# AEA Appendix 2

No Water Contact Construction

PACE
Advanced Water Engineering

REGISTERED PROFESSIONAL ENGINEER
MARK EDWARD KREBS
No. 049292
Exp. 09-30-2017
CIVIL
STATE OF CALIFORNIA

# Technical Memorandum

**Date:** August 5, 2016

**To:** Matt Carpenter, Corey Harpole, and Sam Rojas – Newhall Land

**From:** Mark Krebs, PE and Jose Cruz, PE

**Re:** Santa Clara River Low-Flow Inundation Analysis # 8238E

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## Purpose of Floodplain Hydraulic Analysis

PACE was requested to provide an estimate of inundation limits within the Santa Clara River in the vicinity of the proposed Commerce Center Drive and Long Canyon Bridges for a dry-season flow of 500 cubic feet per second (cfs). The purpose of this exercise is to verify the proposed 165-ft pier spacing for the proposed bridges will not be subjected to flooding during the dry season, which for this Project has been defined as the period between June 1st and September 30th. Based on corresponding monthly peak flows obtained from historical stream gauge data Geosyntec estimates the peak flow that is expected during this window to be approximately 500-cfs.

In order to determine the limits of inundation for this flow at these locations, PACE has prepared hydraulic models using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling software. Results of the hydraulic model analyses were used to prepare exhibits to illustrate the limits of predicted inundation relative to the bridge piles that would be constructed during the dry season window. An overview of the hydraulic model procedure, background, and input parameters is provided in Appendix A.

## Hydraulic Analysis Results

Results of the hydraulic model are presented graphically to illustrate the extents of inundation for the highest estimated flows in the dry-season (approximately 500 cfs). These results will help determine the location of the proposed bridge piers to avoid impacts in areas of active flow.

At Commerce Center Drive Bridge, the dry season flow would be contained between bridge piers C and D, which would be placed 165 feet apart. The predicted maximum width of inundation would be 114-feet, and an average width of 93-feet (See Figure 1).

At Long Canyon Bridge, the dry season flow would be contained between bridge piers A and B, which would be placed 165-feet apart. The predicted maximum width of inundation would be 91-feet, and an average width of 85-feet (See Figure 2).

In conclusion, based on results of the HEC-RAS modeling, the dry season flows would be conveyed between the designed bridge pier locations, and would not inundate the locations where bridge piles would be installed during the dry season bridge pier construction process.

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**Attachments:**

**<u>Figures:</u>**

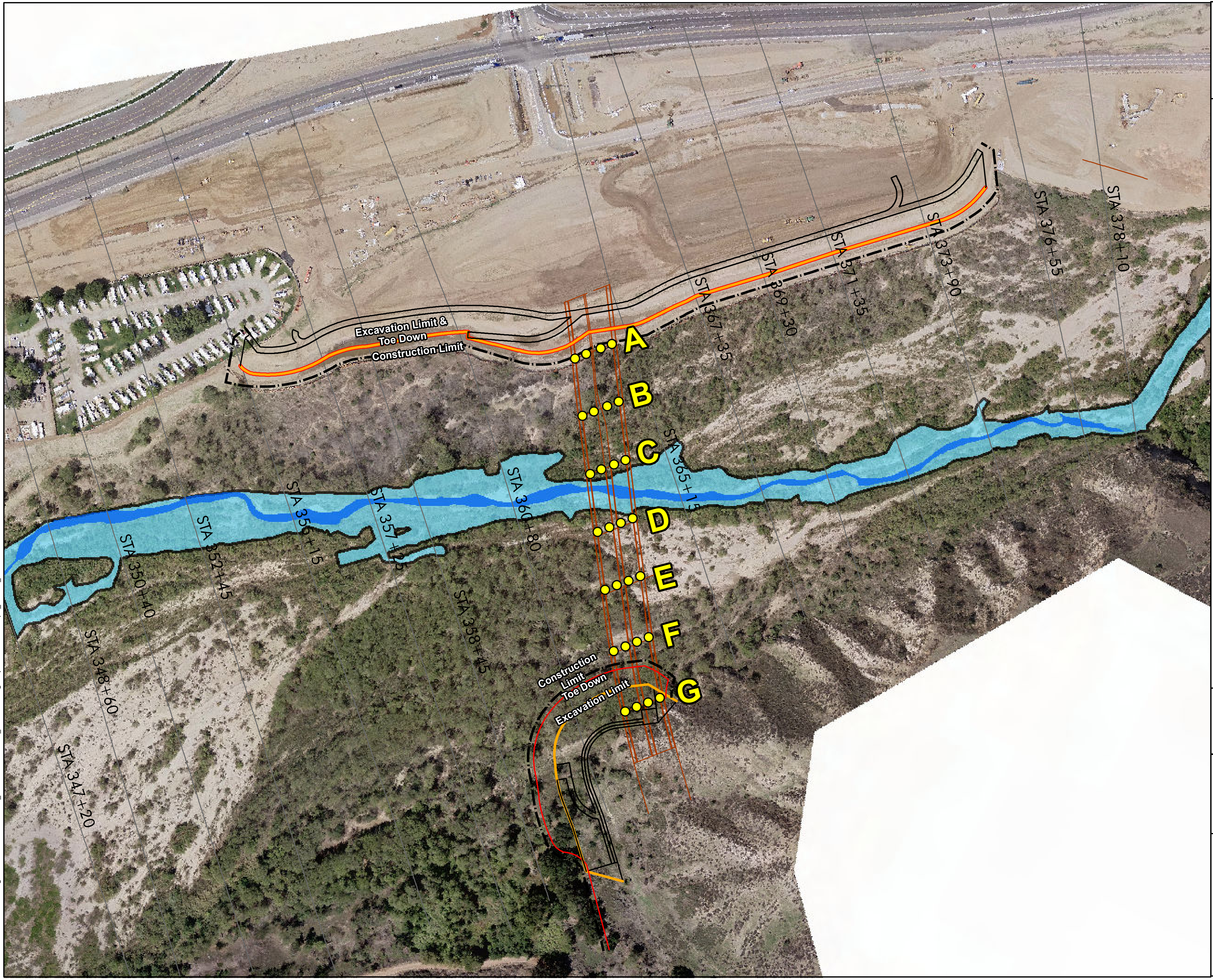
- Commerce Center Drive Bridge - Dry Season Hydrology (500 cfs Flow)
- Long Canyon Bridge - Dry Season Hydrology (500 cfs Flow)

**<u>Appendix:</u>**

Appendix A – HEC-RAS Hydraulic Model Background and Procedure

Appendix B – Santa Clara River Seasonal Streamflow Analysis Memo dated July 2016 – prepared by Geosyntec Consultants

# Figures




NEWHALL RANCH

LA County CA

Legend

- Bridge Pile Locations
- Highest Estimated Dry-Season Flow (500 cfs)
- Low Flow Channel

0 125 250 500 Feet

PACE Advanced Water Engineering

Date: 8/5/2016

Job Number JOB#

Drawn By thowze

Figure 1

COMMERCE CENTER DRIVE BRIDGE DRY SEASON HYDROLOGY 500 CFS

Aerial Imagery collected in 2014

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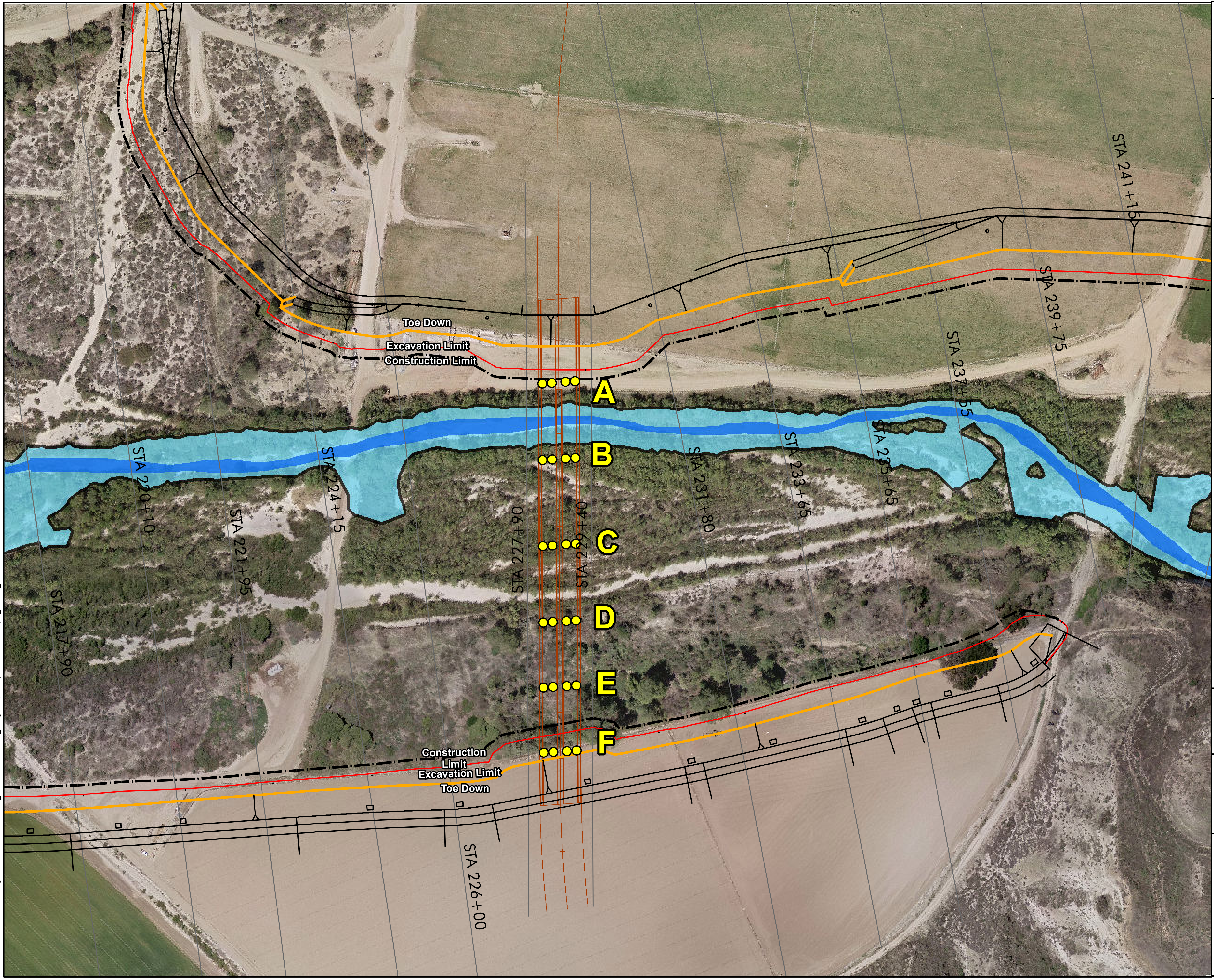


# NEWHALL RANCH

LA County CA

Legend

- Bridge Pile Locations

Area Inundated

- Highest Estimated Dry-Season Flow (500 cfs)
- Low Flow Channel

0 100 200 400 Feet

PACE Advanced Water Engineering

Date: 8/4/2016

Job Number 8238

Drawn By thowze

Figure 2

LONG CANYON BRIDGE
DRY SEASON HYDROLOGY
500 CFS FLOW

Aerial Imagery collected in 2014

P:\8238E\6-GIS\mxds\LongCommerceCrLowFlows_20160303\8238E_LongCanyonDrySeasonLandscape_500cfs_20160606.mxd

# Appendix A

## HEC-RAS Hydraulic Model Background and Procedure

Hydraulic modeling of the Santa Clara River was performed by PACE using HEC-RAS and HEC-GeoRAS computer modeling software developed by the U.S. Army Corps of Engineers. These software programs were utilized to develop a hydraulic model used to assess the hydraulic performance of the natural floodplain in order to understand the hydraulic characteristics of the River and evaluate variations in the trends within the River system. The HEC-RAS hydraulic model provides an accurate estimate of the water surface elevations and variation of different hydraulic parameters for a specific flowrate or steady state conditions using basic hydraulic principles.

HEC-RAS is a rigid boundary hydraulic model that assumes the channel bed and banks do not fluctuate. The basic computational procedure for HEC-RAS is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (using Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation may be used in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e. hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions). The effects of various obstructions such as bridges, culverts, weirs, and structures in the floodplain may be considered in the computations. The water surface profile analysis for the natural River system was based on existing digital topography of the River to establish the channel section geometry utilized in the model.

HEC-GeoRAS is a GIS extension that provides the user with a set of procedures, tools, and utilities for processing geospatial data in Arc-GIS using a graphical user interface (GUI). The interface allows the preparation of geometric data for import into HEC-RAS, and also processes simulation results exported directly from HEC-RAS. To create the import file, the user must have an existing digital terrain model (DTM) of the River system in the Arc-Info TIN format. The user creates a series of line themes pertinent to developing geometric data for HEC-RAS. The various themes that are created include stream centerline, flow path centerlines (*optional*), main channel banks (*optional*), and cross-section cut lines, which are referred to as the *RAS themes*.

## Parameters Used in Hydraulic Model

The parameters involved with the HEC-RAS model include cross-sectional data, channel roughness, flow data, and boundary conditions. The guidelines for developing these parameters are discussed in the following sections.

