Preliminary Drainage Study

Sheep Creek Community Solar

San Bernardino County

CUP Application P201900158

Record ID: DRNSTY-2019-00020

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Executive Summary

This study addresses San Bernardino County's Land Development Division (LDD) request for a preliminary study prior to a Conditional Use Permit (CUP) approval. The study is conservative and is based on simplified assumptions with the understanding that a final study will be submitted as part of the conditions of approval for the proposed Sheep Creek Community Solar Development project).

The proposed site layout maintains the low flow of the main natural drainage course traversing the project site unoccupied and obstructed. The results of this preliminary study indicate that the proposed community solar field is subject to flooding as no grading is proposed and the project site is located in a floodplain. Critical infrastructure (e.g., substation) will be flood-protected from a 100-year storm event based on detailed calculations to be provided during final engineering phase.

Abbreviations

ac	**Acres**
cfs	Cubic Feet per Second
CUP	Conditional Use Permit
ft	Feet
fps	Feet per Second
GIS	Geographical Information Systems
LDD	Land Development Division
SCE	Southern California Edison
PV	PhotoVoltaic
USC&GS	United States Coast and Geodetic Survey
USGS	United States Geological Survey

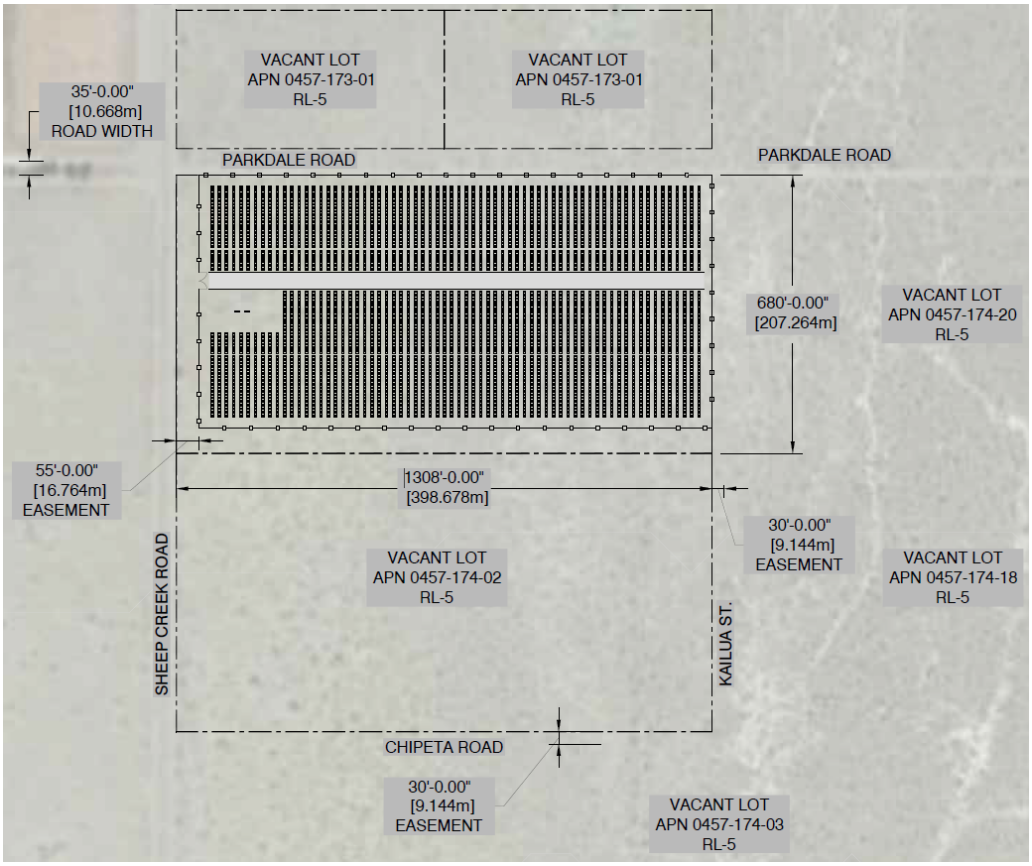
1.0 INTRODUCTION

Phelan Solar, LLC ("Applicant") submitted a Conditional Use Permit Application ("CUP") under project # P201900146 on March 5, 2019 with the San Bernardino County Planning Department ("Planning Department") for a community solar project on APNs 0457-174-01-0000 and 0457-174-02-0000 (the "project"). The project site is approximately 38.5 acres and is zoned Rural Living (RL-5).

