STATE EX REL. STATE ENGINEER v. A & R PRODUCTIONS, ET AL.
Case No. CIV 07-00681 BDB/WDS, Subproceeding 1

Climate Data Assessment and Calculation of Crop ET and Reference ETo, Zuni Pueblo

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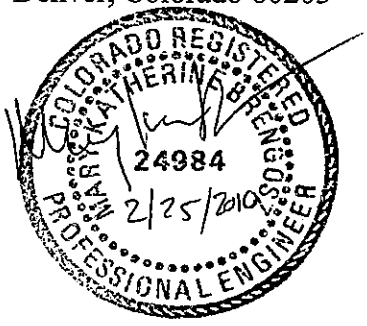

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This report summarizes the methods used to evaluate the climate data from weather stations near the Zuni Pueblo. The data were used in calculation of crop irrigation requirement (CIR) with both the original and modified Blaney-Criddle Methods, and reference evapotranspiration (ETo) with the Hargreaves-Samani Method and the ASCE Standardized Penman-Monteith Method. Figure 1 shows the general location of the Zuni Pueblo.

The original and modified Blaney-Criddle Methods require average monthly temperature and precipitation data, and frost dates. The Hargreaves-Samani Method requires daily maximum and minimum temperature data. These data are generally available from weather stations in the National Oceanic and Atmospheric Administration/National Weather Service (NOAA/NWS) Cooperative Station Network. The standardized ASCE reference ET equation requires more extensive data that are good quality and represent reference conditions. The daily weather data parameters needed are maximum and minimum temperature, a measure of vapor pressure at the site (such as maximum and minimum relative humidity or dewpoint temperature), daily wind speed and solar radiation. Automated weather stations and NOAA/NWS stations that are located at airports may collect data for some or all of these parameters.

NOAA/NWS WEATHER STATIONS NEAR ZUNI PUEBLO

The NOAA/NWS Cooperative Station Network weather stations (coop stations) generally record only minimum and maximum temperature and precipitation data. Stations located at airports may have data for dewpoint temperature or relative humidity, wind speed and weather or sky conditions in addition to temperatures and precipitation. Stations in the coop network are identified by a 6-digit station identifier number and can be one site or a series of sites whose locations typically fall within 2 miles horizontal or 100 feet vertical difference, with exceptions determined by the NWS field manager. Some data stored at the National Climatic Data Center (NCDC) may also be identified with a Weather-Bureau-Army-Navy (WBAN) or World Meteorological Organization (WMO) number. (NCDC 2009).

Seven NOAA/NWS weather stations were selected for evaluation based on proximity to the areas of interest and length of record, and are summarized in Table 1. The station locations are shown on Figure 2. Several of the stations have been moved during the period of record. Only the most recent location is included in Table 1 and Figure 2.

Locations of NOAA/NWS Weather Stations

The seven NOAA stations are located within 30 miles of the Zuni Pueblo, except for the Albuquerque station, located about 130 miles away. The Albuquerque WSFO Airport weather

station (290234) was included in the investigation in part because data from it were used by Natural Resources Consulting Engineers (NRCE) in their report for the United States (US) and the Bureau of Indian Affairs (BIA) in this case (NRCE 2008). The stations were visited and photographed between July 21 and July 24, 2009. The Albuquerque station (290234) is currently located at the airport near the runways, and we were unable to approach close enough to photograph it clearly. The Fence Lake station (293180) ceased operating in 2007. We photographed the location shown in Table 1, but later discovered the station had been moved. The Gallup Municipal Airport coop station (293422) was formerly located at the airport, but was replaced with an Automated Surface Observation Station (ASOS) in 2000. The data for station 293422 now appear to be collected at Gallup Sand and Gravel Company, about 2.6 miles from the airport location. The airport location is located in a grassed area near runways, and the Gallup Sand and Gravel location is surrounded by pavement. Photographs of the Albuquerque, Fence Lake and both Gallup weather station locations are shown in Figure 3. These stations were used for data comparison and substitution.

Table 1
NOAA/NWS Weather Stations
Near Zuni Pueblo, New Mexico

Station Name & Number	Latitude (1) Degrees	Longitude(1) degrees	Elevation m	Elevation ft	Period of Record (2)
Albuquerque WSFO Airport 290234	35.04	106.62	1619	5310	1919-2009
Black Rock 291018	35.08	108.78	1970	6463	1914-1948
El Morro Nat'l. Monument 292785	35.04	108.35	2202	7223	1938-2009
Fence Lake 1N 293180	34.65	108.68	2154	7065	1964-2007
Gallup Municipal Airport (Gallup Sand & Gravel) 293422	35.53	108.75	1983	6505	1973-2009
Mc Gaffey 5SE 295560	35.34	108.44	2439	8000	1949-2009
Zuni 299897	35.07	108.84	1924	6311	1949-2009

(1) Latitude, longitude and elevation are shown for the most recent station location only.
(2) Period of record is for all locations. Limited data may be available in earlier years.

The Zuni (299897), Black Rock (291018), El Morro (292785) and McGaffey (295560) stations were initially selected for further evaluation for use in evapotranspiration calculations at Zuni Pueblo because of their proximity to the irrigated areas, all within 30 miles of the pueblo. Photographs of the current location of the Zuni NOAA station are shown in Figure 4. The same station number, 299897, has been used for stations in several locations. (NOAA 2009). The station is currently in the back yard of the station operator's residence. The station has reportedly been in its current location since 1993. The maximum temperature at this station appears to be somewhat higher at the current location than in earlier years, but the minimum

temperature is not affected. The Black Rock station no longer exists, but we photographed the former location, on the roof of a building near the Black Rock Dam, as shown in Figure 5. It is located about 3.4 miles from the Zuni station. The period of record for the Black Rock station overlaps that of the Zuni station for several months in 1949. Photographs of the El Morro station are shown in Figure 6. The station is located beside the visitor center at El Morro National Monument. The Zuni, Black Rock and El Morro stations are or were located near buildings and pavement and are not near the irrigated areas. The McGaffey station is shown in Figure 7. It is located in the yard of the station operator. It is near the road, but surrounded by grass, trees and other vegetation. We photographed the McGaffey station from the road because the station operator did not allow us to approach any closer.

Climate Data Review for NOAA/NWS Weather Stations

Maximum, minimum and average daily temperature and daily precipitation data for the stations listed in Table 1 were purchased and obtained electronically from the Western Regional Climate Center (WRCC). These parameters were summarized, evaluated for completeness and compared to determine their suitability for replacing missing data at each station. Temperature data from Zuni, Black Rock, Gallup, Fence Lake and El Morro stations were similar to each other on a monthly and annual basis. Albuquerque temperatures were consistently higher and McGaffey temperatures were consistently lower than the other stations. Total monthly and annual precipitation data from the Zuni, Black Rock and Gallup stations were very similar to each other. The Black Rock station was located near the current location of the Zuni station and has a period of record extending back to 1914. The period of record average data for the two stations is slightly different, which could be attributable to a number of factors such as station siting and equipment, operator procedures, and differences in the climate during the different periods of record. There is not enough overlap in the record at the two stations to evaluate the differences further. Precipitation at McGaffey was higher than any other station in all months, and precipitation at Albuquerque was lower in all months. Precipitation at Fence Lake and El Morro was higher than at Zuni, but not as high as McGaffey. Figures 8-11 illustrate the comparison of the raw data parameters on an average basis.

The daily data were graphed and tabulated to identify missing or questionable data. In general, temperature and precipitation data appeared to be good and were not replaced except for missing data. Missing days during 1948-2008 ranged from less than 1% of the days at El Morro to about 7% at Zuni. The Zuni, Black Rock and El Morro stations were used for data replacements for each other when data were available and surrounding days were similar and Gallup was used for data replacements at Zuni after 1973. If temperature data from the nearby station were not available or suitable, the following procedure was used: For three or fewer days of missing data, we used an average of the day before and the day after the missing day or days. For four to nine days of missing data, we used an average of the three days before and the three days after the missing days. For ten or more days of missing data within one month, we used the monthly average from the entire period of record. The exception to this procedure was that all missing temperature data at McGaffey were replaced with average values for the McGaffey station because of the dissimilarity compared to the other stations. Missing precipitation data were generally replaced with an average of the nearby stations for the day, and “accumulated”

readings noted in the data were distributed to the preceding days based on the relative amount of precipitation at the nearby stations.

The filled data for the seven evaluated stations are summarized in Table 2. Summary tables for all the weather stations evaluated, as well as documentation of missing days, are located in Appendix A.

NOAA STATIONS
REFERENCE EVAPOTRANSPIRATION AND CROP IRRIGATION REQUIREMENTS

The reference ETo for the NOAA stations in the Zuni Pueblo area was calculated with the 1985 Hargreaves-Samani method. Calculation of crop CIR at the NOAA stations was done with both the modified Blaney-Criddle Method and the original Blaney-Criddle Method per the request of the OSE.

There are five distinct agricultural areas at the Zuni Pueblo, located at average elevations ranging from approximately 6,200 feet to 6,800 feet within a radius of 22 miles from the pueblo (Figure 2). The Zuni NOAA station is located at an elevation of about 6,310 feet and is somewhat centrally located to all the irrigated areas. The Black Rock station is no longer in operation, but it was located within 3.4 miles and 142 feet of elevation of the Zuni station and has a period of record extending back to 1914. These two stations are likely to be more representative of the climatic conditions of all five agricultural areas than the more distant and higher-elevation El Morro and McGaffey stations. The Black Rock and Zuni stations were analyzed separately, but we understand the results of the ETo and CIR calculations were combined by the OSE to obtain a longer period of record at this location.

Calculation of Hargreaves-Samani Reference ETo, NOAA/NWS Stations

The grass-based reference ETo for the Zuni Pueblo area was calculated with the 1985 Hargreaves-Samani method, using the Ref-ET program from the University of Idaho (2008 version 3.1.01) and the daily filled maximum and minimum temperature data from the Zuni, Black Rock, El Morro and McGaffey stations. Average annual reference ETo ranged from 45.1 inches at the McGaffey weather station to 53.1 inches at the Zuni weather station over the period of record for each station, as shown in Table 3. Annual and monthly results for the Zuni, Black Rock, El Morro and McGaffey weather stations are summarized in Tables 4 through 7.

Blaney-Criddle Crop Consumptive Irrigation Requirement at the NOAA/NWS Stations

Crop CIR was calculated with the modified Blaney-Criddle Method and the original Blaney-Criddle Method. The Modified Blaney-Criddle Method is described in “Irrigation Water Requirements, Technical Release No. 21”, USDA, Soil Conservation Service, September 1970 (TR-21). The Original Blaney-Criddle method is described in “Technical Report 32, Consumptive Use and Water Requirements in New Mexico”, Blaney and Hanson, USDA, Soil

Conservation Service and NM State Engineer, 1965 (TR-32). Table 8 lists the crops, the modified Blaney-Criddle crop coefficients and the growing season start and end criteria used in both methods. Table 9 shows the seasonal coefficients used in the original Blaney-Criddle method. Average monthly results For the Zuni, Black Rock, El Morro and McGaffey weather stations are summarized for each crop in Table 10 for the original Blaney-Criddle method and Table 11 for the modified Blaney-Criddle method. Annual results for the modified Blaney-Criddle method for each crop at the four stations are presented in Tables 12-15. Monthly and annual results for each crop for the four stations are located in Appendix B.

AUTOMATED WEATHER STATIONS NEAR ZUNI PUEBLO

The standardized ASCE Reference ET equation requires data that are good quality and represent reference conditions. The daily weather data parameters needed for input to the equation are maximum and minimum temperature, a measure of vapor pressure at the site (such as maximum and minimum relative humidity or dewpoint temperature), daily wind speed and solar radiation. These data parameters are not typically collected at NOAA/NWS stations, except for some airport locations, but are available at automated weather station that have been established more recently, since about the mid-1980s.

Weather stations in the Remote Automated Weather Station (RAWS) network can collect all the data elements needed for the ASCE Standardized Penman-Monteith (ASCE std. PM) calculations. The purpose of the RAWS network is to monitor weather for danger of forest fires. The stations are typically located in forested or grassland areas where fires might burn, not in irrigated agricultural environments. (USFS 2009. USDA 2003). The RAWS network is relatively recent and data are available for short periods of record. Many stations were not established until 2000 or later. Some weather stations operated by the Federal Aviation Administration (FAA) or NWS, located at airports, collect some of the data elements needed for PM, typically wind speed and dewpoint temperature. Some of these stations also collect cloud cover or hours of sunshine data, but do not have direct measurements of solar radiation.

Four RAWS stations and three airport stations were selected for evaluation based on proximity to Zuni Pueblo and period of record, as shown on Table 16 and Figure 2. Zuni, Zuni Buttes, Ramah and Malpais Lava Flow RAWS stations are located in the general vicinity of the Zuni Pueblo, within approximately 40 miles. The Zuni RAWS station was discontinued and replaced with the Zuni Buttes RAWS station in 2006. Airport stations at Albuquerque and Gallup are the same as shown on Table 1 (NOAA stations). The Zuni airport station (# 299897) shares the identification number of the current Zuni NOAA station and was one of the former locations of the station during the period of record at the station. At the Gallup and Albuquerque airport locations, the manual weather stations were replaced with Automated Weather Observing System (AWOS) or Automated Surface Observing System (ASOS) automated equipment during the period of records, 1996 for Albuquerque and 2000 for Gallup. (Aviation Weather Assets Database, 2009). The Zuni airport was no longer in operation when AWOS/ASOS equipment was introduced.

Table 16
Automated and Airport Weather Stations
Near Zuni Pueblo, New Mexico

Station Name	Station Number	Latitude degrees	Longitude degrees	Elevation, Feet/(meters)	Period of Record [1]
Albuquerque International Airport[2]	290234 (WBAN 23050) (WMO 723650)	35.04	106.61	5351/1631	1941-2009
Gallup Municipal Airport[2]	293422 (WBAN 23081) (WMO 723627)	35.51	108.79	6473/1973	1973-2009
Malpais Lava Flow RAWS[3]	293301	34.9	108.10	7460/2274	1985-2009
Ramah RAWS	-	34.99	108.41	7038/2146	2005-2009
Zuni FAA Airport[2]	299897 (WBAN 93044)	35.10	108.78	6440/1963	1949-1972
Zuni RAWS	-	35.04	108.48	6320/1927	2003-2005
Zuni Buttes RAWS	290603	35.14	108.94	6689/2039	2006-2009

(1) A portion of the period of record at the airport stations is from NOAA/NWS Coop station and a portion is from ASOS/AWOS station.
(2) Same station number and similar location as NOAA station in Table 1
(3) RAWS = Remote Automated Weather Station, AWOS = Automated Weather Observing System operated by the Federal Aviation Administration (FAA), ASOS = Automated Surface Observing System operated by the NWS and FAA,.

Station Siting and Equipment

Ideally, stations to be used for calculating reference ET should be sited within a large level area of well-watered vegetation, have a ground cover of clipped grass and be located away from obstacles that can shade the site or affect the wind measurement. In reality, few weather stations, including those in Table 16, are in ideal locations. Data from a non-ideal site may require adjustment to better represent reference conditions before they are used to calculate reference ETo. (ASCE, 2005).

The Albuquerque and Gallup airport stations and the Ramah and Zuni Buttes RAWS stations were visited and photographed July 21-24, 2009. The Zuni airport station is one of the former locations of the current Zuni NOAA station and its actual location could not be visited. However, a photograph was taken on the site of one of the former runways at the Zuni airport location, as shown in Figure 12. The Albuquerque and Gallup stations, shown in the photographs in Figure 3, are currently ASOS stations located near the airport runways. ASOS stations are sited to provide weather information for aviation purposes, and are not located in

irrigated agricultural areas. The Gallup station ground cover is concrete and non-irrigated grass. Non-irrigated grass and paved roads generally surround the station. Ground cover at the Albuquerque airport could not be determined, but it can be assumed the station is not located in an irrigated crop area. The Ramah and Zuni Buttes RAWS stations, shown in the photographs in Figure 12, are located over non-irrigated grass and other vegetation. They are not located near an agricultural area, but are in higher-elevation areas that are important for forest fire weather prediction. We were unable to visit the Zuni RAWS former location and the Malpais RAWS location, but data were obtained from these stations for data evaluation purposes. Neither the airport stations nor the RAWS stations are located in reference environments. Instrument heights could not be measured because of fencing around the sites. We were unable to obtain information on the instrument heights and dates of calibration or replacement of the sensors at the RAWS stations.

Another consideration in selection of weather stations for use in the Penman-Monteith calculations is distance from the irrigated areas, and elevation differences between the weather stations and the irrigated areas. The Albuquerque station is located about 130 miles from the Zuni Pueblo as shown on Figure 2, is about 1,000 feet lower in elevation, and is on the eastern side of the continental divide. As noted above in the evaluation of data from the NOAA stations, Albuquerque has higher temperatures and lower rainfall than weather stations located closer to Zuni. The great distance and intervening topography reduces the likelihood that weather elements such as solar radiation will be similar to the Zuni area, even when averaged over a month. The Zuni airport station, which is located at the Zuni Pueblo, is in a good location for providing weather data for Penman-Monteith calculations because of its proximity, but the station was discontinued in 1972. Beginning in 1973, similar data were collected at Gallup airport. Gallup is located only 31 miles from the Zuni Pueblo, and within 20 feet of elevation. Data from Gallup are more likely to be more representative of conditions at Zuni agricultural areas than data from Albuquerque airport. The Ramah and Zuni Buttes/Zuni RAWS stations are within 25 miles of the Zuni Pueblo, but the period of record for these stations is very short. The Malpais RAWS has a longer period of record for some data parameters, beginning in 1985, but it is 41 miles from the Zuni Pueblo and 1,000 feet higher in elevation.

Evaluation of Weather Data for Penman-Monteith Calculations at Zuni Pueblo

Precipitation and maximum and minimum temperatures from the Zuni NOAA station were available from 1949-2008 and were evaluated as described above for the NOAA stations. The other climate parameters needed for the ASCE Std. PM method are wind speed, humidity or dewpoint temperature and solar radiation. Wind speed, dewpoint temperatures and solar radiation availability was more limited.

For the RAWS stations, daily maximum and minimum temperature, maximum and minimum relative humidity, average wind speed, solar radiation, and precipitation data were downloaded from the New Mexico Climate Center (NMCC) website (http://weather.nmsu.edu/data/data.htm) and the WRCC Desert Research Institute (DRI) website (http://wrcc.dri.edu). The WRCC/DRI data appear to have been subjected to some QA/QC procedures, because the data are more complete than the NMCC data, but the procedures were not described on the web site. The

NMCC web site has two forms of data available. The "interpolated" data sets have had missing data replaced by an algorithm which uses data from nearby stations but there is no information on which stations were used to generate the interpolated data. A disclaimer on the web site notes that minimal QA/QC has been done, and the user is responsible for evaluating the data. For this analysis, the data from WRCC/DRI were evaluated and the NMCC data were not used.

Temperature, wind and dewpoint data for the Albuquerque, Gallup and Zuni airports were downloaded from the Global Summary of the Day in the Integrated Surface Database at NCDC (http://www7.ncdc.noaa.gov/CDO/). The National Solar Radiation Database (NSRDB) produced by NCDC and the National Renewable Energy Laboratory (NREL) of the US Department of Energy (USDE) contains hourly data for solar radiation at Albuquerque for 1961-2005 and Gallup for 1991-2005. The data were downloaded from http://rredc.nrel.gov/solar/.

Data from the stations in Table 16 for each parameter were tabulated and graphed so that daily, monthly and annual data could be compared among all stations. Albuquerque was not used for data substitutions because of distance and climate differences but was included in some of the comparisons. Table 17 and Figure 13 show the comparisons of raw data on an average monthly basis. In general, the average of the data from the day before and the day after the missing days was used to replace missing data for up to ten days. The data replacements for each climate parameter are discussed in more detail below. A tabulation of the actual daily replacements made for each data parameter is found in Appendix C (electronic only).

Temperature

Daily maximum and minimum air temperatures from the Zuni NOAA station were used.

Precipitation

Precipitation data from Zuni NOAA station were used.

Dewpoint Temperature and Relative Humidity

The Ref-ET program can accept several types of humidity data as input, including dewpoint temperature and relative humidity. Maximum and minimum relative humidity data were available at the RAWS stations for various periods, starting in 1992 for Malpais RAWS, and 2003 for Zuni/Zuni Buttes and Ramah RAWS. Mean relative humidity was available beginning in 1985 at Malpais RAWS. The data downloaded from NMCC also contains minimum and maximum relative humidity at the Albuquerque and Gallup airports beginning in 2002. Graphs of the raw data indicated high variability between the stations, and between years at several stations, and there was extensive missing data. This variability is illustrated on Figure 14. Due to the amount of review and potential data correction that would have been required for a short period of data availability since 1985, the relative humidity data were not used in the Penman-Monteith calculations.

Dewpoint temperatures were available at Zuni airport for 1949-1972, Albuquerque airport for 1948-2008 and Gallup airport for 1973-2008 from the Global Summary of the Day (GSD) available from NCDC. The Gallup average dewpoint temperature was slightly lower than at Zuni airport for the earlier period, and also lower than the average dewpoint at the Albuquerque airport during the 1948-2008 period. The average dewpoint at the Zuni and Albuquerque airports is similar for the overlapping period of record. Summary tables of the raw dewpoint and relative humidity data are located in Appendix D.

None of the airport stations are located in a reference environment. The ASCE publication "The ASCE Standardized Reference Evapotranspiration Equation" by the Task Committee on Standardization of Reference Evapotranspiration (ASCE Task Committee Report), in Appendix E, cautions that when humidity data are available only from a site located in a non-reference environment, then use of an "adjusted" dewpoint temperature may produce a more reliable estimate of reference ET. Arid conditions at the weather station can cause overestimation of reference ET. In general, in a reference environment, Tmin will approach Tdew within a few degrees C. If Tdew consistently is more than three to five degrees C less than Tmin, the station may be affected by aridity. ASCE Task Committee Report Appendix E, Equation E-1, suggests that substituting Tdew = Tmin – Ko, where Ko is 2-5 degrees C for arid and semi-arid regions, can improve estimates of reference ET. If the Tdew is adjusted with this method, further adjustments to air temperatures are generally not needed. (ASCE 2005)

The average difference between Tmin at Zuni NOAA and Tdew from the Zuni (1949-1972) and Gallup (1973-2008) airport stations ranges from near zero in the winter months to over eight degrees C in June. Equation E-1 of ASCE Task Committee Report Appendix E was used to adjust the dewpoint temperature on days when it was more than four degrees C below the minimum temperature. Figure 15 illustrates the average monthly dewpoint temperature for both the raw and adjusted data for the Zuni/Gallup combined data. Table 18 summarizes the adjusted data for 1949-2008.

Wind Speed

Wind speed data were available at Albuquerque airport for 1941-2008, the Zuni airport for 1949-1972 and the Gallup airport from 1973-2008 in the GSD dataset. Wind data were also collected at the RAWS stations for the short period of record at those stations.

The ASCE std. PM equation uses wind speed measured at a height of two meters. Data collected at different heights should be converted to two meters for use in the std. PM equation. Instrument heights could not be measured at the airport or RAWS stations because of fencing around the sites. Standard wind measurement height at ASOS weather stations is currently 10 meters. The Natural Resources Conservation Service (NRCS), National Water and Climate Center reports that the anemometer height at Albuquerque has changed three times over the years, ranging from 14.63 meters in 1939 to 7.01 meters in 1960 to its current height of 10 meters in 1996. (http://www.wcc.nrcs.usda.gov/climate/). This anemometer history did not include information for Gallup or Zuni airports, therefore, a 10 meter (32.8 feet) height was

assumed for Gallup and 14.63 meters was assumed for Zuni airport. Standard wind measurement for RAWS stations is 20 feet (6.1 meters) (USDA 2003). Wind speeds recorded in the raw data were adjusted to reflect the wind speed measured at two meters using the anemometer height assumptions in this section using Equation 33 of the ASCE Task Committee Report. Figure 13 illustrates the comparison of the wind data after adjustment to a measurement height of two meters.

During the period of record (1948-1972) at the Zuni airport, annual average wind speed was higher and more variable than at Albuquerque during the same period or at Gallup during 1973-2008. Average wind speeds at Albuquerque airport were consistently higher than at Gallup airport. The RAWS wind speed data for Ramah and Zuni/Zuni Buttes were similar to the Gallup data during the overlapping period of record. The Malpais RAWS station recorded very low wind speeds until the middle of 2004, when the data become more similar to Gallup and the other RAWS stations. Based on these data comparisons, the Gallup data were used for the 1973-2008 period. Missing days were filled where necessary with daily average values. Because the wind measurement height at the Zuni and Gallup airport stations is unknown, the data may not be correct for wind measured at two meters. Table 19 summarizes the combined Zuni/Gallup airport wind data for 1949-2008.

Solar Radiation

Actual solar radiation (Rs) measurements were available at the Ramah and Zuni/Zuni Buttes RAWS stations from 2005-2008 and at Malpais RAWS from 1998-2008. The solar radiation data for the RAWS stations were evaluated by plotting against the theoretical clear sky solar radiation (Rso) at the Zuni NOAA station location. The Rso was calculated with equation D.2 in ASCE Task Committee Report Appendix D, using the site elevation and latitude, and the remaining data for the site, cleaned and filled as described above. For the purpose of calculating the Rso, we assumed a temperature sensor height of 1.5 meters.

