Appendix H
Water Resources

ORD MOUNTAIN SOLAR AND ENERGY STORAGE PROJECT
ENVIRONMENTAL IMPACT REPORT

Hydrology and Hydraulics Report

HYDROLOGY AND HYDRAULICS REPORT

ORD MOUNTAIN SOLAR PROJECT
SAN BERNARDINO COUNTY, CALIFORNIA

prepared for

NextEra Energy, Inc.
700 Universe Blvd
Juno Beach, FL 33408-0420

Prepared By:

3801 Doris Lane
Round Rock, TX 78664

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February 2, 2018

RRC Project No. MD1603013

experience matters

February 2, 2018

Mr. Donald Hill
NextEra Energy, Inc.
700 Universe Boulevard
Juno Beach, FL 33408-0420

Re: Hydrology and Hydraulics Report
Ord Mountain Solar Project
San Bernardino County, California
RRC Project No. MD1603013

Dear Mr. Hill,

RRC Power & Energy, LLC (RRC) has completed the authorized Hydrology and Hydraulic study for the proposed Ord Mountain Solar Project. The purpose of this study was to analyze existing hydrology and hydraulic conditions at the proposed Ord Mountain Solar Project site and describe any potential development concerns based on the analysis.

The attached report contains a description of our analysis, our engineering interpretation of the results and recommendations for the planned project.

We appreciate the opportunity to be of service to NextEra Energy, Inc. Please call us if you have any questions concerning this report or any of our services.

Respectfully submitted,

RRC

Lenwood S. Adams, P.E. (TX), CFM
Civil Group Manager

SECTION 1: PROJECT DESCRIPTION AND LOCATION

RRC has completed a hydrology and hydraulic study to support the proposed development of a solar farm to be located east of Barstow Road (Highway 247), north of Lucerne Valley in San Bernardino County, California. Because the site is contained within the large Lucerne Valley watershed, an evaluation of the potential offsite storm water flow through the site is essential in the ultimate site design. This report was prepared in accordance with the San Bernardino County Hydrology Manual and the County of San Bernardino Hydrology Manual Addendum for Arid Regions.

1.1 Project Site Information

The proposed project site is bounded by No End Rd to the north, Meridian Rd to the east, Haynes Rd to the south and Fern Rd to the west. The proposed project site is located in the Southern Mojave Watershed (Reference 1). The approximate site location is shown on Figure 1, Site Vicinity Map, within Appendix A.

The proposed project site will encompass an area of approximately 483.3 acres. Currently the site is fallow agricultural land, consisting primarily of desert land with scattered abandoned structures and a transmission line. The land is generally flat with a uniform slope from northwest to southeast with an approximate grade of about 0.7%.

SECTION 2: WATERSHED CHARACTERISTICS

The potential off-site contributing watershed area to the proposed project site is approximately 16,897.5 acres with varying topography and soil conditions. To facilitate the evaluation of the watershed, it was sub-divided into 37 contributing sub-drainage areas with the West boundary being Barstow Road. In addition, watercourse centerlines were obtained from the United States Geologic Survey's National Hydrography Dataset (NHD) and can be seen in Figure 4, within Appendix A. NHD watercourse centerlines do not cross Barstow Road from the north or the west. Consequently, runoff from the north and west of Barstow was not considered in the analysis model. A drainage area map is provided in Figure 2, within Appendix A. The sub-drainage areas were based on topographic data and various reaches that contribute to the overall watershed. The sub-drainage names and areas are shown in Table B.2 within Appendix B.

2.1 Existing Topography

The northern portion of the watershed generally has steep, mountainous characteristics although soils data from NRCS and aerials indicate that the mountainous areas have a layer of soil at least 2" deep. The drainage area transitions to foothill relief and finally a relatively low slope desert landscape with sandy soils. In the past, as fast-flowing streams formed during large storm events encountered this abrupt change in topography, water velocities quickly decreased, releasing sediment and formed alluvial fans. Several alluvial

fans can be seen within the contributing drainage area, including one to the northeast of the project site that may have extended into the project site prior to extensive land disturbance. This can be seen in Figure 3, within Appendix A.

For this report the numerous sub-basins were divided into three regions. The top of the watershed sub-drainage areas E1-E15, E17-E20, F1-F12, G1 & G2 are generally mountainous with low infiltration rates. The mountainous regions transition to foothill regions, which are modeled as moderate infiltration sub-drainage areas. The lower portion of the watershed is modeled as sub-drainage areas F and G to reflect their unique topography of shallow slopes and higher infiltration rates.

2.2 Existing Soil Conditions

Existing soil conditions vary with the topography. NRCS has no information for soils in the Northeast of the study area but from general inspection reflect characteristics that of the surrounding soils. The upper portion of the watershed generally consists of shallow soils over a restrictive feature presumably rock and slopes ranging from 15 to 50%. The foothills consist of loamy sands and sandy loams with slopes ranging from 2 to 15%. The lower portions of the watershed consist primarily of Cajon-Arizo Complex, Loamy Sand and Sandy Loam cover with slopes ranging from 0 to 2%.

Soil conditions within proposed project the site primarily consist of loamy sand, sandy loam and Cajon sand.

The sandy soil conditions and lower percent slopes in the foothills and desert basin provides for high infiltration of storm water runoff. Table B.1 within Appendix B summarizes the infiltration rates and percentages of watershed coverage for each soil type. It can be seen from the table that sand and loam with high infiltration rates covers a significant portion of the contributing drainage area. On more than 90% of the site, the soil depth of restrictive features is at least 8 inches.

SECTION 3: HYDROLOGY

Hydrology on the site was modeled using HEC-HMS 4.2.1 model, a flood routing hydrologic and hydraulic model used to evaluate complex systems, as well as FLO-2D, a 2D hydrological-hydraulic dynamic flood model.

The hydrology characteristics were analyzed for the project site and potential contributing drainage area to the project site.

3.1 Precipitation

The site is located in the southern desert region as described by Caltrans Highway Design Manual (Reference 3). Since the area is greater than 100 mi^2, a Type II 24-hour storm distribution obtained from the NOAA Atlas 14 (Reference 5) was chosen for all models. The cumulative 100-year storm event rainfall was assumed to be uniform across the contributing drainage area for analysis and has a depth of 3.45 inches.

3.2 Modeling Hydrology With HEC-HMS

The project's HEC-HMS model was based on standard NRCS methods and compared to the U.S. Geological Services (USGS) regression equations for peak discharges. Hydrologic input to the model included the site terrain, infiltration rates, impervious cover, and precipitation.

3.2.1 Time of Concentration

Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed (Reference 4). The time of concentration has a significant impact on peak flow estimates. A shorter time of concentration results in a higher peak flow estimate than a longer time of concentration.

Time of concentration is the summation of the flow segments, Sheet Flow (T_{sheet}), Shallow Concentrated Flow ($T_{shallow}$) and Open Channel Flow ($T_{channel}$). The Time of Concentration calculation method is shown in Appendix C, Equations 1 – 6. Calculations for all sub-drainage areas are given in Tables C.3, within Appendix C.

The lag time (T_{lag}) is defined as the time from the centroid of precipitation excess to the time of peak of the unit hydrograph (Reference 3). For ungauged watersheds, T_{lag} is defined with Equation 7, within Appendix C.

The time of concentration and lag time for each sub-drainage area are shown in Table B.2 within Appendix B.

3.2.2 Velocity

The contributing drainage area topography leads to high variation in runoff water velocity. The upper portion of the drainage area tend to have high velocities due to the steep slopes, and the lower portions of the drainage area tend to have low velocities due to the shallow slopes. The minimum velocity was determined to be 1.10 ft/s and the maximum velocity was determined to be 5.93 ft/s. The velocities were determined using Equation 4 within Appendix C, and the results and soil characteristics are summarized in Table B.2, within Appendix B.

3.2.3 Soil Infiltration

The infiltration rate generally is very low for the rocky areas with infiltration rates essentially 0.2 in/hr. The infiltration rate for the Cajon Sand and Cajon-Arizo Complex is high with infiltration rates ranging from 5.95 in/hr to 19.98 in/hr. Soils with a high infiltration rate tend to cause a loss in flow as the water infiltrates the soil. The infiltration values used in the model were at most half of the values specified by NRCS soil data, making the HEC-HMS model quite conservative and causing it to predict a much greater flow than should be expected (i.e. for Cajon-Arizo soil an infiltration rate of 6 in/hr was used). This can be seen in Table B.2 within Appendix B.

3.2.4 Model Description

The HEC-HMS model took into account time of concentration, infiltration rates, depth available for water infiltration and area of sub-basin. Based on NRCS soil data of the area, infiltration values were derived and can be seen in Table B.2, within Appendix B. The infiltration rates chosen for the model were the minimums given in the range of values according to the NRCS soil data. Infiltration depths in the model were at most half of the maximum depth given from the NRCS soil data. Infiltration was calculated using the deficit and constant loss method. Flows in the model were assumed to be mostly channelized, so a Manning's roughness coefficient of 0.035 was selected based on an equation that accounts for channel type, roughness uniformity, vegetation, rock outcroppings, and meanders. (Reference 6)

The hydrology and hydraulics of the HEC-HMS model are calculated on an element by element basis. Each sub-drainage drainage area was measured and input along with time of concentration and other parameters. The inflows were spread out along the domain boundary at several input points to meet model requirements and better match existing conditions. These elements were then chained together to complete the model and run the simulation. The 100-year (1%) storm was assumed to occur uniformly across the entire site in order to provide the most conservative results.

3.3 Modeling Hydrology With FLO-2D

To further study the site, it was necessary to develop a two-dimensional hydrologic/hydraulic model of the site's existing conditions in FLO-2D. The FLO-2D model used a grid size of 100 feet over the same study area as the HEC-HMS model. Infiltration rates were calculated within FLO-2D using SCS curve numbers modified by the antecedent moisture condition per the San Bernardino County Hydrology Manual and the County of San Bernardino Addendum and its Arid Regions Antecedent Moisture Condition Map.(References 7 and 8) . The alluvial fans present in the site's drainage basin cause

channelized flows to spread out into overland sheet flows, so flows in the model were assumed to be an even mixture of channelized flows and overland sheet flows. The Manning's roughness coefficient used in the model was a uniform 0.04, which is a conservative middle ground between the low roughness coefficients associated with channelized flows and the high roughness coefficients associated with overland sheet flow. In addition, the California Department of Transportation Highway Design Manual was referenced in determining this value. (Reference 3)

SECTION 4: SITE DEVELOPMENT

A normal consideration with most development is the potential increase in runoff rates and its potential impact on down gradient properties. The site grades from north to south on the upper section and from north to south and southeast in the lower section of the property.

4.1 HEC-HMS Model

Two scenarios were investigated on the proposed project site using the HEC-HMS model. The first scenario looked at the potential runoff generated from off-site flow and existing site conditions, the second scenario determined potential runoff increase using the approximate amount of impervious cover created from the proposed project.

The existing site conditions scenario determined that any runoff generated from precipitation falling over the site does not leave the site due to the high soil infiltration rate.

The proposed project construction of solar panels with associated inverters and substation will add a very small amount of impervious cover. The solar panels will be supported by small driven piles with a few square inches of impervious cover. The inverter pads will create a negligible amount of impervious cover. No impervious cover is added by the solar panels as they are off the ground and rainfall falling directly on the panels will shed directly on the ground below.

The second HEC-HMS model scenario was run to evaluate the impact, if any, on the site development using the percentage of impervious cover created by the inverter pad, ,solar panel pile foundations, battery storage building, and substation totaling 77,229 square feet or 0.37% cover over the site. The model indicated that again the precipitation falling on the developed project will not result in having any offsite flow but the precipitation will be absorbed quickly into the subsurface. The HEC-HMS model was run with 1% impervious cover to provide a factor of safety of roughly 2.7 and the results indicated that there was no offsite storm water flow nor any flow that will exit the site.

4.2 FLO-2D Model

The two-dimensional FLO-2D model predicted that off-site runoff would enter the site from the north during a 100-year, 24-hour storm. Infiltration in this model was based on SCS curve numbers modified by antecedent moisture per the San Bernardino County Hydrology Manual. The model estimated a maximum of 0.8 feet of water travelling at up to 1.65 ft/s would enter the site from the north northeast during a 100-year, 24-hour storm. Little of the project site will become impervious following construction, so it can be assumed that post-construction flows will be very similar, essentially negligible. According to the model, the substation and battery storage building are not in the path of off-site flows. These structures are located in the southwest corner of the site. Figures 5 through 8 in Appendix D show the predicted flow velocities and depths across the project site and watershed.

SECTION 5: DEVELOPMENT CONSIDERATIONS

This report evaluated the potential off-site storm water that might impact the proposed project site. The large watershed area contributing to the site, surrounding topography and existing soil conditions were considered in determining potential flow behavior which could potentially have a negative impact on development.

This study used two methods to predict storm water flows, both of which modeled a 100-year, 24-hour storm on the site with rainfall distributed in a SCS Type II curve and a total depth of 3.45 inches. HEC-HMS models were developed for pre-construction and post-construction conditions. Infiltration in these models was calculated using the deficit and constant loss method in conjunction with infiltration rates and impervious cover percentages. They predicted that no off-site water would reach the proposed project site during the storm event despite using very conservative infiltration rates and impervious cover percentages.

A FLO-2D model of the site's hydrology was created. Infiltration was calculated in this model using SCS curve numbers modified by antecedent moisture conditions per the San Bernardino County Hydrology Manual. Unlike the HEC-HMS models, it predicted offsite flows would enter the site, though flows would be of minimal velocities that would limit scour and not impact the design or functionality of the proposed project development. Compared with the upstream flow velocity maximum of 12.3 ft/s, flow velocities through the site were very low (maximum 1.65 ft/s). Solar panels and inverter pads are typically 18 inches above ground or designed to be at least 1 foot above flood elevations. Other electrical equipment will be designed to be at least 1 foot above flood elevations. Consequently, the flows predicted in the FLO-2D model would pose no hazard to them. Storm water flows do not enter the southwestern area of the site near the substation and battery storage building. Lastly, the project site adds such a small amount of impervious cover that it will not increase downstream flows.

SECTION 6: REFERENCES

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4. NRCS, Urban Hydrology for Small Watersheds, United States Department of Agriculture, Technical Release 55, June 1986, http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf.
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6. Arcement G.J. Jr., Schneider, V.R., Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains, United States Geological Survey Water-supply Paper 2339, Federal Highway Administration (FHWA), http://www.fhwa.dot.gov/bridge/wsp2339.pdf.
7. Hromadka, T.V. San Bernardino County Hydrology Manual, San Bernardino County Department of Public Works, August 1986, http://cms.sbcounty.gov/Portals/50/floodcontrol/HydrologyManual.pdf.
8. County of San Bernardino Hydrology Manual Addendum for Arid Regions, San Bernardino County Department of Public Works, April 2010, http://cms.sbcounty.gov/Portals/50/floodcontrol/20100412_addendum.pdf.

Appendix A

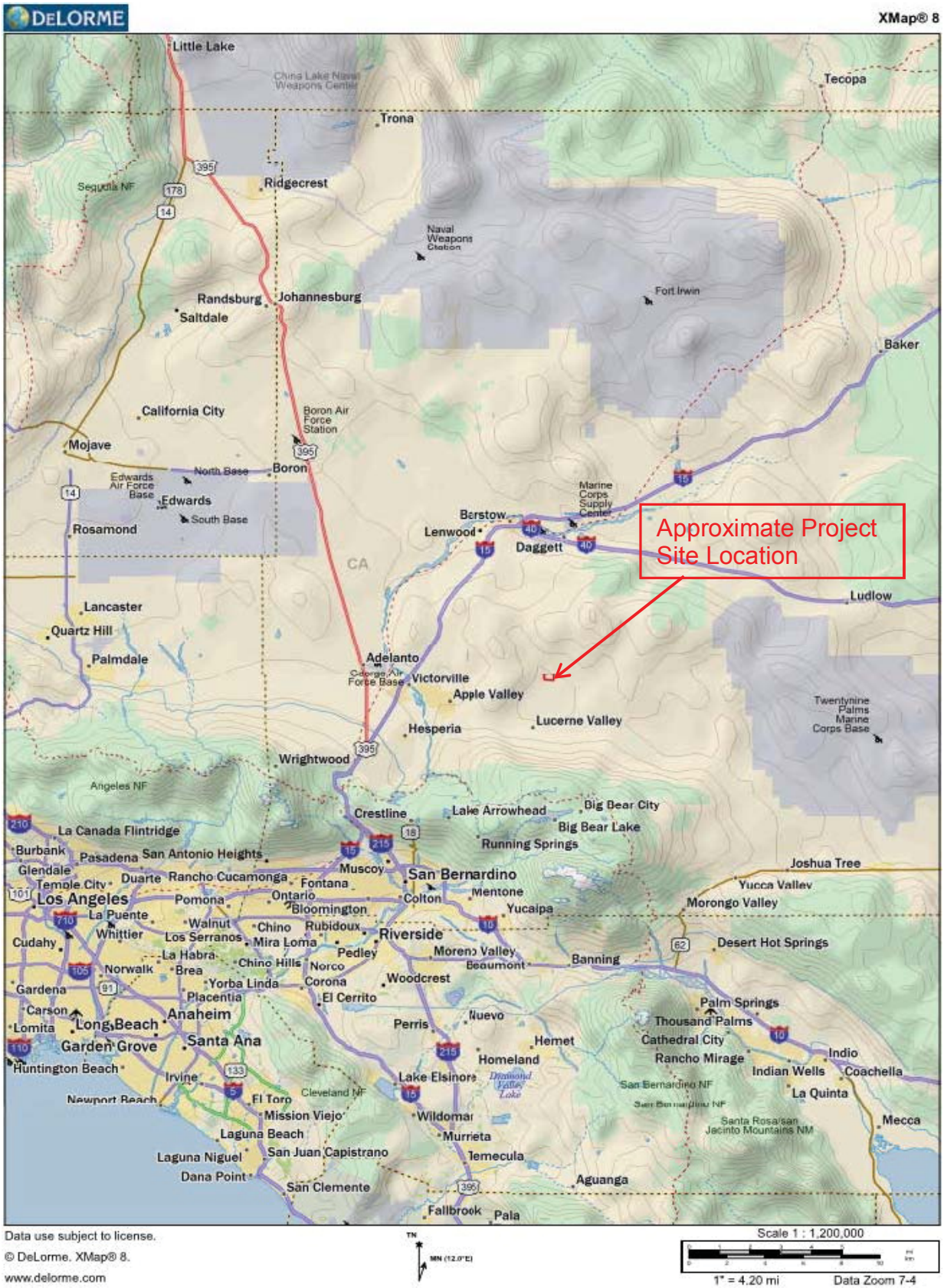
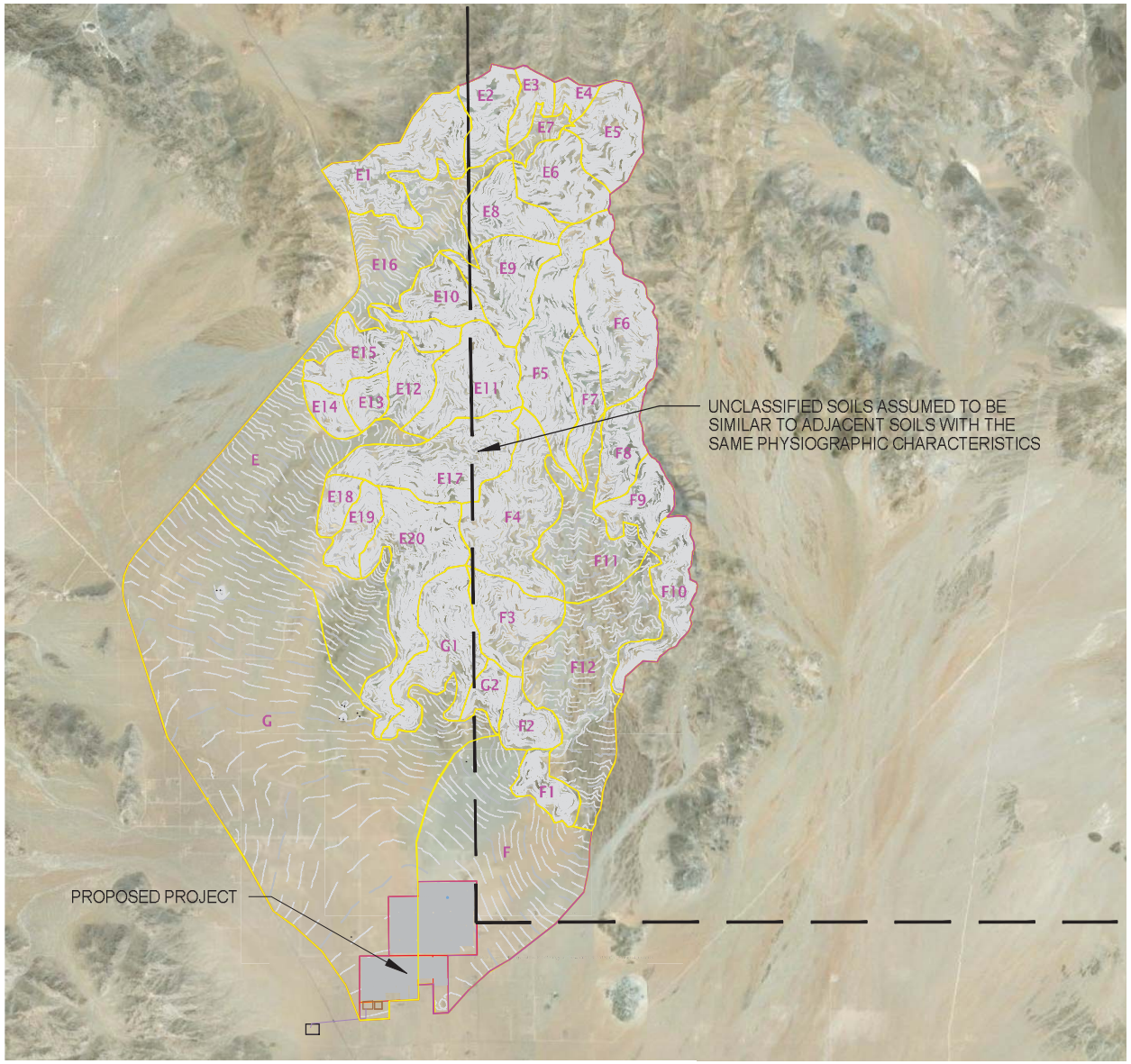
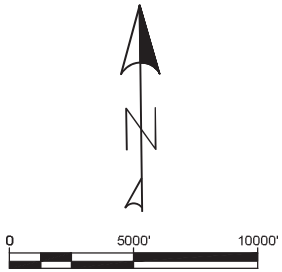


Figure 1: Site Vicinity Map





LEGEND

- DRAINGE AREA SUB BASIN
- SITE BOUNDARY
- EXISTING CONTOURS
- UNCLASSIFIED SOIL BOUNDARY

RRC

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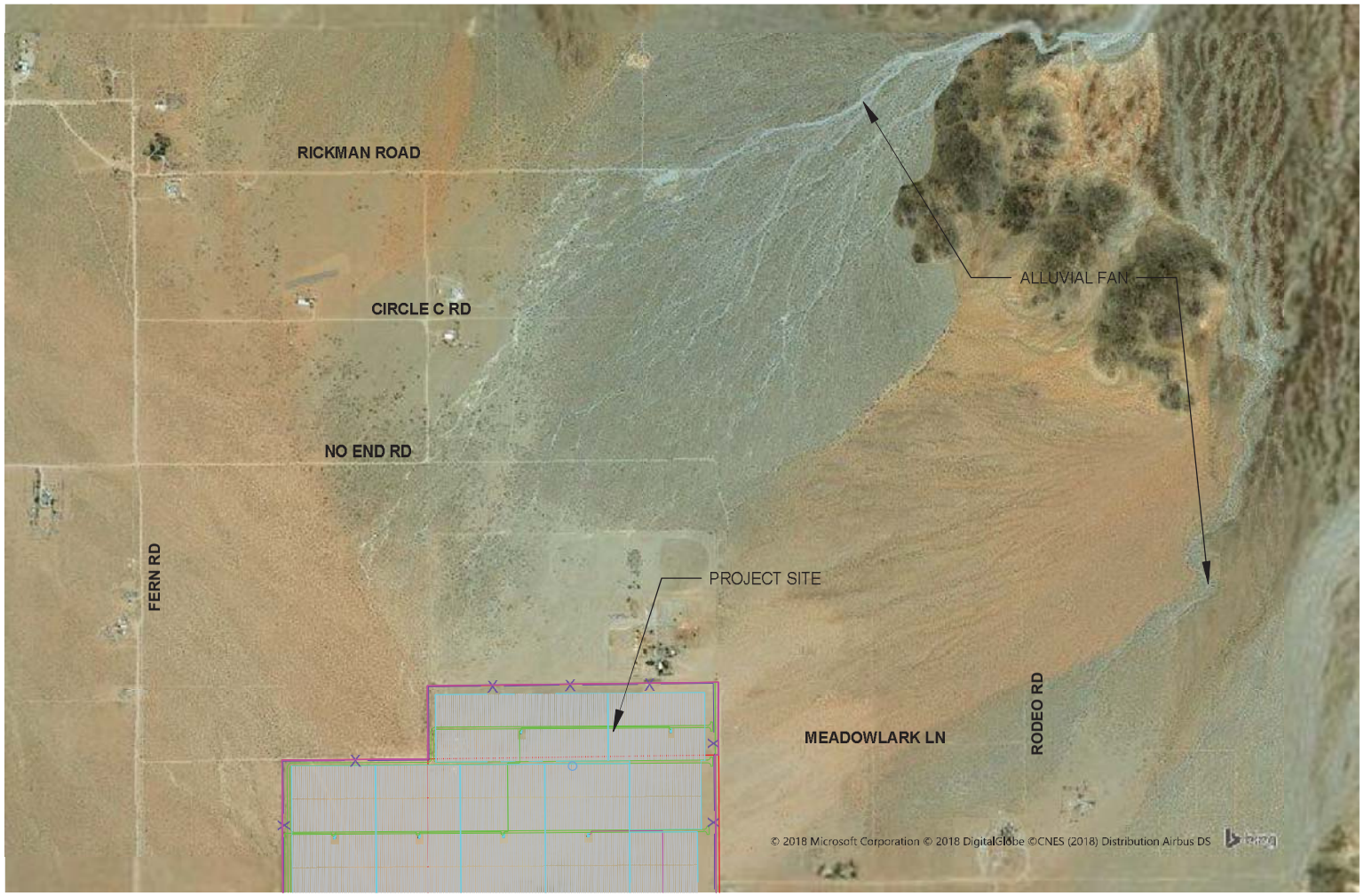
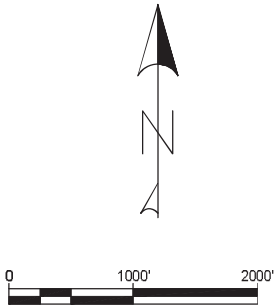
Ord Mountain Solar Project
Lucerne Valley, California

Drawn By: TWB	01/24/2018

Figure 2: Drainage Area Map





RRC

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Ord Mountain Solar Project
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Drawn By: TWB	01/24/2018

FIGURE 3: ALLUVIAL FANS NEAR PROJECT SITE

Figure 4: National Hydrography Dataset Watercourses Near Project Site

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Ord Mountain Solar Project
Lucerne Valley, California

Drawn By: TWB	01/24/2018

Appendix B

Table B.1. Soil Type Summary

ID	Map Unit Name	Acres in AOI	Percent of AOI	Infiltration Rate (in/hr)	Depth to Restrictive Feature (in)	Percent Impervious
112	CAJON SAND, 0 TO 2 PERCENT SLOPES	658.8	3.9%	5.95 - 19.95	>80	0
113	CAJON SAND, 2 TO 9 PERCENT SLOPES	67.6	0.4%	5.95 - 19.98	>80	0
118	CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*	4222.8	25.0%	5.95 - 19.98	>80	0
131	HELENDALE LOAMY SAND, 0 TO 2 PERCENT SLOPES	625.0	3.7%	2.10 - 6.37	>80	0
132	HELENDALE LOAMY SAND, 2 TO 5 PERCENT SLOPES	202.7	1.2%	2.18 – 6.65	>80	0
133	HELENDALE-BRYMAN LOAMY SANDS, 2 TO 5 PERCENT SLOPES*	270.3	1.6%	1.49 – 4.56	>80	0
148	MIRAGE SANDY LOAM, 2 TO 5 PERCENT SLOPES*	810.8	4.8%	0.2 - 0.57	>80	0
158	ROCK OUTCROP-LITHIC TORRIORTHENTS COMPLEX, 15 TO 50 PERCENT SLOPES*	844.6	5.0%	5.01 – 16.74	9 - 20	63
162	SPARKHULE-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES*	2195.8	13.0%	0.2 - 0.57	14 – 20	35
165	TRIGGER-SPARKHULE-ROCK OUTCROP ASSOCIATION, STEEP*	6.4	0.0%	1.22 – 3.64	11.7 - 18.9	30
173	WASCO SANDY LOAM, COOL, 0 TO 2 PERCENT SLOPES	16.9	0.1%	1.98 - 5.95	>80	0
Subtotals for Soil Survey Area		**9915.1**	**58.7%**			
Totals for Area of Interest		**16897.5**	**100.0%**			

Table B.2. Drainage Area Properties

Sub-Drainage Area Name	TOC (min)	Lag Time (min)	Acre (ac)	Velocity (ft/s)	Infiltration Rate (in/hr)	Depth to Restrictive Feature (in)	Percent Impervious
E	87.53	52.52	1593.30	1.96	2	5	0
E1	13.77	8.26	674.90	4.48	6	10	20
E2	18.59	11.15	194.80	4.58	0.2	2	20
E3	13.08	7.85	97.30	4.45	0.2	2	20
E4	6.08	3.65	57.30	5.04	0.2	2	20
E5	17.57	10.54	254.70	4.84	0.2	2	20
E6	17.96	10.78	252.70	4.86	0.2	2	20
E7	25.91	15.55	66.70	2.58	0.2	2	20
E8	16.27	9.76	224.50	4.90	0.2	2	20
E9	20.36	12.22	289.50	3.74	0.2	2	20
E10	13.31	7.98	191.60	4.84	0.2	2	20
E11	30.19	18.11	343.50	3.99	0.2	2	20
E12	21.30	12.78	149.80	3.87	0.2	2	20
E13	11.64	6.99	87.20	4.32	0.2	2	20
E14	8.25	4.95	84.50	5.05	0.2	2	20
E15	19.64	11.79	272.10	4.34	0.2	2	20
E16	101.31	60.78	691.30	2.30	6	10	20
E17	22.87	13.72	453.60	4.19	0.2	2	20
E18	8.76	5.26	86.80	5.28	0.2	2	20
E19	17.97	10.78	132.60	3.72	0.2	2	20
E20	23.42	14.05	516.90	4.33	0.2	2	20
F	89.40	53.64	1386.10	1.62	5	30	1
F1	8.09	4.86	126.90	4.17	0.2	2	0
F2	10.94	6.57	138.40	4.50	0.2	2	0
F3	29.64	17.78	280.50	3.42	0.2	2	0
F4	23.16	13.90	499.80	4.04	0.2	2	0
F5	46.20	27.72	473.40	3.99	0.2	2	0
F6	39.27	23.56	418.90	3.83	0.2	2	0
F7	18.03	10.82	169.20	4.26	0.2	2	0
F8	22.15	13.29	175.80	2.96	0.2	2	0
F9	17.43	10.46	169.80	4.14	0.2	2	0
F10	8.52	5.11	264.60	4.96	0.2	2	0
F11	73.76	44.25	400.50	2.17	2	10	0
F12	70.53	42.32	778.00	1.97	2	10	0
G	480.44	288.26	4427.30	1.10	5	30	2
G1	8.18	4.91	386.70	5.93	2	2	20
G2	11.70	7.02	85.97	4.34	2	2	20

Soil Characteristics

112—CAJON SAND, 0 TO 2 PERCENT SLOPES

Map Unit Setting
National map unit symbol: hkrj
Elevation: 1,800 to 3,200 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Cajon and similar soils: 85 percent
Minor components: 15 percent

Description of Cajon Setting
Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile
H1 - 0 to 7 inches: sand
H2 - 7 to 25 inches: sand
H3 - 25 to 45 inches: gravelly sand
H4 - 45 to 60 inches: stratified sand to loamy fine sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Minor
Percent of map unit: 5 percent
Landform: Playas

Hydric soil rating: Yes

Kimberlina
Percent of map unit: 5 percent

Helendale
Percent of map unit: 5 percent

113—CAJON SAND, 2 TO 9 PERCENT SLOPES

Map Unit Setting
National map unit symbol: hkrk
Elevation: 1,800 to 3,500 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 68 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Cajon and similar soils: 85 percent
Minor components: 15 percent

Description of Cajon Setting
Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed sources

Typical profile
A - 0 to 6 inches: sand
C1 - 6 to 25 inches: sand
C2 - 25 to 60 inches: gravelly sand, stratified gravelly sand to sand

Properties and qualities
Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups
Land capability classification (irrigated): 4e

Land capability classification (non-irrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Minor Components Helendale
Percent of map unit: 5 percent
Landform: Alluvial fans
Hydric soil rating: No

Kimberlina
Percent of map unit: 5 percent
Landform: Alluvial fans
Hydric soil rating: No

Cajon, gravelly surface
Percent of map unit: 5 percent
Landform: Alluvial fans

118—CAJON-ARIZO COMPLEX, 2 TO 15 PERCENT SLOPES*

Map Unit Setting
National map unit symbol: hkrq
Elevation: 2,800 to 3,300 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition
Cajon, gravelly surface, and similar soils: 55 percent
Arizo and similar soils: 30 percent
Minor components: 15 percent

Description of Cajon, Gravelly Surface Setting
Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile
H1 - 0 to 6 inches: gravelly sand
H2 - 6 to 60 inches: gravelly sand

Properties and qualities
Slope: 2 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups
Land capability classification (irrigated): 4s
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: COBBLY SANDY (R030XF028CA)
Hydric soil rating: No

Description of Arizo Setting
Landform: Alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile
H1 - 0 to 6 inches: gravelly loamy sand
H2 - 6 to 60 inches: extremely gravelly loamy coarse sand

Properties and qualities
Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7w
Hydrologic Soil Group: A
Ecological site: GRAVELLY COARSE LOAMY (R030XF025CA)
Hydric soil rating: No

Minor Components

Helendale
Percent of map unit: 4 percent
Hydric soil rating: No

Bryman
Percent of map unit: 4 percent

Hydric soil rating: No

Joshua
Percent of map unit: 4 percent
Hydric soil rating: No

Cajon, clayey substratum
Percent of map unit: 3 percent

131—HELENDALE LOAMY SAND, 0 TO 2 PERCENT SLOPES

Map Unit Setting
National map unit symbol: hks4
Elevation: 2,500 to 3,800 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Helendale and similar soils: 85 percent
Minor components: 13 percent

Description of Helendale Setting
Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile
H1 - 0 to 4 inches: loamy sand
H2 - 4 to 30 inches: sandy loam
H3 - 30 to 66 inches: sandy loam
H4 - 66 to 70 inches: loamy sand

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Minor Components Bryman

Percent of map unit: 5 percent
Hydric soil rating: No

Kimberlina

Percent of map unit: 5 percent
Hydric soil rating: No

Cajon

Percent of map unit: 3 percent
Hydric soil rating: No

132—HELENDALE LOAMY SAND, 2 TO 5 PERCENT SLOPES

Map Unit Setting

National map unit symbol: hks5
Elevation: 2,500 to 3,800 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Helendale and similar soils: 85 percent
Minor components: 15 percent

Description of Helendale

Setting
Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 4 inches: loamy sand
H2 - 4 to 30 inches: sandy loam
H3 - 30 to 66 inches: sandy loam, loamy fine sand
H3 - 30 to 66 inches: loamy sand

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Minor Components Cajon

Percent of map unit: 5 percent
Hydric soil rating: No

Lavic

Percent of map unit: 5 percent
Hydric soil rating: No

Cave

Percent of map unit: 5 percent
Hydric soil rating: No

133—HELENDALE-BRYMAN LOAMY SANDS, 2 TO 5 PERCENT SLOPES*

Map Unit Setting

National map unit symbol: hks6
Elevation: 2,500 to 4,000 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Helendale and similar soils: 50 percent
Bryman and similar soils: 35 percent
Minor components: 10 percent

Description of Helendale Setting

Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 6 inches: loamy sand
H2 - 6 to 30 inches: sandy loam
H3 - 30 to 66 inches: sandy loam
H4 - 66 to 99 inches: loamy sand, sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.8 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Description of Bryman Setting

Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 8 inches: loamy sand
H2 - 8 to 12 inches: sandy loam
H3 - 12 to 44 inches: sandy clay loam
H4 - 44 to 60 inches: loamy sand, coarse sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: C
Ecological site: Sandy (R030XF012CA)
Hydric soil rating: No

Minor Components Cajon

Percent of map unit: 5 percent
Hydric soil rating: No

Mohave variant

Percent of map unit: 5 percent
Hydric soil rating: No

149—MIRAGE SANDY LOAM, 2 TO 5 PERCENT SLOPES*

Map Unit Setting

National map unit symbol: hksp
Elevation: 2,600 to 3,400 feet
Mean annual precipitation: 3 to 5 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 200 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Mirage and similar soils: 85 percent
Minor components: 14 percent

Description of Mirage Setting

Landform: Fan remnants
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite sources

Typical profile

H1 - 0 to 5 inches: sandy loam
H2 - 5 to 21 inches: sandy clay loam, gravelly sandy clay loam, clay loam
H2 - 5 to 21 inches: gravelly sandy loam, gravelly sandy clay loam
H2 - 5 to 21 inches: gravelly loamy sand, very gravelly sand

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Strongly saline (16.0 mmhos/cm)
Available water storage in profile: Low (about 5.5 inches)

Interpretive Groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: C
Ecological site: DESERT PAVEMENT (R030XG024CA)
Hydric soil rating: No

Minor Components Nebona

Percent of map unit: 5 percent
Hydric soil rating: No

Cuddeback

Percent of map unit: 5 percent
Hydric soil rating: No

Mirage

Percent of map unit: 4 percent
Hydric soil rating: No

158—ROCK OUTCROP-LITHIC TORRIORTHENTS COMPLEX, 15 TO 50 PERCENT SLOPES*

Map Unit Setting

National map unit symbol: hkt0
Elevation: 650 to 9,000 feet
Mean annual precipitation: 3 to 5 inches
Mean annual air temperature: 63 to 66 degrees F
Frost-free period: 200 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 60 percent
Lithic torriorthents and similar soils: 30 percent
Minor components: 10 percent

Description of Rock Outcrop Setting

Landform: Mountains
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Mountain flank
Down-slope shape: Concave
Across-slope shape: Concave

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 8s
Hydric soil rating: No

Description of Lithic Torriorthents

Setting
Landform: Hills, mountains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountain flank, side slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Residuum weathered from granite

Typical profile

H2 - 15 to 29 inches: bedrock

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: 8 to 20 inches to lithic bedrock
Natural drainage class: Excessively drained
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7e
Hydric soil rating: No

Minor Components Sparkhule

Percent of map unit: 4 percent
Hydric soil rating: No

Trigger

Percent of map unit: 3 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 3 percent
Hydric soil rating: No

162—SPARKHULE-ROCK OUTCROP COMPLEX, 15 TO 50 PERCENT SLOPES*

Map Unit Setting

National map unit symbol: hkt4
Elevation: 650 to 4,500 feet
Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Sparkhule and similar soils: 60 percent
Rock outcrop: 35 percent
Minor components: 5 percent

Description of Sparkhule Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountain flank
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Colluvium derived from and/or residuum weathered from dacite

Typical profile

H1 - 0 to 2 inches: gravelly sandy loam
H2 - 2 to 18 inches: gravelly sandy clay loam, sandy clay loam, gravelly clay loam

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: 14 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAM (R030XF033CA)
Hydric soil rating: No

Description of Rock Outcrop Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountain flank
Down-slope shape: Concave
Across-slope shape: Concave

Properties and qualities

Slope: 15 to 50 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 8s
Hydric soil rating: No

Minor Components Unnamed, sl-grscl subsoil

Percent of map unit: 5 percent
Hydric soil rating: No

165—TRIGGER-SPARKHULE-ROCK OUTCROP ASSOCIATION, STEEP*

Map Unit Setting

National map unit symbol: hkt7
Elevation: 650 to 4,500 feet
Mean annual precipitation: 3 to 5 inches
Mean annual air temperature: 59 to 66 degrees F
Frost-free period: 180 to 290 days
Farmland classification: Not prime farmland

Map Unit Composition

Trigger and similar soils: 40 percent
Sparkhule and similar soils: 30 percent
Rock outcrop: 30 percent

Description of Trigger Setting

Landform: Hills
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Residuum weathered from calcareous conglomerate

Typical profile

H1 - 0 to 12 inches: gravelly sandy loam

Properties and qualities

Slope: 30 to 40 percent
Depth to restrictive feature: 10 to 18 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAM (R030XF033CA)
Hydric soil rating: No

Description of Sparkhule Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Colluvium derived from and/or residuum weathered from dacite

Typical profile

H1 - 0 to 2 inches: gravelly sandy loam
H2 - 2 to 18 inches: gravelly sandy clay loam, sandy clay loam, gravelly clay loam

Properties and qualities

Slope: 20 to 30 percent
Depth to restrictive feature: 14 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: D
Ecological site: GRAVELLY LOAM (R030XF033CA)
Hydric soil rating: No

Description of Rock Outcrop Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Concave

Properties and qualities

Slope: 20 to 40 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (non-irrigated): 8s
Hydric soil rating: No

173—WASCO SANDY LOAM, COOL, 0 TO 2 PERCENT SLOPES

Map Unit Setting

National map unit symbol: hkth
Elevation: 250 to 3,700 feet

Mean annual precipitation: 3 to 6 inches
Mean annual air temperature: 59 to 63 degrees F
Frost-free period: 180 to 280 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Wasco and similar soils: 85 percent
Minor components: 13 percent

Description of Wasco Setting

Landform: Fan aprons
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite

Typical profile

H1 - 0 to 7 inches: sandy loam
H2 - 7 to 60 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Non-saline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (non-irrigated): 7e
Hydrologic Soil Group: A
Ecological site: COARSE LOAMY (R030XF003CA)
Hydric soil rating: No

Minor Components Cajon, sand

Percent of map unit: 5 percent
Hydric soil rating: No

Lucerne

Percent of map unit: 5 percent
Hydric soil rating: No

Bryman

Percent of map unit: 3 percent
Hydric soil rating: No

Appendix C

Time of Concentration

$$T_c = T_{sheet} + T_{shallow} + T_{channel} \qquad \text{(Equation 1)}$$

Sheet flow is determined using Equation 2.

$$T_{sheet} = \frac{0.42L^{4/5}n^{4/5}}{P_2^{1/2}s^{2/5}} \qquad \text{(Equation 2)}$$

Where: L is the sheet flow length (maximum 300 feet or 100 feet)
n is the manning's roughness coefficient for sheet flow. See table C-1
P is the 2-year, 24-hour rainfall depth (inches)
S is the slope along the sheet flow portion (ft/ft)

Sheet flow is determined using Equation 3.

$$T_{shallow} = \frac{L}{60*V} \qquad \text{(Equation 3)}$$

Where: L is the shallow concentrated flow length (ft)
V is the velocity (ft/s)

The sheet flow velocity is determined by equation 4.

$$V = 3.28kS^{1/2} \qquad \text{(Equation 4)}$$

Where: S is the slope along the sheet flow portion (ft/ft)
K is an interception coefficient dependent on land cover. See table C-2

Channel flow is determined by dividing the channel length by the channel velocity which is determined using Manning's equation.

$$T_{shallow} = \frac{L_{channel}}{V} \qquad \text{(Equation 5)}$$

Where: $L_{channel}$ is the channel length (ft)
V is the velocity (ft/s)

The equation to determine velocity based on Manning's equation is shown in Equation 6.

$$V = \frac{1.49R^{1/3}S^{1/2}}{n} \qquad \text{(Equation 6)}$$

Where: R is the hydraulic radius (ft)
S is the channel slope (ft/ft)

Lag Time

$T_{lag} = 0.6*T_c$ (Equation 7)

Table C.1. Roughness Coefficients for Sheet Flow (n)

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

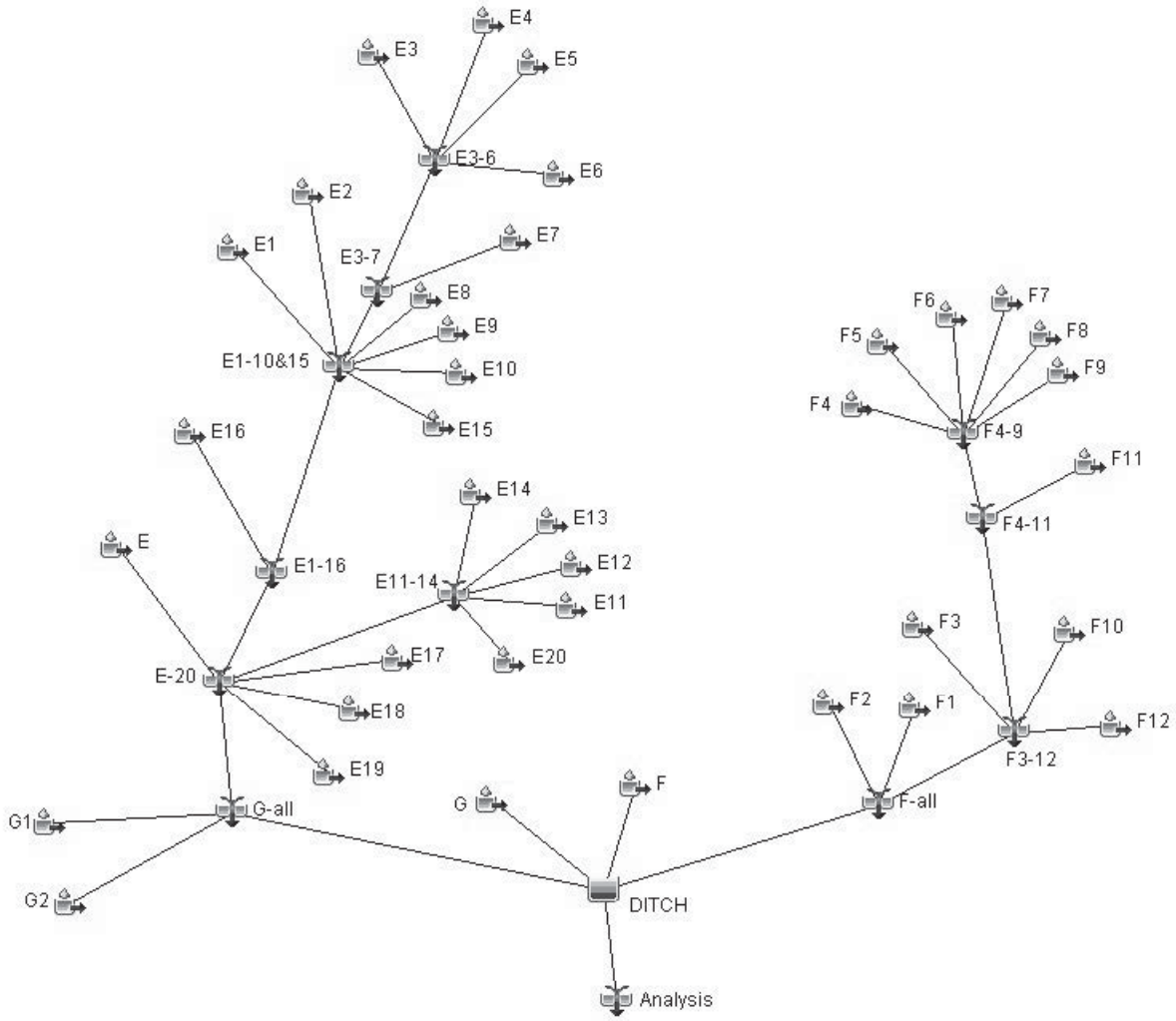
[1] The n values are a composite of information compiled by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Table C.2. Interception Coefficient (k)

Land cover/Flow regime	k
Forest with heavy ground litter; hay meadow	0.076
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland	0.152
Short grass pasture	0.213
Cultivated straight row	0.274
Nearly bare and untilled alluvial fans	0.305
Grassed waterway	0.457
Pavement and small upland gullies	0.620

Appendix D

HEC-HMS 4.2.1 Model



Calculation Tables: Flow Calculations for Sub-Drainage Areas

Drainage Area E

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	6.0
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3636.2				
Elevation after length Lsheet (ft)	3603.1				
Slope (S) (ft/ft)	0.1	**Slope %**	11.0	11.0	
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	81.5
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	9591.0				
Elevation at Drainage Area Outlet (ft)	3234.5				
Slope (ft/ft)	0.0	**Slope %**	3.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	2.0	fps			

Drainage Area E1

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.4
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4852.0				
Elevation after length Lsheet (ft)	4715.7				
Slope (S) (ft/ft)	0.5	**Slope %**	45.4		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	10.3
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	2779.3				
Elevation at Drainage Area Outlet (ft)	4159.1				
Slope (ft/ft)	0.2	**Slope %**	20.0		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.5	fps			

Drainage Area E2

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.1
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5135.5				
Elevation after length Lsheet (ft)	5047.0				
Slope (S) (ft/ft)	0.3	**Slope %**	29.5		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	14.5
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3988.6				
Elevation at Drainage Area Outlet (ft)	4212.3				
Slope (ft/ft)	0.2	**Slope %**	20.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.6	fps			

Drainage Area E3

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.3
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4935.6				
Elevation after length Lsheet (ft)	4857.7				
Slope (S) (ft/ft)	0.3	**Slope %**	26.0		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	8.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	2347.1				
Elevation at Drainage Area Outlet (ft)	4394.0				
Slope (ft/ft)	0.2	**Slope %**	19.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.4	fps			

Drainage Area E4

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.5
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4817.9				
Elevation after length Lsheet (ft)	4685.9				
Slope (S) (ft/ft)	0.4	**Slope %**	44.0		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	2.6
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	792.3				
Elevation at Drainage Area Outlet (ft)	4484.6				
Slope (ft/ft)	0.3	**Slope %**	25.4		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	5.0	fps			

Drainage Area E5

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.7
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5491.1				
Elevation after length Lsheet (ft)	5375.5				
Slope (S) (ft/ft)	0.4	**Slope %**	38.5		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	13.9
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	4044.4				
Elevation at Drainage Area Outlet (ft)	4427.9				
Slope (ft/ft)	0.2	**Slope %**	23.4		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.8	fps			

Drainage Area E6

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.2
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5496.0				
Elevation after length Lsheet (ft)	5335.5				
Slope (S) (ft/ft)	0.5	**Slope %**	53.5		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	14.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	4303.9				
Elevation at Drainage Area Outlet (ft)	4319.1				
Slope (ft/ft)	0.2	**Slope %**	23.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.9	fps			

Drainage Area E7

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	5.7
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4502.3				
Elevation after length Lsheet (ft)	4464.0				
Slope (S) (ft/ft)	0.1	**Slope %**	12.8		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	20.2
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3130.2				
Elevation at Drainage Area Outlet (ft)	4256.0				
Slope (ft/ft)	0.1	**Slope %**	6.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	2.6	fps			

Drainage Area E8

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.5
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5078.0				
Elevation after length Lsheet (ft)	4949.4				
Slope (S) (ft/ft)	0.4	**Slope %**	42.9		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	12.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3751.6				
Elevation at Drainage Area Outlet (ft)	4051.1				
Slope (ft/ft)	0.2	**Slope %**	23.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.9	fps			

Drainage Area E9

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.5
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4734.0				
Elevation after length Lsheet (ft)	4604.0				
Slope (S) (ft/ft)	0.4	**Slope %**	43.3		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	16.9
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3790.0				
Elevation at Drainage Area Outlet (ft)	4073.6				
Slope (ft/ft)	0.1	**Slope %**	14.0		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.7	fps			

Drainage Area E10

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.0
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4544.0				
Elevation after length Lsheet (ft)	4454.2				
Slope (S) (ft/ft)	0.3	**Slope %**	30.0		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	9.3
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	2689.7				
Elevation at Drainage Area Outlet (ft)	3825.3				
Slope (ft/ft)	0.2	**Slope %**	23.4		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.8	fps			

Drainage Area E11

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.7
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4731.2				
Elevation after length Lsheet (ft)	4618.0				
Slope (S) (ft/ft)	0.4	**Slope %**	37.8		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	26.5
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	6344.1				
Elevation at Drainage Area Outlet (ft)	3609.1				
Slope (ft/ft)	0.2	**Slope %**	15.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.0	fps			

Drainage Area E12

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.4
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4288.5				
Elevation after length Lsheet (ft)	4146.9				
Slope (S) (ft/ft)	0.5	**Slope %**	47.2		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	17.9
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	4167.7				
Elevation at Drainage Area Outlet (ft)	3522.3				
Slope (ft/ft)	0.1	**Slope %**	15.0		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.9	fps			

