	7.2	4.9	5.3	6.0	8.9	6.9	4.5	2.0	3.2	4.6	7.9	7.6	4.2	6.2	7.6	7.6	8.1	6.9	7.9	7.5	5.8	7.2	4.3	5.8	10.5	2.0	6.4
1981	4.2	2.7	4.7	7.0	6.3	5.3	11.1	5.2	4.6	6.3	3.7	8.3	2.4	5.6	2.0	5.6	6.2	3.3	6.5	2.2	6.2	5.9	10.1	10.6	7.9	11.4	7.2	4.3	8.2	9.5	12.1	12.1	2.0	6.3
1982	8.6	8.0	7.4	11.7	14.2	6.5	5.3	7.6	4.4	7.7	5.1	7.4	6.8	6.8	10.5	7.3	5.8	6.1	4.1	7.7	6.9	5.0	4.8	6.4	5.8	6.0	5.4	6.9	7.0	6.0	5.6	14.2	4.1	6.9
1983	8.3	9.4	8.8	4.6	7.8	5.8	6.6	4.0	6.4	5.7	5.1	5.9	6.6	7.3	9.5	7.0	7.4	6.9	5.7	5.3	5.4	7.3	6.1	6.2	5.8	6.2	5.5	4.9	5.0	5.1	7.5	9.5	4.0	6.4
1984	4.5	5.0	5.3	3.3	4.4	6.0	6.1	4.3	5.1	4.4	4.7	3.5	2.6	3.4	4.4	3.8	4.4	2.9	6.1	4.5	6.9	4.2	3.5	6.1	6.1	5.3	4.6	6.2	5.6	5.0	4.3	6.9	2.6	4.7
1985	3.0	7.6	4.3	5.7	3.8	4.7	5.0	4.0	4.6	7.1	5.6	5.7	5.8	6.0	8.9	9.0	7.0	6.9	6.6	6.7	5.6	7.2	5.7	9.4	7.2	6.0	6.6	5.7	7.2	7.3	5.4	9.4	3.0	6.2
1986	6.0	6.9	6.1	13.1	13.2	4.9	5.0	6.6	8.4	6.7	6.7	7.3	6.5	7.1	8.1	4.2	6.3	6.1	4.7	6.1	6.3	6.8	4.8	3.7	6.1	7.6	6.6	5.2	4.3	3.7	6.5	13.2	3.7	6.5
1987	5.6	6.3	7.5	10.2	7.7	5.5	5.7	7.3	7.7	10.2	8.2	5.3	5.1	4.7	6.5	10.4	14.2	13.8	4.6	8.3	12.1	10.4	4.4	7.7	7.1	4.2	4.4	4.2	3.8	3.9	4.2	14.2	3.8	7.1
1988	5.6	5.9	4.7	4.3	6.0	5.6	4.8	6.1	2.7	2.9	6.2	6.6	5.6	7.0	4.6	6.9	5.6	5.7	7.0	5.7	4.1	6.5	5.6	5.7	5.8	4.7	6.7	5.6	5.3	5.7	4.8	7.0	2.7	5.5
1989	9.1	5.9	5.1	5.5	6.9	9.1	5.8	7.1	10.8	9.2	7.1	6.1	5.6	7.4	7.3	10.8	7.6	5.2	10.6	8.8	9.3	8.3	5.8	7.7	6.8	4.9	4.7	5.1	5.3	5.8	7.6	10.8	4.7	7.2
1990	8.2	10.4	8.2	5.2	9.0	7.1	7.9	4.8	4.8	4.9	4.5	5.4	9.2	2.4	3.9	4.6	6.5	4.7	5.2	6.1	6.0	5.4	8.8	7.5	9.6	8.6	5.5	5.5	9.2	8.2	7.0	10.4	2.4	6.6
1991	4.2	4.7	5.9	7.2	5.5	5.4	6.6	7.5	7.1	6.6	4.0	5.8	7.6	7.0	6.1	7.9	6.6	6.4	5.8	4.0	6.0	5.0	6.0	7.4	6.5	5.8	3.7	5.5	7.2	4.4	5.7	7.9	3.7	6.0
1992	15.2	6.5	7.4	9.1	5.4	8.2	7.4	7.3	7.8	8.4	7.1	9.5	7.4	4.9	7.6	4.5	5.1	6.5	4.7	5.8	9.7	8.9	5.0	5.0	5.4	3.7	4.3	5.0	4.0	6.4	9.0	15.2	3.7	6.9
1993	6.4	9.0	16.9	17.5	9.1	7.0	8.6	11.7	7.7	7.9	9.0	11.9	8.5	9.2	9.4	9.4	7.5	7.0	6.0	7.3	9.3	7.4	11.9	9.6	8.2	7.9	4.5	7.6	7.9	5.1	5.0	17.5	4.5	8.8
1994	8.4	9.1	10.5	10.9	8.2	9.3	4.9	5.6	5.5	5.8	7.0	8.3	4.9	7.1	8.2	6.1	7.9	7.8	7.0	7.8	6.9	4.5	4.5	5.3	5.2	6.9	9.4	8.2	7.2	6.1	5.6	10.9	4.5	7.1
1995	7.7	9.4	11.3	6.5	4.3	4.3	4.9	4.9	7.3	7.9	6.9	7.0	7.6	5.4	4.7	6.0	4.3	4.0	4.4	4.4	6.5	7.8	6.9	4.2	4.5	5.8	4.5	5.0	8.2	6.2	7.2	11.3	4.0	6.1
1996	6.5	6.3	5.3	4.3	6.8	6.1	7.3	6.4	7.0	6.0	6.8	8.9	4.4	6.6	6.8	7.0	9.2	7.8	4.8	4.9	5.6	5.9	5.5	4.1	9.0	7.9	7.9	6.5	6.2	6.5	5.5	9.2	4.1	6.4
1997	5.5	7.9	5.9	6.0	6.2	8.4	7.6	5.8	5.4	7.5	8.7	7.1	5.3	5.3	6.3	6.2	6.2	6.1	5.3	6.0	3.7	6.3	4.6	3.0	4.8	6.2	5.3	5.4	5.8	6.4	4.9	8.7	3.0	6.0
1998	7.3	8.4	6.0	7.2	6.7	6.3	1.3	3.4	5.1	3.0	6.4	4.2	4.5	4.6	2.1	8.9	6.5	5.8	5.6	7.0	5.8	5.1	5.6	4.7	5.0	5.1	4.2	4.7	4.7	4.3	9.2	9.2	1.3	5.4
1999	6.2	11.3	9.5	8.9	8.1	3.7	6.4	8.4	8.0	8.0	8.5	6.4	7.6	6.4	8.0	7.6	7.0	5.2	4.9	5.1	6.4	4.5	3.7	5.7	6.6	7.4	7.1	6.7	6.5	8.2	8.2	11.3	3.7	7.0
2000	7.7	7.3	9.4	6.8	7.3	5.9	7.5	7.3	5.4	5.8	5.6	6.2	7.8	7.7	7.2	9.5	5.8	5.8	7.6	9.0	5.9	6.9	8.6	8.9	5.7	7.0	7.8	4.9	7.8	7.5	5.9	9.5	4.9	7.1
2001	8.8	8.5	8.0	8.1	6.7	8.2	7.0	7.1	9.9	5.8	4.9	4.8	5.1	8.7	6.4	8.7	6.3	6.7	7.3	5.3	8.7	6.7	7.2	5.7	7.4	3.8	3.6	5.5	9.7	8.4	8.5	9.9	3.6	7.0
2002	6.3	8.0	7.9	6.0	7.1	7.3	8.2	8.5	8.1	7.6	6.6	6.9	6.1	9.5	9.5	8.1	5.4	7.5	5.8	4.4	5.4	9.6	5.2	6.5	7.6	7.0	6.0	5.4		5.5		9.6	4.4	7.0
2003	7.9	6.0	5.7	4.9	8.3	8.5	9.3	5.5	6.0	5.7	8.1	6.8	7.1	7.4	7.9	5.3	8.1	6.4	6.6	6.6	5.9	7.4	6.2	6.0	7.4	9.9	8.9	6.8	6.4	6.5	6.7	9.9	4.9	7.0
2004	8.0	7.0	9.3	8.3	5.3	5.7	11.5	10.6	7.3	6.3	5.5	5.6	5.3	6.5	5.2	5.6	5.9	7.5	6.7	6.3	7.0	8.2	9.1	5.6	6.9	5.5	5.8	8.4	3.4	4.7	6.3	11.5	3.4	6.8
2005	6.4	10.0	9.7	5.5	9.2	10.0	7.9	8.2	7.3	6.4	6.1	4.5	8.9	6.7	4.9	4.9	8.1	5.7	7.9	6.9	6.5	5.8	6.4	6.6	4.8	5.4	6.7	4.0	4.8	6.5	6.2	10.0	4.0	6.7
2006	7.5	7.4	7.6	8.8	8.5	7.6	6.9	4.5	6.0	8.2	6.4	8.0	6.5	3.4	6.9	6.6	4.9	8.3	6.7	6.1	4.4	5.9	6.1	7.3	5.6	8.5	7.9	7.7	6.7	8.7	8.7	8.8	3.4	6.9
2007	4.9	3.6	5.6	8.4	12.3	5.9	3.9	4.7	4.5	5.6	7.6	7.4	8.3	6.1	6.7	5.5	6.4	5.3	6.6	6.4	5.7	4.8	5.6	5.3	5.8	7.5	6.3	3.9	9.0	4.2	4.5	12.3	3.6	6.1
2008	3.7	5.8	6.8	7.1	8.3	5.3	3.7	8.5	7.6	5.1	7.4	6.3	5.0	4.7	5.0	5.5	4.4	4.8	5.7	4.4	4.9	5.9	4.3	5.7	5.2	5.7	8.2	9.3	3.8	4.4	2.7	9.3	2.7	5.7