### *Rigid Boundary Hydraulic Model*

HEC-RAS is a rigid boundary hydraulic model that assumes the channel does not move or erode, but will remain with a fixed geometry. However, the Santa Clara River is an alluvial stream system, which is subject to both vertical and horizontal variation of the channel geometry. Since the dry-season flow being analyzed is not expected to create significant changes to the channel geometry, the assumption of a fixed bed is sufficient to assess the changes in the hydraulic parameters for different channel conditions and comparison purposes of the hydraulic operation.

### *Manning's Roughness Coefficient*

Proper selection of the Manning's roughness coefficient is one of the more critical and subjective elements describing the hydraulics. The selection of the appropriate Manning's roughness coefficient was performed based on (1) field observation and inspection of the existing floodplain conditions, (2) color aerial photographs, and (3) field ground photographs of representative locations along the natural River corridor. The study reach was divided into regions categorized as high, medium, low and very low roughness. These categories were assigned corresponding roughness values of 0.15, 0.05, 0.035, and 0.025 respectively. Manning's roughness values were applied horizontally to each cross-section within the model based on the regions of vegetative patterns and density, generally following the USGS Cowan Method for selecting roughness coefficients for natural channels and floodplains.

*Hydraulic Flow Regime*

The hydraulic analyses for the specific reaches of the Santa Clara River were performed in a subcritical flow regime, and also in a mixed flow regime which allows both subcritical and supercritical flow conditions to occur. This would reflect the range of actual conditions that would occur in the hydraulic system and allow a more complete analysis of the baseline existing floodplain without being influenced by forcing a specific single hydraulic regime. The subcritical flow regime generally creates a higher water surface elevation to determine the maximum area of inundation, whereas the mixed flow regime typically generates higher velocities. Since the Santa Clara River has a bed slope of approximately 0.5%, the results of both analyses indicate that the subcritical flow regime dominates the hydraulic condition of the River; therefore, the results for these analyses are identical.

*Boundary Conditions*

Boundary conditions within the flow data menu are necessary to initiate calculations. Upstream and downstream boundary conditions for the River are based on a normal depth slope. The boundary conditions used for the analysis near the proposed Long Canyon Bridge at the downstream and upstream study limit are based on normal depth for a bed slope of 0.006 and 0.004, respectively. For the analysis performed near the proposed Commerce Center Drive Bridge, the boundary conditions at the downstream and upstream study limits are based on normal depth for a bed slope of 0.005 and 0.004 respectively.

*Cross-Section Alignment and Spacing*

The cross-sections selected for these specific reaches of the Santa Clara River were spaced at approximately 200-ft intervals for the entire study reach. However, in the vicinity of the proposed bridge crossings, additional cross-sections at approximately 50-ft intervals were used in the modeling to provide additional detail and model refinement for the determination of the flow inundation area for the respective reaches analyzed.

*Base Topographic Data*

Existing topographic data was provided by a 2014 LIDAR survey along an 8-mile reach of the Santa Clara River extending from the Interstate 5 Freeway to just downstream of the Los Angeles/Ventura County line. This high-quality topographic data provided the means to create a fine resolution data representation of the Santa Clara River bed topology, as of the date that the topographic data was obtained (2014).

*Hydrologic Data*

The flow data used in the hydraulic modeling was obtained from a memorandum prepared by Geosyntec Consultants titled, “Santa Clara River Seasonal Peak Streamflow Analysis” dated July 2016. Hydraulic model calculations were performed for a dry-season flowrate of 500-cfs.

*Channel Improvements within the Hydraulic Model*

For Commerce Center Drive Bridge, the following channel improvements were included in the HEC-RAS model:

- Existing soil cement bank protection located along the North bank of the River associated with Commerce Center Drive Interchange (CCDI) project – *Recently completed during the summer of 2014*
- Proposed soil cement bank protection located along the South bank of the River associated with the Mission Village development project
- *Note: Proposed bridge structure was not included in the hydraulic model*

For Long Canyon Bridge, the following channel improvements were included in the HEC-RAS model:

- Proposed soil cement bank protection located along the North bank of the River associated with the Landmark Village development project

- Proposed soil cement bank protection located along the South bank of the River associated with the Homestead South development project

- *Note: Proposed bridge structure was not included in the hydraulic model*

Appendix B

# Appendix B

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# Memorandum

Date: July 2016

To: David Hubbard and Mark Dillon, Gatzke Dillon & Ballance LLP

Matt Carpenter and Sam Rojas, Newhall Land

From: Aaron Poresky and Austin Orr, Geosyntec Consultants

Subject: Santa Clara River Seasonal Streamflow Analysis

## PURPOSE

Records from two streamflow gauges on the Santa Clara River near the Los Angeles/Ventura county line were analyzed to estimate (1) normal average streamflow by month, (2) peak instantaneous streamflow observed in each month of the historical record and (3) return interval streamflows for specified seasonal planning windows. The purpose of this analysis was to estimate likely and extreme streamflows that may be present during potential project construction windows. Additionally, dam release records for Castaic Lake and precipitation records for the vicinity of the Newhall Ranch project were analyzed to support interpretation of Santa Clara River streamflow records.

## DATA SOURCES

The data analyzed as part of preparation of this memorandum are listed in Table 1. Additional information about gauge locations and data sources is provided in Attachment A.

**Table 1. Data Sources**

| Data Type | Location | Gauge ID | Agency | Period of Record |
|---|---|---|---|---|
| Newhall Ranch Vicinity Precipitation | Newhall, CA | 046162 | NCDC | 1969-2008 |
| Santa Clara River Mean Daily Streamflow | Santa Clara River near the County Line | 11108500 & 11109000 | USGS | 1953-2015 |
| Santa Clara River Annual Maximum Streamflow | Santa Clara River near the County Line | 11108500 & 11109000 | USGS | 1953-2015 |

| Data Type | Location | Gauge ID | Agency | Period of Record |
|---|---|---|---|---|
| Castaic Dam Releases, Mean Daily Flow | Castaic Dam Discharge to Castaic Creek | 11108135 & 11108134 | USGS | 1976-1978, 1988-2015 |

## MONTHLY NORMAL SANTA CLARA STREAMFLOW

Monthly normal streamflow was estimated for the period of record from 1971 through 2015. Castaic Dam began to influence flows in 1971, and, therefore, data from before 1971 do not represent the current average flow regime and were excluded from this analysis. The most recent 15 years (approximately one-third) of the post-Castaic Dam record were also summarized to assess changes in monthly normal streamflow over time. Monthly normal streamflows are the arithmetic average of all daily average streamflow measurements within a given month. Results of this analysis are presented in Table 2.

**Table 2. Monthly Normal Streamflow for the County Line Gauge Location**

| Month | Monthly Normal Streamflow, cfs | |
|---|---|---|
| | 1971-2015 | 2001-2015 |
| January | 132 | 171 |
| February | 222 | 201 |
| March | 161 | 129 |
| April | 76 | 81 |
| May | 58 | 49 |
| June | 39 | 39 |
| July | 26 | 26 |
| August | 22 | 24 |
| September | 24 | 26 |
| October | 32 | 40 |
| November | 39 | 43 |
| December | 67 | 84 |

## ANALYSIS OF MONTHLY PEAK FLOWRATES

The mean daily streamflow data for the combined County Line Gauge flow record were queried to estimate the most extreme daily streamflow conditions on record in each month of the year. Table 3 displays the results of the analysis. Flows that occurred prior to 1971 (i.e., prior to the effect of the construction of Castaic Dam) are italicized.

Daily mean streamflow data are typically lower than the instantaneous peak during days when streamflow is influenced by storms. Daily instantaneous peak flowrates were not available for a significant portion of the time period of interest. Therefore, to estimate the daily instantaneous peak streamflow, a regression analysis was conducted by matching annual peak streamflow observations to the mean daily streamflow recorded for the same day. The resulting regression equation was used to determine the appropriate intra-day peaking factor equation to apply to daily mean streamflow records to estimate instantaneous peak streamflows. Attachment A includes a more detailed discussion of the regression analysis.

**Table 3. Maximum of Mean Daily Streamflow and Approximate Instantaneous Peak Streamflow by Month for the County Line Gauge Location**

| | All Records (1953-2015) | | |
|---|---|---|---|
| **Month** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Date of Occurrence** |
| January | *27,400* | *60,600* | *1/25/1969* |
| February | *28,800* | *63,201* | *2/25/1969* |
| March | 7,900 | 21,234 | 3/2/1983 |
| April | *3,370* | *10,353* | *4/3/1958* |
| May | 2,150 | 7,087 | 5/6/1998 |
| June | 204 | 204[A] | 6/4/1978 |
| July | 187 | 187[A] | 7/1/1978 |
| August | 83 | 456 | 8/19/1983 |
| September | 92 | 497 | 9/10/1976 |
| October | 894 | 3,382 | 10/20/2004 |
| November | *2,730* | *8,668* | *11/24/1965* |
| December | *7,960* | *21,370* | *12/29/1965* |

Italicized events occurred prior to the Castaic Dam in 1971.
[1]Value is calculated as follows: $10.979x^{0.8432}$ where $x$ is the highest mean daily flow rate in cfs. This regression is known to over-estimate peak instantaneous flowrates under non-storm conditions.
[A] June and July do not experience significant precipitation or associated storm response. Additionally, elevated streamflows observed in these months are explained by controlled Castaic dam releases, elevated base flow conditions, and/or normal discharges from water reclamation plants as discussed later in this memorandum. Therefore, the regression equation for converting daily mean to instantaneous peak streamflow was not applicable for these months.

Table 4 provides additional detail on the largest peak streamflows on record in the dry season months. The peak monthly events are ranked by the calculated value of peak streamflow that occurred in the month and listed with the year they occurred. For purposes of the summary, only the peak streamflow in each month and year combination is reported. For some months listed, there may be other independent peaks that occurred within the same month-year combination are not shown in this table. Italicized text indicates observations that occurred prior to Castaic Dam construction. At least three post-dam monthly peaks are listed for each month. For April, four events are listed because one occurred prior to dam construction. For the remaining months, the top three monthly peaks all occurred after dam construction.

**Table 4: Peak Event Streamflow Ranking By Month for the Combined Gauge Record (1953-2015)**

| | April | | | May | | | June | | | July | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Event Rank** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** |
| **1** | *3,370* | *10,353* | *1958* | 2150 | 7,090 | 1998 | 204 | 204[A] | 1978 | 187 | 187[A] | 1978 |
| **2** | 1,200 | 4,334 | 2006 | 245 | 1,140 | 1983 | 181 | 181[A] | 2006 | 74 | 74[A] | 1998 |
| **3** | 639 | 2,548 | 1993 | 238 | 1,110 | 1977 | 128 | 128[A] | 1975 | 63 | 63[A] | 2008 |
| **4** | 625 | 2,501 | 2005 | | | | | | | | | |

| | August | | | September | | | October | | |
|---|---|---|---|---|---|---|---|---|---|
| **Event Rank** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** | **Peak Mean Daily Flow (CFS)** | **Approximate Instantaneous Peak Flow (CFS)[1]** | **Year** |
| **1** | 83 | 460 | 1983 | 92 | 500 | 1976 | 894 | 3,380 | 2004 |
| **2** | 74 | 410 | 1998 | 86 | 470 | 1983 | 333 | 1,470 | 2009 |
| **3** | 58 | 340 | 2005 | 78 | 430 | 2009 | 284 | 1,290 | 2005 |

Italicized events occurred prior to the Castaic Dam in 1971.

[1]Estimated of monthly instantaneous value is calculated as follows: $10.979x^{0.8432}$ where $x$ is the highest mean daily streamflow in cfs. This regression is known to over-estimate peak instantaneous streamflow under non-storm conditions.

[A] June and July do not experience significant precipitation or associated storm response. Additionally, elevated streamflows observed in these months are explained by controlled Castaic dam releases, elevated base flow conditions, and/or normal discharges from water reclamation plants as discussed later in this memorandum. Therefore, the regression equation for converting daily mean to instantaneous peak streamflow was not applicable for these months.

Note: For purposes of this summary, if multiple peak events occur in the same month they are not listed multiple times. Only the peak flowrate is reported for each month and year to avoid listing multiple days that are part of the same event (e.g., multiday dam discharges, and long storm events).

## FLOW FREQUENCY ANALYSIS

A flow frequency analysis was conducted for two seasonal windows. These analyses were performed for the full period of record and the shorter period of record after construction of the Castaic Dam. A Log-Pearson Type III return period analysis was used (USGS, 1982). The Log-Pearson Type III distribution is a statistical technique for fitting frequency distribution data, based on annual maxima, to predict the design flows of different return intervals. This technique allows estimates for events with return periods beyond the observed flow events. This technique is the standard technique used by federal agencies in the United States for river flow frequency analysis.

The annual maxima used as inputs to the analysis were calculated as the estimates of maximum instantaneous streamflow (based on the regression approach described above) that occurred in each year within the specified seasonal planning window of interest (two different windows were analyzed separately). Table 5 reports the results of the flow-frequency analysis. The windows are inclusive (i.e., the first window includes flows from the beginning of April through the end of October). As discussed earlier, estimates of peak instantaneous flowrate are known to be overestimated for smaller flows and non-storm conditions. The regression equation was not applied to June and July streamflows.