Drainage Area E13

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.0
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3965.6				
Elevation after length Lsheet (ft)	3871.8				
Slope (S) (ft/ft)	0.3	**Slope %**	31.3		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	7.7
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1987.9				
Elevation at Drainage Area Outlet (ft)	3501.3				
Slope (ft/ft)	0.2	**Slope %**	18.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.3	fps			

Drainage Area E14

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.6
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3916.0				
Elevation after length Lsheet (ft)	3797.1				
Slope (S) (ft/ft)	0.4	**Slope %**	39.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	4.6
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1403.6				
Elevation at Drainage Area Outlet (ft)	3439.9				
Slope (ft/ft)	0.3	**Slope %**	25.5		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	5.0	fps			

Drainage Area E15

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.8
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4545.6				
Elevation after length Lsheet (ft)	4488.0				
Slope (S) (ft/ft)	0.2	**Slope %**	19.2		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	14.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3853.9				
Elevation at Drainage Area Outlet (ft)	3764.2				
Slope (ft/ft)	0.2	**Slope %**	18.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.3	fps			

Drainage Area E16

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	7.0
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4256.0				
Elevation after length Lsheet (ft)	4233.2				
Slope (S) (ft/ft)	0.1	**Slope %**	7.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	94.3
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	13001.6				
Elevation at Drainage Area Outlet (ft)	3547.4				
Slope (ft/ft)	0.1	**Slope %**	5.3		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	2.3	fps			

Drainage Area E17

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.1
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4630.0				
Elevation after length Lsheet (ft)	4460.8				
Slope (S) (ft/ft)	0.6	**Slope %**	56.4		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	19.7
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	4962.5				
Elevation at Drainage Area Outlet (ft)	3589.4				
Slope (ft/ft)	0.2	**Slope %**	17.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.2	fps			

Drainage Area E18

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.6
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3960.9				
Elevation after length Lsheet (ft)	3837.4				
Slope (S) (ft/ft)	0.4	**Slope %**	41.1		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	5.2
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1650.4				
Elevation at Drainage Area Outlet (ft)	3377.1				
Slope (ft/ft)	0.3	**Slope %**	27.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	5.3	fps			

Drainage Area E19

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.0
Sheet Flow Length (Lsheet) (ft)	300.0				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3961.7				
Elevation after length Lsheet (ft)	3768.0				
Slope (S) (ft/ft)	0.6	**Slope %**	64.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	15.0
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3345.8				
Elevation at Drainage Area Outlet (ft)	3306.1				
Slope (ft/ft)	0.1	**Slope %**	13.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.7	fps			

Drainage Area E20

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.0
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4331.1				
Elevation after length Lsheet (ft)	4239.1				
Slope (S) (ft/ft)	0.3	**Slope %**	30.7		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	19.4
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	5039.6				
Elevation at Drainage Area Outlet (ft)	3297.1				
Slope (ft/ft)	0.2	**Slope %**	18.7		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.3	fps			

Drainage Area F

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	9.1
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3158.8				
Elevation after length Lsheet (ft)	3147.1				
Slope (S) (ft/ft)	0.0	**Slope %**	3.9		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	80.3
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	7780.38				
Elevation at Drainage Area Outlet (ft)	2944.22				
Slope (ft/ft)	0.0	**Slope %**	2.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	1.6	fps			

Drainage Area F1

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.5
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3390				
Elevation after length Lsheet (ft)	3259.2				
Slope (S) (ft/ft)	0.4	**Slope %**	43.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	4.6
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1156.1				
Elevation at Drainage Area Outlet (ft)	3058.0				
Slope (ft/ft)	0.2	**Slope %**	17.4		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.2	fps			

Drainage Area F2

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.5
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3652.6				
Elevation after length Lsheet (ft)	3521.9				
Slope (S) (ft/ft)	0.4	**Slope %**	43.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	7.5
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	2017.3				
Elevation at Drainage Area Outlet (ft)	3113.2				
Slope (ft/ft)	0.2	**Slope %**	20.3		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.5	fps			

Drainage Area F3

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.7
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4121.2				
Elevation after length Lsheet (ft)	4009.3				
Slope (S) (ft/ft)	0.4	**Slope %**	37.3		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	25.9
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	5329.0				
Elevation at Drainage Area Outlet (ft)	3384.9				
Slope (ft/ft)	0.1	**Slope %**	11.7		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.4	fps			

Drainage Area F4

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.4
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4630				
Elevation after length Lsheet (ft)	4490.6				
Slope (S) (ft/ft)	0.5	**Slope %**	46.5		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	19.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	4796.8				
Elevation at Drainage Area Outlet (ft)	3706.8				
Slope (ft/ft)	0.2	**Slope %**	16.3		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.0	fps			

Drainage Area F5

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.0
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5534				
Elevation after length Lsheet (ft)	5444.3				
Slope (S) (ft/ft)	0.3	**Slope %**	29.9		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	42.2
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	10102.3				
Elevation at Drainage Area Outlet (ft)	3833.8				
Slope (ft/ft)	0.2	**Slope %**	15.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.0	fps			

Drainage Area F6

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.2
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	5295.4				
Elevation after length Lsheet (ft)	5128				
Slope (S) (ft/ft)	0.6	**Slope %**	55.8		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	36.1
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	8303				
Elevation at Drainage Area Outlet (ft)	3910				
Slope (ft/ft)	0.1	**Slope %**	14.7		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.8	fps			

Drainage Area F7

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.9
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.22				
Top of Drainage Area Elevation (ft)	4696				
Elevation after length Lsheet (ft)	4600.2				
Slope (S) (ft/ft)	0.3	**Slope %**	31.9		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	14.1
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3601.9				
Elevation at Drainage Area Outlet (ft)	3947.2				
Slope (ft/ft)	0.2	**Slope %**	18.1		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.3	fps			

Drainage Area F8

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.5
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.22				
Top of Drainage Area Elevation (ft)	4166.7				
Elevation after length Lsheet (ft)	4097.9				
Slope (S) (ft/ft)	0.2	**Slope %**	22.9		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	17.7
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3136.1				
Elevation at Drainage Area Outlet (ft)	3823.2				
Slope (ft/ft)	0.1	**Slope %**	8.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	3.0	fps			

Drainage Area F9

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	4.5
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4245.6				
Elevation after length Lsheet (ft)	4178.5				
Slope (S) (ft/ft)	0.2	**Slope %**	22.4		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	12.9
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	3204.3				
Elevation at Drainage Area Outlet (ft)	3628.6				
Slope (ft/ft)	0.2	**Slope %**	17.2		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.1	fps			

Drainage Report F10

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.4
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	4066				
Elevation after length Lsheet (ft)	3929				
Slope (S) (ft/ft)	0.5	**Slope %**	45.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	5.1
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1520.2				
Elevation at Drainage Area Outlet (ft)	3554.6				
Slope (ft/ft)	0.2	**Slope %**	24.6		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	5.0	fps			

Drainage Report F11

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	9.5
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3909.8				
Elevation after length Lsheet (ft)	3899.1				
Slope (S) (ft/ft)	0.0	**Slope %**	3.6		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	64.3
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	8375.7				
Elevation at Drainage Area Outlet (ft)	3504.6				
Slope (ft/ft)	0.0	**Slope %**	4.7		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	2.2	fps			

Drainage Area F12

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	7.7
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3504.6				
Elevation after length Lsheet (ft)	3486.9				
Slope (S) (ft/ft)	0.1	**Slope %**	5.88		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	62.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	7437.7				
Elevation at Drainage Area Outlet (ft)	3197.1				
Slope (ft/ft)	0.0	**Slope %**	3.9		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	2.0	fps			

Drainage Area G

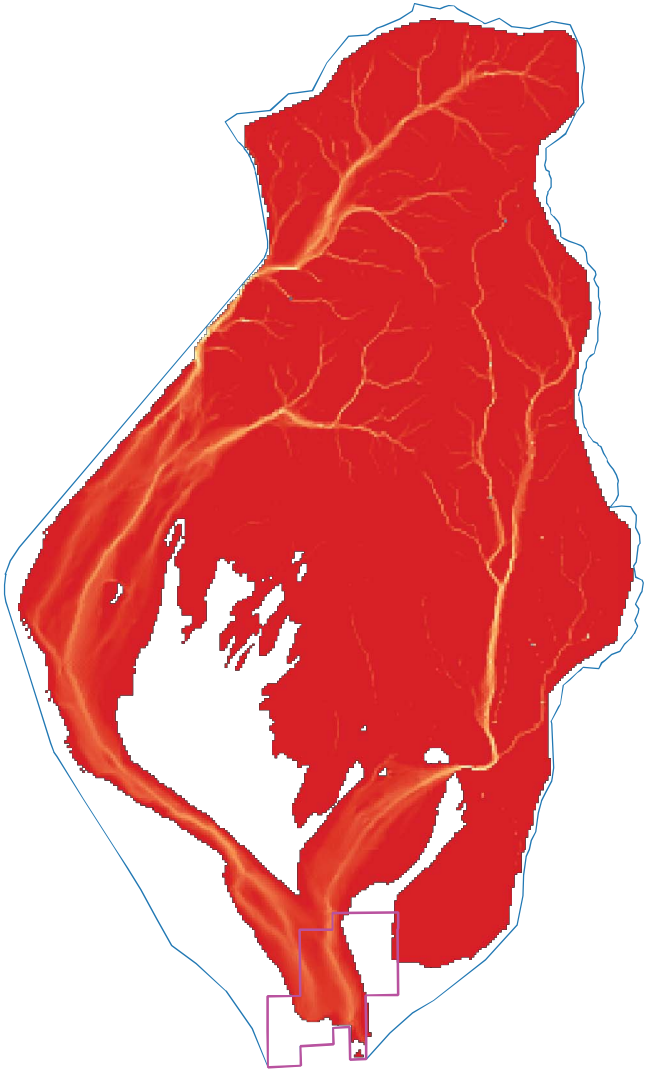
Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	10.2
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.22				
Top of Drainage Area Elevation (ft)	3312.8				
Elevation after length Lsheet (ft)	3303.9				
Slope (S) (ft/ft)	0.0	**Slope %**	3.0		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	470.2
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	31048.1				
Elevation at Drainage Area Outlet (ft)	2928.2				
Slope (ft/ft)	0.0	**Slope %**	1.2		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	1.1	fps			

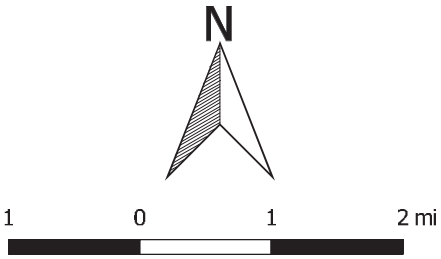
Drainage Area G1

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	1.8
Sheet Flow Length (Lsheet) (ft)	100				
2-yr 24-hr rainfall (P2) (in)	1.22				
Top of Drainage Area Elevation (ft)	4117				
Elevation after length Lsheet (ft)	4093				
Slope (S) (ft/ft)	0.24	**Slope %**	24.0		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	3.1
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	1105				
Elevation at Top of Channel (ft)	3705				
Slope (ft/ft)	0.4	**Slope %**	35.1		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	5.9	fps			

Drainage Area G2

Sheet Flow					
Input				**Output**	
Overland Flow Roughness Coefficient (n)	0.035			tsheet (min)	3.9
Sheet Flow Length (Lsheet) (ft)	300				
2-yr 24-hr rainfall (P2) (in)	1.2				
Top of Drainage Area Elevation (ft)	3620				
Elevation after length Lsheet (ft)	3523				
Slope (S) (ft/ft)	0.3	**Slope %**	32.3		
Shallow Concentrated Flow					
Input				**Output**	
Unpaved				tshallow (min)	7.8
Shallow Concentrated Flow (Lshallow) (ft) if sheet flow used, subtract length used for sheet flow	2025				
Elevation at Drainage Area Outlet (ft)	3142				
Slope (ft/ft)	0.2	**Slope %**	18.8		
Interception Coefficient for Shallow Concentrated Flow (k)	0.305				
Velocity = (3.28)*k*(S^0.5)	4.3	fps			





Legend

- Project Boundary
- Watershed Boundary

Flow Depth (ft)

- 0.1
- 0.35
- 0.6
- 0.85
- 1.1
- 1.35
- 1.6
- 1.85
- 2.1
- 2.35
- 2.6
- 2.85
- 3.1
- 3.35
- 3.6

RRC

RRC Power & Engery, LLC
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Round Rock, TX 78664

Ord Mountain Solar Project
Lucerne Valley, California

Drawn By: TWB	01/24/2018

Figure 5: Flow Depths Predicted by FLO-2D for a 100-Year, 24-Hour Storm

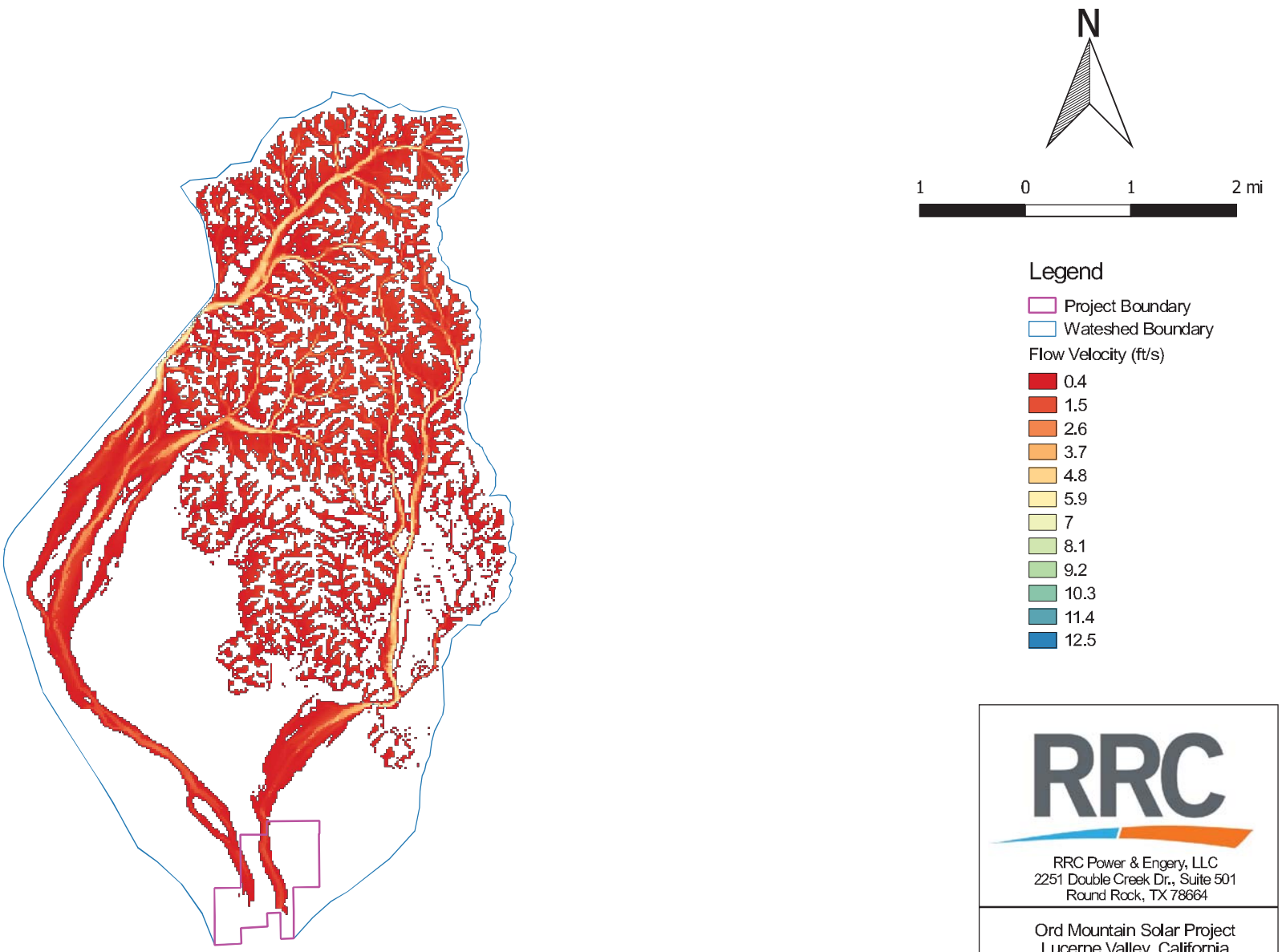

Figure 6: Flow Velocities Predicted by FLO-2D for a 100-Year, 24-Hour Storm

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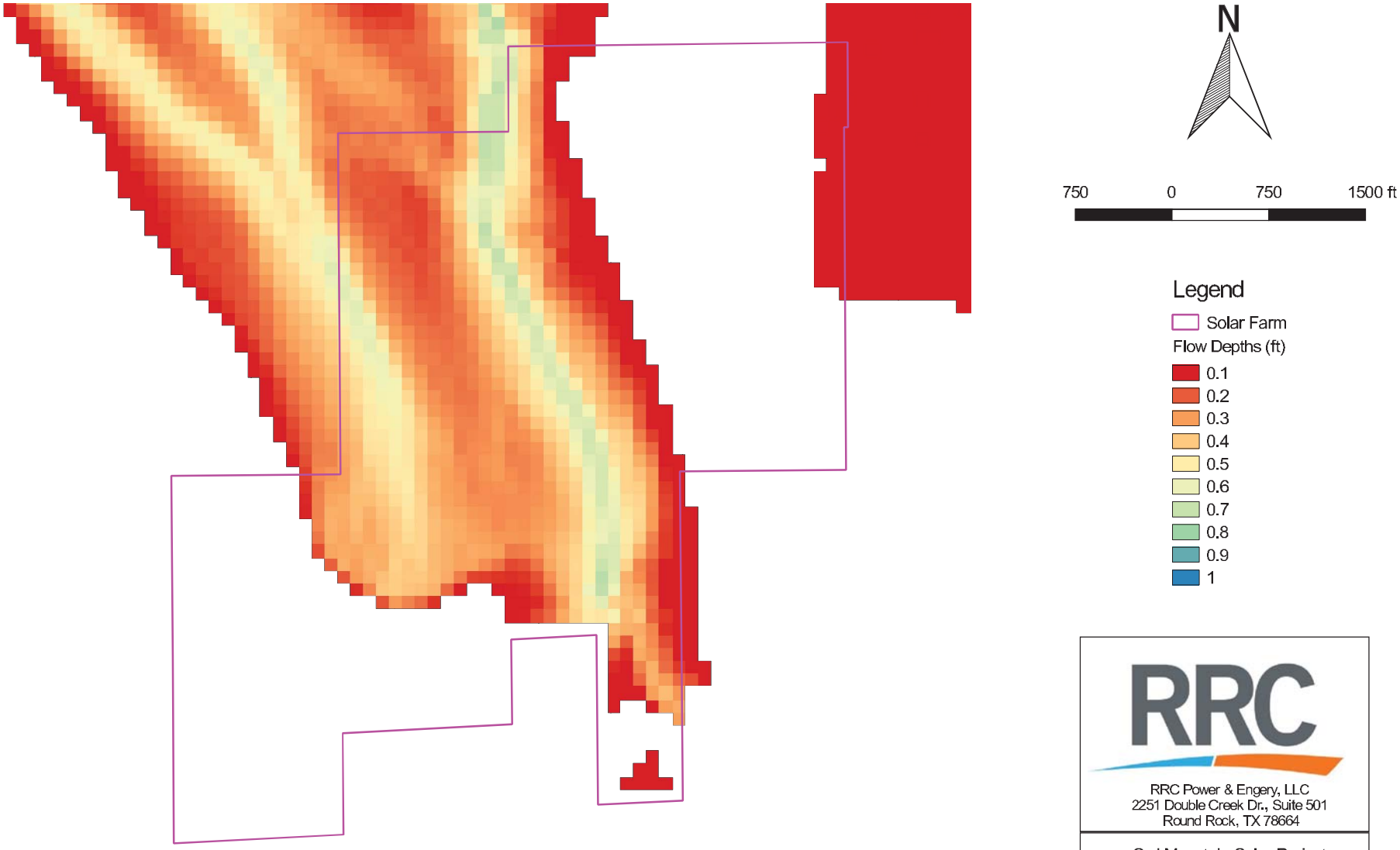
Drawn By: TWB	01/24/2018



RRC

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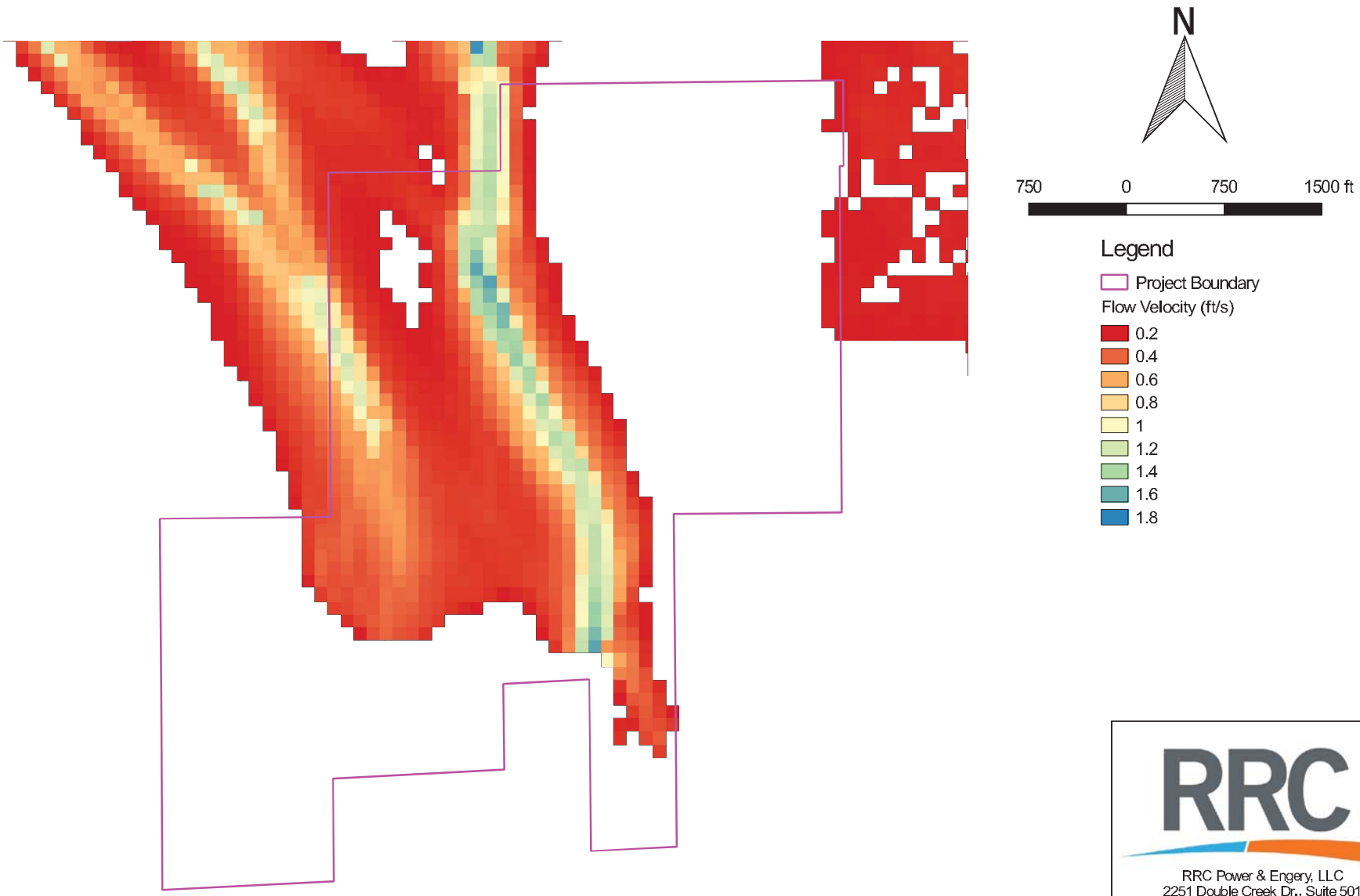
Lucerne Valley, California

Drawn By: TWB	01/24/2018

Figure 7: Flow Depths Predicted by FLO-2D for a 100-Year, 24-Hour Storm on Project Site



RRC

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Ord Mountain Solar Project
Luceme Valley, California

Drawn By: TWB	01/24/2018

Figure 8: Flow Velocities Predicted by FLO-2D for a 100-Year, 24-Hour Storm on Project Site

Drainage Report for Calcite Substation

DRAINAGE REPORT

FOR

CALCITE SUBSTATION

(PREFERRED LOCATION)

SAN BERNARDINO COUNTY, CALIFORNIA

Prepared for:

SOUTHERN CALIFORNIA EDISON
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POMONA, CA 92630

Prepared by:

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October 12, 2016

This report has been prepared by, or under the direction of, the following registered civil engineer who attests to the technical information contained herein.

	12/6/16	
Anthony M. Mistretta Registered Civil Engineer	Date	Seal

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I. PURPOSE AND SCOPE

The purpose of this drainage analysis is to determine the 100-year storm run-off emanating from the on-site and off-site drainage areas for the proposed SCE Calcite Substation (Project) in San Bernardino County, California. The study will compare the pre- and post-development hydrologic conditions, and determine the required on-site drainage infrastructure necessary to protect the proposed grading and site improvements from the 100-year storm event.

The scope of the study includes the following:

1. Determination of points of flow concentration and drainage areas.
2. Determination of the off-site 100-year storm flows utilizing the Civil Design Engineering Software Program Package for San Bernardino County, Rational Method and Synthetic Unit Hydrograph Method.
3. Design of proposed perimeter channels to intercept and re-direct off-site flows around the Project site.
4. Determination of the on-site 100-year storm flows based on the proposed condition, utilizing the Civil Design Engineering Software Program Package for San Bernardino County, Rational Method.
5. Determination of on-site flood depth based on 100-year storm flows (proposed condition).
6. Determination of the 100-year flood volumes based upon the existing and proposed conditions utilizing the Civil Design Engineering Software Program Package for San Bernardino County, Synthetic Unit Hydrograph.
7. Design of proposed on-site retention basin based on difference in on-site flood volume between existing and proposed conditions.
8. Determination of the 100-year floodplain limits and depth based on Normal Depth calculations and a Synthetic Unit Hydrograph analysis of the 100-year/3-hour storm even of the surrounding watershed.
9. Preparation of hydrology maps.
10. Preparation of the hydrology report.

II. PROJECT DESCRIPTION

The proposed Project is located in Lucerne Valley, in an unincorporated area of San Bernardino County, California. The site is approximately 800 feet west of Barstow Road (US highway 247) and 7.0 miles north of highway 18 (See Figure 1). The proposed Project will be an electrical substation comprising approximately 7.1 acres, which is shown on Figure 2.

The proposed project consists of the construction of an electrical transmission substation, measuring approximately 620 feet by 500 feet. Development of the substation includes the installation of switch racks, transformers, circuit breakers and capacitor banks, as well as construction of a Mechanical and Electrical Equipment Room (MEER). After development, the majority of the Project site will be covered with a 4-inch-thick layer of gravel base and thus will remain pervious. Only approximately 1.7 acres will be impervious cover, most of which is attributable to the 20-foot-wide asphalt paved driveway traversing through the interior of the substation. The remaining imperviousness will be due to relatively small and scattered concrete pads/foundations for electrical equipment.

III. DRAINAGE AREA OVERVIEW

Existing Condition

The Project site is located within the floodplain of a relatively larger drainage corridor that conveys runoff flows from the upstream watershed emanating from the northeast. The site is undeveloped and surrounded by vacant desert land with natural vegetation on all sides. Topographically, the site is relatively flat and slopes to the southeast at an overall gradient of less than 2 percent. Site elevations range from 2,908 feet above MSL in the northwest, to 2,897 feet in the southeast. Runoff generated from on-site drainage areas drains southerly via overland sheet flow.

Proposed Condition

Upon development, approximately 1.7 acres of impervious surface will be added to the Project site. Runoff flows from these impervious areas will be conveyed southerly by the proposed grading via overland sheet flow, and ultimately discharge into a proposed retention facility located along the south side of the proposed substation.

In order to mitigate potential impacts of off-site flows from upstream tributary drainage areas, proposed storm drain infrastructure along the upstream sides of the Project site will be necessary to divert run-off around the proposed substation. Once downstream of the Project site, off-site flows will continue along the natural drainage course.

IV. HYDROLOGY

Methodology

The San Bernardino County Hydrology Manual (Reference 1) was used to develop the hydrological parameters for the 100-year storm event. The Rational and Unit Hydrograph Methods were used for the analyses. The Rational Method was used to determine the peak flow rates for the existing and proposed condition, while the Unit Hydrograph Method was used to determine the 100-year flood volumes for the existing and proposed conditions. In instances where the drainage area exceeded 500 acres, the Uniy Hydrograph Method was also used to determine peak flow rates. Computations were performed using the San Bernardino County module for computer programs developed by Civil Cadd/Civil Design

Engineering Software, RSBC for Rational Method and UNSBC for Unit Hydrograph Method.

Hydrology Parameters
Hydrologic Soil Groups were determined using the soils maps provided in the San Bernardino County Hydrology Manual. The entire study area consists of Hydrologic Soil Group (HSG) "C" soils (See Appendix H, Figure C-11).

The rainfall values used for the study were obtained from the maps contained in the San Bernardino County Hydrology Manual (See Appendix H). The rainfall values for the 10-year/1-hour and 100-year/1-hour are 0.75 inches and 1.2 inches, respectively. For the 2-year/6-hour and 100-year/6-hour storm events, the rainfall values are 0.8 inches and 2.0 inches, respectively. For the 2-year/24-hour and 100-year/24-hour, the rainfall values are 1.2 inches and 3.5 inches, respectively.

The cover type assumed for the existing condition is barren land on HSG "C" soils, which yields an AMC-2 Runoff Curve Number (RCN) of 91. Using Table C.1 of the San Bernardino County Hydrology Manual (See Appendix H), the equivalent AMC-3 (100-year) RCN is 98.2.

The ground covers associated with the proposed condition will be concrete, asphalt and gravel. Using Table 2-2a from the Urban Hydrology for Small Watersheds, Technical Release 55, (See Appendix H), the RCN for concrete and asphalt surfaces is 98 and for gravel surface is 89.

V. HYDROLOGY STUDY FINDINGS

Upon development, on-site drainage areas will generate a 100-year peak flow rate of approximately 22.7 cfs, which equates to approximately 0.7 inches of runoff over the Project site. Therefore, electrical components and other critical equipment will be raised a minimum of approximately 6.7 inches above finish ground elevations upon development.

Based on the results of the on-site Unit Hydrograph analysis, the developed Project site will generate approximately 86,149 cf (1.98 ac-ft) of runoff for the 100-year/24-hour storm event, which is approximately 126 cf more than that of the existing condition, 86,023 cf (1.97 ac-ft). This volume difference will be retained on-site in order to mitigate impacts to downstream receiving waters upon development.

Regarding the off-site hydrology study, there is approximately 64.4 acres of upstream drainage area directly discharging to the Project site. For purposes of the study, this area was divided into two separate subareas, A and B, in order to evaluate each of the two upstream sides of the Project site separately. Drainage areas A and B generate approximately 53.7 cfs and 39.0 cfs, respectively. These flows will be diverted around the Project site via perimeter storm drain infrastructure under the proposed condition.

VI. FLOODPLAIN ANALYSIS

Based on USGS maps of the surrounding area, the proposed Project site is located within the floodplain of a relatively large surrounding watershed. The watershed consists of approximately 5,900 acres, with the substation located toward the center of the drainage corridor. Therefore, a floodplain analysis was performed to determine the potential impacts of the surrounding floodplain for the 100-year storm event.

The 100-year peak flow rate was determined by a separate Unit Hydrograph Method analysis of the overall 5,865-acre watershed. The Normal Depth Method was then used to determine the limits and depth of the 100-year floodplain through five existing ground cross sections taken throughout the location of the proposed Project site: the upstream end, downstream end, and quarter points.

The upstream watershed was found to generate approximately 4,710 cfs at the location of the proposed Project site. Throughout the five cross sections analyzed, the 100-year floodplain varies from approximately 2,100 to 2,400 feet in width, and approximately 0.7 to 1.0 feet in depth in the area of the proposed site. Using the maximum flood depth of 1.0 feet, in addition to a recommended 1.0 feet of freeboard, the proposed Project site will need to be raised a minimum of approximately 2.0 feet above existing ground elevations in order to be protected from the 100-year storm event.

VII. PROPOSED FACILITIES

Basin "A" & Basin "B"

In order to mitigate potential impacts to downstream receiving waters due to an increase in on-site runoff generated by development, two proposed retention basins (Basin A and Basin B) will be located along the downstream (south) side of the Project site. The basins are designed to retain the increase in flood volume generated by development (126 cf) with approximately one foot of freeboard. The basins will have 4:1 side slopes and bottom widths of 2 feet to facilitate maintenance. Both basins will have a bottom elevation of 2897.50 feet above MSL, and comprise a cumulative footprint area of approximately 5,800 square feet.

Channel "A"

Channel "A" is a proposed upstream perimeter channel located along the north side of the Project site, and designed to accept run-off flows generated by off-site Area "A". Channel "A" is approximately 620 feet long and is sized to divert a 100-year peak flow rate of approximately 53.7 cfs around the Project site. The channel will be approximately 3.25 feet deep to accommodate the design flow rate with an additional minimum 1 foot of freeboard. Channel "A" will have 2:1 side slopes and a bottom width of 3 feet.

Channel "B"

Channel "B" is a proposed upstream perimeter channel located along the west side of the Project site, and designed to accept run-off flows generated by off-site Area "B". Channel

"B" is approximately 500 feet long and is sized to divert a 100-year peak flow rate of approximately 39.0 cfs around the Project site. The channel will be approximately 2.0 feet deep to accommodate the design flow rate with an additional minimum 1 foot of freeboard. Channel "B" will have 2:1 side slopes and a bottom width of 8 feet.

VIII. CONCLUSIONS

The results of the floodplain analysis require the substation site to be raised a minimum of two feet above existing ground elevations in order to mitigate flood hazards associated with the 100-year floodplain. It is concluded that implementation of the proposed retention basin and on-site channels will provide protection of on-site facilities from the 100-year storm event without adversely impacting the existing downstream drainage conditions.

IX. REFERENCES

1. San Bernardino County Hydrology Manual, August 1986.
2. USDA Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

FIGURE 1: REGIONAL VICINITY MAP

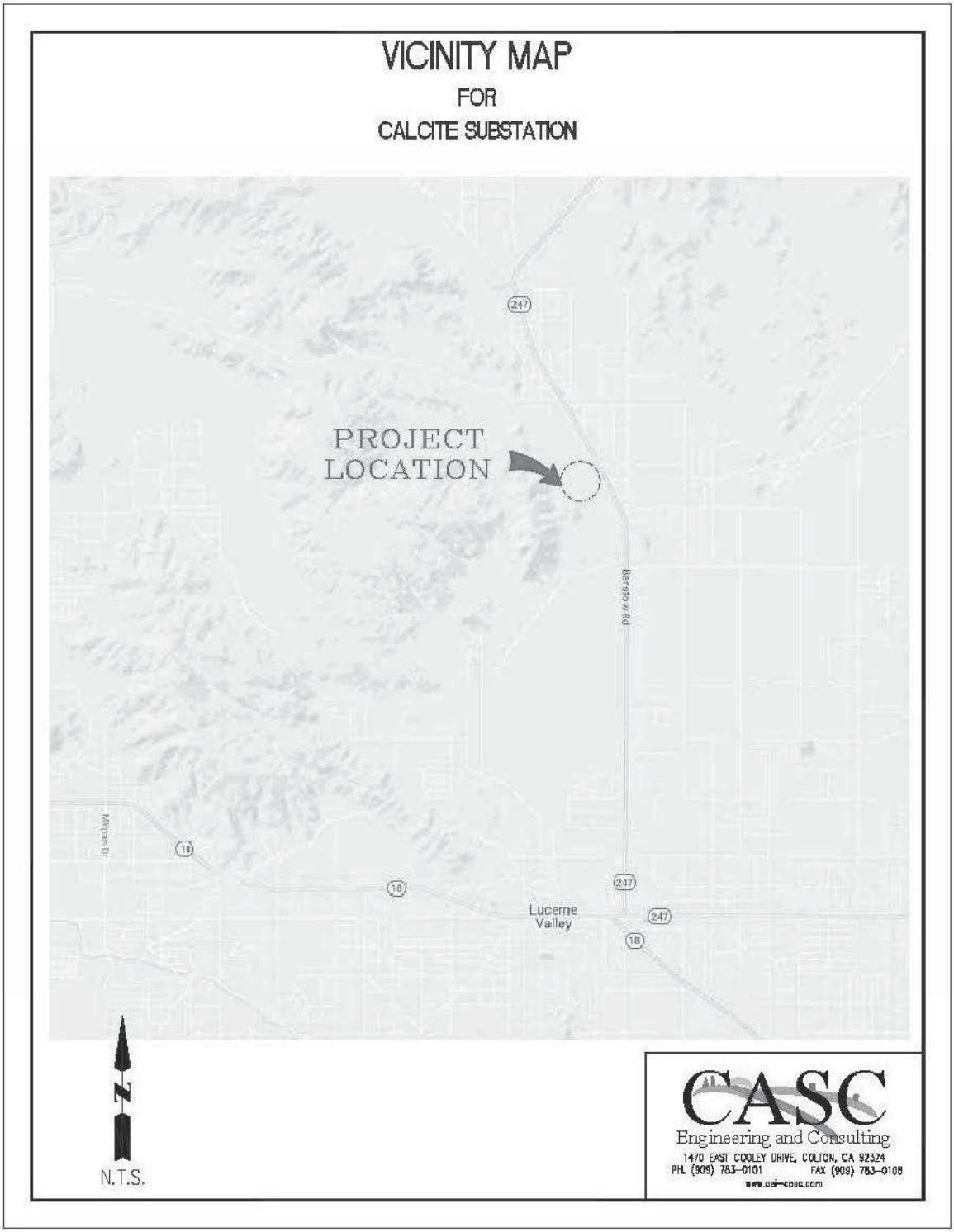


FIGURE 2: LOCAL VICINITY MAP

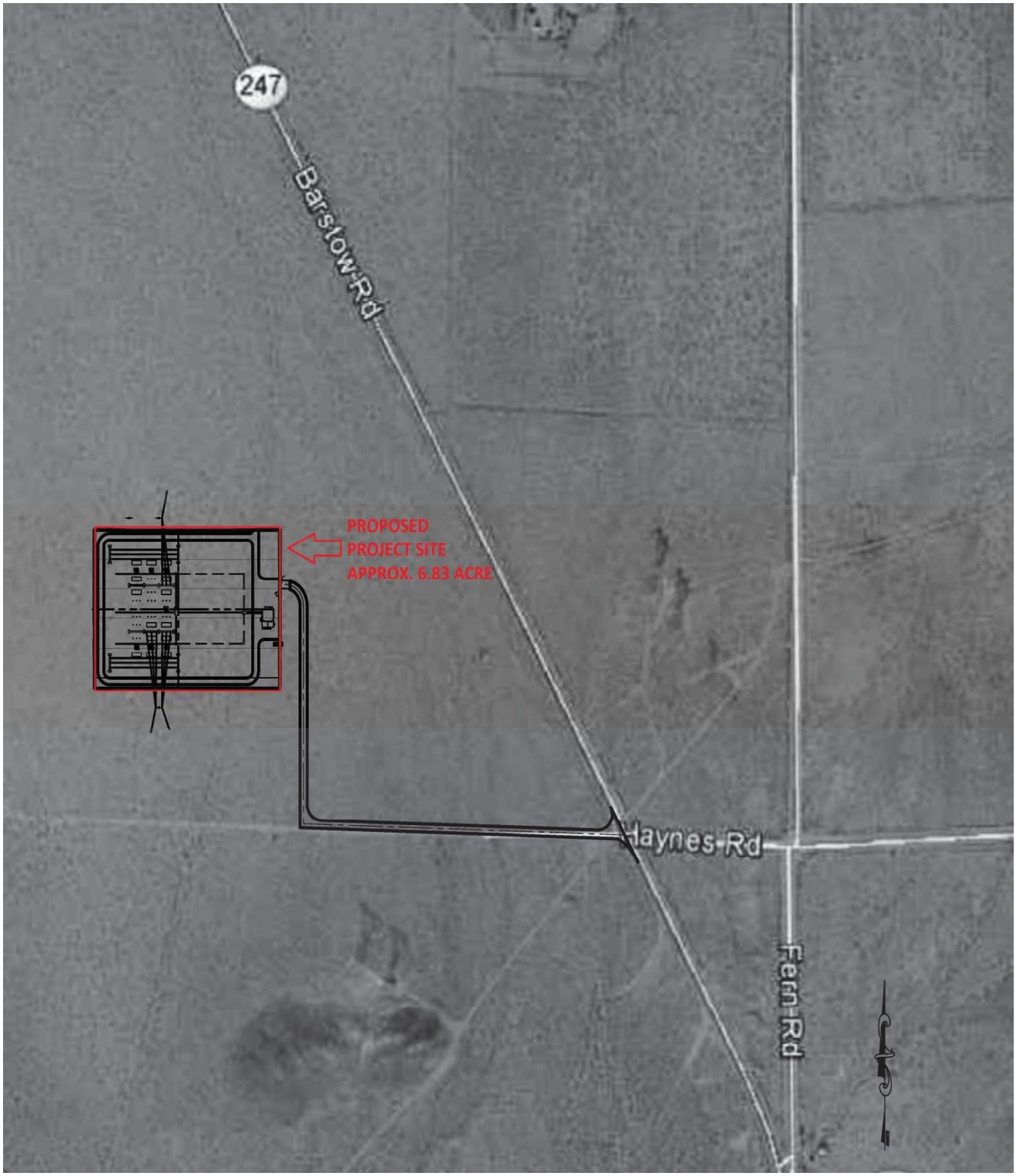
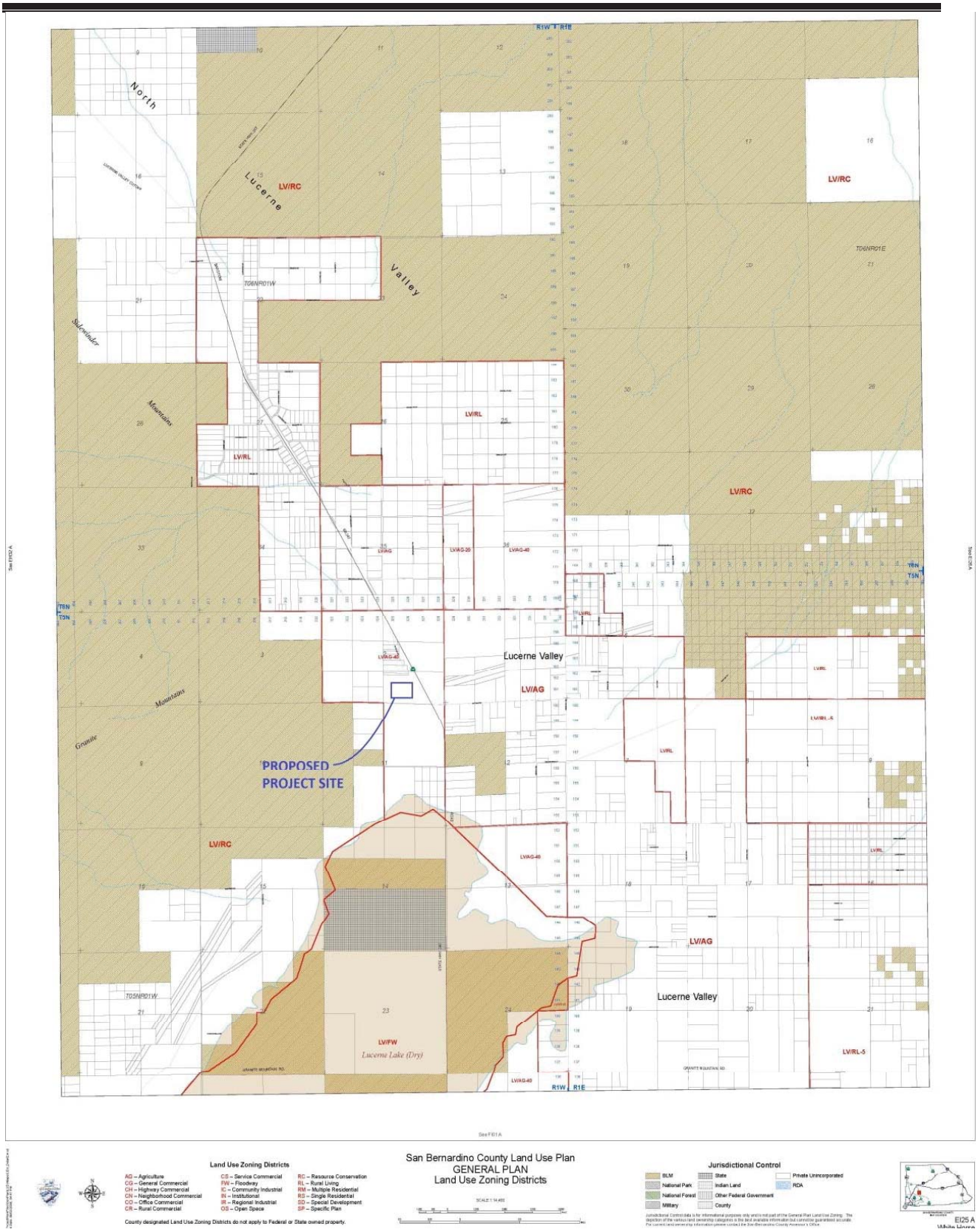


FIGURE 3: LAND USE MAP



APPENDIX A:
OFF-SITE HYDROLOGY CALCULATIONS (RATIONAL METHOD)

APPENDIX A.1:
100-YEAR HYDROLOGY CALCULATIONS

```
                San Bernardino County Rational Hydrology Program

                    (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2004 Version 7.0
        Rational Hydrology Study        Date: 08/08/16
----------------------------------------------------------------------
1235-0247 CALCITE SUBSTATION
AREA A - EXISTING CONDITION
100-YR
FN: AEX100
----------------------------------------------------------------------


Program License Serial Number 4042

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.200 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.000 to Point/Station      101.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Initial subarea data:
Initial area flow distance =   966.000(Ft.)
Top (of initial area) elevation =  3050.000(Ft.)
Bottom (of initial area) elevation =  2989.000(Ft.)
Difference in elevation =    61.000(Ft.)
Slope =    0.06315  s(%)=       6.31
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   14.259 min.
Rainfall intensity =      3.281(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.885
Subarea runoff =     13.006(CFS)
Total initial stream area =        4.480(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.055(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      101.000 to Point/Station      102.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.268(Ft.), Average velocity =   2.336(Ft/s)
       ******* Irregular Channel Data ***********
-----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
-----------------------------------------------------------------
```

```
Sub-Channel flow  =     16.801(CFS)
  '     '       flow top width =     53.630(Ft.)
  '     '    velocity=    2.337(Ft/s)
  '     '       area =      7.191(Sq.Ft)
  '     '       Froude number =     1.125

Upstream point elevation =  2989.000(Ft.)
Downstream point elevation =  2954.000(Ft.)
Flow length =   793.000(Ft.)
Travel time  =    5.66 min.
Time of concentration =   19.92 min.
Depth of flow =   0.268(Ft.)
Average velocity =   2.336(Ft/s)
Total irregular channel flow =    16.801(CFS)
Irregular channel normal depth above invert elev. =   0.268(Ft.)
Average velocity of channel(s) =   2.336(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      2.597(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.881
Subarea runoff =      7.488(CFS) for    4.480(Ac.)
Total runoff =     20.495(CFS)
Effective area this stream =        8.96(Ac.)
Total Study Area (Main Stream No. 1) =        8.96(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.289(Ft.), Average velocity =   2.456(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      102.000 to Point/Station      103.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.376(Ft.), Average velocity =   2.234(Ft/s)
       ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     31.589(CFS)
  '     '       flow top width =     75.211(Ft.)
  '     '    velocity=    2.234(Ft/s)
  '     '       area =     14.142(Sq.Ft)
  '     '       Froude number =     0.908

Upstream point elevation =  2954.000(Ft.)
Downstream point elevation =  2931.000(Ft.)
Flow length =   895.000(Ft.)
Travel time  =    6.68 min.
Time of concentration =   26.59 min.
Depth of flow =   0.376(Ft.)
Average velocity =   2.234(Ft/s)
Total irregular channel flow =    31.589(CFS)
Irregular channel normal depth above invert elev. =   0.376(Ft.)
Average velocity of channel(s) =   2.234(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
```

```
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      2.121(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.876
Subarea runoff =     22.097(CFS) for   13.950(Ac.)
Total runoff =     42.591(CFS)
Effective area this stream =       22.91(Ac.)
Total Study Area (Main Stream No. 1) =       22.91(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.421(Ft.), Average velocity =   2.407(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      103.000 to Point/Station      104.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.480(Ft.), Average velocity =   2.092(Ft/s)
       ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     48.170(CFS)
  '     '       flow top width =     95.966(Ft.)
  '     '    velocity=    2.092(Ft/s)
  '     '       area =     23.023(Sq.Ft)
  '     '       Froude number =     0.753

Upstream point elevation =  2931.000(Ft.)
Downstream point elevation =  2905.000(Ft.)
Flow length =  1596.000(Ft.)
Travel time  =   12.71 min.
Time of concentration =   39.31 min.
Depth of flow =   0.480(Ft.)
Average velocity =   2.092(Ft/s)
Total irregular channel flow =    48.170(CFS)
Irregular channel normal depth above invert elev. =   0.480(Ft.)
Average velocity of channel(s) =   2.092(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      1.613(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.869
Subarea runoff =     11.073(CFS) for   15.360(Ac.)
Total runoff =     53.665(CFS)
Effective area this stream =       38.27(Ac.)
Total Study Area (Main Stream No. 1) =       38.27(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.500(Ft.), Average velocity =   2.149(Ft/s)
End of computations, Total Study Area =           38.27 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.
```

```
Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

```
                San Bernardino County Rational Hydrology Program

                    (Hydrology Manual Date - August 1986)

 CIVILCADD/CIVILDESIGN  Engineering Software, (c) 1989-2004 Version 7.0
        Rational Hydrology Study        Date: 08/08/16
----------------------------------------------------------------------
1235-0247 CALCITE SUBSTATION
AREA B - EXISTING CONDITION
100-YR
FN: BEX100
----------------------------------------------------------------------


Program License Serial Number 4042

----------------------------------------------------------------------
 *********   Hydrology Study Control Information **********

----------------------------------------------------------------------
Rational hydrology study storm event year is   100.0
Computed rainfall intensity:
Storm year =   100.00   1 hour rainfall =     1.200 (In.)
Slope used for rainfall intensity curve b =  0.7000
Soil antecedent moisture condition (AMC) = 3


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.000 to Point/Station      201.000
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Initial subarea data:
Initial area flow distance =   958.000(Ft.)
Top (of initial area) elevation =  3100.000(Ft.)
Bottom (of initial area) elevation =  3013.000(Ft.)
Difference in elevation =    87.000(Ft.)
Slope =    0.09081  s(%)=       9.08
TC = k(0.525)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration =   13.215 min.
Rainfall intensity =      3.460(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.886
Subarea runoff =      9.316(CFS)
Total initial stream area =        3.040(Ac.)
Pervious area fraction = 1.000
Initial area Fm value =    0.055(In/Hr)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      201.000 to Point/Station      202.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.246(Ft.), Average velocity =   2.466(Ft/s)
       ******* Irregular Channel Data ***********
-------------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
-------------------------------------------------------------------
```

```
Sub-Channel flow  =     14.981(CFS)
  '     '       flow top width =     49.292(Ft.)
  '     '    velocity=    2.466(Ft/s)
  '     '       area =      6.074(Sq.Ft)
  '     '       Froude number =     1.238

Upstream point elevation =  3013.000(Ft.)
Downstream point elevation =  2955.000(Ft.)
Flow length =  1054.000(Ft.)
Travel time  =    7.12 min.
Time of concentration =   20.34 min.
Depth of flow =   0.246(Ft.)
Average velocity =   2.466(Ft/s)
Total irregular channel flow =    14.981(CFS)
Irregular channel normal depth above invert elev. =   0.246(Ft.)
Average velocity of channel(s) =   2.466(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      2.559(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.881
Subarea runoff =     11.256(CFS) for    6.090(Ac.)
Total runoff =     20.572(CFS)
Effective area this stream =        9.13(Ac.)
Total Study Area (Main Stream No. 1) =        9.13(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.278(Ft.), Average velocity =   2.670(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      202.000 to Point/Station      203.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.331(Ft.), Average velocity =   2.407(Ft/s)
       ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     26.368(CFS)
  '     '       flow top width =     66.192(Ft.)
  '     '    velocity=    2.407(Ft/s)
  '     '       area =     10.954(Sq.Ft)
  '     '       Froude number =     1.043