Table A-10: Daily Average Wind Speed (Wind) Filled (mph), July

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Max	Min	Avg
1949	6.3	7.9	6.6	6.8	4.9	7.4	4.2	6.8	14.5	6.4	4.0	4.9	6.9	7.6	7.7	6.4	5.0	7.3	7.5	4.9	6.3	7.8	4.8	4.9	5.6	3.9	3.9	4.6	6.0	6.5	5.3	14.5	3.9	6.2
1950	6.3	6.9	11.7	7.2	9.1	7.7	8.9	5.9	5.0	7.9	5.0	11.4	13.0	5.4	7.7	6.9	7.3	5.3	4.9	8.1	10.1	8.0	7.9	7.4	5.5	6.1	6.4	4.9	5.5	6.7	8.8	13.0	4.9	7.4
1951	8.1	8.2	4.8	5.9	10.4	4.2	5.4	5.3	4.5	6.9	5.1	9.6	8.5	5.6	6.0	6.1	7.2	8.6	6.2	6.4	6.5	6.9	9.0	7.4	6.4	4.4	4.6	6.3	5.4	9.2	7.5	10.4	4.2	6.7
1952	5.5	5.1	17.2	6.1	7.2	4.3	9.3	11.9	5.4	6.3	6.8	6.8	6.7	8.2	6.8	6.4	5.9	9.7	8.6	6.3	4.7	5.6	9.0	6.1	8.1	6.5	7.5	7.6	4.9	6.6	6.3	17.2	4.3	7.2
1953	6.2	7.7	8.0	6.7	6.1	11.5	6.2	7.2	6.5	6.7	6.2	10.7	5.8	6.7	6.2	6.7	8.4	5.0	5.3	5.3	7.4	9.8	4.9	5.2	5.7	5.5	6.9	6.0	7.6	7.9	5.6	11.5	4.9	6.8
1954	6.4	8.1	7.0	7.4	7.9	7.4	10.4	7.2	6.6	5.8	8.6	8.5	8.3	6.5	9.1	7.0	8.1	6.1	7.0	7.0	7.3	7.9	11.0	5.8	5.6	7.7	5.9	8.8	8.1	7.9	7.8	11.0	5.6	7.6
1955	5.3	5.7	6.6	10.0	5.8	7.0	7.0	6.7	10.5	9.0	8.5	5.9	4.8	6.3	8.1	7.0	6.7	7.0	7.0	6.4	6.3	4.4	5.9	5.9	6.1	5.6	4.7	5.4	6.9	4.6	6.8	10.5	4.4	6.6
1956	5.7	6.4	5.4	5.9	6.7	10.7	4.3	7.0	11.8	7.4	6.4	6.8	5.4	6.1	5.6	10.5	7.6	7.4	6.9	6.1	5.3	5.8	8.9	7.4	6.0	8.1	6.4	7.0	7.1	6.2	5.9	11.8	4.3	6.9
1957	3.8	5.9	4.9	7.3	6.7	4.3	7.1	5.0	10.3	5.9	5.0	4.3	5.5	3.8	5.9	4.5	5.2	4.4	4.9	4.5	4.7	11.4	6.1	4.8	5.4	5.1	3.9	3.5	5.0	5.6	5.4	11.4	3.5	5.5
1958	6.7	5.8	4.6	6.0	10.3	10.2	6.3	7.8	7.1	6.2	6.8	8.2	8.2	6.9	6.2	6.8	5.9	6.8	4.6	5.6	6.4	6.6	6.9	7.5	7.1	5.9	4.8	10.2	7.0	6.3	4.6	10.3	4.6	6.8
1959	14.3	6.7	5.0	5.8	7.7	5.9	9.0	8.8	13.2	6.7	10.6	8.8	7.6	6.3	8.3	7.0	8.3	8.5	8.8	5.8	6.9	7.4	7.9	7.4	5.8	8.9	7.6	5.6	7.1	7.6	5.4	14.3	5.0	7.8
1960	8.3	4.6	5.4	7.9	9.5	8.0	10.4	7.5	5.4	5.1	4.0	8.8	11.0	7.9	7.7	4.7	7.4	9.2	6.0	5.2	5.4	6.2	4.5	5.4	5.9	5.3	3.9	4.2	6.5	6.5	4.2	11.0	3.9	6.5
1961	5.3	10.9	8.2	5.8	5.2	9.5	6.8	7.8	6.8	3.8	8.4	9.9	7.3	6.1	7.2	5.8	4.1	5.6	5.4	6.3	6.6	6.3	5.3	5.3	7.0	6.7	5.7	5.5	4.9	5.2	6.1	10.9	3.8	6.5
1962	4.3	6.8	7.0	7.3	5.9	4.3	3.8	8.5	3.9	4.5	5.5	6.4	6.8	5.4	4.1	8.1	7.0	5.2	6.7	5.1	6.4	4.5	5.2	5.9	9.7	6.7	5.6	5.6	6.7	7.4	4.9	9.7	3.8	6.0
1963	9.2	9.2	7.5	6.6	7.7	7.6	9.0	8.1	6.3	6.4	6.7	7.3	8.1	7.7	6.5	7.4	5.5	9.6	5.8	7.4	6.3	5.6	5.7	5.9	9.3	7.1	7.5	10.6	7.1	7.1	6.8	10.6	5.5	7.4
1964	4.4	5.2	4.0	7.4	5.0	6.7	6.2	5.4	6.7	4.3	6.5	4.6	3.1	4.7	4.4	5.6	5.4	4.8	5.3	4.5	4.3	4.4	5.6	4.9	4.7	4.7	4.2	3.5	8.9	4.7	3.6	8.9	3.1	5.1
1965	6.0	4.1	10.4	5.3	4.5	5.8	6.3	5.3	5.1	7.3	7.3	5.5	7.2	6.1	5.6	5.8	4.6	5.7	3.9	4.7	7.0	7.2	5.4	8.9	7.5	4.1	6.4	12.1	8.5	4.7	11.7	12.1	3.9	6.5
1966	4.0	4.2	5.3	4.6	3.9	6.8	6.8	5.0	5.6	6.8	4.3	7.3	5.1	4.6	6.1	6.3	5.7	4.9	8.8	5.4	5.5	4.5	8.8	6.3	4.5	6.2	5.4	5.4	7.3	6.2	5.5	8.8	3.9	5.7
1967	7.8	11.1	5.7	9.5	5.6	10.2	6.5	5.6	5.0	6.6	5.2	9.0	8.2	6.1	7.2	8.2	4.4	6.6	12.2	9.6	6.2	7.1	5.7	7.3	7.1	6.1	7.4	7.4	9.3	6.3	5.5	12.2	4.4	7.3
