100-Year FLO-2D Analysis
Panoche Valley Solar Project

San Benito County, California

October 6, 2014

Prepared for:
PV2 Energy, LLC
845 Oak Grove Ave., Suite 202
Menlo Park, CA 94025

Prepared by:
Energy Renewal Partners, LLC
305 Camp Craft Road
Suite 575
Austin, Texas 78746

Date:
October 6, 2014

DRAFT

Jennifer Loeffler
Environmental Scientist

Charles Mickel, P.E.
Project Engineer

Table of Contents

1.0 Objective 1
2.0 Background 1
3.0 Methodology 1
4.0 Results 6
5.0 References 7

List of Tables

Table 1 Subwatershed Drainage Areas
Table 2 Hyetograph
Table 3 Hydrograph, Las Aguilas Creek
Table 4 Hydrograph, Tributary to Las Aguilas Creek
Table 5 Hydrograph, Panoche Creek

List of Figures

Figure 1 Site Location
Figure 2 Inflow Subwatersheds
Figure 3 100-Year Maximum Flow Depth
Figure 4 100-year Maximum Flow Velocity

1.0 Objective

The purpose of this document is to describe the methodology and results of the Panoche Valley 100-Year Flood Event Analysis using FLO-2D Basic software. This flood event analysis was performed in order to identify depth and velocity of water within the proposed project area during a 100-year, 24 hour rain event. Modeling depth and velocity of water at the site during a 100-year, 24 hour rain event can inform structural engineering requirements and develop a site layout that reduces risk of property damage by siting equipment in areas least affected by a 100-year event.

2.0 Background

Site Location

The Panoche Valley Solar Farm (the "project site") is comprised of approximately 2,813 acres in the Panoche Valley of eastern San Benito County, California near the intersection of Little Panoche and Panoche Road (Figure 1). The proposed project will consist of up to a 399 megawatt (MW) solar photovoltaic energy generating facility. A 230 kiloVolt (kV) transmission line currently bisects the center of the project site and the proposed substation would be southwest of the intersection of the existing transmission line and Little Panoche Road. The climate of the project site can be characterized as arid with an annual rainfall of between 8 and 10 inches (Panoche and Panoche 2SW weather stations) with a majority of precipitation occurring from November through March (DWR 1981).

Watershed Description

Two named drainages, Panoche Creek and Las Aguilas Creek, exist on the project site, including Valley Floor Conservation Lands. These ephemeral creeks are often dry in the summer and are fed by smaller washes and drainages that emerge from the surrounding hills. Panoche and Las Aguilas Creeks flow through the project site west to the east and then meander through rolling and flat terrain which dips toward the southeast over Quaternary alluvial floodplain deposits. The physical drainage area of the project site including tributaries consisting of three subwatersheds was delineated to be approximately 73.93 square miles (mi^2) using both elevation data (DEM) and the United States Geological Survey (USGS) National Hydrography Database (Figure 2). The Panoche Valley subwatersheds can be characterized as rural that exhibit runoff characteristics of rangeland grazing. Watershed studies have identified natural runoff and erosion processes occurring in the watershed, including gully and sheet runoff, natural landslides, and streambank sloughing (Boyle 1991).

3.0 Methodology

The overall goal of the 100-year flood event analysis was to identify maximum height, depth, and velocity of water on the project site during a 100-year, 24-hour rain event. FLO-2D Basic Software (Version 2009) was used to model the maximum depth and the flow velocity of a 100-year, 24-hour rain event. FLO-2D Basic is an integrated river and floodplain 2-D flood routing model that combines

hydrologic and hydraulic modeling capabilities. FLO-2D Basic has the capability to route flood hydrographs and rainfall runoff for 24-hour rain events by using the full dynamic wave momentum equation and a central finite-difference routing scheme with eight potential flow directions to predict the progression of a flood event over a system of square grid elements. FLO-2D Basic is approved by FEMA for Flood Insurance Studies.

Additionally, HEC-HMS (Hydrologic Modeling System) was used in this study to generate the 100-year flood hydrographs for three creeks in the project region. The HEC-HMS modeling software was designed by the US Army Corps of Engineers to simulate the precipitation-runoff processes of watershed systems. This includes large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are extensively used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, flood damage reduction, floodplain regulation, and systems operation.

Unit Hydrograph

A unit hydrograph with characteristics of the hydrology, geology, and topography of Panoche Creek, Las Aguilas Creek, and a northern tributary to Las Aguilas Creek was created for use in the FLO-2D Basic model. Because local authorities have no codified preference for a specific methodology for the determination of a modeled hydrograph, the Natural Resource Conservation Service (NRCS) Dimensionless Unit Hydrograph was chosen and used for modeling as it is frequently employed by the National Weather Service. This methodology is incorporated as a computational option in the U.S. Army Corps of Engineers HEC-HMS software which is used to facilitate the creation of the unit hydrograph.

