Appendix B

Selection of Baseline Period for Hydrology Analysis

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Hydrology Data Sources

Multiple hydrology data sources, both measured and modeled, have been analyzed for the Habitat Conservation Plan's (HCP's) baseline hydrology analysis. The primary sources include the measured U.S. Geological Survey (USGS) flow data and the modeled mean daily flow data (hydrology fconsultant sources: Wildermuth, and Geoscience). As part of our hydrology analysis we have performed statistical analysis on the flow data, including exceedance analysis, to determine how often flows of a given magnitude occur on a particular stream reach. In order to compare the modeling data sources with each other it is necessary to use the same base period of analysis for each data set. This is important not only for analyzing the differences between the modeled flow data for the same location, but also to enable use of all of the available data sets (some geographic areas are only covered by one or two of the data sets, yet comparisons need to be made across the entire study area). The periods of record among the data sources vary. For example, the period of record for the USGS data includes records for some gages extending back into the 1800s, while other gages have only been installed and collecting data for less than 20 years.

The modeled flow data (provided by Geoscience and Wildermuth) are based on precipitation records, which are used as input into rainfall-runoff- routing models. The Geoscience model is based on precipitation records from 1934–2008 and the Wildermuth model on precipitation records from 1950–1999. It should be noted that while the precipitation records for the modeled data extend back to 1934 and 1950, respectively, the land use conditions used in each model are based on recent land use patterns. Land use conditions are used in the models to determine how the precipitation translates into runoff and are based on recent conditions at the time each model was developed. Geoscience's Active Recharge Project model assumes 2005 land use conditions, and Wildermuth's Wasteload Allocation Model uses 2000 land use conditions. The modeled data uses a historic precipitation record to include a mixture of years that were drier and wetter than the long-term average to determine how the runoff volumes generated from the precipitation vary with water year type. In other words, the 1934 data from the Geoscience model should be interpreted as the amount of runoff that would occur under 2005 year land use conditions if the precipitation patterns from 1934 occurred in 2005.

Precipitation Analysis

The precipitation data and cumulative precipitation departure graph described below were prepared and provided by Farid Boushaki, Ph.D., P.E., with Riverside Public Utilities. Precipitation records from the San Bernardino Hospital Gage are available for 122 years spanning the period 1892–2014 (water years 1893–2014, see Figure B-1). The annual average precipitation over the 1892–2004 period is 16.0 inches. The annual minimum and maximum over this same period is 2.4 and 36.6 inches, respectively (calculated using water years that begin October 1 and end September 30). For the purposes of this analysis the rainfall record at this gage is assumed to be representative of climatic conditions for the area included in the Santa Ana River HCP with the acknowledgement that absolute precipitation values vary widely throughout the region. The gage does not account for variability in annual snowpack.

Cumulative precipitation departure analysis is a technique used by hydrologists to characterize trends in precipitation time-series data. The cumulative departure line in Figure B-1 is calculated by calculating the difference between a given year's total annual rainfall and the long term average then cumulatively adding each successive year's precipitation departure to the running total from the previous year. A downward trend in the cumulative departure line indicates drier than average conditions whereas an upward trending line indicates wetter than average conditions. Wet and dry classifications are labeled at the bottom of Figure B-1. These classifications are based on interpretation of the precipitation trends. The data indicate the last wet trend occurred for 8 years from 1991–1998, which transitioned into a dry period that has lasted from 1999 to the most recent data in 2014. Although there have been individual years with wetter than average rainfall in the 1999–2014 period (i.e., 2004, 2005, and 2010), the overall pattern is drier than average conditions. Viewed historically, the 1892–1904 period had a greater negative cumulative departure than the 1999–2014 period[1]. Only by analyzing future years of data beyond 2014 will we be able to determine that if the current dry period continues it could cause the trend of net deficit to equal or exceed the deficit obtained in 1904.