1968	8.6	12.7	8.9	7.1	11.5	7.0	4.4	5.1	7.3	5.6	5.2	8.2	6.1	7.1	5.4	5.2	4.1	14.6	10.9	5.1	6.5	7.9	3.9	6.6	5.2	3.9	7.1	5.6	5.3	6.0	8.3	14.6	3.9	7.0
1969	11.8	5.3	8.3	8.9	5.3	8.6	6.4	9.5	6.4	6.7	7.6	5.8	5.0	5.8	7.3	7.0	4.7	6.6	5.7	8.2	6.3	4.9	6.0	6.4	5.2	5.3	7.3	7.5	5.4	7.7	11.7	11.8	4.7	6.9
1970	7.9	6.7	10.4	6.4	6.8	7.5	8.6	6.8	6.8	8.9	7.8	8.4	6.2	7.3	13.0	6.0	7.1	6.2	9.2	9.7	8.6	7.5	6.6	9.5	6.4	7.2	7.3	7.1	5.4	5.6	6.1	13.0	5.4	7.6
1971	12.9	7.1	5.6	5.1	5.2	9.7	4.4	10.2	4.7	5.6	8.8	6.5	9.4	7.1	10.2	9.9	6.3	7.0	12.2	4.7	4.6	7.6	9.3	7.7	7.0	11.5	5.0	6.3	10.3	14.9	7.4	14.9	4.4	7.9
1972	7.1	5.4	14.5	17.1	7.8	6.0	5.4	5.4	7.0	5.3	5.1	9.3	5.1	7.3	11.9	11.6	7.0	11.1	7.6	7.3	7.2	5.8	7.7	7.5	5.6	5.2	5.1	8.8	9.8	6.4	6.4	17.1	5.1	7.7
1973	6.2	3.5	8.3	5.2	2.3	8.3	7.6	5.8	5.5	7.8	7.2	8.8	6.3	6.8	6.6	4.9	7.6	6.0	5.6	7.0	10.2	7.8	7.8	5.2	3.7	8.3	6.5	6.8	5.2	7.9	6.5	10.2	2.3	6.6
1974	11.5	14.1	8.1	6.9	12.1	6.6	5.8	8.2	7.0	10.1	7.5	9.1	7.8	5.8	5.3	5.3	5.8	5.9	6.9	4.2	2.3	4.6	4.3	4.7	3.7	3.2	5.2	7.0	6.6	6.5	6.9	14.1	2.3	6.7
1975	6.6	7.0	4.2	7.8	6.2	6.0	6.3	3.9	5.8	5.8	3.3	2.4	5.0	2.9	7.8	4.3	5.2	4.5	3.2	5.9	2.9	4.5	5.2	7.0	6.6	5.8	7.2	4.3	5.5	5.5	5.0	7.8	2.4	5.3
1976	6.8	10.5	9.1	6.2	8.5	8.9	4.3	7.5	8.5	7.8	8.1	9.1	7.8	5.8	6.2	9.6	5.3	9.8	6.3	7.6	6.6	8.9	9.2	6.2	8.1	5.6	4.0	5.8	4.9	10.5	6.3	10.5	4.0	7.4
1977	10.8	9.2	7.3	7.6	7.2	4.9	5.8	7.9	14.0	9.9	8.9	5.9	7.8	9.4	7.0	6.9	5.3	10.2	9.1	5.3	10.4	7.5	5.8	3.9	7.3	8.2	1.4	8.6	3.2	4.0	4.7	14.0	1.4	7.3
1978	7.2	9.6	13.7	9.9	12.1	7.9	8.9	8.3	6.5	5.2	4.6	7.0	6.3	8.1	6.9	8.5	7.9	7.0	7.0	9.4	8.1	4.0	7.6	5.9	5.5	4.9	4.2	6.3	7.8	7.5	7.5	13.7	4.0	7.5
1979	9.5	6.8	4.3	3.5	5.3	7.8	7.9	6.8	3.5	6.0	5.2	6.8	6.6	6.0	4.9	7.9	11.1	3.5	6.6	8.1	7.9	5.0	5.0	3.5	3.6	4.7	6.6	7.8	9.1	7.6	6.5	11.1	3.5	6.3
1980	10.2	6.5	6.3	5.5	3.9	7.8	10.5	7.2	4.9	5.3	6.0	8.9	6.9	4.5	2.0	3.2	4.6	7.9	7.6	4.2	6.2	7.6	7.6	8.1	6.9	7.9	7.5	5.8	7.2	4.3	5.8	10.5	2.0	6.4
1981	4.2	2.7	4.7	7.0	6.3	5.3	11.1	5.2	4.6	6.3	3.7	8.3	2.4	5.6	2.0	5.6	6.2	3.3	6.5	2.2	6.2	5.9	10.1	10.6	7.9	11.4	7.2	4.3	8.2	9.5	12.1	12.1	2.0	6.3
1982	8.6	8.0	7.4	11.7	14.2	6.5	5.3	7.6	4.4	7.7	5.1	7.4	6.8	6.8	10.5	7.3	5.8	6.1	4.1	7.7	6.9	5.0	4.8	6.4	5.8	6.0	5.4	6.9	7.0	6.0	5.6	14.2	4.1	6.9
1983	8.3	9.4	8.8	4.6	7.8	5.8	6.6	4.0	6.4	5.7	5.1	5.9	6.6	7.3	9.5	7.0	7.4	6.9	5.7	5.3	5.4	7.3	6.1	6.2	5.8	6.2	5.5	4.9	5.0	5.1	7.5	9.5	4.0	6.4
1984	4.5	5.0	5.3	3.3	4.4	6.0	6.1	4.3	5.1	4.4	4.7	3.5	2.6	3.4	4.4	3.8	4.4	2.9	6.1	4.5	6.9	4.2	3.5	6.1	6.1	5.3	4.6	6.2	5.6	5.0	4.3	6.9	2.6	4.7
1985	3.0	7.6	4.3	5.7	3.8	4.7	5.0	4.0	4.6	7.1	5.6	5.7	5.8	6.0	8.9	9.0	7.0	6.9	6.6	6.7	5.6	7.2	5.7	9.4	7.2	6.0	6.6	5.7	7.2	7.3	5.4	9.4	3.0	6.2
1986	6.0	6.9	6.1	13.1	13.2	4.9	5.0	6.6	8.4	6.7	6.7	7.3	6.5	7.1	8.1	4.2	6.3	6.1	4.7	6.1	6.3	6.8	4.8	3.7	6.1	7.6	6.6	5.2	4.3	3.7	6.5	13.2	3.7	6.5
1987	5.6	6.3	7.5	10.2	7.7	5.5	5.7	7.3	7.7	10.2	8.2	5.3	5.1	4.7	6.5	10.4	14.2	13.8	4.6	8.3	12.1	10.4	4.4	7.7	7.1	4.2	4.4	4.2	3.8	3.9	4.2	14.2	3.8	7.1
1988	5.6	5.9	4.7	4.3	6.0	5.6	4.8	6.1	2.7	2.9	6.2	6.6	5.6	7.0	4.6	6.9	5.6	5.7	7.0	5.7	4.1	6.5	5.6	5.7	5.8	4.7	6.7	5.6	5.3	5.7	4.8	7.0	2.7	5.5