**Table 5. Log-Pearson Type III Return Period Analysis for Instantaneous Peak Streamflow during the Dry Season**

| | Santa Clara River near County Line, All Records [1953-2015] (cfs) | |
|---|---|---|
| **Estimated Average Return Interval, year** | **April - October** | **June - Sept** |
| 100 | 7,331 | 711 |
| 50 | 5,552 | 667 |
| 25 | 4,047 | 605 |
| 10 | 2,446 | 483 |
| 5 | 1,503 | 353 |
| 2 | 567 | 136 |

## ANALYSIS OF PRECIPITATION AND DAM RELEASE DATA

Precipitation data and dam release data were analyzed to support interpretation of Santa Clara River streamflow data.

### Precipitation Analysis

Based on analysis the 40-year Newhall precipitation record, three metrics were tabulated for each month in the period of record: monthly total precipitation depth, count of storm events greater than 0.1 inches, and the count of storm events greater than 0.5 inches. The results of this analysis are presented in Attachment A.

**Contribution of Castaic Lake Discharge to Santa Clara River Streamflow Seasonality**

The highest recorded daily mean flowrate in each month was tabulated for Castaic Lake releases to Castaic Creek (See Attachment A).

In order to inspect the relative contribution of dam releases and precipitation-derived streamflow during summer months, the Santa Clara River streamflow was plotted on a consistent time scale with Castaic Dam releases and precipitation for June through September (Figure 1).

As illustrated in Figure 1, June peak streamflows in the Santa Clara River appear to be strongly influenced by controlled releases from Castaic Lake or by cumulative precipitation in previous months contributing to elevated base flows. Elevated streamflows do not appear to be influenced by precipitation events during the month of June. A discussion of the five highest observations in June are provided below.

- Three of the years with highest June discharges (1978, 2000, 2006) corresponded to recorded dam releases of similar magnitude and absence of recorded precipitation.
- Dam release data were not available for the period of the elevated Santa Clara River flowrate observed in 1975, however there was no recorded precipitation associated with the peak flowrate in the Santa Clara River, so a dam discharge likely contributed this peak flow.
- In June of 1998, an elevated streamflow was recorded without accompanying precipitation or significant Castaic Lake release. Upon further inspection, the Santa Clara River streamflow entered June at an elevated level and gradually declined through the month. This is likely attributable to elevated base flow from prior months' precipitation: the 1997-1998 winter was very wet and there were approximately five inches of precipitation recorded in May 1998.

The largest recorded Santa Clara River flowrate in July (1978) was associated with a recorded Castaic Lake release of a similar magnitude. There were no other significantly elevated streamflow events in July.

Overall, it appears that precipitation-derived streamflow peaks in June and July have not been observed in the period of record. Therefore, the regression equation used to convert daily mean streamflow to instantaneous peak streamflow was not used for these months. In contrast, streamflow events in August and September correspond to measured precipitation, and the regression equation was used to estimate intra-day instantaneous peak streamflow.

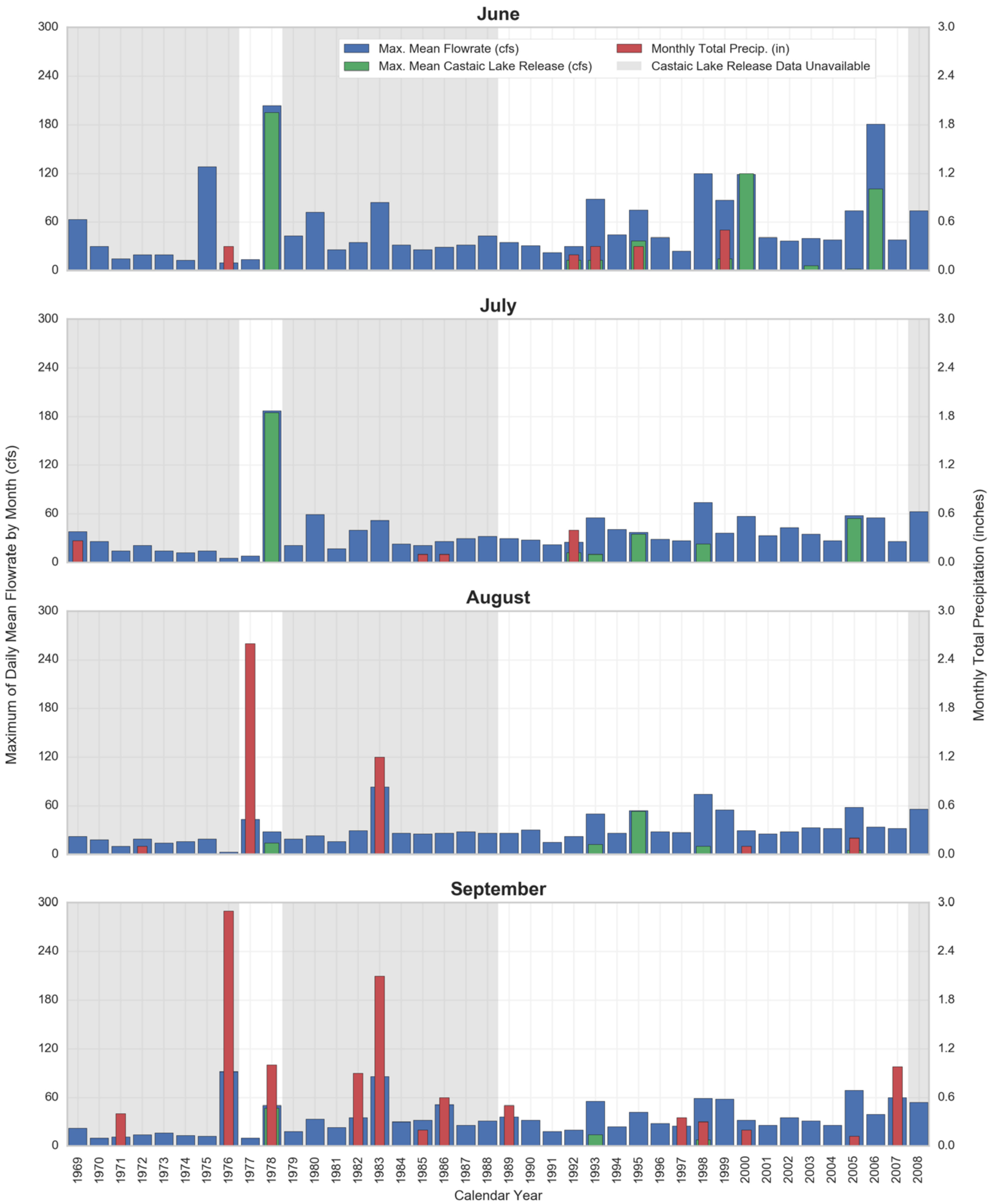


**Figure 1. Castaic Lake Release Flowrate, Santa Clara River Streamflow and Total Monthly Precipitation per Month by Calendar year.**

*Note: Release data is unavailable during years shaded in grey.*

# Attachment A

# Supporting Information

**CONTENTS**

This attachment includes additional information to support the analysis of seasonal streamflow in the Santa Clara River, including (1) data sources, (2) regression analysis for estimation of peak instantaneous streamflow, and (3) long term seasonality plots of precipitation, streamflow, and dam releases.

**DATA SOURCES**

**Precipitation Data**

Precipitation analysis was conducted based on hourly precipitation data from a 40-year period of record (water year (WY) 1969-2008) recorded at the National Climatic Data Center (NCDC) Newhall rain gauge (station number 046162), located in the town of Newhall, California. This dataset is identical to the record was used in water quality impact analyses for the Newhall Ranch Resource Management and Development Plan[1].

**Streamflow Gauge Data**

The United Stated Geological Survey (USGS) streamflow gauges queried for this effort are shown below in Figure A-1. The upstream gauge (11108500, Santa Clara River near County Line) has records for 1953-1996, and the downstream gauge (11109000, Santa Clara River near Piru) spans 1996-2015. The streamflow records from these two gauges were combined for statistical analysis. Data accessible via the web include: (1) mean daily streamflows, and (2) annual instantaneous maximum streamflow. Records were accessed from the publicly-available USGS website (http://streamstatsags.cr.usgs.gov/v3_beta/).

[1] Geosyntec Consultants, 2008. *Newhall Ranch Specific Plan Sub-Regional Stormwater Mitigation Plan*. Prepared for Newhall Land by Geosyntec Consultants. April 2008. Appended with additional precipitation data through 2008 as part of water quality impact analyses supporting the Final EIR for the RMDP, prepared in 2011.

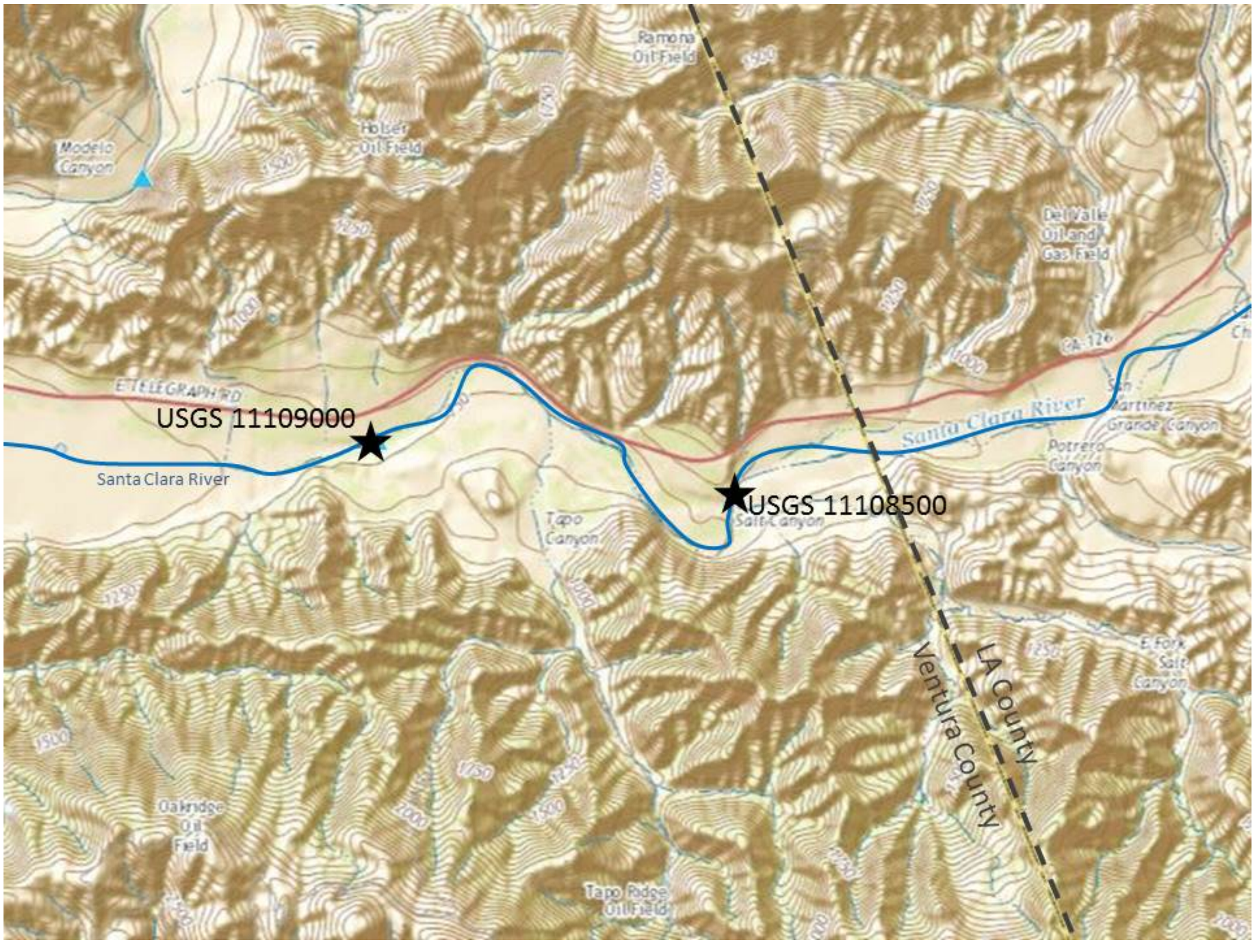


**Figure A-1. USGS Gauge Locations on the Santa Clara River near the Boundary of Ventura and LA Counties**

## Castaic Lake Release Data

Records of flows released from Castaic Lake to Castaic Creek were obtained from USGS gages located downstream of Castaic Lake: USGS Gage 11108135 (Castaic Lagoon) and Gage 11108134 (Castaic Creek below Castaic Lake). Both stations represent releases from the dam downstream of a diversion into the Metropolitan Water District system, therefore represent releases that would streamflow down Castaic Creek toward the Santa Clara River. Data from gage 11108135 were available between 1976-1978 and between 1988-1994. Data from gage 11108134 were available between 1994 and 2007 and between 2009 and 2015. These records were combined for analysis purposes.

## REGRESSION ANALYSIS FOR ESTIMATION OF PEAK INSTANTANEOUS STREAMFLOW

This section provides additional detail about how the datasets listed above were used to derive estimates of daily instantaneous peak streamflow. The *daily peak streamflow* is defined as the peak instantaneous streamflow estimated to have occurred in each day of the period of record. A derived estimate was needed for this metric because (1) daily mean streamflows potentially mask the intra-day peaks that occurred on these days, particularly under storm conditions, and (2) annual maximum streamflows do not provide enough information to support seasonal analysis as only one record per year is available.

### Overview of Analysis

To approximate daily peak streamflows from the available datasets, a regression analysis was performed to determine a functional relationship between daily mean streamflow and annual maximum streamflow. This analysis included the following three steps:

(1) The annual maximum streamflow recorded in each calendar year was tabulated along with the date on which it occurred.