The theoretical Rso curve assumes clean air on cloud-free days. Measured Rs may differ from the theoretical Rso due to clouds, dust, smoke or other turbidity in the atmosphere, in addition to sensor problems such as calibration, dirt on the sensor, or sensor out of level. For this review, if measured Rs at the RAWS stations was within about 5% of the Rso curve at least some of the time during a given period of time, the Rs data were considered acceptable. Malpais RAWS data for 1998-2004 and 2008 were not acceptable, but were not used in the calculation of reference ET, so they were not adjusted. Ramah RAWS data were adjusted upward for 2006 between May 25 and August 26 by between 5 and 10%. Zuni Buttes RAWS had acceptable data for 2007-2008. Figure 16 illustrates the raw and adjusted data.

In their report for the US and BIA in this matter, NRCE developed a total sky cover data set in order to calculate a “cloud factor” that was multiplied by the calculated clear-sky solar radiation in order to obtain an estimated actual solar radiation. They obtained cloud cover data through 1995 from the Albuquerque and Gallup airports from another dataset maintained by NCDC. NRCE used an empirical relationship developed by the Tennessee Valley Authority in its “cloud

factor". For estimating cloud cover after 1995, the cloud factor was estimated from the daily temperature range.

The solar radiation data from the NSRDB compiled by NREL were available for Gallup airport from 1991-2005, and Albuquerque airport for 1961-2005. Data included in the NSRDB are reportedly subjected to extensive QA/QC procedures, and the dataset contains numerous flags relating to data uncertainty and quality. Most of the values in the database for Albuquerque are measured data, with some periods filled with data from the Meteorological-Statistical (METSTAT) model, which uses other meteorological data at the site to estimate actual solar radiation. METSTAT was developed using NWS cloud cover manual observations and measured solar data. When NWS observers were replaced by ASOS automatic observations that were incompatible with METSTAT, beginning in the 1990s, NCDC developed a supplemental cloud data set suitable for use with METSTAT. The Gallup data are all modeled. (NREL, 2007). The Albuquerque data are consistently higher than the Gallup data, as shown on Figure 13.

Since the NSRDB has already produced and published a data set of Rs for Gallup airport based on cloud cover and other meteorological data, these values were used for the period 1991-2005. Data from Ramah and Zuni Buttes RAWS, adjusted as described above, were used for 2006-2008. The 17-year period of 1991-2008 is sufficiently long to compare the ETo estimates calculated with the ASCE std. Penman-Monteith method with the results of the Hargreaves-Samani method.

Summary of Cleaned and Filled Data

A single climate data set for the five Zuni irrigated areas was compiled from the cleaned and filled data described above. The years 1991 through 2008 were selected based on the availability of solar radiation data from the NSRDB and the RAWS stations. Monthly and annual data for each parameter for 1991-2008 are summarized in Tables 20 through 25.

AUTOMATED WEATHER STATIONS REFERENCE ETo

The reference ETo for the Zuni Pueblo area was calculated with the ASCE standardized Penman-Monteith method using the Ref-ET program from the University of Idaho (2008 version 3.1.01) and the cleaned data described above for 1991-2008. The ETo was also calculated with the Hargreaves-Samani method using the same data set for comparison purposes. Annual and monthly results from both methods are summarized in Table 26.

The average annual ASCE Penman-Monteith ETo at Zuni is 57.39 inches, compared to 56.41 inches for the Hargreaves-Samani Method for the same input data and study period, a difference of about one inch. The Hargreaves-Samani ETo for the longer 1948-2008 study period using Zuni temperatures averaged 53.1 inches, indicating the more recent period is different from the long-term average. Because of the use of non-local data from Gallup such as wind, dewpoint and solar radiation, and the location of all the weather stations in non-reference environments, the ASCE Penman-Monteith estimate of ETo during 1991-2008 may not be as reliable as the

Hargreaves-Samani estimate of ETo calculated with local temperature data for a longer study period.

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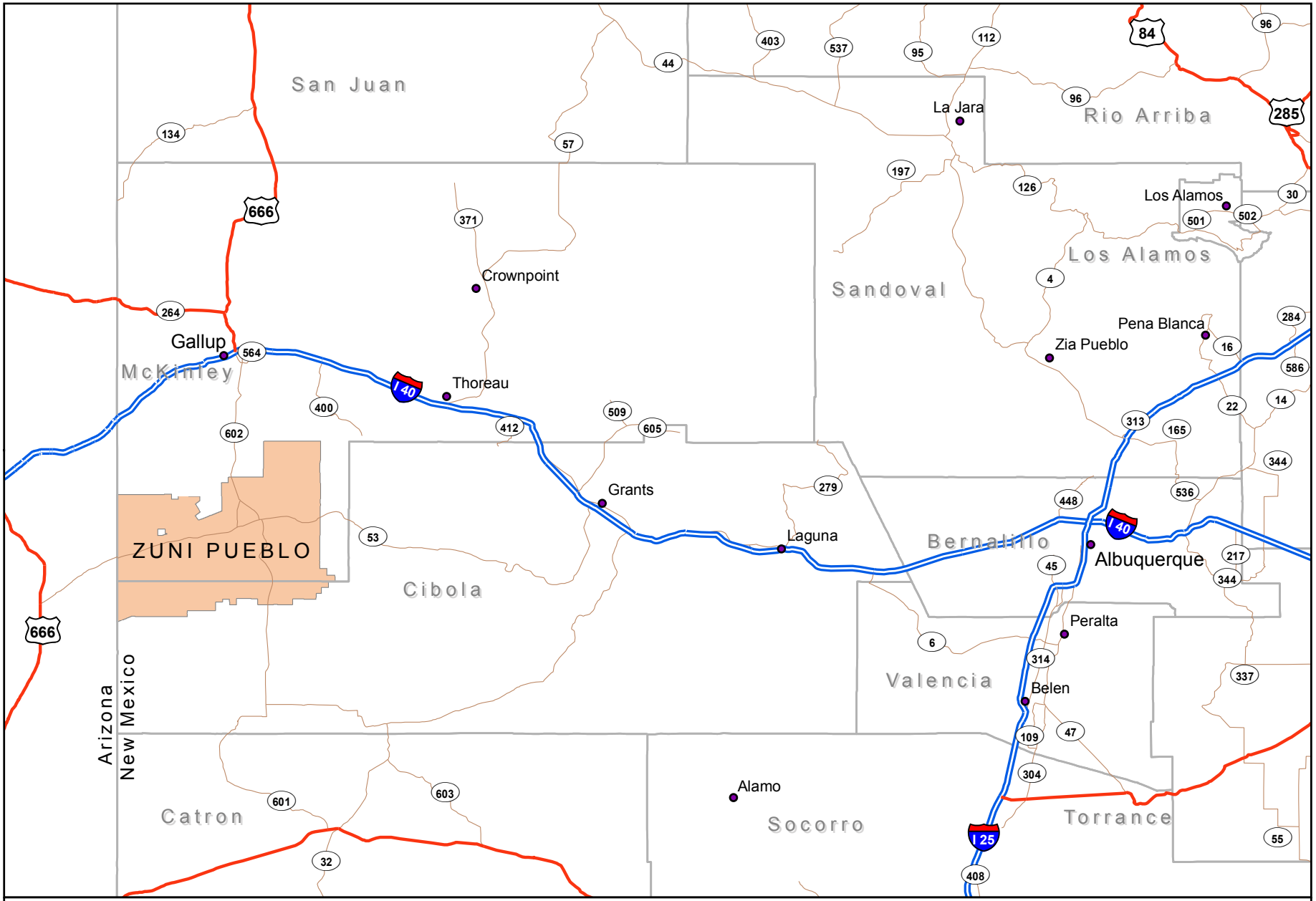
Figures



Source: New Mexico DNR, NOAA

FIGURE 1

Zuni Pueblo, New Mexico
Location Map

Spronk Water Engineers, Inc.
1000 Logan Street Denver, CO 80203

218.11.NM/ jar / 2.12.10

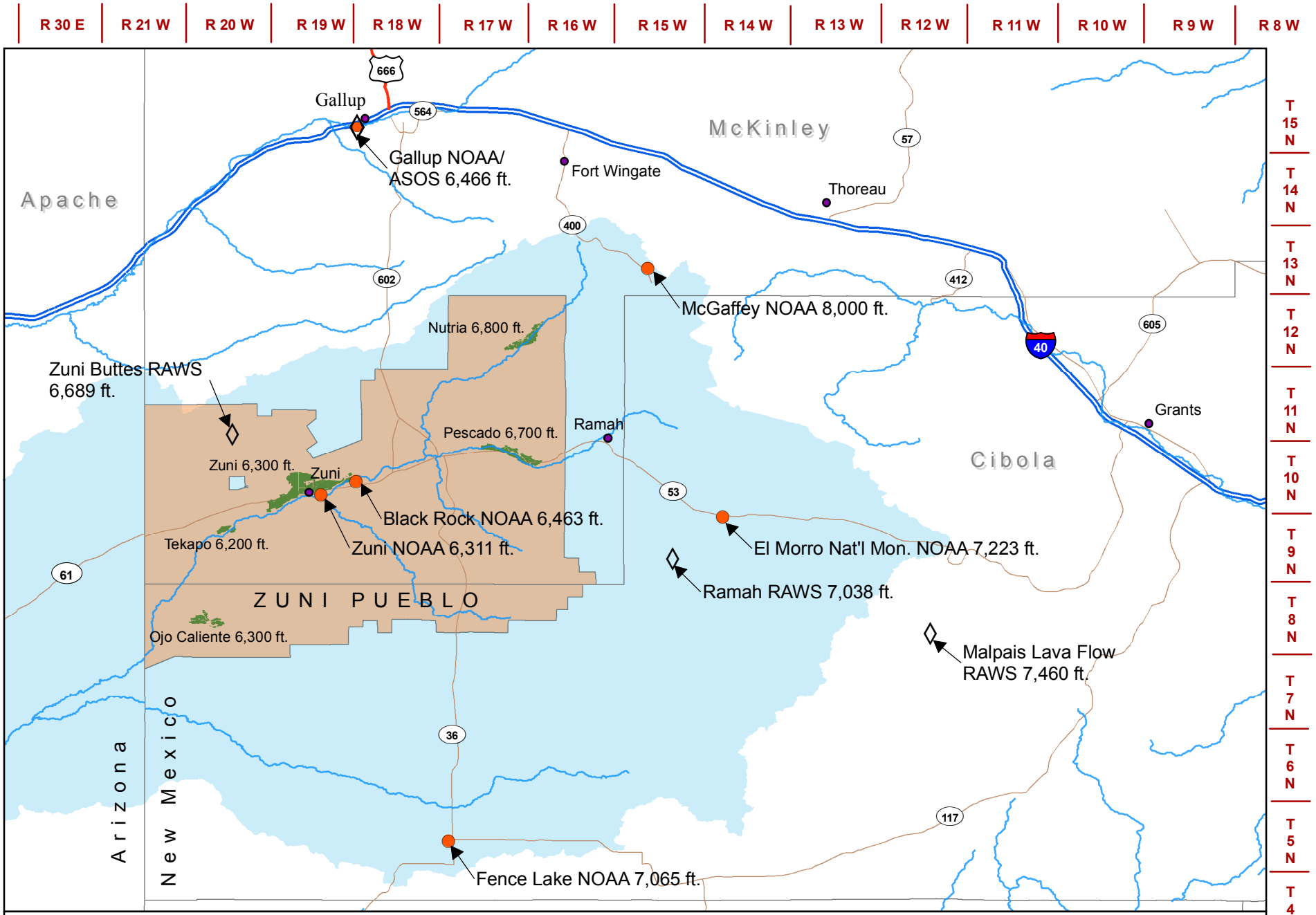

R 30 E
R 21 W
R 20 W
R 19 W
R 18 W
R 17 W
R 16 W
R 15 W
R 14 W
R 13 W
R 12 W
R 11 W
R 10 W
R 9 W
R 8 W
T 15 N
T 14 N
T 13 N
T 12 N
T 11 N
T 10 N
T 9 N
T 8 N
T 7 N
T 6 N
T 5 N
T 4 N
666
564
57
400
602
412
605
40
53
61
36
117
Gallup
Gallup NOAA/
ASOS 6,466 ft.
Fort Wingate
Thoreau
McKinley
Apache
McGaffey NOAA 8,000 ft.
Nutria 6,800 ft.
Zuni Buttes RAWS
6,689 ft.
Pescado 6,700 ft.
Ramah
Grants
Cibola
Zuni 6,300 ft.
Zuni
Black Rock NOAA 6,463 ft.
Zuni NOAA 6,311 ft.
Tekapo 6,200 ft.
El Morro Nat'l Mon. NOAA 7,223 ft.
Ramah RAWS 7,038 ft.
Z U N I P U E B L O
Ojo Caliente 6,300 ft.
Malpais Lava Flow
RAWS 7,460 ft.
Arizona
New Mexico
Fence Lake NOAA 7,065 ft.
Source: New Mexico DNR, NOAA
FIGURE 2
Weather Stations
Near Zuni River Basin, New Mexico
10 5 0 10 20
Miles
Approximate Scale =- 1:700,000
Automated Weather Station
NOAA Weather Station
Zuni Pueblo Agricultural Areas
Zuni River Basin
Zuni Pueblo
Towns
River
N
W
E
S
218.11.NM/ jar / 2.18.10
Spronk Water Engineers, Inc.
1000 Logan Street Denver, CO 80203

Figure 3

Photographs of Weather Stations at Albuquerque, Fence Lake, and Gallup , NM

July 2009

Albuquerque Airport, NM (290234, WBAN 23050, WMO 723650)
(in distance between plane and white shelter in foreground)

Fence Lake, NM NOAA/NWS (293180)

Gallup Airport, NM (293422, WBAN 23081, WMO 723627)

Gallup Sand & Gravel, NM NOAA/NWS (293422)

Figure 4
Location of Zuni, NM NOAA/NWS Weather Station (299897)
July 2009

Figure 5
Former Location of Black Rock, NM Weather Station (291018)
Photographed July 2009

Station was located on roof of building on a small platform.

Figure 6
Current Location of Weather Station at El Morro National Monument, NM (292785)
July 2009

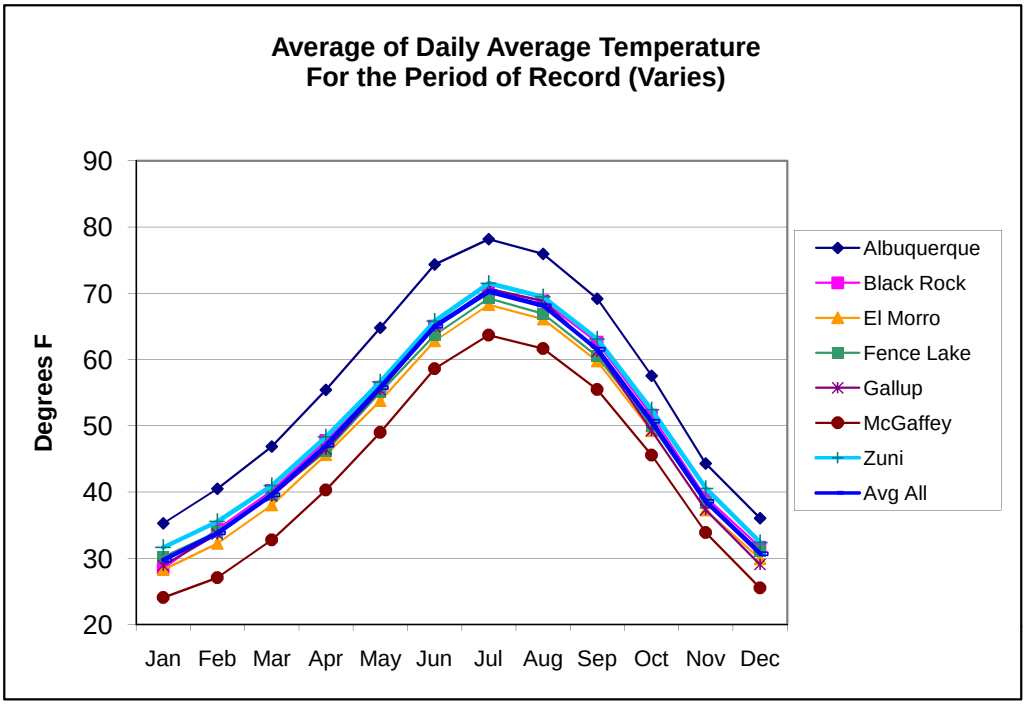
Visitor Center building is located immediately to the right of the photographed area.

Figure 7

Current Location of McGaffey, NM NOAA/NWS Weather Station (295560)

July 2009

Figure 8
NOAA/NWS Weather Stations near Zuni Pueblo, NM
Raw Data



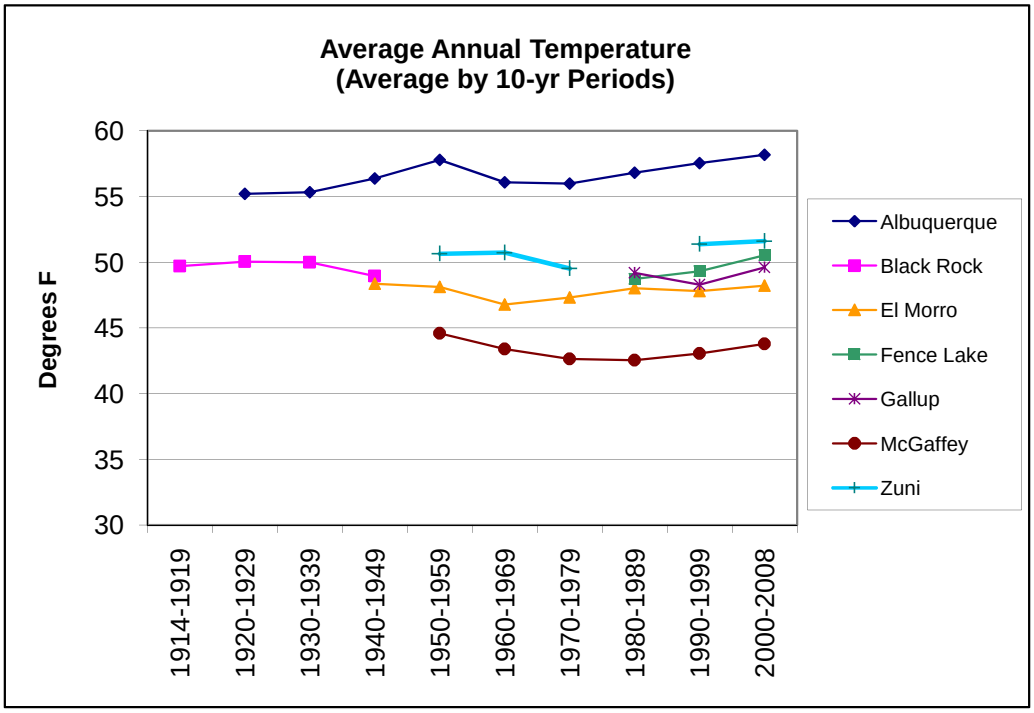
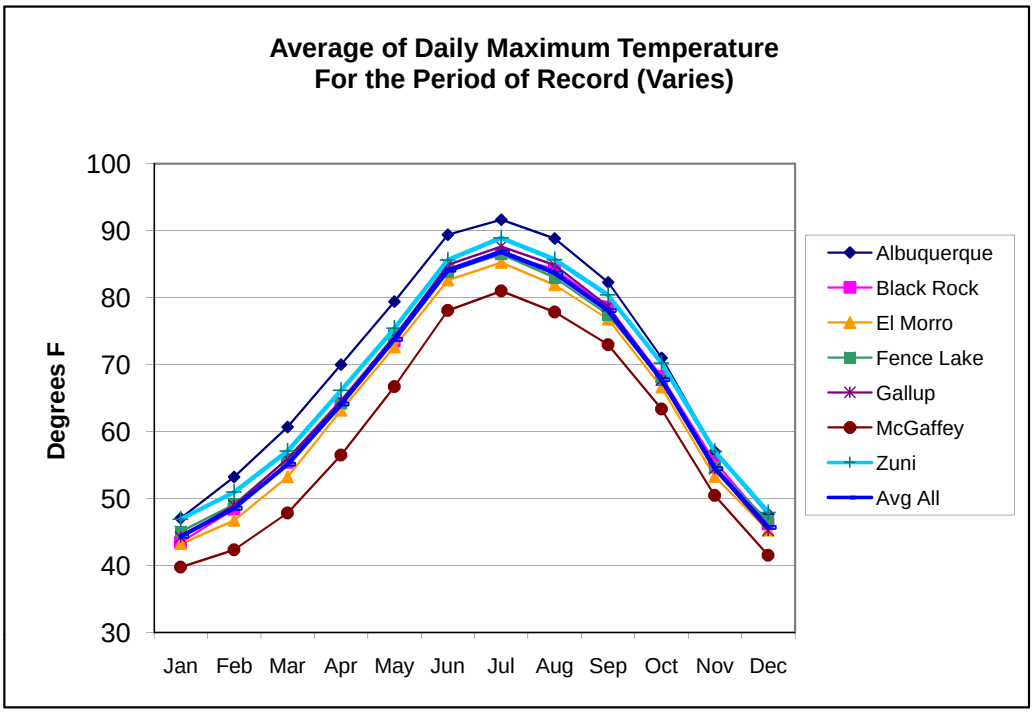


Figure 9

NOAA/NWS Weather Stations near Zuni Pueblo, NM

Raw Data



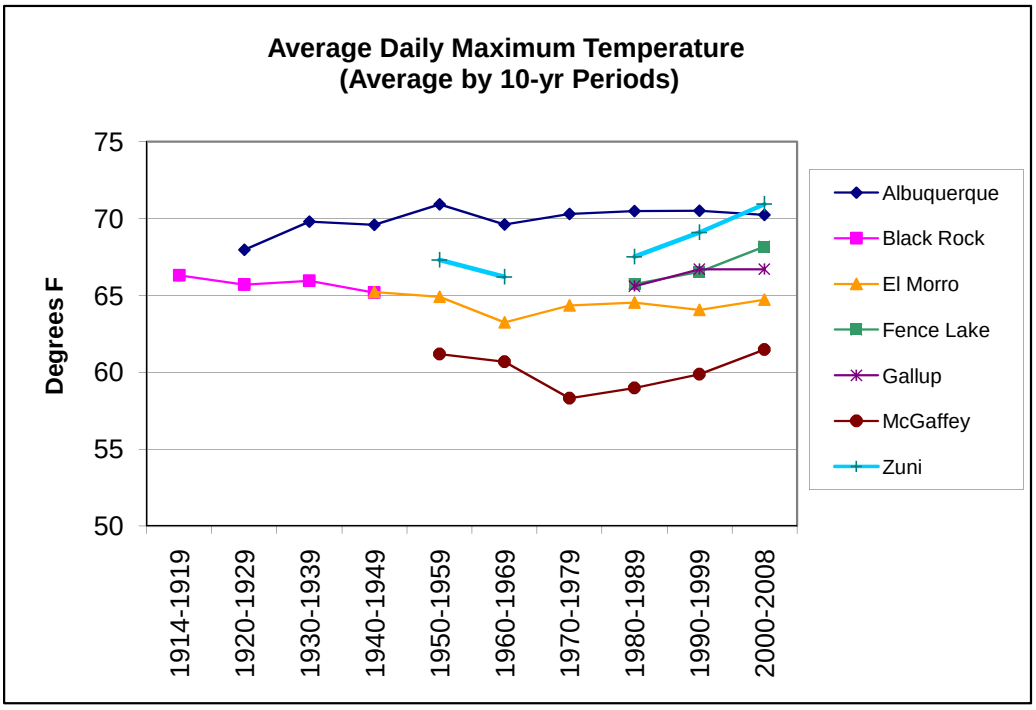
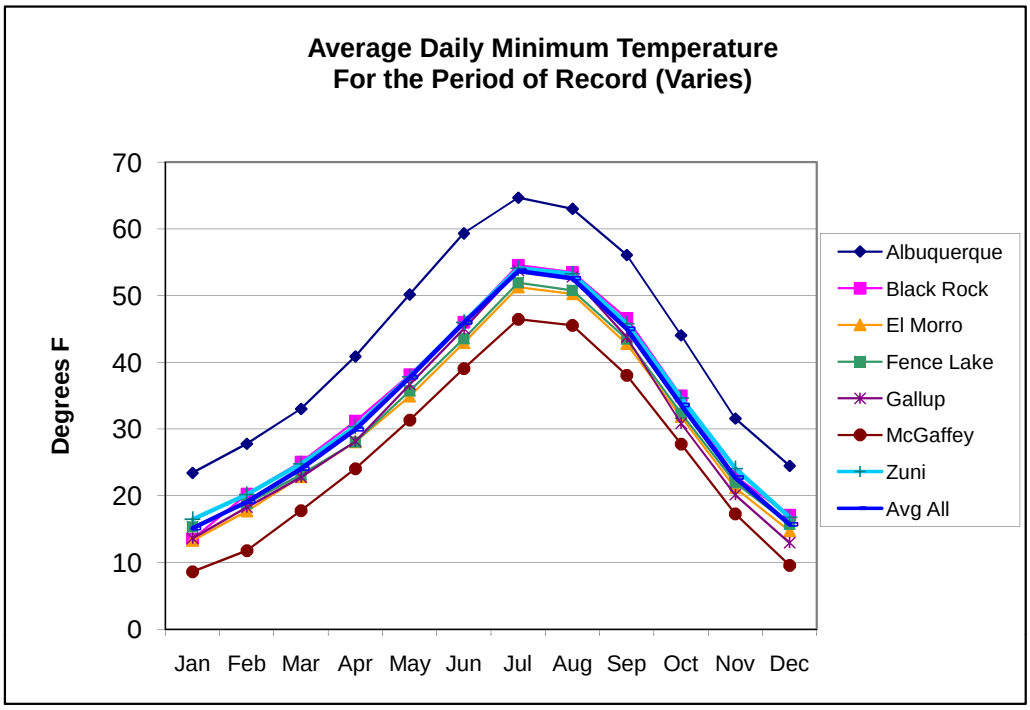