1989	9.1	5.9	5.1	5.5	6.9	9.1	5.8	7.1	10.8	9.2	7.1	6.1	5.6	7.4	7.3	10.8	7.6	5.2	10.6	8.8	9.3	8.3	5.8	7.7	6.8	4.9	4.7	5.1	5.3	5.8	7.6	10.8	4.7	7.2
1990	8.2	10.4	8.2	5.2	9.0	7.1	7.9	4.8	4.8	4.9	4.5	5.4	9.2	2.4	3.9	4.6	6.5	4.7	5.2	6.1	6.0	5.4	8.8	7.5	9.6	8.6	5.5	5.5	9.2	8.2	7.0	10.4	2.4	6.6
1991	4.2	4.7	5.9	7.2	5.5	5.4	6.6	7.5	7.1	6.6	4.0	5.8	7.6	7.0	6.1	7.9	6.6	6.4	5.8	4.0	6.0	5.0	6.0	7.4	6.5	5.8	3.7	5.5	7.2	4.4	5.7	7.9	3.7	6.0
1992	15.2	6.5	7.4	9.1	5.4	8.2	7.4	7.3	7.8	8.4	7.1	9.5	7.4	4.9	7.6	4.5	5.1	6.5	4.7	5.8	9.7	8.9	5.0	5.0	5.4	3.7	4.3	5.0	4.0	6.4	9.0	15.2	3.7	6.9
1993	6.4	9.0	16.9	17.5	9.1	7.0	8.6	11.7	7.7	7.9	9.0	11.9	8.5	9.2	9.4	9.4	7.5	7.0	6.0	7.3	9.3	7.4	11.9	9.6	8.2	7.9	4.5	7.6	7.9	5.1	5.0	17.5	4.5	8.8
1994	8.4	9.1	10.5	10.9	8.2	9.3	4.9	5.6	5.5	5.8	7.0	8.3	4.9	7.1	8.2	6.1	7.9	7.8	7.0	7.8	6.9	4.5	4.5	5.3	5.2	6.9	9.4	8.2	7.2	6.1	5.6	10.9	4.5	7.1
1995	7.7	9.4	11.3	6.5	4.3	4.3	4.9	4.9	7.3	7.9	6.9	7.0	7.6	5.4	4.7	6.0	4.3	4.0	4.4	4.4	6.5	7.8	6.9	4.2	4.5	5.8	4.5	5.0	8.2	6.2	7.2	11.3	4.0	6.1
1996	6.5	6.3	5.3	4.3	6.8	6.1	7.3	6.4	7.0	6.0	6.8	8.9	4.4	6.6	6.8	7.0	9.2	7.8	4.8	4.9	5.6	5.9	5.5	4.1	9.0	7.9	7.9	6.5	6.2	6.5	5.5	9.2	4.1	6.4
1997	5.5	7.9	5.9	6.0	6.2	8.4	7.6	5.8	5.4	7.5	8.7	7.1	5.3	5.3	6.3	6.2	6.2	6.1	5.3	6.0	3.7	6.3	4.6	3.0	4.8	6.2	5.3	5.4	5.8	6.4	4.9	8.7	3.0	6.0
1998	7.3	8.4	6.0	7.2	6.7	6.3	1.3	3.4	5.1	3.0	6.4	4.2	4.5	4.6	2.1	8.9	6.5	5.8	5.6	7.0	5.8	5.1	5.6	4.7	5.0	5.1	4.2	4.7	4.7	4.3	9.2	9.2	1.3	5.4
1999	6.2	11.3	9.5	8.9	8.1	3.7	6.4	8.4	8.0	8.0	8.5	6.4	7.6	6.4	8.0	7.6	7.0	5.2	4.9	5.1	6.4	4.5	3.7	5.7	6.6	7.4	7.1	6.7	6.5	8.2	8.2	11.3	3.7	7.0
2000	7.7	7.3	9.4	6.8	7.3	5.9	7.5	7.3	5.4	5.8	5.6	6.2	7.8	7.7	7.2	9.5	5.8	5.8	7.6	9.0	5.9	6.9	8.6	8.9	5.7	7.0	7.8	4.9	7.8	7.5	5.9	9.5	4.9	7.1
2001	8.8	8.5	8.0	8.1	6.7	8.2	7.0	7.1	9.9	5.8	4.9	4.8	5.1	8.7	6.4	8.7	6.3	6.7	7.3	5.3	8.7	6.7	7.2	5.7	7.4	3.8	3.6	5.5	9.7	8.4	8.5	9.9	3.6	7.0
2002	6.3	8.0	7.9	6.0	7.1	7.3	8.2	8.5	8.1	7.6	6.6	6.9	6.1	9.5	9.5	8.1	5.4	7.5	5.8	4.4	5.4	9.6	5.2	6.5	7.6	7.0	6.0	5.4	10.4	5.5	5.7	10.4	4.4	7.1
2003	7.9	6.0	5.7	4.9	8.3	8.5	9.3	5.5	6.0	5.7	8.1	6.8	7.1	7.4	7.9	5.3	8.1	6.4	6.6	6.6	5.9	7.4	6.2	6.0	7.4	9.9	8.9	6.8	6.4	6.5	6.7	9.9	4.9	7.0
2004	8.0	7.0	9.3	8.3	5.3	5.7	11.5	10.6	7.3	6.3	5.5	5.6	5.3	6.5	5.2	5.6	5.9	7.5	6.7	6.3	7.0	8.2	9.1	5.6	6.9	5.5	5.8	8.4	3.4	4.7	6.3	11.5	3.4	6.8
2005	6.4	10.0	9.7	5.5	9.2	10.0	7.9	8.2	7.3	6.4	6.1	4.5	8.9	6.7	4.9	4.9	8.1	5.7	7.9	6.9	6.5	5.8	6.4	6.6	4.8	5.4	6.7	4.0	4.8	6.5	6.2	10.0	4.0	6.7
2006	7.5	7.4	7.6	8.8	8.5	7.6	6.9	4.5	6.0	8.2	6.4	8.0	6.5	3.4	6.9	6.6	4.9	8.3	6.7	6.1	4.4	5.9	6.1	7.3	5.6	8.5	7.9	7.7	6.7	8.7	8.7	8.8	3.4	6.9
2007	4.9	3.6	5.6	8.4	12.3	5.9	3.9	4.7	4.5	5.6	7.6	7.4	8.3	6.1	6.7	5.5	6.4	5.3	6.6	6.4	5.7	4.8	5.6	5.3	5.8	7.5	6.3	3.9	9.0	4.2	4.5	12.3	3.6	6.1
2008	3.7	5.8	6.8	7.1	8.3	5.3	3.7	8.5	7.6	5.1	7.4	6.3	5.0	4.7	5.0	5.5	4.4	4.8	5.7	4.4	4.9	5.9	4.3	5.7	5.2	5.7	8.2	9.3	3.8	4.4	2.7	9.3	2.7	5.7