The inputs for the unit hydrographs obtained through the HEC-HMS model include a representation of the geographic components and their hydrologic relationship to one another (HEC-HMS refers to this as a *Basin Model)* and a hyetograph representing a storm event (3.3 inches) that is capable of producing 1 percent (%) exceedance conditions, also called the *Time-Series Data* component of HEC-HMS (US DOT 2002).

The first step in producing the basin model is to use ArcGIS to delineate the watershed that contributes to the drainage points of interest on Panoche Creek, Las Aguilas Creek, and the northern tributary to Las Aguilas Creek. Watershed delineation was developed in ArcGIS using a topographic layer and stream network shapefile data from the National Hydrography Database (NHD, USGS). Beginning at a chosen outflow point on a stream or drainage channel, topography is then interpreted to trace the elevated breaks where relief shall force water to flow in opposite directions. Sub-catchments are then delineated based on points along the stream network and using topography as a guide to create boundaries. Multiple sub-catchments were delineated along the stream reaches so as to produce a more dynamic model that could permit more instances of geographically discrete channel flow and overland flow

through the entire basin. Once the catchment boundaries were delineated, their respective areas were calculated in square miles for the purpose of HEC-HMS input (Figure 2).

HEC-HMS also requires that NRCS Curve Number values be assigned to each sub-catchment. Curve numbers represent the ability of a land surface to create runoff (e.g., minimize precipitation infiltration into the land surface). Curve numbers can be assigned on the basis of land-use/land-cover characteristics and the hydrologic soil group associated with the land surface. Soil data was acquired from the NRCS website to determine the hydrologic soil groups associated with the sub-catchments of interest (USDA 2000). The majority of the soils within the HEC-HMS study area were selected to be Class B and C soils based on the local conditions at the project site. Soils in Class B typically have between 10 to 20% clay and 50 to 90% sand and silt, and have silty loam or loamy textures. Class C soils have high clay content and low infiltration rates when thoroughly wetted and have a texture that can range from a silty clay loam to a finer clay loam or clay. Class C soils are classified by the NRCS as having a higher curve number, between 80 and 96 depending on land cover qualities (USDA 1986). A higher curve number can be associated with a higher potential to produce runoff because clay is inherently less permeable than sand and silt. Based on USDA soil maps and visual and field estimations of land-use and land cover within the catchments boundaries, weighted curve numbers ranging between 77 and 88 were assigned.

Lag Time is another required input to the model. The NRCS methodologies empirically estimate that lag time is roughly equal to 60% of Time-to-Concentration which, in turn, was calculated using the Watershed Lag method (NRCS 2010). The Watershed Lag method ultimately incorporates: (a) drainage area; (b) SCS Curve Number or *retardance factor*; and the average overland land slope. The average overland land slope can be calculated in ArcMap by summing the lengths of contour lines within a sub-catchment boundary, multiplying the sum by the contour interval and dividing the product by sub-catchment area.

In this study, there were a total of three channel reaches within the watershed that required evaluation. The Muskingum-Cunge stream routing method was used in HEC-HMS, which is an acceptable model component for NRCS practices. The input parameters used to represent the channel characteristics included a trapezoidal cross sectional shape with a bottom width of 10 feet and a side slope of 0.2 (height/width). In addition, a Manning's roughness coefficient of 0.04 was assigned to all reaches based on analysis of aerial imagery (Mays 1999; The Engineering Toolbox). The length of each reach was calculated in ArcMap and the DEM was used to determine the elevation of the upstream and downstream terminals of each reach. Change in elevation along the length of the reach was then used as the slope variable for each reach component.

Time series precipitation data was then selected for use and input to the HEC-HMS model. This was derived from the NOAA Precipitation Frequency Data Server using a centroid of the gross project area as a reference location which defines a 1% chance exceedance storm event over a 24-hour period for San Benito County as having a cumulative rain depth of 3.3 inches. This region requires the application of a Type I NRCS rainfall distribution within the given 24-hour period (USDA 1986). A conversion table from the *US Department of Transportation Highway Hydrology* was used to facilitate the calculation of rainfall per hour time interval given the desired cumulative total rainfall for the 24 hour period (US DOT 2002).

After the input parameters as described above were entered into the HEC-HMS model, model simulations were conducted and the outputs produced peak discharges of 6512.6, 1416.6, and 878.2 cubic feet per second (cfs) for a 100-year, 24-hour rainfall event for the Panoche Creek, Las Aguilas Creek, and the northern tributary to Las Aguilas Creek, respectively. This level of discharge for a watershed with an estimated area of approximately 73.93 mi^2 is consistent with USGS regression plots that empirically relate these two variables.