Selection of Hydrology Base Period

The cumulative precipitation departure analysis was used to select a base period from the precipitation record that includes a mixture of years that is representative of the long-term average. The base period must begin no earlier than 1950 and end no later than 1999 in order to compare the Geoscience and Wildermuth data. For the reasons described below, we recommend selecting a 25-year base period that begins in 1966 and ends in 1990 as this period allows use of both modeling data sets and includes a dry and wet period that is representative of the long-term conditions measured at the precipitation gage.

Table B-1 compares precipitation statistics of the 1966–1990 period with the gage record of 1892–2014 and the past 20 years of 1995–2014. The annual average precipitation over the recommended base period of 1966–1990 is 16.4 inches, which is similar to the 1892–2014 period (16.0 inches) and slightly higher than the 1995–2014 period (14.0 inches). The percentage of the years with annual rainfall less than the long-term average over the 1966-1990 period is 60%, which is similar to both the 1892-2014 period (56%) and 1995-2014 period (65%). The minimum annual rainfall that occurred in the 1966-1990 period is 8.9 inches. This is higher than both the 1892-2014 and 1995-2014 periods since the lowest annual precipitation ever recorded at the gage of 2.4 inches occurred in 2001.

Figure B-2 shows frequency distributions of mean annual precipitation for both the 1892-2014 period and 1966–1990 period. The red columns indicate the actual number of years of precipitation within the frequency bin interval and the black line curve represents how the frequency distribution would look if the data had a normal distribution around the mean. The intent of showing the normal distribution curve on the graphs is to highlight that the actual distribution frequency is skewed and not normally distributed. The distribution curves were used to designate Dry, Intermediate, and Wet water year type classifications specific to this study. ICF designated Dry years have less than 11 inches of annual precipitation, Intermediate years have 11-19 inches, and Wet years have more than 19 inches of annual precipitation. Table B-2 compares water year type statistics for the 1892–

2014, 1995–2014, and 1966–1990 periods. The results show strong similarity in the percentage of years designated in each of the three water year types between the long term period of 1892–2014 and the selected baseline period of 1966–1990.

In summary, the precipitation record from the recommended base period of 1966–1990 is similar to both the long-term and previous 20-year records in terms of the annual average rainfall and distribution of wetter and drier than average years.

Table B-1. Statistical Comparison of Annual Precipitation for Different Hydrologic Periods

Period	Years In Period	Annual Average (inches)	% Years Below Annual Average	% Years Above Annual Average	Annual Minimum Over Period (inches)	Annual Maximum Over Period (inches)
1892–2014	122	16.0	56	44	2.4	36.6
1950–1999	50	16.0	64	36	6.0	34.4
1966–1990	25	16.4	60	40	8.9	32.4
1995–2014	20	14.0	65	35	2.4	32.7

Table B-2. Comparison of Water Year Type Characteristics Between the 1892–2014, 1995–2014, and 1966–1990 Periods

Period	Water Year Type	Rainfall (inches)	# Years	% Years	Average Rainfall (inches)
1892–2014	Dry	<11	30	24%	8.7
	Intermediate	11–19	62	50%	14.7
	Wet	>19	31	25%	25.4
1995–2014	Dry	<11	9	45%	7.7
	Intermediate	11–19	7	35%	14.4
	Wet	>19	4	20%	27.6
1966–1990	Dry	<11	6	24%	9.8
	Intermediate	11–19	14	56%	14.7
	Wet	>19	5	20%	29.3