JOE DEMAGGIO, P.E.

Supervising Civil / Agricultural Engineer

Mr. DeMaggio has been employed by Stetson Engineers Inc. since 1979. His professional expertise lies in the area of irrigation system design and cost estimation, agricultural water requirements, municipal engineering and facilities design, dam design, environmental engineering, flood control and restoration, surface water and groundwater resource studies, and water rights investigations. Mr. DeMaggio is responsible for directing agricultural and civil engineering projects as well as providing expert witness testimony.

EDUCATION: B.S. Agricultural Engineering
California Polytechnical State University, San Luis Obispo, 1978

CREDENTIALS: Professional Civil Engineer No. 32954, California, 1981
Agricultural Engineer No. 440, California, 1982

PROFESSIONAL EXPERIENCE: 30 years

SELECTED PROJECTS:

Agricultural Engineering

- Irrigation system design for revegetation plan for the Cibola National Wildlife Refuge, Blythe, California. *(Parametrix, 2008 to Present)*
- Quantification of reserved water rights including determination of Practicably Irrigable Acreage (PIA), irrigation facilities design and cost estimation, water supply studies, and HYDROSS modeling for the Flathead Indian Reservation, Montana. *(Bureau of Indian Affairs, 1989 to present)*
- Nutria Irrigation Project feasibility assessment for the Zuni Indian Reservation, New Mexico. *(Zuni Tribe, 2007 to present)*
- Irrigation system and dam design and cost estimation for a Practicably Irrigable Acreage (PIA) study. Including dams, canals, pump, sprinkler system and water supply modeling on the Fort Belknap Indian Reservation, Montana. *(White Shield International, 1999 to present)*
- Irrigation system and dam design and cost estimation for a Practicably Irrigable Acreage (PIA) study. Determined on-farm irrigation system efficiency for presently irrigated lands on the Crow Indian Reservation, Montana. *(White Shield International, 1996 to present)*
- Calculate natural flow of Peoples Creek and Milk River, Montana. *(U.S. Bureau of Indian Affairs, 2005 to 2007)*
- Determine irrigation demand, length of irrigation season for alfalfa, and participate in water rights issues for the Pueblo of Isleta, New Mexico. *(Pueblo of Isleta, 2004 to 2006)*

- Prepare comprehensive water rights claim for the Confederated Tribes of the Umatilla Indian Reservation, Oregon. *(Confederated Tribes of the Umatilla Indian Reservation, 2005)*
- Evaluate water availability for Group 5 lands located on the Uinta Indian Reservation. *(Northern Ute Indian Tribe, 2005)*
- Irrigation system, wells, and dam design and cost estimation including economic analysis for 2,600 acres for determination of the reserved water rights for the Capitan Grande Indian Reservation, California. *(Barona Tribe, 2003 to 2004)*
- PIA study for Round Valley Indian Reservation, California. *(Round Valley Tribe, 2001 to 2004)*
- Design of irrigation system and pipelines for a 50-acre wetlands development at Zuni Heaven in Arizona. *(Zuni Tribe, 2001 to 2003)*
- Agricultural water use efficiency study for 9,000 acres for four of the Cachuma Project Member Units in connection with the State of California Water Resources Control Board hearings. *(Cachuma Conservation District, 2003)*
- Irrigation system design and cost estimation for a PIA study and determination of presently and historically irrigated acreage on the Gila River Indian Reservation, Arizona. *(U.S. Department of Justice, 1996 to 2003)*
- Review of land classification and PIA study for Fort Yuma Indian Reservation, Arizona. *(U.S. Department of Justice, 2001 to 2003)*
- Appraisal-level design and cost estimation of 31 irrigation projects including dams, canals, pump stations, wells, pipelines, tunnels and diversion dams. *(San Carlos Apache Tribe, 2001 to 2002)*
- PIA study for an off-reservation allotment located in the Yakima River Basin, Washington. *(U.S. Department of Justice, 1997 to 2001)*
- Crop water requirement determination for various crops grown in the Pauma Valley, California. *(Pauma Mutual Water Company, 2000)*
- Irrigation system design and cost estimation and crop water requirements for the Pechanga, Cahuilla and Ramona Indian Reservations, California. *(U.S. Department of Justice, 1993 to 2000)*
- PIA study for 2,000 acres for the Lower Peoples Creek area of the Fort Belknap Indian Reservation, Montana, using a storage reservoir. *(U.S. Bureau for Indian Affairs, 1995 to 1999)*
- PIA study for 500 acres for the Upper Peoples Creek area of the Fort Belknap Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1995 to 1998)*
- PIA study and review of technical basis supporting the Fort Peck-Montana Compact, Fort Peck Indian Reservation, Montana. *(U.S. Department of Justice, 1997)*