Upstream point elevation =  2955.000(Ft.)
Downstream point elevation =  2924.000(Ft.)
Flow length =   876.000(Ft.)
Travel time  =    6.06 min.
Time of concentration =   26.40 min.
Depth of flow =   0.331(Ft.)
Average velocity =   2.407(Ft/s)
Total irregular channel flow =    26.368(CFS)
Irregular channel normal depth above invert elev. =   0.331(Ft.)
Average velocity of channel(s) =   2.407(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
```

```
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      2.132(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.877
Subarea runoff =     11.532(CFS) for    8.050(Ac.)
Total runoff =     32.104(CFS)
Effective area this stream =       17.18(Ac.)
Total Study Area (Main Stream No. 1) =       17.18(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.356(Ft.), Average velocity =   2.529(Ft/s)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      203.000 to Point/Station      204.000
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      0.000(CFS)
Depth of flow =   0.425(Ft.), Average velocity =   1.972(Ft/s)
       ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number      'X' coordinate     'Y' coordinate
       1              0.00              1.00
       2            100.00              0.00
       3            200.00              1.00
Manning's 'N' friction factor =   0.035
----------------------------------------------------------------
Sub-Channel flow  =     35.594(CFS)
  '     '       flow top width =     84.975(Ft.)
  '     '    velocity=    1.972(Ft/s)
  '     '       area =     18.052(Sq.Ft)
  '     '       Froude number =     0.754

Upstream point elevation =  2924.000(Ft.)
Downstream point elevation =  2904.500(Ft.)
Flow length =  1146.000(Ft.)
Travel time  =    9.69 min.
Time of concentration =   36.09 min.
Depth of flow =   0.425(Ft.)
Average velocity =   1.972(Ft/s)
Total irregular channel flow =    35.594(CFS)
Irregular channel normal depth above invert elev. =   0.425(Ft.)
Average velocity of channel(s) =   1.972(Ft/s)
 Adding area flow to channel
UNDEVELOPED (poor cover) subarea
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
SCS curve number for soil(AMC 2)  = 86.00
Adjusted SCS curve number for AMC 3 = 97.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.055(In/Hr)
Rainfall intensity =      1.713(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.871
Subarea runoff =      6.889(CFS) for    8.960(Ac.)
Total runoff =     38.993(CFS)
Effective area this stream =       26.14(Ac.)
Total Study Area (Main Stream No. 1) =       26.14(Ac.)
Area averaged Fm value =    0.055(In/Hr)
Depth of flow =   0.440(Ft.), Average velocity =   2.017(Ft/s)
End of computations, Total Study Area =           26.14 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.
```

```
Area averaged pervious area fraction(Ap) = 1.000
Area averaged SCS curve number =  86.0
```

APPENDIX B:
ON-SITE HYDROLOGY CALCULATIONS BASED ON PROPOSED CONDITION
(RATIONAL METHOD)

APPENDIX B.1:
100-YEAR HYDROLOGY CALCULATIONS

San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2004 Version 7.0
Rational Hydrology Study Date: 09/22/16

1235-0247 CALCITE SUBSTATION
AREA C - PROPOSED CONDITION
100-YR
FN: CPR100

Program License Serial Number 4042

********* Hydrology Study Control Information **********

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 1.200 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 3

++
Process from Point/Station 100.000 to Point/Station 101.000
**** INITIAL AREA EVALUATION ****
_____
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.30
Adjusted SCS curve number for AMC 3 = 98.26
Pervious ratio(Ap) = 0.7620 Max loss rate(Fm)= 0.026(In/Hr)
Initial subarea data:
Initial area flow distance = 482.000(Ft.)
Top (of initial area) elevation = 2910.000(Ft.)
Bottom (of initial area) elevation = 2902.800(Ft.)
Difference in elevation = 7.200(Ft.)
Slope = 0.01494 s(%)= 1.49
TC = k(0.462)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 12.688 min.
Rainfall intensity = 3.561(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.893
Subarea runoff = 22.647(CFS)
Total initial stream area = 7.120(Ac.)
Pervious area fraction = 0.762
Initial area Fm value = 0.026(In/Hr)
End of computations, Total Study Area = 7.12 (Ac.)
The following figures may
be used for a unit hydrograph study of the same area.
Note: These figures do not consider reduced effective area
effects caused by confluences in the rational equation.

Area averaged pervious area fraction(Ap) = 0.762
Area averaged SCS curve number = 91.3

Normal Depth Across Substation

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.01500	ft/ft
Bottom Width	620.00	ft
Discharge	22.65	ft^3/s

Results

Normal Depth	0.06	ft
Flow Area	34.31	ft^2
Wetted Perimeter	620.11	ft
Hydraulic Radius	0.06	ft
Top Width	620.00	ft
Critical Depth	0.03	ft
Critical Slope	0.07151	ft/ft
Velocity	0.66	ft/s
Velocity Head	0.01	ft
Specific Energy	0.06	ft
Froude Number	0.49	
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	0.06	ft
Critical Depth	0.03	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.07151	ft/ft

Cross Section-Substation

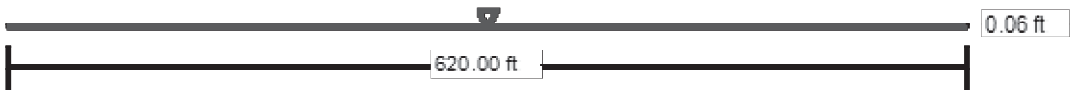
Project Description

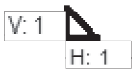
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.01500	ft/ft
Normal Depth	0.06	ft
Bottom Width	620.00	ft
Discharge	22.65	ft^3/s

Cross Section Image





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APPENDIX C:
ON-SITE HYDROLOGY CALCULATIONS BASED ON EXISTING CONDITION
(UNIT HYDROGRAPH METHOD)

APPENDIX C.1:
100 YEAR/24-HOUR HYDROLOGY CALCULATIONS

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 08/22/16

++

San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 4042

1235-0247 CALCITE SUBSTATION
AREA C - EXISTING CONDITION
100YR-24HR
FN: CEX10024

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
7.12	1	0.75
Rainfall data for year 2		
7.12	6	0.80
Rainfall data for year 2		
7.12	24	1.20
Rainfall data for year 100		
7.12	1	1.20
Rainfall data for year 100		
7.12	6	2.00
Rainfall data for year 100		
7.12	24	3.50

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 3)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
91.0	98.2	7.12	1.000	0.036	1.000	0.036

Area-averaged adjusted loss rate Fm (In/Hr) = 0.036

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC3)	S	Pervious Yield Fr
7.12	1.000	91.0	98.2	0.18	0.940

Area-averaged catchment yield fraction, Y = 0.940
Area-averaged low loss fraction, Yb = 0.060
++
Watercourse length = 482.00(Ft.)
Length from concentration point to centroid = 230.00(Ft.)
Elevation difference along watercourse = 7.20(Ft.)
Mannings friction factor along watercourse = 0.035
Watershed area = 7.12(Ac.)
Catchment Lag time = 0.045 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 185.8410
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.060 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.569(In)
Computed peak 30-minute rainfall = 0.975(In)
Specified peak 1-hour rainfall = 1.200(In)
Computed peak 3-hour rainfall = 1.641(In)
Specified peak 6-hour rainfall = 2.000(In)
Specified peak 24-hour rainfall = 3.500(In)

Rainfall depth area reduction factors:
Using a total area of 7.12(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000 Adjusted rainfall = 0.569(In)
30-minute factor = 1.000 Adjusted rainfall = 0.974(In)
1-hour factor = 1.000 Adjusted rainfall = 1.200(In)
3-hour factor = 1.000 Adjusted rainfall = 1.641(In)
6-hour factor = 1.000 Adjusted rainfall = 2.000(In)
24-hour factor = 1.000 Adjusted rainfall = 3.500(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 86.11 (CFS))	
1	39.544	34.050
2	86.097	40.086
3	95.754	8.315
4	98.886	2.697
5	100.000	0.959

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5692	0.5692
2	0.7008	0.1316
3	0.7914	0.0906
4	0.8628	0.0713
5	0.9225	0.0597
6	0.9744	0.0519
7	1.0205	0.0461
8	1.0622	0.0417
9	1.1004	0.0382
10	1.1357	0.0353
11	1.1687	0.0329
12	1.1996	0.0309
13	1.2273	0.0277
14	1.2535	0.0262
15	1.2785	0.0249
16	1.3022	0.0238
17	1.3250	0.0227
18	1.3467	0.0218

19	1.3677	0.0209
20	1.3879	0.0202
21	1.4073	0.0195
22	1.4261	0.0188
23	1.4443	0.0182
24	1.4620	0.0176
25	1.4791	0.0171
26	1.4957	0.0166
27	1.5119	0.0162
28	1.5277	0.0158
29	1.5431	0.0154
30	1.5581	0.0150
31	1.5727	0.0146
32	1.5871	0.0143
33	1.6011	0.0140
34	1.6147	0.0137
35	1.6282	0.0134
36	1.6413	0.0131
37	1.6542	0.0129
38	1.6668	0.0126
39	1.6792	0.0124
40	1.6914	0.0122
41	1.7033	0.0120
42	1.7151	0.0117
43	1.7266	0.0115
44	1.7380	0.0114
45	1.7491	0.0112
46	1.7601	0.0110
47	1.7709	0.0108
48	1.7816	0.0107
49	1.7921	0.0105
50	1.8025	0.0104
51	1.8127	0.0102
52	1.8227	0.0101
53	1.8327	0.0099
54	1.8425	0.0098
55	1.8521	0.0097
56	1.8617	0.0095
57	1.8711	0.0094
58	1.8804	0.0093
59	1.8896	0.0092
60	1.8986	0.0091
61	1.9076	0.0090
62	1.9165	0.0089
63	1.9252	0.0088
64	1.9339	0.0087
65	1.9425	0.0086
66	1.9509	0.0085
67	1.9593	0.0084
68	1.9676	0.0083
69	1.9758	0.0082
70	1.9840	0.0081
71	1.9920	0.0080
72	2.0000	0.0080
73	2.0111	0.0112
74	2.0222	0.0111
75	2.0332	0.0110
76	2.0441	0.0109
77	2.0549	0.0108
78	2.0656	0.0107
79	2.0763	0.0107
80	2.0869	0.0106
81	2.0973	0.0105
82	2.1078	0.0104
83	2.1181	0.0103
84	2.1284	0.0103
85	2.1386	0.0102
86	2.1487	0.0101
87	2.1587	0.0101
88	2.1687	0.0100
89	2.1786	0.0099

90	2.1885	0.0098
91	2.1983	0.0098
92	2.2080	0.0097
93	2.2176	0.0097
94	2.2272	0.0096
95	2.2368	0.0095
96	2.2462	0.0095
97	2.2557	0.0094
98	2.2650	0.0094
99	2.2743	0.0093
100	2.2836	0.0092
101	2.2928	0.0092
102	2.3019	0.0091
103	2.3110	0.0091
104	2.3200	0.0090
105	2.3290	0.0090
106	2.3379	0.0089
107	2.3468	0.0089
108	2.3556	0.0088
109	2.3644	0.0088
110	2.3731	0.0087
111	2.3818	0.0087
112	2.3905	0.0086
113	2.3991	0.0086
114	2.4076	0.0085
115	2.4161	0.0085
116	2.4246	0.0085
117	2.4330	0.0084
118	2.4414	0.0084
119	2.4497	0.0083
120	2.4580	0.0083
121	2.4662	0.0082
122	2.4744	0.0082
123	2.4826	0.0082
124	2.4907	0.0081
125	2.4988	0.0081
126	2.5069	0.0081
127	2.5149	0.0080
128	2.5229	0.0080
129	2.5308	0.0079
130	2.5387	0.0079
131	2.5466	0.0079
132	2.5544	0.0078
133	2.5622	0.0078
134	2.5699	0.0078
135	2.5777	0.0077
136	2.5854	0.0077
137	2.5930	0.0077
138	2.6006	0.0076
139	2.6082	0.0076
140	2.6158	0.0076
141	2.6233	0.0075
142	2.6308	0.0075
143	2.6383	0.0075
144	2.6457	0.0074
145	2.6531	0.0074
146	2.6605	0.0074
147	2.6678	0.0073
148	2.6751	0.0073
149	2.6824	0.0073
150	2.6897	0.0073
151	2.6969	0.0072
152	2.7041	0.0072
153	2.7113	0.0072
154	2.7184	0.0071
155	2.7255	0.0071
156	2.7326	0.0071
157	2.7397	0.0071
158	2.7467	0.0070
159	2.7537	0.0070
160	2.7607	0.0070

161	2.7676	0.0070
162	2.7745	0.0069
163	2.7814	0.0069
164	2.7883	0.0069
165	2.7952	0.0069
166	2.8020	0.0068
167	2.8088	0.0068
168	2.8156	0.0068
169	2.8223	0.0068
170	2.8291	0.0067
171	2.8358	0.0067
172	2.8425	0.0067
173	2.8491	0.0067
174	2.8557	0.0066
175	2.8624	0.0066
176	2.8690	0.0066
177	2.8755	0.0066
178	2.8821	0.0065
179	2.8886	0.0065
180	2.8951	0.0065
181	2.9016	0.0065
182	2.9080	0.0065
183	2.9145	0.0064
184	2.9209	0.0064
185	2.9273	0.0064
186	2.9337	0.0064
187	2.9400	0.0064
188	2.9464	0.0063
189	2.9527	0.0063
190	2.9590	0.0063
191	2.9653	0.0063
192	2.9715	0.0063
193	2.9778	0.0062
194	2.9840	0.0062
195	2.9902	0.0062
196	2.9964	0.0062
197	3.0025	0.0062
198	3.0087	0.0061
199	3.0148	0.0061
200	3.0209	0.0061
201	3.0270	0.0061
202	3.0331	0.0061
203	3.0391	0.0061
204	3.0451	0.0060
205	3.0512	0.0060
206	3.0572	0.0060
207	3.0631	0.0060
208	3.0691	0.0060
209	3.0751	0.0059
210	3.0810	0.0059
211	3.0869	0.0059
212	3.0928	0.0059
213	3.0987	0.0059
214	3.1045	0.0059
215	3.1104	0.0058
216	3.1162	0.0058
217	3.1220	0.0058
218	3.1278	0.0058
219	3.1336	0.0058
220	3.1394	0.0058
221	3.1451	0.0058
222	3.1509	0.0057
223	3.1566	0.0057
224	3.1623	0.0057
225	3.1680	0.0057
226	3.1737	0.0057
227	3.1793	0.0057
228	3.1850	0.0056
229	3.1906	0.0056
230	3.1962	0.0056
231	3.2018	0.0056

232	3.2074	0.0056
233	3.2130	0.0056
234	3.2186	0.0056
235	3.2241	0.0055
236	3.2296	0.0055
237	3.2352	0.0055
238	3.2407	0.0055
239	3.2461	0.0055
240	3.2516	0.0055
241	3.2571	0.0055
242	3.2625	0.0054
243	3.2680	0.0054
244	3.2734	0.0054
245	3.2788	0.0054
246	3.2842	0.0054
247	3.2896	0.0054
248	3.2949	0.0054
249	3.3003	0.0054
250	3.3056	0.0053
251	3.3110	0.0053
252	3.3163	0.0053
253	3.3216	0.0053
254	3.3269	0.0053
255	3.3322	0.0053
256	3.3374	0.0053
257	3.3427	0.0053
258	3.3479	0.0052
259	3.3532	0.0052
260	3.3584	0.0052
261	3.3636	0.0052
262	3.3688	0.0052
263	3.3740	0.0052
264	3.3792	0.0052
265	3.3843	0.0052
266	3.3895	0.0051
267	3.3946	0.0051
268	3.3997	0.0051
269	3.4049	0.0051
270	3.4100	0.0051
271	3.4151	0.0051
272	3.4201	0.0051
273	3.4252	0.0051
274	3.4303	0.0051
275	3.4353	0.0050
276	3.4404	0.0050
277	3.4454	0.0050
278	3.4504	0.0050
279	3.4554	0.0050
280	3.4604	0.0050
281	3.4654	0.0050
282	3.4703	0.0050
283	3.4753	0.0050
284	3.4803	0.0050
285	3.4852	0.0049
286	3.4901	0.0049
287	3.4951	0.0049
288	3.5000	0.0049

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0049	0.0003	0.0046
2	0.0049	0.0003	0.0046
3	0.0049	0.0003	0.0046
4	0.0050	0.0003	0.0047
5	0.0050	0.0003	0.0047
6	0.0050	0.0003	0.0047
7	0.0050	0.0003	0.0047
8	0.0050	0.0003	0.0047
9	0.0050	0.0003	0.0047

10	0.0050	0.0003	0.0047
11	0.0051	0.0003	0.0048
12	0.0051	0.0003	0.0048
13	0.0051	0.0003	0.0048
14	0.0051	0.0003	0.0048
15	0.0051	0.0003	0.0048
16	0.0051	0.0003	0.0048
17	0.0052	0.0003	0.0049
18	0.0052	0.0003	0.0049
19	0.0052	0.0003	0.0049
20	0.0052	0.0003	0.0049
21	0.0052	0.0003	0.0049
22	0.0053	0.0003	0.0049
23	0.0053	0.0003	0.0050
24	0.0053	0.0003	0.0050
25	0.0053	0.0003	0.0050
26	0.0053	0.0003	0.0050
27	0.0054	0.0003	0.0050
28	0.0054	0.0003	0.0050
29	0.0054	0.0003	0.0051
30	0.0054	0.0003	0.0051
31	0.0054	0.0003	0.0051
32	0.0054	0.0003	0.0051
33	0.0055	0.0003	0.0051
34	0.0055	0.0003	0.0052
35	0.0055	0.0003	0.0052
36	0.0055	0.0003	0.0052
37	0.0056	0.0003	0.0052
38	0.0056	0.0003	0.0052
39	0.0056	0.0003	0.0053
40	0.0056	0.0003	0.0053
41	0.0056	0.0003	0.0053
42	0.0057	0.0003	0.0053
43	0.0057	0.0003	0.0053
44	0.0057	0.0003	0.0054
45	0.0057	0.0003	0.0054
46	0.0058	0.0003	0.0054
47	0.0058	0.0003	0.0054
48	0.0058	0.0003	0.0055
49	0.0058	0.0004	0.0055
50	0.0058	0.0004	0.0055
51	0.0059	0.0004	0.0055
52	0.0059	0.0004	0.0055
53	0.0059	0.0004	0.0056
54	0.0059	0.0004	0.0056
55	0.0060	0.0004	0.0056
56	0.0060	0.0004	0.0056
57	0.0060	0.0004	0.0057
58	0.0061	0.0004	0.0057
59	0.0061	0.0004	0.0057
60	0.0061	0.0004	0.0057
61	0.0061	0.0004	0.0058
62	0.0062	0.0004	0.0058
63	0.0062	0.0004	0.0058
64	0.0062	0.0004	0.0058
65	0.0063	0.0004	0.0059
66	0.0063	0.0004	0.0059
67	0.0063	0.0004	0.0059
68	0.0063	0.0004	0.0060
69	0.0064	0.0004	0.0060
70	0.0064	0.0004	0.0060
71	0.0064	0.0004	0.0061
72	0.0065	0.0004	0.0061
73	0.0065	0.0004	0.0061
74	0.0065	0.0004	0.0061
75	0.0066	0.0004	0.0062
76	0.0066	0.0004	0.0062
77	0.0066	0.0004	0.0062
78	0.0067	0.0004	0.0063
79	0.0067	0.0004	0.0063
80	0.0067	0.0004	0.0063

81	0.0068	0.0004	0.0064
82	0.0068	0.0004	0.0064
83	0.0069	0.0004	0.0064
84	0.0069	0.0004	0.0065
85	0.0069	0.0004	0.0065
86	0.0070	0.0004	0.0065
87	0.0070	0.0004	0.0066
88	0.0070	0.0004	0.0066
89	0.0071	0.0004	0.0067
90	0.0071	0.0004	0.0067
91	0.0072	0.0004	0.0067
92	0.0072	0.0004	0.0068
93	0.0073	0.0004	0.0068
94	0.0073	0.0004	0.0068
95	0.0073	0.0004	0.0069
96	0.0074	0.0004	0.0069
97	0.0074	0.0004	0.0070
98	0.0075	0.0004	0.0070
99	0.0075	0.0005	0.0071
100	0.0076	0.0005	0.0071
101	0.0076	0.0005	0.0072
102	0.0077	0.0005	0.0072
103	0.0077	0.0005	0.0073
104	0.0078	0.0005	0.0073
105	0.0078	0.0005	0.0074
106	0.0079	0.0005	0.0074
107	0.0079	0.0005	0.0075
108	0.0080	0.0005	0.0075
109	0.0081	0.0005	0.0076
110	0.0081	0.0005	0.0076
111	0.0082	0.0005	0.0077
112	0.0082	0.0005	0.0077
113	0.0083	0.0005	0.0078
114	0.0083	0.0005	0.0078
115	0.0084	0.0005	0.0079
116	0.0085	0.0005	0.0080
117	0.0085	0.0005	0.0080
118	0.0086	0.0005	0.0081
119	0.0087	0.0005	0.0082
120	0.0087	0.0005	0.0082
121	0.0088	0.0005	0.0083
122	0.0089	0.0005	0.0083
123	0.0090	0.0005	0.0084
124	0.0090	0.0005	0.0085
125	0.0091	0.0006	0.0086
126	0.0092	0.0006	0.0086
127	0.0093	0.0006	0.0087
128	0.0094	0.0006	0.0088
129	0.0095	0.0006	0.0089
130	0.0095	0.0006	0.0090
131	0.0097	0.0006	0.0091
132	0.0097	0.0006	0.0091
133	0.0098	0.0006	0.0093
134	0.0099	0.0006	0.0093
135	0.0101	0.0006	0.0094
136	0.0101	0.0006	0.0095
137	0.0103	0.0006	0.0096
138	0.0103	0.0006	0.0097
139	0.0105	0.0006	0.0099
140	0.0106	0.0006	0.0099
141	0.0107	0.0006	0.0101
142	0.0108	0.0007	0.0102
143	0.0110	0.0007	0.0103
144	0.0111	0.0007	0.0104
145	0.0080	0.0005	0.0075
146	0.0080	0.0005	0.0076
147	0.0082	0.0005	0.0077
148	0.0083	0.0005	0.0078
149	0.0085	0.0005	0.0080
150	0.0086	0.0005	0.0081
151	0.0088	0.0005	0.0082

152	0.0089	0.0005	0.0083
153	0.0091	0.0005	0.0085
154	0.0092	0.0006	0.0086
155	0.0094	0.0006	0.0089
156	0.0095	0.0006	0.0090
157	0.0098	0.0006	0.0092
158	0.0099	0.0006	0.0093
159	0.0102	0.0006	0.0096
160	0.0104	0.0006	0.0097
161	0.0107	0.0006	0.0100
162	0.0108	0.0007	0.0102
163	0.0112	0.0007	0.0105
164	0.0114	0.0007	0.0107
165	0.0117	0.0007	0.0110
166	0.0120	0.0007	0.0112
167	0.0124	0.0007	0.0116
168	0.0126	0.0008	0.0119
169	0.0131	0.0008	0.0124
170	0.0134	0.0008	0.0126
171	0.0140	0.0008	0.0132
172	0.0143	0.0009	0.0135
173	0.0150	0.0009	0.0141
174	0.0154	0.0009	0.0144
175	0.0162	0.0010	0.0152
176	0.0166	0.0010	0.0156
177	0.0176	0.0011	0.0166
178	0.0182	0.0011	0.0171
179	0.0195	0.0012	0.0183
180	0.0202	0.0012	0.0190
181	0.0218	0.0013	0.0205
182	0.0227	0.0014	0.0214
183	0.0249	0.0015	0.0234
184	0.0262	0.0016	0.0247
185	0.0309	0.0019	0.0290
186	0.0329	0.0020	0.0310
187	0.0382	0.0023	0.0359
188	0.0417	0.0025	0.0392
189	0.0519	0.0030	0.0489
190	0.0597	0.0030	0.0568
191	0.0906	0.0030	0.0877
192	0.1316	0.0030	0.1286
193	0.5692	0.0030	0.5662
194	0.0713	0.0030	0.0684
195	0.0461	0.0028	0.0433
196	0.0353	0.0021	0.0332
197	0.0277	0.0017	0.0260
198	0.0238	0.0014	0.0223
199	0.0209	0.0013	0.0197
200	0.0188	0.0011	0.0177
201	0.0171	0.0010	0.0161
202	0.0158	0.0009	0.0148
203	0.0146	0.0009	0.0138
204	0.0137	0.0008	0.0129
205	0.0129	0.0008	0.0121
206	0.0122	0.0007	0.0114
207	0.0115	0.0007	0.0109
208	0.0110	0.0007	0.0103
209	0.0105	0.0006	0.0099
210	0.0101	0.0006	0.0095
211	0.0097	0.0006	0.0091
212	0.0093	0.0006	0.0087
213	0.0090	0.0005	0.0084
214	0.0087	0.0005	0.0081
215	0.0084	0.0005	0.0079
216	0.0081	0.0005	0.0076
217	0.0112	0.0007	0.0105
218	0.0109	0.0007	0.0102
219	0.0107	0.0006	0.0100
220	0.0104	0.0006	0.0098
221	0.0102	0.0006	0.0096
222	0.0100	0.0006	0.0094

223	0.0098	0.0006	0.0092
224	0.0096	0.0006	0.0090
225	0.0094	0.0006	0.0088
226	0.0092	0.0006	0.0087
227	0.0091	0.0005	0.0085
228	0.0089	0.0005	0.0084
229	0.0088	0.0005	0.0083
230	0.0086	0.0005	0.0081
231	0.0085	0.0005	0.0080
232	0.0084	0.0005	0.0079
233	0.0082	0.0005	0.0078
234	0.0081	0.0005	0.0076
235	0.0080	0.0005	0.0075
236	0.0079	0.0005	0.0074
237	0.0078	0.0005	0.0073
238	0.0077	0.0005	0.0072
239	0.0076	0.0005	0.0071
240	0.0075	0.0005	0.0070
241	0.0074	0.0004	0.0070
242	0.0073	0.0004	0.0069
243	0.0072	0.0004	0.0068
244	0.0071	0.0004	0.0067
245	0.0071	0.0004	0.0066
246	0.0070	0.0004	0.0066
247	0.0069	0.0004	0.0065
248	0.0068	0.0004	0.0064
249	0.0068	0.0004	0.0063
250	0.0067	0.0004	0.0063
251	0.0066	0.0004	0.0062
252	0.0065	0.0004	0.0062
253	0.0065	0.0004	0.0061
254	0.0064	0.0004	0.0060
255	0.0064	0.0004	0.0060
256	0.0063	0.0004	0.0059
257	0.0062	0.0004	0.0059
258	0.0062	0.0004	0.0058
259	0.0061	0.0004	0.0058
260	0.0061	0.0004	0.0057
261	0.0060	0.0004	0.0057
262	0.0060	0.0004	0.0056
263	0.0059	0.0004	0.0056
264	0.0059	0.0004	0.0055
265	0.0058	0.0004	0.0055
266	0.0058	0.0003	0.0054
267	0.0057	0.0003	0.0054
268	0.0057	0.0003	0.0053
269	0.0056	0.0003	0.0053
270	0.0056	0.0003	0.0053
271	0.0055	0.0003	0.0052
272	0.0055	0.0003	0.0052
273	0.0055	0.0003	0.0051
274	0.0054	0.0003	0.0051
275	0.0054	0.0003	0.0051
276	0.0053	0.0003	0.0050
277	0.0053	0.0003	0.0050
278	0.0053	0.0003	0.0050
279	0.0052	0.0003	0.0049
280	0.0052	0.0003	0.0049
281	0.0052	0.0003	0.0049
282	0.0051	0.0003	0.0048
283	0.0051	0.0003	0.0048
284	0.0051	0.0003	0.0048
285	0.0050	0.0003	0.0047
286	0.0050	0.0003	0.0047
287	0.0050	0.0003	0.0047
288	0.0049	0.0003	0.0046

Total soil rain loss = 0.17(In)
Total effective rainfall = 3.33(In)
Peak flow rate in flood hydrograph = 26.39(CFS)

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     ------------------------------------------------------------------
     ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                         24 - H O U R    S T O R M
                      R u n o f f     H y d r o g r a p h
     ------------------------------------------------------------------
                   Hydrograph in   5   Minute intervals ((CFS))

     ------------------------------------------------------------------
Time(h+m) Volume Ac.Ft   Q(CFS)  0        7.5      15.0      22.5      30.0
-----------------------------------------------------------------------
  0+ 5       0.0011      0.16  Q         |         |         |         |
  0+10       0.0034      0.34  Q         |         |         |         |
  0+15       0.0061      0.38  Q         |         |         |         |
  0+20       0.0088      0.40  Q         |         |         |         |
  0+25       0.0116      0.40  Q         |         |         |         |
  0+30       0.0143      0.40  Q         |         |         |         |
  0+35       0.0171      0.40  Q         |         |         |         |
  0+40       0.0199      0.41  Q         |         |         |         |
  0+45       0.0227      0.41  Q         |         |         |         |
  0+50       0.0255      0.41  Q         |         |         |         |
  0+55       0.0283      0.41  Q         |         |         |         |
  1+ 0       0.0312      0.41  Q         |         |         |         |
  1+ 5       0.0340      0.41  Q         |         |         |         |
  1+10       0.0368      0.41  Q         |         |         |         |
  1+15       0.0397      0.41  Q         |         |         |         |
  1+20       0.0425      0.42  Q         |         |         |         |
  1+25       0.0454      0.42  Q         |         |         |         |
  1+30       0.0483      0.42  Q         |         |         |         |
  1+35       0.0512      0.42  QV        |         |         |         |
  1+40       0.0541      0.42  QV        |         |         |         |
  1+45       0.0570      0.42  QV        |         |         |         |
  1+50       0.0599      0.42  QV        |         |         |         |
  1+55       0.0629      0.43  QV        |         |         |         |
  2+ 0       0.0658      0.43  QV        |         |         |         |
  2+ 5       0.0688      0.43  QV        |         |         |         |
  2+10       0.0717      0.43  QV        |         |         |         |
  2+15       0.0747      0.43  QV        |         |         |         |
  2+20       0.0777      0.43  QV        |         |         |         |
  2+25       0.0807      0.44  QV        |         |         |         |
  2+30       0.0837      0.44  QV        |         |         |         |
  2+35       0.0867      0.44  QV        |         |         |         |
  2+40       0.0897      0.44  QV        |         |         |         |
  2+45       0.0928      0.44  QV        |         |         |         |
  2+50       0.0958      0.44  QV        |         |         |         |
  2+55       0.0989      0.44  Q V       |         |         |         |
  3+ 0       0.1020      0.45  Q V       |         |         |         |
  3+ 5       0.1051      0.45  Q V       |         |         |         |
  3+10       0.1082      0.45  Q V       |         |         |         |
  3+15       0.1113      0.45  Q V       |         |         |         |
  3+20       0.1144      0.45  Q V       |         |         |         |
  3+25       0.1175      0.46  Q V       |         |         |         |
  3+30       0.1207      0.46  Q V       |         |         |         |
  3+35       0.1238      0.46  Q V       |         |         |         |
  3+40       0.1270      0.46  Q V       |         |         |         |
  3+45       0.1302      0.46  Q V       |         |         |         |
  3+50       0.1334      0.46  Q V       |         |         |         |
  3+55       0.1366      0.47  Q V       |         |         |         |
  4+ 0       0.1398      0.47  Q V       |         |         |         |
  4+ 5       0.1431      0.47  Q V       |         |         |         |
  4+10       0.1463      0.47  Q V       |         |         |         |
  4+15       0.1496      0.47  Q  V      |         |         |         |
  4+20       0.1529      0.48  Q  V      |         |         |         |
  4+25       0.1562      0.48  Q  V      |         |         |         |
  4+30       0.1595      0.48  Q  V      |         |         |         |
  4+35       0.1628      0.48  Q  V      |         |         |         |
  4+40       0.1661      0.48  Q  V      |         |         |         |
  4+45       0.1695      0.49  Q  V      |         |         |         |
  4+50       0.1728      0.49  Q  V      |         |         |         |
  4+55       0.1762      0.49  Q  V      |         |         |         |
  5+ 0       0.1796      0.49  Q  V      |         |         |         |
  5+ 5       0.1830      0.49  Q  V      |         |         |         |
```

```
 5+10       0.1864      0.50  Q  V      |         |         |         |
 5+15       0.1899      0.50  Q  V      |         |         |         |
 5+20       0.1933      0.50  Q  V      |         |         |         |
 5+25       0.1968      0.50  Q  V      |         |         |         |
 5+30       0.2003      0.51  Q   V     |         |         |         |
 5+35       0.2038      0.51  Q   V     |         |         |         |
 5+40       0.2073      0.51  Q   V     |         |         |         |
 5+45       0.2109      0.51  Q   V     |         |         |         |
 5+50       0.2144      0.52  Q   V     |         |         |         |
 5+55       0.2180      0.52  Q   V     |         |         |         |
 6+ 0       0.2216      0.52  Q   V     |         |         |         |
 6+ 5       0.2252      0.52  Q   V     |         |         |         |
 6+10       0.2288      0.53  Q   V     |         |         |         |
 6+15       0.2325      0.53  Q   V     |         |         |         |
 6+20       0.2361      0.53  Q   V     |         |         |         |
 6+25       0.2398      0.53  Q   V     |         |         |         |
 6+30       0.2435      0.54  Q   V     |         |         |         |
 6+35       0.2472      0.54  Q    V    |         |         |         |
 6+40       0.2510      0.54  Q    V    |         |         |         |
 6+45       0.2547      0.55  Q    V    |         |         |         |
 6+50       0.2585      0.55  Q    V    |         |         |         |
 6+55       0.2623      0.55  Q    V    |         |         |         |
 7+ 0       0.2661      0.55  Q    V    |         |         |         |
 7+ 5       0.2699      0.56  Q    V    |         |         |         |
 7+10       0.2738      0.56  Q    V    |         |         |         |
 7+15       0.2777      0.56  Q    V    |         |         |         |
 7+20       0.2816      0.57  Q    V    |         |         |         |
 7+25       0.2855      0.57  Q    V    |         |         |         |
 7+30       0.2895      0.57  Q    V    |         |         |         |
 7+35       0.2934      0.58  Q    V    |         |         |         |
 7+40       0.2974      0.58  Q     V   |         |         |         |
 7+45       0.3015      0.58  Q     V   |         |         |         |
 7+50       0.3055      0.59  Q     V   |         |         |         |
 7+55       0.3096      0.59  Q     V   |         |         |         |
 8+ 0       0.3137      0.59  Q     V   |         |         |         |
 8+ 5       0.3178      0.60  Q     V   |         |         |         |
 8+10       0.3219      0.60  Q     V   |         |         |         |
 8+15       0.3261      0.61  Q     V   |         |         |         |
 8+20       0.3303      0.61  Q     V   |         |         |         |
 8+25       0.3345      0.61  Q     V   |         |         |         |
 8+30       0.3388      0.62  Q     V   |         |         |         |
 8+35       0.3430      0.62  Q     V   |         |         |         |
 8+40       0.3473      0.63  Q      V  |         |         |         |
 8+45       0.3517      0.63  Q      V  |         |         |         |
 8+50       0.3560      0.63  Q      V  |         |         |         |
 8+55       0.3604      0.64  Q      V  |         |         |         |
 9+ 0       0.3649      0.64  Q      V  |         |         |         |
 9+ 5       0.3693      0.65  Q      V  |         |         |         |
 9+10       0.3738      0.65  Q      V  |         |         |         |
 9+15       0.3783      0.66  Q      V  |         |         |         |
 9+20       0.3829      0.66  Q      V  |         |         |         |
 9+25       0.3875      0.67  Q      V  |         |         |         |
 9+30       0.3921      0.67  Q      V  |         |         |         |
 9+35       0.3967      0.68  Q       V |         |         |         |
 9+40       0.4014      0.68  Q       V |         |         |         |
 9+45       0.4062      0.69  Q       V |         |         |         |
 9+50       0.4109      0.69  Q       V |         |         |         |
 9+55       0.4157      0.70  Q       V |         |         |         |
10+ 0       0.4206      0.70  Q       V |         |         |         |
10+ 5       0.4255      0.71  Q       V |         |         |         |
10+10       0.4304      0.71  Q       V |         |         |         |
10+15       0.4353      0.72  Q       V |         |         |         |
10+20       0.4404      0.73  Q       V |         |         |         |
10+25       0.4454      0.73  Q        V|         |         |         |
10+30       0.4505      0.74  Q        V|         |         |         |
10+35       0.4556      0.75  Q        V|         |         |         |
10+40       0.4608      0.75  |Q       V|         |         |         |
10+45       0.4661      0.76  |Q       V|         |         |         |
10+50       0.4713      0.77  |Q       V|         |         |         |
10+55       0.4767      0.77  |Q       V|         |         |         |
11+ 0       0.4821      0.78  |Q       V|         |         |         |
```

```
11+ 5       0.4875      0.79  |Q       V|         |         |         |
11+10       0.4930      0.80  |Q       V|         |         |         |
11+15       0.4985      0.81  |Q        V         |         |         |
11+20       0.5041      0.81  |Q        V         |         |         |
11+25       0.5098      0.82  |Q        V         |         |         |
11+30       0.5155      0.83  |Q        V         |         |         |
11+35       0.5213      0.84  |Q        V         |         |         |
11+40       0.5272      0.85  |Q        V         |         |         |
11+45       0.5331      0.86  |Q        V         |         |         |
11+50       0.5391      0.87  |Q        V         |         |         |
11+55       0.5451      0.88  |Q        |V        |         |         |
12+ 0       0.5512      0.89  |Q        |V        |         |         |
12+ 5       0.5567      0.79  |Q        |V        |         |         |
12+10       0.5614      0.68  Q         |V        |         |         |
12+15       0.5660      0.67  Q         |V        |         |         |
12+20       0.5706      0.67  Q         |V        |         |         |
12+25       0.5752      0.68  Q         |V        |         |         |
12+30       0.5800      0.69  Q         |V        |         |         |
12+35       0.5848      0.70  Q         |V        |         |         |
12+40       0.5897      0.71  Q         |V        |         |         |
12+45       0.5946      0.72  Q         | V       |         |         |
12+50       0.5997      0.74  Q         | V       |         |         |
12+55       0.6049      0.75  Q         | V       |         |         |
13+ 0       0.6101      0.76  |Q        | V       |         |         |
13+ 5       0.6155      0.78  |Q        | V       |         |         |
13+10       0.6209      0.79  |Q        | V       |         |         |
13+15       0.6265      0.81  |Q        | V       |         |         |
13+20       0.6322      0.83  |Q        | V       |         |         |
13+25       0.6380      0.84  |Q        | V       |         |         |
13+30       0.6440      0.86  |Q        |  V      |         |         |
13+35       0.6501      0.88  |Q        |  V      |         |         |
13+40       0.6563      0.91  |Q        |  V      |         |         |
13+45       0.6627      0.93  |Q        |  V      |         |         |
13+50       0.6692      0.95  |Q        |  V      |         |         |
13+55       0.6760      0.98  |Q        |  V      |         |         |
14+ 0       0.6829      1.00  |Q        |  V      |         |         |
14+ 5       0.6900      1.03  |Q        |  V      |         |         |
14+10       0.6973      1.07  |Q        |   V     |         |         |
14+15       0.7049      1.10  |Q        |   V     |         |         |
14+20       0.7127      1.13  |Q        |   V     |         |         |
14+25       0.7208      1.17  |Q        |   V     |         |         |
14+30       0.7292      1.22  |Q        |   V     |         |         |
14+35       0.7379      1.26  |Q        |   V     |         |         |
14+40       0.7469      1.31  |Q        |    V    |         |         |
14+45       0.7564      1.37  |Q        |    V    |         |         |
14+50       0.7663      1.43  |Q        |    V    |         |         |
14+55       0.7766      1.50  | Q       |    V    |         |         |
15+ 0       0.7875      1.58  | Q       |    V    |         |         |
15+ 5       0.7990      1.67  | Q       |     V   |         |         |
15+10       0.8112      1.77  | Q       |     V   |         |         |
15+15       0.8242      1.89  | Q       |     V   |         |         |
15+20       0.8382      2.03  | Q       |     V   |         |         |
15+25       0.8537      2.25  | Q       |      V  |         |         |
15+30       0.8710      2.51  |  Q      |      V  |         |         |
15+35       0.8902      2.79  |  Q      |       V |         |         |
15+40       0.9118      3.13  |   Q     |       V |         |         |
15+45       0.9369      3.65  |   Q     |       V |         |         |
15+50       0.9668      4.34  |    Q    |        V|         |         |
15+55       1.0068      5.81  |      Q  |         V         |         |
16+ 0       1.0656      8.53  |         |Q        |V        |         |
16+ 5       1.2403     25.36  |         |         |    V    |  Q      |
16+10       1.4220     26.39  |         |         |       V |    Q    |
16+15       1.4864      9.36  |         | Q       |         V         |
16+20       1.5215      5.09  |     Q   |         |         V         |
16+25       1.5442      3.31  |   Q     |         |         |V        |
16+30       1.5598      2.26  |  Q      |         |         |V        |
16+35       1.5730      1.91  | Q       |         |         |V        |
16+40       1.5846      1.68  | Q       |         |         | V       |
16+45       1.5949      1.51  | Q       |         |         | V       |
16+50       1.6044      1.37  |Q        |         |         | V       |
16+55       1.6131      1.26  |Q        |         |         | V       |
```

```
17+ 0       1.6211      1.17  |Q         |          |          | V        |
17+ 5       1.6287      1.10  |Q         |          |          | V        |
17+10       1.6358      1.03  |Q         |          |          |  V       |
17+15       1.6425      0.98  |Q         |          |          |  V       |
17+20       1.6489      0.93  |Q         |          |          |  V       |
17+25       1.6550      0.88  |Q         |          |          |  V       |
17+30       1.6608      0.84  |Q         |          |          |  V       |
17+35       1.6664      0.81  |Q         |          |          |  V       |
17+40       1.6717      0.78  |Q         |          |          |  V       |
17+45       1.6769      0.75  Q          |          |          |  V       |
17+50       1.6819      0.72  Q          |          |          |   V      |
17+55       1.6867      0.70  Q          |          |          |   V      |
18+ 0       1.6913      0.67  Q          |          |          |   V      |
18+ 5       1.6965      0.76  |Q         |          |          |   V      |
18+10       1.7025      0.86  |Q         |          |          |   V      |
18+15       1.7084      0.87  |Q         |          |          |   V      |
18+20       1.7143      0.86  |Q         |          |          |   V      |
18+25       1.7201      0.84  |Q         |          |          |   V      |
18+30       1.7258      0.82  |Q         |          |          |   V      |
18+35       1.7313      0.80  |Q         |          |          |    V     |
18+40       1.7367      0.79  |Q         |          |          |    V     |
18+45       1.7421      0.77  |Q         |          |          |    V     |
18+50       1.7473      0.76  |Q         |          |          |    V     |
18+55       1.7524      0.75  Q          |          |          |    V     |
19+ 0       1.7575      0.73  Q          |          |          |    V     |
19+ 5       1.7624      0.72  Q          |          |          |    V     |
19+10       1.7673      0.71  Q          |          |          |    V     |
19+15       1.7721      0.70  Q          |          |          |    V     |
19+20       1.7769      0.69  Q          |          |          |    V     |
19+25       1.7815      0.68  Q          |          |          |     V    |
19+30       1.7861      0.67  Q          |          |          |     V    |
19+35       1.7906      0.66  Q          |          |          |     V    |
19+40       1.7951      0.65  Q          |          |          |     V    |
19+45       1.7995      0.64  Q          |          |          |     V    |
19+50       1.8038      0.63  Q          |          |          |     V    |
19+55       1.8081      0.62  Q          |          |          |     V    |
20+ 0       1.8123      0.61  Q          |          |          |     V    |
20+ 5       1.8164      0.61  Q          |          |          |     V    |
20+10       1.8206      0.60  Q          |          |          |     V    |
20+15       1.8246      0.59  Q          |          |          |     V    |
20+20       1.8286      0.58  Q          |          |          |      V   |
20+25       1.8326      0.58  Q          |          |          |      V   |
20+30       1.8365      0.57  Q          |          |          |      V   |
20+35       1.8404      0.56  Q          |          |          |      V   |
20+40       1.8443      0.56  Q          |          |          |      V   |
20+45       1.8481      0.55  Q          |          |          |      V   |
20+50       1.8518      0.55  Q          |          |          |      V   |
20+55       1.8555      0.54  Q          |          |          |      V   |
21+ 0       1.8592      0.53  Q          |          |          |      V   |
21+ 5       1.8629      0.53  Q          |          |          |      V   |
21+10       1.8665      0.52  Q          |          |          |      V   |
21+15       1.8700      0.52  Q          |          |          |      V   |
21+20       1.8736      0.51  Q          |          |          |      V   |
21+25       1.8771      0.51  Q          |          |          |       V  |
21+30       1.8805      0.50  Q          |          |          |       V  |
21+35       1.8840      0.50  Q          |          |          |       V  |
21+40       1.8874      0.49  Q          |          |          |       V  |
21+45       1.8908      0.49  Q          |          |          |       V  |
21+50       1.8941      0.49  Q          |          |          |       V  |
21+55       1.8974      0.48  Q          |          |          |       V  |
22+ 0       1.9007      0.48  Q          |          |          |       V  |
22+ 5       1.9040      0.47  Q          |          |          |       V  |
22+10       1.9072      0.47  Q          |          |          |       V  |
22+15       1.9104      0.47  Q          |          |          |       V  |
22+20       1.9136      0.46  Q          |          |          |       V  |
22+25       1.9168      0.46  Q          |          |          |       V  |
22+30       1.9199      0.46  Q          |          |          |       V  |
22+35       1.9230      0.45  Q          |          |          |       V  |
22+40       1.9261      0.45  Q          |          |          |        V|
22+45       1.9292      0.44  Q          |          |          |        V|
22+50       1.9322      0.44  Q          |          |          |        V|
```

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   22+55       1.9352      0.44  Q         |         |         |        V|
   23+ 0       1.9382      0.43  Q         |         |         |        V|
   23+ 5       1.9412      0.43  Q         |         |         |        V|
   23+10       1.9441      0.43  Q         |         |         |        V|
   23+15       1.9471      0.43  Q         |         |         |        V|
   23+20       1.9500      0.42  Q         |         |         |        V|
   23+25       1.9529      0.42  Q         |         |         |        V|
   23+30       1.9558      0.42  Q         |         |         |        V|
   23+35       1.9586      0.41  Q         |         |         |        V|
   23+40       1.9614      0.41  Q         |         |         |        V|
   23+45       1.9643      0.41  Q         |         |         |        V|
   23+50       1.9671      0.41  Q         |         |         |        V|
   23+55       1.9698      0.40  Q         |         |         |        V|
   24+ 0       1.9726      0.40  Q         |         |         |        V|
   24+ 5       1.9743      0.24  Q         |         |         |        V|
   24+10       1.9746      0.06  Q         |         |         |        V|
   24+15       1.9748      0.02  Q         |         |         |        V|
   24+20       1.9748      0.00  Q         |         |         |        V|
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APPENDIX D:
ON-SITE HYDROLOGY CALCULATIONS BASED ON PROPOSED CONDITION
(UNIT HYDROGRAPH METHOD)

APPENDIX D.1:
100 YEAR/24-HOUR HYDROLOGY CALCULATIONS

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 08/22/16

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 4042

1235-0247 CALCITE SUBSTATION
AREA C - PROPOSED CONDITION
100YR-24HR
FN: CPR10024

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
7.12	1	0.75
Rainfall data for year 2		
7.12	6	0.80
Rainfall data for year 2		
7.12	24	1.20
Rainfall data for year 100		
7.12	1	1.20
Rainfall data for year 100		
7.12	6	2.00
Rainfall data for year 100		
7.12	24	3.50

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 3)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
91.3	98.3	7.12	1.000	0.035	0.762	0.026

Area-averaged adjusted loss rate Fm (In/Hr) = 0.026

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC3)	S	Pervious Yield Fr
5.43	0.762	91.3	98.3	0.18	0.941
1.69	0.238	98.0	98.0	0.20	0.933

Area-averaged catchment yield fraction, Y = 0.939
Area-averaged low loss fraction, Yb = 0.061
++
Watercourse length = 482.00(Ft.)
Length from concentration point to centroid = 230.00(Ft.)
Elevation difference along watercourse = 7.20(Ft.)
Mannings friction factor along watercourse = 0.040
Watershed area = 7.12(Ac.)
Catchment Lag time = 0.051 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 162.6109
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.026(In/Hr)
Average low loss rate fraction (Yb) = 0.061 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.569(In)
Computed peak 30-minute rainfall = 0.975(In)
Specified peak 1-hour rainfall = 1.200(In)
Computed peak 3-hour rainfall = 1.641(In)
Specified peak 6-hour rainfall = 2.000(In)
Specified peak 24-hour rainfall = 3.500(In)

Rainfall depth area reduction factors:
Using a total area of 7.12(Ac.) (Ref: fig. E-4)

5-minute factor = 1.000 Adjusted rainfall = 0.569(In)
30-minute factor = 1.000 Adjusted rainfall = 0.974(In)
1-hour factor = 1.000 Adjusted rainfall = 1.200(In)
3-hour factor = 1.000 Adjusted rainfall = 1.641(In)
6-hour factor = 1.000 Adjusted rainfall = 2.000(In)
24-hour factor = 1.000 Adjusted rainfall = 3.500(In)

U n i t H y d r o g r a p h
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Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 86.11 (CFS))	
1	34.652	29.838
2	82.802	41.461
3	93.869	9.529
4	97.908	3.478
5	100.000	1.801

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.5692	0.5692
2	0.7008	0.1316
3	0.7914	0.0906
4	0.8628	0.0713
5	0.9225	0.0597
6	0.9744	0.0519
7	1.0205	0.0461
8	1.0622	0.0417
9	1.1004	0.0382
10	1.1357	0.0353
11	1.1687	0.0329
12	1.1996	0.0309
13	1.2273	0.0277
14	1.2535	0.0262
15	1.2785	0.0249
16	1.3022	0.0238
17	1.3250	0.0227

18	1.3467	0.0218
19	1.3677	0.0209
20	1.3879	0.0202
21	1.4073	0.0195
22	1.4261	0.0188
23	1.4443	0.0182
24	1.4620	0.0176
25	1.4791	0.0171
26	1.4957	0.0166
27	1.5119	0.0162
28	1.5277	0.0158
29	1.5431	0.0154
30	1.5581	0.0150
31	1.5727	0.0146
32	1.5871	0.0143
33	1.6011	0.0140
34	1.6147	0.0137
35	1.6282	0.0134
36	1.6413	0.0131
37	1.6542	0.0129
38	1.6668	0.0126
39	1.6792	0.0124
40	1.6914	0.0122
41	1.7033	0.0120
42	1.7151	0.0117
43	1.7266	0.0115
44	1.7380	0.0114
45	1.7491	0.0112
46	1.7601	0.0110
47	1.7709	0.0108
48	1.7816	0.0107
49	1.7921	0.0105
50	1.8025	0.0104
51	1.8127	0.0102
52	1.8227	0.0101
53	1.8327	0.0099
54	1.8425	0.0098
55	1.8521	0.0097
56	1.8617	0.0095
57	1.8711	0.0094
58	1.8804	0.0093
59	1.8896	0.0092
60	1.8986	0.0091
61	1.9076	0.0090
62	1.9165	0.0089
63	1.9252	0.0088
64	1.9339	0.0087
65	1.9425	0.0086
66	1.9509	0.0085
67	1.9593	0.0084
68	1.9676	0.0083
69	1.9758	0.0082
70	1.9840	0.0081
71	1.9920	0.0080
72	2.0000	0.0080
73	2.0111	0.0112
74	2.0222	0.0111
75	2.0332	0.0110
76	2.0441	0.0109
77	2.0549	0.0108
78	2.0656	0.0107
79	2.0763	0.0107
80	2.0869	0.0106
81	2.0973	0.0105
82	2.1078	0.0104
83	2.1181	0.0103
84	2.1284	0.0103
85	2.1386	0.0102
86	2.1487	0.0101
87	2.1587	0.0101
88	2.1687	0.0100