Figure 10

NOAA/NWS Weather Stations near Zuni Pueblo, NM

Raw Data



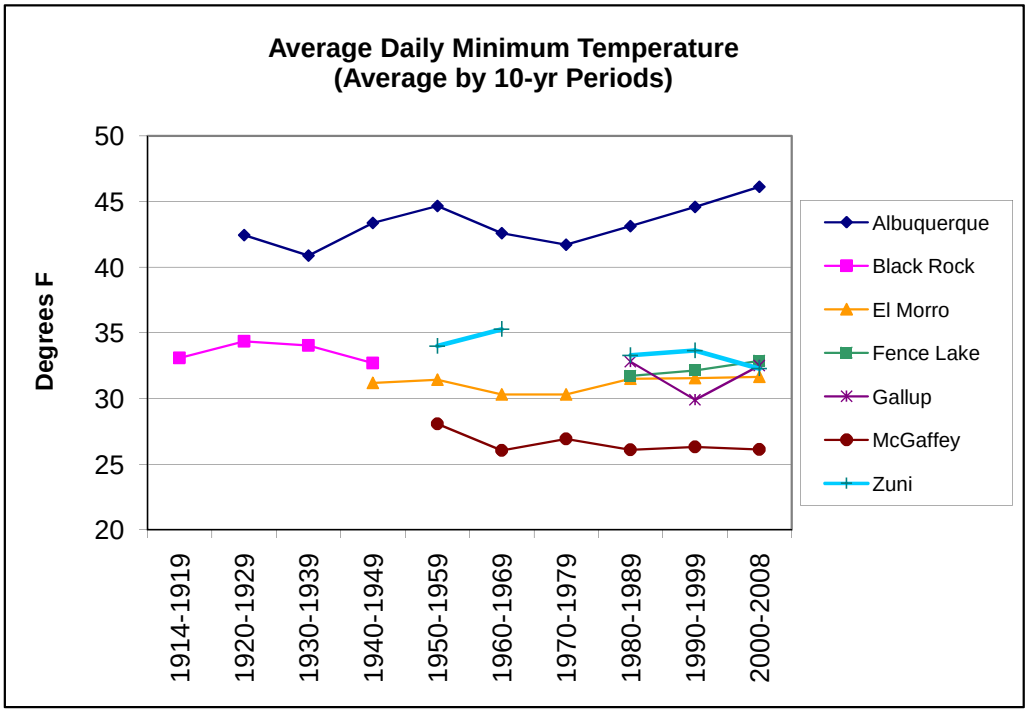
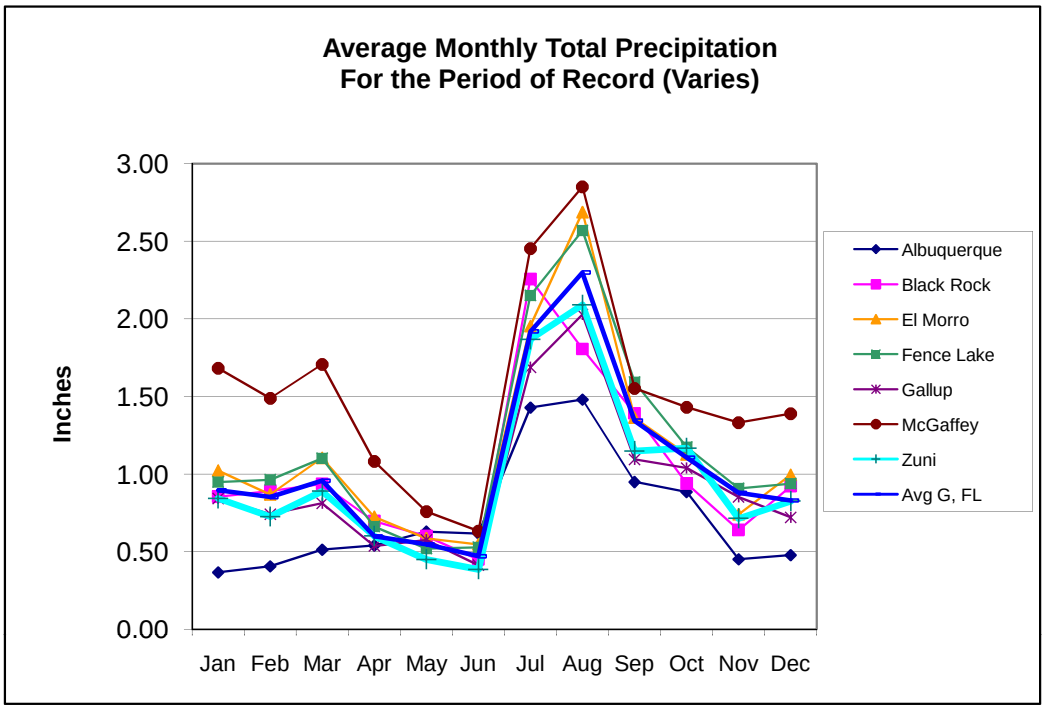


Figure 11
NOAA/NWS Weather Stations near Zuni Pueblo, NM
Raw Data



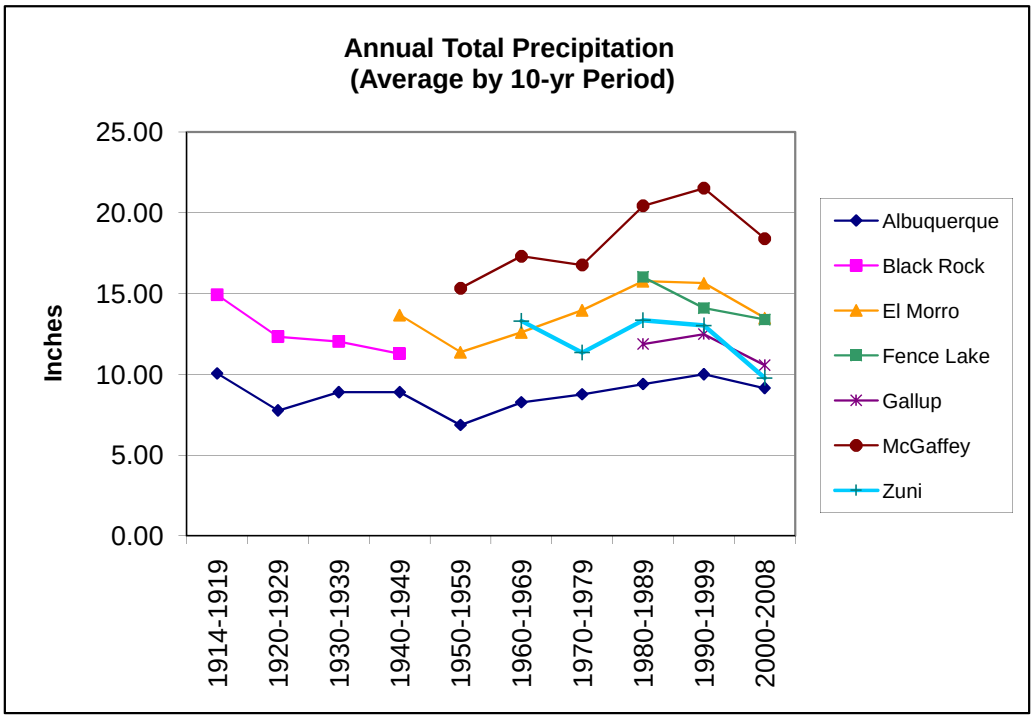


Figure 12
Automated Weather Stations at Ramah and Zuni Buttes, NM
July, 2009

Ramah, NM RAWS

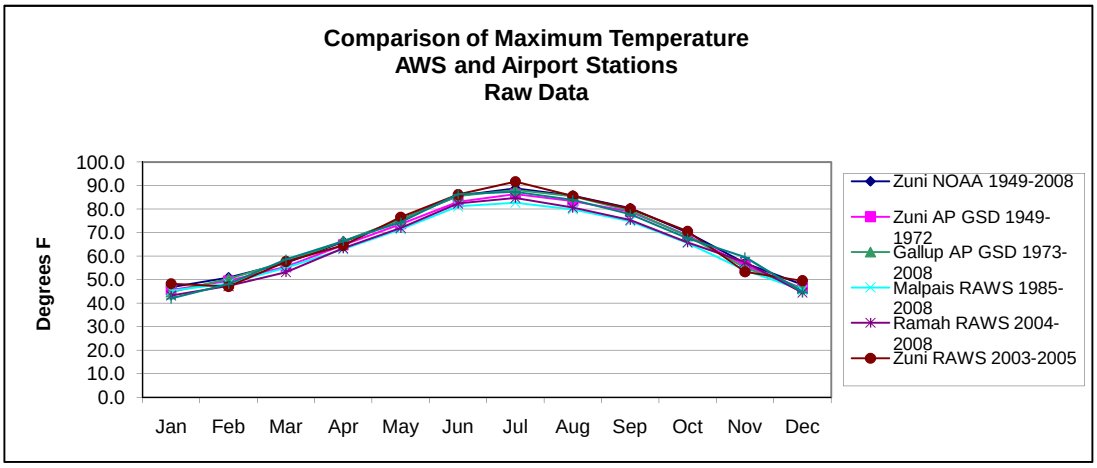
Zuni Buttes, NM RAWS

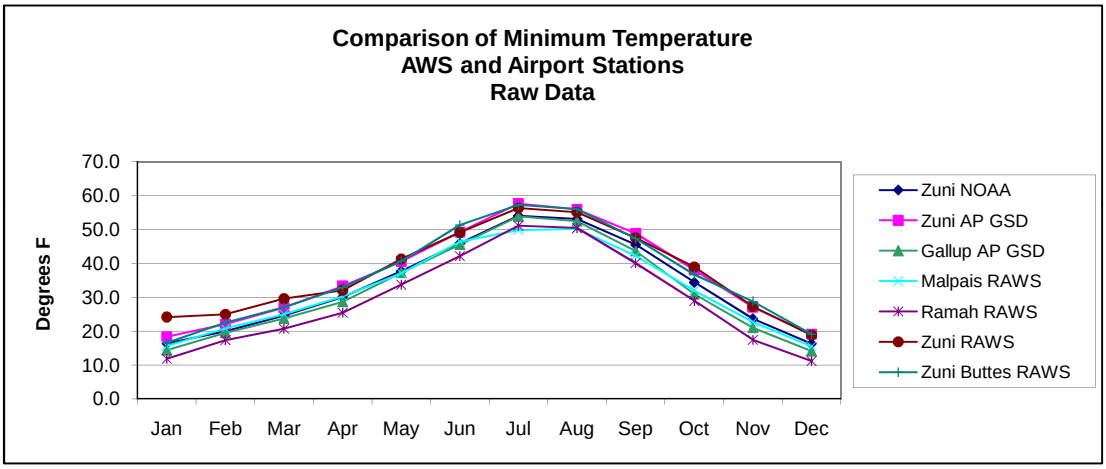
Location of Zuni FAA Airport, NM (Former location of NOAA/NWS 299897, WBAN 93044)

Zuni FAA Airport, NM View 1

Zuni FAA Airport, NM View 2

Figure 13
Automated and Airport Weather Stations near Zuni Pueblo
Summary of Raw Data





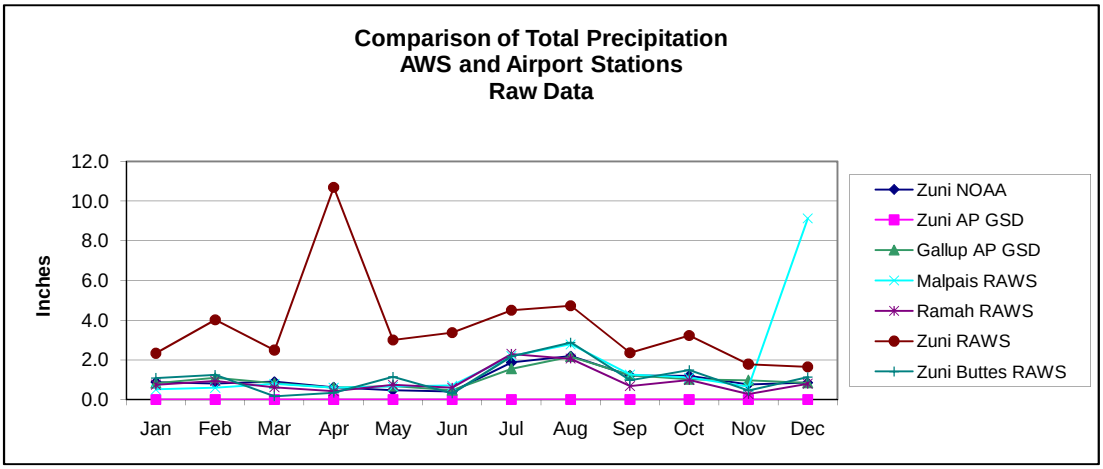
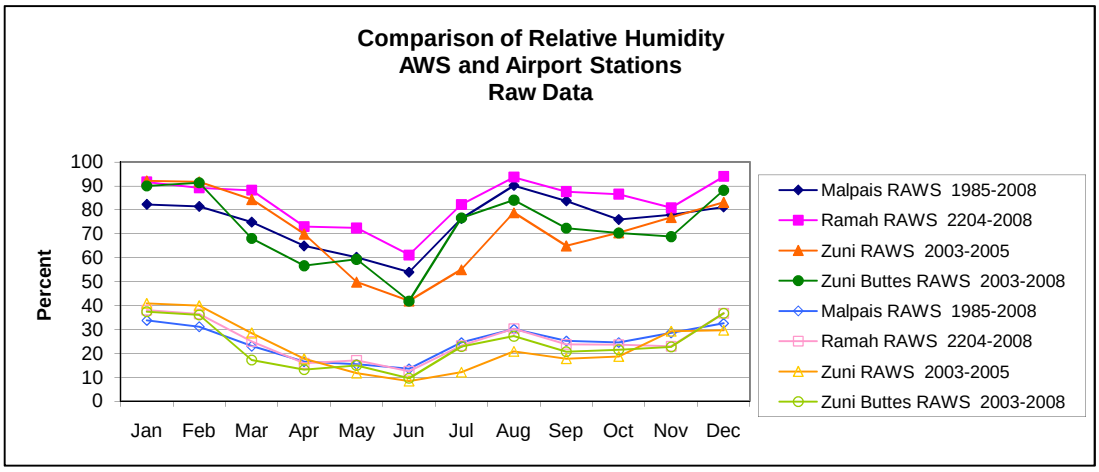
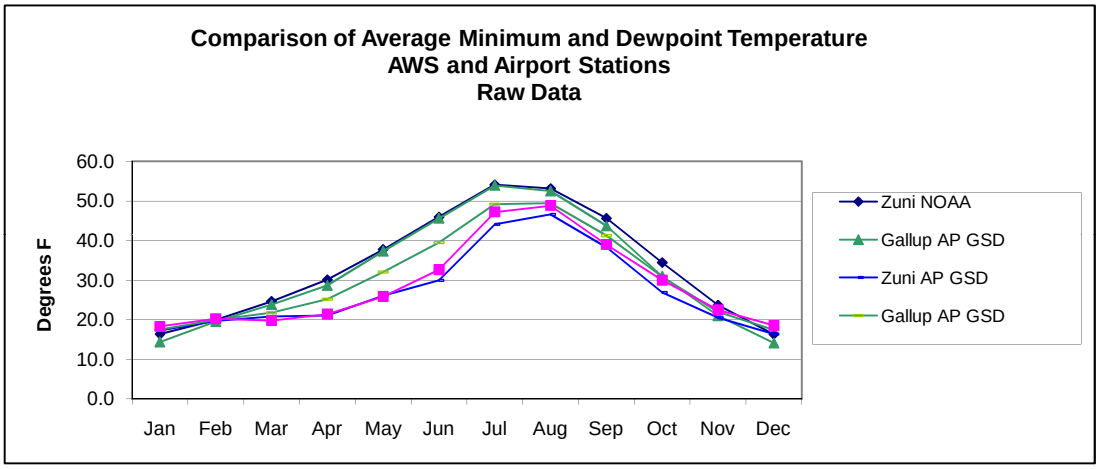


Figure 13
Automated and Airport Weather Stations near Zuni Pueblo
Summary of Raw Data





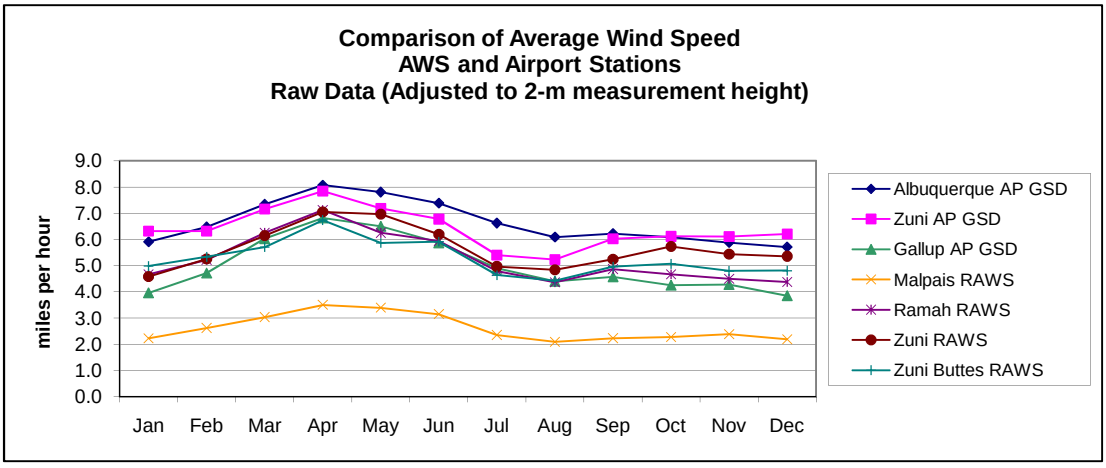


Figure 13
Automated and Airport Weather Stations near Zuni Pueblo
Summary of Raw Data

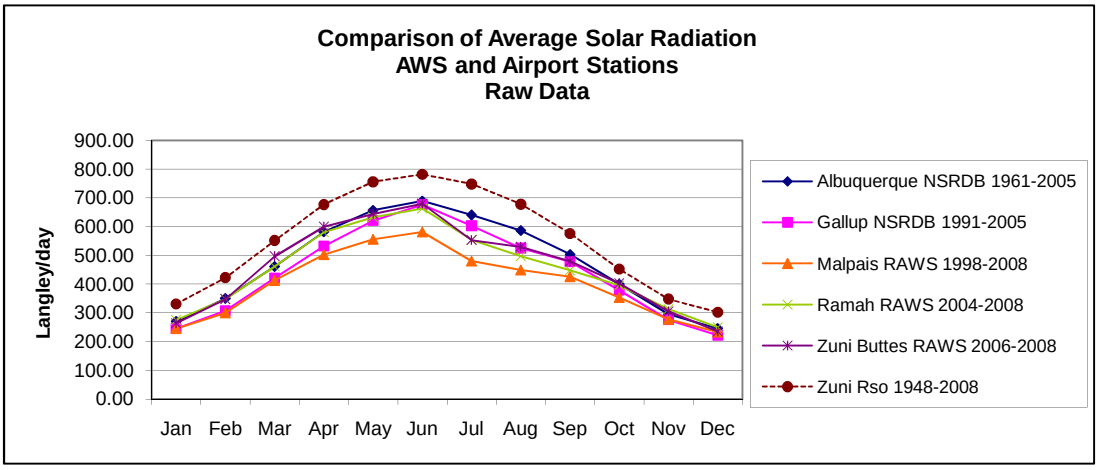


Figure 14
Comparison of Relative Humidity
Automated and Airport Weather Stations
Raw Data

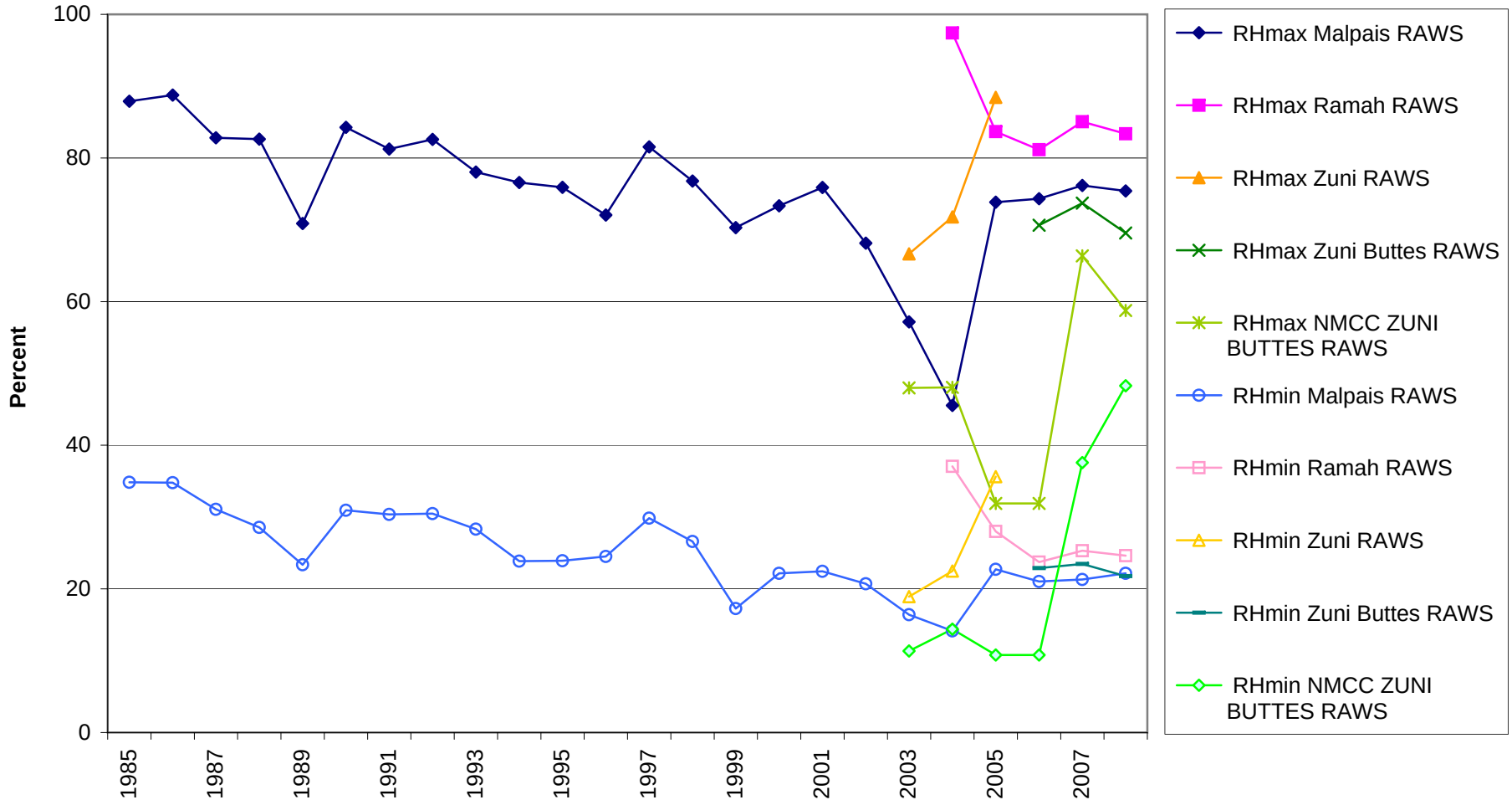


Figure 15

Dewpoint Temperature
Zuni and Gallup Airport Weather Stations
Raw and Adjusted Data