- PIA study for 1,800 acres including appraisal-level RCC dam design and cost estimation for the Shivwits Indian Reservation, Utah. *(U.S. Department of Justice, 1997)*
- Center Pivot, micro sprinkler and drip irrigation system design and cost estimation for 6,000 acres located on the Navajo Indian Reservation, Arizona. *(Natural Resources Consulting Engineers, 1994 to 1996)*
- Crop water requirement and presently/historically irrigated acreage determination for the Owyhee River basin located upstream of the Duck Valley Indian Reservation, Nevada. *(Shoshone-Paiute Tribes, 1994 to 1995)*
- Design and cost estimation for four dams/reservoirs and water delivery system operation model for about 130,000 irrigated acres as part of the Uinta Basin Replacement Project, Utah. *(Northern Ute Indian Tribe, 1994 to 1995)*
- Sprinkler and drip irrigation system and pump station design and cost estimation for 32,700 acres located in the Toppenish, Simcoe and Satus Creek basins on the Yakama Indian Reservation, Washington. *(HKM Associates and U.S. Department of Justice, 1994 to 1995)*
- Quantification of the water resources and irrigation system design and cost estimation for a PIA study for 18,000 acres, Fort Belknap Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1987 to 1994)*
- U.S. Whiterocks Canal water distribution and operation study for 4,000 acres of irrigated land located on the Uintah and Ouray Indian Reservation, Utah. *(Northern Ute Indian Tribe, Uintah and Ouray Reservation, Utah, 1993 to 1994)*
- Quantification of the water resources and irrigation system design and cost estimation for a PIA study for 30,000 acres, Flathead Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1986 to 1994)*
- Sprinkler and drip irrigation system and pump station design and cost estimation for 3,600 acres located in the Ahtanum Creek basin on the Yakama Indian Reservation, Washington. *(U.S. Department of Justice, 1993)*
- On-farm irrigation system design and cost estimation for 33,000 acres using center pivots, drip, micro sprinklers and level furrow irrigation systems for the proposed Leupp Irrigation Project located on the Navajo and Hopi Indian Reservations, Arizona. *(U.S. Department of Justice 1991 to 1992)*
- Outlet Creek Waterfowl Production Area review of impacts on Tribal water supply, Fort Peck Indian Reservation, Montana. *(Sonosky, Chambers, Sachse & Endreson, 1992)*
- Surface water depletion study and agricultural development plan including irrigation system design and cost estimation for a PIA study for 100,000 acres, Yakama Indian Reservation, Washington. *(U.S. Department of Justice, 1984 to 1991)*
- Irrigation development plan for the south slope of Ahtanum Ridge, consisting of about 9,000 acres, Yakama Indian Reservation, Washington. *(Confederated Tribes and Bands of the Yakama Indian Nation, 1990)*

- Conceptual irrigation system design for the Duck Valley Indian Reservation, Idaho. *(U.S. Bureau of Indian Affairs, 1988)*
- Feasibility study of using drainage runoff water to irrigate 3,000 acres of land located on the Fallon Naval Air Station, Nevada. *(Pyramid Lake Paiute Tribe, 1987)*
- Center pivot and wheelline sprinkler irrigation system design for 2,400 acres using water pumped from Truckee River, Nevada. *(Pyramid Lake Paiute Tribe, 1987)*
- Studies in connection with the "President's Water Policy Implementation 10-Year Plan for Review of Indian Water Claims" including water supply, irrigation water requirements, irrigation system design and cost estimation and related studies, Fort Hall Indian Reservation, Idaho. *(Shoshone and Bannock Tribes, 1984 to 1987)*
- Drip irrigation system evaluation for five acres of specialty crops, Hollister, California. *(Cienega Valley Farms, 1986)*
- Irrigation system design and cost estimation for 1,100 acres and water resources and water requirement evaluation, Warm Springs Indian Reservation, Oregon. *(Confederated Tribes of the Warm Springs Reservation, 1984)*
- Quantification of water resources and potential water requirements of the Fort Belknap and Rocky Boys Indian Reservations, Montana. *(U.S. Bureau of Indian Affairs, 1982 to 1984)*
- Design and construction supervision of a drip irrigation system, including well and filtration system, for 140 acres of wine grapes located in Hollister, California. *(Almaden Vineyards, 1984)*
- Preliminary water and land resource inventory and design and cost estimation of center pivot irrigation system for 1,500 acres, Standing Rock Sioux Indian Reservation, North Dakota. *(Standing Rock Sioux Tribe, 1983)*
- Water resource and agricultural development investigations for a PIA study for the San Carlos Indian Reservation, Arizona. *(San Carlos Apache Tribe, 1981)*
- Preparation of comprehensive water development plan including an agricultural engineering study of potential irrigation water demand, Northern Cheyenne Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1979 to 1983)*
- Agricultural system development plan including irrigation system design and cost estimation for a PIA study for 60,000 acres, and determination of future and historic irrigation water requirements, Wind River Indian Reservation, adjudication of the Big Horn River System, Wyoming. *(U.S. Bureau of Indian Affairs and U.S. Department of Justice, 1979 to 1982)*

Municipal Engineering and Facilities Design

- Water treatment plant design for Stinson Beach, California. *(Stinson Beach Water District, 2008 to present)*