(2) The daily mean streamflow corresponding to date of each annual maximum streamflow from step 1 was matched based on calendar date and added to the tabulation. The resulting dataset is presented in Table A-1, below.

(3) This dataset was plotted on an X-Y scatter plot, and a best fit regression line was selected by minimizing the coefficient of determination ($R^2$ value) in Microsoft Excel.

### Regression Analysis Dataset

Table A-1 contains the matching records available for the combined County Line Gauge dataset from water year(WY) 1953 through 2014. Note that each entry in this table represents a single water year. This dataset is the result of Step 1 and 2, described above, and was used in the regression analysis.

**Table A-1. Annual Maximum and Corresponding Mean Daily Streamflows for the Combined County Line Gauge Record**

| USGS Gauge ID | Date of Annual Maximum Flow | Annual Maximum Streamflow (cfs) | Daily Mean Streamflow (cfs) |
|---|---|---|---|
| 11108500 | 11/15/1952 | 490 | 88 |
| 11108500 | 2/13/1954 | 755 | 195 |

| USGS Gauge ID | Date of Annual Maximum Flow | Annual Maximum Streamflow (cfs) | Daily Mean Streamflow (cfs) |
|---|---|---|---|
| 11108500 | 1/18/1955 | 548 | 88 |
| 11108500 | 1/26/1956 | 878 | 514 |
| 11108500 | 3/1/1957 | 1,580 | 275 |
| 11108500 | 4/3/1958 | 7,070 | 3,370 |
| 11108500 | 1/6/1959 | 2,040 | 236 |
| 11108500 | 4/27/1960 | 109 | 20 |
| 11108500 | 11/6/1960 | 190 | 44 |
| 11108500 | 2/11/1962 | 9,100 | 5,470 |
| 11108500 | 3/16/1963 | 1,340 | 94 |
| 11108500 | 1/22/1964 | 536 | 88 |
| 11108500 | 4/9/1965 | 1,390 | 254 |
| 11108500 | 12/29/1965 | 32,000 | 7,960 |
| 11108500 | 1/24/1967 | 6,530 | 1,850 |
| 11108500 | 11/19/1967 | 2,840 | 283 |
| 11108500 | 1/25/1969 | 68,800 | 27,400 |
| 11108500 | 3/2/1970 | 992 | 339 |
| 11108500 | 11/29/1970 | 9,080 | 2,370 |
| 11108500 | 12/27/1971 | 3,410 | 590 |
| 11108500 | 2/11/1973 | 12,800 | 4,480 |
| 11108500 | 1/7/1974 | 5,150 | 2,080 |
| 11108500 | 12/4/1974 | 2,210 | 243 |
| 11108500 | 2/9/1976 | 1,700 | 216 |
| 11108500 | 5/8/1977 | 1,880 | 238 |
| 11108500 | 2/9/1978 | 22,800 | 6,500 |
| 11108500 | 3/27/1979 | 6,020 | 1,090 |
| 11108500 | 2/16/1980 | 13,900 | 5,000 |
| 11108500 | 1/28/1981 | 2,470 | 319 |
| 11108500 | 3/17/1982 | 1,730 | 621 |
| 11108500 | 3/1/1983 | 30,600 | 6,000 |
| 11108500 | 12/25/1983 | 308 | 161 |
| 11108500 | 12/19/1984 | 2,270 | 1,040 |
| 11108500 | 2/15/1986 | 12,300 | 3,080 |
| 11108500 | 11/18/1986 | 1,460 | 205 |
| 11108500 | 2/28/1988 | 3,900 | 292 |
| 11108500 | 12/16/1988 | 11,000 | 2,760 |
| 11108500 | 2/17/1990 | 1,870 | 440 |

| USGS Gauge ID | Date of Annual Maximum Flow | Annual Maximum Streamflow (cfs) | Daily Mean Streamflow (cfs) |
|---|---|---|---|
| 11108500 | 3/1/1991 | 6,960 | 1,790 |
| 11108500 | 2/12/1992 | 12,300 | 5,080 |
| 11108500 | 2/18/1993 | 10,700 | 2,360 |
| 11108500 | 12/11/1993 | 597 | 108 |
| 11108500 | 1/10/1995 | 17,100 | 6,150 |
| 11108500 | 2/20/1996 | 4,450 | 1,950 |
| 11109000 | 4/12/1999 | 277 | 187 |
| 11109000 | 2/23/2000 | 2,440 | 1,310 |
| 11109000 | 3/6/2001 | 1,230 | 495 |
| 11109000 | 11/24/2001 | 729 | 125 |
| 11109000 | 2/12/2003 | 2,330 | 1,190 |
| 11109000 | 2/26/2004 | 2,640 | 1,070 |
| 11109000 | 1/9/2005 | 32,000 | 8,920 |
| 11109000 | 1/2/2006 | 12,500 | 1,860 |
| 11109000 | 12/10/2006 | 274 | 101 |
| 11109000 | 1/25/2008 | 3,130 | 2,140 |
| 11109000 | 2/16/2009 | 1,710 | 704 |
| 11109000 | 1/20/2010 | 4,440 | 1,120 |
| 11109000 | 3/20/2011 | 8,380 | 2,740 |
| 11109000 | 3/25/2012 | 1,520 | 311 |
| 11109000 | 3/8/2013 | 893 | 177 |
| 11109000 | 2/28/2014 | 1,750 | 645 |

**Regression Analysis Results**

Based on this regression analysis, a power equation was found to be most appropriate to convert daily mean streamflow to estimates of the daily maximum streamflow. This relationship is expressed as:

$$y = 10.979x^{0.8432}$$

Where:

$y$ is daily peak streamflow in cfs

$x$ is daily mean streamflow in cfs

This equation was applied to the daily mean streamflow in each day of the period of record to estimate the daily peak streamflow that occurred in that day. Figure A-2 shows the power relationship plotted with the underlying dataset.

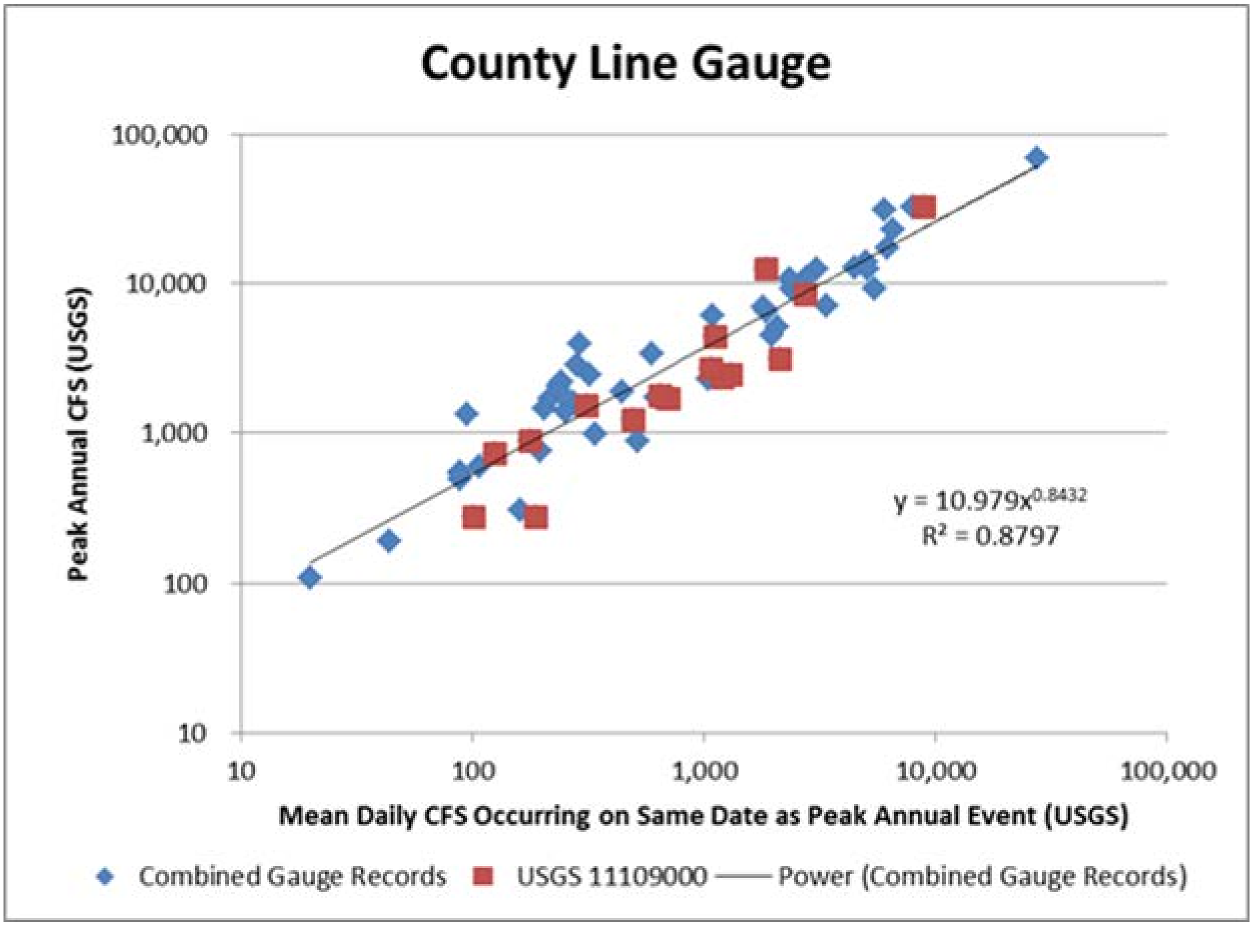


**Figure A-2. Relationship of Annual Peak Streamflow to Daily Mean Streamflow for the Same Event for the County Line Gauge**

**Discussion of Reliability of Analysis Results**

The best fit power relationship provided a relatively good visual fit for a broad range of streamflows (see Figure A-2).

The regression was based on the entire period of record (WY 1953 to 2014). To evaluate whether this regression is similarly appropriate for the most recent 16 years at the downstream gauge location (USGS 11109000), these records were highlighted in red. Based on this visual comparison, the latest 16 years appear to follow a similar regression relationship and are appropriate to be combined for the purpose of the regression analysis. On average, these newer data tend to be somewhat to the lower right of the regression line, indicating that the regression would have resulted in somewhat lower estimates of daily maximum streamflow had only the newer data been used in the regression.

The relationship tends to result in a higher ratio between daily maximum streamflow and daily mean streamflow when streamflows are smaller. For example, when the daily mean streamflow is 50 cfs, the estimated daily maximum streamflow is approximately 300 cfs (i.e., 6 times higher), but when the daily mean streamflow is 5,000 cfs, the estimated daily maximum streamflow is approximately 14,400 cfs (i.e., 3 times higher). Therefore, this relationship appropriately accounts for the observation that smaller storms can have a shorter period of peak flow, resulting in a higher ratio of peak streamflow to average streamflow for a given day.

This approach is inherently more appropriate for estimating the relationship between daily mean streamflow and daily maximum streamflow under storm conditions. This is because most, if not all, of the annual maxima used in the regression were recorded in response to storm conditions. During days when the streamflow does not change significantly, such as during base streamflow conditions or gradual dam releases, this regression is known to significantly over-estimate the peak instantaneous streamflow. This likely results in major over-estimates of daily peak streamflows during summer months. This method is therefore conservative for forecasting the peak streamflows during a dry season construction window.

Actual data points lie on both sides of the best-fit regression line. This indicates this regression equation has the potential to over-predict or under-predict peak streamflows for a given day. However, for days with lower daily mean streamflows (i.e., less than 200 cfs), the best fit regression appears to be more likely to result in an over-estimate of daily maximum streamflow rather than an under-estimate.

The combination of the discussions in the previous two paragraphs suggest that this approach is likely to significantly over-estimate daily maximum streamflows in months with relatively low daily mean streamflows and relatively little precipitation (e.g., May through September).

## LONG TERM SEASONALITY PLOTS

### Precipitation

Based on analysis the 40-year Newhall precipitation record, three metrics were tabulated for each month in the period of record:

- Monthly total precipitation depth, inches (Figure A-3).
- Count of storm events greater than 0.1 inches, separated by a minimum inter-event time of 6 hours (Figure A-4).
- Count of storm events greater than 0.5 inches, separated by a minimum inter-event time of 6 hours (Figure A-5).

The monthly values for each metric for each calendar year were plotted in Figure A-3, Figure A-4, and Figure A-5, respectively. This allows a longitudinal visual inspection of year-over-year trends of the same statistics in each month.

**Santa Clara River Streamflow**

Based on the analysis of 62 years of streamflow data for the County Line gage, two metrics were tabulated for each month:

- Highest recorded daily mean streamflow in each month (Figure A-6). Note that, the summer streamflow regime changed during the 1960s with Saugus and Valencia water reclamation plants being put into operation in 1962 and 1967, respectively. Streamflow data from before approximately 1965 is very low, however data are available and reported.
- Number of discrete streamflow pulses in each month (Figure A-7). For this analysis, a streamflow pulse was defined as a daily mean streamflow record that is greater than two times the average streamflow for the month in which it is observed. Consecutive days of elevated streamflow were not counted as discrete pulses. A stream streamflow pulse can be indicative of a storm event or could occur as a result of changes in operations of Castaic Dam or wastewater treatment plants.

The monthly values for each metric for each calendar year were plotted in Figure A-6 and Figure A-7, respectively. This allows a longitudinal visual inspection of year-over-year trends of the same statistics in each month.