The Sheep Creek Community Solar generating facility ("Sheep Creek Community Solar") is proposed to be built at 4301-4681 Parkdale Road at the southeast corner of Parkdale Road and Sheep Creek Road in Adelanto, California. The proposed project will have a capacity of 3 Megawatts (AC) and will be connected to the distribution grid of Southern California Edison ("SCE"), not SCE's transmission grid. The electricity generated by this small-scale solar photovoltaic (PV) generating facility will ultimately be purchased by residential, agricultural, and commercial off takers under SCE's Green Tariff Shared Renewables program (GTSR Tariff).

Sheep Creek Community Solar has been approved as a community solar project by SCE under SCE's GTSR Tariff program ("Community Solar Program"). SCE's Community Solar Program is the result of Senate Bill 43, which allows participating utility customers to meet up to 100 percent of their energy usage from local renewable energy resources. Under the SCE Community Solar Program, SCE customers are allowed to subscribe up to 100% of their energy need from a local renewable energy project and receive bill credits from SCE based on their energy subscription directly from the local renewable energy project.

This Preliminary Drainage Study was requested by San Bernardino County's Land Development Division (LDD) via Interoffice Memo dated July 15, 2019. The site is located in an undetermined flood hazard area (FEMA Zone D). Please see attached Sheep Creek Community Solar Conceptual Site Plan for further details.



2.0 HYDROLOGY

The proposed project site is located within the City of Adelanto in the high desert region of San Bernardino County and is on the southwest end of the expansive Mojave Desert. The City of Adelanto adopted a Drainage Master Plan Update prepared by So & Associates Engineers, Inc. in May of 2012. The project site is located to the west of the study watershed limits and is not a part of the latest City's Master Plan update. Mapping and topography were developed from 2,000 scale (7.5 minute) USC&GS quadrangle maps of the entire tributary area to the project site.

This Preliminary Drainage Study utilizes preliminary Geographical Information System (GIS) level site topography along with a conceptual site layout as the basis of design. The project site is not impacted by United States Geological Survey (USGS) mapped blue line streams. Our initial research indicates that the project site is located in an undefined floodplain with an extensive tributary area. Based on our experience in this area, this preliminary study is general in nature and presents a conservative analysis based on simplifying assumptions to estimate the level of site flooding (at a high-level order of magnitude). Since no on-site grading is proposed, the proposed development will not increase the pre-development runoff flowrate.