- Design plans and specifications for 60 foot span bridge crossing Pala Creek on the Pala Indian Reservation, California. *(Pala Tribe, 2008 to present)*
- Water distribution system evaluation, City of Solvang, California. *(ID#1, 2008)*
- Design plans for capital improvement projects for Santa Ynez River Water Conservation District No.1 (ID#1), California. *(ID#1, 2006 to present)*
- Water Delivery System Hydraulic Capability – Evaluation for Santa Ynez River Water Conservation District Improvement District No. 1 (ID#1), California. *(ID# 1, 2006 to 2007)*
- Pump station design for Hollywood Hills Memorial Park, California. *(Forest Lawn, 2005 to 2007)*
- Structural analysis for single family residence located in Bear Valley, California. *(Steve Evanko, 2006)*
- Preparation of a reconnaissance level plan for relocating the Hoh Indian Tribe's Housing and Municipal facilities, Washington. *(Entrix, 2005 to 2006)*
- Prepare improvement plans and management plan for Lake H and I and Cope Lake groundwater recharge facilities located in Pleasanton, California. *(Zone 7 Water Agency, 2002 to 2006)*
- Arroyo Mocho turnout and fish screen design for a 100 cfs capacity for diversion of state water project water, California. *(Hanson Aggregates, 2002 to 2006)*
- Design three creek crossings for rural driveway access across Arroyo Mocho located in Livermore, California. *(Zone 7 Water Agency, 2003 to 2005)*
- Prepare design plans and specifications for a temporary 35 cfs pumping plant. *(Zone 7 Water Agency, 2003 to 2004)*
- Prepare water supply study for Marin Country Club. *(Marin Country Club, 2004)*
- Well pump specification for six municipal wells located in the San Gabriel Valley Water District, California. *(San Gabriel Water Company, 2003 to 2004)*
- Prepare construction design plans and specifications for two 6-inch diameter outlet works for two dams. *(Wetlands Research Associates, 2001)*
- Water System Master Plan for the town of Wadsworth, Nevada. *(Pyramid Lake Paiute Tribe, 2000 to 2001)*
- Gallery well water delivery system evaluation located in Santa Ynez, California. *(Santa Ynez River Water Conservation District, Improvement District No. 1, 1998 to 2000)*
- Conformance review and report for a 3,800 gpm capacity booster pump station located in Santa Ynez, California. *(Santa Ynez River Water Conservation District, Improvement District No. 1, 1998 to 1999)*

- Design and construction of a booster pump station with 1,100 gpm capacity located in Santa Ynez, California.
  (Santa Ynez River Water Conservation District, Improvement District No. 1, 1998)
- Design and specifications for a booster pump station with 6,000 gpm capacity costing $300,000 for delivering water from the State Water Project to Santa Ynez Water Conservation District, California.
  (Santa Ynez River Water Conservation District, Improvement District No. 1, 1995 to 1996)
- Conjunctive water use study including irrigation system survey, water use investigation and irrigation economics study for the Lower Mokelumne River area, California.
  (East Bay Municipal Utility District, 1994)
- Design of pipeline connection from State Water Project to existing Santa Ynez Water Conservation Districts system, Santa Ynez, California.
  (Santa Ynez River Water Conservation District Improvement District No. 1, 1991)
- Design the pipeline connection from the State Water Project to the City of Buellton's existing system, Buellton, California. *(Buellton Community Services District, 1991)*
- Water tank design and water treatment plant modifications for the City of Buellton, California. *(Buellton Community Services District, 1990)*
- Evaluate the water supply and present demand, and estimate the future water demand for the City of Buellton. Determined future system improvements needed for development based on computerized Hardy Cross pipe network analysis for the City of Buellton, California.
  (Buellton Community Services District, 1987)
- Assessment of the probable cause of foundation movement of a house located in Moraga, California. *(Action Adjusters and Appraisers, 1986)*
- Appraisal-level design and cost estimate for an inverted siphon under the Missouri River, Fort Peck Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1984)*

Flood Control and Restoration

- Watershed Flood Damage reduction and creek management study for Corte Madera Creek/ San Anselmo Creek, California.
  (Marin County Flood Control & Water Conservation District, 2009)
- Hydrology and hydrologic analysis for the design of the Lagunitas Road bridge located in Ross, California. *(URS Corporation, 2007 to 2008)*
- Provide construction design plans, specifications and cost estimates for creek channel design and culvert replacement to improve fish passage at five sites located in Woodacre, California.
  (Marin County Department of Public Works, 2005 to 2008)
- Fish ladder design and cost estimate at Pastori, Sanders and Lansdale sites on San Anselmo Creek, California. *(Friends of Corte Madera Creek, 2005 to present)*

- Prepare design plans for creek bank erosion control on Fairfax Creek, California. *(John Legnitto, 2007)*
- Prepare design plans for creek bank erosion control on Fairfax Creek, California. *(Scot Lance, 2006 to 2007)*
- Analysis of fish passage and bank stability on Corte Madera Creek below Lagunitas Bridge, Fairfax, California. *(Friends of Corte Madera Creek Watershed, 2005 to 2006)*
- Prepare design plans for creek bank erosion control on Novato Creek, California. *(Art Olsen, 2006)*
- Prepare design plans for creek bank erosion control on Fairfax Creek, California. *(Laury Croter, 2006)*
- Prepare design plans for creek bank erosion control on Fairfax Creek, California. *(Gary Leo, 2006)*
- Review of 100-year flood hydrology and hydraulics in connection with the environmental study of Corte Madera Pond, California. *(Town of Corte Madera, 2004 to 2005)*
- Prepare design plans for creek bank stabilization on San Anselmo Creek, California. *(Kunst Family Trust, 2003 to 2004)*
- Determine 100-year flood flow and water surface elevation for HUD housing on the Duck Valley Indian Reservation, Nevada. *(Shoshone-Paiute Tribes, 2004)*
- Appian Creek channel improvements design and construction, El Sobrante, California. *(Salvation Army, 1993)*

Water Rights Investigations

- Consultant for Imperial Irrigation District equitable distribution of water group, Imperial California. *(Mike Maloney, 2006 to2008)*
- Water rights investigations for the Newlands Project, Nevada. *(Pyramid Lake Paiute Tribe, 1999 to present)*
- Participation in the Fort Belknap Indian Reservation water rights negotiations with the Montana Reserved Water Rights Compact Commission. *(U.S. Bureau of Indian Affairs, 1998 to 2006)*
- Participation in the Flathead Indian Reservation Federal Negotiation Technical Team water rights negotiations, Montana. *(U.S. Bureau of Indian Affairs, 1998 to present)*
- Quantification of the reserved water rights for the Umatilla Indian Reservation, Oregon. *(Confederated Tribes of the Umatilla Indian Reservation, 2005)*
- Quantification of DCMI water rights claim for the Pascua Yaqui Indian Reservation, Arizona. *(Pascua Yaqui Tribe, 2004)*

- Determine crop water requirements for Safford Valley lands in connection with Globe Equity decree, Arizona. *(U.S. Department of Justice, 2001 to 2003)*
- Water rights negotiation for the Shoshone-Paiute Tribes of the Duck Valley Indian Reservation with the State of Idaho and Riddle Ranch. *(Shoshone-Paiute Tribes, 1999 to 2003)*
- Water rights negotiation for the Shoshone-Paiute Tribes with the State of Nevada and the Owyhee River upstream water users. *(Shoshone Paiute Tribes, 1995 to 2003)*
- Technical analysis supporting the Fort Peck-Montana compact, Montana. *(U.S. Department of Justice, 1997)*
- Surface water resources investigation, Little Colorado River basin, determination of present and future water use and preparation of preliminary water rights claims, Navajo and Hopi Indian Reservations, Arizona. *(U.S. Department of Justice, 1985 to 1991)*
- Determination of available water supply, present and future water requirements and preparation of preliminary water rights claims, Camp Verde, Prescott and Fort McDowell Indian Reservations, Arizona. *(U.S. Bureau of Indian Affairs, 1985)*