**Castaic Lake Discharge**

The highest recorded daily mean streamflow in each month was tabulated for Castaic Lake releases to Castaic Creek for each month for which data were available (Figure A-8).

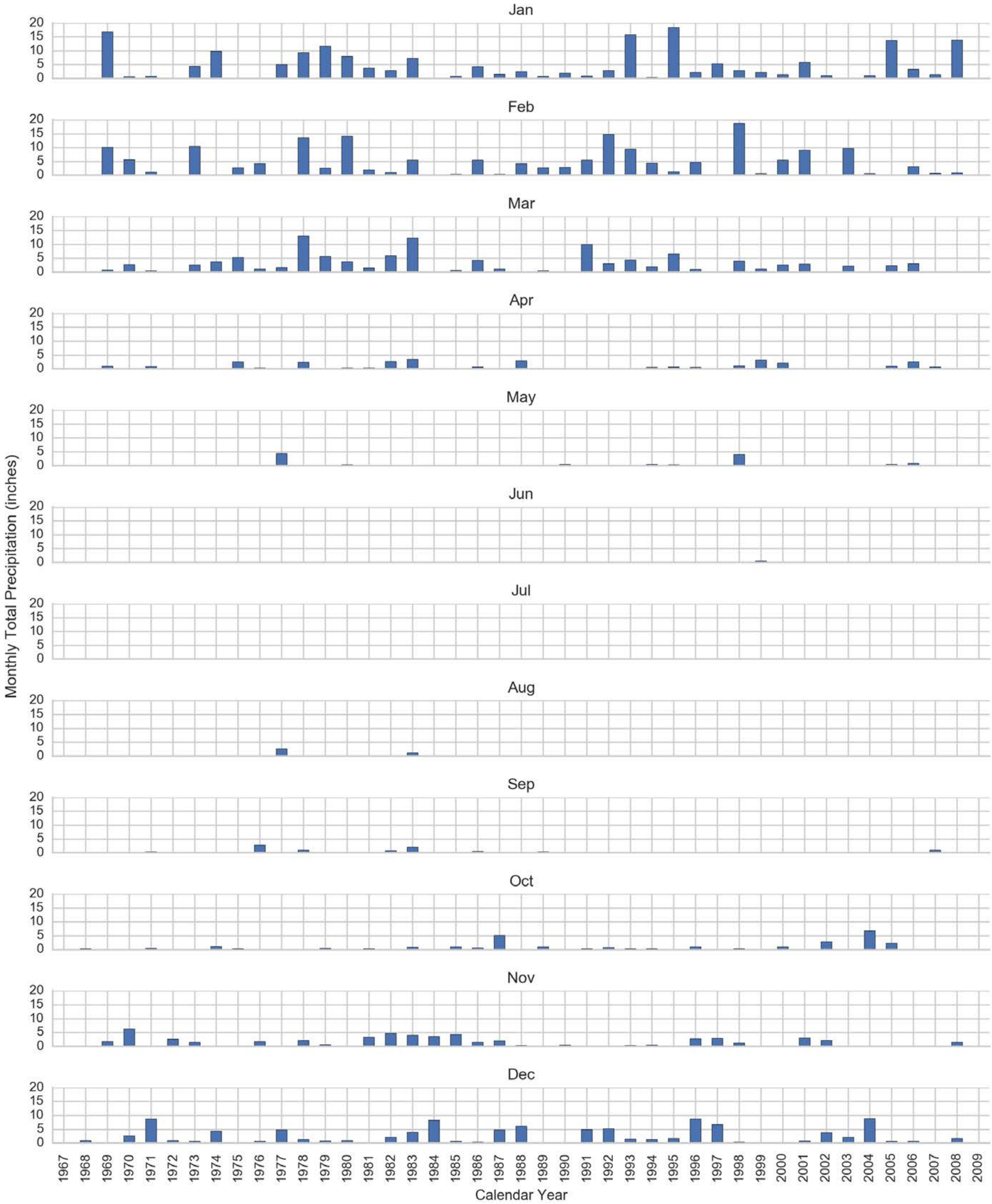


**Figure A-3. Total Precipitation Volume per Month by Calendar Year**

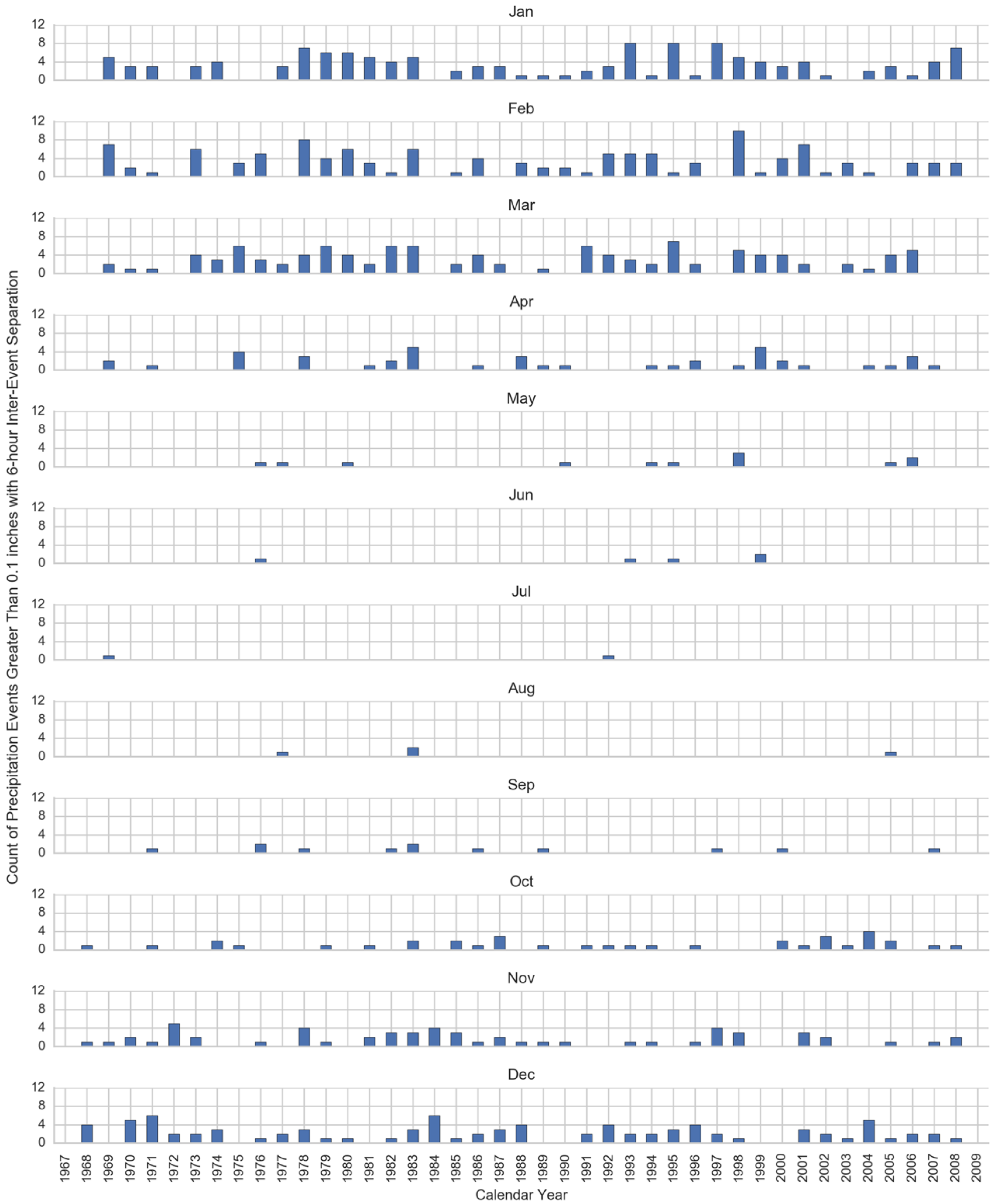


**Figure A-4. Count of Precipitation Events Greater Than 0.1 inches per Month by Year**

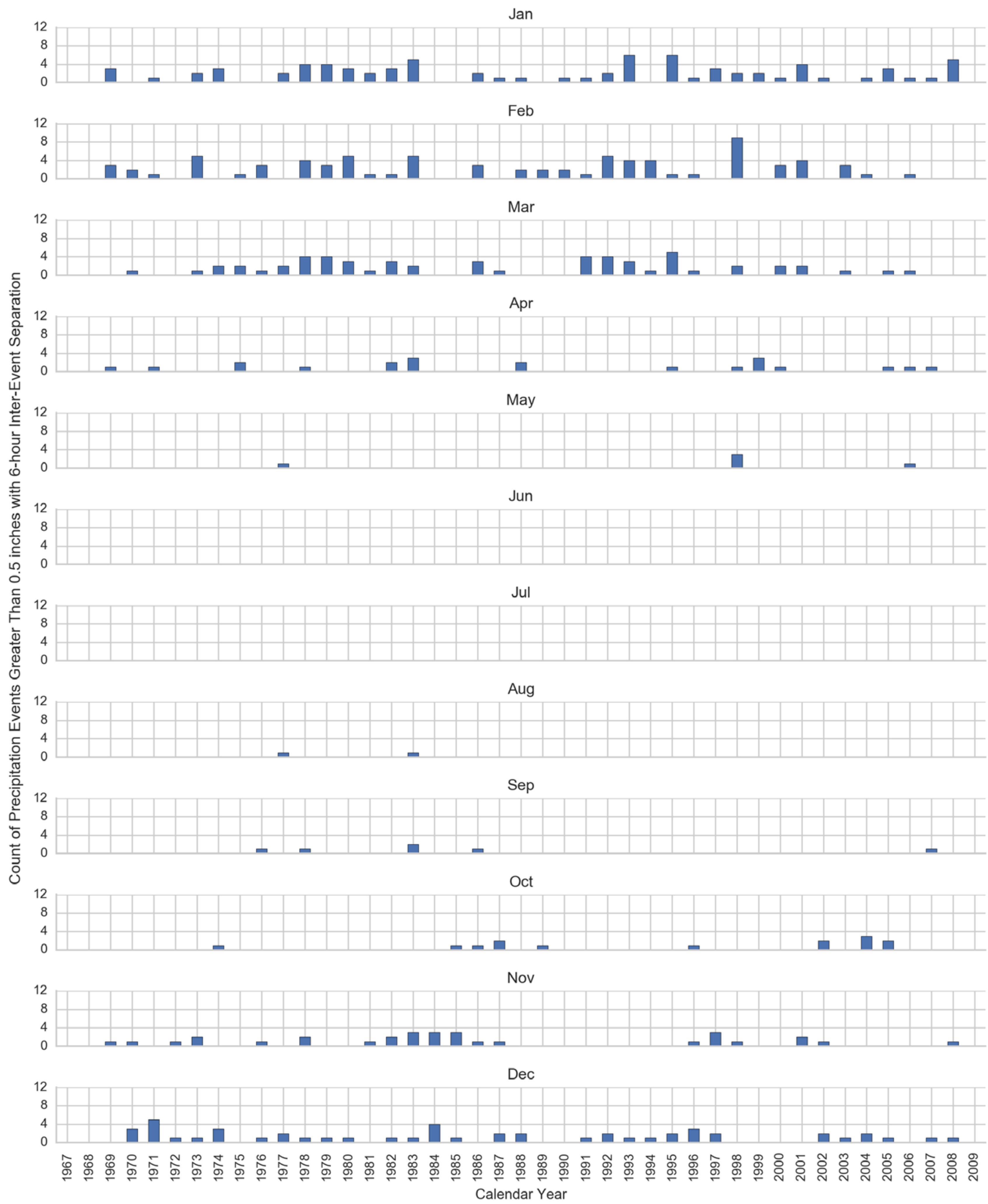


**Figure A-5. Count of Precipitation Events Greater Than 0.5 inches per Month by Year**

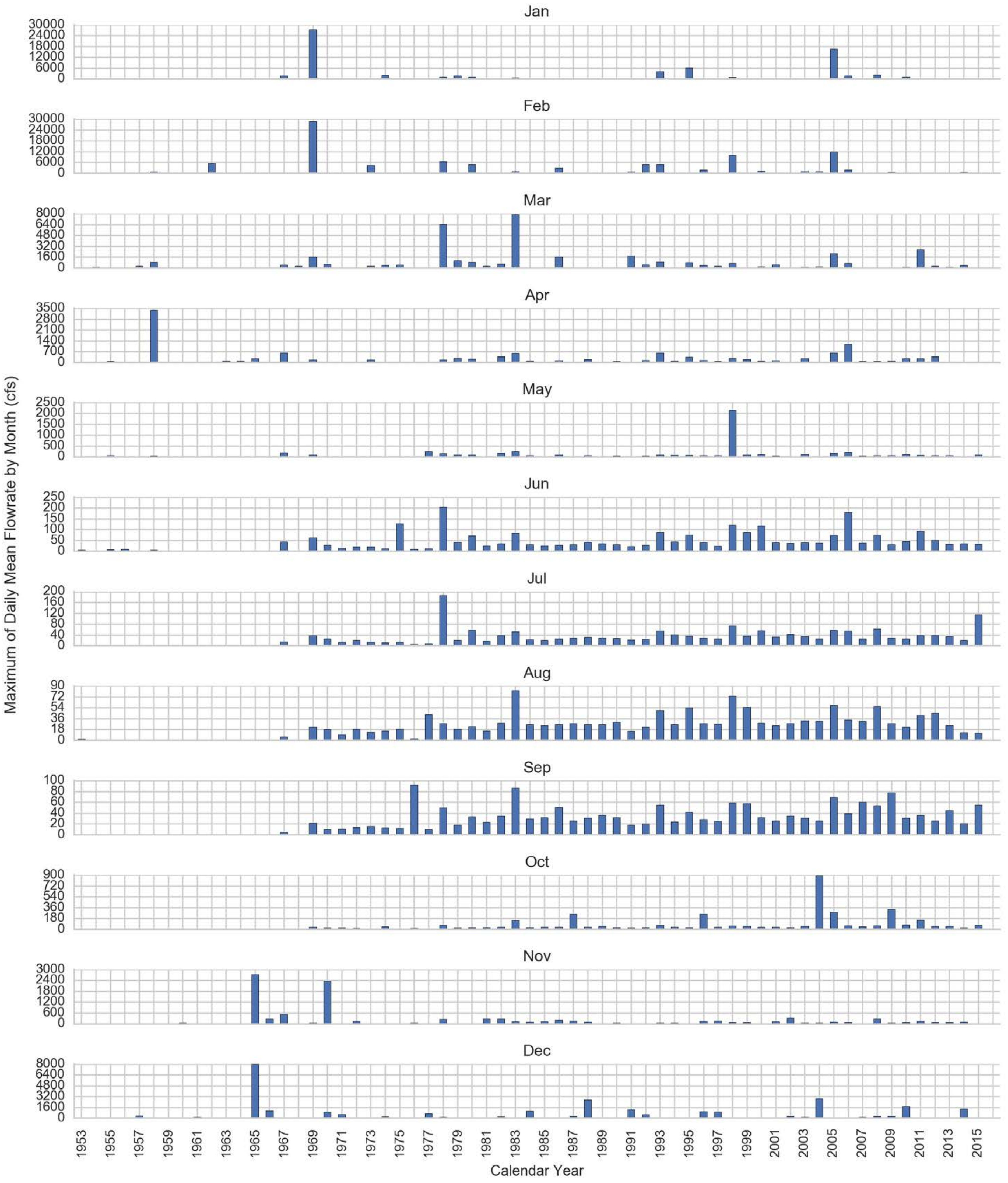


**Figure A-6. Maximum of Daily Mean Streamflow Occurring in Each Month by Year for the Combined County Line Gauge Record**

*Note: Vertical scale differs for each month. Summer flows are very low before approximately 1965, but data are present.*

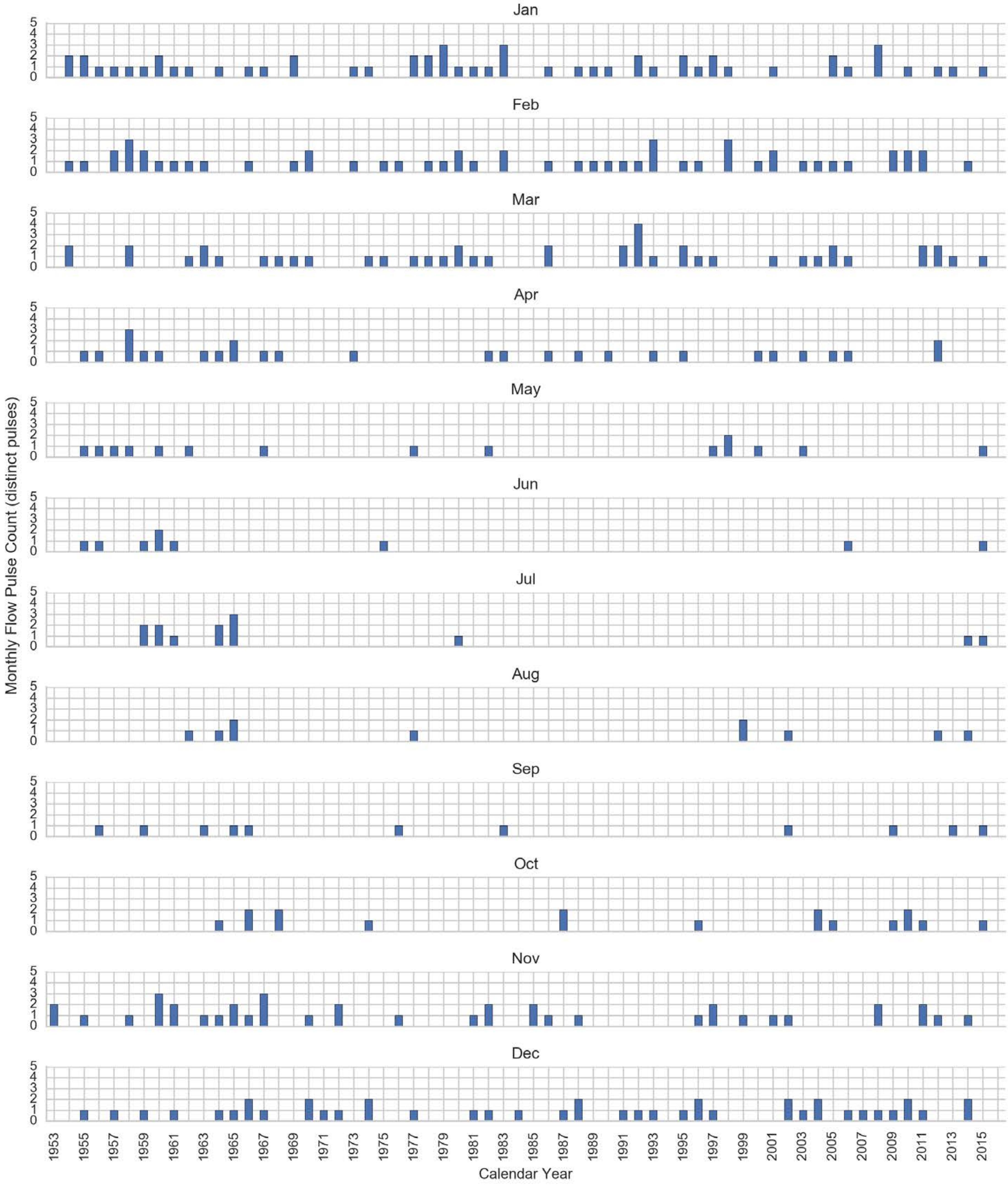


**Figure A-7. Streamflow Pulse Count per Month by Year for the Combined County Line Gauge Record**

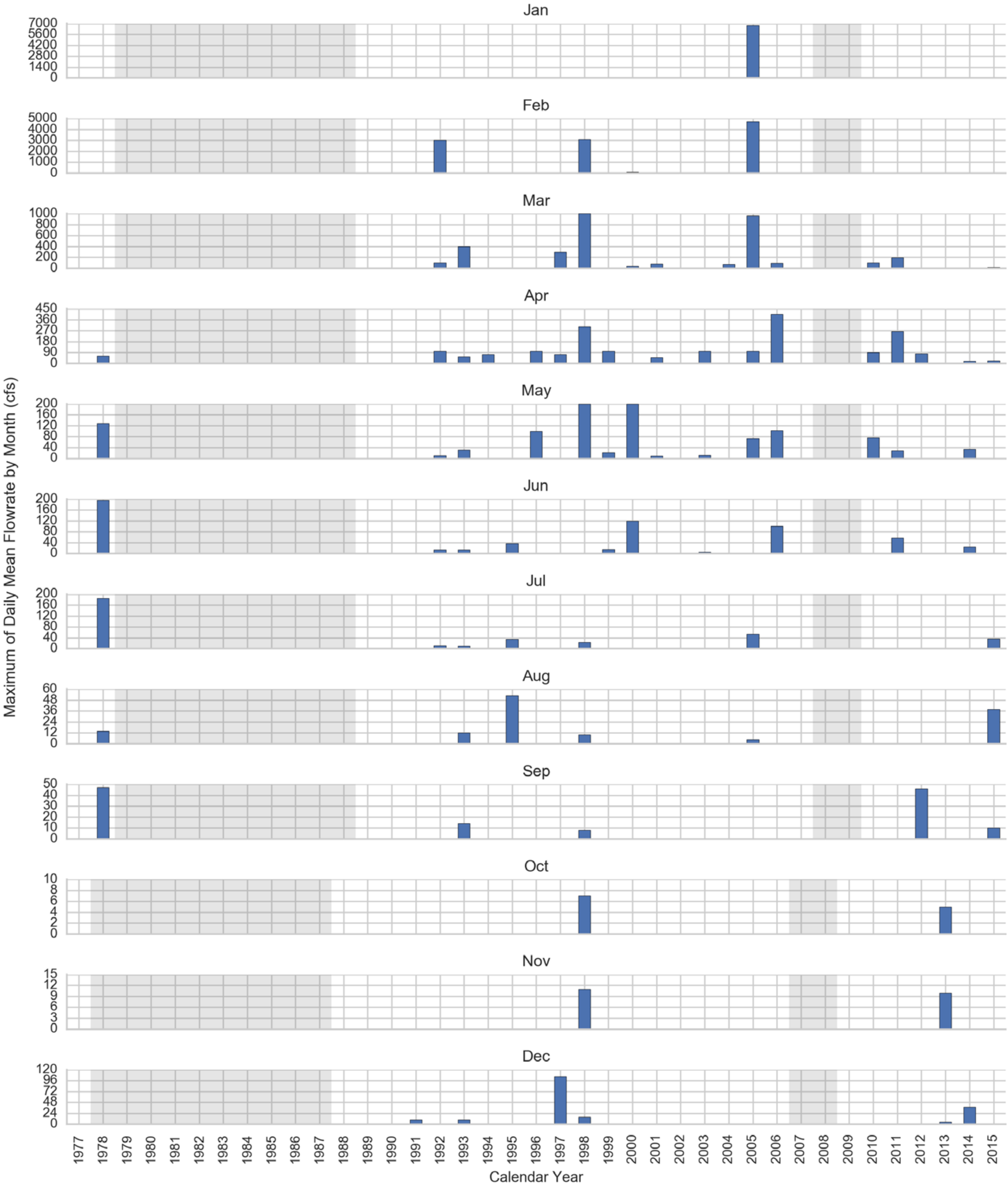


**Figure A-8. Maximum of Daily Mean Dam Release Streamflow Occurring in Each Month by Year for the Combined Castaic Lake and Castaic Lagoon Gage Records**

*Note: Vertical scale differs for each month. Release data is unavailable during years shaded in grey.*

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# Memorandum

**To:** Gatzke Dillon & Ballance LLP
Newhall Land and Farming

**From:** Gary Antonucci

**Date:** August 3, 2016

**Subject:** Pile Installation Procedures

**Project:** Commerce Center Drive and Long Canyon Road Bridges (CIDH)
Temporary Haul Route Bridges (Temporary Steel HP Piles)

## 1.0 INTRODUCTION

This memorandum outlines the Cast-In-Drilled-Hole (CIDH) construction techniques using a full-depth steel casing, the method of construction proposed for all piles associated with the Commerce Center Drive and Long Canyon Bridges of the Newhall Ranch Specific Plan. This memo will also comment on the installation and extraction of temporary steel HP Piles. These piles are recommended for use in the temporary haul route bridges which are proposed across the Santa Clara River.