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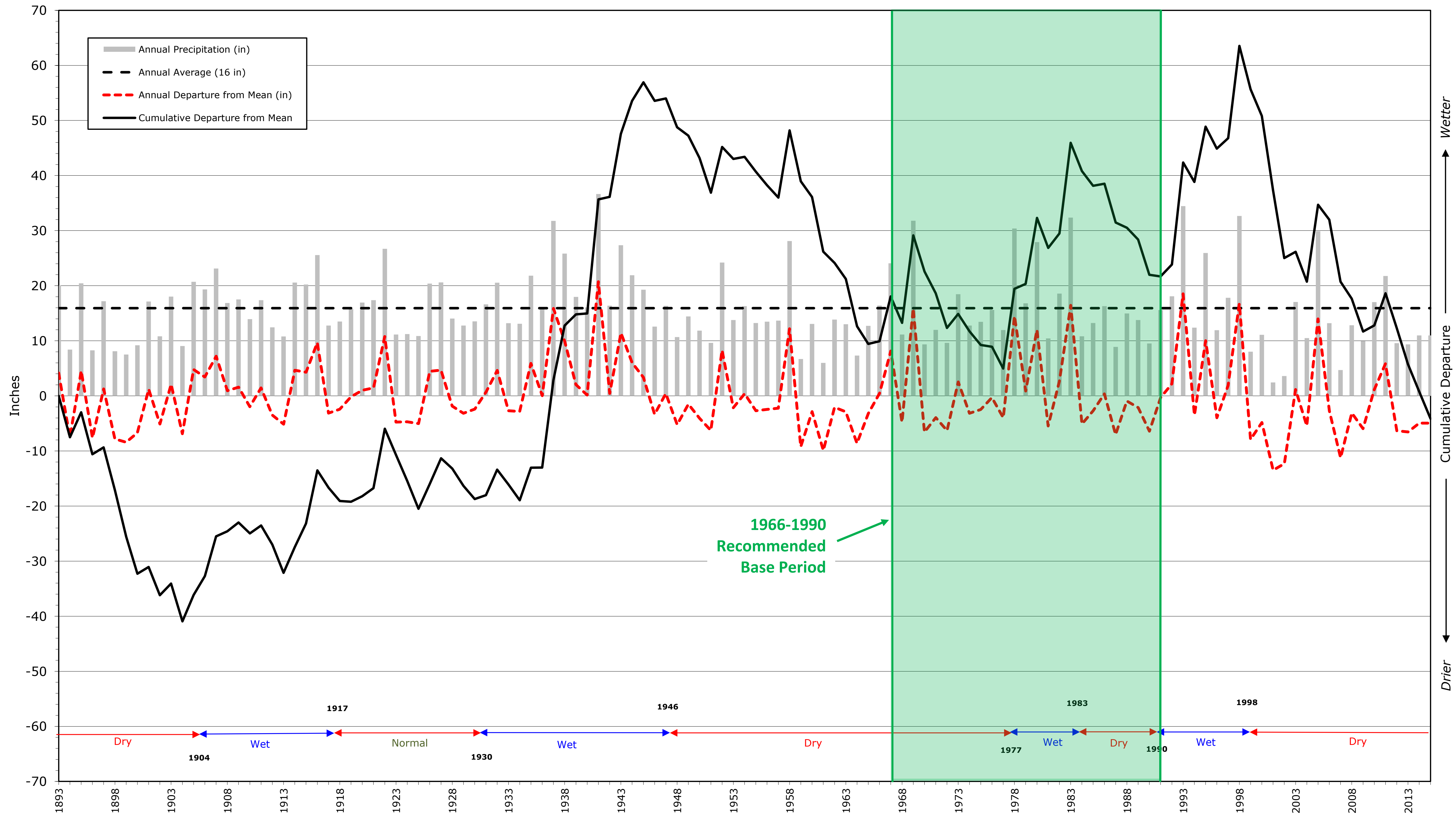

Source: Farid Boushaki, Riverside Public Utilities.