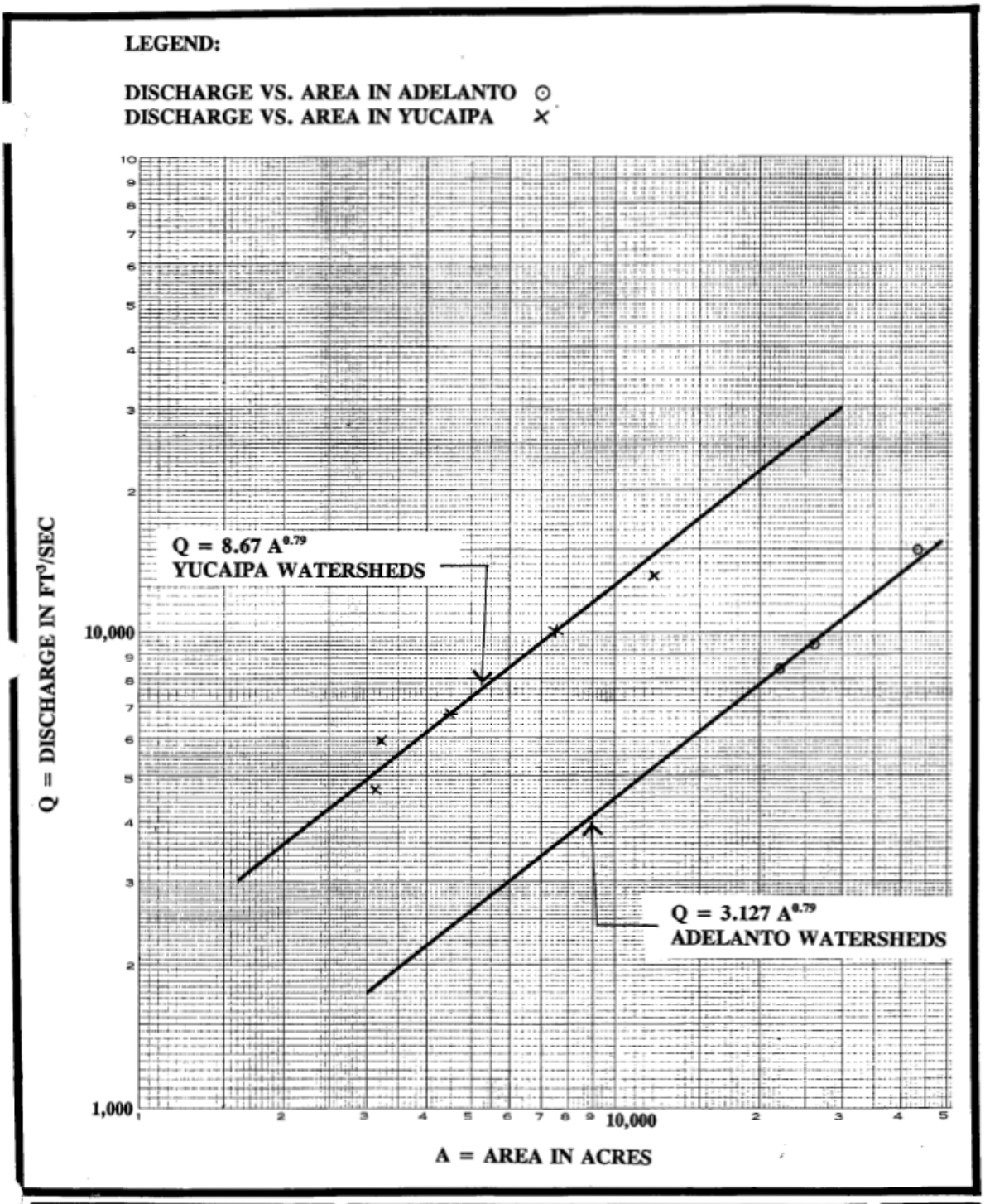
The preliminary hydrological design flow rate is based on a figure included in the Master Plan of Drainage prepared by Rivertech Inc. in November of 1992. The figure, titled "Figure 2" as shown on the next page, depicts a graph of the area/runoff curves for the Adelanto and Yucaipa Watersheds. The figure includes both a logarithmic graph as well as an equation to correlate the design flow (in cubic feet per second) given a watershed size (in Acres). The provided formula is $Q = 3.127\ A^{0.79}$.

Based on a preliminary delineation of the existing tributary area to the project's southern boundary, the off-site tributary area is 3,400 acres (see Appendix A). Consequently, the preliminary non-bulked design flow rate tributary to the site, and including the project site, is determined as follows:

$Q = 3.127\ A^{0.79} = 3.127\ (3400)^{0.79} = 1928\ \text{cfs} \approx 2000\ \text{cfs}$

In a similar manner, the flowrate for the larger watershed that generally follows the County delineated master planned hydrology boundary, which generally follows the offsite USGS blue line stream is determined as follows:

$Q = 3.127\ A^{0.79} = 3.127\ (9917)^{0.79} = 4490\ \text{cfs} \approx 4500\ \text{cfs}$