## 2.0 CIDH PILES USING STEEL CASING[1]

CIDH piles for both the Commerce Center Drive Bridge and Long Canyon Bridges are proposed to be constructed using a full-depth steel casing to address potentially unstable soil conditions from anticipated excavations in loose soils below the groundwater table. A steel casing is installed to the full depth of the pile using an *oscillator/rotator technique.* The steel casing can be used to stabilize the drilled shaft during construction and to minimize the possibility of soil caving and geometric irregularities during concrete placement. Drilling is performed with a drill rig and auger that fits within the open area of the steel casing. The construction procedures described herein are applicable the Commerce Center Drive and Long Canyon Road Bridges.

After drilling is completed using the full-depth steel casing, a rebar cage is lowered into the boring and a pipe is lowered to the bottom of the hole. Concrete is then pumped to the bottom of the hole using a tremie pipe technique. As concrete fills the bore hole, the steel casing is raised, allowing the concrete to become in contact with the soil walls of the boring. Water displaced during the concrete filling of the boring will be collected from the steel casing and

[1] Chapters 5-3 and 6, United States Department of Transportation Federal Highway Administration. Drilled Shafts: Construction Procedures and LRFD Design Methods. Publication No. FHWA-NHI-10-016. May 2010.

then directed to temporary storage tanks for proper handling or subsequent upland disposal. The extraction of the steel casing will continue until the steel casing is still 20 feet below the ground surface, at which point, the steel casing will be left in place as a permanent steel casing with a minimum 5 feet of additional permanent steel casing remaining above the ground surface. The permanent casing will be accommodated for in the bridge pile foundation design.

During CIDH construction perimeter containment will be deployed around the work zone (**K-rail**[2] barriers and conventional BMPs such as straw waddles, silt fence, or soil berms) to ensure that all drill cuttings and fluids managed above ground will not be released to surface water. Cuttings from the boring will be staged in the work zone and then transported by loaders or dump trucks as necessary to an upland location. A system of pumps, tanks, shaker screens, and pipe lines will be used to securely convey fluids between mixing and storage tanks and the bore holes. These facilities can be visually inspected for leaks or loss of material. Any spilled materials can be readily cleaned up in the same manner as handling drill cuttings from the CIDH borings.