89	2.1786	0.0099
90	2.1885	0.0098
91	2.1983	0.0098
92	2.2080	0.0097
93	2.2176	0.0097
94	2.2272	0.0096
95	2.2368	0.0095
96	2.2462	0.0095
97	2.2557	0.0094
98	2.2650	0.0094
99	2.2743	0.0093
100	2.2836	0.0092
101	2.2928	0.0092
102	2.3019	0.0091
103	2.3110	0.0091
104	2.3200	0.0090
105	2.3290	0.0090
106	2.3379	0.0089
107	2.3468	0.0089
108	2.3556	0.0088
109	2.3644	0.0088
110	2.3731	0.0087
111	2.3818	0.0087
112	2.3905	0.0086
113	2.3991	0.0086
114	2.4076	0.0085
115	2.4161	0.0085
116	2.4246	0.0085
117	2.4330	0.0084
118	2.4414	0.0084
119	2.4497	0.0083
120	2.4580	0.0083
121	2.4662	0.0082
122	2.4744	0.0082
123	2.4826	0.0082
124	2.4907	0.0081
125	2.4988	0.0081
126	2.5069	0.0081
127	2.5149	0.0080
128	2.5229	0.0080
129	2.5308	0.0079
130	2.5387	0.0079
131	2.5466	0.0079
132	2.5544	0.0078
133	2.5622	0.0078
134	2.5699	0.0078
135	2.5777	0.0077
136	2.5854	0.0077
137	2.5930	0.0077
138	2.6006	0.0076
139	2.6082	0.0076
140	2.6158	0.0076
141	2.6233	0.0075
142	2.6308	0.0075
143	2.6383	0.0075
144	2.6457	0.0074
145	2.6531	0.0074
146	2.6605	0.0074
147	2.6678	0.0073
148	2.6751	0.0073
149	2.6824	0.0073
150	2.6897	0.0073
151	2.6969	0.0072
152	2.7041	0.0072
153	2.7113	0.0072
154	2.7184	0.0071
155	2.7255	0.0071
156	2.7326	0.0071
157	2.7397	0.0071
158	2.7467	0.0070
159	2.7537	0.0070

160	2.7607	0.0070
161	2.7676	0.0070
162	2.7745	0.0069
163	2.7814	0.0069
164	2.7883	0.0069
165	2.7952	0.0069
166	2.8020	0.0068
167	2.8088	0.0068
168	2.8156	0.0068
169	2.8223	0.0068
170	2.8291	0.0067
171	2.8358	0.0067
172	2.8425	0.0067
173	2.8491	0.0067
174	2.8557	0.0066
175	2.8624	0.0066
176	2.8690	0.0066
177	2.8755	0.0066
178	2.8821	0.0065
179	2.8886	0.0065
180	2.8951	0.0065
181	2.9016	0.0065
182	2.9080	0.0065
183	2.9145	0.0064
184	2.9209	0.0064
185	2.9273	0.0064
186	2.9337	0.0064
187	2.9400	0.0064
188	2.9464	0.0063
189	2.9527	0.0063
190	2.9590	0.0063
191	2.9653	0.0063
192	2.9715	0.0063
193	2.9778	0.0062
194	2.9840	0.0062
195	2.9902	0.0062
196	2.9964	0.0062
197	3.0025	0.0062
198	3.0087	0.0061
199	3.0148	0.0061
200	3.0209	0.0061
201	3.0270	0.0061
202	3.0331	0.0061
203	3.0391	0.0061
204	3.0451	0.0060
205	3.0512	0.0060
206	3.0572	0.0060
207	3.0631	0.0060
208	3.0691	0.0060
209	3.0751	0.0059
210	3.0810	0.0059
211	3.0869	0.0059
212	3.0928	0.0059
213	3.0987	0.0059
214	3.1045	0.0059
215	3.1104	0.0058
216	3.1162	0.0058
217	3.1220	0.0058
218	3.1278	0.0058
219	3.1336	0.0058
220	3.1394	0.0058
221	3.1451	0.0058
222	3.1509	0.0057
223	3.1566	0.0057
224	3.1623	0.0057
225	3.1680	0.0057
226	3.1737	0.0057
227	3.1793	0.0057
228	3.1850	0.0056
229	3.1906	0.0056
230	3.1962	0.0056

231	3.2018	0.0056
232	3.2074	0.0056
233	3.2130	0.0056
234	3.2186	0.0056
235	3.2241	0.0055
236	3.2296	0.0055
237	3.2352	0.0055
238	3.2407	0.0055
239	3.2461	0.0055
240	3.2516	0.0055
241	3.2571	0.0055
242	3.2625	0.0054
243	3.2680	0.0054
244	3.2734	0.0054
245	3.2788	0.0054
246	3.2842	0.0054
247	3.2896	0.0054
248	3.2949	0.0054
249	3.3003	0.0054
250	3.3056	0.0053
251	3.3110	0.0053
252	3.3163	0.0053
253	3.3216	0.0053
254	3.3269	0.0053
255	3.3322	0.0053
256	3.3374	0.0053
257	3.3427	0.0053
258	3.3479	0.0052
259	3.3532	0.0052
260	3.3584	0.0052
261	3.3636	0.0052
262	3.3688	0.0052
263	3.3740	0.0052
264	3.3792	0.0052
265	3.3843	0.0052
266	3.3895	0.0051
267	3.3946	0.0051
268	3.3997	0.0051
269	3.4049	0.0051
270	3.4100	0.0051
271	3.4151	0.0051
272	3.4201	0.0051
273	3.4252	0.0051
274	3.4303	0.0051
275	3.4353	0.0050
276	3.4404	0.0050
277	3.4454	0.0050
278	3.4504	0.0050
279	3.4554	0.0050
280	3.4604	0.0050
281	3.4654	0.0050
282	3.4703	0.0050
283	3.4753	0.0050
284	3.4803	0.0050
285	3.4852	0.0049
286	3.4901	0.0049
287	3.4951	0.0049
288	3.5000	0.0049

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0049	0.0003	0.0046
2	0.0049	0.0003	0.0046
3	0.0049	0.0003	0.0046
4	0.0050	0.0003	0.0047
5	0.0050	0.0003	0.0047
6	0.0050	0.0003	0.0047
7	0.0050	0.0003	0.0047
8	0.0050	0.0003	0.0047

9	0.0050	0.0003	0.0047
10	0.0050	0.0003	0.0047
11	0.0051	0.0003	0.0048
12	0.0051	0.0003	0.0048
13	0.0051	0.0003	0.0048
14	0.0051	0.0003	0.0048
15	0.0051	0.0003	0.0048
16	0.0051	0.0003	0.0048
17	0.0052	0.0003	0.0049
18	0.0052	0.0003	0.0049
19	0.0052	0.0003	0.0049
20	0.0052	0.0003	0.0049
21	0.0052	0.0003	0.0049
22	0.0053	0.0003	0.0049
23	0.0053	0.0003	0.0050
24	0.0053	0.0003	0.0050
25	0.0053	0.0003	0.0050
26	0.0053	0.0003	0.0050
27	0.0054	0.0003	0.0050
28	0.0054	0.0003	0.0050
29	0.0054	0.0003	0.0051
30	0.0054	0.0003	0.0051
31	0.0054	0.0003	0.0051
32	0.0054	0.0003	0.0051
33	0.0055	0.0003	0.0051
34	0.0055	0.0003	0.0052
35	0.0055	0.0003	0.0052
36	0.0055	0.0003	0.0052
37	0.0056	0.0003	0.0052
38	0.0056	0.0003	0.0052
39	0.0056	0.0003	0.0053
40	0.0056	0.0003	0.0053
41	0.0056	0.0003	0.0053
42	0.0057	0.0003	0.0053
43	0.0057	0.0003	0.0053
44	0.0057	0.0003	0.0054
45	0.0057	0.0003	0.0054
46	0.0058	0.0003	0.0054
47	0.0058	0.0004	0.0054
48	0.0058	0.0004	0.0054
49	0.0058	0.0004	0.0055
50	0.0058	0.0004	0.0055
51	0.0059	0.0004	0.0055
52	0.0059	0.0004	0.0055
53	0.0059	0.0004	0.0056
54	0.0059	0.0004	0.0056
55	0.0060	0.0004	0.0056
56	0.0060	0.0004	0.0056
57	0.0060	0.0004	0.0057
58	0.0061	0.0004	0.0057
59	0.0061	0.0004	0.0057
60	0.0061	0.0004	0.0057
61	0.0061	0.0004	0.0058
62	0.0062	0.0004	0.0058
63	0.0062	0.0004	0.0058
64	0.0062	0.0004	0.0058
65	0.0063	0.0004	0.0059
66	0.0063	0.0004	0.0059
67	0.0063	0.0004	0.0059
68	0.0063	0.0004	0.0060
69	0.0064	0.0004	0.0060
70	0.0064	0.0004	0.0060
71	0.0064	0.0004	0.0060
72	0.0065	0.0004	0.0061
73	0.0065	0.0004	0.0061
74	0.0065	0.0004	0.0061
75	0.0066	0.0004	0.0062
76	0.0066	0.0004	0.0062
77	0.0066	0.0004	0.0062
78	0.0067	0.0004	0.0063
79	0.0067	0.0004	0.0063

80	0.0067	0.0004	0.0063
81	0.0068	0.0004	0.0064
82	0.0068	0.0004	0.0064
83	0.0069	0.0004	0.0064
84	0.0069	0.0004	0.0065
85	0.0069	0.0004	0.0065
86	0.0070	0.0004	0.0065
87	0.0070	0.0004	0.0066
88	0.0070	0.0004	0.0066
89	0.0071	0.0004	0.0067
90	0.0071	0.0004	0.0067
91	0.0072	0.0004	0.0067
92	0.0072	0.0004	0.0068
93	0.0073	0.0004	0.0068
94	0.0073	0.0004	0.0068
95	0.0073	0.0004	0.0069
96	0.0074	0.0004	0.0069
97	0.0074	0.0004	0.0070
98	0.0075	0.0005	0.0070
99	0.0075	0.0005	0.0071
100	0.0076	0.0005	0.0071
101	0.0076	0.0005	0.0072
102	0.0077	0.0005	0.0072
103	0.0077	0.0005	0.0073
104	0.0078	0.0005	0.0073
105	0.0078	0.0005	0.0074
106	0.0079	0.0005	0.0074
107	0.0079	0.0005	0.0075
108	0.0080	0.0005	0.0075
109	0.0081	0.0005	0.0076
110	0.0081	0.0005	0.0076
111	0.0082	0.0005	0.0077
112	0.0082	0.0005	0.0077
113	0.0083	0.0005	0.0078
114	0.0083	0.0005	0.0078
115	0.0084	0.0005	0.0079
116	0.0085	0.0005	0.0079
117	0.0085	0.0005	0.0080
118	0.0086	0.0005	0.0081
119	0.0087	0.0005	0.0082
120	0.0087	0.0005	0.0082
121	0.0088	0.0005	0.0083
122	0.0089	0.0005	0.0083
123	0.0090	0.0005	0.0084
124	0.0090	0.0005	0.0085
125	0.0091	0.0006	0.0086
126	0.0092	0.0006	0.0086
127	0.0093	0.0006	0.0087
128	0.0094	0.0006	0.0088
129	0.0095	0.0006	0.0089
130	0.0095	0.0006	0.0090
131	0.0097	0.0006	0.0091
132	0.0097	0.0006	0.0091
133	0.0098	0.0006	0.0093
134	0.0099	0.0006	0.0093
135	0.0101	0.0006	0.0094
136	0.0101	0.0006	0.0095
137	0.0103	0.0006	0.0096
138	0.0103	0.0006	0.0097
139	0.0105	0.0006	0.0099
140	0.0106	0.0006	0.0099
141	0.0107	0.0006	0.0101
142	0.0108	0.0007	0.0102
143	0.0110	0.0007	0.0103
144	0.0111	0.0007	0.0104
145	0.0080	0.0005	0.0075
146	0.0080	0.0005	0.0076
147	0.0082	0.0005	0.0077
148	0.0083	0.0005	0.0078
149	0.0085	0.0005	0.0080
150	0.0086	0.0005	0.0080

151	0.0088	0.0005	0.0082
152	0.0089	0.0005	0.0083
153	0.0091	0.0005	0.0085
154	0.0092	0.0006	0.0086
155	0.0094	0.0006	0.0088
156	0.0095	0.0006	0.0090
157	0.0098	0.0006	0.0092
158	0.0099	0.0006	0.0093
159	0.0102	0.0006	0.0096
160	0.0104	0.0006	0.0097
161	0.0107	0.0006	0.0100
162	0.0108	0.0007	0.0102
163	0.0112	0.0007	0.0105
164	0.0114	0.0007	0.0107
165	0.0117	0.0007	0.0110
166	0.0120	0.0007	0.0112
167	0.0124	0.0007	0.0116
168	0.0126	0.0008	0.0119
169	0.0131	0.0008	0.0123
170	0.0134	0.0008	0.0126
171	0.0140	0.0008	0.0132
172	0.0143	0.0009	0.0134
173	0.0150	0.0009	0.0141
174	0.0154	0.0009	0.0144
175	0.0162	0.0010	0.0152
176	0.0166	0.0010	0.0156
177	0.0176	0.0011	0.0166
178	0.0182	0.0011	0.0171
179	0.0195	0.0012	0.0183
180	0.0202	0.0012	0.0189
181	0.0218	0.0013	0.0205
182	0.0227	0.0014	0.0213
183	0.0249	0.0015	0.0234
184	0.0262	0.0016	0.0246
185	0.0309	0.0019	0.0290
186	0.0329	0.0020	0.0309
187	0.0382	0.0022	0.0360
188	0.0417	0.0022	0.0395
189	0.0519	0.0022	0.0497
190	0.0597	0.0022	0.0575
191	0.0906	0.0022	0.0884
192	0.1316	0.0022	0.1294
193	0.5692	0.0022	0.5670
194	0.0713	0.0022	0.0691
195	0.0461	0.0022	0.0439
196	0.0353	0.0021	0.0332
197	0.0277	0.0017	0.0260
198	0.0238	0.0014	0.0223
199	0.0209	0.0013	0.0197
200	0.0188	0.0011	0.0177
201	0.0171	0.0010	0.0161
202	0.0158	0.0010	0.0148
203	0.0146	0.0009	0.0138
204	0.0137	0.0008	0.0129
205	0.0129	0.0008	0.0121
206	0.0122	0.0007	0.0114
207	0.0115	0.0007	0.0108
208	0.0110	0.0007	0.0103
209	0.0105	0.0006	0.0099
210	0.0101	0.0006	0.0095
211	0.0097	0.0006	0.0091
212	0.0093	0.0006	0.0087
213	0.0090	0.0005	0.0084
214	0.0087	0.0005	0.0081
215	0.0084	0.0005	0.0079
216	0.0081	0.0005	0.0076
217	0.0112	0.0007	0.0105
218	0.0109	0.0007	0.0102
219	0.0107	0.0006	0.0100
220	0.0104	0.0006	0.0098
221	0.0102	0.0006	0.0096

222	0.0100	0.0006	0.0094
223	0.0098	0.0006	0.0092
224	0.0096	0.0006	0.0090
225	0.0094	0.0006	0.0088
226	0.0092	0.0006	0.0087
227	0.0091	0.0005	0.0085
228	0.0089	0.0005	0.0084
229	0.0088	0.0005	0.0082
230	0.0086	0.0005	0.0081
231	0.0085	0.0005	0.0080
232	0.0084	0.0005	0.0079
233	0.0082	0.0005	0.0077
234	0.0081	0.0005	0.0076
235	0.0080	0.0005	0.0075
236	0.0079	0.0005	0.0074
237	0.0078	0.0005	0.0073
238	0.0077	0.0005	0.0072
239	0.0076	0.0005	0.0071
240	0.0075	0.0005	0.0070
241	0.0074	0.0004	0.0070
242	0.0073	0.0004	0.0069
243	0.0072	0.0004	0.0068
244	0.0071	0.0004	0.0067
245	0.0071	0.0004	0.0066
246	0.0070	0.0004	0.0066
247	0.0069	0.0004	0.0065
248	0.0068	0.0004	0.0064
249	0.0068	0.0004	0.0063
250	0.0067	0.0004	0.0063
251	0.0066	0.0004	0.0062
252	0.0065	0.0004	0.0062
253	0.0065	0.0004	0.0061
254	0.0064	0.0004	0.0060
255	0.0064	0.0004	0.0060
256	0.0063	0.0004	0.0059
257	0.0062	0.0004	0.0059
258	0.0062	0.0004	0.0058
259	0.0061	0.0004	0.0058
260	0.0061	0.0004	0.0057
261	0.0060	0.0004	0.0057
262	0.0060	0.0004	0.0056
263	0.0059	0.0004	0.0056
264	0.0059	0.0004	0.0055
265	0.0058	0.0004	0.0055
266	0.0058	0.0003	0.0054
267	0.0057	0.0003	0.0054
268	0.0057	0.0003	0.0053
269	0.0056	0.0003	0.0053
270	0.0056	0.0003	0.0053
271	0.0055	0.0003	0.0052
272	0.0055	0.0003	0.0052
273	0.0055	0.0003	0.0051
274	0.0054	0.0003	0.0051
275	0.0054	0.0003	0.0051
276	0.0053	0.0003	0.0050
277	0.0053	0.0003	0.0050
278	0.0053	0.0003	0.0050
279	0.0052	0.0003	0.0049
280	0.0052	0.0003	0.0049
281	0.0052	0.0003	0.0048
282	0.0051	0.0003	0.0048
283	0.0051	0.0003	0.0048
284	0.0051	0.0003	0.0048
285	0.0050	0.0003	0.0047
286	0.0050	0.0003	0.0047
287	0.0050	0.0003	0.0047
288	0.0049	0.0003	0.0046

Total soil rain loss = 0.17(In)
Total effective rainfall = 3.33(In)

Peak flow rate in flood hydrograph = 27.22(CFS)

++

24 - H O U R S T O R M

R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0 7.5 15.0 22.5 30.0
0+ 5	0.0009	0.14	Q
0+10	0.0032	0.33	Q
0+15	0.0058	0.37	Q
0+20	0.0085	0.39	Q
0+25	0.0112	0.40	Q
0+30	0.0140	0.40	Q
0+35	0.0168	0.40	Q
0+40	0.0196	0.40	Q
0+45	0.0224	0.41	Q
0+50	0.0252	0.41	Q
0+55	0.0280	0.41	Q
1+ 0	0.0308	0.41	Q
1+ 5	0.0337	0.41	Q
1+10	0.0365	0.41	Q
1+15	0.0394	0.41	Q
1+20	0.0422	0.42	Q
1+25	0.0451	0.42	Q
1+30	0.0480	0.42	Q
1+35	0.0509	0.42	QV
1+40	0.0538	0.42	QV
1+45	0.0567	0.42	QV
1+50	0.0596	0.42	QV
1+55	0.0625	0.43	QV
2+ 0	0.0655	0.43	QV
2+ 5	0.0684	0.43	QV
2+10	0.0714	0.43	QV
2+15	0.0744	0.43	QV
2+20	0.0773	0.43	QV
2+25	0.0803	0.43	QV
2+30	0.0833	0.44	QV
2+35	0.0864	0.44	QV
2+40	0.0894	0.44	QV
2+45	0.0924	0.44	QV
2+50	0.0955	0.44	QV
2+55	0.0985	0.44	QV
3+ 0	0.1016	0.45	Q V
3+ 5	0.1047	0.45	Q V
3+10	0.1078	0.45	Q V
3+15	0.1109	0.45	Q V
3+20	0.1140	0.45	Q V
3+25	0.1172	0.45	Q V
3+30	0.1203	0.46	Q V
3+35	0.1235	0.46	Q V
3+40	0.1266	0.46	Q V
3+45	0.1298	0.46	Q V
3+50	0.1330	0.46	Q V
3+55	0.1362	0.47	Q V
4+ 0	0.1394	0.47	Q V
4+ 5	0.1427	0.47	Q V
4+10	0.1459	0.47	Q V
4+15	0.1492	0.47	Q V
4+20	0.1525	0.48	Q V
4+25	0.1557	0.48	Q V
4+30	0.1590	0.48	Q V
4+35	0.1624	0.48	Q V
4+40	0.1657	0.48	Q V
4+45	0.1690	0.49	Q V
4+50	0.1724	0.49	Q V
4+55	0.1758	0.49	Q V
5+ 0	0.1792	0.49	Q V

```
 5+ 5       0.1826      0.49  Q  V      |         |         |         |
 5+10       0.1860      0.50  Q  V      |         |         |         |
 5+15       0.1894      0.50  Q  V      |         |         |         |
 5+20       0.1929      0.50  Q  V      |         |         |         |
 5+25       0.1964      0.50  Q  V      |         |         |         |
 5+30       0.1998      0.51  Q   V     |         |         |         |
 5+35       0.2033      0.51  Q   V     |         |         |         |
 5+40       0.2069      0.51  Q   V     |         |         |         |
 5+45       0.2104      0.51  Q   V     |         |         |         |
 5+50       0.2140      0.52  Q   V     |         |         |         |
 5+55       0.2175      0.52  Q   V     |         |         |         |
 6+ 0       0.2211      0.52  Q   V     |         |         |         |
 6+ 5       0.2247      0.52  Q   V     |         |         |         |
 6+10       0.2283      0.53  Q   V     |         |         |         |
 6+15       0.2320      0.53  Q   V     |         |         |         |
 6+20       0.2356      0.53  Q   V     |         |         |         |
 6+25       0.2393      0.53  Q   V     |         |         |         |
 6+30       0.2430      0.54  Q   V     |         |         |         |
 6+35       0.2467      0.54  Q   V     |         |         |         |
 6+40       0.2505      0.54  Q    V    |         |         |         |
 6+45       0.2542      0.55  Q    V    |         |         |         |
 6+50       0.2580      0.55  Q    V    |         |         |         |
 6+55       0.2618      0.55  Q    V    |         |         |         |
 7+ 0       0.2656      0.55  Q    V    |         |         |         |
 7+ 5       0.2694      0.56  Q    V    |         |         |         |
 7+10       0.2733      0.56  Q    V    |         |         |         |
 7+15       0.2772      0.56  Q    V    |         |         |         |
 7+20       0.2811      0.57  Q    V    |         |         |         |
 7+25       0.2850      0.57  Q    V    |         |         |         |
 7+30       0.2889      0.57  Q    V    |         |         |         |
 7+35       0.2929      0.58  Q    V    |         |         |         |
 7+40       0.2969      0.58  Q     V   |         |         |         |
 7+45       0.3009      0.58  Q     V   |         |         |         |
 7+50       0.3050      0.59  Q     V   |         |         |         |
 7+55       0.3090      0.59  Q     V   |         |         |         |
 8+ 0       0.3131      0.59  Q     V   |         |         |         |
 8+ 5       0.3172      0.60  Q     V   |         |         |         |
 8+10       0.3214      0.60  Q     V   |         |         |         |
 8+15       0.3255      0.60  Q     V   |         |         |         |
 8+20       0.3297      0.61  Q     V   |         |         |         |
 8+25       0.3339      0.61  Q     V   |         |         |         |
 8+30       0.3382      0.62  Q     V   |         |         |         |
 8+35       0.3425      0.62  Q     V   |         |         |         |
 8+40       0.3468      0.62  Q      V  |         |         |         |
 8+45       0.3511      0.63  Q      V  |         |         |         |
 8+50       0.3554      0.63  Q      V  |         |         |         |
 8+55       0.3598      0.64  Q      V  |         |         |         |
 9+ 0       0.3643      0.64  Q      V  |         |         |         |
 9+ 5       0.3687      0.65  Q      V  |         |         |         |
 9+10       0.3732      0.65  Q      V  |         |         |         |
 9+15       0.3777      0.66  Q      V  |         |         |         |
 9+20       0.3823      0.66  Q      V  |         |         |         |
 9+25       0.3868      0.67  Q      V  |         |         |         |
 9+30       0.3915      0.67  Q      V  |         |         |         |
 9+35       0.3961      0.68  Q       V |         |         |         |
 9+40       0.4008      0.68  Q       V |         |         |         |
 9+45       0.4055      0.69  Q       V |         |         |         |
 9+50       0.4103      0.69  Q       V |         |         |         |
 9+55       0.4151      0.70  Q       V |         |         |         |
10+ 0       0.4199      0.70  Q       V |         |         |         |
10+ 5       0.4248      0.71  Q       V |         |         |         |
10+10       0.4297      0.71  Q       V |         |         |         |
10+15       0.4347      0.72  Q       V |         |         |         |
10+20       0.4397      0.73  Q       V |         |         |         |
10+25       0.4447      0.73  Q       V |         |         |         |
10+30       0.4498      0.74  Q        V|         |         |         |
10+35       0.4549      0.75  Q        V|         |         |         |
10+40       0.4601      0.75  |Q       V|         |         |         |
10+45       0.4653      0.76  |Q       V|         |         |         |
10+50       0.4706      0.77  |Q       V|         |         |         |
10+55       0.4759      0.77  |Q       V|         |         |         |
```

```
11+ 0       0.4813      0.78  |Q       V|         |         |         |
11+ 5       0.4867      0.79  |Q       V|         |         |         |
11+10       0.4922      0.80  |Q       V|         |         |         |
11+15       0.4978      0.80  |Q        V         |         |         |
11+20       0.5034      0.81  |Q        V         |         |         |
11+25       0.5090      0.82  |Q        V         |         |         |
11+30       0.5147      0.83  |Q        V         |         |         |
11+35       0.5205      0.84  |Q        V         |         |         |
11+40       0.5263      0.85  |Q        V         |         |         |
11+45       0.5323      0.86  |Q        V         |         |         |
11+50       0.5382      0.87  |Q        V         |         |         |
11+55       0.5443      0.88  |Q        |V        |         |         |
12+ 0       0.5504      0.89  |Q        |V        |         |         |
12+ 5       0.5559      0.81  |Q        |V        |         |         |
12+10       0.5607      0.69  Q         |V        |         |         |
12+15       0.5653      0.67  Q         |V        |         |         |
12+20       0.5699      0.67  Q         |V        |         |         |
12+25       0.5745      0.67  Q         |V        |         |         |
12+30       0.5793      0.68  Q         |V        |         |         |
12+35       0.5841      0.70  Q         |V        |         |         |
12+40       0.5889      0.71  Q         |V        |         |         |
12+45       0.5939      0.72  Q         | V       |         |         |
12+50       0.5989      0.73  Q         | V       |         |         |
12+55       0.6041      0.75  Q         | V       |         |         |
13+ 0       0.6093      0.76  |Q        | V       |         |         |
13+ 5       0.6147      0.78  |Q        | V       |         |         |
13+10       0.6201      0.79  |Q        | V       |         |         |
13+15       0.6257      0.81  |Q        | V       |         |         |
13+20       0.6314      0.82  |Q        | V       |         |         |
13+25       0.6372      0.84  |Q        | V       |         |         |
13+30       0.6431      0.86  |Q        |  V      |         |         |
13+35       0.6492      0.88  |Q        |  V      |         |         |
13+40       0.6554      0.90  |Q        |  V      |         |         |
13+45       0.6618      0.92  |Q        |  V      |         |         |
13+50       0.6683      0.95  |Q        |  V      |         |         |
13+55       0.6750      0.97  |Q        |  V      |         |         |
14+ 0       0.6819      1.00  |Q        |  V      |         |         |
14+ 5       0.6890      1.03  |Q        |  V      |         |         |
14+10       0.6963      1.06  |Q        |   V     |         |         |
14+15       0.7038      1.09  |Q        |   V     |         |         |
14+20       0.7116      1.13  |Q        |   V     |         |         |
14+25       0.7197      1.17  |Q        |   V     |         |         |
14+30       0.7280      1.21  |Q        |   V     |         |         |
14+35       0.7367      1.26  |Q        |   V     |         |         |
14+40       0.7457      1.31  |Q        |    V    |         |         |
14+45       0.7551      1.36  |Q        |    V    |         |         |
14+50       0.7649      1.43  |Q        |    V    |         |         |
14+55       0.7752      1.49  |Q        |    V    |         |         |
15+ 0       0.7860      1.57  | Q       |    V    |         |         |
15+ 5       0.7975      1.66  | Q       |     V   |         |         |
15+10       0.8096      1.76  | Q       |     V   |         |         |
15+15       0.8225      1.88  | Q       |     V   |         |         |
15+20       0.8364      2.01  | Q       |     V   |         |         |
15+25       0.8517      2.22  | Q       |      V  |         |         |
15+30       0.8688      2.48  |  Q      |      V  |         |         |
15+35       0.8878      2.76  |  Q      |      V  |         |         |
15+40       0.9093      3.11  |   Q     |       V |         |         |
15+45       0.9342      3.62  |   Q     |       V |         |         |
15+50       0.9640      4.33  |    Q    |        V|         |         |
15+55       1.0033      5.70  |      Q  |         V         |         |
16+ 0       1.0606      8.32  |         |Q        |V        |         |
16+ 5       1.2218     23.41  |         |         |   V     |Q        |
16+10       1.4093     27.22  |         |         |       V |     Q   |
16+15       1.4795     10.19  |         |  Q      |        V|         |
16+20       1.5185      5.68  |      Q  |         |         V         |
16+25       1.5449      3.83  |    Q    |         |         |V        |
16+30       1.5610      2.34  |  Q      |         |         |V        |
16+35       1.5745      1.96  | Q       |         |         |V        |
16+40       1.5863      1.71  | Q       |         |         | V       |
16+45       1.5968      1.52  | Q       |         |         | V       |
16+50       1.6063      1.39  |Q        |         |         | V       |
```

```
16+55       1.6151      1.28  |Q         |          |          | V        |
17+ 0       1.6232      1.18  |Q         |          |          | V        |
17+ 5       1.6309      1.11  |Q         |          |          | V        |
17+10       1.6380      1.04  |Q         |          |          |  V       |
17+15       1.6448      0.98  |Q         |          |          |  V       |
17+20       1.6512      0.93  |Q         |          |          |  V       |
17+25       1.6573      0.89  |Q         |          |          |  V       |
17+30       1.6632      0.85  |Q         |          |          |  V       |
17+35       1.6688      0.81  |Q         |          |          |  V       |
17+40       1.6741      0.78  |Q         |          |          |  V       |
17+45       1.6793      0.75  |Q         |          |          |  V       |
17+50       1.6843      0.72  Q          |          |          |   V      |
17+55       1.6891      0.70  Q          |          |          |   V      |
18+ 0       1.6938      0.68  Q          |          |          |   V      |
18+ 5       1.6989      0.75  Q          |          |          |   V      |
18+10       1.7048      0.86  |Q         |          |          |   V      |
18+15       1.7108      0.86  |Q         |          |          |   V      |
18+20       1.7166      0.85  |Q         |          |          |   V      |
18+25       1.7224      0.84  |Q         |          |          |   V      |
18+30       1.7281      0.82  |Q         |          |          |   V      |
18+35       1.7337      0.81  |Q         |          |          |    V     |
18+40       1.7391      0.79  |Q         |          |          |    V     |
18+45       1.7444      0.78  |Q         |          |          |    V     |
18+50       1.7497      0.76  |Q         |          |          |    V     |
18+55       1.7548      0.75  Q          |          |          |    V     |
19+ 0       1.7599      0.73  Q          |          |          |    V     |
19+ 5       1.7649      0.72  Q          |          |          |    V     |
19+10       1.7697      0.71  Q          |          |          |    V     |
19+15       1.7745      0.70  Q          |          |          |    V     |
19+20       1.7793      0.69  Q          |          |          |    V     |
19+25       1.7839      0.68  Q          |          |          |     V    |
19+30       1.7885      0.67  Q          |          |          |     V    |
19+35       1.7931      0.66  Q          |          |          |     V    |
19+40       1.7975      0.65  Q          |          |          |     V    |
19+45       1.8019      0.64  Q          |          |          |     V    |
19+50       1.8062      0.63  Q          |          |          |     V    |
19+55       1.8105      0.62  Q          |          |          |     V    |
20+ 0       1.8148      0.61  Q          |          |          |     V    |
20+ 5       1.8189      0.61  Q          |          |          |     V    |
20+10       1.8230      0.60  Q          |          |          |     V    |
20+15       1.8271      0.59  Q          |          |          |     V    |
20+20       1.8311      0.58  Q          |          |          |      V   |
20+25       1.8351      0.58  Q          |          |          |      V   |
20+30       1.8390      0.57  Q          |          |          |      V   |
20+35       1.8429      0.56  Q          |          |          |      V   |
20+40       1.8468      0.56  Q          |          |          |      V   |
20+45       1.8506      0.55  Q          |          |          |      V   |
20+50       1.8543      0.55  Q          |          |          |      V   |
20+55       1.8580      0.54  Q          |          |          |      V   |
21+ 0       1.8617      0.53  Q          |          |          |      V   |
21+ 5       1.8654      0.53  Q          |          |          |      V   |
21+10       1.8690      0.52  Q          |          |          |      V   |
21+15       1.8726      0.52  Q          |          |          |      V   |
21+20       1.8761      0.51  Q          |          |          |      V   |
21+25       1.8796      0.51  Q          |          |          |       V  |
21+30       1.8831      0.50  Q          |          |          |       V  |
21+35       1.8865      0.50  Q          |          |          |       V  |
21+40       1.8899      0.50  Q          |          |          |       V  |
21+45       1.8933      0.49  Q          |          |          |       V  |
21+50       1.8966      0.49  Q          |          |          |       V  |
21+55       1.9000      0.48  Q          |          |          |       V  |
22+ 0       1.9033      0.48  Q          |          |          |       V  |
22+ 5       1.9065      0.47  Q          |          |          |       V  |
22+10       1.9098      0.47  Q          |          |          |       V  |
22+15       1.9130      0.47  Q          |          |          |       V  |
22+20       1.9162      0.46  Q          |          |          |       V  |
22+25       1.9193      0.46  Q          |          |          |       V  |
22+30       1.9225      0.46  Q          |          |          |       V  |
22+35       1.9256      0.45  Q          |          |          |       V  |
22+40       1.9287      0.45  Q          |          |          |        V|
22+45       1.9317      0.44  Q          |          |          |        V|
```

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  22+50       1.9348      0.44  Q         |         |         |        V|
  22+55       1.9378      0.44  Q         |         |         |        V|
  23+ 0       1.9408      0.44  Q         |         |         |        V|
  23+ 5       1.9438      0.43  Q         |         |         |        V|
  23+10       1.9467      0.43  Q         |         |         |        V|
  23+15       1.9496      0.43  Q         |         |         |        V|
  23+20       1.9526      0.42  Q         |         |         |        V|
  23+25       1.9555      0.42  Q         |         |         |        V|
  23+30       1.9583      0.42  Q         |         |         |        V|
  23+35       1.9612      0.41  Q         |         |         |        V|
  23+40       1.9640      0.41  Q         |         |         |        V|
  23+45       1.9668      0.41  Q         |         |         |        V|
  23+50       1.9696      0.41  Q         |         |         |        V|
  23+55       1.9724      0.40  Q         |         |         |        V|
  24+ 0       1.9752      0.40  Q         |         |         |        V|
  24+ 5       1.9770      0.26  Q         |         |         |        V|
  24+10       1.9775      0.07  Q         |         |         |        V|
  24+15       1.9776      0.02  Q         |         |         |        V|
  24+20       1.9777      0.01  Q         |         |         |         V
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APPENDIX E:
100-YEAR FLOODPLAIN ANALYSIS

APPENDIX E.1:
100-YEAR/3-HOUR HYDROLOGY CALCULATION

U n i t H y d r o g r a p h A n a l y s i s

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2004, Version 7.0

Study date 08/31/16

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San Bernardino County Synthetic Unit Hydrology Method
Manual date - August 1986

Program License Serial Number 4042

1235-0247 CALCITE SUBSTATION
AREA A - EXISTING CONDITION
100YR-3HR
FN: AEX1003

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
Rainfall data for year 10		
5865.00	1	0.75
Rainfall data for year 2		
5865.00	6	0.80
Rainfall data for year 2		
5865.00	24	1.20
Rainfall data for year 100		
5865.00	1	1.20
Rainfall data for year 100		
5865.00	6	2.00
Rainfall data for year 100		
5865.00	24	3.50

++

******** Area-averaged max loss rate, Fm ********

SCS curve No.(AMCII)	SCS curve NO.(AMC 3)	Area (Ac.)	Area Fraction	Fp(Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
92.7	98.5	5865.00	1.000	0.029	1.000	0.029

Area-averaged adjusted loss rate Fm (In/Hr) = 0.029

********* Area-Averaged low loss rate fraction, Yb **********

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC3)	S	Pervious Yield Fr
5865.00	1.000	92.7	98.5	0.15	0.951

Area-averaged catchment yield fraction, Y = 0.951
Area-averaged low loss fraction, Yb = 0.049
++
Watercourse length = 36547.00(Ft.)
Length from concentration point to centroid = 21940.31(Ft.)
Elevation difference along watercourse = 1902.98(Ft.)
Mannings friction factor along watercourse = 0.035
Watershed area = 5865.00(Ac.)
Catchment Lag time = 1.036 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 8.0470
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.029(In/Hr)
Average low loss rate fraction (Yb) = 0.049 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.569(In)
Computed peak 30-minute rainfall = 0.975(In)
Specified peak 1-hour rainfall = 1.200(In)
Computed peak 3-hour rainfall = 1.641(In)
Specified peak 6-hour rainfall = 2.000(In)
Specified peak 24-hour rainfall = 3.500(In)

Rainfall depth area reduction factors:
Using a total area of 5865.00(Ac.) (Ref: fig. E-4)

5-minute factor = 0.763 Adjusted rainfall = 0.434(In)
30-minute factor = 0.763 Adjusted rainfall = 0.743(In)
1-hour factor = 0.763 Adjusted rainfall = 0.915(In)
3-hour factor = 0.967 Adjusted rainfall = 1.587(In)
6-hour factor = 0.983 Adjusted rainfall = 1.967(In)
24-hour factor = 0.992 Adjusted rainfall = 3.471(In)

U n i t H y d r o g r a p h
++

Interval Number	'S' Graph Mean values	Unit Hydrograph ((CFS))
	(K = 70929.84 (CFS))	
1	0.354	251.141
2	1.126	547.827
3	2.380	888.992
4	3.989	1141.079
5	6.021	1441.939
6	8.571	1808.378
7	12.031	2454.529
8	17.210	3673.017
9	24.541	5200.336
10	32.469	5623.169
11	39.413	4925.139
12	45.226	4123.368
13	50.218	3540.492
14	54.490	3030.301
15	58.106	2564.754
16	61.133	2147.091
17	63.726	1839.337
18	66.076	1666.637
19	68.189	1499.027
20	70.160	1397.950
21	71.987	1295.656
22	73.596	1141.456
23	75.066	1042.796
24	76.467	993.393
25	77.819	958.770
26	78.986	828.326

27	80.049	753.424
28	81.111	753.317
29	82.069	679.636
30	82.938	616.438
31	83.807	616.438
32	84.634	586.646
33	85.407	548.100
34	86.179	547.945
35	86.908	516.793
36	87.554	458.004
37	88.197	456.621
38	88.800	427.094
39	89.289	346.965
40	89.771	342.465
41	90.248	338.183
42	90.701	321.348
43	91.152	319.634
44	91.594	313.794
45	91.988	279.549
46	92.375	273.972
47	92.758	272.155
48	93.118	255.264
49	93.472	251.141
50	93.823	248.703
51	94.117	208.356
52	94.390	194.064
53	94.664	194.064
54	94.938	194.064
55	95.211	194.064
56	95.485	193.922
57	95.721	167.774
58	95.930	148.402
59	96.140	148.402
60	96.349	148.402
61	96.558	148.402
62	96.767	148.402
63	96.952	131.303
64	97.098	103.153
65	97.243	102.740
66	97.387	102.740
67	97.532	102.740
68	97.677	102.740
69	97.808	93.036
70	97.893	59.844
71	97.973	57.078
72	98.054	57.078
73	98.134	57.078
74	98.215	57.078
75	98.297	58.175
76	98.391	66.693
77	98.487	68.493
78	98.584	68.493
79	98.680	68.493
80	98.777	68.493
81	98.873	68.493
82	98.970	68.493
83	99.067	68.493
84	99.163	68.493
85	99.260	68.493
86	99.356	68.493
87	99.453	68.491
88	99.526	51.706
89	99.576	35.673
90	99.626	35.673
91	99.677	35.673
92	99.727	35.673
93	99.777	35.673
94	99.827	35.673
95	99.878	35.673
96	99.928	35.673
97	100.000	17.837

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.4342	0.4342
2	0.5346	0.1004
3	0.6037	0.0691
4	0.6581	0.0544
5	0.7037	0.0456
6	0.7433	0.0396
7	0.7784	0.0352
8	0.8103	0.0318
9	0.8394	0.0291
10	0.8664	0.0270
11	0.8915	0.0251
12	0.9151	0.0236
13	0.9525	0.0375
14	0.9886	0.0360
15	1.0233	0.0348
16	1.0570	0.0336
17	1.0896	0.0326
18	1.1212	0.0317
19	1.1520	0.0308
20	1.1820	0.0300
21	1.2113	0.0293
22	1.2399	0.0286
23	1.2678	0.0279
24	1.2951	0.0273
25	1.3219	0.0268
26	1.3481	0.0262
27	1.3739	0.0257
28	1.3992	0.0253
29	1.4240	0.0248
30	1.4484	0.0244
31	1.4724	0.0240
32	1.4960	0.0236
33	1.5192	0.0232
34	1.5421	0.0229
35	1.5647	0.0226
36	1.5869	0.0222

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0222	0.0011	0.0212
2	0.0226	0.0011	0.0215
3	0.0232	0.0011	0.0221
4	0.0236	0.0012	0.0225
5	0.0244	0.0012	0.0232
6	0.0248	0.0012	0.0236
7	0.0257	0.0013	0.0245
8	0.0262	0.0013	0.0250
9	0.0273	0.0013	0.0260
10	0.0279	0.0014	0.0266
11	0.0293	0.0014	0.0278
12	0.0300	0.0015	0.0285
13	0.0317	0.0016	0.0301
14	0.0326	0.0016	0.0310
15	0.0348	0.0017	0.0331
16	0.0360	0.0018	0.0343
17	0.0236	0.0012	0.0224
18	0.0251	0.0012	0.0239
19	0.0291	0.0014	0.0277
20	0.0318	0.0016	0.0303
21	0.0396	0.0019	0.0376
22	0.0456	0.0022	0.0433
23	0.0691	0.0024	0.0667
24	0.1004	0.0024	0.0979
25	0.4342	0.0024	0.4318
26	0.0544	0.0024	0.0520
27	0.0352	0.0017	0.0335

28	0.0270	0.0013	0.0256
29	0.0375	0.0018	0.0356
30	0.0336	0.0017	0.0320
31	0.0308	0.0015	0.0293
32	0.0286	0.0014	0.0272
33	0.0268	0.0013	0.0255
34	0.0253	0.0012	0.0240
35	0.0240	0.0012	0.0228
36	0.0229	0.0011	0.0218

Total soil rain loss = 0.06(In)
Total effective rainfall = 1.53(In)
Peak flow rate in flood hydrograph = 4709.95(CFS)

++

3 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

```
Time(h+m) Volume Ac.Ft   Q(CFS)  0     1200.0    2400.0    3600.0    4800.0
-----------------------------------------------------------------------------
  0+ 5       0.0366      5.31  Q         |         |         |         |
  0+10       0.1535     16.98  Q         |         |         |         |
  0+15       0.4023     36.12  Q         |         |         |         |
  0+20       0.8221     60.97  Q         |         |         |         |
  0+25       1.4611     92.77  Q         |         |         |         |
  0+30       2.3773    133.03  VQ        |         |         |         |
  0+35       3.6716    187.94  VQ        |         |         |         |
  0+40       5.5302    269.87  V Q       |         |         |         |
  0+45       8.1890    386.06  V  Q      |         |         |         |
  0+50      11.7283    513.90  V   Q     |         |         |         |
  0+55      16.0696    630.36  V    Q    |         |         |         |
  1+ 0      21.1185    733.10  |V    Q   |         |         |         |
  1+ 5      26.8128    826.82  |V    Q   |         |         |         |
  1+10      33.1001    912.91  |V     Q  |         |         |         |
  1+15      39.9366    992.66  | V     Q |         |         |         |
  1+20      47.2854   1067.04  | V     Q |         |         |         |
  1+25      55.1041   1135.28  | V      Q|         |         |         |
  1+30      63.3660   1199.63  |  V     Q|         |         |         |
  1+35      72.0473   1260.52  |  V      Q         |         |         |
  1+40      81.1457   1321.08  |   V     |Q        |         |         |
  1+45      90.6675   1382.58  |   V     |Q        |         |         |
  1+50     100.6148   1444.34  |    V    | Q       |         |         |
  1+55     111.0126   1509.77  |    V    | Q       |         |         |
  2+ 0     121.8933   1579.87  |     V   |  Q      |         |         |
  2+ 5     133.8528   1736.52  |      V  |   Q     |         |         |
  2+10     147.0288   1913.15  |      V  |    Q    |         |         |
  2+15     161.6270   2119.66  |       V |      Q  |         |         |
  2+20     177.5639   2314.04  |        V|        Q|         |         |
  2+25     195.1334   2551.09  |         V         |Q        |         |
  2+30     214.7461   2847.77  |         |V        |  Q      |         |
  2+35     237.3663   3284.45  |         | V       |      Q  |         |
  2+40     264.3606   3919.57  |         |   V     |         | Q       |
  2+45     295.8543   4572.89  |         |    V    |         |       Q |
  2+50     328.2920   4709.95  |         |      V  |         |        Q|
  2+55     358.3942   4370.84  |         |        V|         |     Q   |
  3+ 0     385.7872   3977.47  |         |         V         |  Q      |
  3+ 5     411.0800   3672.51  |         |         |V        Q         |
  3+10     434.4750   3396.96  |         |         |  V    Q |         |
  3+15     456.0141   3127.48  |         |         |   V Q   |         |
  3+20     475.8061   2873.79  |         |         |  Q V    |         |
  3+25     494.1449   2662.80  |         |         | Q   V   |         |
  3+30     511.3695   2501.00  |         |         Q      V  |         |
  3+35     527.4474   2334.52  |         |        Q|       V |         |
  3+40     542.3815   2168.42  |         |       Q |        V|         |
  3+45     555.9671   1972.63  |         |     Q   |        V|         |
  3+50     568.0727   1757.74  |         |   Q     |         V         |
  3+55     578.9934   1585.68  |         |  Q      |         V         |
```

```
    4+ 0     589.0055   1453.76  |          | Q       |          |V        |
    4+ 5     598.2387   1340.65  |          |Q        |          |V        |
    4+10     606.5538   1207.36  |          Q         |          | V       |
    4+15     614.1853   1108.09  |         Q|         |          | V       |
    4+20     621.3925   1046.49  |        Q |         |          |  V      |
    4+25     628.0567    967.64  |        Q |         |          |  V      |
    4+30     634.2468    898.81  |       Q  |         |          |  V      |
    4+35     640.1565    858.09  |       Q  |         |          |   V     |
    4+40     645.7382    810.47  |      Q   |         |          |   V     |
    4+45     650.9865    762.05  |      Q   |         |          |   V     |
    4+50     656.0087    729.22  |      Q   |         |          |    V    |
    4+55     660.7412    687.16  |     Q    |         |          |    V    |
    5+ 0     665.1326    637.63  |     Q    |         |          |    V    |
    5+ 5     669.3260    608.88  |     Q    |         |          |    V    |
    5+10     673.2696    572.61  |    Q     |         |          |     V   |
    5+15     676.8644    521.97  |    Q     |         |          |     V   |
    5+20     680.3041    499.44  |    Q     |         |          |     V   |
    5+25     683.6097    479.96  |  Q       |         |          |     V   |
    5+30     686.7639    457.99  |  Q       |         |          |     V   |
    5+35     689.7999    440.83  |  Q       |         |          |     V   |
    5+40     692.7101    422.56  |  Q       |         |          |      V  |
    5+45     695.4349    395.64  |  Q       |         |          |      V  |
    5+50     698.0433    378.74  |  Q       |         |          |      V  |
    5+55     700.5493    363.86  |  Q       |         |          |      V  |
    6+ 0     702.9266    345.19  | Q        |         |          |      V  |
-------------------------------------------------------------------------
```

APPENDIX E.2:
NORMAL DEPTH CALCULATIONS

Calcite Substation Preferred Site-Section A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01670	ft/ft
Discharge	4710.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	2909.00
0+46	2907.94
0+80	2908.34
2+78	2906.67
6+24	2907.92
6+73	2907.67
7+30	2907.81
8+28	2907.64
9+00	2907.71
9+47	2907.59
9+80	2907.81
10+36	2907.57
10+94	2907.70
11+27	2907.86
12+06	2907.65
12+45	2907.78
12+66	2907.50
13+09	2907.78
13+37	2907.67
14+48	2907.98
15+12	2907.62
15+65	2907.59
16+11	2907.02
16+44	2907.13
16+51	2907.00
16+92	2907.63
19+40	2907.92

Calcite Substation Preferred Site-Section A

Input Data

Station (ft)	Elevation (ft)
20+32	2906.97
20+46	2908.00
20+63	2907.93
20+69	2907.83
20+80	2908.00
21+15	2907.80
23+06	2907.96
24+12	2908.03
24+97	2908.63
25+10	2908.50
27+17	2909.00

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		1.52	ft
Elevation Range	2906.67 to 2909.00 ft		
Flow Area		1287.89	ft²
Wetted Perimeter		2368.01	ft
Hydraulic Radius		0.54	ft
Top Width		2367.93	ft
Normal Depth		1.52	ft
Critical Depth		1.47	ft
Critical Slope		0.02249	ft/ft
Velocity		3.66	ft/s
Velocity Head		0.21	ft
Specific Energy		1.73	ft
Froude Number		0.87	
Flow Type	Subcritical		

Calcite Substation Preferred Site-Section A

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	1.52	ft
Critical Depth	1.47	ft
Channel Slope	0.01670	ft/ft
Critical Slope	0.02249	ft/ft

Cross Section for Calcite Substation Preferred Site-Section A

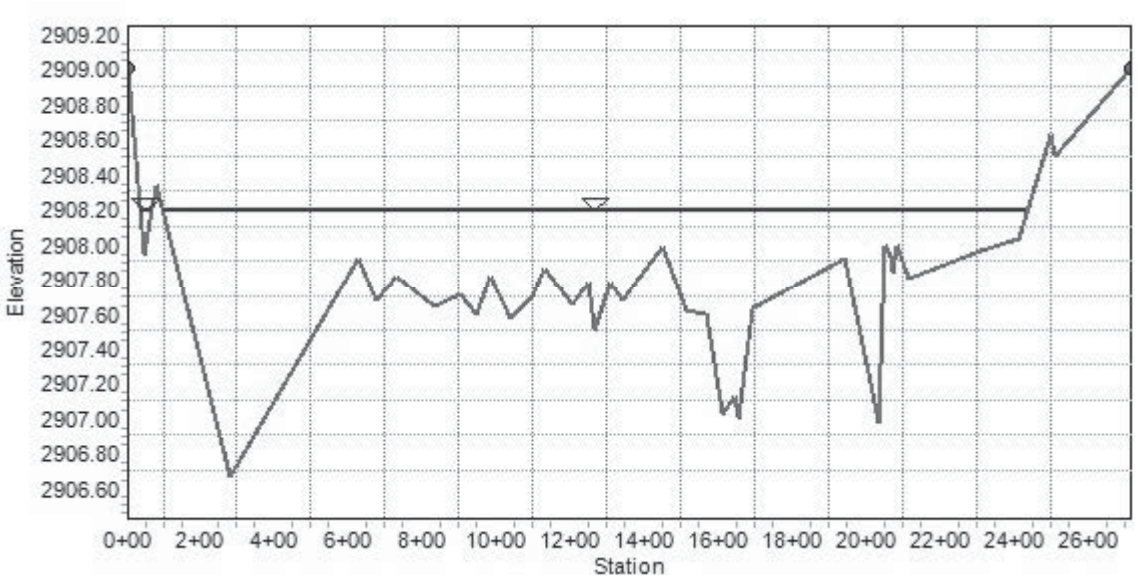
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01670	ft/ft
Normal Depth	1.52	ft
Discharge	4710.00	ft³/s

Cross Section Image



Calcite Substation Preferred Site-Section B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Discharge	4710.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	2907.00
1+12	2906.00
1+31	2905.51
1+47	2905.73
2+24	2905.36
2+49	2904.98
2+68	2905.29
2+80	2905.33
3+16	2905.04
3+74	2904.90
3+97	2904.53
4+60	2904.00
5+34	2904.11
6+03	2904.47
7+13	2904.85
7+80	2905.00
8+94	2905.00
9+43	2904.76
9+73	2904.84
9+97	2904.76
10+68	2904.89
10+98	2904.74
11+58	2904.75
11+87	2904.63
12+17	2904.87
13+03	2904.82
13+35	2905.00

Calcite Substation Preferred Site-Section B

Input Data

Station (ft)	Elevation (ft)
13+74	2904.73
14+03	2904.87
14+43	2904.71
14+69	2904.76
14+96	2904.60
15+24	2904.70
15+79	2904.75
16+27	2904.00
16+92	2904.80
17+46	2904.68
21+43	2904.80
21+62	2905.03
21+72	2905.00
21+88	2903.95
21+99	2905.00
22+09	2905.04
22+19	2905.00
22+26	2904.83
22+34	2905.05
23+29	2905.07
23+39	2905.00
24+58	2905.00
25+01	2905.18
25+88	2905.99
26+85	2906.59
27+86	2907.00

Options

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

Calcite Substation Preferred Site-Section B

Results

Normal Depth		1.39	ft
Elevation Range	2903.95 to 2907.00 ft		
Flow Area		1313.89	ft²
Wetted Perimeter		2292.82	ft
Hydraulic Radius		0.57	ft
Top Width		2292.69	ft
Normal Depth		1.39	ft
Critical Depth		1.32	ft
Critical Slope		0.02230	ft/ft
Velocity		3.58	ft/s
Velocity Head		0.20	ft
Specific Energy		1.59	ft
Froude Number		0.83	
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	1.39	ft
Critical Depth	1.32	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02230	ft/ft