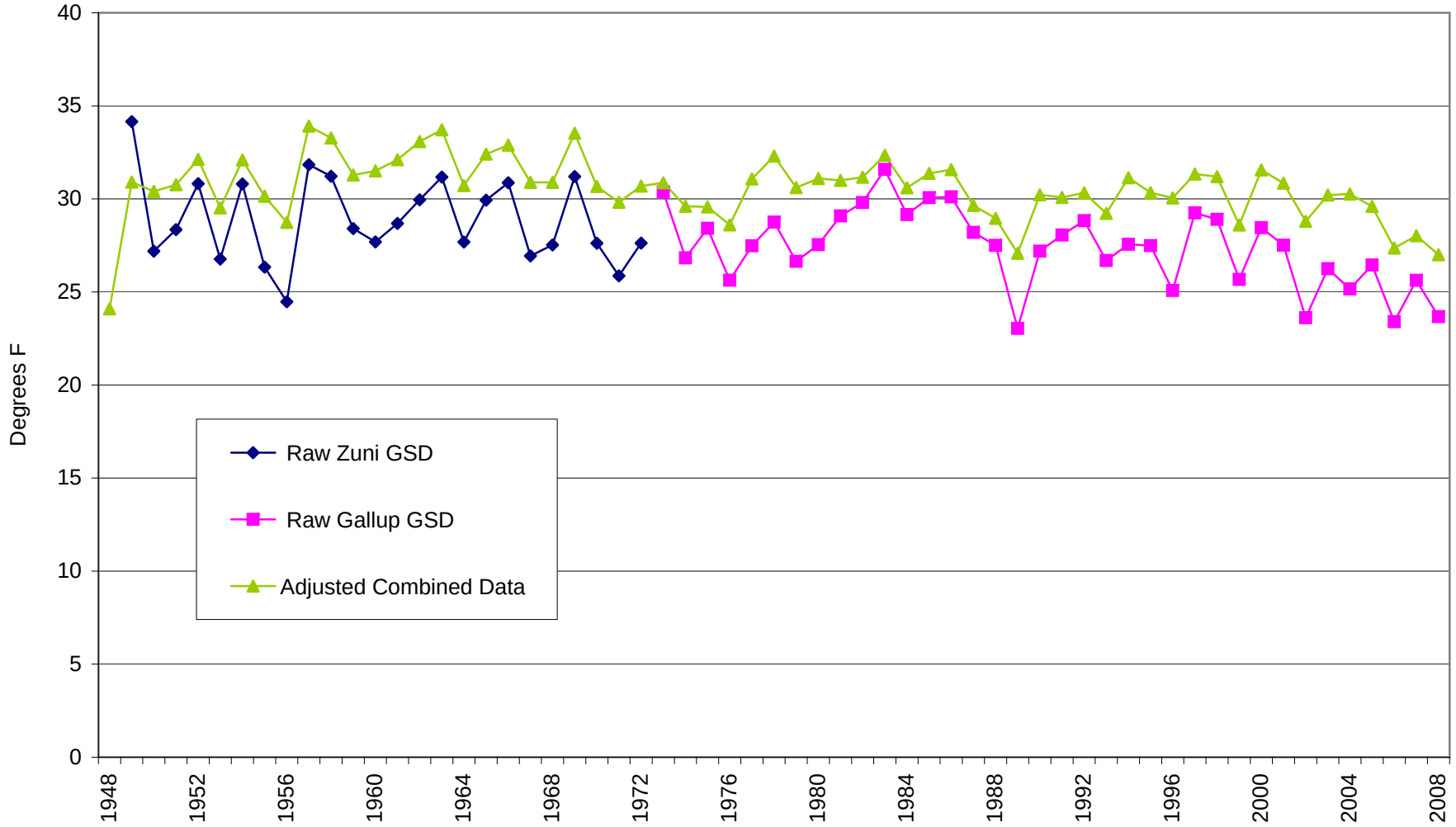
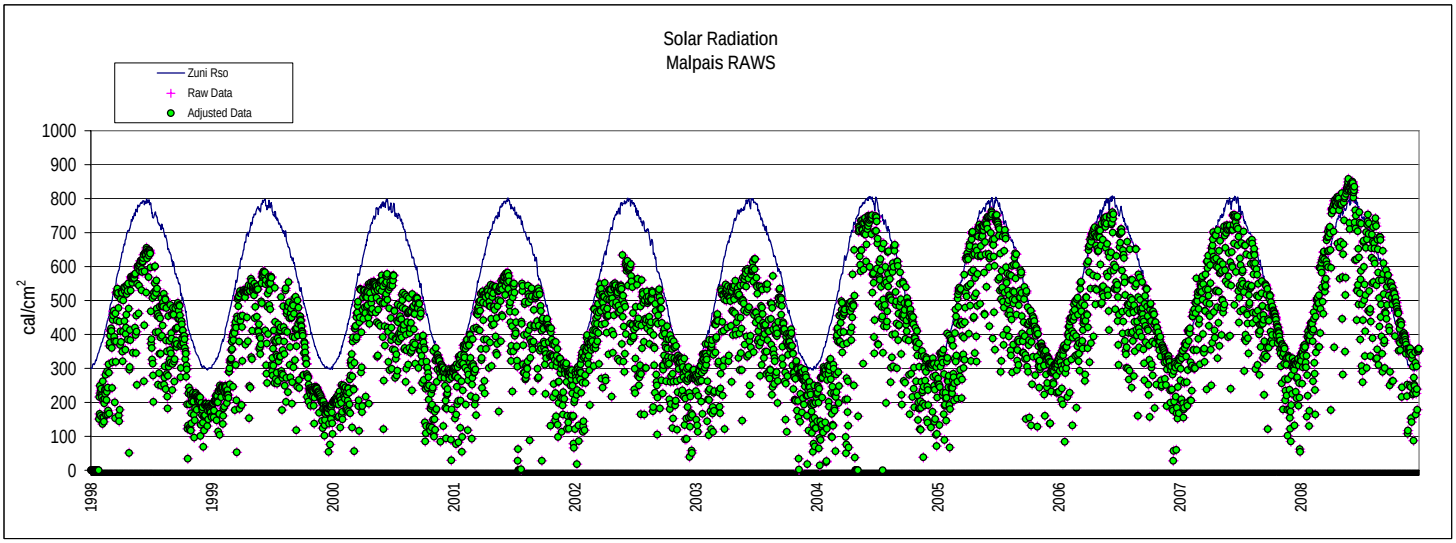
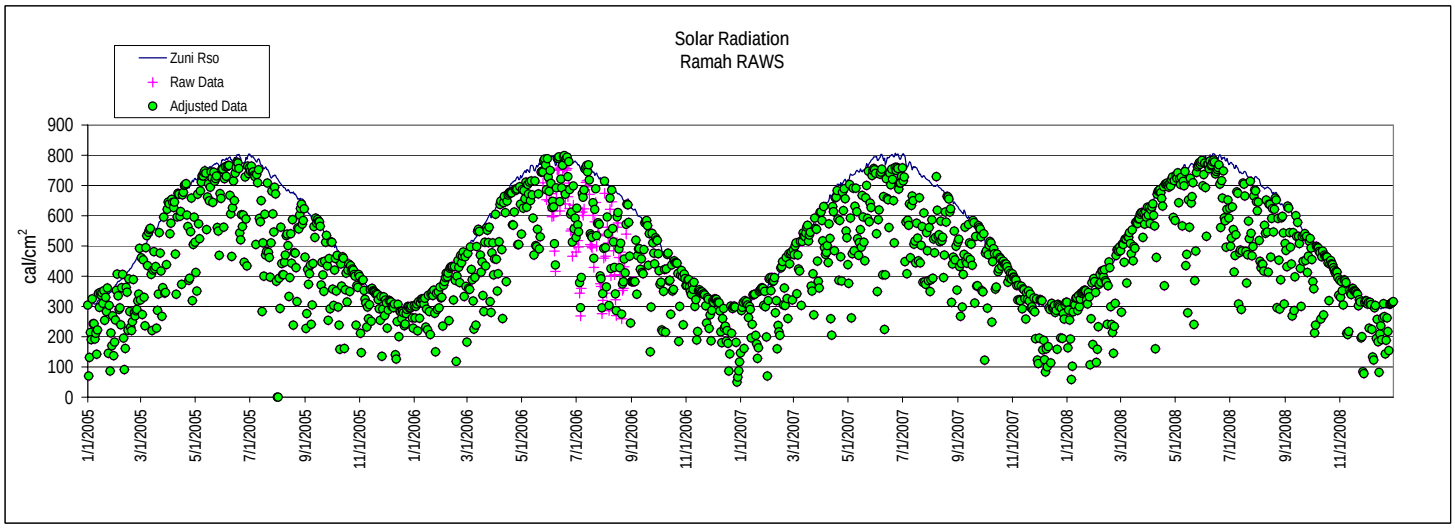


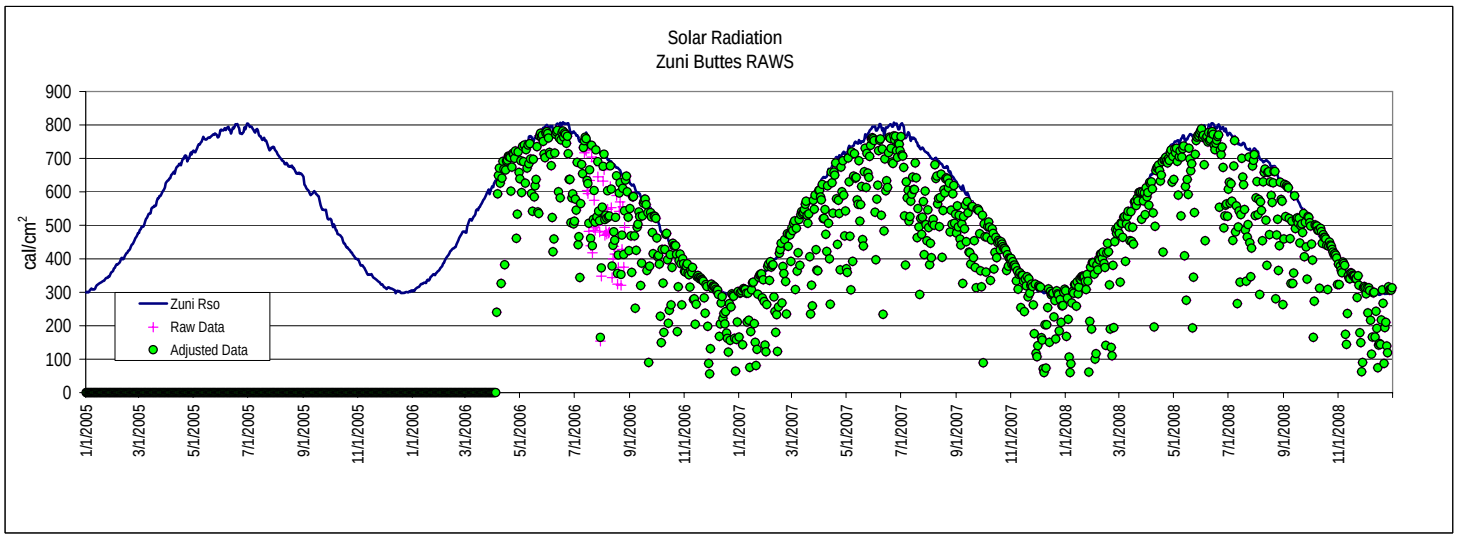
Figure 16

Weather Stations near Zuni Pueblo, New Mexico

Raw and Adjusted Solar Radiation Data







Tables

Table 2

Zuni Pueblo Area
Summary of Weather Data
NOAA/NWS Weather Stations

Monthly Average Maximum Temperature, Degrees F

Station	Period	Elevation, ft	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque	1948-2008	5,350	47.5	53.4	61.1	70.6	80.0	90.1	92.2	89.2	82.7	71.2	57.2	47.7	70.2
Zuni	1949-2008	6,309	46.6	50.7	57.1	66.1	75.4	85.6	88.8	85.7	80.3	70.0	57.0	47.8	67.6
Black Rock	1914-1949	6,450	43.5	48.3	55.3	64.3	73.5	84.1	86.5	83.9	78.5	68.1	55.5	46.0	65.6
Gallup	1973-2008	6,470	44.2	49.0	56.0	64.7	74.2	84.9	87.7	84.9	78.7	67.7	54.4	45.2	66.0
Fence Lake	1964-2007	7,060	45.4	49.6	56.1	64.8	74.6	84.4	86.6	83.0	77.8	68.0	55.4	46.5	66.0
El Morro	1938-2008	7,231	43.2	46.8	53.3	63.2	72.7	82.6	85.3	81.9	76.8	66.6	53.5	44.9	64.2
McGaffey	1949-2008	7,999	39.9	42.5	47.8	56.5	66.8	77.8	81.0	77.8	72.9	63.4	50.5	41.5	59.9

Monthly Average Minimum Temperature, Degrees F

Station	Period	Elevation, ft	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque	1948-2008	5,350	24.0	28.0	33.4	41.3	50.5	60.0	65.3	63.6	56.5	44.5	32.3	24.8	43.7
Zuni	1949-2008	6,309	16.3	19.8	24.6	30.1	37.7	45.9	54.1	53.1	45.6	34.4	23.6	16.3	33.5
Black Rock	1914-1949	6,450	13.5	20.2	24.9	31.2	38.1	46.2	54.5	53.4	46.6	35.0	23.0	16.9	33.6
Gallup	1973-2008	6,470	13.6	18.3	22.8	28.2	36.7	45.0	53.8	52.8	43.8	30.8	20.2	13.0	31.6
Fence Lake	1964-2007	7,060	15.2	18.9	22.9	27.7	35.4	43.5	51.9	50.7	43.4	32.1	22.0	15.1	31.6
El Morro	1938-2008	7,231	13.3	17.7	22.8	28.1	34.9	42.9	51.3	50.3	42.8	31.9	21.2	14.6	31.0
McGaffey	1949-2008	7,999	8.5	11.9	17.7	24.1	31.3	38.9	46.4	45.5	38.1	27.7	17.3	9.6	26.4

Monthly Average Temperature, Degrees F

Station	Period	Elevation, ft	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque	1948-2008	5,350	35.7	40.7	47.3	55.9	65.3	75.1	78.7	76.4	69.6	57.8	44.8	36.2	57.0
Zuni	1949-2008	6,309	31.4	35.3	40.9	48.1	56.6	65.8	71.4	69.4	63.0	52.2	40.3	32.1	50.5
Black Rock	1914-1949	6,450	28.5	34.2	40.1	47.7	55.8	65.2	70.5	68.7	62.6	51.5	39.2	31.4	49.6
Gallup	1973-2008	6,470	28.9	33.6	39.4	46.4	55.4	65.0	70.7	68.8	61.2	49.2	37.3	29.1	48.8
Fence Lake	1964-2007	7,060	30.3	34.2	39.5	46.2	55.0	64.0	69.2	66.8	60.6	50.1	38.7	30.8	48.8
El Morro	1938-2008	7,231	28.2	32.2	38.0	45.6	53.8	62.8	68.3	66.1	59.8	49.2	37.4	29.7	47.6
McGaffey	1949-2008	7,999	24.2	27.2	32.7	40.3	49.0	58.4	63.7	61.6	55.5	45.5	33.9	25.6	43.1

Monthly Average Precipitation, Inches

Station	Period	Elevation, ft	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque	1948-2008	5,350	0.39	0.46	0.54	0.50	0.51	0.57	1.40	1.51	0.94	0.91	0.47	0.49	8.69
Zuni	1949-2008	6,309	0.89	0.74	0.90	0.60	0.46	0.39	1.86	2.19	1.18	1.19	0.74	0.85	11.98
Black Rock	1914-1949	6,450	0.83	0.88	0.92	0.70	0.60	0.47	2.20	1.89	1.39	0.94	0.64	0.92	12.37
Gallup	1973-2008	6,470	0.84	0.74	0.85	0.54	0.59	0.41	1.69	2.03	1.09	1.04	0.85	0.72	11.40
Fence Lake	1964-2007	7,060	0.95	0.87	1.10	0.66	0.47	0.53	2.18	2.59	1.58	1.26	0.91	1.09	14.12
El Morro	1938-2008	7,231	1.02	0.87	1.12	0.72	0.59	0.55	1.95	2.72	1.36	1.15	0.76	1.00	13.82
McGaffey	1949-2008	7,999	1.75	1.48	1.76	1.07	0.76	0.66	2.49	2.85	1.62	1.50	1.40	1.49	18.83

Table 3

NOAA/NWS Weather Stations near Zuni Pueblo, NM
Average Hargreaves-Samani Reference Evapotranspiration

			ETo, inches												
Weather Station	Period	Elevation, ft.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Zuni 299897	1949-2008	6311	1.44	1.91	3.23	4.70	6.54	7.85	8.08	6.96	5.34	3.65	2.03	1.38	53.10
Black Rock 291018	1914-1948	6453	1.29	1.75	3.05	4.46	6.24	7.62	7.66	6.65	5.08	3.46	1.95	1.29	50.51
Gallup 293422	1973-2008	6505	1.30	1.79	3.10	4.54	6.37	7.77	7.89	6.83	5.16	3.45	1.87	1.23	51.28
El Morro 292785	1938-2008	7223	1.26	1.67	2.90	4.39	6.20	7.48	7.63	6.52	5.00	3.38	1.84	1.24	49.53
McGaffey 295560	1949-2008	8000	1.11	1.43	2.46	3.73	5.48	6.90	7.18	6.13	4.69	3.17	1.69	1.09	45.08

Table 4

Black Rock NOAA Station
Monthly Hargreaves-Samani Reference ETo

(Values in Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1914	1.32	1.76	3.06	3.90	6.00	7.06	6.52	6.59	4.93	3.12	2.18	1.03	47.47
1915	1.08	1.45	2.81	4.10	5.53	6.95	6.89	6.67	4.82	3.76	1.95	1.26	47.26
1916	1.15	1.99	3.43	4.53	6.17	7.72	7.11	6.16	4.91	3.09	1.94	1.24	49.42
1917	1.83	1.91	3.42	4.79	6.06	8.06	8.02	7.29	5.53	4.06	2.33	1.73	55.02
1918	1.09	1.72	3.16	4.35	6.08	8.04	7.59	6.73	5.53	3.49	1.76	1.01	50.55
1919	1.01	1.31	2.91	4.78	6.66	8.68	8.26	7.62	5.34	3.23	2.00	1.50	53.30
1920	1.56	1.93	3.02	4.05	6.50	7.64	7.68	7.11	5.19	3.29	1.96	1.24	51.16
1921	1.54	2.02	3.49	4.36	6.25	7.50	7.07	6.16	5.45	3.87	2.32	1.51	51.53
1922	1.28	1.71	2.99	3.99	6.31	8.09	7.88	6.55	5.25	3.28	1.59	1.33	50.24
1923	1.58	1.71	2.58	4.14	6.36	7.69	7.76	5.97	4.62	3.15	1.70	1.13	48.41
1924	1.37	2.09	2.50	4.13	6.44	8.15	7.47	7.25	5.40	3.53	2.23	1.01	51.56
1925	1.11	1.98	3.49	4.91	6.73	6.87	7.57	6.22	4.75	3.25	1.72	1.30	49.91
1926	1.16	1.98	2.86	3.88	5.68	7.62	7.35	7.27	5.15	3.72	2.09	1.06	49.80
1927	1.56	1.80	2.94	4.51	6.47	7.10	7.77	6.65	4.51	3.62	2.19	1.11	50.23
1928	1.66	1.72	3.39	4.42	6.08	7.58	8.03	6.78	4.80	3.60	1.79	1.29	51.14
1929	1.35	1.41	2.95	4.22	6.08	7.92	7.20	6.18	4.78	3.50	1.90	1.71	49.19
1930	1.12	2.07	2.97	5.00	5.75	8.10	7.41	6.96	5.31	3.76	1.82	1.24	51.51
1931	1.32	1.63	3.20	4.47	6.35	7.74	8.08	6.95	5.11	3.63	2.09	0.87	51.44
1932	0.94	1.86	3.02	4.83	6.18	7.55	7.54	6.75	5.33	3.56	2.33	1.02	50.89
1933	1.00	1.39	3.43	4.06	5.97	7.76	7.75	6.00	4.69	2.77	1.73	1.25	47.79
1934	1.31	1.76	3.35	4.46	6.26	7.07	7.04	5.69	4.50	3.78	2.01	1.47	48.70
1935	1.42	1.73	2.95	4.34	5.14	7.68	7.77	6.50	5.10	3.63	1.95	1.34	49.54
1936	1.40	1.65	3.22	4.81	6.69	7.91	7.80	6.68	4.48	3.34	1.98	1.32	51.27
1937	0.80	1.50	2.80	4.64	6.58	7.32	7.74	7.29	5.45	3.75	2.17	1.43	51.46
1938	1.53	1.72	2.94	4.77	6.18	7.50	7.88	7.14	4.97	3.67	1.84	1.46	51.60
1939	1.20	1.16	3.08	4.73	6.56	7.86	8.23	7.36	5.17	3.36	1.97	1.43	52.11
1940	1.19	1.66	3.33	4.37	6.58	7.46	7.68	6.10	4.24	3.05	1.51	1.16	48.32
1941	1.04	1.57	2.62	3.22	5.42	6.20	6.66	6.00	4.56	2.65	1.63	1.04	42.61
1942	1.09	1.41	2.71	4.31	6.04	7.69	7.78	5.97	5.25	3.21	2.02	1.49	48.99
1943	1.46	2.20	3.18	5.22	6.61	7.48	7.94	6.73	5.38	3.59	2.20	1.38	53.37
1944	1.38	1.88	3.01	4.20	6.21	7.63	7.75	7.31	5.34	3.59	1.84	1.35	51.51
1945	1.39	1.93	2.81	4.65	6.65	7.70	8.22	7.16	5.76	3.64	2.07	1.16	53.14
1946	1.18	1.92	3.29	5.28	6.32	8.20	8.12	5.94	5.05	3.26	1.93	1.66	52.15
1947	1.29	2.13	3.42	4.71	6.75	7.54	8.39	5.82	5.61	3.79	1.63	1.32	52.38
1948	1.54	1.71	2.51	5.02	6.77	7.56	8.22	7.20	5.57	3.45	1.84	1.37	52.77
Average	1.29	1.75	3.05	4.46	6.24	7.62	7.66	6.65	5.08	3.46	1.95	1.29	50.51