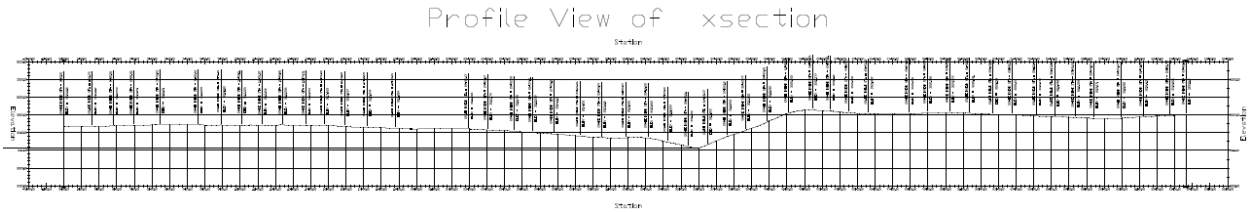
RIVERTECH INC

COMPARISON OF NON-BULKED DISCHARGES AT WATERSHEDS OF ADELANTO AND YUCAIPA

FIGURE 2

3.0 HYDRAULICS

A preliminary analysis of the depth of flow for the off-site runoff over the site has been estimated using normal depth calculations based on the estimated design flowrate and a cross-section of the site perpendicular to the existing natural drainage course, as follows:



Note: The above cross-section was obtained at the project's southerly boundary along the northern boundary of APN 0457-174-02.

Using simplified normal depth calculations, the estimated depth of flow resulting from 2,000 cfs over a 1% site slope is approximately 1 ft with a velocity of approximately 3 fps. This ponding depth result is obtained with the assumption that the tributary flows are contained within the project site and that the neighboring eastern and western properties are also flooded to the same depth at the adjoining boundaries. Due to the relatively "flat" site, the floodplain resulting from the 2,000 cfs flowrate will not be contained within the area tributary to the site and will "spill" over to the blueline stream of the larger master planned boundary.

Utilizing the larger County delineated master plan boundary (adjusted per this study based on aerial photos), the estimated depth of flow at the blueline stream (off-site) resulting from 4,500 cfs is approximately 3.2-ft with a velocity of approximately 5 fps. For the cross-section used in this analysis (shown above based on a projection at the middle of project site), the depth of flow is at elevation 3,014 while the site is at elevation 3017. Therefore, the project site is approximately 3-ft above the water level at the main drainage course (blueline stream located near the airport).

Therefore, the estimated flow depth over the project site is anticipated to be less than 1-ft with velocities less than 3 fps.