Cross Section for Calcite Substation Preferred Site-Section B

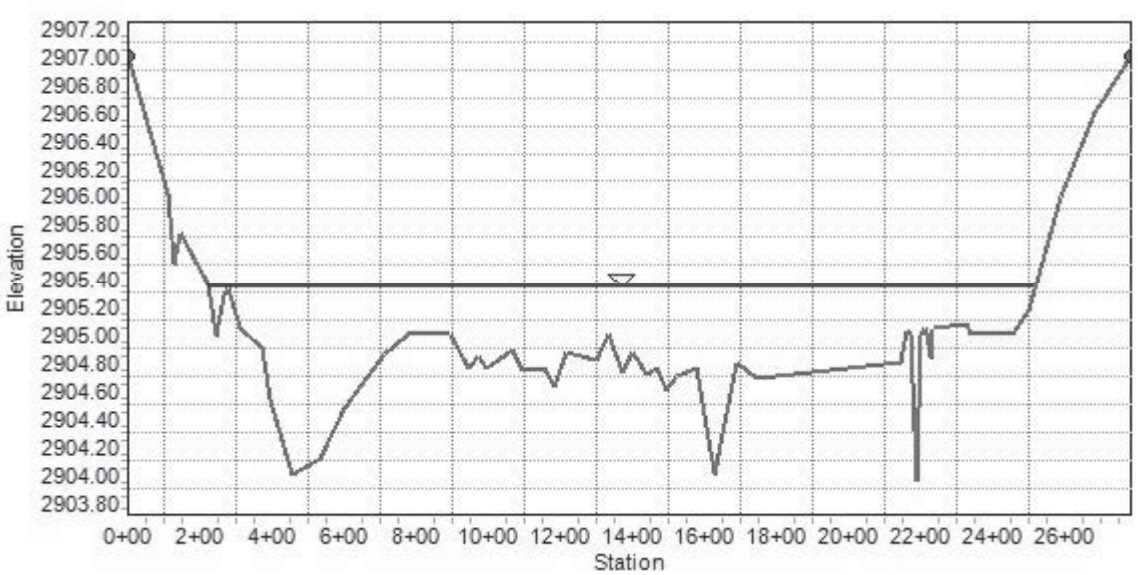
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Normal Depth	1.39	ft
Discharge	4710.00	ft³/s

Cross Section Image



Calcite Substation Preferred Site-Section C

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01540	ft/ft
Discharge	4710.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	2904.00
2+15	2902.52
2+68	2902.53
2+89	2901.99
3+23	2902.32
4+67	2901.59
5+47	2902.00
6+84	2902.06
7+37	2902.37
9+33	2902.36
11+72	2902.26
14+14	2901.85
15+34	2902.02
18+04	2901.88
19+59	2902.07
20+67	2901.87
22+14	2902.01
22+23	2903.00
23+08	2902.37
23+59	2902.95
24+52	2902.99
25+72	2903.59
26+49	2904.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient

Calcite Substation Preferred Site-Section C

Input Data

Start Station	Ending Station	Roughness Coefficient
(0+00, 2904.00)	(26+49, 2904.00)	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		1.11	ft
Elevation Range	2901.59 to 2904.00 ft		
Flow Area		1259.35	ft²
Wetted Perimeter		2104.39	ft
Hydraulic Radius		0.60	ft
Top Width		2104.33	ft
Normal Depth		1.11	ft
Critical Depth		1.05	ft
Critical Slope		0.02189	ft/ft
Velocity		3.74	ft/s
Velocity Head		0.22	ft
Specific Energy		1.33	ft
Froude Number		0.85	
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	1.11	ft
Critical Depth	1.05	ft
Channel Slope	0.01540	ft/ft

GVF Output Data

Critical Slope	0.02189	ft/ft

Cross Section for Calcite Substation Preferred Site-Section C

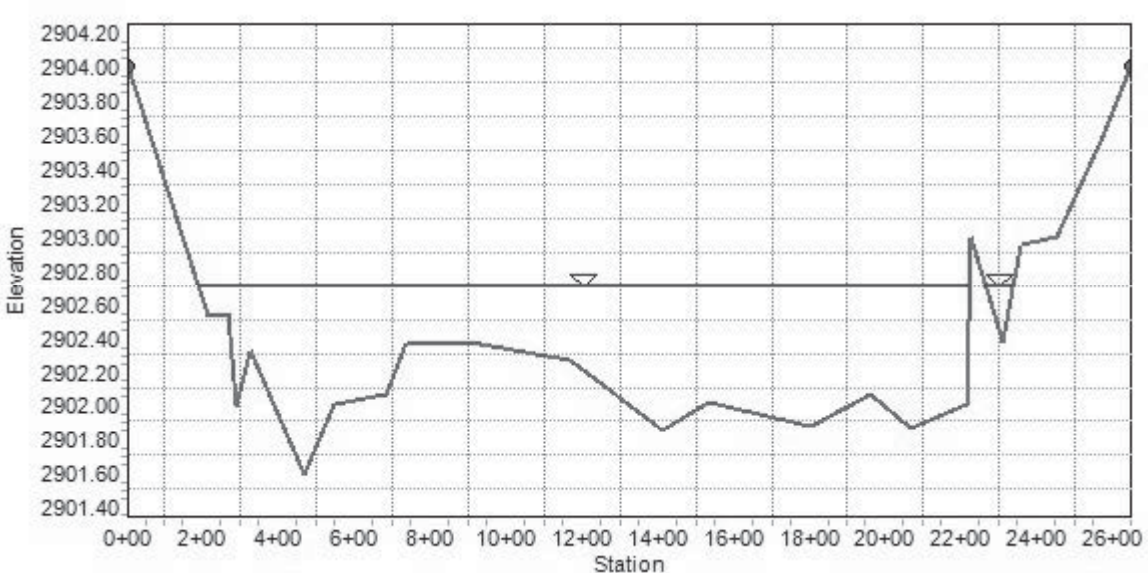
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01540	ft/ft
Normal Depth	1.11	ft
Discharge	4710.00	ft³/s

Cross Section Image



Calcite Substation Preferred Site-Section D

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Discharge	4710.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	2901.04
0+80	2900.21
1+72	2899.99
2+40	2899.84
3+36	2899.55
3+50	2899.69
3+58	2899.66
3+75	2899.02
3+83	2898.98
3+95	2899.09
4+19	2899.20
4+40	2899.34
4+82	2899.46
5+56	2899.51
6+04	2899.42
6+32	2899.47
6+80	2899.39
7+46	2899.75
8+35	2899.61
8+71	2899.43
9+19	2899.56
10+61	2899.51
10+91	2899.42
11+28	2899.54
12+46	2899.37
13+06	2899.00
13+47	2899.39

Calcite Substation Preferred Site-Section D

Input Data

Station (ft)	Elevation (ft)
15+52	2899.26
15+97	2899.08
16+38	2899.20
18+10	2899.32
19+48	2899.47
20+37	2899.00
21+42	2899.30
21+54	2899.59
21+77	2899.00
22+05	2899.02
22+27	2899.48
22+31	2899.74
22+36	2899.93
22+67	2899.36
23+42	2899.96
24+20	2900.32
24+77	2901.00
25+05	2901.04

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	1.03	ft
Elevation Range	2898.98 to 2901.04 ft	
Flow Area	1288.83	ft²
Wetted Perimeter	2187.57	ft
Hydraulic Radius	0.59	ft
Top Width	2187.51	ft
Normal Depth	1.03	ft

Calcite Substation Preferred Site-Section D

Results

Critical Depth		0.96	ft
Critical Slope		0.02204	ft/ft
Velocity		3.65	ft/s
Velocity Head		0.21	ft
Specific Energy		1.23	ft
Froude Number		0.84	
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	1.03	ft
Critical Depth	0.96	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02204	ft/ft

Cross Section for Calcite Substation Preferred Site-Section D

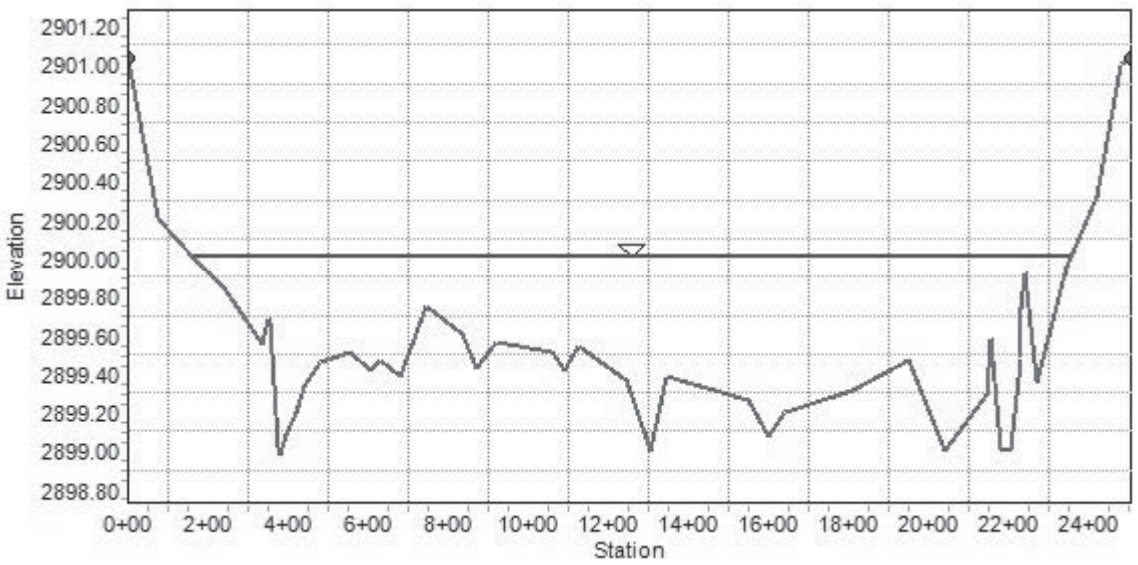
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Normal Depth	1.03	ft
Discharge	4710.00	ft³/s

Cross Section Image



Calcite Substation Preferred Site-Section E

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Discharge	4710.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+00	2898.38
1+33	2896.92
2+53	2897.00
3+85	2896.81
4+02	2896.46
4+52	2896.96
4+77	2896.73
5+68	2896.88
6+58	2896.69
6+77	2896.47
8+78	2896.89
9+66	2896.62
10+78	2896.65
11+02	2896.47
11+13	2896.54
11+34	2896.28
11+88	2896.67
12+58	2896.66
13+38	2896.84
14+09	2896.65
14+63	2896.77
15+31	2896.75
15+81	2896.58
16+18	2896.73
17+23	2896.89
18+66	2897.00
19+05	2897.06

Calcite Substation Preferred Site-Section E

Input Data

Station (ft)	Elevation (ft)
19+22	2897.00
19+98	2897.06
20+30	2897.00
21+73	2897.04
22+14	2897.00
22+25	2896.69
22+64	2897.00
23+21	2898.00
24+04	2898.38

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		1.12	ft
Elevation Range	2896.28 to 2898.38 ft		
Flow Area		1291.09	ft²
Wetted Perimeter		2197.25	ft
Hydraulic Radius		0.59	ft
Top Width		2197.23	ft
Normal Depth		1.12	ft
Critical Depth		1.06	ft
Critical Slope		0.02214	ft/ft
Velocity		3.65	ft/s
Velocity Head		0.21	ft
Specific Energy		1.33	ft
Froude Number		0.84	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft

Calcite Substation Preferred Site-Section E

GVF Input Data

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	1.12	ft
Critical Depth	1.06	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.02214	ft/ft

Cross Section for Calcite Substation Preferred Site-Section E

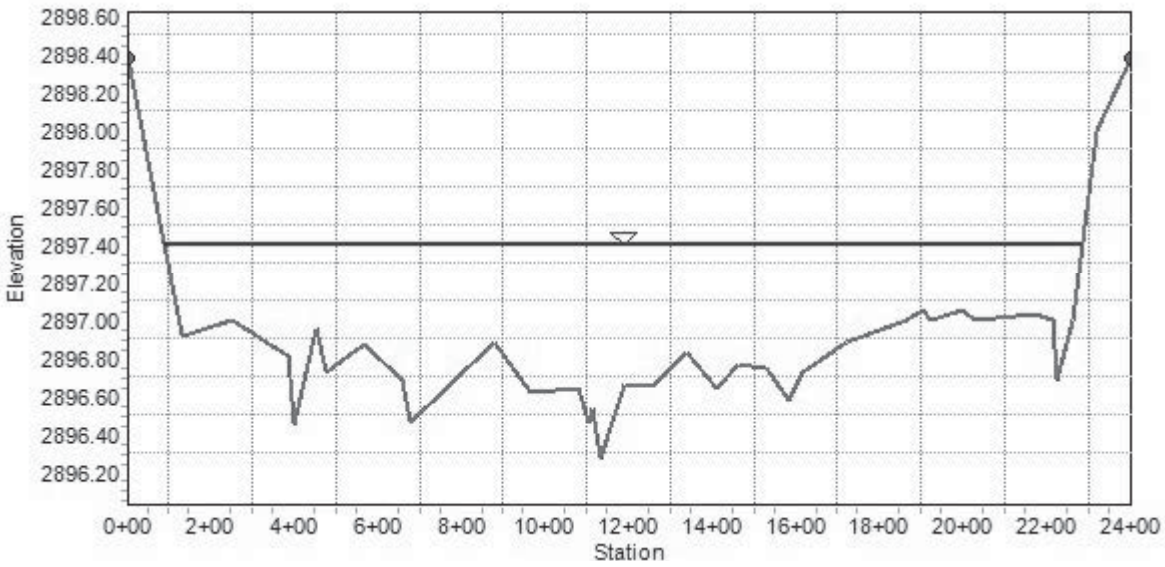
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01500	ft/ft
Normal Depth	1.12	ft
Discharge	4710.00	ft³/s

Cross Section Image



APPENDIX F:
RETENTION BASIN SIZING CALCULATIONS

Calcite Substation Project

Retention Basin Design Calculation

100-yr/24-hr Runoff Volume

Existing Condition	86,023	CF
Proposed Condition	86,149	CF
Volume Increase	126	CF

Basin A					
Contour Elevation	Contour Area (SF)	Contour Area (AC)	*Contour Interval Volume (CF)	Total Basin Volume (CF)	Total Basin Depth (FT)
2902.7	3,470	0.080		1,895	1.0
			1,895		
2901.7	680	0.016		0	0.0

Basin B					
Contour Elevation	Contour Area (SF)	Contour Area (AC)	*Contour Interval Volume (CF)	Total Basin Volume (CF)	Total Basin Depth (FT)
2902.7	2,350	0.054		1,276	1.0
			1,276		
2901.7	450	0.010		0	0.0

* Contour volume calculations are based on the volume of the frustum of a pyramid:

$$Volume = \frac{1}{3}h\left(A_1 + A_2 + \sqrt{A_1 \times A_2}\right)$$

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APPENDIX G:
CHANNEL CAPACITY CALCULATIONS

Worksheet for Trapezoidal Channel A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.00520	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	53.70	ft^3/s

Results

Normal Depth	2.25	ft
Flow Area	16.89	ft^2
Wetted Perimeter	13.07	ft
Hydraulic Radius	1.29	ft
Top Width	12.01	ft
Critical Depth	1.54	ft
Critical Slope	0.02563	ft/ft
Velocity	3.18	ft/s
Velocity Head	0.16	ft
Specific Energy	2.41	ft
Froude Number	0.47	
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	2.25	ft
Critical Depth	1.54	ft
Channel Slope	0.00520	ft/ft

Worksheet for Trapezoidal Channel A

GVF Output Data

Critical Slope	0.02563	ft/ft

Cross Section for Trapezoidal Channel A

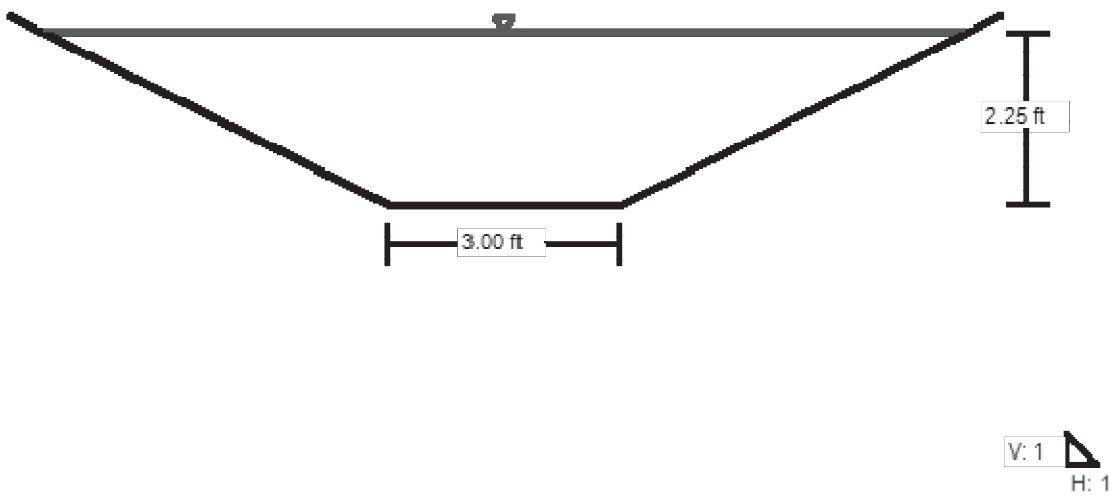
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.00520	ft/ft
Normal Depth	2.25	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	53.70	ft³/s

Cross Section Image



Worksheet for Trapezoidal Channel B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	39.00	ft^3/s

Results

Normal Depth	1.00	ft
Flow Area	9.95	ft^2
Wetted Perimeter	12.45	ft
Hydraulic Radius	0.80	ft
Top Width	11.98	ft
Critical Depth	0.84	ft
Critical Slope	0.02729	ft/ft
Velocity	3.92	ft/s
Velocity Head	0.24	ft
Specific Energy	1.23	ft
Froude Number	0.76	
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	1.00	ft
Critical Depth	0.84	ft
Channel Slope	0.01500	ft/ft

Worksheet for Trapezoidal Channel B

GVF Output Data

Critical Slope	0.02729	ft/ft

Cross Section for Trapezoidal Channel B

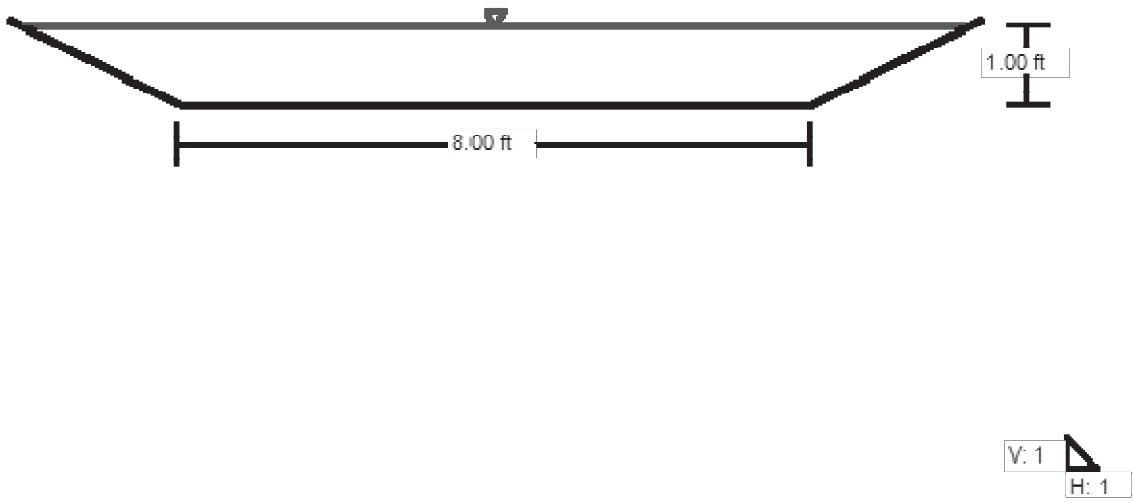
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

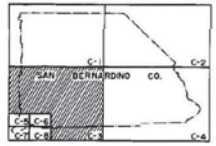
Input Data

Roughness Coefficient	0.040	
Channel Slope	0.01500	ft/ft
Normal Depth	1.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	39.00	ft³/s

Cross Section Image



APPENDIX H:
REFERENCE FIGURES, TABLES, AND PLATES



INDEX MAP

Scale 1:250,000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
TRANSVERSE MERCATOR PROJECTION

BASE MAP REPRODUCED FROM U.S.G.S. "SAN BERNARDINO" TOPOGRAPHIC MAP

SCALE REDUCED BY 1/2

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHCENTRAL AREA

FIGURE C-11

Curve (1) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren EXISTING CONDITION (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79
AGRICULTURAL COVERS -					
Fallow (Land plowed but not tilled or seeded)		77	86	91	94

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

CURVE NUMBERS FOR PERVIOUS AREAS

Figure C-3 (1 of 2)

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. CONCRETE (excluding right-of-way)	PROPOSED CONDITION	98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

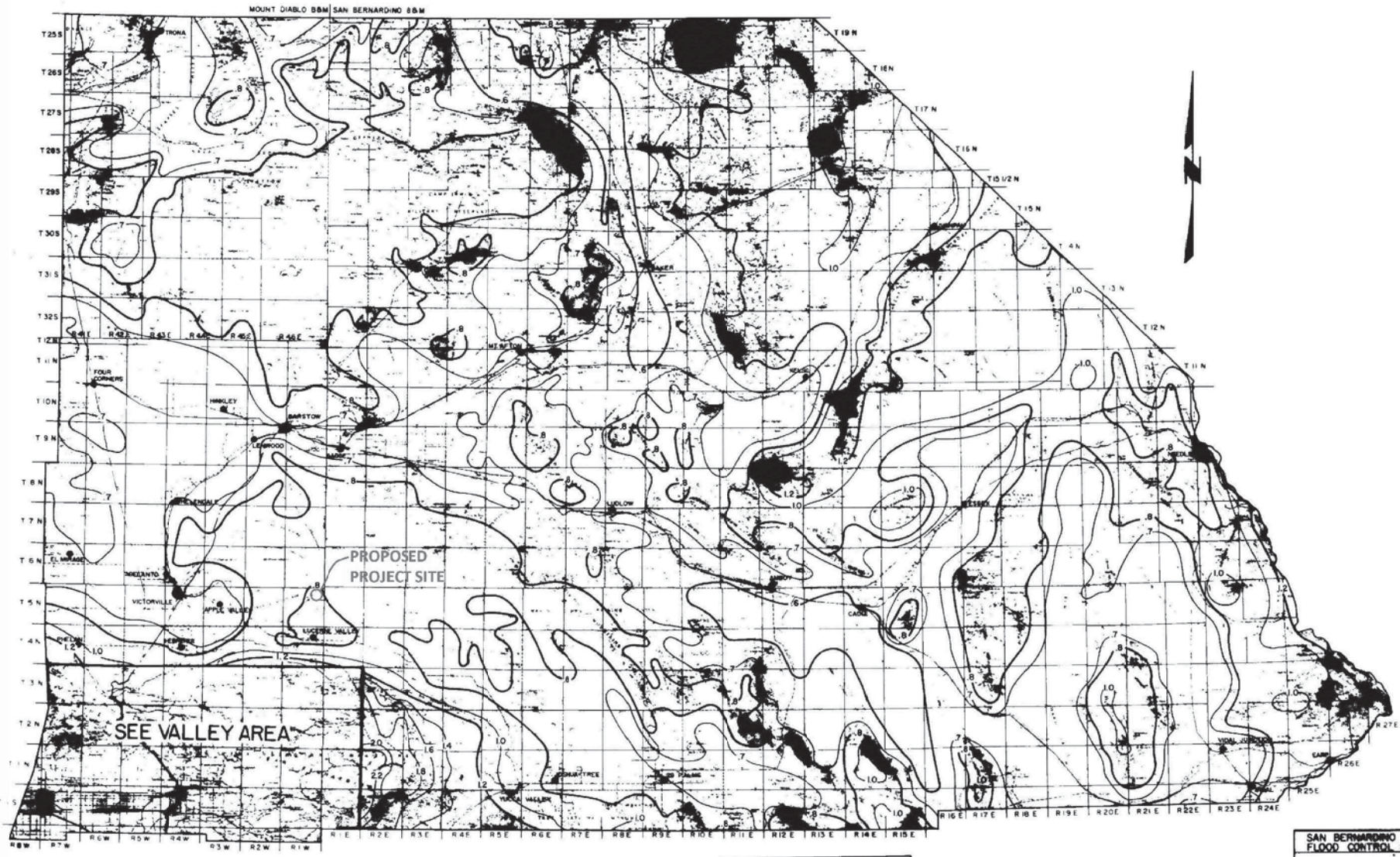
TABLE C.1. CURVE NUMBER RELATIONSHIPS

CN for AMC Condition II	Corresponding CN for AMC Condition I	III
100	100	100
95	87	99 ← 98.2 BY INTERPOLATION
91 → 90	78	98
85	70	97
80	63	94
75	57	91
70	51	87
65	45	83
60	40	79
55	35	75
50	31	70
45	27	65
40	23	60
35	19	55
30	15	50
25	12	45
20	9	39
15	7	33
10	4	26
5	2	17
0	0	0

C.6. ESTIMATION OF LOSS RATES

In estimating loss rates for design hydrology, a watershed curve number (CN) is determined for each soil-cover complex within the watershed using Figure C-3. The working range of CN values is between 0 and 98, where a low CN indicates low runoff potential (high infiltration), and a high CN indicates high runoff potential (low infiltration). Selection of a CN takes into account the major factors affecting loss rates on pervious surfaces including the hydrologic soil group, cover type and quality, and antecedent moisture condition (AMC).

Also included in the CN selection are the effects of "initial abstraction" (Ia) which represents the combined effects of other effective rainfall losses including depression storage, vegetation interception, evaporation, and transpiration, among other factors.



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

LEGEND:

1.0 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_1 - 2 YEAR 6 HOUR

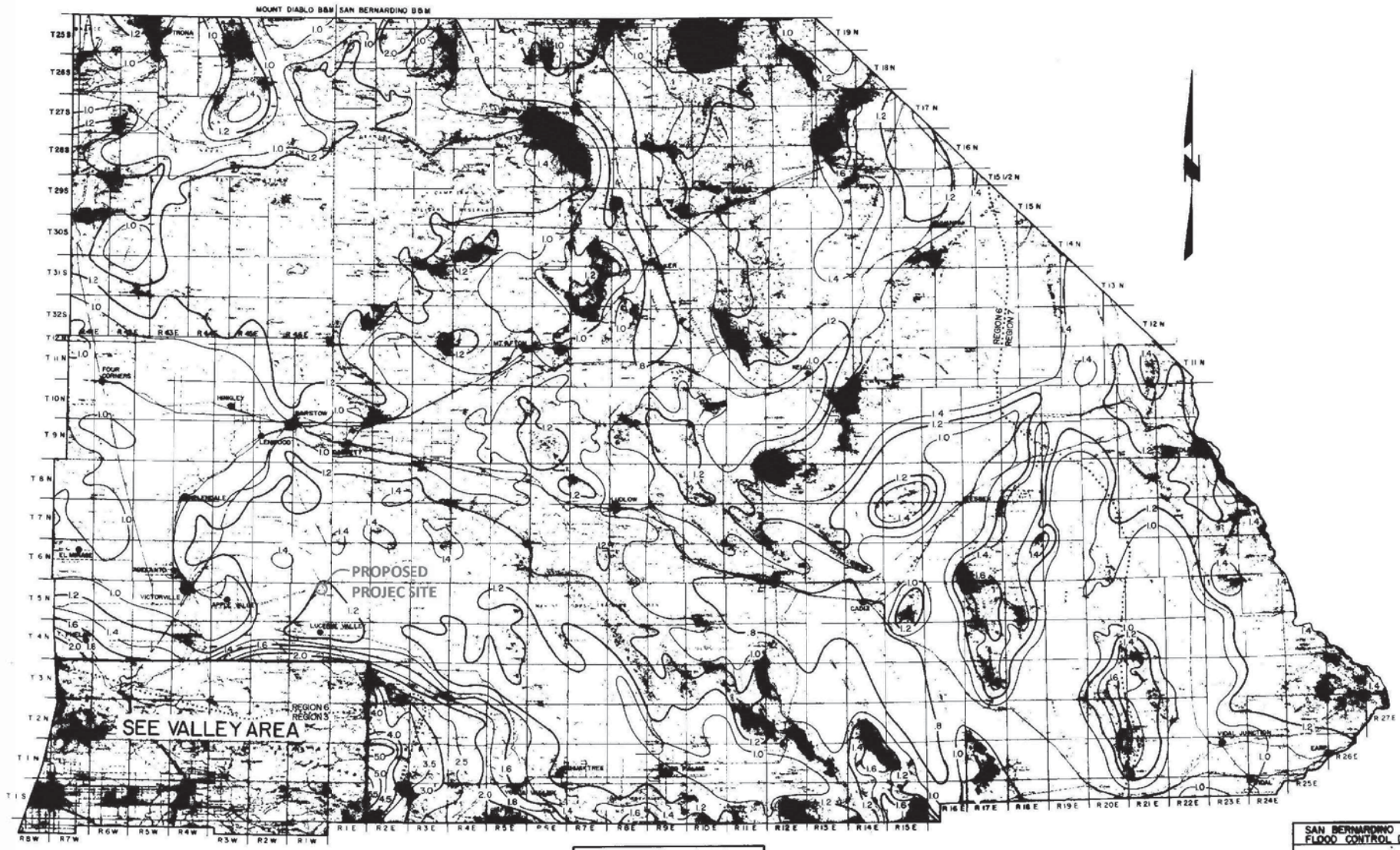
BASED ON U.S.G.C., NOAA ATLAS 2, 1973

APPROVED BY

FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG NO.
1982	1" = 6MI	WRD-1	7 of 12

FIGURE B-7



REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

LEGEND:

12 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_6 - 2 YEAR 24 HOUR

BASED ON USDC, NOAA ATLAS 2, 1973

APPROVED BY

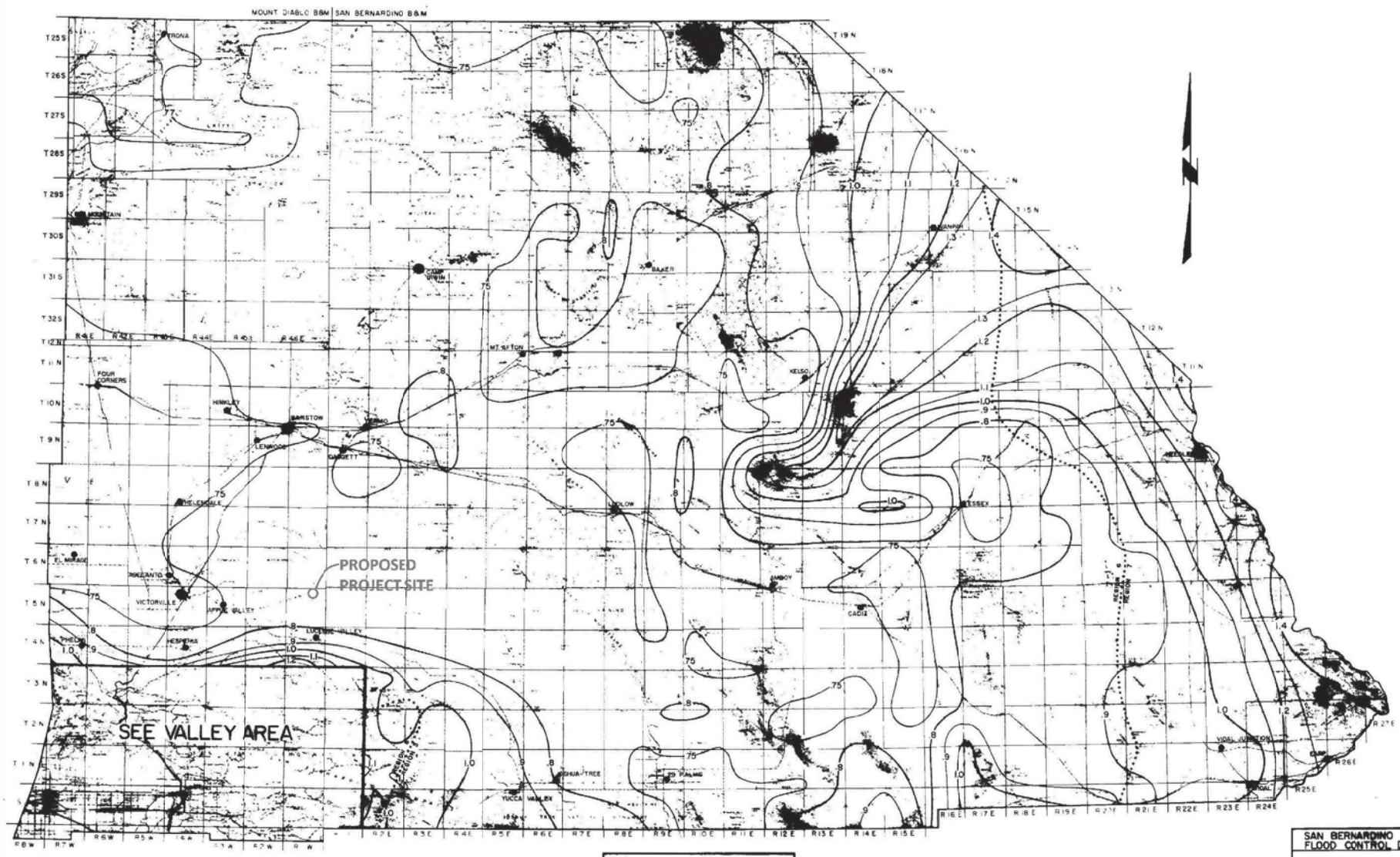
FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 8 MI	1880-1	8 of 12

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

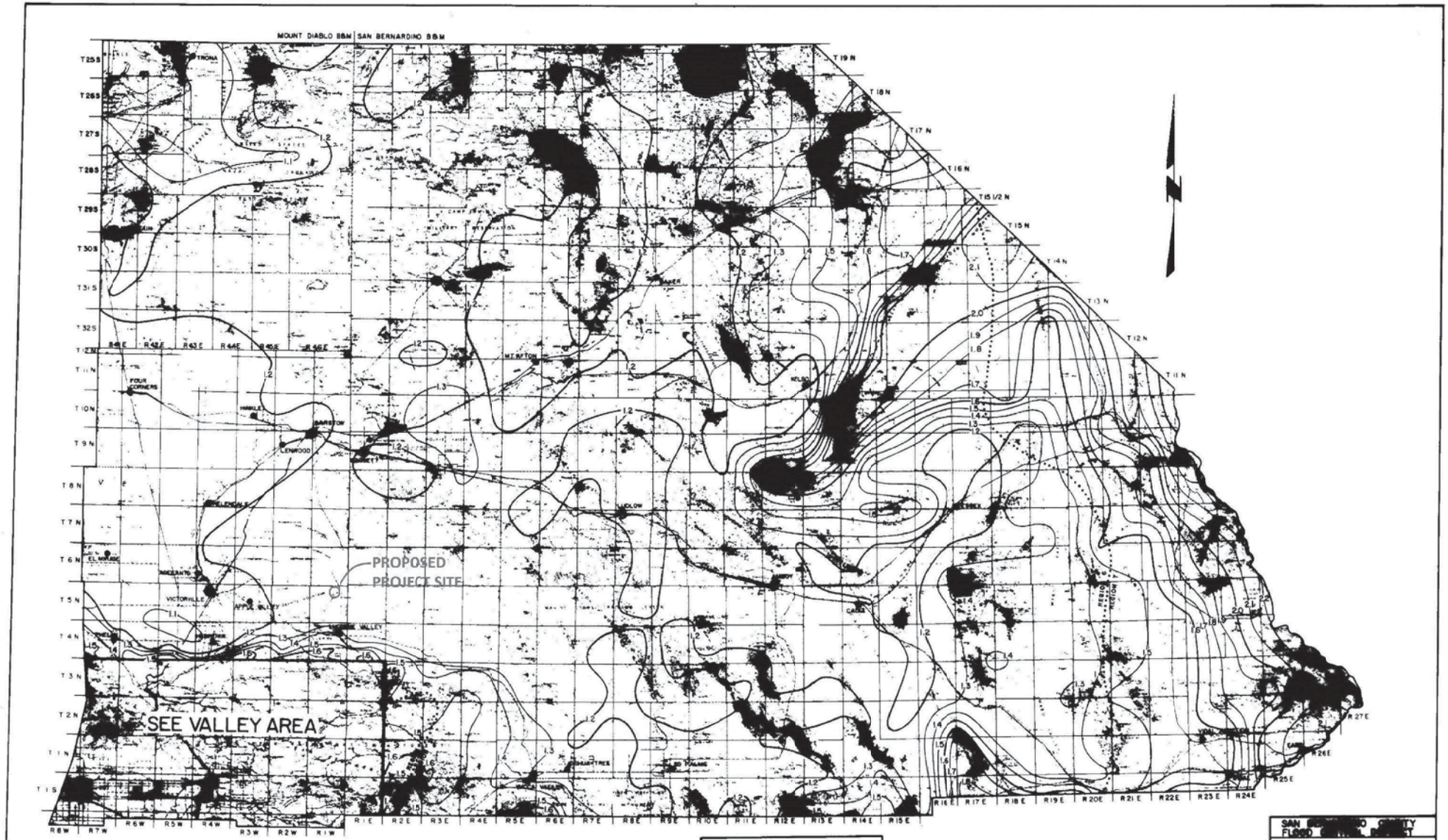
FIGURE B-8



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

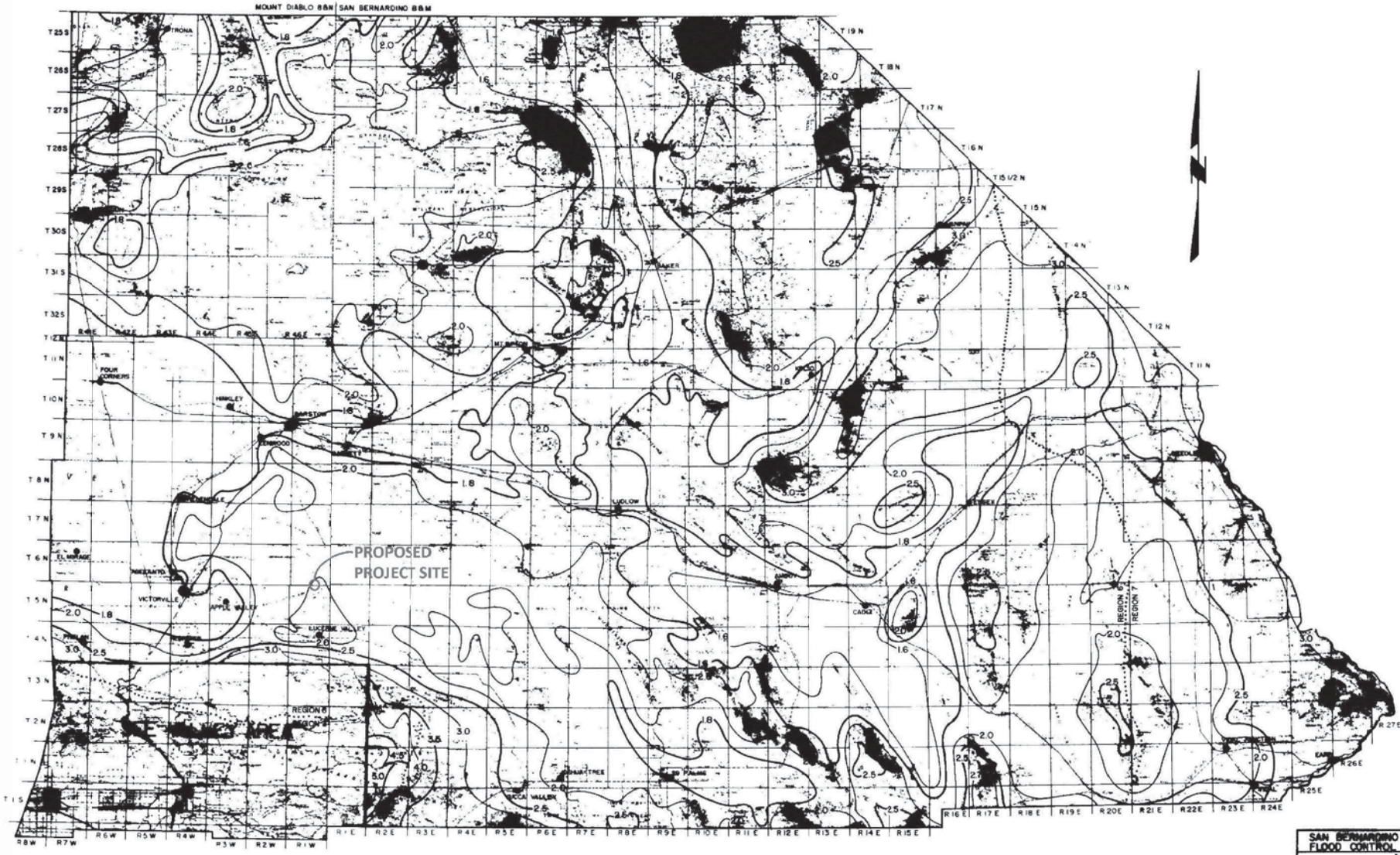
FIGURE B-9



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

FIGURE B-10



SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

LEGEND:

2.0 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

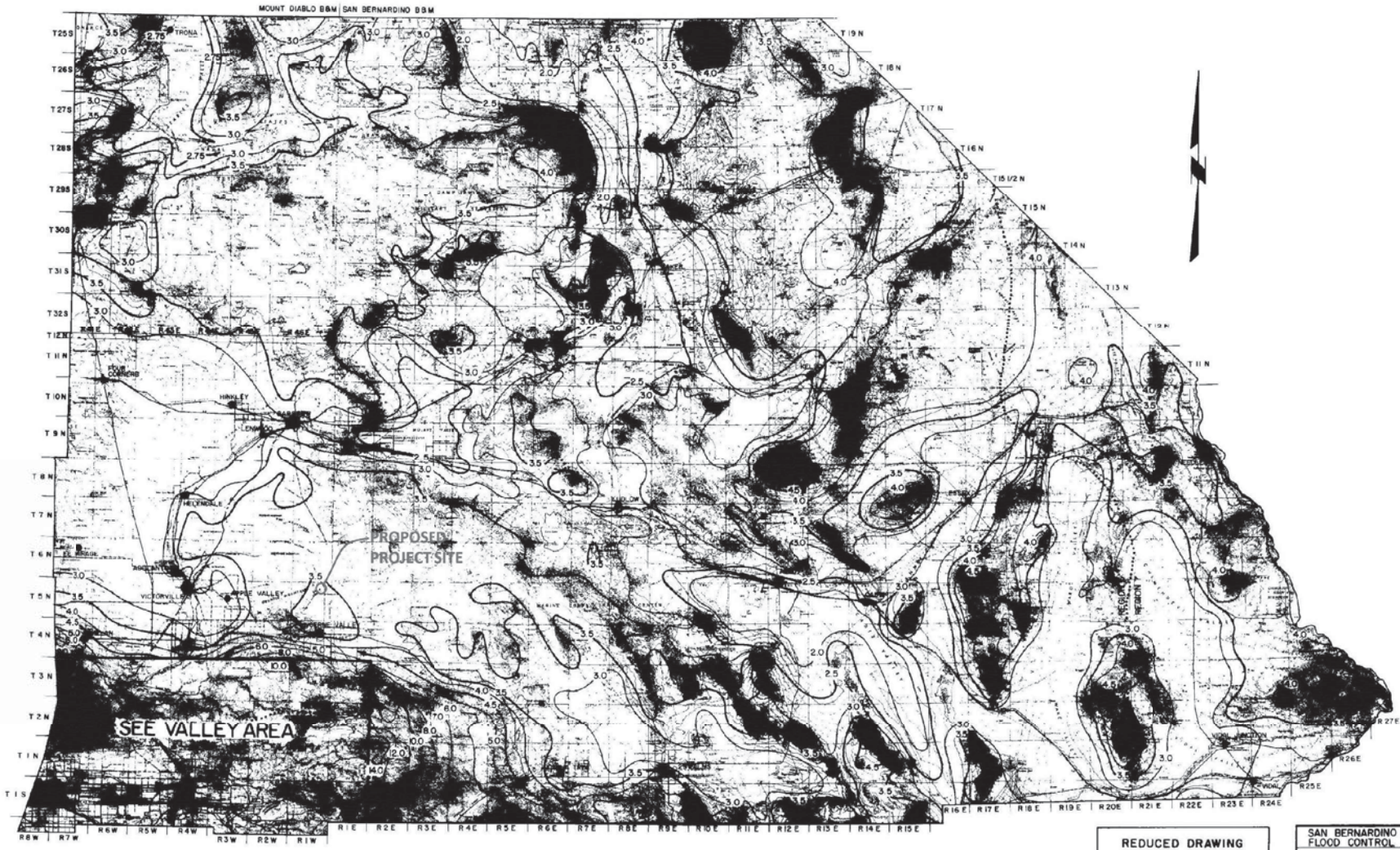
X_3 -100 YEAR 6 HOUR

BASED ON U.S.G.C., N.O.A.A. ATLAS 2, 1973

APPROVED BY R. A. Bergman FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 6 MI.	1980-1	11 of 12

FIGURE B-11



REDUCED DRAWING

0 1 2 3

3 INCHES ON ORIGINAL

LEGEND:

3.5 ISOLINES PRECIPITATION (INCHES)

SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT

DESERT AREA

ISOHYETALS

X_4 -100 YEAR 24 HOUR

BASED ON U.S.D.C., NOAA ATLAS 2, 1973

APPROVED BY

FLOOD CONTROL ENGINEER

DATE	SCALE	FILE NO.	DRWG. NO.
1982	1" = 6 MI.	WRD-	12 of 12

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

FIGURE B-12

EXHIBITS

EXHIBIT A:
OFF-SITE HYDROLOGY MAP

LEGEND

XXX / XX.X	NODE/CONCENTRATION POINT / ELEVATION
XX / X.XX	SUBAREA / ACRES
L=XXX'	MAIN FLOW PATH
	FLOW PATH
	PROJECT BOUNDARY
	WATERSHED BOUNDARY

GRAPHIC SCALE

150 0 75 150 300

SCALE: 1"=150'

FLOW DATA

NODE	AREA (AC.)	Q100 (CFS)	TC (MIN)
104	58.3	53.7	39.3
204	26.1	39.0	36.1

EXHIBIT "A"
HYDROLOGY MAP FOR CALCITE SUBSTATION OFF-SITE DRAINAGE AREAS

CASC
Engineering and Consulting
1670 E. 91 CENTER LANE, SPOKANE, WA 99218
PH. (509) 783-2101 FAX (509) 783-2108
www.cascengineering.com

Drawing Name: S:\CASC-Jobs\7 Calcite Substation\Civil Drawings Maps\123-027 Calcite Substation OFF-Site.dwg
Last Saved: 04.14.2008 Saved by: tim

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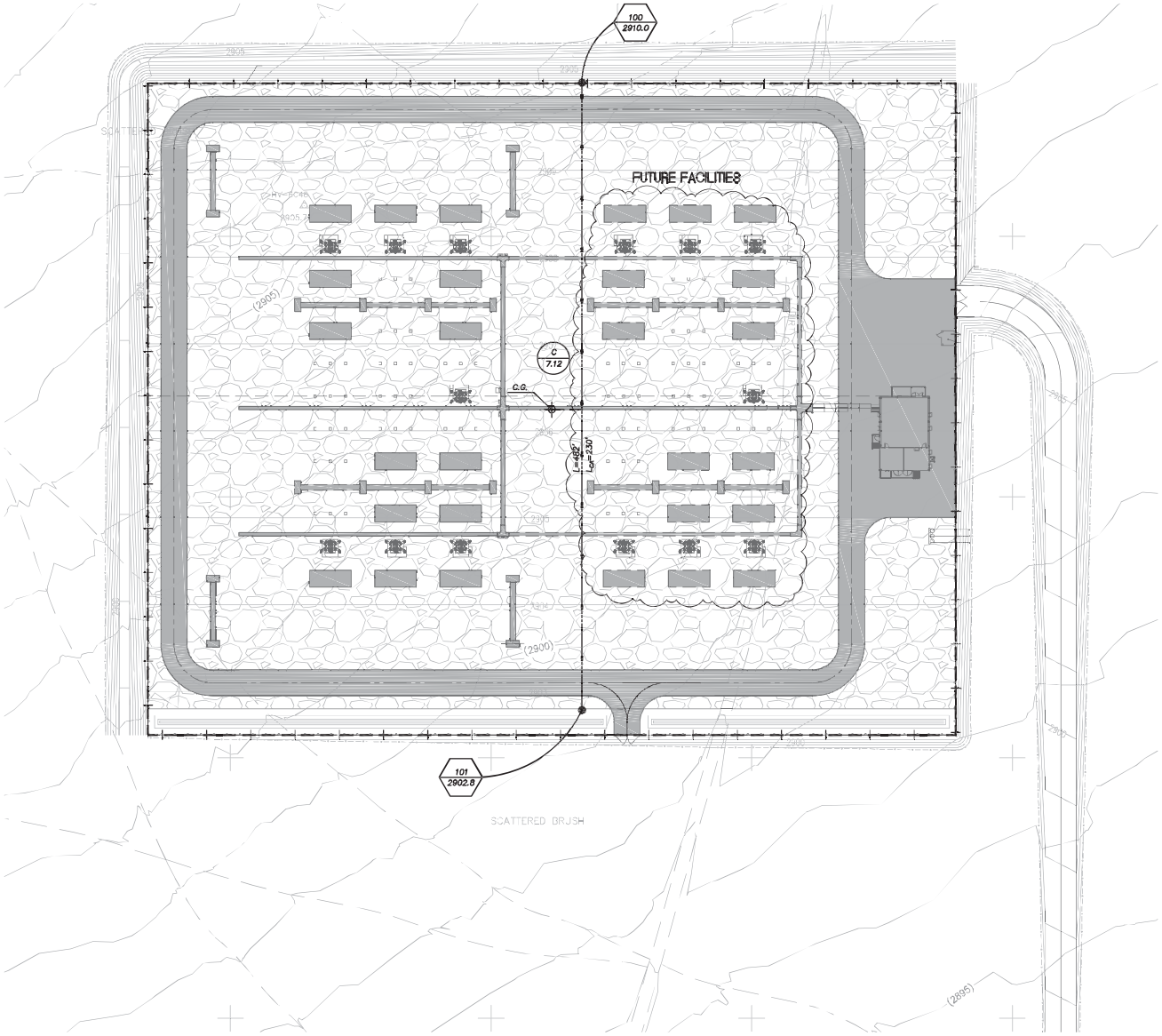
EXHIBIT B:
ON-SITE HYDROLOGY MAP



LEGEND

XXX / XX.X	NODE/CONCENTRATION POINT ELEVATION
XX / X.X	SUBAREA ACRES
L=XXX'	MAIN FLOW PATH
L_{CM}=XXX'	FLOW DISTANCE MEASURED UPSTREAM TO POINT OF CENTROID
C.G.	MAIN CENTROID
	FLOW PATH
	PROJECT BOUNDARY
	WATERSHED BOUNDARY
	PROPOSED IMPERVIOUS SURFACE
	PROPOSED GRAVEL

HYDROLOGY SUMMARY

PEAK FLOOD VOLUME			
FREQUENCY/DURATION	EXISTING CONDITION	PROPOSED CONDITION	INCREASE
100-YR/24-HR	86,023 CF	86,149 CF	126 CF
100-YR/24-HR	1.975 AC-FT	1.978 AC-FT	0.003 AC-FT

100-YR PEAK FLOW RATE		
AREA	Q100	TC
C	22.7 CFS	12.6 MIN.