Table 5

Zuni NOAA Station
Monthly Hargreaves-Samani Reference ETo

(Values in Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1949	0.97	1.54	3.05	4.71	6.21	7.14	7.31	6.97	5.37	3.35	2.52	1.28	50.42
1950	1.45	2.05	3.32	4.99	6.43	7.88	7.44	7.35	5.06	4.37	2.38	1.78	54.50
1951	1.44	1.78	3.08	4.26	6.40	7.64	8.36	6.90	5.65	3.45	1.84	1.14	51.94
1952	1.44	1.79	2.50	4.33	6.35	7.53	7.86	7.20	5.55	4.24	1.63	1.20	51.63
1953	1.64	1.84	3.21	4.42	5.74	7.88	8.12	7.19	6.02	3.75	2.13	1.05	53.00
1954	1.60	2.33	2.79	5.24	6.45	7.79	8.15	6.89	5.46	3.84	2.36	1.36	54.26
1955	1.12	1.39	3.16	4.39	5.96	7.42	7.81	6.56	5.74	4.02	2.08	1.60	51.23
1956	1.62	1.50	3.65	4.38	6.94	8.15	8.11	6.82	5.97	3.71	1.88	1.40	54.13
1957	1.32	2.12	2.94	4.17	5.40	7.48	7.62	6.40	5.54	3.15	1.62	1.55	49.30
1958	1.41	1.91	2.33	4.24	6.92	7.94	8.15	7.07	4.98	3.52	2.03	1.78	52.28
1959	1.65	1.81	3.23	4.72	6.39	7.82	8.34	6.53	5.38	3.44	2.01	1.34	52.66
1960	1.12	1.44	3.44	4.83	6.27	7.72	7.82	7.27	5.52	3.18	2.06	1.22	51.88
1961	1.56	1.82	2.99	4.55	6.55	8.08	7.95	6.40	4.85	3.51	1.67	1.13	51.05
1962	1.18	1.70	2.68	5.09	6.29	7.58	7.75	7.47	5.04	3.55	2.11	1.49	51.93
1963	1.15	1.94	3.14	4.55	6.71	7.64	7.93	6.06	5.24	3.75	1.95	1.49	51.53
1964	1.32	1.46	2.65	4.08	6.42	7.50	7.72	6.41	4.79	3.99	1.84	1.23	49.40
1965	1.45	1.64	2.79	4.36	5.81	6.78	7.22	6.84	4.64	3.96	2.08	1.36	48.92
1966	1.31	1.51	3.50	4.75	6.83	7.41	8.23	6.94	5.00	3.63	2.24	1.26	52.60
1967	1.43	2.07	3.59	4.43	6.15	7.02	7.53	6.32	4.82	3.80	2.23	1.00	50.38
1968	1.28	2.06	3.12	4.04	6.13	7.67	7.55	6.28	5.24	3.64	1.76	1.16	49.92
1969	1.40	1.71	2.75	4.70	6.53	7.38	7.68	6.99	5.21	3.17	1.82	1.50	50.83
1970	1.42	2.02	2.68	3.92	6.55	7.31	7.71	6.97	4.84	3.07	2.10	1.45	50.04
1971	1.59	1.81	3.52	4.42	5.95	7.71	8.14	6.49	5.03	3.05	1.91	1.14	50.74
1972	1.62	2.38	4.01	4.90	6.56	7.10	8.19	6.62	5.06	2.89	1.57	1.25	52.14
1973	1.49	1.92	2.08	3.96	6.39	7.26	7.91	7.11	5.25	3.70	1.99	1.38	50.43
1974	1.16	1.66	3.49	4.42	6.92	8.24	7.22	6.78	5.01	3.11	1.86	1.23	51.08
1975	1.44	1.56	2.85	4.00	5.96	7.55	7.21	7.11	4.68	3.80	2.01	1.27	49.43
1976	1.44	2.07	2.98	4.56	6.37	7.84	7.79	6.70	5.02	3.17	2.10	1.27	51.31
1977	1.12	1.97	2.93	4.64	5.87	7.30	7.36	6.61	4.96	3.62	2.11	1.53	50.02
1978	1.29	1.63	3.23	4.68	6.01	7.52	7.98	6.34	4.60	3.79	1.77	1.04	49.87
1979	1.09	1.71	2.82	4.59	5.28	7.12	7.97	6.76	5.60	3.97	1.68	1.52	50.11
1980	1.22	1.87	2.84	4.50	5.79	7.80	8.36	6.72	5.29	3.76	2.16	1.76	52.07
1981	1.74	2.19	2.76	4.95	5.99	7.61	7.57	6.86	4.90	3.25	2.31	1.57	51.71
1982	1.28	1.71	2.96	4.40	5.88	7.46	7.60	6.46	4.97	3.45	1.75	1.26	49.17
1983	1.41	1.75	2.81	4.06	6.36	7.50	7.92	6.04	4.72	2.93	1.68	1.14	48.30
1984	1.35	2.13	3.45	4.42	7.48	7.53	7.98	6.81	5.26	2.77	2.03	1.38	52.59
1985	1.28	1.70	3.11	5.00	6.45	8.29	8.31	7.43	5.07	3.69	1.92	1.52	53.76
1986	2.10	2.09	3.66	4.77	6.79	7.73	7.61	7.34	5.22	3.49	1.93	1.33	54.05
1987	1.44	1.75	2.93	5.09	6.25	8.05	8.16	6.84	5.60	3.99	1.95	1.38	53.41
1988	1.32	2.22	3.61	4.82	6.77	8.08	8.37	6.72	5.26	4.13	2.05	1.48	54.80
1989	1.43	2.11	4.08	5.78	7.23	8.30	8.67	7.19	5.96	3.63	2.19	1.46	58.03
1990	1.47	1.79	3.13	4.74	6.16	8.74	8.10	7.09	5.37	3.80	2.11	1.16	53.67
1991	1.27	2.25	2.88	4.87	6.98	7.62	8.26	6.99	5.47	4.04	1.90	1.29	53.81
1992	1.27	2.00	3.29	5.39	5.82	7.64	7.79	7.12	5.63	3.84	1.74	1.26	52.79
1993	1.46	1.86	3.49	5.05	6.71	8.24	8.65	6.95	5.61	3.62	1.85	1.56	55.04
1994	1.71	1.92	3.56	4.89	6.77	8.68	8.53	6.94	5.62	3.46	1.83	1.52	55.43
1995	1.42	2.34	3.48	4.41	6.04	7.92	8.71	7.58	5.63	4.11	2.33	1.59	55.54
1996	1.73	2.42	3.66	5.38	7.65	8.33	8.62	7.45	4.91	3.54	2.11	1.52	57.31
1997	1.33	1.97	4.03	4.49	7.05	7.75	8.51	7.32	5.52	3.72	2.11	1.21	55.00
1998	1.53	1.57	3.23	4.29	6.72	7.99	8.07	7.42	5.79	3.71	2.15	1.63	54.10
1999	1.85	2.40	4.03	4.53	6.64	7.98	7.67	6.81	5.48	4.16	2.73	1.46	55.75
2000	1.78	2.57	3.40	5.62	7.86	8.40	8.80	7.62	5.97	3.45	1.63	1.63	58.73
2001	1.42	1.99	3.63	4.98	7.40	8.67	8.26	7.21	5.92	4.05	2.16	1.43	57.09
2002	1.56	2.19	3.68	5.52	7.37	8.95	8.47	7.66	5.46	3.54	2.11	1.23	57.73
2003	1.90	1.79	3.31	4.92	7.24	8.39	9.56	7.53	5.94	4.20	2.07	1.64	58.48
2004	1.56	1.89	4.22	4.76	7.47	8.45	8.71	7.34	5.59	3.64	1.93	1.50	57.03
2005	1.69	1.77	3.11	5.03	7.12	8.21	9.45	7.38	5.90	3.99	2.40	1.55	57.61
2006	1.83	2.31	3.21	5.49	7.85	8.96	8.59	6.88	5.22	3.58	2.34	1.47	57.71
2007	1.42	1.93	3.90	5.12	6.92	8.82	9.03	7.67	5.94	4.14	2.59	1.31	58.78
2008	1.35	1.96	3.73	5.27	6.75	8.57	8.40	7.84	5.93	3.98	2.30	1.41	57.48
Average	1.44	1.91	3.23	4.70	6.54	7.85	8.08	6.96	5.34	3.65	2.03	1.38	53.10

Table 6
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El Morro National Monument NOAA Station
Monthly Hargreaves-Samani Reference ETo

(Values in Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1938	1.31	1.69	2.73	4.45	5.85	7.18	7.55	6.95	4.62	3.47	1.72	1.36	48.88
1939	1.09	1.00	2.74	4.44	6.23	7.40	7.74	6.84	4.79	3.33	1.86	1.43	48.89
1940	1.18	1.58	3.12	4.32	6.55	7.46	7.82	6.60	4.44	3.37	1.77	1.37	49.57
1941	1.15	1.56	2.56	3.31	5.72	6.63	7.45	6.31	4.83	2.99	1.91	1.11	45.54
1942	1.37	1.52	2.68	4.32	6.61	7.77	8.37	6.72	5.44	3.35	2.25	1.41	51.79
1943	1.43	2.09	3.02	5.13	6.44	7.41	7.84	6.59	5.24	3.45	2.09	1.29	52.02
1944	1.31	1.71	2.83	4.07	6.16	7.49	7.80	7.21	5.05	3.30	1.62	1.28	49.82
1945	1.24	1.81	2.63	4.39	6.43	7.41	7.98	7.01	5.40	3.43	2.01	1.06	50.80
1946	1.07	1.63	3.13	5.10	6.01	8.03	7.61	5.94	4.46	3.13	1.84	1.56	49.51
1947	1.18	1.92	3.16	4.37	6.41	7.09	8.01	5.74	5.17	3.58	1.63	1.14	49.40
1948	1.49	1.64	2.37	4.89	6.44	7.46	8.21	6.67	5.42	3.37	1.62	1.34	50.91
1949	0.96	1.40	3.00	4.70	6.34	7.22	7.18	6.93	5.21	3.24	2.37	1.19	49.71
1950	1.34	1.82	3.10	4.76	6.26	7.89	7.12	7.15	4.85	4.13	2.16	1.63	52.21
1951	1.34	1.60	2.87	4.15	6.33	7.52	8.14	6.47	5.51	3.28	1.72	1.08	50.01
1952	1.27	1.54	2.29	4.14	6.15	7.50	7.69	6.68	5.28	3.98	1.53	1.08	49.12
1953	1.44	1.62	2.98	4.16	5.58	7.80	7.71	6.92	5.71	3.49	1.98	1.03	50.43
1954	1.39	2.12	2.66	5.06	6.31	7.72	7.69	6.33	4.99	3.58	2.15	1.33	51.34
1955	1.00	1.27	2.99	4.29	5.78	7.23	7.26	5.86	5.52	3.75	1.87	1.35	48.16
1956	1.45	1.27	3.28	4.23	6.68	7.71	7.62	6.64	5.80	3.51	1.73	1.30	51.22
1957	1.23	1.93	2.65	3.99	5.26	7.35	7.10	5.98	5.35	2.89	1.39	1.37	46.49
1958	1.28	1.74	2.28	4.08	6.67	7.75	7.81	6.91	4.88	3.37	1.85	1.60	50.23
1959	1.43	1.63	2.97	4.52	6.35	7.74	8.15	6.08	5.15	3.21	1.84	1.25	50.31
1960	0.97	1.28	3.08	4.57	6.07	7.68	7.75	7.15	5.41	3.03	1.90	1.04	49.93
1961	1.35	1.71	2.83	4.38	6.49	8.05	7.83	6.36	4.72	3.25	1.50	1.03	49.49
1962	1.09	1.61	2.43	4.74	6.21	7.39	7.59	7.33	4.90	3.31	1.92	1.33	49.85
1963	0.94	1.69	2.88	4.47	6.63	7.48	7.92	5.84	4.83	3.60	1.78	1.30	49.36
1964	1.13	1.21	2.30	3.88	6.15	7.29	7.61	6.18	4.60	3.67	1.74	1.00	46.77
1965	1.28	1.48	2.55	4.11	5.59	6.67	7.05	6.80	4.65	3.76	1.94	1.18	47.04
1966	1.08	1.22	3.06	4.39	6.39	7.14	7.93	6.58	4.73	3.38	2.06	1.16	49.09
1967	1.30	1.85	3.37	4.39	6.00	6.66	7.28	6.09	4.71	3.71	2.05	0.91	48.31
1968	1.17	1.78	2.85	3.93	5.84	7.50	7.17	5.92	4.86	3.47	1.60	1.08	47.16
1969	1.27	1.54	2.50	4.57	6.37	7.35	7.66	6.87	4.91	3.07	1.75	1.37	49.21
1970	1.30	1.88	2.58	3.81	6.46	7.38	7.80	6.75	4.98	2.90	1.95	1.37	49.14
1971	1.45	1.70	3.27	4.36	5.99	7.66	8.21	6.37	5.01	2.98	1.86	1.05	49.88
1972	1.50	2.19	3.88	4.79	6.38	7.16	8.02	6.44	4.73	2.94	1.43	1.18	50.63
1973	1.12	1.39	2.17	3.60	5.68	7.27	7.58	6.89	5.11	3.70	2.01	1.35	47.86
1974	1.17	1.73	3.44	4.44	6.86	8.19	7.46	6.52	4.91	3.01	1.82	1.13	50.69
1975	1.24	1.42	2.72	3.80	5.77	7.41	7.22	6.80	4.34	3.64	2.03	1.17	47.57
1976	1.25	2.10	3.00	4.40	6.07	7.67	7.58	6.61	4.87	3.42	1.94	1.38	50.29
1977	1.09	1.74	2.81	4.65	6.04	7.92	7.44	7.04	5.08	3.63	1.99	1.50	50.92
1978	1.20	1.51	3.20	4.63	6.03	7.81	8.36	7.13	5.38	3.80	1.78	1.03	51.85
1979	0.90	1.56	2.56	4.42	5.51	7.17	8.10	6.64	5.60	3.93	1.52	1.43	49.32

Table 6
Page (2 of 2)

El Morro National Monument NOAA Station
Monthly Hargreaves-Samani Reference ETo

(Values in Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1.19	1.78	2.69	4.36	5.94	8.21	8.36	6.76	5.26	3.70	2.06	1.73	52.03
1981	1.60	2.02	2.64	4.81	5.92	7.84	7.50	6.83	5.05	3.25	2.20	1.51	51.16
1982	1.20	1.56	2.79	4.40	5.96	7.54	7.53	6.19	4.83	3.43	1.65	1.11	48.19
1983	1.31	1.62	2.41	3.62	6.11	7.17	7.72	6.84	5.23	3.21	1.81	1.18	48.22
1984	1.39	1.92	3.15	4.07	7.12	7.32	7.66	6.20	4.87	2.48	1.80	1.20	49.16
1985	1.19	1.48	2.71	4.70	6.21	8.08	7.81	6.98	4.83	3.41	1.77	1.38	50.55
1986	1.90	1.92	3.25	4.33	6.17	7.12	6.80	6.63	4.79	3.09	1.68	1.13	48.80
1987	1.24	1.47	2.51	4.56	5.54	7.29	7.56	6.18	4.97	3.62	1.69	1.14	47.77
1988	1.16	1.88	3.11	4.34	6.12	7.08	7.23	5.71	4.84	3.69	1.81	1.22	48.18
1989	1.19	1.83	3.65	5.24	6.77	7.78	7.71	6.34	5.23	3.25	1.92	1.34	52.23
1990	1.31	1.63	3.05	4.31	6.04	8.10	6.84	6.28	4.94	3.35	1.85	0.98	48.68
1991	1.06	1.87	2.54	4.42	6.43	6.94	7.18	6.33	4.86	3.67	1.64	1.08	48.01
1992	1.11	1.65	2.95	4.85	5.24	6.99	7.07	6.30	5.15	3.51	1.45	1.05	47.32
1993	1.21	1.50	3.05	4.55	5.97	7.42	7.71	5.96	5.10	3.17	1.63	1.32	48.60
1994	1.46	1.57	3.11	4.28	6.16	7.86	7.89	6.82	4.83	3.11	1.64	1.30	50.04
1995	1.19	2.03	3.07	4.00	5.70	7.19	7.77	6.77	4.92	3.68	2.04	1.37	49.71
1996	1.46	2.01	3.15	4.71	7.08	7.62	7.64	6.72	4.51	3.21	1.82	1.26	51.17
1997	1.10	1.67	3.49	3.84	6.25	7.10	7.29	6.28	4.82	3.29	1.69	0.95	47.76
1998	1.33	1.25	2.65	4.00	6.26	7.35	7.10	6.40	5.17	3.28	1.90	1.39	48.07
1999	1.58	2.08	3.49	4.17	6.03	7.17	6.66	6.07	4.90	3.74	2.73	1.26	49.87
2000	1.47	2.12	3.03	4.96	7.28	7.50	7.91	6.98	5.43	2.89	1.31	1.32	52.21
2001	1.11	1.86	2.95	4.57	6.51	7.74	7.40	6.23	5.25	3.58	1.84	1.16	50.21
2002	1.24	1.80	3.17	5.02	6.64	8.14	7.46	6.84	4.65	3.08	1.78	1.03	50.85
2003	1.64	1.51	2.81	4.50	6.44	7.44	8.50	6.38	5.14	3.76	1.74	1.38	51.22
2004	1.26	1.52	3.63	4.06	6.63	7.53	7.62	6.31	4.80	3.16	1.55	1.26	49.31
2005	1.39	1.44	2.57	4.42	6.47	7.37	8.27	6.24	5.03	3.34	2.07	1.37	49.96
2006	1.53	2.03	2.79	4.98	6.94	7.88	7.33	5.58	4.15	2.84	1.81	0.99	48.86
2007	0.99	1.46	3.08	4.09	5.49	7.46	7.74	6.51	5.03	3.49	2.24	1.06	48.63
2008	1.05	1.62	3.12	4.52	6.03	7.54	7.07	6.44	4.97	3.41	1.94	1.21	48.92
Average	1.26	1.67	2.90	4.39	6.20	7.48	7.63	6.52	5.00	3.38	1.84	1.24	49.53

Table 7

McGaffey NOAA Station
Monthly Hargreaves-Samani Reference ETo

(Values in Inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1949	0.99	1.23	2.51	3.97	5.41	6.58	6.94	6.39	4.81	2.99	2.10	1.04	44.97
1950	1.14	1.59	2.61	4.22	5.60	7.18	6.69	6.52	4.40	3.68	1.97	1.40	47.00
1951	1.09	1.43	2.46	3.49	5.59	6.80	7.39	6.28	5.09	2.91	1.44	0.94	44.89
1952	1.05	1.23	1.86	3.60	5.46	6.86	7.10	6.32	4.86	3.68	1.35	0.92	44.28
1953	1.32	1.34	2.56	3.63	4.68	6.97	7.24	6.19	5.35	3.37	1.49	0.86	45.01
1954	1.21	1.80	2.26	4.44	5.30	7.05	7.04	6.19	4.40	2.77	1.87	1.16	45.47
1955	0.83	1.01	2.56	3.85	5.72	6.77	6.65	5.60	5.05	3.41	1.69	1.12	44.25
1956	1.14	1.49	2.48	3.73	5.94	7.23	6.83	6.14	4.88	3.32	1.68	1.15	46.02
1957	1.03	1.77	2.36	3.43	4.53	6.77	7.10	5.89	4.95	2.85	1.34	1.35	43.35
1958	1.14	1.51	1.94	3.46	6.09	7.23	7.81	6.39	4.44	3.32	1.74	1.45	46.52
1959	1.38	1.38	2.76	4.13	5.96	7.36	7.66	6.05	5.20	3.02	1.80	1.25	47.95
1960	0.94	1.09	2.65	4.02	5.66	7.01	8.12	7.28	5.56	2.91	1.81	1.03	48.09
1961	1.34	1.61	2.48	3.88	6.14	7.62	7.61	6.36	4.90	3.35	1.47	1.02	47.79
1962	1.10	1.47	2.15	4.09	5.71	7.40	7.69	6.94	4.79	3.44	1.99	1.17	47.93
1963	0.99	1.60	2.60	3.66	6.26	6.90	7.82	5.84	4.96	3.73	1.86	1.37	47.58
1964	1.11	1.14	2.02	3.55	5.84	7.27	7.52	6.22	4.47	3.55	1.72	1.08	45.48
1965	1.27	1.34	2.17	3.53	4.94	5.92	7.06	6.43	4.57	3.69	2.01	1.15	44.07
1966	0.98	1.25	2.76	4.04	5.99	6.98	7.67	6.49	4.80	3.22	2.01	1.19	47.37
1967	1.17	1.72	2.98	3.68	5.40	6.27	6.68	6.08	4.56	3.44	2.05	0.90	44.92
1968	1.15	1.58	2.47	3.29	5.36	7.17	7.16	5.65	4.67	3.40	1.56	1.03	44.47
1969	1.23	1.31	2.18	3.86	5.28	6.94	7.26	6.33	4.39	2.68	1.45	1.23	44.15
1970	1.04	1.67	1.98	3.31	5.62	6.62	7.09	6.02	4.43	2.57	1.65	1.19	43.18
1971	1.11	1.36	2.66	3.65	5.14	6.81	7.44	6.07	4.49	2.57	1.69	0.90	43.89
1972	1.18	1.78	3.30	4.00	5.59	6.37	7.20	6.08	4.37	2.56	1.18	0.90	44.51
1973	0.92	1.18	1.85	2.86	4.78	6.29	6.79	6.24	4.50	3.26	1.78	1.09	41.54
1974	0.94	1.29	2.81	3.56	5.96	7.48	6.59	5.93	4.61	2.85	1.58	0.96	44.56
1975	1.02	1.21	2.05	3.00	4.87	6.54	6.52	6.31	4.14	3.15	1.72	1.03	41.53
1976	1.07	1.64	2.29	3.66	5.19	6.74	6.77	5.76	4.24	2.84	1.71	1.13	43.05
1977	0.90	1.38	2.12	3.87	5.03	6.90	6.89	6.05	4.43	3.12	1.69	1.14	43.52
1978	0.99	1.24	2.31	3.61	5.00	6.96	7.44	6.34	4.51	3.24	1.44	0.74	43.81
1979	0.73	1.32	2.05	3.44	4.51	6.18	7.38	6.02	5.13	3.45	1.23	1.23	42.66
1980	0.93	1.39	2.07	3.41	4.85	7.18	7.36	6.15	4.69	3.09	1.78	1.48	44.38
1981	1.42	1.67	2.09	3.90	5.14	7.07	6.59	6.09	4.40	2.87	1.94	1.27	44.45
1982	1.02	1.35	2.13	3.63	4.98	6.66	6.87	5.59	4.39	2.95	1.40	0.91	41.88
1983	1.20	1.32	2.07	2.96	4.90	6.33	6.95	5.94	4.83	2.85	1.61	0.96	41.92
1984	1.17	1.50	2.62	3.38	6.17	6.39	6.85	5.75	4.63	2.24	1.66	1.09	43.45
1985	1.01	1.19	2.37	3.82	5.22	7.04	7.03	6.27	4.39	3.06	1.46	1.20	44.04
1986	1.60	1.59	2.93	3.74	5.32	6.40	6.39	6.17	4.17	2.88	1.58	1.05	43.81
1987	1.09	1.26	2.24	3.90	4.88	6.72	6.99	5.50	4.56	3.48	1.63	0.99	43.22
1988	1.03	1.61	2.61	3.57	5.32	6.45	6.71	5.58	4.50	3.55	1.64	1.03	43.59
1989	0.99	1.46	3.07	4.70	6.16	7.07	7.69	6.18	4.98	3.07	1.79	1.19	48.35
1990	1.06	1.31	2.54	3.80	5.26	7.37	6.54	5.81	4.64	3.15	1.78	0.91	44.17
1991	0.95	1.72	2.09	3.62	5.56	6.27	6.92	6.06	4.66	3.46	1.36	0.95	43.60
1992	0.97	1.40	2.47	4.28	4.92	6.43	6.75	5.93	4.91	3.43	1.33	0.84	43.65
1993	1.06	1.24	2.46	3.79	5.45	6.74	7.35	5.99	4.75	3.05	1.52	1.15	44.54
1994	1.32	1.34	2.68	3.55	5.33	7.50	7.85	6.44	4.56	2.98	1.43	1.18	46.17
1995	1.04	1.74	2.47	3.26	4.68	6.44	7.25	6.36	4.67	3.43	1.97	1.28	44.57
1996	1.24	1.84	2.61	4.31	6.55	7.23	7.38	6.27	4.08	2.99	1.64	1.10	47.22
1997	0.95	1.43	3.06	3.25	5.47	6.44	7.42	5.76	4.64	3.16	1.71	0.95	44.22
1998	1.21	1.13	2.25	3.16	5.45	6.70	7.11	6.26	5.03	3.12	1.75	1.24	44.41
1999	1.35	1.81	3.12	3.51	5.53	6.71	6.39	5.73	4.50	3.65	2.40	1.04	45.73
2000	1.34	1.73	2.69	4.56	6.67	7.14	7.60	6.57	5.16	2.88	1.14	1.24	48.71
2001	1.03	1.45	2.73	4.03	6.08	7.54	7.38	5.83	5.20	3.74	1.95	1.03	47.99
2002	1.02	1.44	2.58	4.48	6.00	7.80	7.27	6.60	4.59	3.10	1.71	0.87	47.45
2003	1.44	1.21	2.43	3.63	5.84	7.21	8.45	6.46	4.97	3.68	1.67	1.19	48.18
2004	1.04	1.21	3.19	3.44	5.97	7.22	7.21	6.25	4.69	3.00	1.36	1.22	45.76
2005	1.27	1.27	2.20	3.62	5.47	6.43	7.95	5.68	4.68	3.10	2.11	1.17	44.96
2006	1.34	1.64	2.26	4.42	6.34	7.59	6.77	5.34	4.28	3.01	1.98	1.09	46.06
2007	1.01	1.37	2.87	3.64	5.57	7.59	7.57	6.45	4.93	3.42	2.24	0.98	47.63
2008	0.94	1.46	2.75	3.96	5.36	7.10	7.05	6.66	5.00	3.37	1.96	1.02	46.63
Average	1.11	1.43	2.46	3.73	5.48	6.90	7.18	6.13	4.69	3.17	1.69	1.09	45.08

Table 8

Modified Blaney-Criddle Method
Crop Coefficients[1] and Growing Season Criteria[2]
Zuni Pueblo Area, New Mexico

	Monthly Coefficients													
Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Growing Season Start Date Criteria	Growing Season End Date Criteria
Alfalfa	0.63	0.73	0.86	0.99	1.08	1.13	1.11	1.06	0.99	0.91	0.78	0.64	50 Mean	28 Frost
Pasture/Grass Hay	0.49	0.57	0.73	0.85	0.90	0.92	0.92	0.91	0.87	0.79	0.67	0.55	45 Mean	45 Mean

	Percent of Growing Season Coefficients													
Crop	0	10	20	30	40	50	60	70	80	90	100	Growing Season Start Date Criteria	Growing Season End Date Criteria	Maximum Season Days
Spring Grain	0.28	0.46	0.51	0.94	1.14	1.31	1.27	1.04	0.69	0.30	0.00	45 Mean	Fall 32 Frost	130
Small Vegetables[3]	0.29	0.39	0.56	0.69	0.78	0.82	0.83	0.80	0.72	0.58	0.38	50 Mean	Fall 32 Frost	200
Corn (Grain)	0.44	0.49	0.58	0.71	0.92	1.05	1.08	1.06	1.00	0.93	0.85	55 Mean	Fall 32 Frost	140

Notes:
(1) All crop coefficients are based on TR-21.
(2) Start and End Criteria are based on TR-21 unless otherwise noted.
(3) Crop growth criteria selected to encompass growth periods of most garden crops.

Table 9

Zuni Pueblo Area, New Mexico
Original Blaney-Criddle Crop Coefficients

Crop	During Frost-Free Period	Outside Frost-Free Period
Alfalfa	0.85	0.50
Corn, Grain	0.75	0.40
Misc. Vegetables	0.65	0.40
Pasture, Improved	0.80	0.50
Pasture, Native	0.70	0.50
Spring Grain	0.70	0.70

Note: Coefficients are based on New Mexico State Engineer information.