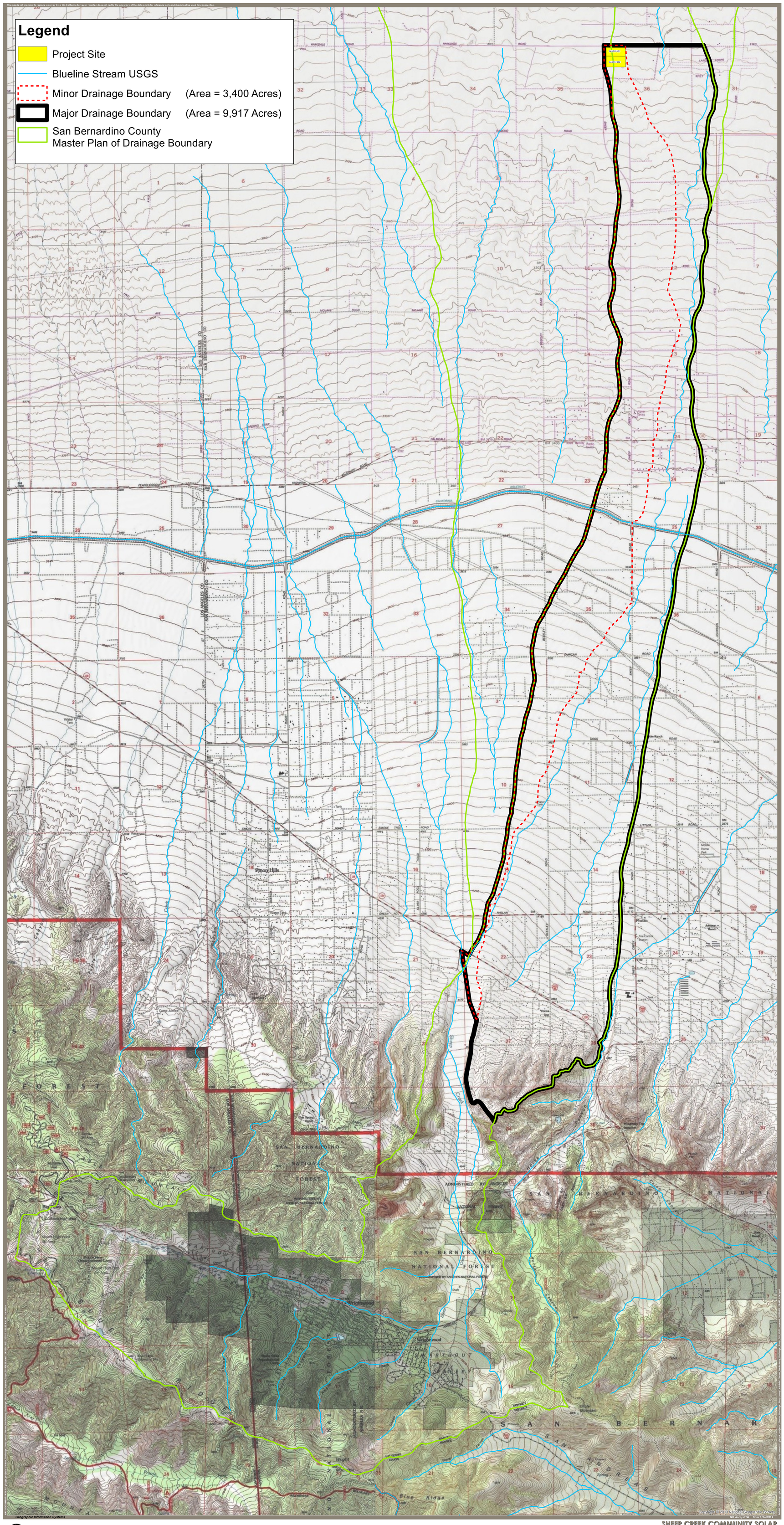
The foundation of the single axis trackers will be designed to withstand the flow velocities without excessive scour and the modules will be adjusted so that the lowest points are above the flow depth. Critical facilities, such as substation, will be designed so that the pad is at least 1-ft above the floodplain, as refined by a final hydrology study to be prepared during final engineering efforts.

The type, location and size of the drainage facilities proposed in this study are preliminary. Precise facilities design will be determined during the final project engineering and design phase. This task does not include the analysis of existing downstream facilities (capacity and/or determination of adequacy of those facilities).

The hydraulic calculations are shown in Appendix B.

APPENDIX A

Off-site Hydrology Key Maps



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0 1,000 2,000 4,000 Feet
1 inch = 2,000 feet