FLO-2D Basic

FLO-2D Basic was used to model the maximum height, depth, and velocity of a 100-year, 24-hour rain event. The inputs used in the FLO-2D Basic model included 10 meter (m) DEM elevation data, aerial imagery, and the HEC-HMS derived unit hydrograph described above. There are five basic steps to create a flood simulation:

I. Import elevation points and create a FLO-2D grid system.
II. Define the computational area and create the FLO-2D Basic data files for a simple overland flow simulation in the Grid Developer System (GDS).
III. Create input files for elevation, infiltration, terrain roughness, and inflow/outflow characteristics to model grid elements as well as temporally dependent variables such as rainfall and inflow discharge.
IV. Run the FLO-2D flood simulation.
V. Generate shaded maps depicting the maximum flood depths and maximum flow velocities over an aerial photograph.

The elevation data input into the GDS was 10 meter resolution elevation data converted into Standard English units of feet, in the form of a point-shapefile. Within the GDS, a computational grid size of 100 feet was selected based on common industry practice in which peak discharge divided by the grid size area does not exceed 1 cfs/$feet^2$. A grid size of 100 feet provides sufficient resolution and allows the model to run within a manageable time frame. The GDS then interpolates the elevation data assigning elevation values to each 100 feet grid element.

Aerial images were imported to define the computational area surrounding the project site. The computational area was selected to ensure that a large enough area is provided to not alter the natural flow of runoff, but small enough for the model computation to run efficiently. Thus, the selected contributing area upland of the project site was included as well as those adjacent areas into which Panoche and Las Aguilas Creeks drain. A preliminary model simulation was conducted and evaluated to ensure that the boundary conditions established in the model were of sufficient extent to capture the effect of drainage at peak flow. The final FLO-2D Basic study area was defined as 24.02 mi^2.

After the computational area was defined, elevation data were interpolated within each grid. Based on aerial imagery and field observations, a Manning's roughness coefficient was assigned to each grid cell. A value of 0.03 (unitless) was assigned for overland flow representing rangeland conditions with a sandy to silty clay loam soil substrate and 0.04 for open channel flow over vegetated gravel to cobble-size material (Chow 1959; The Engineering Toolbox). It should be noted that the intermittent nature of Panoche and Las Aguilas Creeks allow for the visible presence of dry land vegetation in the channel and as such a higher Manning's Roughness coefficient value, commonly ascribed to regular flow channels absent of vegetation, was not chosen. The suggested Manning's Roughness Coefficient value for non-vegetated channels is 0.035, while the suggested Manning's Roughness coefficient value adjustment for a partially vegetated channel is 0.005 (Aldridge and Garrett 1973). This adjustment reflects the Manning's roughness coefficient value used within the FLO-2D Basic model for open channel flow (0.04). The unit hydrograph was then input into the GDS and spatially referenced to the Panoche Creek, its southwestern tributary, and Las Aguilas Creek. Grid elements along the computational boundary that represent the low-lying floodplains were coded as Outflow elements in which overland and channel flow can flow out of the project boundary.

The infiltration data were then input into the FLO-2D Basic model. These input data were based on the same soil dataset and NRCS Curve Numbers used in the HEC-HMS model. A shapefile representing the Class B and Class D soil groups was imported into the GDS for interpolation of grid cell values of 77 and 88, respectively. It should be noted that infiltration was not 'double counted' by being calculated in HEC-HMS and in FLO-2D. The HEC-HMS was used to calculate the 13.7 mi^2 basin contributing to the Lindsey Creek junction where the hydrograph is modeled and not the adjacent smaller FLO-2D Basic computational area.

The same rainfall distribution that was used in the HEC-HMS model simulations for the three stream hydrographs was also used as an input for the FLO-2D Basic model for the computational area encompassing the project area and its immediate surrounds. As in HEC-HMS model and as is the standard for such studies, the rainfall is evenly distributed throughout the entire FLO-2D Basic computational area.

After the unit hydrograph was input into the FLO-2D Basic model, the simulation time (24-hours) and the outflow time interval (0.1 hours) were defined. The program then creates seven preliminary data files, including the floodplain data to be used in the model simulation. The FLO-2D Basic model was then initiated and the results were post-processed with the FLO-2D Mapper software to generate shaded contours representing the maximum height, depth, and velocity of a 100-year, 24 hour rain event for the Panoche Valley adjacent to the project site.

4.0 Results

The FLO-2D Basic model computes an area of inundation, or the 100-year flood event extent, as a contour line representing water depth greater than 0.2 feet. Deeper water depths are represented by shaded colors within the 0.2 feet contour. The result of the FLO-2D Basic model simulation illustrates floodwater within the area of inundation that has accumulated as a result of overland flow and stream flow from Panoche Creek, Las Aguilas Creek and its northern tributary within the project area and within the Valley Floor Conservation Lands during a 100-year, 24 hour rainfall event (Figure 3).