Figure B-1. San Bernardino Hospital Gage Cumulative Precipitation Departure Analysis from 1892–2014

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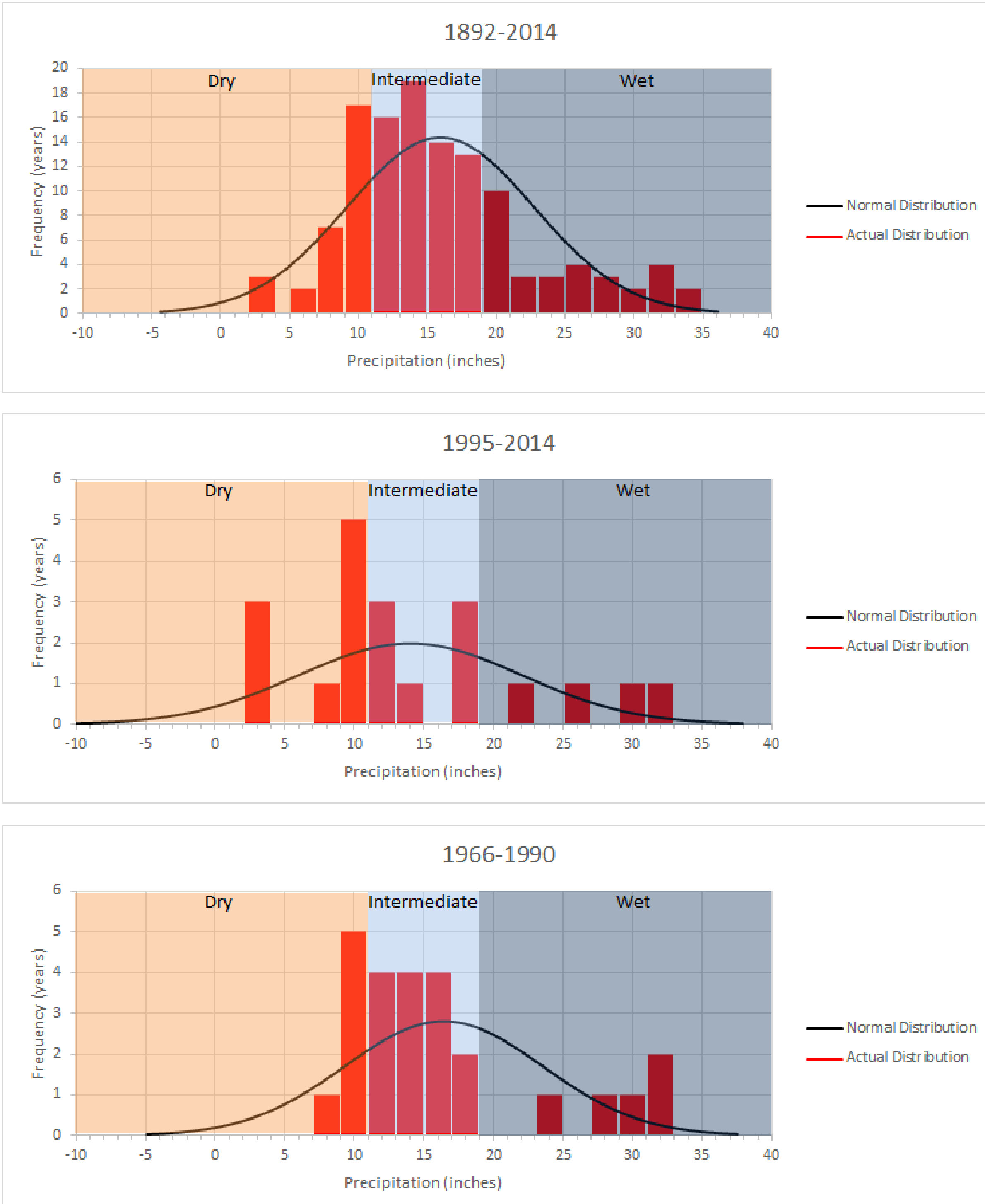

Figure B-2. Frequency Distribution Curves and Water Year Type Designations for 1892–2014, 1995–2014, and 1966–1990 Periods Based on San Bernardino Hospital Gage Precipitation Data

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