GRAPHIC SCALE
SCALE: 1"=40'

EXHIBIT "B"
HYDROLOGY MAP FOR CALCITE SUBSTATION ON-SITE DRAINAGE AREA

CASC Engineering and Consulting
14701 St. Mary's Lane, Houston, TX 77079
Ph. (281) 752-5101 Fax (832) 752-5108
www.cascengineering.com

Drawing Name: S:\NLD\2-0027 / Calcite Substation\Civil\Drainage\Hydrology Maps\1-23-2027 / Calcite Substation On-Site.dwg
Last Saved: Mar 11, 2026 2:24pm by Tuan

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EXHIBIT C:
FLOODPLAIN ANALYSIS EXHIBIT

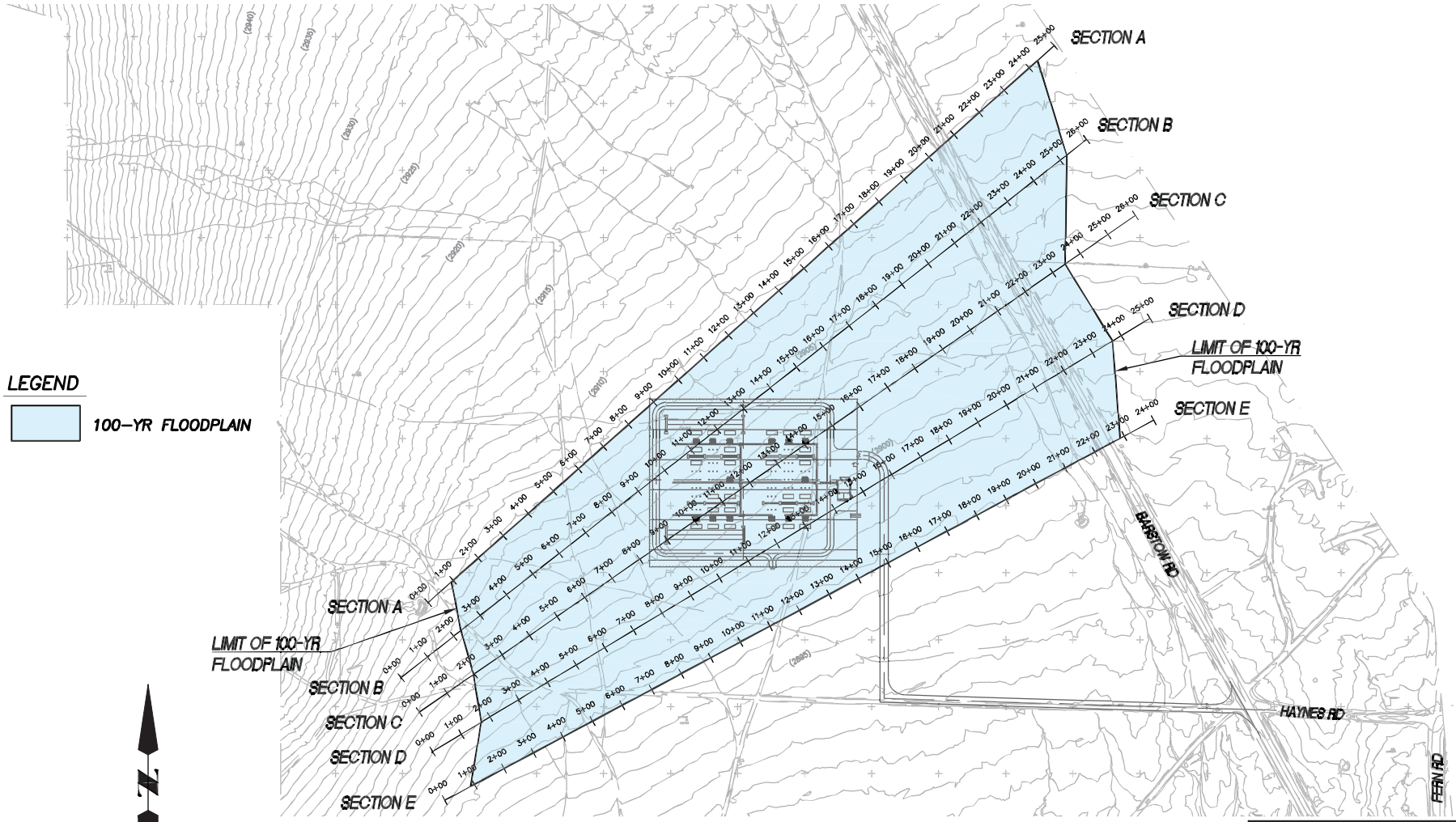

EXHIBIT "C"
FLOODPLAIN ANALYSIS EXHIBIT FOR CALCITE SUBSTATION

CASC
Engineering and Consulting
1470 EAST COOLEY DRIVE, COLTON, CA 92324
PH. (909) 783-0101 FAX (909) 783-0105
www.cel-casc.com

Drawing name: G:\Land Dev\ [illegible]
Last Opened: Oct 10, 2016 - 2:36pm by [illegible]

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Water Quality Management Plan

www.RRCcompanies.com

181 East 56th Avenue, Suite 100
Denver, CO 80216
303.872.9089

September 26, 2016

Mr. Donald Hill
NextEra Energy, Inc.
700 Universe Boulevard
Juno Beach, FL 33408-0420

Re: Water Quality Management Plan
Ord Mountain Solar Project
San Bernardino County, California
RRC Project No. MD1603013

Dear Mr. Hill,

RRC Power & Energy, LLC (RRC) has completed the authorized Water Quality Management Plan for the proposed Ord Mountain Solar Project. The purpose of this plan is to provide a plan for the elimination of potential pollutants.

We appreciate the opportunity to be of service to NextEra Energy, Inc. Please call us if you have any questions concerning this report or any of our services.

Respectfully submitted,

RRC

Lenwood S. Adams, P.E. (TX), CFM
Civil Group Manager

WATER QUALITY MANAGEMENT PLAN
(WQMP)

For compliance with Santa Ana Regional Water Quality Board
Order Number R8-2002-0012 (NPDES Permit No. CAS618036)

ORD MOUNTAIN SOLAR PROJECT
SAN BERNARDINO COUNTY, CALIFORNIA

prepared for

NextEra Energy, Inc.
700 Universe Blvd
Juno Beach, FL 33408-0420

Prepared by

Forest Pfeiffer, EIT (TX), CFM
Graduate Engineer

Reviewed by

Lenwood S. Adams, P.E. (TX), CFM
Civil Group Manager

Approved by

Zhigang "Winter" Yao, P.E.

September 26, 2016 ***Project No. MD1603013***

UNAUTHORIZED USE OR COPYING OF THIS DOCUMENT IS STRICTLY PROHIBITED BY ANYONE OTHER THAN THE CLIENT FOR THE SPECIFIC PROJECT.

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APPENDIX
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WATER QUALITY MANAGEMENT PLAN (WQMP)

Project Site Information

Name of Project: Ord Mountain Solar Project

Project Location: San Bernardino County, CA

Size of Significant Re-Development on an Already Developed Site (in feet^2): N/A

Size of New Development (in feet^2): 21,770,160

Number of Home Subdivisions: N/A

SIC Codes: 4911

Erosive Site Conditions?: No

Natural Slope More Than 25%?: No

Projects Requiring a WQMP

Check Below	Project Categories
	1. All significant re-development projects. Significant re-development is defined as the addition or creation of 5,000 or more square feet of impervious surface on an already developed site. This includes, but is not limited to, additional buildings and/or structures, extension of existing footprint of a building, construction of parking lots, etc. Where redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to SUSMP's, the design standards apply only to the addition, and not the entire development. When the re-development results in an increase of more than fifty percent of the impervious surfaces, then a WQMP is required for the entire development (new and existing).
	2. Home subdivisions of 10 units or more. This includes single family residences, multi-family residence, condominiums, apartments, etc.
	3. Industrial/commercial developments of 100,000 square feet or more. Commercial developments include non-residential developments such as hospitals, educational institutions, recreational facilities, mini-malls, hotels, office buildings, warehouses and light industrial facilities.
	4. Automotive repair shops (with SIC codes: 5013, 5014, 5541, 7532 – 7534, 7536-7539)
	5. Restaurants where the land area of development is 5,000 square feet or more.
	6. Hillside developments of 10,000 square feet or more which are located on areas with known erosive soil conditions or where the natural slope is twenty-five percent or more.
	7. Developments of 2,500 square feet of impervious surface or more adjacent to (within 200 feet) or discharging directly into environmentally sensitive areas such as areas designated in the Ocean Plan as areas of special biological significance or waterbodies listed on the CWA Section 303 (d) list of impaired waters.
	8. Parking lots of 5,000 square feet or more of exposed to storm water. Parking lot is defined as land area of facility for the temporary storage of motor vehicles.
X	The project does not fall into any of the categories described above. (If the project requires a precise plan of development [e.g. all commercial or industrial projects, residential projects of less than 10 dwelling units, and all land development projects with potential for significant adverse water quality impacts] or subdivision of land, it is defined as a Non-Category Project.)

SECTION 1: INTRODUCTION AND PROJECT DESCRIPTION

1.1 Project Owner Information

Name: NextEra Energy, Inc.
Address: 700 Universe Blvd., Juno Beach, FL 33408-0420
Phone Number: (516) 691-7171
Project Site Address: To be determined

1.2 Permits

There are no current permits associated with the project at this time.

1.3 Project Description

The proposed project solar farm project which falls into the category of a project requiring a precise plan of development and is listed on the previous table as "does not fall into any of the categories."

The proposed project site will encompass an area of approximately 460 acres.

A site vicinity map is provided in Figure 1 within the Appendix. A proposed site plan is provided in Figure 2 within the Appendix.

1.4 Project Site Information

The proposed project is located east of Barstow Road (Highway 247), north of Lucerne Valley in San Bernardino County, California. The proposed project site is bounded by No End Rd to the north, Meridian Rd to the east, Haynes Rd to the south and Fern Rd to the west. The proposed project site is located in the Southern Mojave Watershed (Reference 1).

Currently the site is undeveloped consisting primarily of desert land with scattered abandoned structures and a transmission line.

No pre-existing water quality problems have been identified within the vicinity of the proposed project site.

SECTION 2: POLLUTANTS AND HYDROLOGIC CONDITIONS OF CONCERN

2.1 Pollutants of Concern

There are no pollutants of concern with the proposed solar farm site as the site will not generate chemical or any other potentially hazardous pollutants. The proposed site is defined as Non-Category Project.

2.2 Hydrologic Conditions of Concern

There are no hydrologic conditions of concern as the proposed site is defined as Non-Category Project. The only pollutant of concern is sediment runoff.

2.3 Watershed Impact of Project

According to the California State Water Resources Control Board (SWRD), there are no impaired bodies of water in the vicinity of the proposed project site (Reference 2).

Any potential adverse impact due to stormwater runoff from the project site will be mitigated by capturing sediment with erosion control fencing.

SECTION 3: BEST MANAGEMENT PRACTICE SELECTION PROCESS

3.1 Site Design BMPs

Site BMPs primarily consist of erosion control fencing. The erosion control fence will encompass the southern portion of the project site.

The erosion control fence is temporary and will be removed upon completion of the project.

Additional site BMPs description and uses are summarized in the table below.

1. Minimize Stormwater Runoff, Minimize Project's Impervious Footprint and Conserve Natural Areas		
Maximize the permeable area.		
Yes	No X	
Describe actions taken or justification/alternative: There will be minimal change in permeable area in the project site as 0.2% impervious cover will be added to the site.		
Runoff from developed areas may be reduced by using alternative materials or surfaces with a lower Coefficient of Runoff, or "C-Factor."		
Yes	No X	
Describe actions taken or justification/alternative: Development will primarily consist of constructing a private access road which will consist of compacted native soil or other permeable roadway surface. Only the solar panel foundations have an impact on runoff.		
Conserve natural areas.		
Yes X	No	
Describe actions taken or justification/alternative:		

The solar panels will be laid out in a space efficient manner. The proposed roadway will be located as close to the panels as can be safely located and roadway length is minimized as much as possible.		
Construct walkways, trails, patios, overflow parking lots, driveways, low-traffic streets and other low-traffic areas with open-joined paving materials or other permeable surfaces.		
Yes X	No	
Describe actions taken or justification/alternative: The proposed site access roadway and temporary parking will be a compacted native soil or other permeable roadway surface.		
Construct streets, sidewalks and parking lots to minimum width necessary.		
Yes X	No	
Describe actions taken or justification/alternative: The perimeter roadways will have a minimum width of 26 feet to allow for the passage of emergency vehicles and the interior roadways will have a minimum width of 20 feet.		
Reduce widths of street where off-street parking is available.		
Yes	No X	
Describe actions taken or justification/alternative: Not applicable, street width is dictated by emergency vehicle access.		
Other comparable site design options that are equally effective.		
Describe actions taken or justification/alternative: Not applicable, no alternative site designs required.		
Minimize the use of impervious surfaces, such as decorative concrete, in the landscape design.		
Yes	No X	
Describe actions taken or justification/alternative: Not applicable, no landscaping and minimal impervious surface will be created only by the solar panel foundations.		
Use natural drainage systems		
Yes X	No	
Describe actions taken or justification/alternative: Storm water will primarily be allowed to flow over the site without any modifications to the drainage behavior as the site is not impervious.		
Where soil conditions are suitable, use perforated pipe or gravel filtration pits for low flow infiltration.		
Yes	No X	
Describe actions taken or justification/alternative:		

The ground surface slope is relatively low; therefore, the storm water velocity is low. Since the existing soil has naturally high infiltration, virtually all low flow will infiltrate naturally.		
Construct onsite ponding areas, rain gardens or retention facilities to increase opportunities for infiltration, while being cognizant of the need to prevent the development of vector breeding areas.		
Yes	No X	
Describe actions taken or justification/alternative: The existing soil has naturally high infiltration and the slope is low; hence, virtually all potential storm water will infiltrate naturally.		

2. Minimize Directly Connected Impervious Areas		
Where landscaping is proposed, drain rooftops into adjacent landscaping prior to discharging to the storm drain.		
Yes	No X	
Describe actions taken or justification/alternative: Not applicable to the proposed project		
Where landscaping is proposed, drain impervious sidewalks, walkways, trails and patios into adjacent landscaping.		
Yes	No X	
Describe actions taken or justification/alternative: Not applicable to the proposed project		
Increase the use of vegetated drainage swales in lieu of underground piping or imperviously lined swales.		
Yes	No X	
Describe actions taken or justification/alternative: Not applicable to the proposed project		
Use one or more of the following:		
Yes	No	Design Feature
	X	Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings.
	X	Urban curb/swale system; street slopes to curb; periodic swale inlets drain to vegetated swale/biofilter.

	X	Dual drainage system: First flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to municipal storm drain systems.
	X	Other comparable design concepts that are equally effective.
Describe actions taken or justification/alternative: Not applicable to the proposed project. All proposed roadways are located on the site. Any runoff from the roadways will infiltrate before leaving the site. Sediment will be captured with erosion control fencing.		
Use one or more of the following features for design of driveways and private residential parking areas:		
Yes	No	Design Feature
	X	Design driveways with shared access, flared (single lane at street) or wheel strips (paving only under tires); or, drain into landscaping prior to discharging to the municipal storm drain system.
	X	Uncovered temporary or guest parking on private residential lots may be paved with a permeable surface; or designed to drain into landscaping prior to discharging to the municipal storm drain system.
	X	Other comparable design concepts that are equally effective.
Other comparable site design options that are equally effective.		
Describe actions taken or justification/alternative: Not applicable, the site has two access driveways, and temporary compacted native soil or other permeable surface parking areas.		
Use one or more of the following design concepts for the design of parking areas:		
Yes	No	
	X	Where landscaping is proposed in parking areas, incorporate landscape areas into the drainage design.
	X	Overflow parking (parking stalls provided in excess of the minimum parking requirements) may be constructed with permeable paving.
	X	Other comparable design concepts that are equally effective.
Describe actions taken or justification/alternative: Temporary parking will be constructed with temporary compacted native soil or other permeable surface.		

3.2 Source Control BMPs

Source control BMPs to be used are Activity Restrictions and Employee Training. Activities on the project site shall be limited to construction related activities during the construction phase and occasional maintenance activities following construction completion.

Employees shall be trained in the proper care and maintenance procedures to maintain good BMPs.

3.3 Treatment Control BMPs

Treatment control BMPs are not required for this project.

SECTION 4: BMPS OPERATIONS AND MAINTENANCE

4.1 O&M Description and Schedule

The BMPs that require management are the erosion control fencing.

During the construction phase, the erosion control fence require inspection prior to all anticipated storm events and following a storm event, within 2 business days of a storm event producing one half inch or more of precipitation. Any repairs shall be made as soon as possible.

Following completion of the construction phase the erosion control fencing will be removed.

The erosion control fence shall be installed prior to any earth disturbance activities in the area the erosion control fence is designated. The startup date will be determined when the construction schedule is developed and an amended plan will be filed for the BMPs.

NextEra Energy is the party responsible for BMP's O&M. The point of contact is:
Contact name: To be determined
Address: To be determined
Telephone Number: To be determined

SECTION 5: FUNDING

Funding identification is not required in this plan as there are no Treatment Control BMPs to be used.

SECTION 6: WQMP CERTIFICATION

"This Water Quality Management Plan has been prepared for NextEra Energy, Inc. by RRC Power & Energy, LLC. It is intended to comply with the requirements of San Bernardino County for Section 36 Township: 6 North and Section 1: Township 5 North requiring the preparation of a Water Quality Management Plan (WQMP). The undersigned is aware that Best Management Practices (BMPs) are enforceable pursuant to the County's Water Quality Ordinance No. 4136. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with San Bernardino County's Municipal Stormwater Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the county shall be notified to the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity."

"I certify under a penalty of law that the provisions (implementation, operation, maintenance and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

Applicant's Signature	Date
Applicant's Name	Applicant's Telephone Number

SECTION 7: REFERENCES

1. USEPA, Surf You Watershed, Southern Mojave Watershed – 18100100, https://cfpub.epa.gov/surf/huc.cfm?huc_code=18100100.
2. State Water Resources Control Board, Impaired Water Bodies Map, California Environmental Protection Agency, http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

Appendix

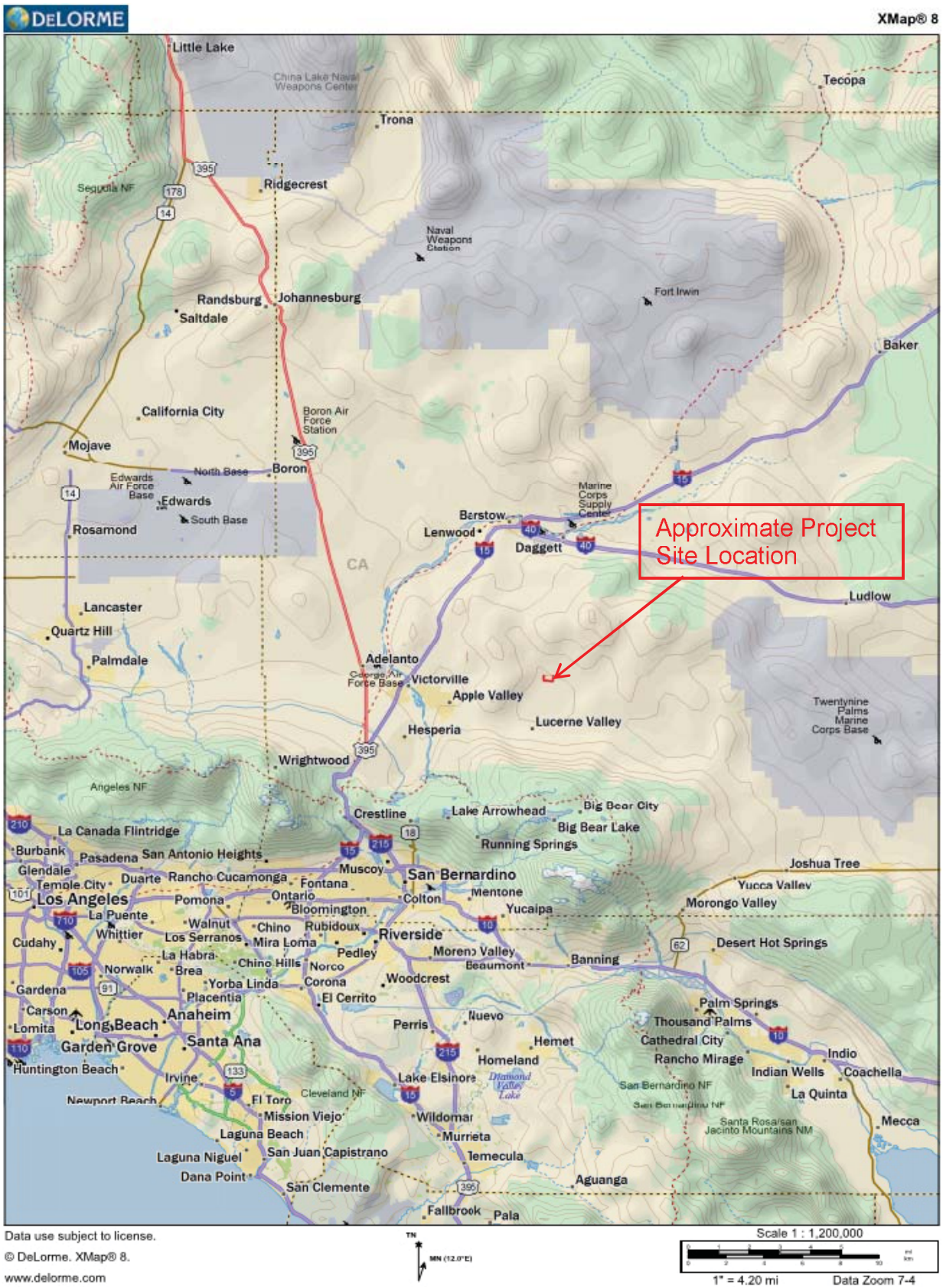

Figure 1: Site Vicinity Map

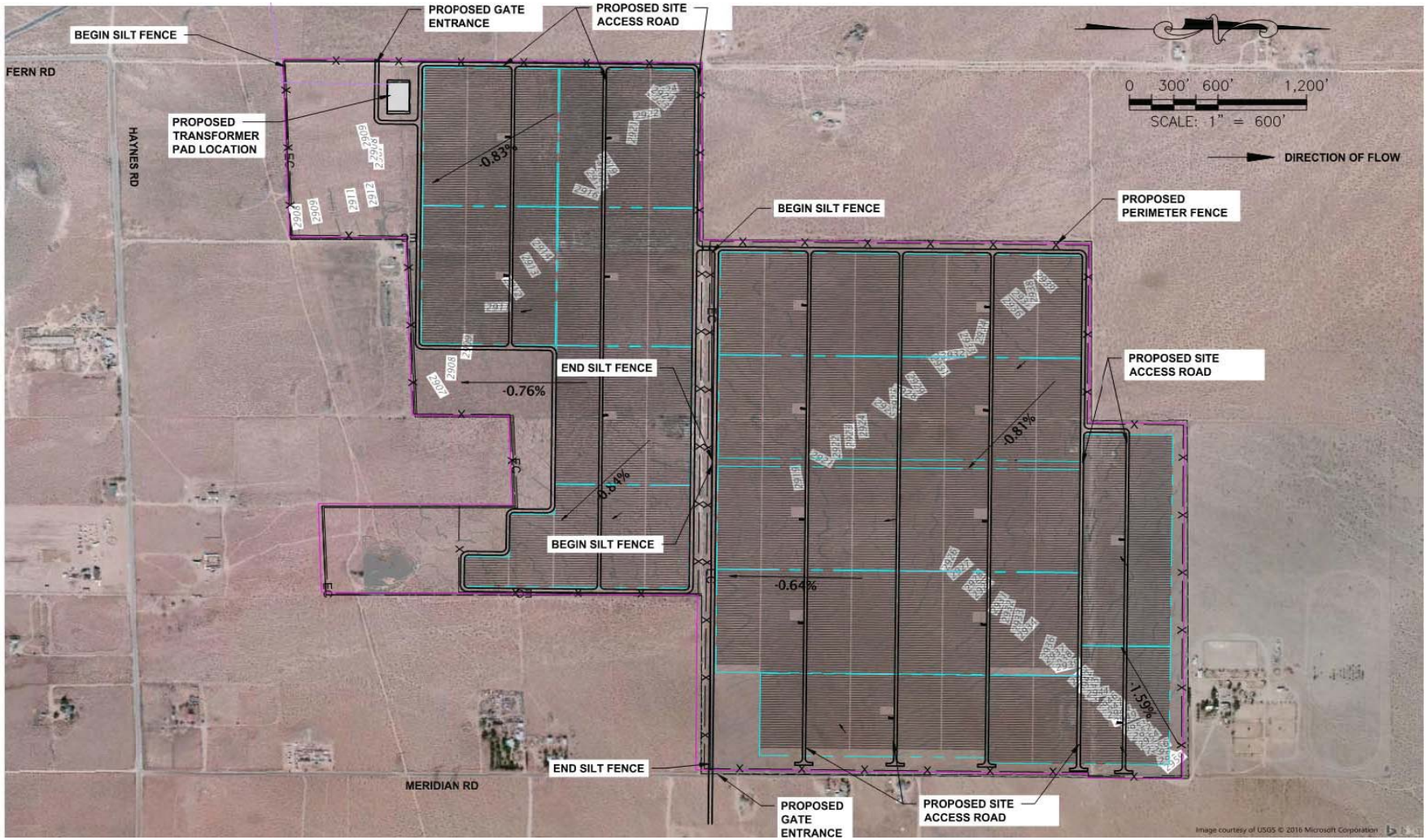

Figure 2: Site Map

Groundwater Availability Report

DRAFT

Ord Mountain Solar Energy Project
Groundwater Availability Report
San Bernardino County, California

Lead Agency:

County of San Bernardino
Land Use Services Department
385 North Arrowhead Avenue
San Bernardino, California 92415-0182
Contact: Doug Feremenga, AICP, Planner

Project Applicant:

NextEra Energy Resources
700 Universe Boulevard
Juno Beach, Florida 33408
Contact: Jesse Marshall

Prepared by:

DUDEK
605 Third Street
Encinitas, California 92024
Contact: Trey Driscoll, PG No. 8511, CHG No. 936

SEPTEMBER 2016

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ACRONYMS AND ABBREVIATIONS

AFY	acre-feet per year
AMSL	above mean seal level
APN	Assessor's Parcel Numbers
BAP	Base Annual Production
btoc	below the top of casing
CEQA	California Environmental Quality Act
County	County of San Bernardino
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FPA	Free Production Allowance
ft^2/day	square feet per day
gen-tie line	generation tie line
gpd/ft	gallons per day per foot
gpm	gallons per minute
MCL	maximum contaminant level
NWIS	National Water Information System
Project	Ord Mountain Solar Project
USGS	U.S. Geological Survey

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1 INTRODUCTION

This report documents the results of a groundwater resources evaluation prepared for the Ord Mountain Solar and Energy Storage Project (Project) located in the Mojave Desert north of Lucerne Valley in unincorporated San Bernardino County, California. Figure 1 shows the regional location of the project and Figure 2 is a site vicinity map. A literature review was performed to document previous work and provides the descriptions of the hydrogeologic and hydrologic setting, groundwater quality, and groundwater budget. Site-specific aquifer testing and groundwater quality sampling were conducted to provide information for the aquifer in the vicinity of the Project site and to verify the suitability of existing wells for providing groundwater supply for construction and operation of the Project. Finally, a determination was made as to groundwater availability for the Project.

1.1 Project Area and Site

The Project area is situated roughly in the southern portion of Section 36, Township 6 North, Range 1 West, the northern portion of Section 1, Township 5 North, Range 1 West, and the southern portion of Section 2, Township 5 North, Ranch 1 West, S.B.B. & M. of the White Horse Mountain, California U.S. Geological Survey (USGS) 7.5-topographic quadrangle at approximately Lat/Long 34°33'36.74"N/116°56'0.97"W and 2,927 feet above mean seal level (AMSL) (Figure 2).

The Project site is located east of State Route 247; north of Haynes Road; and west of Meridian Road, approximately 8 miles north of Lucerne Valley in unincorporated San Bernardino County. The generation tie line (gen-tie line) would extend southwest from the Project site to the Calcite Substation, proposed west of State Route 247, close to the existing high-voltage transmission corridor.

1.2 Project Description

The applicant proposes to construct and operate the project on approximately 484 acres to produce approximately 160,000 megawatt-hours of renewable energy annually. The Project would be a 60-megawatt alternating-current photovoltaic solar energy facility with associated on-site substation, inverters, fencing, roads, and supervisory control and data acquisition system. The Project would include a 230-kilovolt overhead gen-tie line, which would extend approximately 0.6 mile southwest to Southern California Edison's proposed Calcite Substation.

1.3 Description of Study Area

The 1996 Mojave Basin area adjudication created five subareas, including the Este Subarea that includes the Lucerne Valley Groundwater Basin and the Fifteenmile Valley Groundwater

Basin (Judgement 1996). The proposed Project site is located within the Lucerne Valley Groundwater Basin (Basin 7-19) and within the Lucerne Lake Hydrologic Unit (701.00) (Figure 3). The Lucerne Lake Hydrologic Unit internally drains to Lucerne Lake, a terminal dry lake playa. The Ord Mountains, Granite Mountains, and Fry Mountains form the northern, western, and eastern boundaries of the Lucerne Valley, respectively. To the south, the San Bernardino Mountains rise to an average elevation of approximately 7,500 feet AMSL, with local peaks up to 8,398 feet AMSL at Delamar Mountain. By comparison, the elevation of Lucerne Lake is approximately 2,850 feet AMSL.

1.4 Applicable Groundwater Regulations

County of San Bernardino. The Desert Groundwater Management Ordinance contained within the County of San Bernardino (County) Code of Ordinances, Title 3, Division 3, Chapter 6, Article 5, apply to all groundwater aquifers that have not been adjudicated in the County. Because the Project site overlies the adjudicated Lucerne Valley Groundwater Basin, the County's Desert Groundwater Management Ordinance does not apply.

County Development Code Chapter 84.29.035(c)(6), Required Findings for Approval of a Commercial Solar Energy Facility, states, "The proposed commercial solar energy generation facility will not adversely affect to a significant degree the availability of groundwater supplies for existing communities and existing and developing rural residential areas" (County of San Bernardino 2014).

The County of San Bernardino Guidelines for Preparation of a Groundwater Monitoring Plan was reviewed for developing monitoring measures for the Project (County of San Bernardino 2000).

Mojave Basin Judgement. City of Barstow et al. v. City of Adelanto et al. (case number 208568), or Mojave Basin Judgment (Judgement), established a decreasing Free Production Allowance (FPA) in each subarea of the Lucerne Valley Groundwater Basin. The FPA is allocated among the producers in the subarea based on each producer's percentage share of the FPA. All water produced in excess of any producer's share of the FPA must be replaced by the producer, either by payment to the Watermaster of funds sufficient to purchase replacement water, or by transfer of unused FPA from another producer (Judgement 1996, 2008). Each producer's percentage share of the FPA in a subarea was determined by first verifying the maximum annual water production (termed Base Annual Production (BAP)) for each producer during the 5-year, 1986–1990 base period and then calculating each producer's percentage share of the total of all such BAPs in the subarea. All percentage allocations are of equal priority (Judgement 1996).

The water supply to be used in serving the Project's demands are adjudicated production rights to be transferred from Gabrych, the current owner of the Project site, to the Project applicant. Gabrych is a party to the Judgment and holds a BAP right of 2,201 acre-feet per year (AFY) in the Este Subarea. Under the 80% ramp-down currently in effect for the Este Subarea, Gabrych's FPA is approximately 1,761 AFY (Judgement 2015).

The Project would acquire temporary transfer of sufficient BAP/FPA (which may include carryover water) from Gabrych to produce approximately 75 acre-feet for the 1-year construction period, and permanent transfer of sufficient BAP from Gabrych to allow the production of up to 10 AFY of water for operation. Additionally, approximately 38 acre-feet will need to be acquired for the Calcite Substation. As carryover water from the producer's share of the FPA must be used within 1 year according to the Judgement, coordination would be required with Gabrych and the Mojave Water Agency to determine current availability of carryover water for the Project. If carryover water is not available, the Project would need to secure a portion of Gabrych's FPA. The Project applicant would coordinate with the Mojave Water Agency and Gabrych to verify the plan for securing appropriate BAP/FPA.

1.4.1 Water Supply Assessment

A water supply assessment was previously prepared for the Lucerne Valley Solar Energy Center in 2010 (WorleyParsons 2010). In 2011–2012, amendments to California Water Code Section 10912(a)(5)(B) defined what a "project" is for solar and wind projects. It states that a "proposed photovoltaic or wind energy generation facility approved on or after the effective date of the amendments made to this section at the 2011–12 Regular Session is not a project if the facility would demand no more than 75 acre-feet of water annually." The Project-proposed construction water demand is 75 acre-feet over approximately a 1-year construction period, and 6.6 AFY during operation up to a maximum of 10 AFY. Additionally, up to 38 acre-feet may be supplied for construction of the Calcite Substation. As the Project would demand less than 75 acre-feet of water annually amortized over the life of the Project, an updated water supply assessment is not required.

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2 BACKGROUND AND EXISTING CONDITIONS

2.1 Previous Work

Geologic Mapping and Gravity Studies. Geologic mapping of the area includes Riley (1956), Dibblee (1964a and 1964b), Rogers (1967), Bortugno, and Spittler (1986), and Miller and Matti (2001). A detailed gravity study was previously conducted by (Aksoy 1986) close to the Helendale Fault, which provides a preliminary estimate of depth to bedrock of 300 to 1,700 feet in the Lucerne Valley. Additional modeling of gravity data by Surko (2006) indicates that the Lucerne Valley Groundwater Basin is very shallow, with average basin depths from 1,000 to 1,800 feet.

Hydrologic and Hydrogeological Investigations. Hydrologic investigations began around the turn of the 20th century in the Mojave Desert region with USGS documenting water resources (Mendenhall 1909) and performing geologic and hydrologic reconnaissance (Thompson 1929). The California Department of Water Resources (DWR) completed a detailed study of Mojave River Groundwater Basins in 1967, and provides a summary of the Lucerne Valley Groundwater Basin in Bulletin 118 (DWR 1967, 2003). A series of reports addressing the hydrological and hydrogeological conditions of the Lucerne Valley and Fifteenmile Valley Groundwater Basins include Riley (1956), Goodrich (1978), Schaefer (1979), Brose (1987), Pirnie (1990), Stamos et al. (2001), and Laton et al. (2005). Since 1992, the USGS, in cooperation with the Mojave Water Agency, has completed regional groundwater level and groundwater quality monitoring. Additional data and associated reports are available from USGS's Mojave Groundwater Resources website (http://ca.water.usgs.gov/mojave/).

2.2 Existing Conditions

Dudek performed a site well reconnaissance in April 2016 of Assessor's Parcel Numbers (APNs) 045-309-131, 045-309-129, 045-309-124, 045-309-112, 045-309-151, 045-309-172, 045-309-148, and 045-309-111 to determine the potential of using existing groundwater wells for construction and operational water supply. A total of 19 existing groundwater wells were located during the site reconnaissance (Figure 4). To assess the condition of well casing, the well screen, and the available water column in each well, Pacific Surveys of Claremont, California, performed downhole video surveys of 13 of the accessible groundwater wells (OM-5, OM-6, OM-8, OM-9, OM-10, OM-11, OM-12, OM-13, OM-14, OM-15, OM-16, OM-17, and OM-19) between April 14 and August 19, 2016 (see Table 1). Video survey reports for the wells are provided in Appendix A. Wells OM-1, OM-2, OM-3, OM-4, OM-7, and OM-18 were not included in the survey due to insufficient water column, which precludes consideration as a groundwater production well.

Table 1
Well Completion Details and Groundwater Levels for On-Site Wells

Well ID	Latitude[a]	Longitude[a]	Casing Diameter (inches)	Depth To Water (feet)	Total Depth (feet)	Existing Pump Installed	Potential as Groundwater Production Well	Potential as a Groundwater Monitoring Well
OM-1	34.55369792	-116.94296564	12.25	Dry	134	No	No	No
OM-2	34.55382090	-116.94355874	10	Dry	126	No	No	No
OM-3	34.55390713	-116.93988965	10	147.2	151	No	No	No
OM-4	34.55391904	-116.93997347	12.25	Dry	19	No	No	No
OM-5	34.55612540	-116.93717920	13.25	154.9[b]	319.9[b]	No	No	No
OM-6	34.55627762	-116.93696328	10	154.8[b]	265.6[b]	No	No	No
OM-7	34.55642774	-116.93697225	12.25	Dry	140	No	No	No
OM-8	34.55627234	-116.93609843	12.25	N/A	127.8[e]	Yes[d]	No	No
OM-9	34.56076638	-116.93640907	N/A	N/A	N/A	Yes[d]	No	No
OM-10	34.56009977	-116.93524591	8	N/A[b]	N/A[b]	No	No	No
OM-11	34.56021150	-116.93289680	12.25	N/A[b]	N/Ab	No	No	No
OM-12	34.56015827	-116.92783891	8.25	190.4[b]	257[b]	No	No	Yes
OM-13	34.56400023	-116.92773263	14	N/A	340[c]	Yes[d]	No	Yes
OM-14	34.56555421	-116.92772826	14	N/A	330[c]	Yes[d]	Yes	Yes
OM-15	34.56562018	-116.93599629	15.5	N/Ab	N/A	No	No	No
OM-16	34.56536679	-116.93616658	13.5	183.6[b]	319.8[b]	No	Yes	Yes
OM-17	34.56344557	-116.93585695	8.5	176.9[b]	234.6[b]	No	No	Yes
OM-18	34.56374011	-116.93206305	14	Dry	10	No	No	No
OM-19	34.56364766	-116.93203162	13.5	183.6[b]	318.6[b]	No	Yes	Yes

Source: Dudek 2016
Note: Highlighted wells were determined to potentially be suitable as groundwater production wells.
[a] Coordinates are UTM ZONE15N
[b] Determined by April 2016 video survey
[c] Determined by DWR well completion reports
[d] Existing pump and motor was determined to be inoperable and removed from the well
[e] OM-8 well casing was bridged at 127.8 feet below top of casing, and the video survey ended

3 DESCRIPTION OF HYDROGEOLOGIC SETTING

The geology of the proposed Project site and surrounding vicinity is characterized as a veneer of quaternary alluvium overlying bedrock consisting of mesozioc-age granite and quartz monzonite intruded into Paleozoic metasedimentary rocks (Dibblee 1964a, 1964b). Where present in the basin underlying the alluvium, Old Woman Sandstone is composed of sandstone and conglomerate, as well as lesser areas of shale, limestone, and basalt (Laton et al. 2005).

3.1 Consolidated Rocks

Consolidated rocks include Precambrian-age metamorphic rocks, Paleozoic-age metasedimentary and igneous rocks, Mesozoic plutonic and igneous rocks, and Cenozoic sedimentary and volcanic rocks. Consolidated rocks underlay unconsolidated deposits at the Project site and are considered low-water-bearing compared to unconsolidated deposits.

Old Woman Sandstone is an important source aquifer in the Este Subarea (Laton et al. 2005). The non-marine Tertiary Old Woman Sandstone consists of a sequence of siltstones, sandstones, and conglomerates that lie unconformably on top of the older basement complex (Surko 2006). Cross-sections by Dibblee (1964a) suggest that the Old Woman Sandstone is up to 300 meters (1,000 feet) thick, with thinning of the formation east of the Helendale Fault. DWR's Well Completion Reports for the Project site are not of sufficient detail to distinguish alluvium from Old Women Sandstone. Old Woman Sandstone is typically distinguished, primarily in well logs, by the appearance of a cemented layer approximately 150 to 300 feet below ground surface (Blazevic 2005).

3.2 Unconsolidated Deposits

The most prolific aquifer material of the Lucerne Valley Groundwater Basin is the quaternary alluvium, composed of unconsolidated to semi-consolidated boulders, gravel, sand, silt, and clay (DWR 2003). Based on well completion reports provided by DWR, the alluvium of the Project site ranges from 165 feet to 330 feet in thickness (Appendix B). Mapped surficial geologic units in the Project area are shown in Figures 5 and 6 and include the following:

- **Sedimentary deposits (Q):** Recent to late Pleistocene Age unconsolidated deposits consisting of sand, alluvium, and clay.
- **Older sedimentary deposits (Ooa):** Pleistocene Age older alluvium, gravel, and fanglomerate.
- **Land slide deposits (Qls):** Recent to Pleistocene Age landslide deposits.

A geologic cross section adapted from Dibblee (1964a) shows the consolidated and unconsolidated deposits underlying the Project site (Figure 6).

3.3 Structural Features

The predominant structural features in the Este Hydrologic Subbasin that influence the movement of water, including the location and distribution of the non-water-bearing deposits, are a set of active northwest-trending strike slip-faults: Helendale, Lenwood, Camp Rock, and Old Woman Springs fault zones, and the North Frontal thrust system of the San Bernardino Mountains (Figure 5). The North Frontal thrust system of the San Bernardino Mountains acts as a boundary to the basin aquifer at the southern edge of Lucerne Valley and Fifteenmile Valley (Lanton et al. 2005).

3.4 DWR Well Completion Reports for On-Site Wells

Well completion reports for the proposed Project's APNs were requested from DWR. DWR provided scanned PDFs of the available well completion reports for the site and the immediate vicinity. These files are included in Appendix B. Of the eight individual reports provided, Dudek was able to match four reports to existing wells on the site. The remaining reports provided by DWR appear to be off-site wells or destroyed wells.

Existing on-site wells OM-11, OM-13, OM-14, and OM-17 are associated with a well completion report provided by DWR. Table 2 summarizes well construction information provided in the DWR files.

Table 2
Well Completion Report Summary for On-Site Wells

Well ID	Assessor's Parcel Number	DWR Well Log	Casing Diameter (inches)	Total Completion Depth (feet)	Screen Interval (feet)	Production Estimate (GPM)	Date Drilled
OM-11	045309129	WCR No. 47112	12.25	230	185–230	N/A	1963
OM-13	045309131	WCR No. 093747	14	340	187–340	25[a]	1981
OM-14	045309131	WCR No. 093746	14	330	180–330	1,200	1981
OM-17	045309129	WCR No. 32955	8.5	266	226–266	N/A	1970

Source: Dudek 2016.
GPM = gallons per minute; N/A = not available
a. Based on the size of the pump and motor installed in well OM-13 (20 HP motor with a 10-stage pump of unknown make/model), the production estimate on the Well Completion Report is likely a typo.

Based on the DWR well completion reports, the ages of the wells range from 35 to 53 years. The useful life of water wells can vary greatly depending on several factors, including type of casing material, well construction method, scaling and corrosion, and biological growth and activity. A

study of 34 public supply wells in Arizona indicated that the useful life of mild steel wells is 40 to 50 years (Roscoe Moss Company 2016). Therefore, the age of the majority of on-site wells is likely approaching the upper limit of what is considered a useful well.[1]

[1] Dudek prepared a well destruction recommendation memorandum indicating that 13 groundwater wells (OM-1 through OM-11, OM-15, and OM-18) are no longer useful wells and should be abandoned according to DWR California Water Well Standards set forth in bulletins 74-81 and 74-90. As USGS has historically used on-site well OM-12 as a monitoring well, Dudek recommends preserving this well as a monitoring well. Additionally, wells OM-13 and OM-17 may be useful to retain as monitoring wells. Wells OM-14, OM-16, and OM-19 would be retained as productions wells. It is estimated that the wells to be retained have a reaming useful life of 5 to 30 years. There is potential that a new well(s) would be required to be drilled during the life of the Project to meet operational water demand.

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4 DESCRIPTION OF HYDROLOGIC SETTING

4.1 Climate

The Project site is located in the Mojave Desert region of Southern California and is characterized by hot summers and mild to cool winters. Large daily temperature fluctuations are common, with an average daily temperature range of 35°F over the year. Average temperatures also vary greatly over the year within the region. Mean maximum temperatures in the summer reach the high 90s (°F) and drop to the high 60s (°F) to low 90s (°F) in the fall. Temperatures fall below freezing in the winter, with mean minimum temperatures in the low 30s (°F) (WRCC 2016). Table 3 shows the average monthly minimum and maximum temperatures and precipitation from the Lucerne Valley monitoring station, located approximately 7 miles south of the Project site.

Table 3
Temperature and Precipitation Data Recorded at Lucerne Valley Station

Month	Temperatures (°F) 1919 to 1973		Precipitation (inches) 1919 to 1973	
	Monthly Averages		*Monthly Averages*	
			Rain	*Snowfall*
Jan.	58.9	27.3	0.72	0.7
Feb.	63.6	30.6	0.5	0.5
Mar.	68.2	35.2	0.38	0
Apr.	75	41.8	0.26	0
May	82.8	48.4	0.06	0
June	92.8	55.8	0.01	0
July	99.6	63.4	0.24	0
Aug.	97.8	60.4	0.3	0
Sep.	91.4	52.9	0.28	0
Oct.	80.5	42.5	0.13	0
Nov.	68.2	33.3	0.53	0
Dec.	59.2	27.4	0.63	1.1
Year	78.2	43.2	4.04	2.3

Source: WRCC 2016
Note: Lucerne Valley Station (045182) was previously located at 34°27', -116°57' at an elevation of approximately 300 feet.

The Lucerne Valley Station averaged 4.04 inches per year of precipitation from 1919 to 1973 (WRCC 2016). Most areas of the Mojave Desert basin floor receive 4 to 6 inches per year of precipitation (Stamos et al. 2004). Average annual precipitation for the Project site is approximately 6 inches based on the period of record from 1980 to 2010. Annual mean reference evapotranspiration is reported at 57 inches by the California Irrigation

Management Information System for the Project site, located in Zone 14, Mid-Central Valley, Southern Sierra Nevada, Tehachapi & High Desert Mountains (CIMIS 1999). Regional mean precipitation and California Irrigation Management Information System evaporation zones are shown in Figure 7.

4.2 Recharge and Groundwater Flow

Groundwater has historically flowed from the periphery of the Lucerne Valley basin toward the dry Lucerne Lakebed. Recharge to the groundwater system from direct infiltration of precipitation is minimal (Stamos et al. 2004). In the vicinity of the proposed Project, groundwater flows to the south with a gradient of 0.0067 feet per foot (DWR 2004).

4.3 Groundwater Levels

Generally, depth to groundwater in the Lucerne Valley basin ranges from 100 feet to 250 feet below ground surface. Groundwater levels have steadily declined since 1954, with an average drop of 77 feet, largely due to extraction for agricultural irrigation. Following the Mojave Basin adjudication in 1996, groundwater levels have been recovering.

Historical groundwater levels are available for the Project site from the USGS National Water Information System (NWIS) Mapper (USGS 2016), and for the Este Subarea from the Mojave Water Agency (MWA 2016). Inactive groundwater sites provide historical groundwater levels for several wells located on the Project site. Historical groundwater level data from NWIS Mapper Well Site Number 343324116561501 and Site Name 5N001W01C001S confirms the general regional trend of groundwater level decline that occurred from the 1950s to 1970s (Exhibit 1). Over this period of record, well 5N001W01C001S declined approximately 61 feet.

There is one active groundwater site from NWIS Mapper that is interpreted to be on-site well OM-12 based on the similar well location and reported well depth. Historical groundwater level data from NWIS Mapper Well Site Number 343338116553801 and Site Name 6N001W36J001S is provided in Exhibit 2. Well 6N001W36J001S confirms the regional trend of increasing groundwater levels since the 1996 Mojave Basin adjudication. Groundwater levels have recovered approximately 9 feet in well 6N001W36J001S from 1994 to 2016 (Exhibit 2). Historical groundwater levels are presented in Table 4.