***Figure 1, Drilling and Casing Installation using the Oscillator/Rotator Technique (Excavation Bucket Shown)***

## Oscillator/Rotator Technique

This installation technique uses a large oscillator or rotator machine to press and twist the steel casing into the ground. Oscillator and rotator machines are hydraulic-driven tools which clamp onto the casing with hydraulic jaws and apply upward and downward force to the casing by leveraging against a temporary frame constructed around the shaft. An oscillator twists back

2 "K-Rail" would be installed per Caltrans specifications http://www.dot.ca.gov/hq/esc/oe/project_plans/Errata/Errata-2006/2006_StdPln_Errata_No_16/Entire-2006-Errata-No-16.pdf (last accessed July 26, 2016).

and forth while a rotator twists 360°. The bottom of the casing is fitted with cutting teeth slightly larger than the diameter of the casing to relieve stress on the casing and facilitate penetration into the soil.

Using this construction technique, the soil within the casing is excavated as the casing is advanced. Typically, a soil plug is left in place at the bottom of the shaft to ensure stability of the hole. To maintain pressure at the bottom of the shaft during construction, the casing will be filled with water or, alternatively, a drilling fluid. As the shaft is advanced it may be necessary to add sections to the casing. This can be done by welding or through the use of a preformed mechanical connection. When the shaft reaches the target depth, the soil plug is removed and the shaft is cleaned in preparation for the concrete pour.

The casing is removed while the concrete is still fluid, and the bottom of casing is kept approximately 5-ft below the top of concrete. The casing is oscillated back and forth during extraction, even if a continuous rotation was used for the installation. This ensures that the rebar cage inside of the shaft does not rotate out of place. If the casing was installed in sections, the sections will be dismantled as the casing is removed. As discussed above, a portion of the casing will remain as permanent casing.

***Figure 2, Installation using the Oscillator/Rotator Technique***
***Source: Delta Drilling Company, [http://www.bkdelta.by/en/technologies/cased-kelly-piles](http://www.bkdelta.by/en/technologies/cased-kelly-piles)***

## 3.0 EXTRACTION OF TEMPORARY STEEL HP PILES

To construct the proposed temporary haul route bridges crossing the wetted channel of the Santa Clara River, the bridges will be founded on temporary steel HP Piles. These piles will be vibrated to their desired depth using a vibratory hammer. To extract these piles, the vibratory hammer will be clamped to the top of each pile and powered to facilitate removal.

Ground disturbance during installation and extraction of HP Piles in sand substrate is limited and not likely to visibly disturb the ground surface beyond one to three feet from the pile location. As the proposed piles will be installed a minimum of 10 feet from the wetted channel, no disturbance to the wetted channel is expected. It is recommended that the pile location is confirmed at the time of installation to be a minimum of 10 feet from the wetted channel and that BMPs (orange construction fencing, silt fence, and/or sand bags) be deployed to ensure that construction equipment does not enter the wetted channel and any potential contaminants from the equipment operations is contained within the work area. As the pile is removed, the vibration will cause loose sands and sediment to fill the small void left by the steel HP Pile. Therefore, after the pile is fully removed, no voids will be left in the ground.

Each pile can be installed in a matter of minutes and the equipment installing the piles is highly mobile. Therefore, during installation, there is very little likelihood that river flow conditions would change to the extent inundation of the work area could occur. As proposed, piles will only be installed during periods with a clear weather window. A clear weather window is defined specifically for this Project as a greater than 40% chance of 0.1” of precipitation within the next 48 hours.

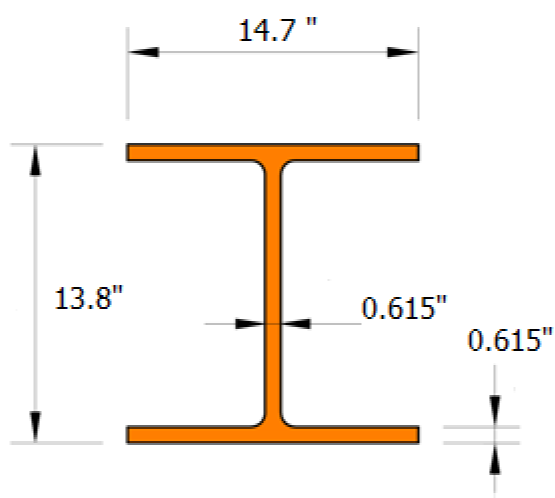


***Figure 1, HP 14x89 Steel Pile Section***

## 4.0 CAST-IN-DRILLED-HOLE PILE CONSTRUCTION SEQUENCE

A more comprehensive description of CIDH construction methods is provided in the *Cast-In-Drilled-Hole Shaft Installation Process Memorandum* prepared by Moffatt & Nichol on August 2016. Although there are several acceptable methods for constructing CIDH piles, the memorandum generally captures the preferred construction sequence anticipated for the Commerce Center Drive and Long Canyon Road Bridges and assumes that a full-depth steel casing, installed using oscillator/rotator techniques, is used, with a minimum 25 feet of permanent steel casing left near the ground surface of the borings (20 feet below ground surface and 5 feet above ground surface). The construction method preferred by the Contractor may differ due to material availability, proprietary drilling techniques, and cost, among other factors.

## 5.0 REFERENCES

California Department of Transportation. Foundation Manual. Sacramento, CA: October 2015.

United States Department of Transportation Federal Highway Administration. Drilled Shafts: Construction Procedures and LRFD Design Methods. Publication No. FHWA-NHI-10-016. May 2010. 6-1 – 6-9.


COMMERCE CENTER DRIVE BRIDGE

CIDH Equipment Layout and SWPPPs Containment

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# Memorandum

**To:** The Newhall Land and Farming Company

**From:** Gary Antonucci

**Date:** August 2016

**Subject:** Implementation of Proposed “No Water Contact” Construction Program

**Project:** Santa Clara River RMDP Permanent Bridges and Temporary Haul Route Bridges

## 1.0 INTRODUCTION

The RMDP Project infrastructure includes two permanent bridges across the Santa Clara River, one at Commerce Center Drive and the other at Long Canyon Road. In addition, the RMDP-covered activities include two temporary haul routes for grading equipment that will cross the River.

This memorandum evaluates whether the permanent bridges, as well as the temporary haul route bridges, can be constructed pursuant to a “No Water Contact” construction program. As explained below, the permanent bridges will be constructed differently than the temporary haul route bridges, not only in terms of installation method but also in terms of construction duration. And, as their name implies, the permanent bridges will remain in place after the Project is built to serve as part of the Project’s transportation/circulation infrastructure, whereas the temporary haul route bridges will be removed once grading operations at Landmark Village have been completed. Note, however, that both the permanent and temporary bridges can be implemented using standard engineering and construction techniques common to California.

## 2.0 DESCRIPTION OF “NO WATER CONTACT” APPROACH TO BRIDGE CONSTRUCTION

The RMDP’s permanent bridges and temporary haul route bridges would cross the Santa Clara River, which is home to the unarmored threespine stickleback, a small fish listed as endangered under both the Federal Endangered Species Act and the California Endangered Species Act, and identified as fully-protected under the California Fish and Game Code. The California Supreme Court recently held that efforts to collect and relocate stickleback during construction activities as mitigation in an EIR under the California Environmental Quality Act would violate the take prohibition of Fish and Game Code section 5515 – the statute that designates the stickleback as a fully-protected species.

In light of the Supreme Court ruling, the applicant has elected to avoid bridge-construction impacts on stickleback by eliminating any need to collect or relocate the fish during both permanent and temporary bridge pier or deck installation processes. From a design and constructability perspective, this means that the bridges must be installed without diverting the Santa Clara River and all work must be completed without any construction activity impacting or entering the wetted channel of the River.

**Permanent Bridges at Commerce Center Drive and Long Canyon Road**

To construct the permanent bridges using a “no-water contact” approach, the bridge support piers would be installed only in the dry riverbed. Where necessary to avoid the wetted channel of the Santa Clara River, other bridge components – most notably girders and bridge decks – would be constructed overhead to span the wetted channel. In all events, the proposed permanent bridge construction process will avoid contact with the wetted channel of the River and prevent bridge construction equipment, concrete, or other materials from entering or being discharged to the wetted channel.

The *permanent bridges* include construction of structural elements in a pre-determined sequence. This sequence of construction is as follows:

(i) Clear vegetation at construction site and grade access ramps;

(ii) Construct Cast-in-Drilled-Hole (CIDH) piles[1];

(iii) Extend bridge *columns* above the support piles to the height of the bridge deck;

(iv) Install pile caps to receive pre-cast girder members;

(v) Construct girders to span the space between columns in areas above dry riverbed;

(vi) Place pre-cast girders above wetted channel of the Santa Clara River;

(vii) Pour bridge decks; and

(viii) Complete bridge deck work (curbs, barriers, lighting pedestals, and lane striping).

Construction items (i), (ii), (iii), and (iv) would be constructed during the dry season[2] of the first year of bridge construction. The remaining items – (v), (vi), (vii) and (viii) – would be constructed during the second year of construction, with all work conducted from the top of the bridge structure (i.e., no access to the riverbed required).

[1] The bridge support piles would be installed using a Cast-in-Drilled Hole (“CIDH”) technique relying on a full-depth steel casing due to the presence of loose soils and groundwater, as further detailed in Moffatt & Nichol’s memorandum of August 3, 2010, titled “Pile Installation Procedures,” included here as **Attachment B**.

[2] For this Project, the dry season is defined as June 1 to September 30, and represents the period when the Santa Clara River is not subject to large storm induced flows and associated flooding, and is based on PACE’s memorandum of August 5, 2016, titled “Santa Clara River Low-Flow Inundation Analysis,” included here as **Attachment C** and the Geosyntec Consultants memorandum dated July 2016, titled “Santa Clara River Seasonal Streamflow Analysis” included as Appendix B to Attachment C.

Hydrology information provided by Geosyntec Consultants confirms that even during the largest summer storm runoff events ever recorded in the Santa Clarita Valley, flow levels in the Santa Clara River within the RMDP/SCP Project site are estimated to not exceed 500 cubic feet per second (cfs) during the period from June to September.[3] Thus, for purposes of this memorandum and this Project, the "summer dry season" is defined as that period from June 1 through September 30. During this period, maximum flows are not expected to exceed 500 cfs (Geosyntec 2016).

Based on the geometry and gradient of the Santa Clara River in the location of the two permanent bridges, the estimated maximum peak flow of 500 cfs would result in an inundation area that is less than 165 feet wide and in a position to allow ample space for constructing support piers (PACE 2016).

Building a bridge with piers at 165-foot intervals does not require unconventional engineering or construction techniques. As for the bridge deck girders, the segments over the wetted channel of the River would be pre-cast structures installed overhead, or "in the air", using cranes positioned on the completed portions of the permanent bridge deck itself. This technique – sometimes referred to as "girder launching" – is becoming more common in projects with limited access, and eliminates the need for construction equipment in the riverbed. Portions of the pier columns and bridge deck girders outside of the wetted channel may be constructed using more typical bridge construction techniques, including temporary falsework to support concrete forms for cast-in-place bridge columns and girders where such elements are located within the dry riverbed.

Based on the flow data and bridge type selection, we are confident that support piers can be constructed at 165-foot intervals, and that this spacing will allow for equipment access and construction of piers and girders to occur in the dry riverbed (i.e., without contact with the water). Furthermore, provided a pre-cast girder is used over the wetted channel, this method of construction eliminates any access to the wetted channel of the River.

Construction of the piers and girders in the dry riverbed must occur during the defined summer dry season. Assuming such a timing restriction, we are confident that the pier installation areas and any falsework needed to construct the columns and girders will remain dry (i.e., untouched by the wetted channel of the River) even during storm events approaching the historic high flow rates discussed above (i.e., 500 cfs).

Bridge construction typically involves the construction activities described in **Table 2.2-1**, Bridge Construction Sequencing. Each of these elements is described in detail below.

**Table 2.2-1, Bridge Construction Sequencing**

| **RMDP INSFRASTRUCTURE – BRIDGE CONSTRUCTION SEQUENCE** |
|---|

[3] According to a review of historical records, these peak flows are substantially higher than the mean daily flows measured for August (24 cfs) and September (26 cfs) (Geosyntec 2016).

| BRIDGE ELEMENT | Construction Season | Construction Timing |
|---|---|---|
| Pre-Construction Vegetation Removal / Grading of Access Ramps | Prior to Year 1 | Prior to nesting season |
| **1. Drill CIDH Piles and place rebar/concrete (Long Canyon only – bents A and F)*** | **Year 1** | **April through June** |
| 2. Drill CIDH Piles and place rebar/concrete | Year 1 | June through August |
| 3. Cast-in-Place Column Construction (using falsework/prefabricated forms) | Year 1 | July through September |
| 4. Construct Bent Cap at Columns that will receive Pre-Cast Girder (using falsework) | Year 1 | September (critical path) |
| ***5. Construct Bridge Abutments (North and South) – located in uplands/farm field areas*** | ***Year 1*** | ***September through October*** |
| 6. Cast-in-Place Girder Construction (using falsework) | Year 2 | June |
| 7. Pour Deck Frame Concrete (supported on Cast-in-Place Girders) | Year 2 | June through July |
| 8. Install Pre-Cast Girders (overhead crane) | Year 2 | August |
| 9. Pour Deck Frame Concrete (supported on Pre-Cast Girders) | Year 2 | September |
| ***10. Deck Work / Bridge Finish Work (curbs, rails, barriers, pedestals, lane marking)*** | ***Year 2*** | ***August through December*** |

*Items in ***Bold*** represent bridge work that is completed outside of the limits of the streambed or occur on top of the completed bridge structure.