Overland flow generated by a 100-year rainfall event within the FLO-2D Basic study area results in the inundation of lower topographic areas in the northwest, central, and south-central portions of the project site primarily within the Valley Floor Conservation Lands. Within the area of inundation, a majority of the overland flow predicted by the FLO-2D Basic model simulation is of a depth less than 0.6 feet. A maximum overland flow depth of 1.0-1.8 feet occurs outside of drainage areas primarily within the northwestern and south-central boundaries of the project site. A maximum flow depth of 5.6 to 9.9 feet occurs within the tributary of Las Aguilas Creek flowing northwest to southeast which then contributes to a maximum flow depth of 3.2 to 5.6 feet within the wider banks of Las Aguilas Creek at the south-central portion of the project site (Figure 3). A maximum flow depth of 5.6 to 9.9 feet occurs within Panoche Creek directly south of the project site. The proposed location of the substation located on the southwestern corner of Little Panoche Road and Vasquez Creek Road remains outside of the area of inundation.

Maximum flow velocities of overland flow predicted by the FLO-2D Basic model simulation are between 0.3 and 0.9 feet per second (ft/s) and occur within the northwestern and south-central portions of the project site within the area of inundation (Figure 4). Outside the area of inundation and throughout most of the project site, the maximum flow velocity predicted for overland flow is between 0.1 and 0.2 ft/s. The maximum flow velocity predicted within Las Aguilas Creek is 4.4 to 7.5 ft/s and within its northern tributary is 1.5 to 2.5 ft/s. Panoche Creek, directly south of the project site has a predicted maximum flow velocity of 4.4 to 7.5 ft/s.

5.0 References

Aldridge, B.N., and Garrett, J.M., 1973. Roughness coefficients for stream channels in Arizona: U.S. Geological Survey Open-File Report, 87 p.

Boyle, 1991. Preliminary draft letter report - evaluation of general resource conditions, Panoche/Silver Creek Watershed Management Plan. Sacramento, California. August

Chow, V. T., 1959. Open-Channel Hydraulics. McGraw-Hill, Inc. (Classic text)

Engineering Toolbox. Manning's roughness coefficient values. Available at: http://www.engineeringtoolbox.com/mannings-roughness-d_799.html

Mays, L. W. editor., 1999. Hydraulic design handbook. McGraw-Hill Book Co.

Natural Resource Conservation Service (NRCS), 2000. Soil Survey Geographic Database. Available at: http://soildatamart.nrcs.usda.gov/Survey.aspx?County=TX271

Natural Resource Conservation Service (NRCS), 2010. Part 630 - Hydrology - National Engineering Handbook – Chapter 15 – Time of Concentration. Available at: ftp://ftp.wcc.nrcs.usda.gov/wntsc/H&H/NEHhydrology/ch15.pdf

United States Department of Agriculture , 1986. Urban hydrology for small watersheds. Technical Release 55 (TR-55) (Second Edition ed.). Natural Resources Conservation Service, Conservation Engineering Division. Available at: http://www.cpesc.org/reference/tr55.pdf

United States Department of Transportation, 2002. HCS-2 Highway Hydrology (Second Ed.). Federal Highway Administration, Hydraulics Engineering Division. Available at: http://www.fhwa.dot.gov/engineering/hydraulics/library_sub.cfm?keyword=010

Table 1 Subwatershed Drainage Areas

Subwatershed Name	Subwatershed ID	Drainage Area (mi^2)
Panoche Creek	SW3	38.27
Las Aguilas Creek	SW2	7.09
Northern Tributary to Las Aguilas Creek	SW1	4.55
FLO-2D Basic Study Area		24.02

Table 2 Hyetograph

Hyetograph		
Time (hrs)	Cumulative Percent	Total Rainfall (in)
0	0	0
1	0.017	0.0561
2	0.035	0.1155
3	0.055	0.1815
4	0.076	0.2508
5	0.099	0.3267
6	0.126	0.4158
7	0.156	0.5148
8	0.194	0.6402
9	0.254	0.8382
10	0.515	1.6995
11	0.624	2.0592
12	0.682	2.2506
13	0.728	2.4024
14	0.766	2.5278
15	0.799	2.6367
16	0.83	2.739
17	0.857	2.8281
18	0.882	2.9106
19	0.905	2.9865
20	0.926	3.0558
21	0.946	3.1218
22	0.965	3.1845
23	0.983	3.2439
24	1	3.3

Table 3 Hydrograph, Las Aguilas Creek

Las Aguilas Creek	
Time (hrs)	Q (cfs)
0	0
0.25	0
0.5	0
0.75	0
1	0
1.25	0
1.5	0
1.75	0
2	0
2.25	0
2.5	0
2.75	0
3	0
3.25	0
3.5	0
3.75	0
4	0
4.25	0
4.5	0
4.75	0
5	0
5.25	0.1
5.5	0.5
5.75	1.9
6	4.9
6.25	10.2
6.5	18
6.75	28.5
7	41.2
7.25	56.8
7.5	77
7.75	103.8
8	135.6
8.25	195.7
8.5	320.1
8.75	547.5
9	857.9