Table 4
Historical On-Site Groundwater Levels

Site Name	Latitude	Longitude	Well Depth (feet)	Land Surface Elevation (feet)	Date	Depth to Groundwater (feet below land surface)	USGS Active Site
006N001W36K001S	34°33'44"	116°55'59"	ND	2,933	2/17/1953	115.8	Inactive
006N001W36K001S	34°33'44"	116°55'59"	ND	2,933	11/10/1953	112.7	Inactive
006N001W36K001S	34°33'44"	116°55'59"	ND	2,933	5/12/1954	114.4	Inactive
006N001W36K002S	34°33'43"	116°55'59"	ND	2,940	2/17/1953	110.75	Inactive
006N001W36K002S	34°33'43"	116°55'59"	ND	2,940	4/13/1953	114.34	Inactive
006N001W36K002S	34°33'43"	116°55'59"	ND	2,940	11/10/1953	112.1	Inactive
006N001W36K002S	34°33'43"	116°55'59"	ND	2,940	11/17/1954	112.9	Inactive
006N001W36K002S	34°33'43"	116°55'59"	ND	2,940	11/30/1954	127.76	Inactive
005N001W01E001S	34°33'11"	116°56'31"	135	2,915	11/30/1954	94.84	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	1/15/1953	93.3	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	2/17/1953	94.17	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	3/16/1953	92.9	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	4/13/1953	91.8	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	9/13/1953	115.47	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	11/10/1953	98.3	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	11/17/1954	96.75	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	11/30/1954	97.77	Inactive
005N001W01F001S	34°33'11"	116°56'15"	150	2,920	4/13/1955	103.1	Inactive
005N001W01G001S	34°33'11"	116°55'59"	158	2,920	2/17/1953	93.4	Inactive
005N001W01G001S	34°33'11"	116°55'59"	158	2,920	11/17/1954	90.8	Inactive
005N001W01G001S	34°33'11"	116°55'59"	158	2,920	11/30/1954	96.28	Inactive
005N001W01G001S	34°33'11"	116°55'59"	158	2,920	4/13/1955	85.1	Inactive
005N001W01G001S	34°33'11"	116°55'59"	158	2,920	11/20/1957	11.25	Inactive
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	7/21/1994	197.53	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	5/17/1996	192.9	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/5/1998	214.69	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/7/2000	191.11	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/12/2002	200.77	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/3/2004	190.72	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	4/12/2006	191.09	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	4/17/2008	190.36	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/8/2010	190.39	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/30/2012	189.89	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/6/2014	188.4	Active
006N001W36J001S	34°33'38"	116°55'38"	266	2,948	3/17/2016	188.29	Active
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	1/15/1953	93.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	2/17/1953	94.67	Inactive

Table 4
Historical On-Site Groundwater Levels

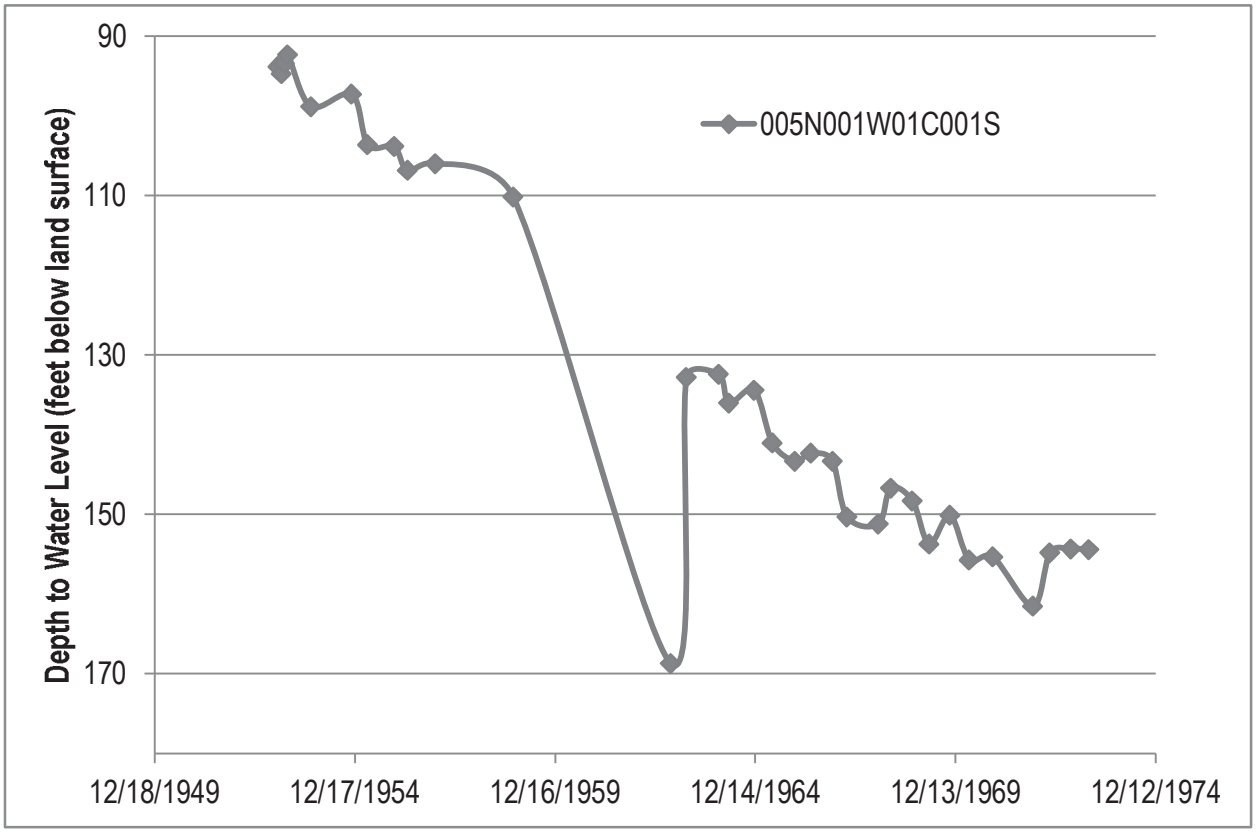
Site Name	Latitude	Longitude	Well Depth (feet)	Land Surface Elevation (feet)	Date	Depth to Groundwater (feet below land surface)	USGS Active Site
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	3/16/1953	93.4	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/13/1953	92.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/10/1953	98.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/17/1954	97.25	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/13/1955	103.6	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	12/9/1955	103.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/10/1956	106.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	12/20/1956	105.96	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/28/1958	110.12	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/2/1962	168.68	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	3/25/1963	132.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	1/15/1964	132.4	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/17/1964	136	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	12/3/1964	134.4	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	5/18/1965	141	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	12/7/1965	143.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	5/3/1966	142.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/16/1966	143.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	3/30/1967	150.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	1/8/1968	151.2	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	5/1/1968	146.7	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/14/1968	148.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/16/1969	153.7	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	10/23/1969	150.1	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/15/1970	155.7	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/18/1970	155.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	11/18/1971	161.5	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/19/1972	154.8	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	10/30/1972	154.3	Inactive
005N001W01C001S	34°33'24"	116°56'15"	ND	2,919	4/11/1973	154.4	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	1/15/1953	79.4	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/13/1953	80.7	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/10/1953	83.15	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/10/1954	85.73	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/17/1954	85.7	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/13/1955	86.5	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	12/9/1955	88.25	Inactive

Table 4
Historical On-Site Groundwater Levels

Site Name	Latitude	Longitude	Well Depth (feet)	Land Surface Elevation (feet)	Date	Depth to Groundwater (feet below land surface)	USGS Active Site
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/10/1956	89.78	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	12/20/1956	92.43	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	5/1/1957	95.33	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/22/1958	95.15	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/28/1958	100.11	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/9/1959	103.11	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	3/22/1960	102.34	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/13/1961	105.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	6/9/1961	108.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	3/19/1962	107.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/2/1962	113.65	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	3/25/1963	114.05	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	1/14/1964	114.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/16/1964	124.35	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	12/2/1964	119.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	5/18/1965	134.65	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	12/7/1965	121.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	5/3/1966	122.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/16/1966	124.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	3/30/1967	125.15	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	12/2/1967	119.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	1/8/1968	144.95	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	5/1/1968	133.75	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/14/1968	129.65	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/16/1969	130.15	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	10/23/1969	134.75	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/15/1970	131.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/18/1970	134.15	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/7/1971	133.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	11/18/1971	134.85	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/19/1972	134.35	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	10/30/1972	137.55	Inactive
005N001W01L001S	34°33'12"	116°56'27"	134	2,910	4/11/1973	134.85	Inactive

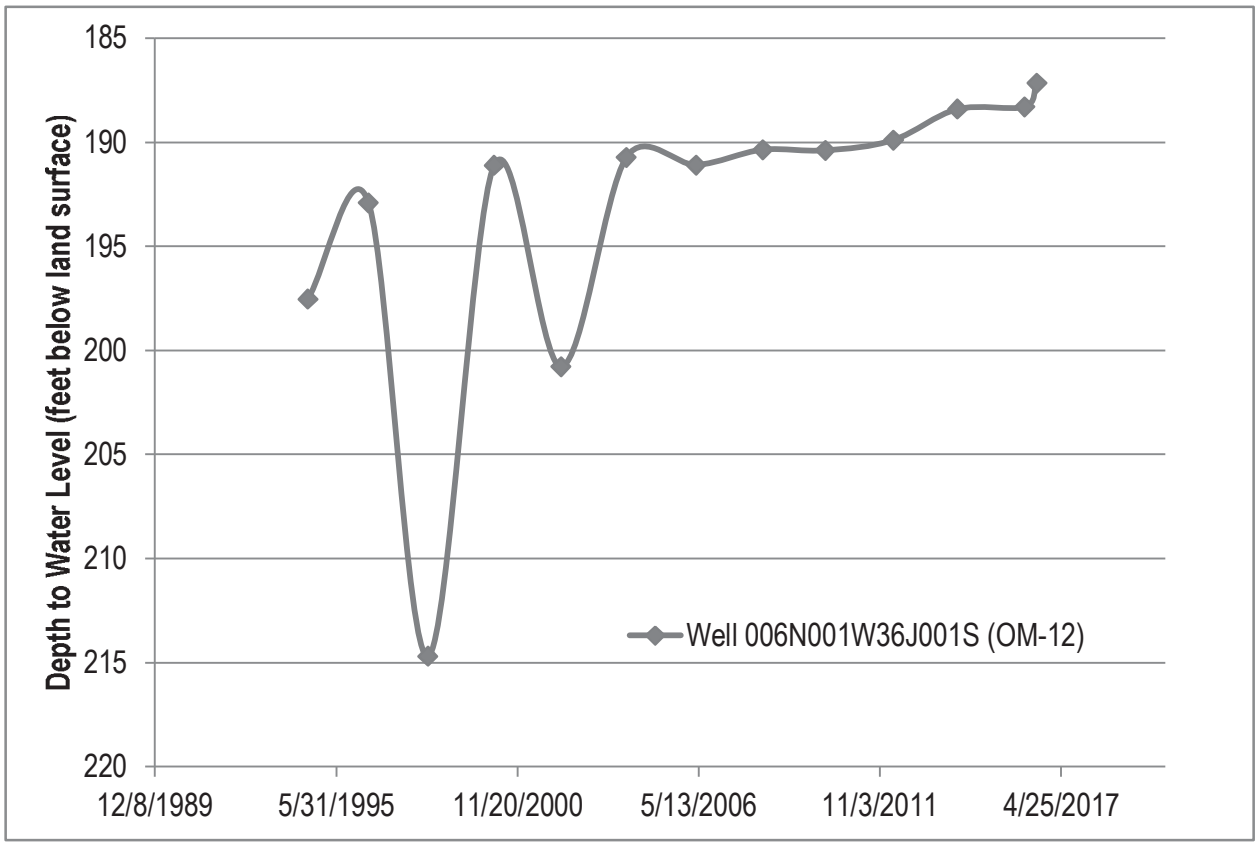
Source: USGS 2016
ND = Not Determined
Note: Horizontal coordinates NAD 27 and Vertical Coordinates NGVD29

Exhibit 1
Well 5N001W01C001S Historical Groundwater Levels



Source: USGS 2016

Exhibit 2
Well 6N001W36J001S (OM-12) Historical Groundwater Levels



Sources: Dudek 2016; USGS 2016

4.4 Historical On-Site Groundwater Production

Dudek performed a review of available aerial imagery of the Project site from 1953, 1969, 1975, and 1989. The property was historically used as agricultural land to grow alfalfa, and the planted acreage of alfalfa was calculated from the aerial photographs reviewed. The maximum planted acreage occurred in 1953 (316 acres), and the minimum acreage planted occurred in 1989 (117 acres), with a historical average of 227 acres of alfalfa planted on the Project site. Based on a study of water demand for growing alfalfa in various high desert locations (e.g., Owens Valley, Inyokern, Lucerne Valley, Mojave River Basin, Antelope Valley), water use for growing alfalfa is higher in these locations than other growing regions with similar crop yield due to the arid climate (Orloff and Gildersleeve 1991). Typical water use in Lucerne Valley was determined to be between 6.0 and 6.5 acre-feet of water per acre per year. Assuming an average annual planted acreage of 227 acres with a water demand of 6.5 acre-feet per acre, the historical annual water

demand for growing alfalfa on the Project site was approximately 1,472 AFY. The Project water demand for construction phase (75 AF) over 1 year represents 5% of the historical annual water demand for growing alfalfa. The Project water demand for operations (6.6 AFY) represents 0.45% of the historical annual water demand for growing alfalfa.

5 GROUNDWATER QUALITY

5.1 Este Subbasin Groundwater Quality

A summary of groundwater quality chemistry for the Este Subbasin was prepared by California State University Fullerton (CSU Fullerton 2005). Results excerpted from the Este Hydrologic Atlas are provided in Table 5.

Table 5
Este Subbasin Groundwater Quality Chemistry

Constituent	Minimum Reading	Maximum Reading	Average Reading	Maximum Contaminant Level (MCL)	Lucerne Valley Groundwater Basin Objectives[c]
Units	mg/L	mg/L	mg/L	mg/L	mg/L
Magnesium (Mg)	3.7	96	31.2	Not Regulated	–
Sodium (Na)	11	610	139	Not Regulated	–
Calcium (Ca)	20	270	81	Not Regulated	–
Chloride (CL)	5.1	1,200	244	250[a]	–
Sulfate (SO_4)	20	630	169	250[a]	–
Nitrate (NO_3)	ND	72	9.23	10	10
Arsenic (As)	ND	0.004	0.001	0.05	0.05
Total Chromium (Cr)	ND	0.017	0.0032	0.05	–
Hardness (as $CaCO_3$)	66	1,100	333	Not Regulated	–
Total Dissolved Solids (TDS)	260	3,400	1,017	500/1,000/1,500[b]	–
pH	7.29	8.34	7.74	6.5–8.5[a]	6.0–9.0

Source: CSU Fullerton 2005
mg/L = milligrams per liter
[a]. Secondary MCL
[b] Recommended/Upper/Short-Term Secondary MCLs
[c] Basin Objective from the Regional Water Quality Control Board Basin Plan

Groundwater quality varies across the Este Subbasin, but is generally suitable for beneficial uses. However, the average total dissolved solids concentration exceeds the recommended and upper secondary California drinking water maximum contaminant level (MCL) for total dissolved solids. Only the Fifteenmile Valley Groundwater Basin and the southern portions of the Lucerne Valley Groundwater Basin have groundwater quality below the total dissolved solids secondary MCL of 500 milligrams per liter. Additionally, elevated concentrations of other constituents are noted locally in the subbasin. In particular, elevated concentrations of magnesium, chloride, sodium, calcium, and sulfate are noted in relation to Lucerne Dry Lake. The majority of the subbasin is below the drinking water MCL for nitrate except the northern portion of Lucerne Valley and Cove Valley (CSU Fullerton 2005).

5.2 Project Groundwater Quality

A groundwater quality sample was collected from on-site wells OM-14 and OM-19 on July 29, 2016, at 4:25 a.m. and on September 8, 2016, at 3:10 p.m., respectively. Well OM-14 had been pumping for approximately 6 hours into the 8-hour step test. Approximately 58,760 gallons of water were purged from well OM-14 prior to sampling. Well OM-19 had been pumping for approximately 19 hours when the sample was collected, and approximately 165,000 gallons of water was purged prior to sampling, greatly exceeding standard sampling protocol to purge a minimum of three casing volumes.

Prior to the collection of the groundwater sample from wells OM-14 and OM-19, Dudek measured water quality parameters, including pH, temperature, salinity, specific conductance (EC), turbidity, and total dissolved solids using a HACH sension156 water quality meter (for well OM-14) and a YSI Quatro ProPlus water quality meter (for well OM-19), which were calibrated in the field. Dudek continued to monitor and record water quality parameters for the duration of the step test and constant rate test. These field measurements are summarized in Table 6. The groundwater samples for laboratory analysis was placed in laboratory-certified bottles, packed in a cooler with ice, and delivered under chain-of-custody to Babcock Laboratories of Riverside, California, within the specified holding times.

The groundwater samples were analyzed for a wide range of water-quality parameters, including general minerals, inorganic minerals, and general physical analysis. The laboratory reports are provided in Appendix C. Tables 7 and 8 list the results of the water quality analyses, analytical method, and comparison to California drinking water primary and secondary MCLs.

Table 6
Water Quality Results of Field Analysis

Well ID	Date	Time	Specific Conductance	Temperature	TDS	Salinity	pH	Turbidity
			µS/cm	*°F*	*mg/L*	*ppt*	*pH units*	*NTU*
OM-14[a]	7/28/2016	23:27	705	75.9	354	0.4	7.51	-
	7/29/2016	0:01	684	73.7	343	0.3	7.87	-
	7/29/2016	1:02	684	73.5	342	0.3	7.82	-
	7/29/2016	1:41	688	73	344	0.3	7.97	-
	7/29/2016	2:34	687	72.8	343	0.3	8.06	-
	7/29/2016	3:44	684	72.6	341	0.3	8.21	-
	7/29/2016	4:21	682	72.3	341	0.3	8.38	-

Table 6
Water Quality Results of Field Analysis

Well ID	Date	Time	Specific Conductance	Temperature	TDS	Salinity	pH	Turbidity
			µS/cm	*°F*	*mg/L*	*ppt*	*pH units*	*NTU*
OM-14[a]	7/29/2016	4:24	684	72.1	344	0.3	8.32	-
	7/29/2016	5:45	689	72	347	0.3	8.40	-
	7/29/2016	7:27	685	74.3	345	0.3	8.54	-
	7/29/2016	10:31	681	76.8	342	0.3	8.57	-
	7/29/2016	13:03	691	78	347	0.3	8.63	-
	7/29/2016	16:05	678	78.5	339	0.3	8.68	-
	7/29/2016	20:16	684	75.9	342	0.3	8.79	-
	7/29/2016	23:19	691	74.6	345	0.3	8.83	-
	7/30/2016	6:19	690	73.7	343	0.3	8.89	-
OM-19	9/7/2016	20:21	840	71.8	-	-	7.60	12.7
	9/7/2016	20:33	793	72.0	-	-	7.60	4.53
	9/7/2016	21:20	777	72.0	-	-	7.65	2.86
	9/7/2016	21:43	774	72.0	-	-	7.64	2.35
	9/7/2016	22:07	776	71.4	-	-	7.64	346
	9/7/2016	22:18	403	71.8	-	-	7.65	13.1
	9/7/2016	22:46	772	71.6	-	-	7.67	7.01
	9/7/2016	23:10	397	71.6	-	-	7.72	3.52
	9/8/2016	00:11	400	71.6	-	-	7.77	350
	9/8/2016	00:20	398	71.6	-	-	7.77	99.6
	9/8/2016	02:16	777	71.2	-	-	7.77	10.9
	9/8/2016	04:06	769	71.1	-	-	7.69	3.25
	9/8/2016	08:08	781	71.8	-	-	7.79	3.19
	9/8/2016	09:47	804	73.8	-	-	7.92	2.66
	9/8/2016	10:43	808	73.8	-	-	7.89	2.50
	9/8/2016	12:45	808	74.0	-	-	7.81	2.17
	9/8/2016	13:42	818	74.7	-	-	7.92	2.32
	9/8/2016	15:31	824	75.6	-	-	7.87	2.27
	9/8/2016	18:47	814	74.3	-	-	7.71	2.23
	9/8/2016	20:03	791	72.1	-	-	7.58	1.01
	9/9/2016	00:46	789	71.8	-	-	7.67	1.72

[a] There appears to be drift in the field pH data collected for well OM-14 associated with meter accuracy when compared to the laboratory result.
µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; ppt = parts per thousand; NTU = nephelometric units; TDS = total dissolved solids

Table 7
General Mineral Water Quality Results

Constituent	Analytical Method	Units	OM-14 Result	OM-19 Result	California Drinking Water MCLs
Cations					
Total Hardness	EPA 200.7	mg $CaCO_3$/L	200	240	—
Calcium	EPA 200.7	mg/L	47	58	—
Magnesium	EPA 200.7	mg/L	19	22	—
Sodium	EPA 200.7	mg/L	75	69	—
Potassium	EPA 200.7	mg/L	3.7	3.4	—
Sodium Adsorption Ratio (SAR)	EPA 200.7	None	2.3	3.6	—
Adjusted SAR	EPA 200.7	None	4.1	2.0	—
Total Cations	*Calculated*	*me/L*	*7.3*	*7.8*	—
Anions					
Total Alkalinity	SM2320B	mg $CaCO_3$/L	110	100	—
Hydroxide	SM2320B	mg $CaCO_3$/L	<3.0	<3.0	—
Carbonate	SM2320B	mg $CaCO_3$/L	<3.0	<3.0	—
Bicarbonate	SM2320B	mg $CaCO_3$/L	130	120	—
Chloride	EPA 300.0	mg/L	73	100	250/500/600[a]
Sulfate	EPA 300.0	mg/L	120	110	250/500/600[a]
Fluoride	SM4500 F C	mg/L	1.2	1.0	—
Nitrate (as N)	EPA 300.0	mg/L	5	4.1	10
Nitrate (as NO_3)	EPA 300.0	mg/L	22	18	45
Total Anions	*Calculated*	*me/L*	*7.18*	7.45	—
Aggregate Properties					
pH	SM4500H +B	pH Units	7.7	7.8	6.5–8.5[b]
Specific Conductance	SM2510 B	umhos/cm[c]	800	800	900/1,600/2,200[a] (µS/cm)
Aggressive Index	Calculated	None	11.8	12.0	—
Langlier Index @ 25C	SM2330 B	None	0.02	0.17	—
Solids					
Total Dissolved Solids	SM2540 C	mg/L	510	510	500/1,000/1,500[a]
General Physical					
Color	SM2120 B	Color Units	10	<3.0	15
Odor	SM2150	T.O.N.	<1.0	<1.0	3
Turbidity	SM2130 B	NTU	4.0	0.98	5
Surfactants					
MBAS	SM5540C	mg/L	<0.08	<0.08	0.5[a]

Table 7
General Mineral Water Quality Results

Constituent	Analytical Method	Units	OM-14 Result	OM-19 Result	California Drinking Water MCLs
General Inorganics and Nutrients					
Cyanide	SM4500CN E	mg/L	<0.1	<0.1	0.15
Perchlorate	EPA314.0	mg/L	<0.004	<0.004	0.006
Nitrite as N	SM4500N02 B	mg/L	<0.1	<0.1	1

MBAS = methylene blue active substances; MCL = maximum contaminant level; mg/L = milligrams per liter; me/L = milliequivalents per liter; mg $CaCO_3$/L = milligrams as carbonate; T.O.N. = threshold odor number; NTU = nephelometric units

a. Recommended/Upper/Short-Term Secondary MCLs.

b Secondary MCLs.

c. umhos/cm = micromhos per centimeter which his equivalent to microsiemens per centimeter (µS/cm).

Table 8
Inorganic Minerals Water Quality Results

Constituent	Analytical Method	Units	OM-14 Result	OM-19 Result	California Drinking Water MCLs
Aluminum	EPA 200.7	ug/L	<50	<50	1,000
Antimony	EPA 200.8	ug/L	<6	<6	6
Arsenic	EPA 200.8	ug/L	<2	2.0	10
Barium	EPA 200.8	ug/L	48	44	1,000
Beryllium	EPA 200.8	ug/L	<1	<1	4
Boron	EPA 200.7	ug/L	290	210	1,000[c]
Cadmium	EPA 200.8	ug/L	<1	<1	5
Chromium (Total)	EPA 200.8	ug/L	<1	<1	50
Copper	EPA 200.8	ug/L	<50	<50	1,300[a]
Iron	EPA 200.7	ug/L	<100	<100	300[b]
Lead	EPA 200.8	ug/L	<5	<5	15[a]
Manganese	EPA 200.8	ug/L	<20	28	50[b]
Mercury	EPA 200.8	ug/L	<1	<1	0.002
Nickel	EPA 200.8	ug/L	<10	<10	0.1
Silver	EPA 200.8	ug/L	<10	<10	—
Selenium	EPA 200.8	ug/L	<5	<5	50
Thallium	EPA 200.8	ug/L	<1	<1	2
Zinc	EPA 200.8	ug/L	<50	<50	5,000[a]

EPA = U.S. Environmental Protection Agency; MCL = maximum contaminant level; ug/L = micrograms per liter

a Values referred to as MCLs for lead and copper are not actually MCLs; instead, they are called "Action Levels" under the lead and copper rule.

b Secondary MCLs.

c California Notification Level

The groundwater quality results from wells OM-14 and OM-19 indicate that all constituents sampled are below the U.S. Environmental Protection Agency (EPA) and State of California MCLs.

6 SUMMARY OF WATER BUDGET

A water budget is used to evaluate changes in groundwater storage, which may be summarized by the following expression:

Inflow = Outflow ± Change in Storage

As the Este Subarea is considered a closed basin, the inflow parameters include precipitation, groundwater inflow, return flow, and overland flow, and the outflow parameters include evaporation, transpiration, and groundwater production. The Mojave Watermaster has updated the water budget for the 19-year period since the Judgement. The water budget indicates that there is a continuing overdraft in the Lucerne Valley and a slight surplus in the Fifteenmile Valley (Judgement 2016). The Twenty-Second Annual Report of the Mojave Basin Area Watermaster states, "Water levels in Este have remained stable for the past several years indicating a relative balance between recharge and discharge" (Judgement 2016). Thus, the water balance conflicts with the empirical groundwater level data. This is likely due to the uncertainty with the parameters used to estimate the water budget. The verified groundwater production for the Este Subarea is 5,823 acre-feet for the 2014–2015 water year, although the Watermaster recognizes and is attempting to further quantify groundwater production that is not documented. The production safe yield for the Este Subarea is 7,156 acre-feet based on the consumptive use analysis (Judgement 2016).

The groundwater budget for the Este Subarea is regulated through adjudication. Pumping rights and allocations are prescribed in the Mojave Basin Judgement (Judgement 2015). As discussed in Section 1.4 of this report, the water produced for Project demand would be applied to the adjudicated production rights from the landowner, Gabrych. The Judgement established a BAP of 2,201 AFY for Gabrych in the Este Subarea. Factoring in the current 80% ramp-down in effect for the Este Subarea, Gabrych's FPA in the Este Subarea is approximately 1,761 AFY. The Project water demand for the construction phase would be 75 acre-feet over approximately 1 year. The construction water demand represents 4.3% of Gabrych's FPA in the Este Subarea. Operational demand would be 6.6 AFY for a duration of 30 years, which represents 0.4% of Gabrych's current FPA in the Este Subarea. The overall water demand to the Project represents a small fraction of the established production rights within the Este Subarea assigned to the landowner.

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7 GROUNDWATER AVAILABILITY FOR PROPOSED PROJECT

7.1 On-Site Production Wells

Based on Dudek's preliminary site evaluation (Dudek 2016), 19 groundwater wells were identified (OM-1 through OM-19). All of these wells were likely installed with the intent for use as production wells for prior agricultural use on the property. Many of these wells were adjacent to old agricultural irrigation infrastructure such as large-diameter irrigation pipelines and storage ponds. Based on downhole video surveys of the groundwater wells and well completion information provided by DWR, Dudek identified several wells (OM-14, OM-16, and OM-19) that are suitable for use as production wells for construction and operation of the Project. As part of this groundwater availability report, Dudek performed pump testing of wells OM-14, OM-16, and OM-19. The results of the tests performed on wells OM-14 and OM-19 were used to estimate aquifer properties. Well OM-16 was tested to verify its sustainable groundwater production rate.

7.2 Primary Production Well

7.2.1 OM-14

An 8-hour step test was performed at well OM-14 from July 28, 2016, at 10:20 p.m. through July 29, 2016 at 6:22 a.m. The purpose of this step-drawdown test was to establish an optimal pumping rate for the 24-hour constant rate test. The 24-hour aquifer test was performed at well OM-14 beginning on July 29, 2016, at 7:02 a.m. and ending on July 30, 2016, at 7:03 a.m. The 24-hour constant rate test was performed to determine the feasibility of groundwater use for Project construction and operational water supply, and to characterize the hydraulic properties of the aquifer in the vicinity of the well. A groundwater quality sample was collected on July 29, 2016, at 4:25 a.m. The results of groundwater quality analysis are presented in Section 5 of this report.

Prior to the 8-hour step test, a Goulds Model 6CHC-5 submersible pump and Hitachi 30 horsepower (HP) submersible motor were installed in well OM-14 to a depth of 304 feet. An In-Situ Level Troll 400 pressure transducer was installed 298 feet below the top of casing (btoc) in a 1.25-inch-diameter sounding tube in well OM-14 on July 28, 2016. Additionally, pressure transducers were installed in on-site wells OM-13 and OM-19 (as shown in Figure 4). These wells were equipped with pressure transducers to quantify the effects, if any, of the drawdown induced by the aquifer test. Automatic groundwater level readings were recorded every minute prior to, during, and after the pump tests by the pressure transducers installed in the observation wells.

In addition to the observation wells equipped with pressure transducers, wells OM-12 and OM-19 were monitored during the testing at production well OM-14 by measuring depth to water with a water level sounder. Multiple manual groundwater level measurements were obtained in the observation wells, including at the time of transducer installation. A Solinst Barologger was stored at the wellhead and used to measure barometric pressure before, during, and after the 8-hour and 24-hour tests. The pressure transducer data collected at the pumping well and observation wells were corrected using this barometric data. Manual groundwater level measurements were recorded prior to the test, at the start of the test, periodically over the test interval, and during recovery after pumping ceased. Flow and total gallons pumped were measured using an in-line flow meter equipped with a flow totalizer.

The static groundwater levels at well OM-14 prior to the start of the 8-hour and 24 hour tests were measured at 209.35 and 210.80 feet btoc, respectively. The 24-hour constant rate aquifer test commenced on July 29, 2016, at 7:02 a.m. Well OM-14 was pumped at an average flow rate of 248 gallons per minute (gpm) over the duration of the 24-hour test, with a total drawdown of 49.9 feet. The total volume of water pumped over the 24-hour period of the test was approximately 354,090 gallons. The pumped water was discharged to the ground surface at the Project site approximately 150 feet from the wellhead.

7.2.1.1 Well Test Analysis

The results of the well OM-14 aquifer test (pumping well and observation wells) are presented in Figures 8, 9, and 10. Aquifer transmissivity (the rate at which water flows through a vertical strip of the aquifer 1 foot wide and extending through the full saturated thickness, under a hydraulic gradient of 1 or 100%) is calculated using the Cooper–Jacob approximation to the Theis equation (Cooper and Jacob 1953) as follows:

$$T = \frac{2.303\,Q}{4\,\pi\,\Delta s}$$

Where:

T = transmissivity (feet^2/day) [multiply by 7.48 to get units of gpd/foot]
Q = average pumping rate (feet^2/day) [multiply gpm by 193]
π = pi (3.14)
Δs = difference in drawdown over one log cycle (feet)

The transmissivity (T) was estimated using the drawdown response from observation well OM-13 (Figures 11 and 12). Calculating aquifer properties from observation well data avoids any pumping well effects or inefficiencies, particularly at this site where the production well (OM-14) is old and the well screen was visually documented to be impaired with growth and

physical deterioration (Appendix A). The drawdown response observed at observation well OM-13 was sufficient for aquifer property calculations, although it is important to note there was steepening of the drawdown slope in the late-time drawdown data indicating a boundary condition (Figure 12). Therefore, the aquifer properties must be calculated from the early-time data (Driscoll 1986).

The transmissivity was estimated manually using the graphical Cooper-Jacob straight-line method at 32,401 square feet per day (ft^2/day) or 242,363 gallons per day per foot (gpd/ft) (Figure 12). Additionally, the aquifer test data were analyzed using the computer program Aqtesolv Pro, version 4.50 (Aqtesolv). The pumping data required for this modeling software included the groundwater level in the pumping well, the rate of pumping, and elapsed time of pumping. The transmissivity values obtained through the Aqtesolv modeling software ranged from 27,400 ft^2/day to 31,130 ft^2/day (204,952 to 232,852 gpd/ft). The transmissivity estimated for well OM-14 that best fit the data is 31,130 ft^2/day or 232,852 gpd/ft using Aqtesolv Cooper-Jacob method with a sum of squares of 0.1145 (Appendix D). Table 9 shows the range of aquifer parameters and residual statistics obtained from the Aqtesolv modeling.

Table 9
OM-14 Aquifer Property Estimates and Methods

Solution Method	Parameter Estimates		Residual Statistics			
	Transmissivity (square feet per day)	*Storativity*	*Sum of Squares (square feet)*	*Variance (square feet)*	*Standard Deviation (feet)*	*Mean (feet)*
Graphical Cooper-Jacob Straight Line	32,401	0.0044	N/A			
Aqtesolv Cooper–Jacob	31,130	0.0043	0.1145	0.0001778	0.01334	8.66E-10
Aqtesolv Theis	27,400	0.0055	0.1562	0.0002425	0.01557	-0.0005864

The aquifer coefficient of storage (also called storativity) is the volume of water released from storage per unit decline in hydraulic head in the aquifer per unit area of the aquifer. Due to well losses and inefficiency of the pumping well, an observation well is required to calculate the coefficient of storage. The coefficient of storage is also estimated using the Copper-Jacob approximation to the Theis equation (Cooper and Jacob 1953) as follows:

$$S = \frac{2.25\, T\, t_o}{r^2}$$

Where:

S = Coefficient of Storage (dimensionless)

T = transmissivity (ft^2/day) = 32,401 ft^2/day
t_o = intercept with x-axis, time (days) = 0.018 days
r = distance to observation well (feet) = 546 feet

The coefficient of storage (S) calculated from data obtained in the observation well (well OM-13) was 0.0044 (Figure 12). This is a typical value for a coefficient of storage in a confined or semi-confined aquifer (10^3 to 10^5) as opposed to storage values typical of unconfined aquifers (0.3 to 0.01) (Driscoll 1986). This agrees with the driller's lithology log, obtained through a DWR records request, which notes the presence of a predominant clay matrix encountered at 50 to 230 feet and 262 to 308 feet below ground surface during the drilling of well OM-14 (Appendix B).

The Cooper-Jacob method was verified by validating that dimensionless time (u) is sufficiently small (u <0.05) using the equation as follows:

$$u = \frac{r^2 S}{4\,T\,t}$$

Where:

u = time (dimensionless)
r = distance to center of pumping (feet) = 546 feet
S = Coefficient of Storage (dimensionless)
T = transmissivity (ft^2/day) = 32,401 ft^2/day
t = time since pumping started

During a constant rate aquifer test, drawdown data plot on a straight line except at large values of u, or small values of 1/u. At values of u less than about 0.05, the Cooper-Jacob approximation is valid (Driscoll 1986). For the 24-hour test, a sufficiently small value of u was assumed and used to solve for time since pumping started (t) (Figure 12). The calculated value of t was 0.2 minutes, which is less than the data used for the Cooper-Jacob approximation, validating the analysis.

Groundwater level response from pumping well OM-14 in observation wells OM-12, OM-16, and OM-19 is shown in Figures 13, 14, and 15. There was not a clear groundwater level response in wells observation wells OM-12, OM-16, and OM-19 from pumping OM-14. Fluctuations in the groundwater level observed in well OM-12 during the OM-14 pump test may be due to localized pumping by off-site wells.

7.3 Secondary Production Wells

Based on the results of the downhole video surveys, wells OM-16 and OM-19 were identified as potential sources of groundwater supply. These wells were tested to assess their suitability as a secondary source of groundwater supply. The testing procedures and results are described below.

7.3.1 OM-16

Subsequent to the testing at well OM-14, an 8-hour step test was performed at well OM-16 starting on August 12, 2106, at 8:22 a.m. and ending on August 12, 2016, at 4:20 p.m. The purpose of performing the step-drawdown test at well OM-16 was to verify the production capacity of this well. The same model pump and motor (Goulds Model 6CHC-5 submersible pump and Hitachi 30 HP submersible motor) used for the test at OM-14 was used for the step-test at OM-16, with the pump set to a depth of 304 feet. The pumping well was equipped with an In-Situ Level Troll 400 pressure transducer, installed to a depth of 300 feet inside a 1.25-inch-diameter sounding tube. Additionally, pressure transducers were installed in on-site wells OM-13, OM-17, and OM-19 to quantify the effects, if any, of the drawdown induced by the aquifer test. Automatic groundwater level readings were recorded every minute prior to, during, and after the pump tests by the pressure transducers installed in the observation wells. In addition to the observation wells equipped with pressure transducers, well OM-14 was monitored during the testing at production well OM-16 by measuring depth to water with an electronic groundwater level sounder. A Solinst Barologger was stored at the wellhead of well OM-16 and was used to measure barometric pressure before, during, and after the 8-hour test. The pressure transducer data collected at the pumping well and observation wells were corrected using this barometric data.

During the testing at well OM-16, no drawdown response occurred at any of the observation wells due to pumping from the OM-16 step-test (Figures 11 and 15). Based on the results of the 8-hour step-test, well OM-16 can sustainably produce approximately 30 gpm. Maximum drawdown at well OM-16 during testing was 104.6 feet. The production rate from well OM-16 is not sufficient to replace the production at primary pumping well OM-14, but well OM-16 could be useful for filling on-site water storage tanks.

7.3.2 OM-19

A 6-hour step test was performed at well OM-19 from September 7, 2016, at 7:59 p.m. through September 8, 2016 at 1:56 a.m. The purpose of this step-drawdown test was to establish an optimal pumping rate for the 24-hour constant rate test. The 24-hour aquifer test was performed at well OM-19 beginning September 8, 2016, at 2:10 a.m. and ending on September 9, 2016, at

2:02 a.m. The 24-hour constant rate test at well OM-19 was performed to determine the suitability of the well to provide a back-up source of water supply and to characterize the hydraulic properties of the aquifer in the vicinity of the well. A groundwater quality sample was collected on September 8, 2016 at 3:10 p.m. The results of groundwater quality analysis are summarized in Section 5, above.

Prior to the step test, the same pump and motor used during testing at wells OM-14 and OM-16 (Goulds Model 6CHC-5 pump and Hitachi 30 HP motor) was installed in well OM-19 to a depth of 304 feet. On September 7, 2016, an In-Situ Level Troll 400 pressure transducer was installed 298 feet btoc in a 1.25-inch-diameter sounding tube. Additionally, wells OM-12, OM-13, and OM-17 were equipped with pressure transducers and monitored as observation wells to quantify the effects, if any, of the drawdown induced by the aquifer test. Automatic groundwater level readings were recorded every minute prior to, during, and after the pump tests by the pressure transducers installed in the observation wells.

Similar to the tests at wells OM-14 and OM-16, a Solinst Barologger was stored at the wellhead and used to measure barometric pressure before, during, and after the 8-hour and 24-hour tests. The pressure transducer data collected at the pumping well and observation wells were corrected using this barometric data. Manual groundwater level measurements were recorded prior to the test, at the start of the test, periodically over the test interval, and during recovery after pumping ceased. Flow and total gallons pumped were measured using an in-line flow meter equipped with a flow totalizer.

The static groundwater level at well OM-19 prior to the start of the 6-hour test was measured at 184.04 feet btoc. The 24-hour constant rate aquifer test commenced on September 8, 2016, at 2:10 a.m. Well OM-14 was pumped at an average flow rate of 142 gpm over the duration of the 24-hour test with a total drawdown of 40 feet. The total volume of water pumped over the 24-hour period of the test was approximately 204,665 gallons. The pumped water was discharged to the ground surface at the Project site approximately 100 feet from the wellhead. The tested production rate from well OM-19 (142 gpm) is a suitable secondary source of supply to meet Project construction and operational water demands.

7.3.2.1 Well Test Analysis

The results of the well OM-19 aquifer test are presented in Figures 16 and 17. During the testing at well OM-19, no drawdown response was observed in the observation wells. Due to well losses and inefficiency of the pumping well, an observation well is required to calculate the coefficient of storage. Therefore, a coefficient of storage value was not able to be estimated based on the results of this test. The transmissivity (T) was estimated using the drawdown

measured in the pumping well. A steepening of the drawdown slope in the late-time data at well OM-19 (similar to observation well OM-13 drawdown response during pumping of well OM-14) indicated a boundary condition was encountered during the course of the test (Figure 17). Due to this observed condition, the transmissivity was estimated using the early-time test data from the well OM-19 test.

The transmissivity was estimated manually using the graphical Cooper-Jacob straight-line method at 1,022.3 ft^2/day or 7,646.5 gpd/ft (Figure 17). Additionally, the aquifer test data were analyzed using the computer program Aqtesolv. The transmissivity values obtained through the Aqtesolv modeling software ranged from 855.8 ft^2/day to 856.5 ft^2/day (6,401.4 to 6,406.6 gpd/ft). The transmissivity estimated for well OM-19 that best fit the data is 855.8 ft^2/day or 6,401.4 gpd/ft using Aqtesolv Cooper-Jacob method with a sum of squares of 291.7. Table 10 shows the range of aquifer parameters and residual statistics obtained from the Aqtesolv modeling.

Table 10
OM-19 Aquifer Property Estimates and Methods

Solution Method	Parameter Estimates	Residual Statistics			
	Transmissivity (square feet per day)	*Sum of Squares (square feet)*	*Variance (square feet)*	*Standard Deviation (feet)*	*Mean (feet)*
Graphical Cooper-Jacob Straight Line	1,022.3	N/A			
Aqtesolv Cooper–Jacob	855.8	291.7	0.563	0.7504	-2.5E-9
Aqtesolv Theis	856.5	292.3	0.564	0.7512	-2.5E-4

Groundwater level response from pumping well OM-19 in observation wells OM-12 and OM-13 is shown in Figures 11 and 13. There was not a clear groundwater level response in wells observation wells OM-12 and OM-13 from pumping OM-19. Fluctuations in the groundwater level observed in wells OM-12 during the OM-19 pump test may be due to localized pumping by off-site wells.

7.4 Project Groundwater Pumping Drawdown Projection

Projected drawdown due to pumping well OM-14 was calculated for various distances from OM-14 up to 1 mile (5,280 feet). The Project construction demand, assuming a quantity of 75 acre-feet over 1 year is approximately 46.5 gpm. Additionally, projected drawdown was calculated, including the combined water demands of the Project and an additional 38 acre-feet or 23.6 gpm for the Calcite Substation project (113 acre-feet or 70.1 gpm combined). The following estimate

of groundwater drawdown induced by Project pumping relies on the Cooper-Jacob approximation to the Theis non-equilibrium flow equation (USGS 1962) as follows:

$$s = \frac{264Q}{T} \log_{10} \frac{0.3Tt}{r^2 S}$$

Where:

s = predicted drawdown (feet)
Q = amortized pumping rate = 15.5 GPM
S = coefficient of storage (dimensionless) = 0.0044
T = Transmissivity (feet^2/day) = 32,401 feet^2/day
t = time (days) = calculated at 1 year (365 days) and 2 years (730 days)
r = distance from pumping well OM-14 (feet) = varies

Drawdown due to Project pumping at the closest observation well, well OM-13 (546 feet south) is estimated to be 0.22 feet over the 1-year construction period, and 0.33 feet with the water demand for the Calcite Substation. Drawdown due to Project pumping at the nearest neighboring residential well, located approximately 500 feet west-northwest of well OM-14, is estimated to be 0.22 feet over the 1-year construction period and 0.33 feet when including water demand for the Calcite Substation. Drawdown at a 1-mile (5,280-foot) radius around well OM-14 is estimated to be 0.12 feet over the 1-year construction period for the Project, and 0.18 feet when including water demand for the Calcite Substation (Table 11).

Table 11
Well OM-14 Drawdown Calculations

Distance from Pumping Well OM-14 (feet)	1 Year Drawdown Due to Pumping Well OM-14 (feet) for Project (75 acre-feet)	u	1 Year Drawdown Due to Pumping Well OM-14 (feet) for Project with supply to Calcite Substation (113 acre-feet)	u
50	0.32	0.0000002	0.49	0.0000002
100	0.29	0.0000009	0.44	0.0000009
250	0.25	0.0000058	0.38	0.0000058
500	0.22	0.0000233	0.33	0.0000233
1,000	0.19	0.0000930	0.29	0.0000930
2,500	0.15	0.0005813	0.23	0.0005813
5,280	0.12	0.0025930	0.18	0.0025930

8 CONCLUSION

The purpose of this Groundwater Availability Report is to assess on-site groundwater resources available for the Ord Mountain Solar Project. Dudek performed an initial evaluation of the Project site in April 2016. During this initial evaluation, 19 existing groundwater wells were identified. These wells were likely installed as production wells for previous agricultural irrigation on the property. Based on physical inspection of the wells (including downhole video surveys) and information obtained through DWR records request, Dudek identified three wells (wells OM-14, OM-16, and OM-19) for potential consideration as a source of Project water supply. According to the information obtained, well OM-14 appeared to be most capable of producing and sustaining Project water demands.

In July 2016, Dudek conducted a site-specific aquifer test at well OM-14. The purpose of this testing was to verify groundwater production from well OM-14 as a sustainable source of Project water supply, to observe the effects of pumping well OM-14 on nearby wells, and to estimate aquifer properties. Based on the 8-hour step test and the 24-hour constant rate, well OM-14 can sustainably produce approximately 250 gpm. Therefore, well OM-14 would be a suitable source to meet the Project pumping demand of 46.5 gpm (based on Project demand of 75 acre-feet amortized over the 1-year construction period). Well OM-14 has sufficient capacity to meet the Project water demand when including water demand for the Calcite Substation of 38 acre-feet (113 acre-feet or 70.1 gpm combined). The transmissivity of the aquifer in the vicinity of well OM-14 was estimated to be approximately 32,401 ft^2/day or 242,363 gpd/ft, and the coefficient of storage was calculated to be 0.0044. Typically, transmissivity values of greater than 10,000 gpd/ft indicate the well will be useful for large-scale operations such as irrigation, agricultural, or other high-demand use (Driscoll 1986). Additionally, Dudek collected a water sample during the testing at well OM-14 and submitted the sample to an analytical laboratory to assess groundwater quality. The groundwater quality results show that all constituents sampled are below the EPA and California MCLs; therefore, there are no water quality restrictions on construction use of groundwater.

Based on the results of aquifer testing at well OM-14 and the stated Project water demand, there is sufficient groundwater production from existing on-site well OM-14 to supply Project demands. Thus, OM-14 is suitable as the primary production well.

In the event of pumping equipment failure or other unanticipated interruption to the Project's primary source of water supply at well OM-14, Dudek recommends a secondary source of groundwater supply. Based on the results of the downhole video surveys, wells OM-16 and OM-19 were identified as potential sources of groundwater supply. These wells were tested to assess their suitability as a secondary source of groundwater supply. An 8-hour step test was performed at well OM-16 to verify the production capacity of this well. Based on the test results, well OM-

16 can sustainably produce approximately 30 gpm. Although this production rate cannot replace supply from well OM-14, it may be useful for filling up on-site water storage tanks. A 6-hour step test and a 24-hour constant rate test was performed at well OM-19. Based on the step test and constant rate, well OM-19 can sustainably produce approximately 140 gpm. The transmissivity of the aquifer in the vicinity of well OM-19 was estimated to be 855.8 ft^2/day or 6,401.4 gpd/ft. There was no drawdown response at the observation wells monitored during the testing at well OM-19; therefore, a coefficient of storage value was not estimated. Additionally, Dudek collected a water sample during the testing at well OM-19 and submitted the sample to an analytical laboratory to assess groundwater quality. The groundwater quality results for well OM-19 show that all constituents sampled are below the EPA and California MCLs; therefore, there are no water quality restrictions on construction use of groundwater.

Review of historical groundwater levels, current groundwater levels, a well reconnaissance to identify the nearest off-site wells, site-specific aquifer testing, and Judgment requirements was performed to evaluate groundwater availability for the Project. Additionally, estimates of drawdown at select distances, including at the nearest off-site well, as a result of Project groundwater production were made using the site-specific aquifer properties calculated from the constant rate test. Based on the limited drawdown estimated for the nearest off-site wells and compliance of the Project with the Judgment by obtaining available FPA/BAP from the property owner, the proposed commercial solar energy generation facility would not adversely affect to a significant degree the availability of groundwater supplies for existing communities or existing and developing rural residential areas (County Development Code Chapter 84.29.035 Required Findings for Approval of a Commercial Solar Energy Facility, (c) (6)). Furthermore, the proposed groundwater utilization for the intended Project land use advances the goal of continued water level recovery both basin-wide and within the adjudicated Este Subbasin.

8.1 Project Impact Analysis

The Project's groundwater demand was evaluated to determine if Project pumping would result in an adverse impact with respect to groundwater in storage, impact neighboring wells, or create water quality concerns. Appendix G of the California Environmental Quality Act (CEQA) checklist indicates criteria under which the project would have a significant impact on the environment. The following items in Appendix G of the CEQA checklist are relevant to the Project:

Item IX.a) Violate any water quality standards or waste discharge requirements?

Based on water quality testing and results presented in Section 5 of this report, all groundwater constituents sampled are below the EPA and California MCLs. Therefore, there would be no

Project-induced impact or violation to water quality. No waste discharge requirements are needed for use of groundwater to supply construction and operational water demands.

Item IX.b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing or planned land uses for which permits have been granted)?

Based on the aquifer testing at well OM-14, drawdown due to Project pumping at the nearest neighboring residential well, located approximately 500 feet west-northwest of well OM-14, is estimated to be 0.22 feet over the 1-year construction period and 0.33 feet when including the water demand for the Calcite Substation. Additionally, the Project construction water demand of 75 AFY was compared to the historical land use (growing alfalfa) peak water demand of 1,472 AFY. The Project water demand for the construction phase over 1 year represents 5% of the historical peak annual water demand. The Project water demand for operations (6.6 AFY) represents 0.45% of the historical peak annual water demand for growing alfalfa.

Due to historical groundwater overdraft and lowering of the water table in Lucerne Valley, the groundwater budget for the Este Subarea is regulated through adjudication. The landowner of the Project property has rights to pump 1,761 AFY from the Este Subarea. The Project water demand for construction represents 4.3% of the landowner's pumping allocation for the Este Subarea, and the Project operational water demand represents 0.4%. Groundwater pumping for the construction and operational phases of the Project would be compliant with the Judgment and would not deplete groundwater supplies. As the increase in impermeable surface area at the Project site is limited and USGS has determined that recharge to the groundwater system from direct infiltration of precipitation is minimal, the Project is expected to have no net effect on recharge to the aquifer system. Thus, the aquifer volume (groundwater in storage) and the local groundwater table are expected to remain stable as a result of the Project. Overall, the results show that the Project would not have a significant impact on the groundwater supply or interfere with groundwater recharge.

Item XVII.d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?

The results of the well tests described in Section 7 of this report show that existing on-site groundwater wells have the capacity to provide a sustainable water supply for Project use. Additionally, the existing allocated groundwater pumping rights prescribed to the landowner

through adjudication provide sufficient water supply for the Project with no need for new or expanded entitlements.