A work zone (100 feet upstream and 100 feet downstream of the bridge location) would require that vegetation be cut and cleared to facilitate bridge construction. Such clearing activities, however, would not require equipment to cross or make contact with the wetted channel of the Santa Clara River. Minor grading in the dry riverbed will take place to create ramps between the terraces of the dry riverbed and existing farm areas, with some minor surface contouring. This ensures a safe, level work area at bridge pier or false work locations.

After equipment mobilization, CIDH piles would be initiated with a boring or shaft augured to a depth necessary to ensure a competent foundation for the bridge super-structure. Protective barriers and spill containment devices would be deployed during CIDH construction to collect and retain any debris, spoils and drilling fluids, and to ensure construction equipment stays within the defined work zone.

Two techniques for constructing CIDH shafts are commonly used: (i) the slurry displacement method, and (ii) the temporary casing method. For this Project, we recommend that the steel casing method be used.[4] Temporary steel casings stabilize the drilled shaft during construction and minimize the possibility of soil caving and geometric irregularities during concrete placement. After drilling is completed using the full-depth steel casing, a rebar cage is lowered into the boring and concrete is pumped into the bore hole. As concrete fills the bore hole, the steel casing is raised. The extraction of the temporary steel casing will continue until the lower edge of the steel casing is 20 feet below the ground surface and the top edge is 5 feet above the ground surface, at which point the steel casing will be left in place as a permanent element of the pier. This permanent steel casing will be accommodated for in the bridge pile foundation design.

The process of drilling a pile hole and filling it with concrete takes less than five days. During this period, the extension of the steel casing 5 feet above the ground surface would provide additional protection from any potential inundation of the open hole. Each casing would also be capped except when actual construction work requires access to the hole (e.g., when pouring cement or actively drilling). A clear weather forecast (i.e., no forecast storm events[5]) would be required for the initiation of any new pile drilling operation. If there is a forecast storm event, or if drilling is in progress and a rain event occurs, drilling would be suspended, equipment demobilized, and the only authorized work would be to maintain the site Best Management Practices (BMPs, e.g., silt fence, waddles, sand bags, etc.) and containment systems. In addition to standard BMPs used in construction, a "K-rail"[6] barrier system would be deployed around the perimeter of the pier work zone. **Attachment A** shows a typical work zone for a bridge project, including equipment work areas, BMPs and barrier system. The barrier system acts as both a containment berm for the construction area and a barrier to prevent construction equipment from inadvertently entering the wetted channel of the Santa Clara River. Access to the dry riverbed for the CIDH work would also be restricted to the dry season.

At the completion of each CIDH pile, a vertical column would be constructed using conventional false work or prefabricated forms. This would include concrete pours under the clear weather forecast restrictions described above. Together, the piles and columns create the bridge piers. The remainder of the bridge structure is supported on these elements.

Following bridge pier installation, construction of bridge girders and the bridge decks would use methods that do not require access into, or through, the wetted channel of the Santa Clara River. The girder and deck superstructure elements would be constructed using conventional

[4] The steel casing method, as applied to CIDH piles, is further described in **Attachment B**.

[5] A "forecast storm event" is defined for this Project as a NOAA forecast of a >0.1" precipitation event with more than a 40% chance of occurrence in the next 48 hours.

[6] "K-Rail" would be installed per Caltrans specifications: http://www.dot.ca.gov/hq/esc/oe/project_plans/Errata/Errata-2006/2006_StdPln_Errata_No_16/Entire-2006-Errata-No-16.pdf.

engineering and construction techniques within the dry portion of the riverbed**.** This involves cast-in-place concrete forms that are supported on temporary false work (wood and steel columns and beams). The false work will be erected directly in contact with the dry portion of the riverbed. The forms and false work supports would remain in place during an initial curing period of the concrete structure, after which time the false work and forms are “stripped” and removed from the work zone. As previously stated, concrete pours would only proceed with a clear weather forecast and be suspended in the event of a precipitation event. Conversely, in areas where construction access to the riverbed is prohibited due to the proximity or presence of the wetted channel of the Santa Clara River, pre-cast girders will be used. These girders are placed using over-head cranes (gantry or truck mounted) onto cast-in-place receiving supports integrated into the top of the columns at pier locations located on either side of the wetted channel. No access to the wetted channel is required for this work.

To prevent the inadvertent discharge of concrete, debris, or other construction materials into the wetted channel of the Santa Clara River, an underslung tarp, netting, or equivalent catchment or deflecting barrier would be deployed beneath the bridge deck. This catchment system would be maintained in place until completion of the bridge. Furthermore, equipment and personnel access to the dry portion of the riverbed would be restricted to the dry season.

Pipelines and utilities, crossing the river at the bridge locations, would be integrated into the superstructure of the bridge, suspended between or beneath the girders. Pipe sleeves and conduits, mounting brackets, and pipe hangers, as appropriate, would be placed prior to construction of the bridge deck. Depending on the location of the utilities in relation to the finished bridge deck, construction equipment access to the dry riverbed may be required during this phase of construction. Access to the dry portion of the riverbed would be restricted to the dry season.

All of the work described above would be completed during the dry season defined for the Project, and may require multiple construction seasons as suggested in **Table 2.2-1**.

The bridge deck would be constructed by pouring concrete into the prepared wood and steel deck frames that are supported on the completed girders and bridge piers. Because this work takes place in the air above the riverbed, it may be conducted outside of the summer dry season, although the above-described restrictions on pouring concrete would still apply in the event of a forecast storm event. Each deck frame would be poured and then allowed to set for a period of time prior to stripping of the frames. Deck work, including barriers, curbs, rails and other final features of the bridge are completed entirely from the top of the bridge. As previously stated, concrete pours would only proceed with a clear weather forecast and would be suspended in the event of a precipitation event. All construction of the bridge decks and subsequent deck work would occur from the top of the superstructure and no access to the wetted channel of the Santa Clara River is required for this work to be completed.

**Temporary Haul Route Bridges**

The *temporary haul routes* will include a modular bridge deck section that spans the wetted channel of the Santa Clara River. As with the permanent bridges, the temporary haul route bridges will be constructed in a manner that does not require installation of bridge support piers in the wetted channel. Instead, the spans of the haul route bridges will be wide enough to allow for the installation of the support piers in dry portions of the riverbed. The haul route bridges will not be permanent and will not be placed as high (vertical clearance) over the River channel as the permanent Commerce Center Drive Bridge and Long Canyon Road Bridge.

The purpose of the temporary haul route bridges is to allow construction equipment – more formally known as Material Hauling Equipment[7] – to move back and forth between the north and south portions of the Project site, which is bisected by the Santa Clara River. These temporary haul route bridges will facilitate earthwork operations associated with construction of the Project, including the Newhall Ranch Specific Plan.

Temporary haul route bridges can be constructed using methods that greatly reduce pier installation time. The most important of these methods is vibratory pile installation. Under this method, no hole is pre-augered and then filled with rebar and concrete. Instead, a steel pile is vibrated into place, making its own hole as it penetrates the dry riverbed. Modular deck sections can quickly be installed on the steel piles during the non-stormflow season[8] using overhead crane methods. All use of the temporary haul route bridges will be limited to the non-stormflow season.

The temporary haul route bridges would consist of the following elements:

(i) Support piers made of steel piles[9] that would be vibrated into place. The steel pile would extend above the river bed to support the temporary bridge deck;

(ii) Pile cap to support each of the modular temporary bridge deck sections;

(iii) Modular temporary bridge decks; and

(iv) Deck work consisting of K-rail barriers/curbing, cover soil / road surface, and fencing.

Temporary bridge items (i) and (ii), above, would remain in place during the winter season (herein defined as December 1 through April 30), as these elements are constructed to withstand winter flood flows. Items (iii) and (iv) would be installed after the winter season (i.e., after May 1) and removed at the end of the non-stormflow season (i.e., November 30) as these elements could be subject to damage during winter flood flows.

[7] According to Caltrans' Bridge Memo to Designers (MTD) 15-15, Material Hauling Equipment (MHE) is defined as construction equipment such as dump trucks, trailers, earthmovers, scrapers, and transit-mix trucks. Additionally, per MTD 15-15, MHE lanes are generally designed for a minimum 20-ft wide lane. We used these same parameters when designing the temporary haul routes for the RMDP project.

[8] For this Project, the non-stormflow season is defined as May 1 to November 30, and represents the period when the temporary bridge deck would not be subject to over-topping winter flood flows (Geosyntec 2016, PACE 2016).

[9] The temporary bridge support piles would consist of pre-fabricated steel HP piles installed using vibratory methods, as further detailed in **Attachment B**.

Prior to installation, the locations for temporary haul route bridges would be surveyed for the edge of the wetted channel to identify and demarcate a sufficient margin (herein defined as 10 feet) between the wetted channel and support pier installation. Orange construction fencing, silt fence, or other BMPs would be deployed between the pile location and the wetted channel. A pre-fabricated steel pile would be placed in this predetermined location within the dry riverbed and mechanically vibrated, while pressure is applied from the top. This combination of forces pushes the pile down through the soil to the appointed depth, at which point it can serve as the foundation for the temporary bridge deck.

Each pile row would consist of 2 to 4 piles (depending on bridge deck width), and pile rows would be spaced from 60 to 90' along the length of the temporary haul route bridge. Each pile can be vibrated into place in less than two hours (approximately 5 per day) (By comparison, at the permanent bridges, each CIDH pile takes up to 5 days to complete). Consequently, all piles can be installed in the dry riverbed and quickly vibrated into place. Upon installation of the support piles, pile caps would be welded to the top of each pile row, creating a receiving platform for the modular bridge decks. The piles and pile cap portion of the temporary haul route bridge structure would remain in-place until the haul route is no longer needed for the transport of construction equipment. It is expected that the piles will remain in place and subject to two winter storm seasons.

Once the piles are in place, modular bridge decks would be lowered onto the prepared pile caps using over-head cranes. A soil travel surface, edge curbing, fencing and other bridge edge protections would be installed above and along the edges of the modular bridge decks to allow the structure to adequately support the earth moving equipment and prevent any debris from leaving the travel surface. All installation would occur from locations within the dry portion of the riverbed or from the bridge deck. The modular deck installation would only occur during the non-storm flow season (May 1 through November 30). Consequently, the temporary bridges would only be in operation during this same period to eliminate the potential for river flows to overtop the bridge deck during a high flow storm event. The removal of the temporary haul route bridge soil covering, curbing, and fencing would be conducted using equipment similar to that used in the installation, and would be accomplished from the bridge deck or using cranes located in the dry portion of the riverbed. The temporary haul route bridges would be stripped down to the pile and pile caps by November 30 each year. When use of the haul routes resumes in subsequent years, the modular bridge decks, travel surface, and bridge edge protections would be re-installed or re-deployed. Again, this work would be initiated no earlier than May 1 and would be conducted from either the dry riverbed or the surface of the bridge itself.

Once the temporary haul route bridges are no longer required for grading operations, the pile caps would be removed and piles extracted using equipment similar to that used for installation. However, instead of applying pressure to push the pile into the ground, the equipment would extract the pile by pulling it up. Extraction of each pile can be done in a matter of minutes, so the same clear weather window and work location restrictions described for installation are also protective of the wetted channel of the Santa Clara River during extraction of the piles. The equipment used to extract the piles would be located in the dry riverbed, thereby assuring no contact with the wetted channel.

## 3.0 CONCLUSION

The RMDP permanent bridges at Commerce Center Drive and Long Canyon Road can be constructed pursuant to a “No Water Contact” construction program. The modified construction approach calls for the permanent bridge piers to be placed at least 165 feet apart over the wetted channel of the Santa Clara River. Provided the work takes place during the summer dry season, the bridge piers can be installed in the dry riverbed without impacting the wetted channel. This can be accomplished fairly easily because the support pile holes take only 4 to 5 days to construct. In addition, during that 4 to 5 day period, when not actively under construction, each hole would be protected by a capped steel casing. The entire pier installation program can be accomplished in 60 to 90 days per bridge, well within the defined summer dry season determined by Geosyntec and outside of the estimated maximum flooded area during this period determined by PACE. As outlined in this memo and summarized in **Table 2.2-1**, it is also feasible to construct the remaining bridge elements within these timing restrictions.

The temporary haul route bridges likewise can be constructed without water contact. If installed during a clear weather window, the piers (consisting of prefabricated steel piles) can be vibrated into place within the dry riverbed, away from the wetted channel of the Santa Clara River. This also should be fairly easy to accomplish, given that each pile can be installed in a matter of hours. In the unlikely event that a large and unexpected storm were to occur during installation of the piles, the mobile equipment could be removed from the riverbed and as there would be no remaining pile hole, no inundation risk is presented. Once the bridges are completed, they may be used by earthmoving equipment during the non-storm flow season, defined here as May 1 through November 30. Installation, operation, and removal of the temporary modular bridge decks and operating surfaces can be accomplished during this period, eliminating any potential for bridge materials to be deposited into the wetted channel by high flows overtopping the temporary bridge deck structure.

In summary, both the proposed permanent and temporary bridges can be constructed using standard techniques and best management practices that eliminate any need for construction work to take place in the wetted channel of the Santa Clara River. Consequently, the proposed bridges would not require stream diversion or fish relocation.