Surface Water Resource Studies

- Prefeasibility Analysis of the Valsetz Reservoir for the Siletz Indians, Oregon. *(Entrix, 2008)*
- HYDROSS model review and calibration for the Flathead Indian Irrigation Project (120,000 acres) for the Flathead Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1998 to present)*
- Evaluate El Vado Reservoir operation model for the storage of their prior and paramount water rights for the Pueblo of Isleta, New Mexico. *(Pueblo of Isleta, 2004 to 2006)*
- HYDROSS model documentation report for the Milk River Basin, Montana. *(U.S. Bureau of Indian Affairs, 1998 to 1999)*
- Design and cost estimation for Little Bighorn Dam, located on the Crow Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1996 to 2000)*
- Inventory of surface water supplies potentially available to the Round Valley Tribe; developed model to determine unregulated and natural flow from gaged data for the upper Eel River basin to evaluate the Potter Valley Project (FERC relicense) transbasin diversion impacts; use the model to evaluate the Potter Valley Projects transbasin diversions and reservoir operation scenarios impact on the fishery; develop fisheries flow regimes. *(Round Valley Indian Tribe, 1997 to 1999)*
- Fresno Reservoir enlargement, conceptual irrigation development plan, and wildlife habitat, design and cost estimation for the Fort Belknap Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1995 to 1998)*

- RCC dam design and cost estimation for the Shivwits Indian Reservation, Utah. *(U.S. Dept. of Justice, 1997)*
- Design and cost estimation for four dams/reservoirs located on the Uintah and Ouray Reservation, Utah. *(Northern Ute Indian Tribe, 1994 to 1995)*
- Reservoir operation model for three proposed reservoirs located on the Fort Belknap Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1994)*
- Appraisal-level dam and spillway design and cost estimation for three dams located on the Fort Belknap Indian Reservation, Montana. *(U.S. Bureau of Indian Affairs, 1990 to 1991)*

Ground Water Resource Studies

- Groundwater recharge pond design plans and specifications for Camp Pendleton, California. *(United States Marine Corps, 2008 to present)*
- Value engineering construction cost evaluation of estimates made by USBR and Bookman-Edmonston for the Madera Ranch Groundwater Banking Project. *(U.S. Bureau of Reclamation, 1998)*
- Groundwater modeling for Pryor Creek, Crow Indian Reservation, Montana. *(White Shield International, 1996 to present)*
- Analysis of benefits and costs of the seepage reduction options available to the San Luis Drainage Unit located in the Central Valley of California. *(U.S. Bureau of Reclamation, 1990)*

Environmental Engineering Studies

- Lake O'Neill dredging design plans and specifications for Camp Pendleton, California. *(United States Marine Corps, 2008 to present)*
- Evaluation of Boadle Tract Duck Ponds located near Great Falls, Montana. *(Montana Department of Justice 2008 to present)*
- Evaluation of water system facilities for Zuni Heaven Wetlands, Arizona. *(Zuni Tribe, 2005 to present)*
- Prepare construction plan edits for the N-1 Channel filling for a 160-acre wetland development located in Fremont, California. *(Prologis, 2006 to 2007)*
- Review of hydrology and hydraulics in connection with environmental study of Corte Madera pond located in Corte Madera, California. *(Town of Corte Madera, 2004)*
- Lake O'Neill rehabilitation feasibility study for a 1,500 acre-foot lake located on Camp Pendleton, California. *(United States Marine Corps, 2004)*
- Prepare construction plans and specifications for a 45-acre wetland development located in Fremont, California. *(Wetlands Research Associates, 2002)*

- Santa Margarita River Recharge and Recovery Enhancement Program, Permit 15000 Feasibility Study for Marine Corps Base, Camp Pendleton. *(United States Marine Corps, 2000 to 2001)*
- Programmatic Environmental Assessment on Section 504 of Title V, Public Law 102-575 for the Uintah and Ouray Indian Reservation, Utah. *(Northern Ute Tribe, 1999 to 2001)*
- Prepare construction plans for wetlands as part of a mitigation plan for a housing development in Rohnert Park, California. *(Brookfield Homes, 2001)*
- Prepare construction plans and specifications for 160 acres of wetlands including design of a temporary steel bridge for a 100-ton scraper. *(Wetlands Research Associates, 2001)*
- Review and comment on Water Quality Standards submitted by the Shoshone-Paiute Tribes to the EPA. *(Shoshone-Paiute Tribes, 2000)*

Expert Witness Testimony

- United States *v.* Alpine Land & Reservoir Company (Civil No.D-184-HDM). Water right transfer hearings for the Newlands Project, Nevada. *(Pyramid Lake Paiute Tribe, 2000 to present)*
- Testify at the State of California Water Resources Control Board hearings regarding agriculture water use efficiency for 9,000 acres served by the Cachuma Project located near Santa Barbara, California. *(Cachuma Conservation District, 2003)*
- State of Washington, Department of Ecology *v.* Acquavella, et al., (Civil No. 77-2-01484-5), Superior Court, Yakima County, Washington. Off-Reservation Allotment Number HA-355 Conceptual Irrigation Development Plan and Irrigation Water Requirements, Yakima Indian Nation, Washington. *(U.S. Department of Justice, 2001)*
- State of Washington, Department of Ecology *v.* Acquavella, et al., (Civil No. 77-2-01484-5), Superior Court, Yakima County, Washington. Irrigation system design and cost for the Yakama Indian Nation, Washington. *(U.S. Department of Justice, 1991)*

PROFESSIONAL AFFILIATIONS

- American Society of Agricultural Engineers

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW MEXICO

UNITED STATES OF AMERICA and ZUNI INDIAN TRIBE, Plaintiffs, -v- STATE OF NEW MEXICO, ex rel. STATE ENGINEER, et al., Defendants.	)	07cv00681-BB ZUNI RIVER BASIN ADJUDICATION **Subproceeding 1** **Zuni Indian Claims**

CERTIFICATE OF SERVICE
OF ZUNI INDIAN TRIBE'S DISCLOSURES

The Zuni Indian Tribe, through undersigned counsel, hereby certifies that, pursuant to Fed.R.Civ.P. 26(a)(2) and the September 24, 2008 *Scheduling Order* (Doc. No. 264), on March 12, 2009, the *Zuni Indian Tribe's Rule 26(a)(2) Disclosures Concerning Claims Based on Evidence of Past or Present Irrigation By Means of Permanent Irrigation Works* were served via first class mail, postage prepaid on the following counsel of record and *pro se* parties:

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Dated: March 12, 2009

Electronically Filed

By: /s/

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CERTIFICATE OF SERVICE

I HEREBY CERTIFY that, on March 12, 2009, I filed the foregoing *Certificate of Service of Zuni Indian Tribe's Disclosures* electronically through the CM/ECF system, which caused CM/ECF Participants to be served by electronic means, as more fully reflected on the Notice of Electronic Filing.

By: /s/
Jane Marx