Table 10a

Zuni Pueblo Area
Original Blaney-Criddle Method

Crop Potential Evapotranspiration (PET), Inches

Average Monthly Original Blaney-Criddle Crop PET for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.49	3.33	5.46	6.04	5.53	4.47	1.23	0.00	0.00	26.54
Black Rock (1914-1948)	0.00	0.00	0.00	0.42	3.34	5.41	5.96	5.47	4.45	1.61	0.00	0.00	26.66
El Morro (1938-2008)	0.00	0.00	0.00	0.00	2.37	4.92	5.76	5.27	3.96	0.13	0.00	0.00	22.41
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.85	3.92	5.39	4.91	2.72	0.00	0.00	0.00	17.79

Average Monthly Original Blaney-Criddle Crop PET for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.99	4.82	5.33	4.88	3.68	0.50	0.00	0.00	21.18
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	1.81	4.77	5.26	4.83	3.92	0.10	0.00	0.00	20.69
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.68	4.31	5.09	4.65	3.13	0.00	0.00	0.00	17.85
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.00	2.97	4.76	4.34	1.86	0.00	0.00	0.00	13.92

Average Monthly Original Blaney-Criddle Crop PET for Improved Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	1.91	3.25	5.14	5.68	5.20	4.21	2.25	0.19	0.00	27.82
Black Rock (1914-1948)	0.00	0.00	0.00	1.75	3.25	5.09	5.61	5.15	4.18	2.34	0.09	0.00	27.47
El Morro (1938-2008)	0.00	0.00	0.00	1.07	2.63	4.66	5.42	4.96	3.75	1.75	0.00	0.00	24.24
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	2.16	3.77	5.07	4.62	3.06	1.04	0.00	0.00	19.73

Average Monthly Original Blaney-Criddle Crop PET for Native Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	1.91	3.09	4.49	4.97	4.55	3.68	2.19	0.19	0.00	25.07
Black Rock (1914-1948)	0.00	0.00	0.00	1.75	3.08	4.45	4.91	4.51	3.66	2.24	0.09	0.00	24.69
El Morro (1938-2008)	0.00	0.00	0.00	1.07	2.63	4.13	4.75	4.34	3.33	1.75	0.00	0.00	22.00
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	2.16	3.46	4.44	4.05	2.81	1.04	0.00	0.00	17.97

Average Monthly Original Blaney-Criddle Crop PET for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	2.67	3.87	4.49	4.97	1.61	0.00	0.00	0.00	0.00	17.62
Black Rock (1914-1948)	0.00	0.00	0.00	2.46	3.82	4.45	4.91	1.89	0.00	0.00	0.00	0.00	17.52
El Morro (1938-2008)	0.00	0.00	0.00	1.50	3.68	4.29	4.75	3.08	0.00	0.00	0.00	0.00	17.30
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	3.03	4.00	4.44	4.05	1.08	0.00	0.00	0.00	16.59

Average Monthly Original Blaney-Criddle Crop PET for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.40	2.61	4.17	4.62	4.23	3.42	0.43	0.00	0.00	19.87
Black Rock (1914-1948)	0.00	0.00	0.00	0.34	2.62	4.13	4.56	4.19	3.40	0.68	0.00	0.00	19.91
El Morro (1938-2008)	0.00	0.00	0.00	0.00	1.90	3.78	4.41	4.03	2.71	0.00	0.00	0.00	16.82
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.68	3.05	4.12	3.76	1.61	0.00	0.00	0.00	13.21

Table 10b

Zuni Pueblo Area
Original Blaney-Criddle Method

Effective Precipitation (USBR Method), Inches

Average Monthly Original Blaney-Criddle Effective Precipitation for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.13	0.45	0.37	1.73	2.01	1.11	0.55	0.00	0.00	6.36
Black Rock (1914-1948)	0.00	0.00	0.00	0.13	0.59	0.42	2.06	1.76	1.31	0.55	0.00	0.00	6.83
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.51	0.52	1.81	2.44	1.27	0.07	0.00	0.00	6.63
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.26	0.63	2.26	2.60	1.21	0.00	0.00	0.00	6.96

Average Monthly Original Blaney-Criddle Effective Precipitation for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.29	0.37	1.73	2.01	1.04	0.00	0.00	0.00	5.44
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	0.32	0.42	2.06	1.76	1.31	0.03	0.00	0.00	5.90
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.18	0.52	1.81	2.44	1.06	0.00	0.00	0.00	6.02
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.00	0.52	2.26	2.60	0.80	0.00	0.00	0.00	6.19

Average Monthly Original Blaney-Criddle Effective Precipitation for Improved Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.51	0.45	0.37	1.73	2.01	1.11	1.13	0.09	0.00	7.41
Black Rock (1914-1948)	0.00	0.00	0.00	0.56	0.59	0.42	2.06	1.76	1.31	0.90	0.04	0.00	7.65
El Morro (1938-2008)	0.00	0.00	0.00	0.37	0.56	0.52	1.81	2.44	1.27	0.98	0.00	0.00	7.96
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.66	0.63	2.26	2.60	1.51	0.82	0.00	0.00	8.48

Average Monthly Original Blaney-Criddle Effective Precipitation for Native Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.51	0.45	0.37	1.73	2.01	1.11	1.13	0.09	0.00	7.41
Black Rock (1914-1948)	0.00	0.00	0.00	0.56	0.59	0.42	2.06	1.76	1.31	0.90	0.04	0.00	7.65
El Morro (1938-2008)	0.00	0.00	0.00	0.37	0.56	0.52	1.81	2.44	1.27	0.98	0.00	0.00	7.96
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.66	0.63	2.26	2.60	1.51	0.82	0.00	0.00	8.48

Average Monthly Original Blaney-Criddle Effective Precipitation for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.51	0.45	0.37	1.73	0.71	0.00	0.00	0.00	0.00	3.78
Black Rock (1914-1948)	0.00	0.00	0.00	0.56	0.59	0.42	2.06	0.74	0.00	0.00	0.00	0.00	4.37
El Morro (1938-2008)	0.00	0.00	0.00	0.37	0.56	0.52	1.81	1.73	0.00	0.00	0.00	0.00	5.00
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.66	0.63	2.26	2.60	0.50	0.00	0.00	0.00	6.65

Average Monthly Original Blaney-Criddle Crop PET for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.13	0.45	0.37	1.73	2.01	1.11	0.18	0.00	0.00	5.99
Black Rock (1914-1948)	0.00	0.00	0.00	0.13	0.59	0.42	2.06	1.76	1.31	0.23	0.00	0.00	6.51
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.51	0.52	1.81	2.44	1.06	0.00	0.00	0.00	6.34
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.26	0.63	2.26	2.60	0.80	0.00	0.00	0.00	6.56

Table 10c

Zuni Pueblo Area
Original Blaney-Criddle Method

Crop Irrigation Requirement (CIR), Inches

Average Monthly Original Blaney-Criddle Crop Irrigation Requirement for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.36	2.88	5.09	4.30	3.51	3.36	0.68	0.00	0.00	20.18
Black Rock (1914-1948)	0.00	0.00	0.00	0.29	2.75	4.99	3.90	3.71	3.14	1.06	0.00	0.00	19.83
El Morro (1938-2008)	0.00	0.00	0.00	0.00	1.86	4.40	3.95	2.83	2.68	0.06	0.00	0.00	15.78
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.59	3.29	3.13	2.31	1.52	0.00	0.00	0.00	10.84

Average Monthly Original Blaney-Criddle Crop Irrigation Requirement for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.70	4.44	3.59	2.86	2.64	0.50	0.00	0.00	15.74
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	1.49	4.35	3.19	3.07	2.61	0.07	0.00	0.00	14.79
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.50	3.79	3.27	2.21	2.06	0.00	0.00	0.00	11.83
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.00	2.45	2.50	1.73	1.05	0.00	0.00	0.00	7.72

Average Monthly Original Blaney-Criddle Crop Irrigation Requirement for Improved Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	1.40	2.80	4.77	3.95	3.19	3.10	1.12	0.09	0.00	20.41
Black Rock (1914-1948)	0.00	0.00	0.00	1.19	2.66	4.67	3.54	3.39	2.87	1.44	0.05	0.00	19.83
El Morro (1938-2008)	0.00	0.00	0.00	0.70	2.06	4.14	3.61	2.52	2.48	0.77	0.00	0.00	16.28
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.50	3.14	2.81	2.02	1.55	0.22	0.00	0.00	11.25

Average Monthly Original Blaney-Criddle Crop Irrigation Requirement for Native Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	1.40	2.64	4.12	3.24	2.54	2.57	1.06	0.09	0.00	17.65
Black Rock (1914-1948)	0.00	0.00	0.00	1.19	2.49	4.03	2.84	2.75	2.35	1.34	0.05	0.00	17.04
El Morro (1938-2008)	0.00	0.00	0.00	0.70	2.06	3.61	2.93	1.90	2.06	0.77	0.00	0.00	14.04
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.50	2.84	2.18	1.44	1.31	0.22	0.00	0.00	9.49

Average Monthly Original Blaney-Criddle Crop Irrigation Requirement for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	2.16	3.42	4.12	3.24	0.90	0.00	0.00	0.00	0.00	13.84
Black Rock (1914-1948)	0.00	0.00	0.00	1.89	3.23	4.03	2.84	1.15	0.00	0.00	0.00	0.00	13.15
El Morro (1938-2008)	0.00	0.00	0.00	1.13	3.11	3.77	2.93	1.35	0.00	0.00	0.00	0.00	12.30
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	2.37	3.37	2.18	1.44	0.58	0.00	0.00	0.00	9.94

Average Monthly Original Blaney-Criddle Crop PET for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.26	2.17	3.80	2.88	2.21	2.31	0.25	0.00	0.00	13.88
Black Rock (1914-1948)	0.00	0.00	0.00	0.20	2.03	3.72	2.49	2.43	2.09	0.45	0.00	0.00	13.41
El Morro (1938-2008)	0.00	0.00	0.00	0.00	1.39	3.26	2.59	1.59	1.65	0.00	0.00	0.00	10.48
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.42	2.42	1.86	1.15	0.80	0.00	0.00	0.00	6.66

Table 11a

Zuni Pueblo Area
Modified Blaney-Criddle Method

Crop Potential Evapotranspiration (PET), Inches

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.86	3.94	5.99	7.27	6.12	4.00	1.25	0.03	0.00	29.46
Black Rock (1914-1948)	0.00	0.00	0.00	0.75	3.79	5.86	7.05	5.96	3.98	1.42	0.03	0.00	28.84
El Morro (1938-2008)	0.00	0.00	0.00	0.24	3.26	5.36	6.53	5.45	3.23	0.45	0.00	0.00	24.52
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.40	4.50	5.55	4.56	2.33	0.15	0.00	0.00	18.49

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.02	1.34	3.58	6.66	6.05	3.01	0.06	0.00	0.00	20.72
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	1.18	3.36	6.34	5.95	3.28	0.11	0.00	0.00	20.22
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.69	2.85	5.76	5.42	2.65	0.08	0.00	0.00	17.45
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.08	1.80	4.47	4.48	1.65	0.02	0.00	0.00	12.50

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.15	1.68	3.32	4.87	6.02	5.25	3.56	1.87	0.18	0.00	26.90
Black Rock (1914-1948)	0.00	0.00	0.10	1.59	3.20	4.77	5.84	5.12	3.50	1.79	0.10	0.00	26.01
El Morro (1938-2008)	0.00	0.00	0.01	1.11	2.92	4.36	5.41	4.68	3.14	1.45	0.02	0.00	23.10
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.16	2.14	3.67	4.60	3.96	2.61	0.85	0.00	0.00	17.99

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.07	0.95	3.60	6.51	4.34	0.40	0.00	0.00	0.00	0.00	15.87
Black Rock (1914-1948)	0.00	0.00	0.05	0.87	3.36	6.45	4.56	0.48	0.00	0.00	0.00	0.00	15.77
El Morro (1938-2008)	0.00	0.00	0.00	0.55	2.41	5.94	5.58	0.94	0.00	0.00	0.00	0.00	15.42
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.07	1.16	4.14	6.18	2.54	0.11	0.00	0.00	0.00	14.20

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.28	1.70	3.78	5.35	4.57	2.35	0.38	0.00	0.00	18.41
Black Rock (1914-1948)	0.00	0.00	0.00	0.25	1.59	3.63	5.17	4.52	2.50	0.40	0.00	0.00	18.06
El Morro (1938-2008)	0.00	0.00	0.00	0.07	1.26	3.29	4.81	3.98	1.65	0.09	0.00	0.00	15.15
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.46	2.39	4.04	3.26	0.98	0.01	0.00	0.00	11.14

Table 11b

Zuni Pueblo Area
Modified Blaney-Criddle Method

Crop Effective Precipitation (SCS Method), Inches

Average Monthly Modified Blaney-Criddle Crop Effective Precipitation for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.08	0.31	0.29	1.56	1.70	0.82	0.37	0.01	0.00	5.14
Black Rock (1914-1948)	0.00	0.00	0.00	0.09	0.42	0.34	1.83	1.47	0.97	0.38	0.00	0.00	5.50
El Morro (1938-2008)	0.00	0.00	0.00	0.01	0.35	0.42	1.58	1.99	0.84	0.10	0.00	0.00	5.29
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.15	0.47	1.85	1.99	0.83	0.05	0.00	0.00	5.34

Average Monthly Modified Blaney-Criddle Crop Effective Precipitation for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.17	0.26	1.50	1.70	0.60	0.00	0.00	0.00	4.23
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	0.21	0.30	1.75	1.48	0.81	0.03	0.00	0.00	4.58
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.10	0.36	1.51	1.99	0.73	0.01	0.00	0.00	4.70
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.00	0.33	1.75	1.96	0.59	0.00	0.00	0.00	4.63

Average Monthly Modified Blaney-Criddle Crop Effective Precipitation for Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.03	0.30	0.31	0.27	1.45	1.61	0.81	0.67	0.05	0.00	5.50
Black Rock (1914-1948)	0.00	0.00	0.02	0.34	0.41	0.32	1.71	1.41	0.95	0.55	0.01	0.00	5.72
El Morro (1938-2008)	0.00	0.00	0.00	0.22	0.39	0.39	1.48	1.90	0.91	0.54	0.00	0.00	5.83
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.02	0.42	0.45	1.76	1.95	1.05	0.39	0.00	0.00	6.04

Average Monthly Modified Blaney-Criddle Crop Effective Precipitation for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.02	0.27	0.31	0.30	1.31	0.32	0.00	0.00	0.00	0.00	2.53
Black Rock (1914-1948)	0.00	0.00	0.02	0.32	0.42	0.35	1.55	0.28	0.00	0.00	0.00	0.00	2.94
El Morro (1938-2008)	0.00	0.00	0.00	0.21	0.38	0.43	1.49	0.78	0.00	0.00	0.00	0.00	3.29
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.03	0.37	0.47	1.92	1.57	0.10	0.00	0.00	0.00	4.46

Average Monthly Modified Blaney-Criddle Crop Potential Evapotranspiration for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.07	0.27	0.26	1.40	1.56	0.70	0.16	0.00	0.00	4.42
Black Rock (1914-1948)	0.00	0.00	0.00	0.09	0.38	0.30	1.64	1.36	0.87	0.17	0.00	0.00	4.81
El Morro (1938-2008)	0.00	0.00	0.00	0.01	0.30	0.37	1.43	1.81	0.69	0.03	0.00	0.00	4.64
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.12	0.42	1.71	1.81	0.54	0.00	0.00	0.00	4.60

Table 11c

Zuni Pueblo Area
Modified Blaney-Criddle Method

Crop Irrigation Requirement (CIR), Inches

Average Monthly Modified Blaney-Criddle Crop Irrigation Requirement for Alfalfa

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.78	3.63	5.70	5.71	4.42	3.18	0.88	0.02	0.00	24.32
Black Rock (1914-1948)	0.00	0.00	0.00	0.66	3.37	5.52	5.22	4.49	3.01	1.04	0.03	0.00	23.34
El Morro (1938-2008)	0.00	0.00	0.00	0.23	2.91	4.94	4.95	3.46	2.39	0.35	0.00	0.00	19.23
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	1.25	4.03	3.70	2.57	1.50	0.10	0.00	0.00	13.15

Average Monthly Modified Blaney-Criddle Crop Irrigation Requirement for Corn, Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.02	1.17	3.32	5.16	4.35	2.41	0.06	0.00	0.00	16.49
Black Rock (1914-1948)	0.00	0.00	0.00	0.00	0.97	3.06	4.59	4.47	2.47	0.08	0.00	0.00	15.64
El Morro (1938-2008)	0.00	0.00	0.00	0.00	0.59	2.49	4.25	3.43	1.92	0.07	0.00	0.00	12.75
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.08	1.47	2.72	2.52	1.06	0.02	0.00	0.00	7.87

Average Monthly Modified Blaney-Criddle Crop Irrigation Requirement for Pasture

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.12	1.38	3.01	4.60	4.57	3.64	2.75	1.20	0.13	0.00	21.40
Black Rock (1914-1948)	0.00	0.00	0.08	1.25	2.79	4.45	4.13	3.71	2.55	1.24	0.09	0.00	20.29
El Morro (1938-2008)	0.00	0.00	0.01	0.89	2.53	3.97	3.93	2.78	2.23	0.91	0.02	0.00	17.27
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.14	1.72	3.22	2.84	2.01	1.56	0.46	0.00	0.00	11.95

Average Monthly Modified Blaney-Criddle Crop Irrigation Requirement for Spring Grain

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.05	0.68	3.29	6.21	3.03	0.08	0.00	0.00	0.00	0.00	13.34
Black Rock (1914-1948)	0.00	0.00	0.03	0.55	2.94	6.10	3.01	0.20	0.00	0.00	0.00	0.00	12.83
El Morro (1938-2008)	0.00	0.00	0.00	0.34	2.03	5.51	4.09	0.16	0.00	0.00	0.00	0.00	12.13
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.04	0.79	3.67	4.26	0.97	0.01	0.00	0.00	0.00	9.74

Average Monthly Modified Blaney-Criddle Crop Irrigation Requirement for Misc. Vegetables

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Zuni NOAA (1949-2008)	0.00	0.00	0.00	0.21	1.43	3.52	3.95	3.01	1.65	0.22	0.00	0.00	13.99
Black Rock (1914-1948)	0.00	0.00	0.00	0.16	1.21	3.33	3.53	3.16	1.63	0.23	0.00	0.00	13.25
El Morro (1938-2008)	0.00	0.00	0.00	0.06	0.96	2.92	3.38	2.17	0.96	0.06	0.00	0.00	10.51
McGaffey NOAA (1949-2008)	0.00	0.00	0.00	0.00	0.34	1.97	2.33	1.45	0.44	0.01	0.00	0.00	6.54

Table 12

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
Black Rock, NM (291018) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1914	20.18	12.31	16.50	10.53	9.91
1915	17.77	11.04	15.38	8.33	8.41
1916	21.17	13.88	18.31	10.40	12.37
1917	26.07	17.81	23.47	13.79	14.82
1918	23.42	15.05	20.71	13.77	12.64
1919	18.29	12.14	15.91	11.51	9.53
1920	21.54	15.57	18.88	14.55	12.76
1921	21.54	13.53	19.65	10.02	11.53
1922	26.75	18.80	23.14	15.86	16.25
1923	21.22	14.03	18.00	13.92	11.09
1924	26.56	19.33	24.20	16.15	15.93
1925	24.03	15.59	20.36	11.41	13.58
1926	25.09	16.97	21.78	11.95	14.89
1927	23.71	14.90	20.41	12.75	12.13
1928	24.65	17.18	21.92	12.38	14.52
1929	20.29	12.68	16.91	11.87	10.42
1930	25.89	17.32	22.74	12.43	15.22
1931	24.77	16.20	20.73	12.61	13.84
1932	24.42	16.34	21.09	12.18	13.96
1933	22.44	15.68	18.92	13.82	12.72
1934	23.67	14.89	20.70	10.95	13.31
1935	24.38	16.92	21.99	13.06	14.61
1936	24.88	15.96	21.15	14.25	13.82
1937	23.39	16.01	20.55	12.19	13.53
1938	24.23	16.96	21.88	13.15	14.65
1939	26.81	18.97	23.56	14.52	16.49
1940	22.26	14.91	18.75	13.41	12.46
1941	17.81	12.16	14.67	11.83	9.63
1942	23.47	15.82	20.26	14.06	13.93
1943	25.89	17.37	22.50	12.02	15.43
1944	23.66	15.60	20.19	13.70	12.63
1945	23.11	16.63	21.49	13.72	13.53
1946	24.14	15.05	21.11	13.25	14.07
1947	23.50	15.94	20.27	13.37	13.49
1948	25.64	18.26	22.28	15.16	15.53
Average	23.33	15.65	20.30	12.82	13.25

Table 13

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
Zuni, NM (299897) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1949	25.04	16.95	22.57	12.62	14.83
1950	30.08	18.90	26.44	13.48	18.75
1951	26.43	18.78	23.19	14.91	16.03
1952	24.49	15.46	21.03	13.29	12.28
1953	26.53	19.23	24.01	14.95	16.27
1954	27.76	17.92	24.11	13.52	16.50
1955	22.75	15.88	21.54	12.55	13.24
1956	26.77	17.86	23.45	14.56	16.14
1957	20.75	14.53	17.69	11.30	11.57
1958	26.39	18.01	22.54	16.30	15.48
1959	25.95	17.36	21.73	15.12	15.13
1960	28.13	20.40	24.57	13.39	17.73
1961	25.35	17.50	21.61	15.56	14.93
1962	27.92	19.54	23.48	15.08	17.44
1963	25.82	16.64	21.84	16.02	14.68
1964	24.87	16.03	21.25	13.97	13.62
1965	19.70	12.87	18.51	10.40	10.40
1966	26.50	18.16	23.87	13.92	15.56
1967	21.22	13.39	19.74	10.57	11.12
1968	22.58	15.00	19.43	12.69	12.84
1969	24.05	16.72	20.40	13.43	13.86
1970	23.57	16.85	20.22	14.57	13.71
1971	21.35	14.04	18.41	15.17	11.68
1972	24.50	17.88	22.29	10.66	15.17
1973	19.15	11.96	17.74	11.85	9.42
1974	22.67	16.38	19.41	14.68	13.26
1975	20.91	14.01	18.78	13.80	11.63
1976	23.24	15.99	20.33	13.25	13.67
1977	24.63	15.31	21.25	14.59	14.17
1978	26.11	17.81	23.63	13.21	15.88
1979	25.24	16.98	22.11	13.08	15.27
1980	25.48	17.92	23.36	14.62	15.82
1981	22.81	14.54	19.50	12.25	13.06
1982	17.46	11.23	16.22	12.11	8.93
1983	18.77	12.72	15.98	10.97	10.18
1984	22.74	16.04	18.74	15.02	12.64
1985	26.29	18.16	22.40	12.78	14.88
1986	21.74	14.52	18.65	10.86	11.79
1987	21.52	12.46	18.61	10.83	10.48
1988	19.20	12.69	17.62	13.08	9.90
1989	27.08	17.10	23.36	12.38	14.36
1990	24.46	16.27	21.57	13.46	14.42
1991	24.57	16.76	21.56	14.31	14.03

Table 13

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
Zuni, NM (299897) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1992	20.03	12.11	17.40	8.78	10.66
1993	25.72	17.63	22.71	14.79	14.50
1994	25.63	18.59	21.63	11.23	15.08
1995	24.76	18.12	23.34	13.94	14.88
1996	25.66	17.34	22.13	14.12	14.24
1997	23.41	15.87	20.07	10.31	13.01
1998	22.99	16.60	19.45	13.14	13.33
1999	22.33	14.60	21.20	10.26	12.00
2000	31.09	20.97	26.25	15.36	18.16
2001	26.84	17.85	24.38	13.75	15.92
2002	26.37	18.69	22.97	14.36	15.76
2003	30.58	21.31	26.97	17.16	18.71
2004	25.94	19.16	25.12	12.42	15.91
2005	28.04	19.47	24.52	14.82	17.03
2006	23.65	16.99	20.99	15.30	14.07
2007	21.06	14.99	20.21	13.33	11.75
2008	22.28	14.74	20.38	12.55	11.80
Average	24.32	16.50	21.41	13.35	13.99

Table 14

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
El Morro, NM (292785) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1938	19.57	13.40	17.93	12.25	11.08
1939	23.40	16.10	20.63	13.82	13.90
1940	19.93	12.58	16.70	12.35	10.48
1941	15.33	10.74	13.93	10.65	8.22
1942	22.01	14.30	19.49	13.46	12.62
1943	20.13	12.98	17.34	11.40	11.15
1944	19.83	14.08	17.66	12.47	11.57
1945	19.58	12.26	18.17	11.95	10.40
1946	21.14	12.91	18.49	12.67	12.07
1947	16.84	10.47	14.48	11.77	8.76
1948	20.32	13.65	17.49	12.34	11.22
1949	20.20	13.84	17.98	12.37	11.66
1950	18.77	12.18	20.01	12.28	10.82
1951	21.75	14.06	19.31	13.38	11.40
1952	18.62	12.83	18.44	12.19	10.28
1953	20.41	14.48	19.55	12.86	11.70
1954	20.19	12.51	17.43	12.24	10.85
1955	17.35	10.76	16.67	9.88	8.51
1956	23.23	16.22	20.29	13.54	13.77
1957	16.41	10.90	15.16	10.31	8.47
1958	23.04	15.62	19.54	13.86	12.48
1959	20.29	13.13	17.90	14.30	11.12
1960	23.43	16.24	20.71	13.51	13.56
1961	17.86	12.20	17.53	13.46	10.03
1962	20.67	13.36	18.24	13.16	12.07
1963	19.81	12.97	17.21	13.69	10.71
1964	17.66	11.69	15.83	11.99	9.50
1965	15.16	9.91	14.82	8.73	8.09
1966	20.89	13.87	18.11	12.47	11.59
1967	17.18	9.53	16.04	10.19	7.82
1968	18.00	11.92	17.29	11.85	9.90
1969	19.63	13.60	16.72	11.95	10.84
1970	19.42	13.46	17.38	13.41	10.72
1971	16.58	10.32	15.27	13.00	8.57
1972	18.04	11.78	16.25	11.63	9.69
1973	18.36	12.81	17.28	12.49	10.33
1974	21.00	14.52	17.98	14.74	11.95
1975	17.67	11.30	16.05	13.53	9.64
1976	20.28	14.30	17.95	12.37	11.55
1977	18.12	11.49	15.52	10.88	9.11
1978	20.05	14.41	20.18	12.25	11.86
1979	19.68	13.86	17.42	11.25	11.10
1980	21.95	15.05	19.36	14.82	12.49