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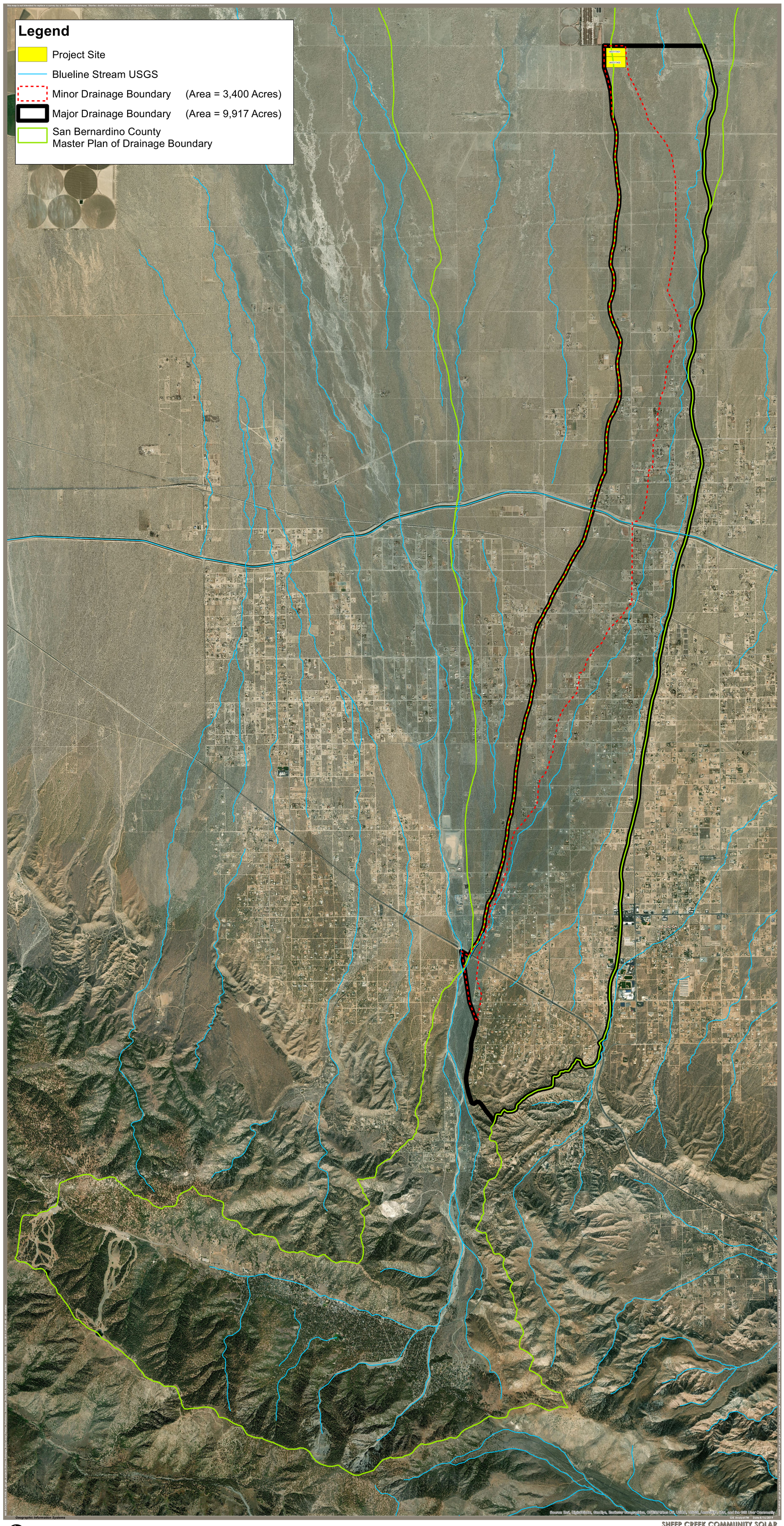
SHEEP CREEK COMMUNITY SOLAR
PHELAN SOLAR, LLC CUP #P201900146
Preliminary Drainage Study



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0 1,000 2,000 4,000 Feet
1 inch = 2,000 feet

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SHEEP CREEK COMMUNITY SOLAR
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APPENDIX B

Hydraulic Calculations

Sheep Creek Community Solar Local Site Boundary

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Discharge	2000.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	18.00
0+01	16.60
5+46	17.20
7+62	17.20
10+09	17.00
11+26	17.00
12+41	17.20
13+14	17.00
13+15	18.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 18.00)	(13+15, 18.00)	0.035

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.97	ft
Elevation Range	16.60 to 18.00 ft	
Flow Area	710.34	ft²
Wetted Perimeter	1314.99	ft

Sheep Creek Community Solar Local Site Boundary

Results

Hydraulic Radius		0.54	ft
Top Width		1314.25	ft
Normal Depth		0.97	ft
Critical Depth		0.84	ft
Critical Slope		0.02392	ft/ft
Velocity		2.82	ft/s
Velocity Head		0.12	ft
Specific Energy		1.09	ft
Froude Number		0.68	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.97	ft
Critical Depth	0.84	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.02392	ft/ft