Time (hrs)	Q (cfs)
9.25	1174.9
9.5	1416.6
9.75	1513
10	1494.3
10.25	1413.3
10.5	1301.8
10.75	1176
11	1055.3
11.25	944.1
11.5	847.1
11.75	767.8
12	705.3
12.25	654.6
12.5	611.9
12.75	574.9
13	543.2
13.25	516
13.5	491.9
13.75	469.9
14	451
14.25	434.9
14.5	421.8
14.75	410.8
15	401.9
15.25	394
15.5	385.8
15.75	376.2
16	366.2
16.25	356.7
16.5	347.8
16.75	339.6
17	332.4
17.25	325.9
17.5	319.7
17.75	313.4
18	307.4
18.25	301.6
18.5	295.9
18.75	289.8

Time (hrs)	Q (cfs)
19	284
19.25	278.5
19.5	273.6
19.75	269.1
20	265.3
20.25	261.8
20.5	258.6
20.75	255.3
21	252.2
21.25	249.3
21.5	246.4
21.75	243.3
22	240.4
22.25	237.5
22.5	234.6
22.75	231.6
23	228.6
23.25	221.5
23.5	205
23.75	174.9
24	137.5
24.25	100.9
24.5	70.1
24.75	48
25	33.3
25.25	23.1
25.5	15.9
25.75	10.9
26	7.5
26.25	5.1
26.5	3.5
26.75	2.3
27	1.5
27.25	1
27.5	0.6
27.75	0.3
28	0.1

Table 4 Hydrograph, Tributary to Las Aguilas Creek

Northern Tributary to Las Aguilas Creek	
Time (hrs)	Q (cfs)
0	0
0.25	0
0.5	0
0.75	0
1	0
1.25	0
1.5	0
1.75	0
2	0
2.25	0
2.5	0
2.75	0
3	0
3.25	0
3.5	0
3.75	0
4	0
4.25	0
4.5	0
4.75	0
5	0
5.25	0
5.5	0
5.75	0.2
6	0.5
6.25	1.7
6.5	4
6.75	7.9
7	13.1
7.25	20.3
7.5	31.3
7.75	47.2
8	65.8
8.25	102
8.5	197.7
8.75	375

Time (hrs)	Q (cfs)
9	596
9.25	786
9.5	878.2
9.75	868.9
10	819.3
10.25	764.1
10.5	699.3
10.75	620.5
11	549.5
11.25	493.8
11.5	449.3
11.75	410.8
12	381.2
12.25	359
12.5	339.7
12.75	320.6
13	304.6
13.25	292.2
13.5	281
13.75	269.4
14	259.6
14.25	252.1
14.5	246.1
14.75	240.7
15	236.4
15.25	232.6
15.5	227.8
15.75	221.3
16	215.1
16.25	210
16.5	205.4
16.75	200.7
17	196.7
17.25	193.5
17.5	190.1
17.75	186.2
18	182.6
18.25	179.6

Time (hrs)	Q (cfs)
18.5	176.4
18.75	172.5
19	168.9
19.25	166.1
19.5	163.5
19.75	161
20	158.9
20.25	157.2
20.5	155.5
20.75	153.4
21	151.6
21.25	150.1
21.5	148.5
21.75	146.5
22	144.7
22.25	143.2
22.5	141.5
22.75	139.5
23	137.7
23.25	132.9
23.5	118.3
23.75	92.8
24	66
24.25	44.6
24.5	29.6
24.75	19.4
25	12.9
25.25	8.7
25.5	5.8
25.75	3.9
26	2.6
26.25	1.7
26.5	1.2
26.75	0.8
27	0.5
27.25	0.3
27.5	0.2