Table 14

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
El Morro, NM (292785) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1981	21.01	13.58	17.69	11.43	11.51
1982	17.04	11.38	16.09	11.43	9.13
1983	15.97	10.70	14.38	11.41	8.44
1984	17.94	11.98	14.50	12.23	9.04
1985	20.39	13.24	17.70	12.05	11.05
1986	15.73	10.22	14.79	9.15	8.10
1987	17.29	9.83	15.38	10.18	7.67
1988	17.39	11.24	16.37	10.77	8.80
1989	20.68	13.49	19.14	11.74	11.69
1990	18.90	12.60	16.20	10.77	10.23
1991	18.86	12.70	16.95	11.66	10.64
1992	17.22	11.40	15.44	9.21	9.13
1993	16.93	10.53	15.63	13.29	9.19
1994	20.00	14.05	16.62	11.79	11.01
1995	18.53	12.53	17.28	12.42	10.48
1996	18.77	12.67	15.89	12.96	10.11
1997	17.67	11.76	14.89	9.83	9.11
1998	18.13	11.65	15.29	9.96	9.53
1999	17.27	11.17	16.05	9.82	8.68
2000	22.63	15.97	20.10	14.40	13.40
2001	18.56	12.76	18.81	12.70	10.31
2002	21.02	13.25	17.74	13.45	12.13
2003	23.81	16.18	21.03	14.73	13.06
2004	19.38	12.44	17.57	12.49	10.36
2005	22.10	14.34	19.25	13.33	11.72
2006	16.30	9.99	14.08	11.85	8.11
2007	17.63	12.27	16.80	11.52	9.54
2008	18.38	12.40	15.97	10.63	9.74
Average	19.23	12.75	17.26	12.13	10.50

Table 15

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
McGaffey, NM (295560) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1949	6.56	5.77	7.70	3.34	5.41
1950	7.33	6.74	7.55	5.03	6.69
1951	6.30	5.66	7.41	5.15	5.34
1952	6.48	5.77	6.68	5.01	5.93
1953	3.57	3.46	4.71	1.30	3.25
1954	4.99	4.60	6.01	2.98	4.54
1955	5.89	5.59	6.68	2.10	5.21
1956	3.73	3.23	3.93	2.18	2.98
1957	3.56	3.02	4.93	2.29	2.83
1958	3.46	2.63	4.14	2.01	2.56
1959	8.25	7.98	8.54	4.71	7.53
1960	5.92	5.34	6.39	4.57	5.41
1961	5.92	4.98	6.24	4.94	5.18
1962	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00
1968	Total	Total	Total	Total	Total
1969	19.57	13.40	17.93	12.25	11.08
1970	23.40	16.10	20.63	13.82	13.90
1971	19.93	12.58	16.70	12.35	10.48
1972	15.33	10.74	13.93	10.65	8.22
1973	22.01	14.30	19.49	13.46	12.62
1974	20.13	12.98	17.34	11.40	11.15
1975	19.83	14.08	17.66	12.47	11.57
1976	19.58	12.26	18.17	11.95	10.40
1977	21.14	12.91	18.49	12.67	12.07
1978	16.84	10.47	14.48	11.77	8.76
1979	20.32	13.65	17.49	12.34	11.22
1980	20.20	13.84	17.98	12.37	11.66
1981	18.77	12.18	20.01	12.28	10.82
1982	21.75	14.06	19.31	13.38	11.40
1983	18.62	12.83	18.44	12.19	10.28
1984	20.41	14.48	19.55	12.86	11.70
1985	20.19	12.51	17.43	12.24	10.85
1986	17.35	10.76	16.67	9.88	8.51
1987	23.23	16.22	20.29	13.54	13.77
1988	16.41	10.90	15.16	10.31	8.47
1989	23.04	15.62	19.54	13.86	12.48
1990	20.29	13.13	17.90	14.30	11.12
1991	23.43	16.24	20.71	13.51	13.56

Table 15

Modified Blaney-Criddle Method
Annual Crop Irrigation Requirement
McGaffey, NM (295560) Weather Station

Values in Inches

Year	Alfalfa	Corn	Grass	Spring Grain	Small Veg.
1992	17.86	12.20	17.53	13.46	10.03
1993	20.67	13.36	18.24	13.16	12.07
1994	19.81	12.97	17.21	13.69	10.71
1995	17.66	11.69	15.83	11.99	9.50
1996	15.16	9.91	14.82	8.73	8.09
1997	20.89	13.87	18.11	12.47	11.59
1998	17.18	9.53	16.04	10.19	7.82
1999	18.00	11.92	17.29	11.85	9.90
2000	19.63	13.60	16.72	11.95	10.84
2001	19.42	13.46	17.38	13.41	10.72
2002	16.58	10.32	15.27	13.00	8.57
2003	18.04	11.78	16.25	11.63	9.69
2004	18.36	12.81	17.28	12.49	10.33
2005	21.00	14.52	17.98	14.74	11.95
2006	17.67	11.30	16.05	13.53	9.64
2007	20.28	14.30	17.95	12.37	11.55
2008	18.12	11.49	15.52	10.88	9.11
Average	14.41	9.83	13.25	9.17	8.32

Table 17

Automated and Airport Weather Stations near Zuni Pueblo
Summary of Raw Data

Monthly Average Maximum Temperature, Degrees F

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Zuni NOAA	1949-2008	46.7	50.9	57.1	66.1	75.4	85.6	88.8	85.7	80.3	70.0	57.0	47.8	67.7
Zuni AP GSD	1949-1972	45.6	49.5	55.5	64.8	73.6	83.1	86.4	83.4	78.9	68.9	56.1	46.3	66.3
Gallup AP GSD	1973-2008	44.7	50.3	57.7	66.3	75.5	85.5	88.1	85.4	79.2	68.5	55.0	46.2	67.1
Malpais RAWS	1985-2008	45.2	48.4	55.1	62.9	71.4	81.2	82.7	79.8	74.8	65.5	53.9	45.6	64.1
Ramah RAWS	2004-2008	43.3	47.3	53.2	63.3	71.9	82.3	84.7	80.6	75.4	65.8	57.4	44.5	63.8
Zuni RAWS	2003-2005	48.3	47.1	57.7	64.6	76.5	86.1	91.6	85.6	80.1	70.5	53.3	49.6	66.8
Zuni Buttes RAWS	2006-2008	42.0	48.1	58.6	66.4	74.4	86.3	87.3	83.9	77.7	67.5	59.5	44.7	67.9

Monthly Average Minimum Temperature, Degrees F

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Zuni NOAA	1949-2008	16.4	19.9	24.6	30.1	37.7	45.9	54.1	53.1	45.6	34.4	23.6	16.3	33.6
Zuni AP GSD	1949-1972	18.4	22.0	27.0	33.3	40.6	49.2	57.7	56.0	48.9	38.1	27.1	19.1	36.7
Gallup AP GSD	1973-2008	14.4	19.5	23.8	28.7	37.3	45.6	53.9	52.5	43.7	31.0	21.0	14.1	32.2
Malpais RAWS	1985-2008	15.6	20.8	25.0	30.3	37.1	46.4	49.9	50.2	42.3	32.0	22.8	15.5	32.5
Ramah RAWS	2004-2008	11.8	17.4	20.7	25.4	33.7	42.2	51.1	50.4	40.1	28.9	17.4	11.2	28.9
Zuni RAWS	2003-2005	24.2	25.0	29.6	32.1	41.3	49.2	56.4	55.2	47.6	39.0	27.3	18.8	36.5
Zuni Buttes RAWS	2006-2008	16.5	22.5	27.1	32.9	40.7	51.4	57.3	56.1	47.4	36.7	28.8	19.1	37.7

Monthly Average Total Precipitation, Inches

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Zuni NOAA	1949-2008	0.88	0.81	0.90	0.62	0.46	0.40	1.86	2.19	1.21	1.19	0.76	0.85	12.14
Zuni AP GSD	1949-1972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gallup AP GSD	1973-2008	0.83	1.10	0.83	0.61	0.69	0.47	1.56	2.16	1.23	1.02	0.98	0.85	12.32
Malpais RAWS	1985-2008	0.51	0.60	0.79	0.60	0.65	0.70	2.20	2.78	1.26	1.11	0.64	9.12	20.96
Ramah RAWS	2004-2008	0.75	0.94	0.61	0.42	0.74	0.60	2.30	2.06	0.67	0.98	0.27	0.79	11.12
Zuni RAWS	2003-2005	2.34	4.02	2.49	10.69	3.00	3.37	4.51	4.73	2.36	3.23	1.78	1.65	44.15
Zuni Buttes RAWS	2006-2008	1.09	1.23	0.16	0.34	1.15	0.30	2.17	2.87	0.96	1.48	0.45	1.13	13.33

Monthly Average Dewpoint Temperature, Degrees F

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque AP GSD	1948-2006	18.33	20.25	19.82	21.42	25.87	32.66	47.24	48.82	38.99	29.99	22.48	18.56	28.85
Zuni AP GSD	1949-1972	17.27	19.68	20.81	21.04	26.08	29.97	44.15	46.64	38.26	26.92	20.51	16.35	27.36
Gallup AP GSD	1973-2008	17.51	19.92	21.78	25.18	32.07	39.48	49.19	49.41	41.21	30.79	21.93	17.42	30.55

Monthly Average Maximum Relative Humidity (%)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Malpais RAWS	1985-2008	82.28	81.38	74.82	64.88	60.14	53.90	76.38	90.17	83.69	75.92	77.91	81.15	75.27
Ramah RAWS	2004-2008	91.60	89.23	88.19	72.99	72.40	61.13	82.18	93.68	87.61	86.53	80.83	93.92	83.59
Zuni RAWS	2003-2005	92.10	91.65	84.32	69.88	49.83	41.88	54.97	78.77	64.93	70.42	76.78	83.11	72.39
Zuni Buttes RAWS	2003-2008	89.95	91.26	68.00	56.58	59.29	41.87	76.58	84.00	72.30	70.31	68.74	88.17	71.37

Monthly Average Minimum Relative Humidity (%)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Malpais RAWS	1985-2008	33.77	31.12	22.97	16.49	15.36	13.49	24.51	30.10	25.18	24.54	28.59	32.53	24.90
Ramah RAWS	2004-2008	38.02	36.46	24.93	15.80	17.02	12.53	23.21	30.29	23.73	23.63	22.90	36.75	25.64
Zuni RAWS	2003-2005	40.81	39.91	28.45	17.64	11.69	8.35	12.06	20.74	17.73	18.63	29.17	29.60	23.16
Zuni Buttes RAWS	2003-2008	37.34	36.00	17.15	13.10	14.91	9.53	22.73	27.13	20.66	21.44	22.63	36.73	22.70

Monthly Average Wind Speed, miles per hour (Adjusted to 2-meter measurement height)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque AP GSD	1949-2008	5.91	6.48	7.35	8.08	7.81	7.39	6.63	6.09	6.22	6.08	5.88	5.71	6.64
Zuni AP GSD	1949-1972	6.32	6.32	7.16	7.85	7.19	6.78	5.40	5.23	6.03	6.12	6.11	6.21	6.39
Gallup AP GSD	1973-2008	3.96	4.72	6.04	6.82	6.50	5.88	4.91	4.40	4.58	4.26	4.29	3.86	5.02
Malpais RAWS	1985-2008	2.22	2.62	3.04	3.50	3.39	3.15	2.35	2.09	2.23	2.27	2.38	2.19	2.62
Ramah RAWS	2004-2008	4.66	5.22	6.25	7.12	6.25	5.94	4.79	4.36	4.87	4.66	4.49	4.37	5.23
Zuni RAWS	2003-2005	4.59	5.26	6.15	7.05	6.97	6.20	4.97	4.84	5.25	5.74	5.44	5.36	5.70
Zuni Buttes RAWS	2006-2008	4.99	5.34	5.71	6.74	5.87	5.92	4.64	4.42	4.96	5.07	4.80	4.81	5.26

Monthly Average Solar Radiation (Ly/d)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Albuquerque NSRDB	1961-2005	270.02	350.07	461.17	581.97	656.63	689.34	640.64	586.39	503.15	399.93	295.07	245.42	473.76
Gallup NSRDB	1991-2005	245.53	307.72	420.90	531.74	620.80	676.32	602.78	524.68	477.85	378.66	276.02	222.06	440.87
Malpais RAWS	1998-2008	244.91	299.86	412.69	501.90	555.94	581.13	480.17	449.05	425.61	352.75	277.37	232.76	401.86
Ramah RAWS	2004-2008	275.01	347.81	460.94	580.67	632.88	662.73	554.06	497.11	447.69	395.42	313.06	249.35	447.63
Zuni Buttes RAWS	2006-2008	263.79	347.93	497.18	599.41	644.42	679.69	553.03	529.51	478.99	402.92	305.36	235.32	469.35
Zuni Rso	1948-2008	330.12	422.39	551.54	676.39	755.47	781.46	747.84	677.57	575.30	451.89	347.66	301.70	552.10

Table 18

Zuni Pueblo Area[1]

Average Adjusted[2] Dewpoint Temperature

Degrees F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1948	3.43	7.49	8.12	21.50	29.28	40.63	46.45	45.99	39.02	28.61	10.42	7.61	24.09
1949	4.99	9.39	25.32	30.06	34.60	44.19	52.98	49.11	46.83	32.61	23.18	16.16	30.90
1950	17.87	25.13	21.42	27.52	30.95	39.25	52.47	44.42	39.28	32.77	18.44	14.94	30.41
1951	17.19	21.76	18.14	27.52	34.22	34.87	50.98	51.14	38.21	31.37	22.84	20.02	30.76
1952	24.25	20.10	22.85	32.11	34.82	41.97	49.13	52.15	40.36	26.31	21.38	19.55	32.13
1953	22.51	16.15	23.16	24.17	27.59	39.66	51.64	46.74	36.63	29.79	22.74	12.34	29.52
1954	18.92	20.23	22.22	28.88	35.80	38.57	52.49	49.69	44.84	32.91	21.80	17.80	32.09
1955	16.76	14.53	19.13	22.57	33.21	38.61	47.83	54.24	39.43	30.11	21.11	22.76	30.15
1956	22.91	14.76	18.42	24.14	31.06	42.71	47.36	45.52	39.08	30.41	13.97	13.79	28.74
1957	25.00	29.55	24.72	25.19	34.21	41.17	51.10	53.09	37.47	37.11	24.93	22.78	33.91
1958	20.27	25.58	25.84	26.79	35.27	43.59	47.39	52.43	46.23	34.64	23.39	17.37	33.28
1959	18.65	22.17	16.75	27.62	30.14	43.85	48.90	52.28	37.00	32.08	22.83	22.53	31.29
1960	14.45	17.82	23.71	24.67	32.55	44.90	50.20	49.00	43.11	34.14	22.99	20.01	31.51
1961	17.01	22.17	24.36	26.11	32.18	43.84	50.51	52.86	40.92	29.72	26.04	18.90	32.11
1962	17.80	25.53	20.18	28.50	30.51	40.32	50.29	47.80	46.97	35.80	29.25	23.68	33.08
1963	17.46	27.23	23.48	24.99	34.77	39.87	51.70	54.48	48.36	37.16	29.75	14.93	33.71
1964	10.34	13.46	19.40	25.38	33.75	40.23	53.09	51.19	45.91	30.50	22.97	21.64	30.72
1965	24.15	19.29	20.76	27.08	32.59	39.28	53.23	48.45	40.96	30.09	27.12	24.77	32.41
1966	17.45	18.38	24.04	27.97	36.58	42.67	52.22	51.68	46.32	31.60	25.56	19.16	32.89
1967	15.14	18.63	22.93	24.30	31.38	42.19	53.05	50.49	44.50	29.02	23.37	14.85	30.89
1968	16.60	25.44	23.72	26.80	32.84	40.77	49.67	47.93	38.53	30.85	23.91	13.51	30.89
1969	24.94	21.47	20.07	27.07	36.34	40.15	53.60	54.04	45.25	32.18	24.23	21.95	33.53
1970	17.47	22.52	22.91	21.86	32.59	41.89	51.65	51.30	40.65	29.01	19.27	16.15	30.67
1971	13.24	16.15	18.03	23.46	29.73	39.97	49.46	51.59	39.29	32.30	22.48	20.99	29.82
1972	14.10	14.05	20.09	22.03	30.01	42.76	49.87	48.83	40.91	41.49	24.86	18.49	30.69
1973	16.53	26.02	29.93	26.92	35.88	38.93	49.50	48.52	37.77	24.63	21.12	14.21	30.86
1974	19.41	14.31	22.58	19.34	30.01	39.76	49.47	44.12	39.27	37.69	23.67	14.29	29.61
1975	15.69	19.95	25.06	26.30	30.71	35.87	50.79	44.25	44.20	28.84	16.01	16.39	29.57
1976	14.41	21.74	17.20	26.00	34.17	37.26	49.27	46.07	43.05	26.05	16.15	11.69	28.60
1977	14.47	17.93	17.80	25.83	32.37	44.36	50.83	50.38	43.49	33.03	23.06	18.46	31.07
1978	24.36	24.80	27.72	25.21	30.73	41.20	48.17	44.33	40.30	31.30	30.98	18.05	32.30
1979	18.64	20.89	24.30	26.41	38.86	41.14	45.70	44.83	40.74	30.10	19.34	15.57	30.61
1980	26.59	24.38	21.42	26.18	30.41	38.52	46.65	46.89	40.84	27.50	17.87	25.45	31.10
1981	15.17	14.81	24.45	28.83	33.98	42.98	51.05	48.25	43.93	30.62	19.25	17.41	30.99
1982	18.30	23.18	25.98	24.20	31.83	34.57	47.26	53.79	44.95	23.65	25.65	20.04	31.17
1983	19.17	24.01	26.99	22.04	28.95	35.35	48.94	51.50	44.42	35.65	24.97	25.27	32.35
1984	17.39	13.01	18.16	23.86	31.83	39.50	49.99	51.16	43.21	33.68	20.89	23.54	30.60
1985	20.80	19.21	24.97	27.09	35.25	38.52	48.80	46.45	38.60	33.65	24.62	17.45	31.37
1986	16.33	22.56	23.82	26.98	30.08	43.02	49.04	49.75	39.26	30.39	26.55	20.54	31.57
1987	14.55	23.00	20.99	25.22	34.55	38.29	42.37	48.48	36.66	31.12	23.75	16.35	29.65
1988	15.94	20.96	13.66	24.78	28.80	40.70	47.59	52.28	35.83	29.52	21.79	15.36	28.96
1989	14.66	19.74	21.00	25.30	30.06	35.10	48.27	44.69	36.08	27.71	14.42	7.25	27.08
1990	11.61	16.67	24.83	29.89	31.14	39.19	49.23	45.21	46.87	29.61	26.03	11.73	30.22
1991	16.95	21.94	23.72	19.95	25.23	37.90	48.44	50.94	40.84	28.53	23.27	22.51	30.08
1992	16.59	24.23	25.76	27.49	39.90	37.25	45.65	46.78	38.23	29.90	18.15	13.56	30.33
1993	25.40	24.10	21.15	20.80	33.56	35.38	42.01	49.93	37.41	30.21	16.62	13.41	29.22
1994	11.14	18.98	24.59	26.07	33.43	40.52	48.72	56.25	41.47	29.32	21.90	20.27	31.14
1995	22.79	24.68	25.49	23.97	30.80	35.46	44.11	52.73	41.59	23.96	21.98	15.98	30.34
1996	15.65	21.47	18.35	22.67	30.33	40.88	49.93	48.04	41.18	31.02	24.62	16.19	30.05
1997	20.61	19.65	18.85	26.08	34.05	39.47	46.03	51.45	48.73	29.82	22.34	18.16	31.33
1998	21.83	23.03	23.38	23.70	28.45	33.29	52.40	49.92	43.34	32.41	24.29	17.47	31.19
1999	13.60	13.37	19.33	23.04	31.09	37.34	52.46	52.25	44.03	25.24	18.45	11.79	28.60
2000	18.93	21.30	24.00	26.33	31.49	43.15	49.08	51.21	41.77	35.35	20.27	15.25	31.55
2001	16.43	20.06	23.66	26.78	32.41	38.34	50.49	50.19	40.97	28.92	25.41	15.73	30.85
2002	15.15	11.50	14.71	26.80	27.85	38.90	50.35	45.40	41.25	32.44	20.34	19.60	28.80
2003	21.45	20.23	21.74	20.87	32.48	38.31	47.81	51.42	39.61	31.73	20.20	15.65	30.21
2004	19.81	16.80	26.54	27.98	28.64	38.56	44.45	45.96	38.53	31.95	25.17	18.25	30.27
2005	25.69	27.93	23.85	23.20	32.26	34.71	44.09	48.06	39.66	31.40	14.84	9.13	29.60
2006	10.06	8.07	19.58	22.67	28.09	38.23	48.72	50.37	35.79	32.25	17.03	15.71	27.36
2007	15.29	21.23	17.07	22.27	32.79	33.55	46.52	48.88	37.66	24.44	17.10	18.73	28.02
2008	13.84	20.91	16.29	16.47	26.69	34.96	49.38	46.71	36.24	22.15	20.59	19.43	27.00
Average	17.51	19.92	21.78	25.18	32.07	39.48	49.19	49.41	41.21	30.79	21.93	17.42	30.55
1991-2008	17.85	19.97	21.56	23.73	31.08	37.57	47.81	49.81	40.46	29.50	20.70	16.49	29.77

[1]Source: Zuni Airport/ Gallup Airport combined.

[2]Adjusted with Equation E-1 of the ASCE Task Committee Report, Appendix E, January 2005.