Cross Section for Local Site Boundary Section

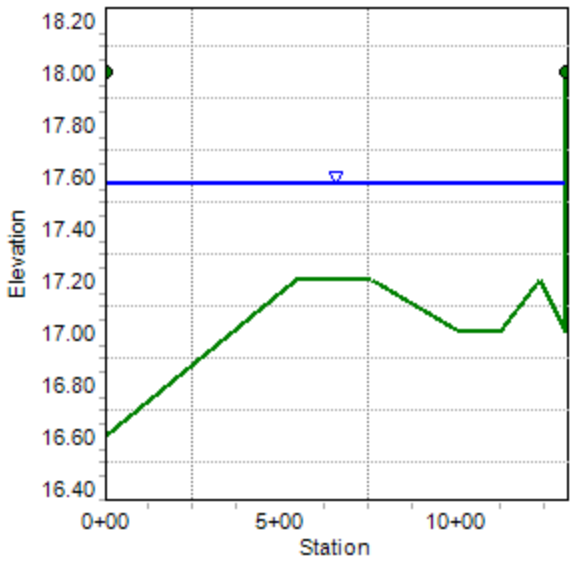
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Normal Depth	0.97	ft
Discharge	2000.00	ft³/s

Cross Section Image



Sheep Creek Community Solar Master Drainage Plan Boundary

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Discharge	4500.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	18.00
0+01	16.60
5+46	17.20
7+62	17.20
10+09	17.00
11+26	17.00
12+41	17.20
13+74	16.90
14+76	17.10
15+92	16.70
17+18	16.50
18+79	16.30
22+96	16.10
24+04	15.80
25+52	15.40
26+58	15.10
27+79	14.60
30+50	13.60
31+86	13.60
33+15	13.50
34+23	12.30
35+43	11.00
35+80	10.80
36+48	11.60
39+87	18.00

Roughness Segment Definitions

Sheep Creek Community Solar Master Drainage Plan Boundary

Input Data

Start Station	Ending Station	Roughness Coefficient
(0+00, 18.00)	(39+87, 18.00)	0.035

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth		3.16	ft
Elevation Range	10.80 to 18.00 ft		
Flow Area		956.16	ft²
Wetted Perimeter		819.29	ft
Hydraulic Radius		1.17	ft
Top Width		819.25	ft
Normal Depth		3.16	ft
Critical Depth		2.93	ft
Critical Slope		0.01760	ft/ft
Velocity		4.71	ft/s
Velocity Head		0.34	ft
Specific Energy		3.50	ft
Froude Number		0.77	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.16	ft

Sheep Creek Community Solar Master Drainage Plan Boundary

GVF Output Data

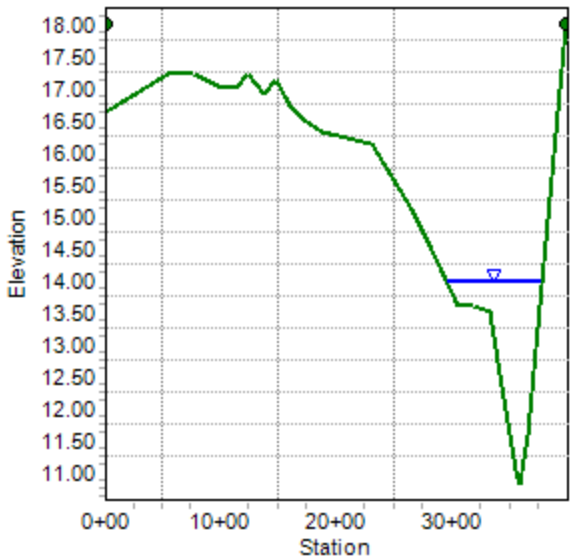
Critical Depth	2.93	ft
Channel Slope	0.01000	ft/ft
Critical Slope	0.01760	ft/ft

Cross Section for Master Plan Boundary Section

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Normal Depth	3.16	ft
Discharge	4500.00	ft³/s

Cross Section Image