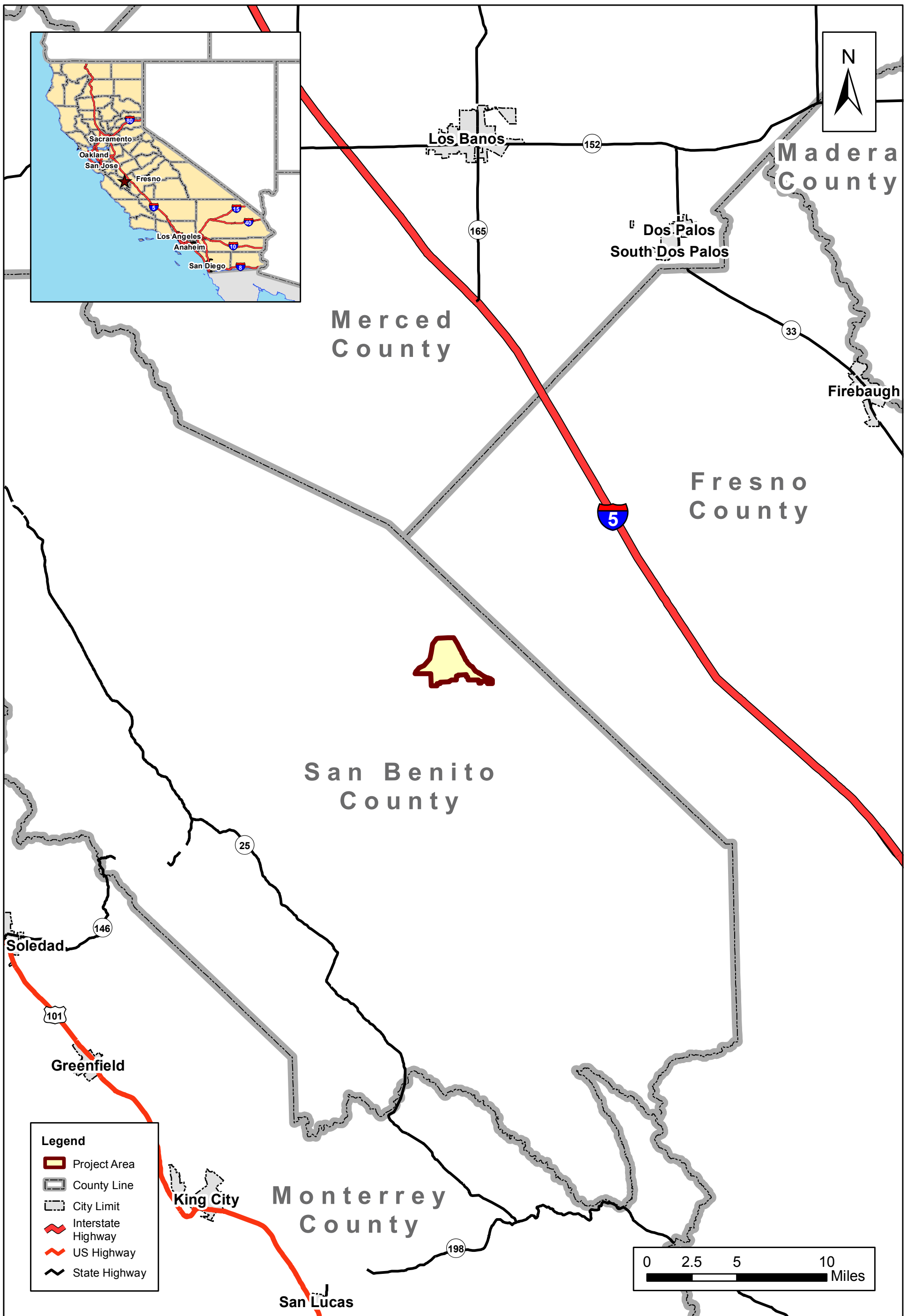
Table 5 Hydrograph, Panoche Creek

Panoche Creek	
Time (hrs)	Q (cfs)
0	0
0.25	0
0.5	0
0.75	0
1	0
1.25	0
1.5	0
1.75	0
2	0
2.25	0
2.5	0
2.75	0
3	0
3.25	0
3.5	0
3.75	0
4	0
4.25	0
4.5	0
4.75	0
5	0
5.25	0
5.5	0
5.75	0.2
6	0.7
6.25	2
6.5	4.6
6.75	9.5
7	18.2
7.25	33.4
7.5	58.1
7.75	94.8

Time (hrs)	Q (cfs)
8	146
8.25	224.2
8.5	345.2
8.75	528
9	800.7
9.25	1176.3
9.5	1670.1
9.75	2301.6
10	3125.4
10.25	4225.1
10.5	5250.6
10.75	5998.4
11	6402.8
11.25	6512.5
11.5	6401.8
11.75	6137.3
12	5784.1
12.25	5397.1
12.5	5014.6
12.75	4658.9
13	4332.8
13.25	4038
13.5	3776.6
13.75	3546.8
14	3342.8
14.25	3161
14.5	2999.4
14.75	2856.4
15	2729.2
15.25	2616
15.5	2515.5
15.75	2427
16	2348.2

Time (hrs)	Q (cfs)
16.25	2277.1
16.5	2212.1
16.75	2151.8
17	2094.2
17.25	2038.1
17.5	1984
17.75	1933.1
18	1885.3
18.25	1840.4
18.5	1798.6
18.75	1759.7
19	1723
19.25	1687.7
19.5	1653.8
19.75	1621.3
20	1589.8
20.25	1559.4
20.5	1530.4
20.75	1503.3
21	1478.2
21.25	1454.7
21.5	1432.8
21.75	1412.6
22	1393.5
22.25	1375.1
22.5	1357.4
22.75	1340.3
23	1323.5
23.25	1304.8
23.5	1282.1
23.75	1253.5
24	1215.5
24.25	1165.4

Time (hrs)	Q (cfs)
24.5	1100.9
24.75	1019
25	917.4
25.25	799.9
25.5	676.7
25.75	558.1
26	451.4
26.25	360
26.5	284.6
26.75	224.8
27	178.2
27.25	141.6
27.5	112.7
27.75	89.8
28	71.5
28.25	56.9
28.5	45.3
28.75	36
29	28.6
29.25	22.7
29.5	18
29.75	14.2
30	11.2
30.25	8.7
30.5	6.7
30.75	5.2
31	3.9
31.25	2.9
31.5	2
31.75	1.2
32	0.7
32.25	0.3