Table 19

Zuni Pueblo Area[1]
Average Wind Speed at 2 Meters

Values in miles per hour

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1949		7.02	6.29	4.72	6.96	6.82	4.78	5.23	5.71	5.65	6.78	6.94	6.03
1950	8.49	5.24	7.15	6.70	6.70	5.91	3.94	4.64	5.55	6.42	6.57	6.34	6.14
1951	5.69	5.60	7.02	8.17	7.74	7.66	5.73	5.86	7.12	7.05	6.81	8.38	6.91
1952	6.31	6.69	7.96	6.46	6.99	6.92	5.33	5.07	6.47	8.03	6.02	7.03	6.61
1953	7.10	7.27	7.97	10.33	9.35	8.39	6.20	6.28	6.90	6.69	6.35	6.85	7.47
1954	7.03	5.97	9.59	8.68	7.96	7.95	5.36	4.77	5.33	5.00	7.37	5.83	6.74
1955	5.20	6.62	7.06	8.33	6.51	6.37	5.16	3.51	5.13	5.54	6.09	5.65	5.92
1956	5.92	6.25	6.25	6.48	5.99	5.31	4.00	3.96	4.69	5.16	5.92	6.19	5.51
1957	6.47	6.17	7.46	8.65	6.77	6.41	4.85	4.55	5.84	5.17	5.42	5.81	6.13
1958	5.63	6.27	6.26	8.43	7.42	7.69	6.45	5.18	6.44	5.18	4.89	4.86	6.22
1959	4.52	4.81	6.25	8.20	8.87	7.78	7.07	6.18	7.90	7.08	7.18	6.80	6.89
1960	7.85	8.67	8.76	8.75	8.11	7.69	6.41	6.29	6.80	6.67	7.47	6.82	7.51
1961	6.34	6.04	7.28	8.10	7.73	7.05	6.22	5.81	6.78	6.14	6.56	6.41	6.71
1962	6.11	6.64	6.43	6.08	7.06	5.80	4.34	5.15	5.56	6.73	5.85	5.56	5.94
1963	5.97	5.58	7.53	10.28	8.48	9.10	8.44	7.49	8.09	7.78	4.08	4.70	7.30
1964	8.26	8.34	9.15	10.51	8.83	8.12	5.96	6.39	6.47	6.61	5.92	6.56	7.59
1965	6.86	7.09	7.72	8.45	8.21	6.80	5.86	7.16	9.07	8.65	8.70	8.19	7.73
1966	8.57	8.42	9.22	9.01	6.53	5.26	4.37	4.42	4.89	5.71	5.90	5.81	6.50
1967	5.32	5.49	6.30	7.91	5.84	5.70	3.73	4.39	3.58	5.48	6.22	5.80	5.47
1968	5.52	5.32	5.17	6.90	7.62	8.72	7.58	7.04	6.53	5.98	5.63	7.28	6.61
1969	6.80	6.07	6.58	6.62	6.05	6.76	4.85	4.15	4.36	6.10	5.06	5.83	5.77
1970	5.06	5.14	6.42	7.91	6.17	5.98	4.57	4.67	6.16	5.82	7.03	5.23	5.84
1971	5.11	5.47	5.92	5.78	5.41	3.87	3.95	3.63	4.99	4.92	4.10	3.96	4.75
1972	5.16	5.88	6.18	6.87	5.29	4.69	4.46	3.78	4.30	3.31	4.76	2.80	4.78
1973	3.96	4.19	6.82	6.46	5.63	5.28	4.84	4.38	4.93	3.99	5.67	4.33	5.04
1974	4.22	4.08	6.97	6.68	6.74	5.01	4.83	4.93	4.84	4.21	3.44	3.80	4.99
1975	4.55	4.72	7.27	7.83	6.28	6.19	3.97	3.80	3.51	4.09	3.98	2.60	4.90
1976	2.68	5.17	7.29	7.09	5.68	6.60	5.31	4.80	4.54	4.25	3.02	2.26	4.88
1977	2.53	4.23	7.19	5.88	8.31	5.90	5.44	4.63	5.69	3.57	4.47	5.06	5.25
1978	4.00	5.63	5.71	7.65	6.36	6.24	5.41	5.93	5.91	3.86	4.95	4.55	5.51
1979	5.16	4.22	5.55	6.73	6.35	5.88	4.79	4.76	4.20	4.51	4.77	2.69	4.97
1980	5.76	5.22	7.34	6.20	7.23	5.92	4.77	5.28	4.05	3.95	3.41	2.83	5.17
1981	3.38	4.22	5.81	5.85	6.98	5.80	4.45	4.86	4.07	5.56	3.90	3.89	4.90
1982	4.96	4.46	6.94	9.31	7.31	5.57	5.17	3.97	5.47	3.86	5.06	4.78	5.57
1983	2.44	3.80	6.54	7.12	5.96	5.30	4.80	3.76	4.24	3.67	5.21	6.29	4.93
1984	3.32	4.67	5.88	7.31	6.54	5.97	3.51	3.94	4.84	4.90	4.55	4.70	5.01
1985	4.26	3.81	7.54	5.94	6.03	4.89	4.60	4.17	5.26	4.67	6.46	3.05	5.06
1986	2.65	5.25	4.84	7.64	6.60	4.83	4.84	3.76	5.49	3.82	3.82	2.35	4.64
1987	3.26	3.93	5.04	5.10	5.21	4.43	5.34	3.80	3.36	2.94	4.00	3.56	4.16
1988	3.34	3.81	5.31	5.03	5.93	5.00	4.11	3.98	4.69	3.96	5.34	4.77	4.61
1989	3.61	5.33	5.87	5.90	7.04	6.11	5.38	4.71	5.33	4.10	4.01	3.17	5.04
1990	4.18	4.96	5.37	6.57	7.89	6.58	4.99	4.76	3.86	4.06	3.94	4.19	5.11
1991	2.66	3.41	6.89	6.86	6.24	5.89	4.50	3.92	4.05	4.34	4.27	3.93	4.75
1992	4.00	4.63	5.32	4.75	5.63	5.97	5.18	4.78	4.40	4.39	4.11	3.41	4.71
1993	4.90	6.30	5.35	6.89	5.78	6.33	6.56	4.63	3.90	4.00	3.97	3.38	5.16
1994	3.18	4.44	4.91	6.23	5.40	5.24	5.35	4.35	3.69	4.28	5.38	3.37	4.65
1995	4.41	4.57	6.66	6.91	7.27	5.60	4.60	4.07	4.23	3.39	3.57	2.78	4.84
1996	4.86	4.86	5.53	6.49	7.64	5.43	4.82	4.77	4.49	4.93	4.02	5.00	5.24
1997	4.94	4.84	4.91	6.26	4.79	4.74	4.46	3.86	4.09	4.01	3.32	3.60	4.48
1998	3.43	5.35	5.70	6.05	5.21	7.06	4.06	3.47	4.36	4.61	3.97	3.88	4.75
1999	4.38	4.85	6.09	7.30	7.37	6.40	5.18	4.43	4.33	3.42	2.78	3.65	5.01
2000	4.42	5.51	5.34	6.04	6.91	6.26	5.59	4.81	5.34	4.77	3.96	3.78	5.22
2001	3.52	4.84	4.66	8.15	5.63	6.08	5.32	4.21	4.23	4.66	4.60	4.03	4.98
2002	4.17	4.46	6.48	7.79	7.05	6.69	5.16	4.60	5.08	4.33	4.33	3.67	5.32
2003	3.28	6.03	5.83	8.57	6.88	6.78	5.23	4.37	4.41	4.34	5.71	4.18	5.45
2004	4.01	4.77	4.78	6.89	7.74	6.26	5.17	5.48	5.42	5.77	4.97	3.44	5.39
2005	4.73	4.76	6.46	7.72	6.39	6.97	5.05	4.01	5.33	4.61	4.41	4.16	5.38
2006	4.94	4.72	7.28	7.23	6.58	6.01	5.20	4.18	5.09	4.45	4.13	3.85	5.31
2007	4.61	5.29	5.39	7.19	6.36	5.88	4.45	4.27	4.83	4.67	3.10	5.05	5.09
2008	4.03	4.56	6.40	7.91	7.18	6.41	4.24	4.10	3.33	4.29	3.80	4.85	5.09
Average	4.88	5.35	6.49	7.23	6.78	6.24	5.10	4.74	5.16	5.00	5.02	4.74	5.56

[1]Source: Zuni Airport/ Gallup Airport combined.

Table 20

Zuni Pueblo Area[1]

Average Maximum Temperature 1991-2008

Values in Degrees F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	43.5	57.0	53.6	67.3	77.8	83.3	89.4	86.2	81.2	73.2	54.7	46.6	67.9
1992	42.6	51.5	58.4	71.7	71.9	83.4	86.0	85.7	82.4	72.5	51.1	45.2	66.9
1993	48.0	50.9	60.2	68.8	76.9	87.2	90.5	85.6	81.9	69.2	54.2	51.4	68.8
1994	52.0	51.4	61.4	67.9	77.1	90.9	92.1	90.0	82.8	67.5	53.5	51.3	69.9
1995	46.6	58.6	60.5	63.2	71.3	85.2	91.5	90.7	82.6	74.8	63.4	51.8	70.1
1996	52.0	58.2	61.5	71.5	82.8	89.1	92.3	89.1	76.3	68.5	58.9	50.9	71.0
1997	44.5	52.2	65.4	64.1	79.2	84.7	90.5	88.5	83.7	70.2	58.5	44.2	68.9
1998	48.4	45.5	57.3	62.2	76.2	85.1	89.6	89.3	85.1	70.6	59.7	52.7	68.6
1999	54.6	59.3	65.9	64.2	76.0	86.1	87.1	85.1	81.9	75.3	68.7	49.7	71.2
2000	53.3	60.4	59.4	73.4	84.2	89.7	93.4	89.9	86.4	68.4	50.3	52.8	71.8
2001	46.1	52.6	61.3	68.9	81.2	90.5	90.2	87.7	85.3	75.2	59.4	48.6	70.7
2002	48.8	55.6	62.0	73.5	80.5	92.2	91.6	89.2	81.0	68.5	59.2	44.6	70.6
2003	55.4	50.0	58.1	67.8	80.5	88.8	97.0	89.3	85.3	76.9	58.1	53.0	71.8
2004	49.2	49.0	67.3	66.8	81.5	89.2	91.3	87.5	81.8	69.9	55.6	50.5	70.0
2005	51.9	49.9	56.1	69.1	79.2	86.8	95.6	87.5	85.0	73.7	63.3	51.9	70.9
2006	54.8	58.4	56.8	72.8	84.0	92.2	91.0	84.2	77.6	68.5	62.0	49.9	71.1
2007	46.3	51.4	64.6	69.6	77.5	90.6	92.9	88.9	84.0	75.3	66.3	46.3	71.3
2008	44.9	50.4	62.2	70.6	76.0	89.3	89.3	89.8	83.9	73.9	62.3	48.7	70.2
Average	49.0	53.5	60.7	68.5	78.5	88.0	91.2	88.0	82.7	71.8	58.8	49.5	70.1

[1]Source: Zuni NOAA Weather Station (#299897)

Table 21

Zuni Pueblo Area[1]

Average Minimum Temperature 1991-2008

Values in Degrees F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	17.5	22.3	23.6	24.8	31.7	42.7	53.2	54.5	45.0	33.5	23.8	21.0	32.9
1992	13.5	24.7	28.0	31.7	42.5	43.1	50.4	50.4	43.3	35.2	18.7	15.4	33.1
1993	24.6	23.3	24.7	27.1	38.5	42.3	48.6	53.7	42.9	33.4	20.8	15.8	33.0
1994	12.6	18.3	26.5	31.0	38.1	46.9	55.8	62.4	45.7	33.6	23.6	21.7	34.8
1995	20.9	25.6	27.3	27.6	34.7	42.0	50.6	57.4	46.4	30.8	28.0	19.2	34.3
1996	16.9	25.5	22.8	29.3	37.5	47.6	55.7	54.0	44.5	35.5	25.4	18.1	34.4
1997	19.1	20.5	23.5	30.1	39.2	45.3	51.5	55.1	52.2	33.6	24.1	16.9	34.3
1998	21.3	21.4	24.4	27.8	34.9	40.1	56.7	55.4	49.2	35.3	26.2	17.8	34.3
1999	15.2	17.3	24.4	28.0	36.7	44.4	56.3	54.2	46.6	31.7	24.1	10.4	32.5
2000	18.7	21.5	25.4	31.0	38.2	49.2	55.8	53.9	48.0	38.0	21.2	16.8	34.8
2001	15.6	18.5	24.9	31.5	38.4	45.2	55.9	54.3	46.9	35.5	28.4	15.3	34.3
2002	15.3	16.3	21.1	32.9	34.8	46.1	56.3	50.3	44.6	34.5	25.0	18.9	33.1
2003	22.6	23.1	25.1	26.2	39.4	45.5	54.2	54.0	44.6	36.5	22.7	15.5	34.2
2004	18.9	18.9	30.7	32.2	35.5	45.6	50.3	51.0	43.6	33.9	26.2	14.0	33.5
2005	24.6	26.6	24.8	27.7	37.9	41.1	50.5	50.2	44.7	33.8	19.4	10.8	32.7
2006	11.9	12.2	19.7	28.2	35.0	45.1	52.2	50.2	37.8	28.9	16.6	9.9	29.1
2007	9.3	13.1	17.2	23.8	35.2	40.1	49.5	48.8	40.6	27.2	20.9	18.6	28.8
2008	16.4	20.3	21.9	23.2	32.0	41.6	49.8	47.4	37.7	25.7	24.9	18.7	30.0
Average	17.5	20.5	24.2	28.6	36.7	44.1	53.0	53.2	44.7	33.1	23.3	16.4	33.0

[1]Source: Zuni NOAA Weather Station (#299897)

Table 22

Zuni Pueblo Area[1]

Average Dewpoint Temperature[2] 1991-2008

Values in Degrees F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	15.8	20.3	21.6	19.7	25.2	37.4	48.4	50.7	40.5	28.2	21.9	20.1	29.2
1992	13.1	23.0	25.2	27.3	39.5	37.2	45.6	46.5	38.1	29.5	17.2	12.2	29.6
1993	23.5	22.0	20.9	20.8	33.4	35.4	42.0	49.7	37.4	29.5	16.1	12.6	28.7
1994	9.6	16.7	23.8	26.0	32.9	40.4	48.7	56.2	41.2	29.1	20.7	19.5	30.5
1995	19.7	23.5	24.5	23.7	30.3	35.3	44.1	52.6	41.2	24.0	22.0	15.3	29.7
1996	14.3	21.1	18.0	22.7	30.3	40.8	49.9	48.0	40.6	30.6	23.2	15.4	29.6
1997	18.1	18.5	18.2	25.5	33.8	39.3	46.0	51.3	48.5	29.3	21.3	16.0	30.5
1998	20.2	20.3	22.2	23.2	28.3	33.3	52.4	49.8	43.3	31.1	23.3	16.0	30.4
1999	12.7	12.9	18.7	22.7	30.9	37.3	52.2	52.0	43.2	25.2	18.4	8.6	28.0
2000	16.1	19.3	22.8	25.7	31.3	43.2	49.1	50.7	41.8	34.9	19.0	13.9	30.7
2001	13.8	16.9	22.4	26.7	32.2	38.3	50.4	49.9	40.9	28.9	24.6	13.3	29.9
2002	12.6	11.0	14.7	26.5	27.8	38.9	50.3	45.1	40.6	31.4	20.2	17.8	28.2
2003	20.4	19.9	21.2	20.6	32.5	38.3	47.8	50.7	39.4	31.3	19.3	13.4	29.6
2004	17.8	16.1	26.0	27.6	28.6	38.6	44.3	45.8	38.3	30.9	23.9	13.5	29.3
2005	23.4	25.8	22.6	22.4	32.1	34.7	44.1	47.5	39.6	30.4	14.1	8.1	28.8
2006	8.2	7.2	16.7	22.6	28.1	38.2	48.0	48.8	34.7	27.8	14.7	9.8	25.5
2007	9.0	12.9	14.9	20.4	31.3	33.4	45.5	47.2	36.9	23.2	16.2	17.0	25.8
2008	13.4	19.1	16.2	16.5	26.3	34.9	47.8	44.8	34.8	21.0	19.8	17.7	26.1
Average	15.7	18.1	20.6	23.4	30.8	37.5	47.6	49.3	40.1	28.7	19.8	14.5	28.9

[1]Source: Gallup Airport (#293422/23081)

[2]Adjusted with Equation E-1 of the ASCE Task Committee Report, Appendix E, January 2005.

Table 23

Zuni Pueblo Area[1]

Average Precipitation 1991-2008

Values in Inches

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	1.23	0.36	2.00	0.01	0.00	0.89	0.53	2.42	0.96	0.77	1.72	1.41	12.30
1992	1.23	0.44	1.84	0.10	3.29	0.28	4.52	2.75	0.58	1.23	0.47	1.69	18.42
1993	3.63	0.51	1.21	0.02	0.46	0.00	0.05	3.49	0.04	1.11	1.37	0.19	12.08
1994	0.02	0.90	0.81	1.43	1.10	0.69	1.98	1.72	1.71	2.62	0.55	0.89	14.42
1995	1.67	1.16	1.08	0.75	0.76	0.00	0.41	2.35	0.23	0.00	1.42	0.42	10.25
1996	0.63	0.80	0.36	0.21	0.00	0.41	3.01	1.94	2.74	1.24	1.25	0.00	12.59
1997	2.07	0.57	0.00	2.07	0.85	1.61	1.04	3.97	1.06	1.05	1.15	1.46	16.90
1998	0.64	2.02	1.98	0.74	0.00	0.00	3.57	1.83	1.40	3.22	1.50	0.68	17.58
1999	0.05	0.10	0.21	0.55	0.70	0.42	3.08	3.60	1.19	0.00	0.00	0.04	9.94
2000	0.59	0.50	1.79	0.00	0.00	1.09	0.12	2.13	0.45	2.12	0.65	0.18	9.62
2001	0.60	0.69	0.10	0.92	0.23	0.11	1.69	3.68	0.93	0.33	0.47	0.64	10.39
2002	0.85	0.18	0.56	0.79	0.00	0.33	1.15	1.92	2.83	1.63	0.31	1.68	12.23
2003	0.10	1.04	0.67	0.04	0.00	0.05	0.91	0.78	0.58	0.89	0.78	0.25	6.09
2004	0.42	0.51	0.92	0.62	0.00	0.20	0.39	1.34	1.16	0.57	0.72	0.92	7.77
2005	1.55	2.56	1.58	1.05	0.22	0.23	0.69	1.05	0.36	0.76	0.12	0.19	10.36
2006	0.11	0.00	1.08	0.28	0.00	0.52	1.83	1.92	1.49	1.75	0.42	1.12	10.52
2007	0.81	0.91	0.06	0.64	1.41	0.14	2.03	3.86	0.35	0.38	0.09	2.08	12.76
2008	1.48	1.36	0.14	0.16	1.68	0.07	2.04	1.32	0.39	1.38	0.69	1.74	12.45
Average	0.98	0.81	0.91	0.58	0.59	0.39	1.61	2.34	1.03	1.17	0.76	0.87	12.04

[1]Source: Zuni NOAA Weather Station (#299897)

Table 24

Zuni Pueblo Area[1]

Average Wind Speed 1991-2008
at 2 Meters Height

Values in Miles per Hour

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	2.7	3.4	6.9	6.9	6.2	5.9	4.5	3.9	4.0	4.3	4.3	3.9	4.8
1992	4.0	4.6	5.3	4.7	5.6	6.0	5.2	4.8	4.4	4.4	4.1	3.4	4.7
1993	4.9	6.3	5.4	6.9	5.8	6.3	6.6	4.6	3.9	4.0	4.0	3.4	5.2
1994	3.2	4.4	4.9	6.2	5.4	5.2	5.4	4.4	3.7	4.3	5.4	3.4	4.6
1995	4.4	4.6	6.7	6.9	7.3	5.6	4.6	4.1	4.2	3.4	3.6	2.8	4.8
1996	4.9	4.9	5.5	6.5	7.6	5.4	4.8	4.8	4.5	4.9	4.0	5.0	5.2
1997	4.9	4.8	4.9	6.3	4.8	4.7	4.5	3.9	4.1	4.0	3.3	3.6	4.5
1998	3.4	5.3	5.7	6.1	5.2	7.1	4.1	3.5	4.4	4.6	4.0	3.9	4.8
1999	4.4	4.9	6.1	7.3	7.4	6.4	5.2	4.4	4.3	3.4	2.8	3.7	5.0
2000	4.4	5.5	5.3	6.0	6.9	6.3	5.6	4.8	5.3	4.8	4.0	3.8	5.2
2001	3.5	4.8	4.7	8.1	5.6	6.1	5.3	4.2	4.2	4.7	4.6	4.0	5.0
2002	4.2	4.5	6.5	7.8	7.0	6.7	5.2	4.6	5.1	4.3	4.3	3.7	5.3
2003	3.3	6.0	5.8	8.6	6.9	6.8	5.2	4.4	4.4	4.3	5.7	4.2	5.5
2004	4.0	4.8	4.8	6.9	7.7	6.3	5.2	5.5	5.4	5.8	5.0	3.4	5.4
2005	4.7	4.8	6.5	7.7	6.4	7.0	5.0	4.0	5.3	4.6	4.4	4.2	5.4
2006	4.9	4.7	7.3	7.2	6.6	6.0	5.2	4.2	5.1	4.4	4.1	3.9	5.3
2007	4.6	5.3	5.4	7.2	6.4	5.9	4.5	4.3	4.8	4.7	3.1	5.1	5.1
2008	4.0	4.6	6.4	7.9	7.2	6.4	4.2	4.1	3.3	4.3	3.8	4.9	5.1
Average	4.1	4.9	5.8	7.0	6.4	6.1	5.0	4.4	4.5	4.4	4.1	3.9	5.0

[1]Source: Gallup Airport (#293422/23081)

Table 25

Zuni Pueblo Area[1]

Average Solar Radiation 1991-2008

Values in Langleys per Day

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1991	249	343	392	591	664	604	596	498	456	364	243	165	431
1992	235	268	343	532	510	661	559	510	508	378	268	184	413
1993	212	268	436	548	593	688	674	508	535	380	280	230	447
1994	278	302	435	478	604	688	622	530	472	361	268	211	438
1995	201	303	397	466	541	662	610	519	463	417	296	222	425
1996	258	294	435	563	674	622	565	508	427	361	250	202	430
1997	210	276	446	434	574	643	569	469	443	384	253	192	408
1998	217	280	390	512	612	702	573	496	443	334	271	237	423
1999	280	357	464	528	610	673	527	502	469	431	324	233	450
2000	253	331	426	582	680	652	607	560	503	358	272	252	457
2001	247	338	409	547	616	710	590	554	527	423	282	242	457
2002	275	385	467	562	678	721	590	561	459	350	305	216	464
2003	295	308	408	563	598	684	643	535	499	405	266	246	455
2004	247	306	476	491	694	710	617	549	499	351	245	236	452
2005	226	253	383	577	665	724	700	571	459	373	316	264	460
2006	298	387	422	577	660	683	567	486	456	373	322	234	455
2007	252	349	470	551	605	664	561	554	471	424	314	235	454
2008	276	347	524	629	643	697	546	538	494	424	302	228	471
Average	250	316	429	541	623	677	595	525	477	383	282	224	444

[1]Source: 1991-2005 National Solar Radiation Database, Gallup Airport (#723627)
2006 Ramah RAWS (#297248)
2007-2008 Zuni Buttes RAWS (#290603)

Table 26

Zuni Pueblo Area
Monthly ASCE Std. Penman-Monteith Reference ETo

Values in Inches

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1991	1.28	2.23	3.26	5.75	7.63	7.49	7.54	6.12	5.11	3.95	1.89	1.28	53.50
1992	1.38	2.08	3.30	5.34	5.55	7.82	7.25	6.53	5.63	4.03	1.94	1.23	52.08
1993	1.56	2.03	3.85	5.80	6.83	8.60	9.17	6.42	5.51	3.56	1.98	1.70	57.01
1994	1.74	2.01	3.78	5.07	6.77	8.51	8.42	6.85	5.13	3.58	2.18	1.50	55.54
1995	1.45	2.37	3.81	4.78	6.26	7.86	8.00	6.75	5.38	4.10	2.45	1.64	54.85
1996	2.10	2.67	4.11	6.05	8.80	8.05	7.76	6.92	4.67	3.71	2.12	1.93	58.88
1997	1.36	2.15	4.42	4.55	6.60	7.43	7.55	6.11	5.13	3.75	2.03	1.17	52.24
1998	1.46	1.70	3.41	4.64	6.77	8.80	7.21	6.26	5.53	3.83	2.21	1.80	53.63
1999	2.25	2.90	4.85	5.19	7.23	8.40	7.06	6.13	5.27	4.06	2.54	1.75	57.61
2000	2.00	2.93	3.65	6.21	8.55	8.55	8.62	7.23	6.33	3.52	1.73	1.79	61.11
2001	1.36	2.19	3.67	5.73	7.47	8.99	7.95	6.67	5.89	4.53	2.48	1.68	58.62
2002	1.87	2.69	4.52	6.48	8.22	9.61	8.04	7.20	5.37	3.62	2.34	1.32	61.26
2003	1.94	2.23	3.67	6.03	7.52	8.93	9.11	6.80	5.72	4.27	2.60	1.80	60.61
2004	1.64	2.16	4.54	5.23	8.66	9.00	8.28	7.28	5.86	4.05	2.15	1.38	60.23
2005	1.69	1.72	3.39	5.85	7.64	9.02	9.30	6.69	6.10	4.24	2.78	2.02	60.43
2006	2.46	2.87	3.80	6.30	8.47	9.09	7.75	5.80	5.05	3.47	2.50	1.62	59.18
2007	1.56	2.09	4.35	5.72	6.97	8.74	7.63	6.78	5.76	4.48	2.56	1.55	58.18
2008	1.48	1.99	4.73	6.61	7.48	8.91	6.95	6.76	5.20	4.17	2.29	1.48	58.05
Average	1.70	2.28	3.95	5.63	7.41	8.54	7.98	6.63	5.48	3.94	2.26	1.59	57.39

Zuni Pueblo Area
Monthly Hargreaves-Samani Reference ETo

Values in Inches

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1991	1.27	2.25	2.88	4.87	6.98	7.62	8.26	6.99	5.47	4.04	1.90	1.29	53.81
1992	1.27	2.00	3.29	5.39	5.82	7.64	7.79	7.12	5.63	3.84	1.74	1.26	52.79
1993	1.46	1.86	3.49	5.05	6.71	8.24	8.65	6.95	5.61	3.62	1.85	1.56	55.04
1994	1.71	1.92	3.56	4.89	6.77	8.68	8.53	6.94	5.62	3.46	1.83	1.52	55.43
1995	1.42	2.34	3.48	4.41	6.04	7.92	8.71	7.58	5.63	4.11	2.33	1.59	55.54
1996	1.73	2.42	3.66	5.38	7.65	8.33	8.62	7.45	4.91	3.54	2.11	1.52	57.31
1997	1.33	1.97	4.03	4.49	7.05	7.75	8.51	7.32	5.52	3.72	2.11	1.21	55.00
1998	1.53	1.57	3.23	4.29	6.72	7.99	8.07	7.42	5.79	3.71	2.15	1.63	54.10
1999	1.85	2.40	4.03	4.53	6.64	7.98	7.67	6.81	5.48	4.16	2.73	1.46	55.75
2000	1.78	2.57	3.40	5.62	7.86	8.40	8.80	7.62	5.97	3.45	1.63	1.63	58.73
2001	1.42	1.99	3.63	4.98	7.40	8.67	8.26	7.21	5.92	4.05	2.16	1.43	57.09
2002	1.56	2.19	3.68	5.52	7.37	8.95	8.47	7.66	5.46	3.54	2.11	1.23	57.73
2003	1.90	1.79	3.31	4.92	7.24	8.39	9.56	7.53	5.94	4.20	2.07	1.64	58.48
2004	1.56	1.89	4.22	4.76	7.47	8.45	8.71	7.34	5.59	3.64	1.93	1.50	57.03
2005	1.69	1.77	3.11	5.03	7.12	8.21	9.45	7.38	5.90	3.99	2.40	1.55	57.61
2006	1.83	2.31	3.21	5.49	7.85	8.96	8.59	6.88	5.22	3.58	2.34	1.47	57.71
2007	1.42	1.93	3.90	5.12	6.92	8.82	9.03	7.67	5.94	4.14	2.59	1.31	58.78
2008	1.35	1.96	3.73	5.27	6.75	8.57	8.40	7.84	5.93	3.98	2.30	1.41	57.48
Average	1.56	2.06	3.55	5.00	7.02	8.31	8.56	7.32	5.64	3.82	2.13	1.46	56.41