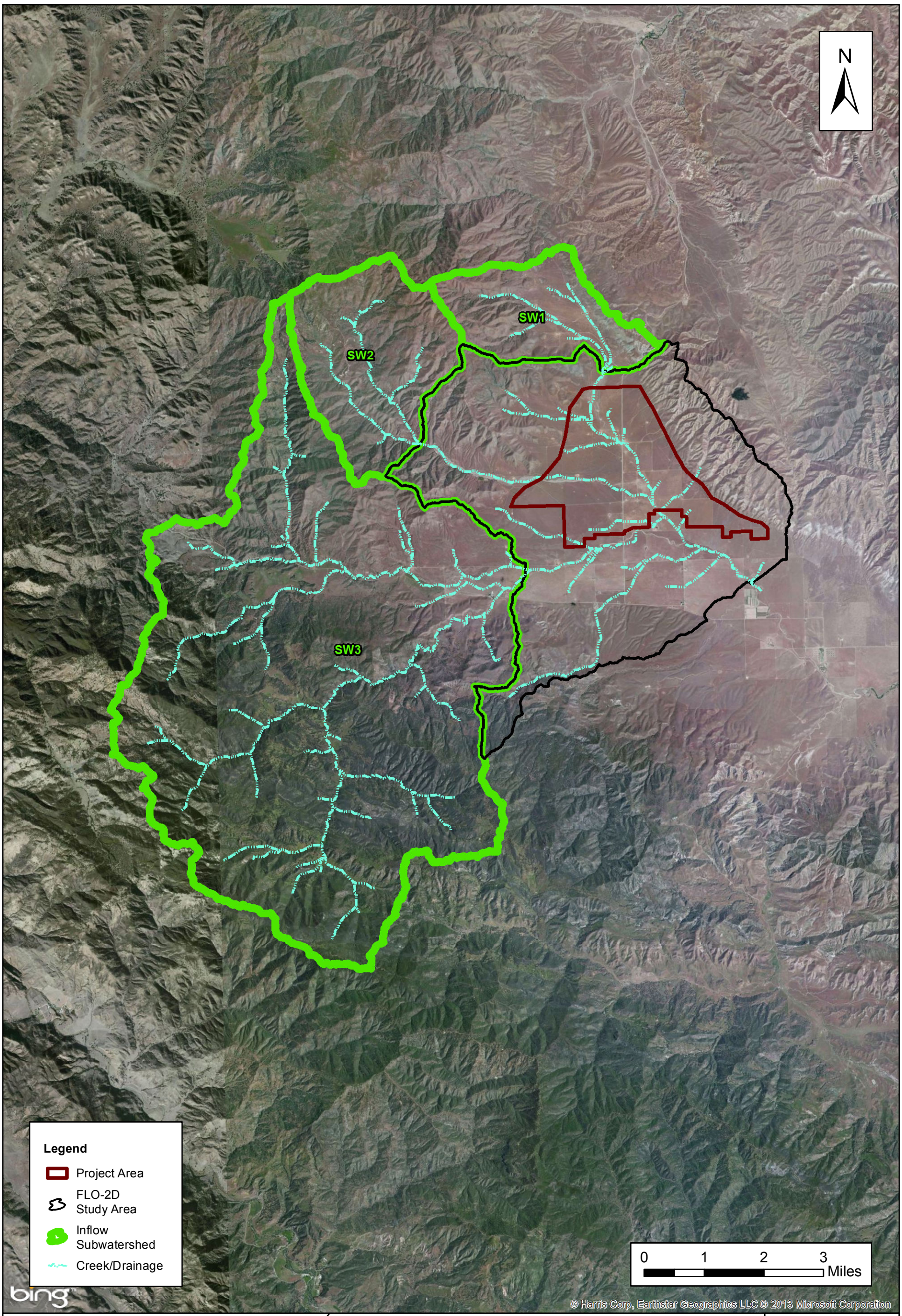
Energy Renewal PARTNERS, LLC

DFB
8/2/2013

Panoche Valley Solar Project

Regional Location

Figure 1



Energy Renewal PARTNERS, LLC

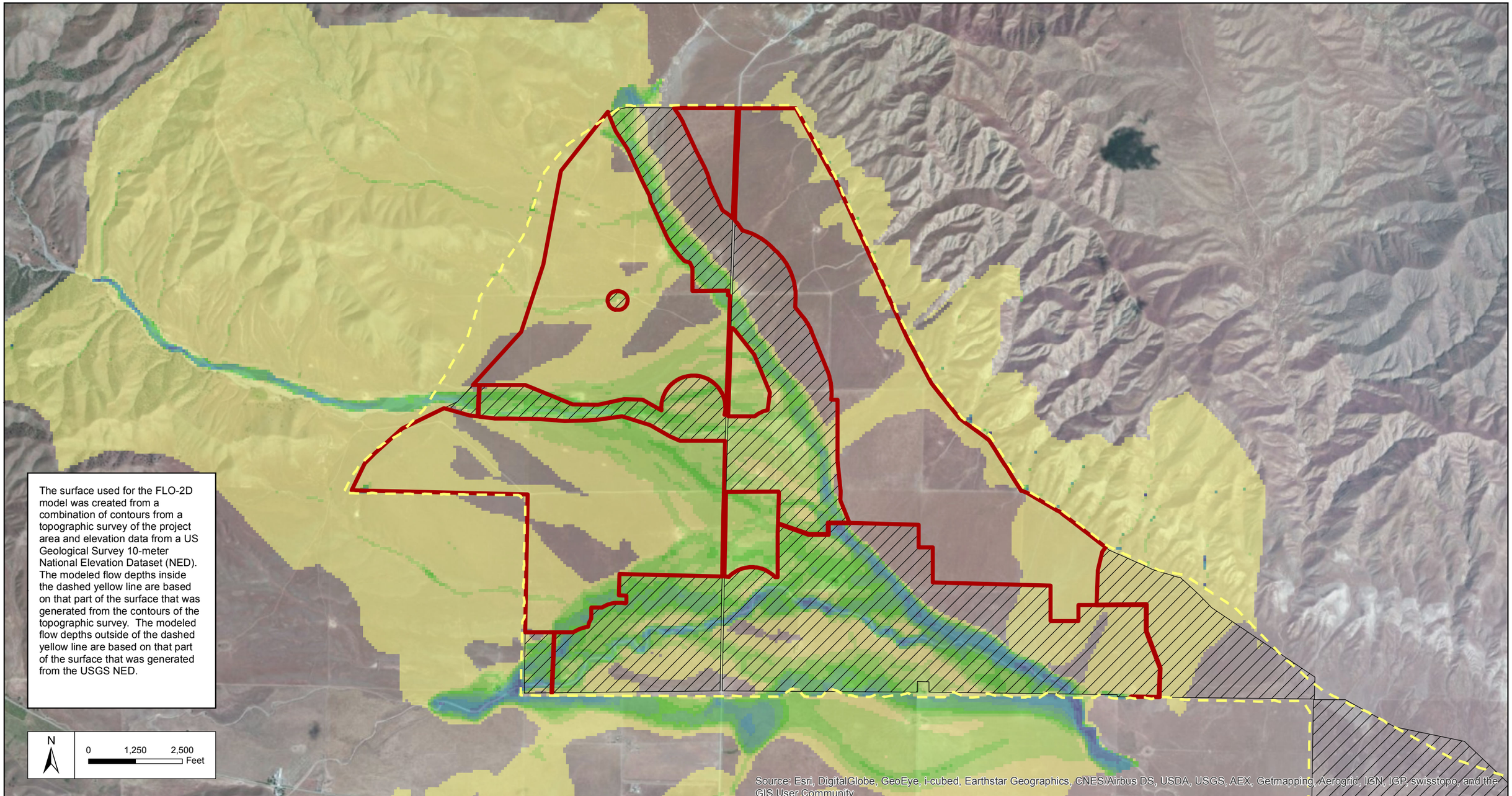
DFB
7/31/2013

Panoche Valley Solar Project

FLO-2D Study Area and Inflow Subwatersheds

* Watershed delineation and stream network generated by Global Mapper software utilizing USGS 10 meter DEM.

Figure 2



305 Camp Craft Road, Suite 575
West Lake Hills, Texas 78746
512-222-1125
www.energyrenewalpartners.com
Energy Renewal
PARTNERS, LLC

Legend

- Project Area
- Valley Floor Conservation Lands
- Extent of Topographic Survey

Modeled Flow Depth (feet)

0.10 - 0.25	1.01 - 1.50	4.01 - 6.00
0.26 - 0.50	1.51 - 2.00	> 6.00
0.51 - 0.75	2.01 - 3.00	
0.76 - 1.00	3.01 - 4.00	

Panoche Valley Solar Project

Maximum Flow Depth

100-year, 24-hour Rain Event

FIGURE

3

JH 2014-07-22

The surface used for the FLO-2D model was created from a combination of contours from a topographic survey of the project area and elevation data from a US Geological Survey 10-meter National Elevation Dataset (NED). The modeled flow velocities inside the dashed yellow line are based on that part of the surface that was generated from the contours of the topographic survey. The modeled flow velocities outside of the dashed yellow line are based on that part of the surface that was generated from the USGS NED.

N

0 1,250 2,500 Feet

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

305 Camp Craft Road, Suite 575
West Lake Hills, Texas 78746
512-222-1125
www.energyrenewalpartners.com

Energy Renewal PARTNERS, LLC

Legend

- Project Area
- Valley Floor Conservation Lands
- Extent of Topographic Survey

Modeled Flow Velocity (ft/s)

- 0.2 - 0.5
- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 4.0
- 4.1 - 6.0
- > 6.0

Panoche Valley Solar Project

Maximum Flow Velocity

100-year, 24-hour Rain Event

FIGURE

4

JH 2014-07-22