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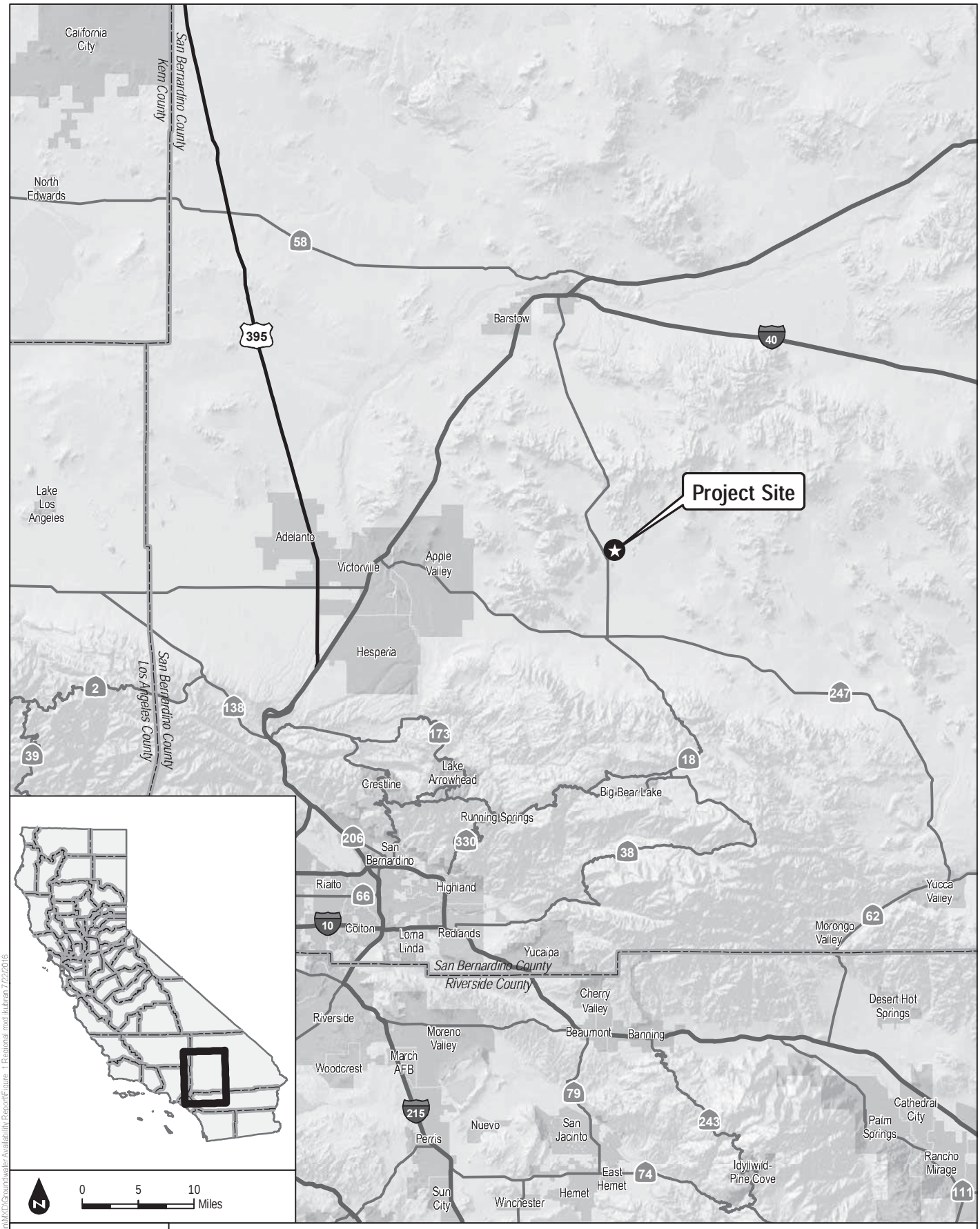

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FIGURE 1
Regional Map

Ord Mountain Solar Energy Project - Groundwater Availability Report

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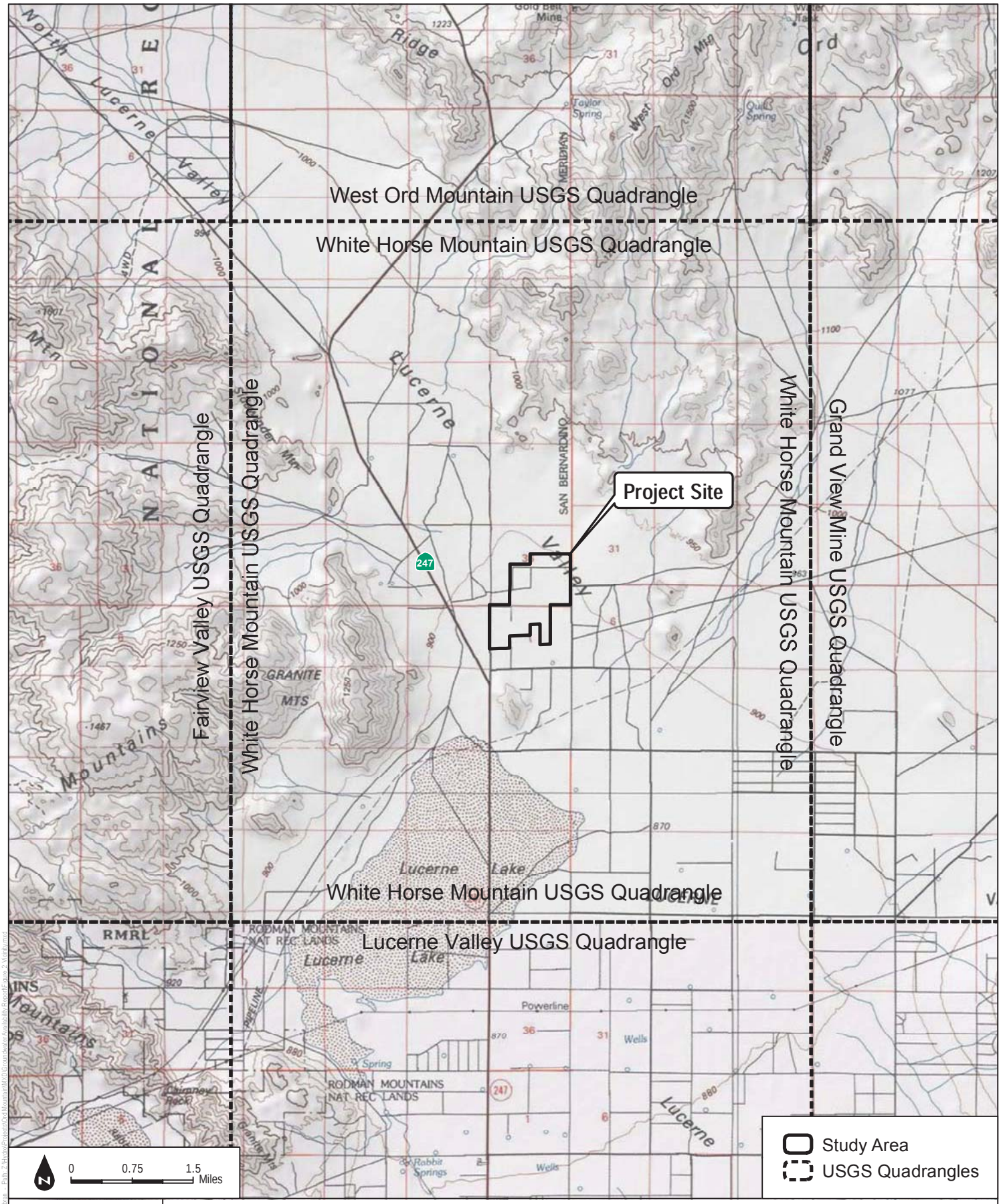

SOURCE: USGS 7.5-Minute Series White Horse Mountain Quadrangle

FIGURE 2

Vicinity Map

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Ord Mountain Solar Project - Groundwater Availability Report

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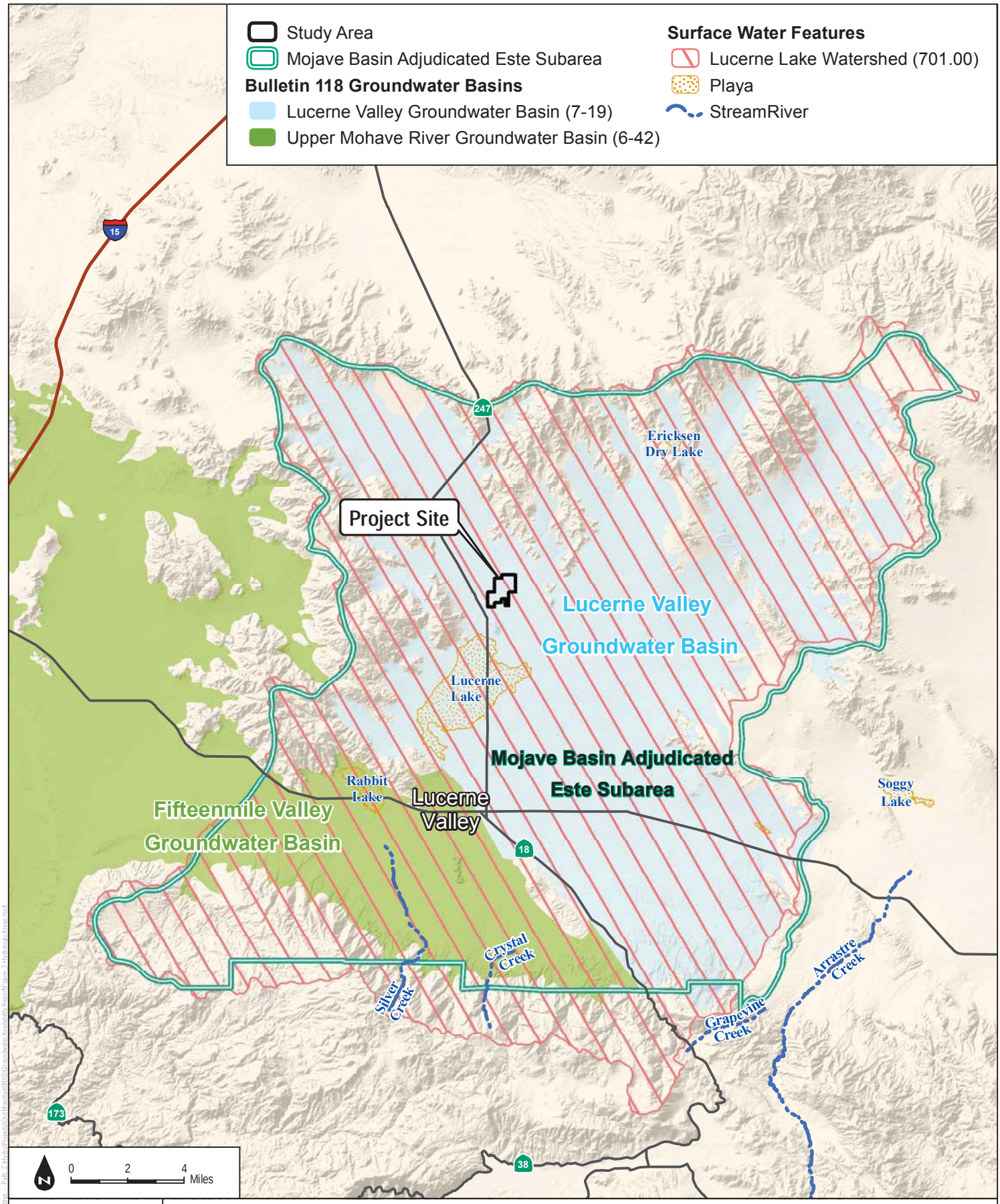

SOURCE: USGS

FIGURE 3

Hydrologic Areas

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Ord Mountain Solar Project - Groundwater Availability Report

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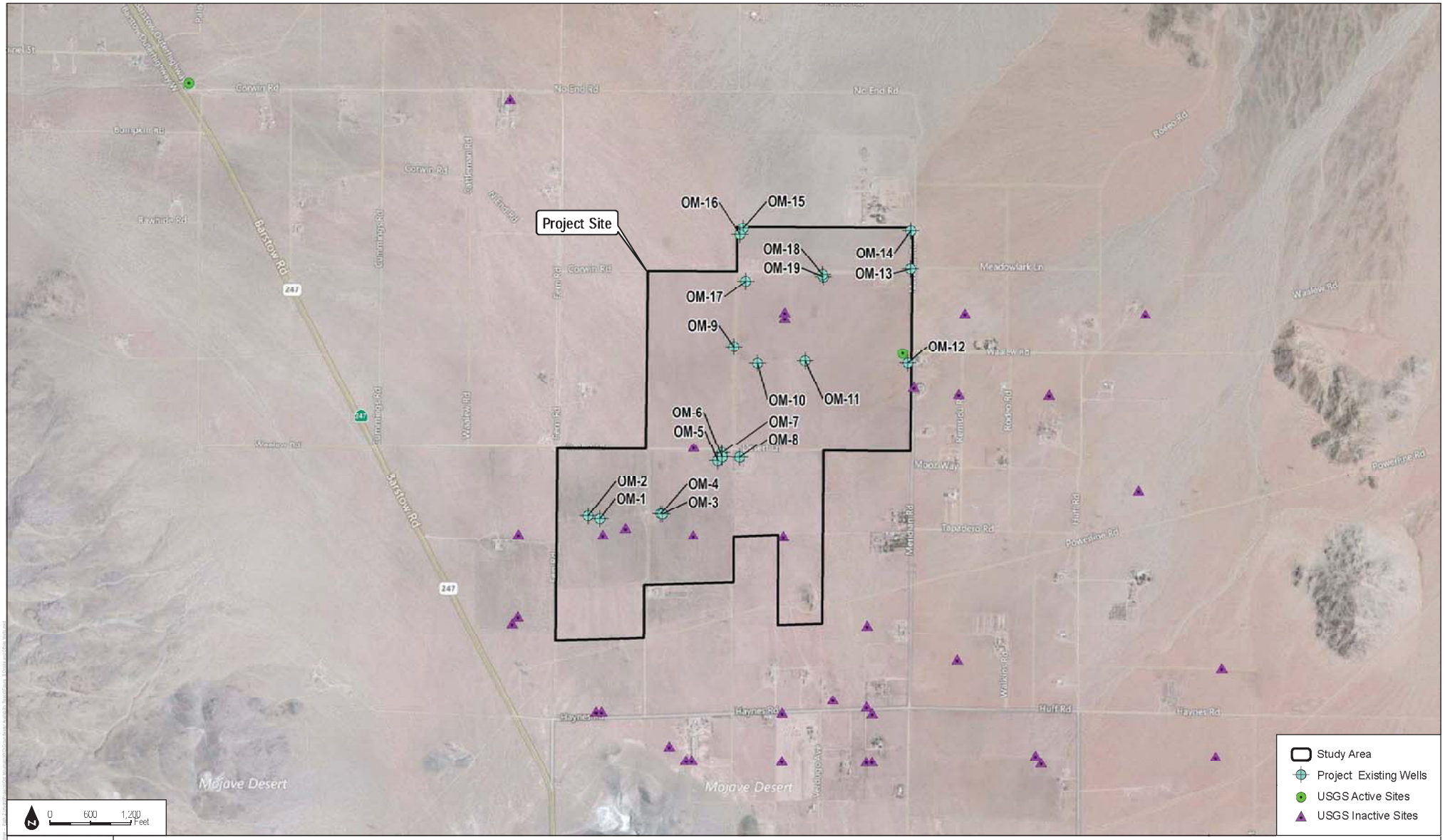

DUDEK

SOURCE: Bing Maps, USGS

FIGURE 4

On-site and Off-site Well Locations

Ord Mountain Solar Project - Groundwater Availability Report

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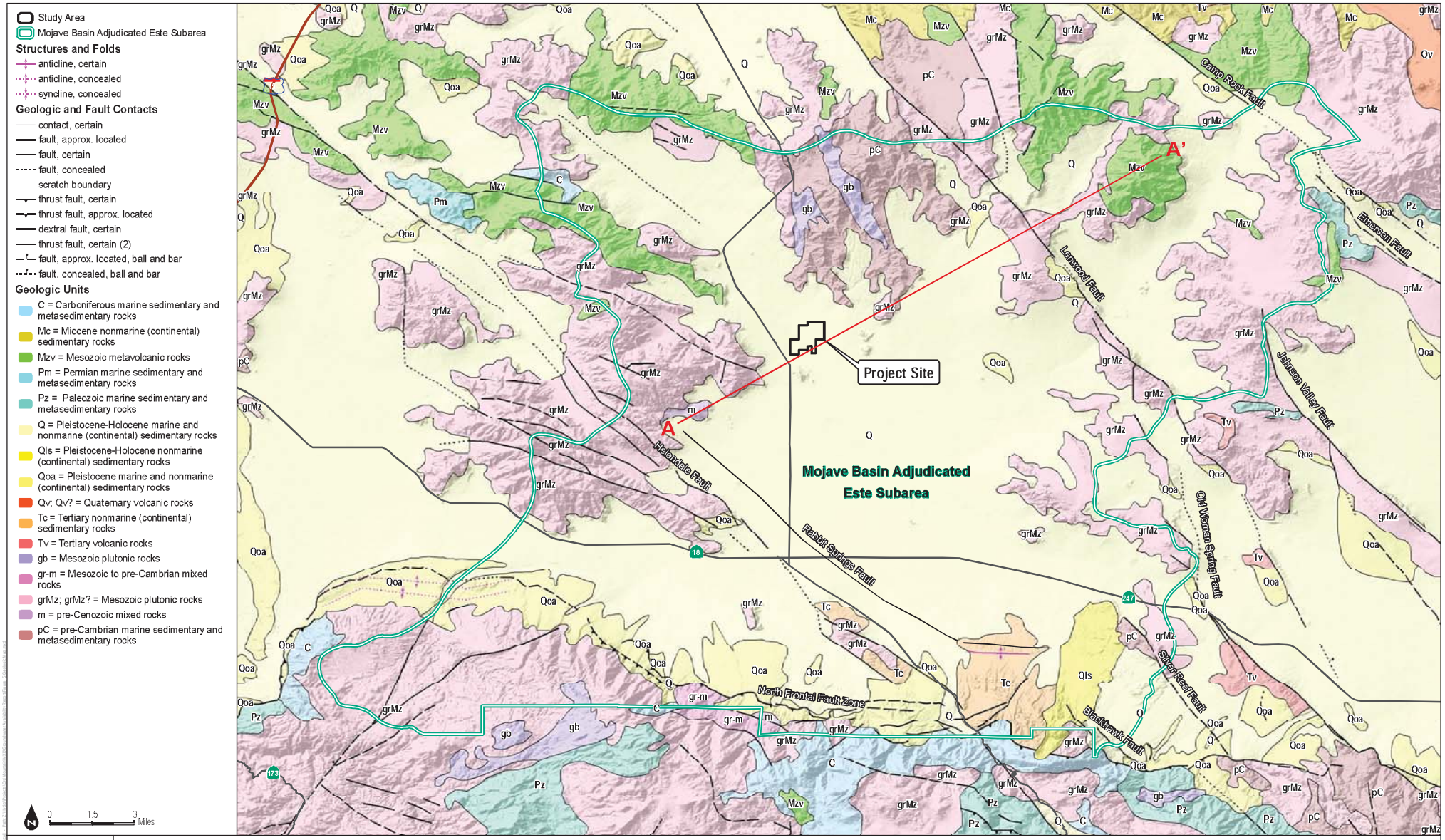

SOURCE: California Geologic Survey 2010

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FIGURE 5
Geologic Map

Ord Mountain Solar Project - Groundwater Availability Report

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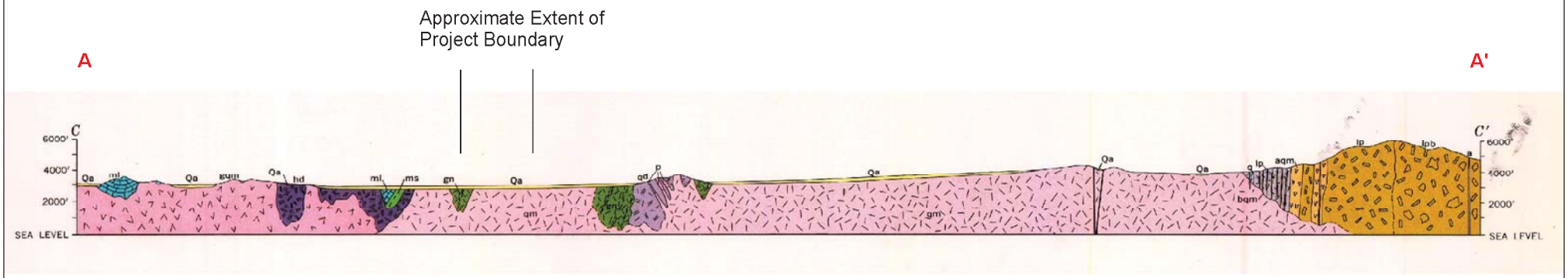

Geologic Unit Explanation

SURFICIAL SEDIMENTS
Qa - alluvium

PLUTONIC AND HYPABBYSSAL IGNEOUS ROCKS
q - quartz
a - aplite
p - pegmatite
qm - quartz monzonite
qd - quartz diorite
aqm - aplitic quartz monzonite
lp - latite porphyry
lpb - latite porphyry breccia
gqm - granite and quartz monzonite
hd - horblende diorite gabbro

METAMORPHIC ROCKS
ml - marble
ms - schist
gn - quartz diorite gneiss

DUDEK

SOURCE: Dibblee, T.W. Jr, Geologic Map of the Ord Mountains Quad, 1964.

FIGURE 6
Geologic Cross Section

Ord Mountain Solar Project - Groundwater Availability Report

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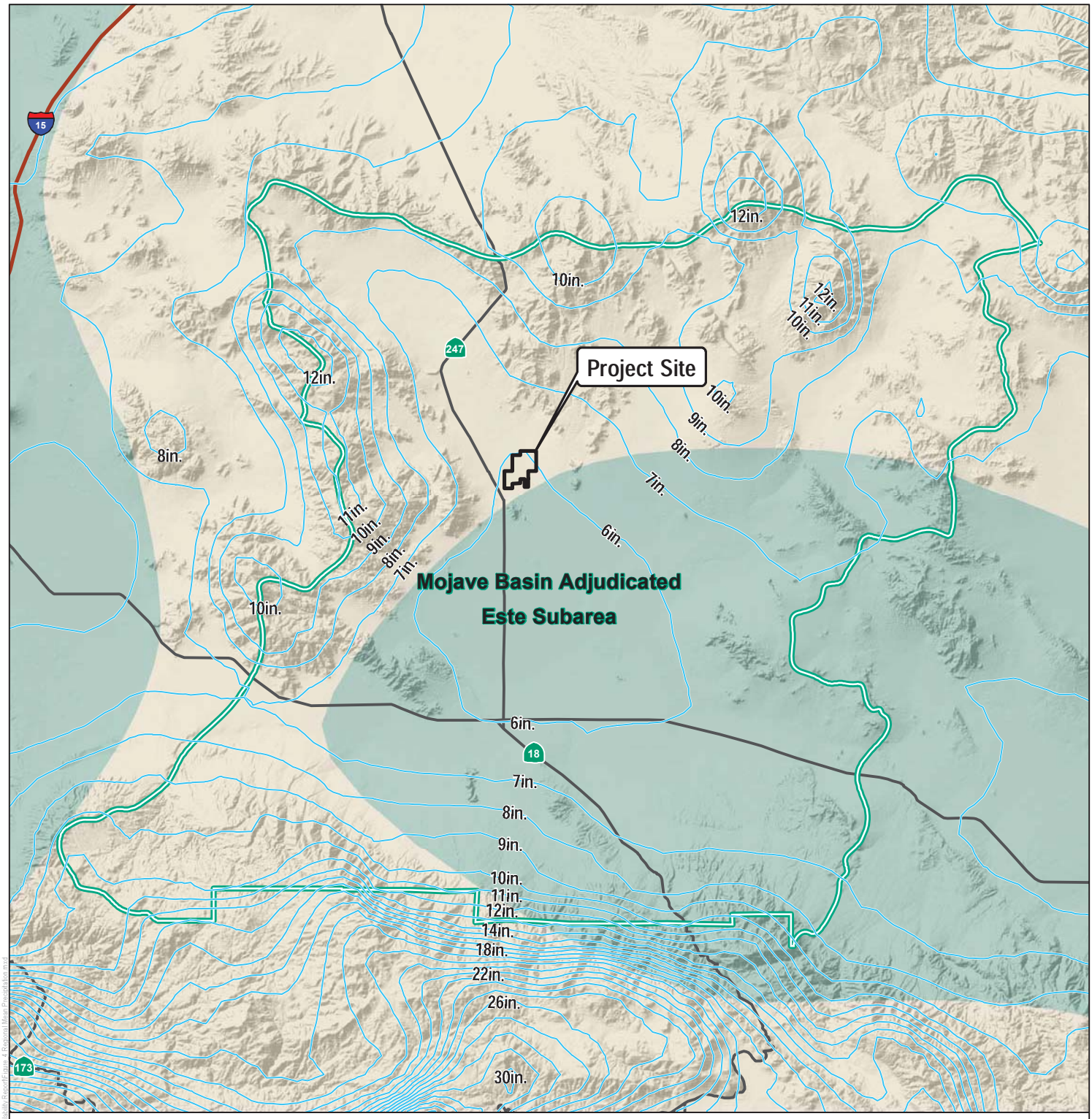

Study Area

Mojave Basin Adjudicated Este Subarea

Average Annual Precipitation (1980-2010)

Reference EvapoTranspiration (ETo) Zones

Mid-Central Valley, Southern Sierra Nevada, Tehachapi & High Desert Mountains (Zone 14)

High Desert Valleys (Zone 17)

N

0 2 4 Miles

DUDEK

SOURCE: DWR/UC Davis

FIGURE 7

Regional Mean Precipitation and Reference EvapoTranspiration Zones

Ord Mountain Solar Project - Groundwater Availability Report

Date: 7/26/2016 - Last saved by: jhutzler - Path: Z:\Hydro\Projects\Ord Mountain\NI\GW\Groundwater Availability Report\Figures & Regional Mean Precipitation.mxd

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Figure 8. Well OM-14 Groundwater Level Hydrograph

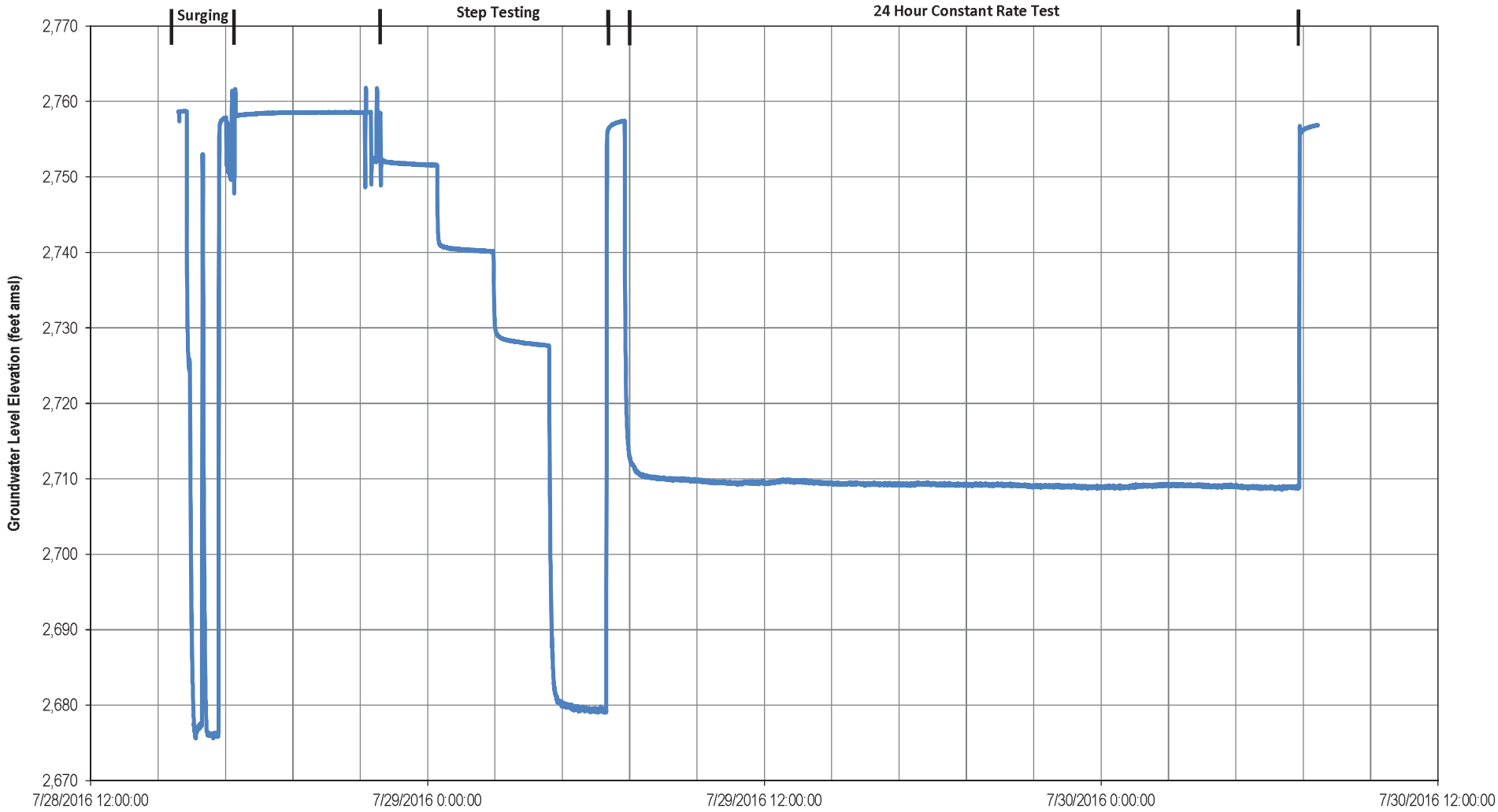

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Figure 9. Well OM-14 Step Test Drawdown

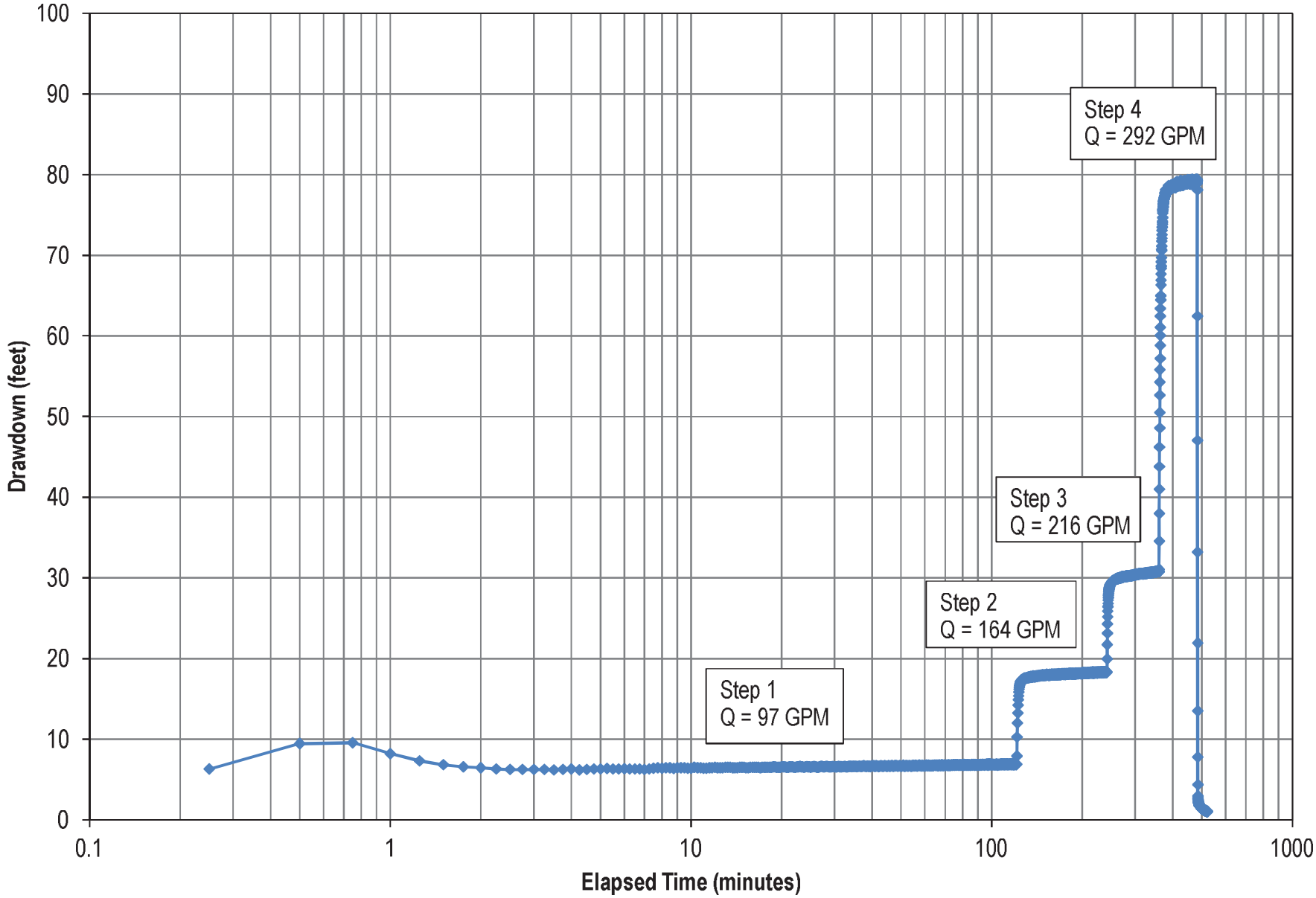

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Figure 10. Well OM-14 Constant Rate Test Drawdown

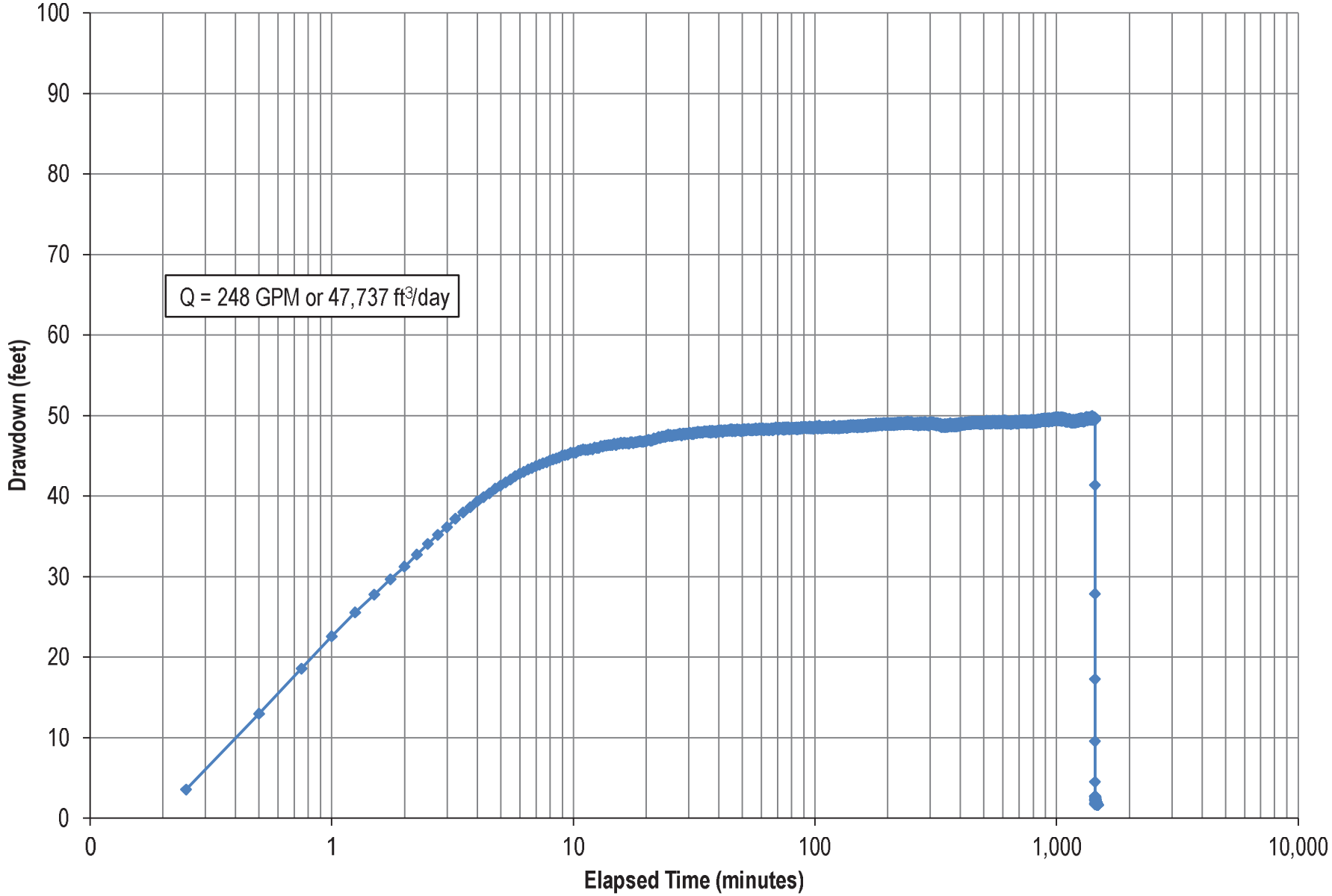

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Figure 11. Well OM-13 Groundwater Level Hydrograph

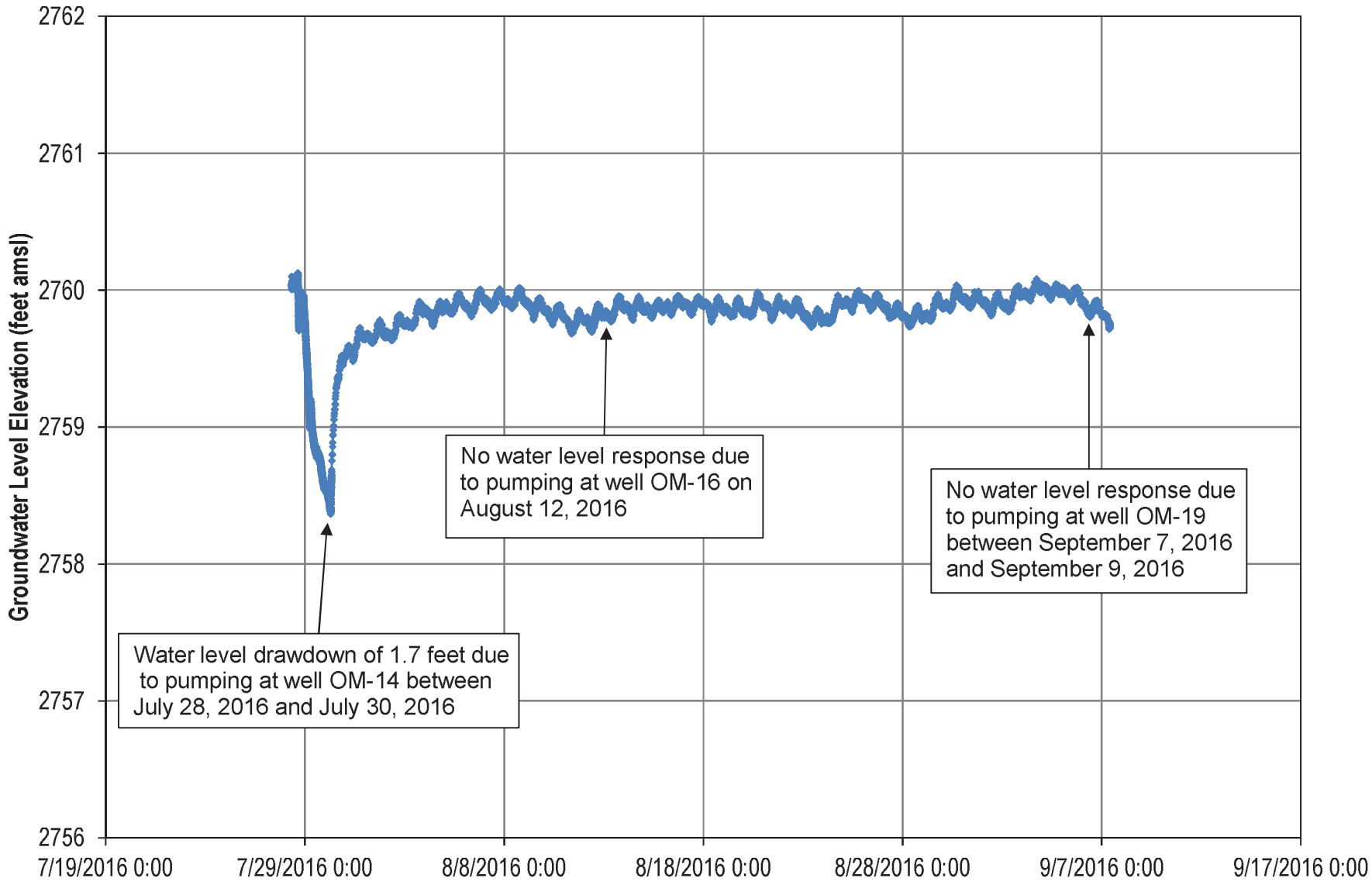

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Figure 12. Observation Well OM-13 Constant Rate Test Analysis

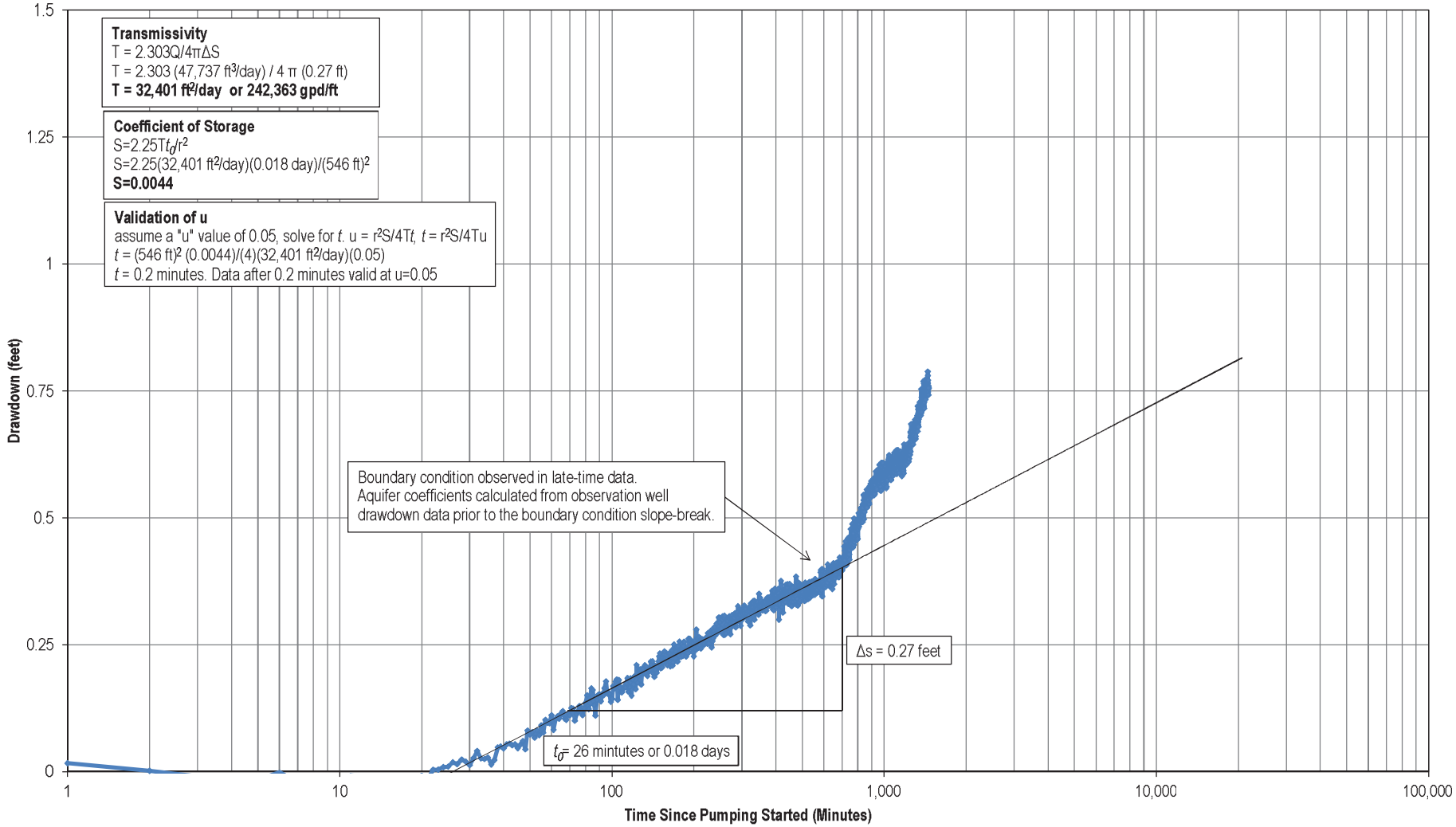

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Figure 13. Well OM-12 Groundwater Level Hydrograph

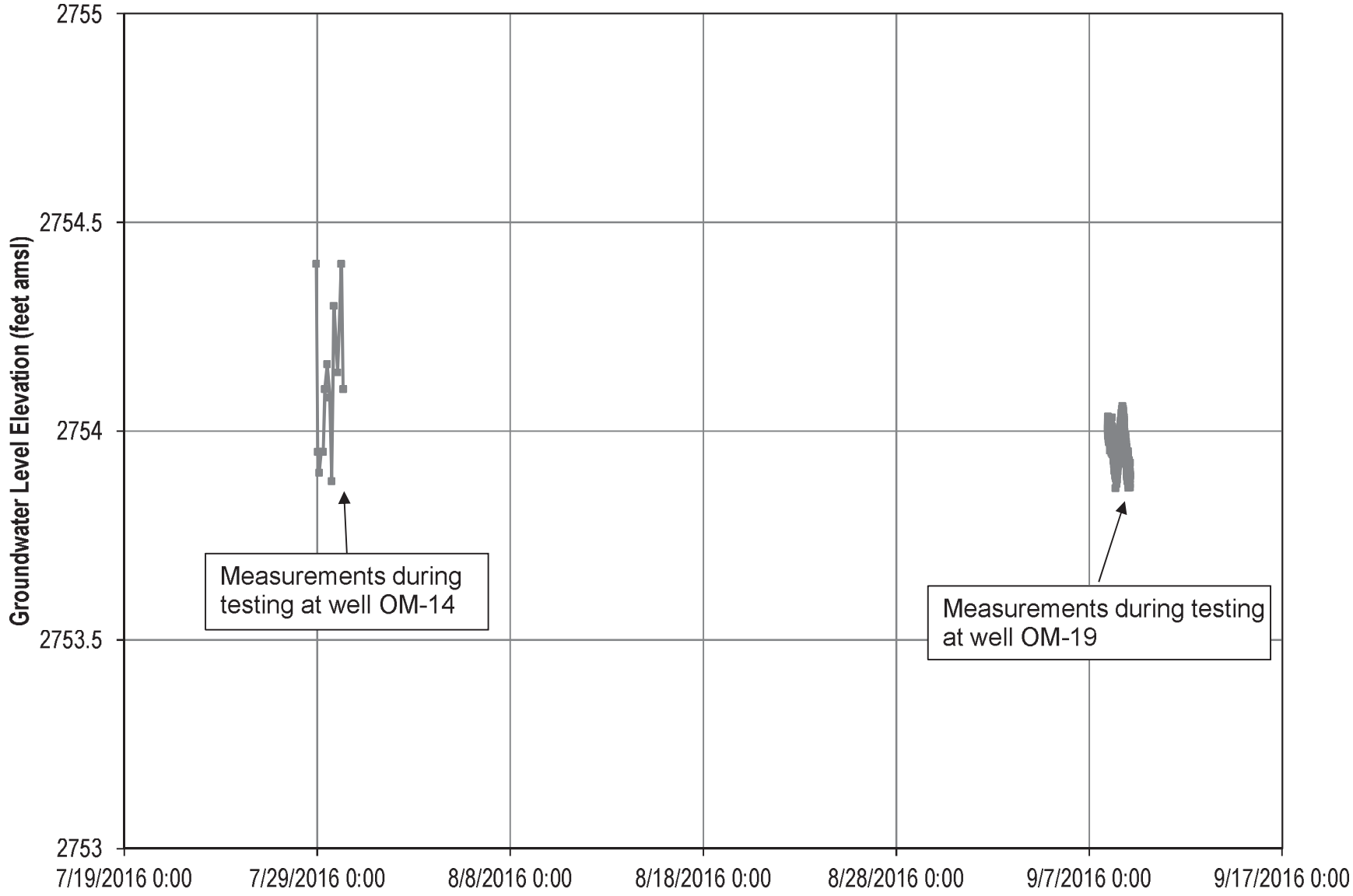

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Figure 14. Well OM-16 Groundwater Level Hydrograph

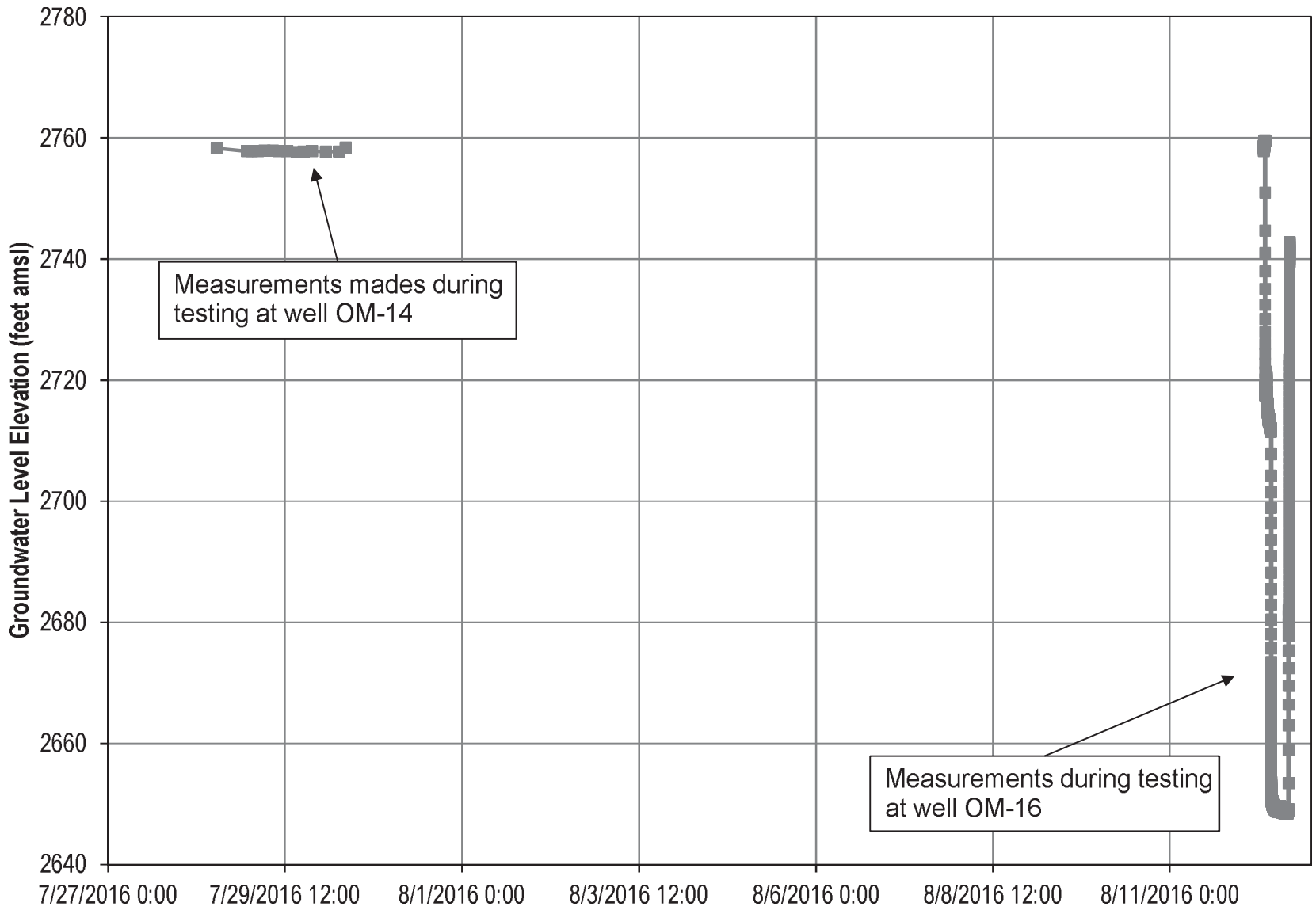

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Figure 15. Well OM-19 Groundwater Level Hydrograph

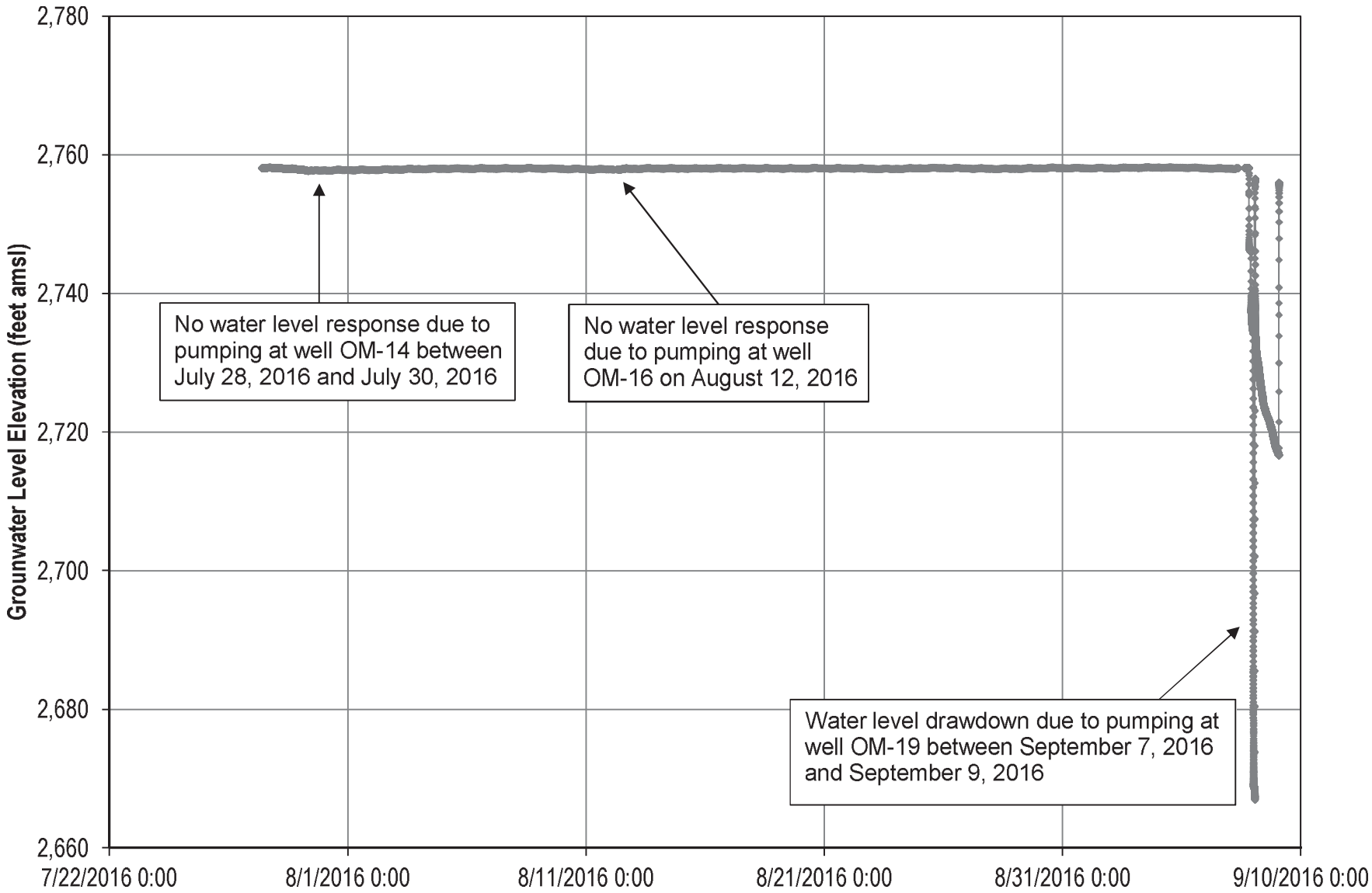

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Figure 16. Well OM-19 Step Test Drawdown

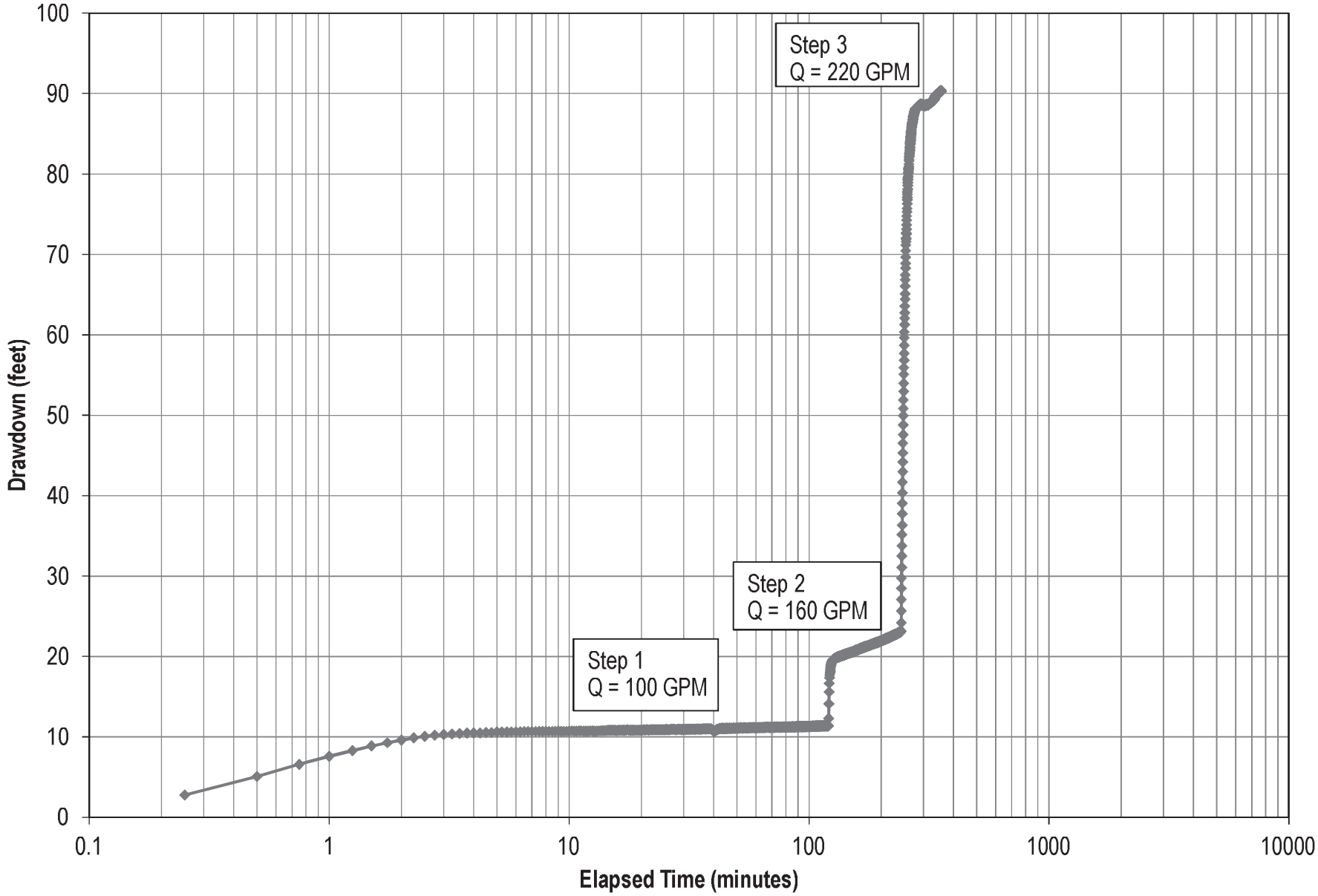

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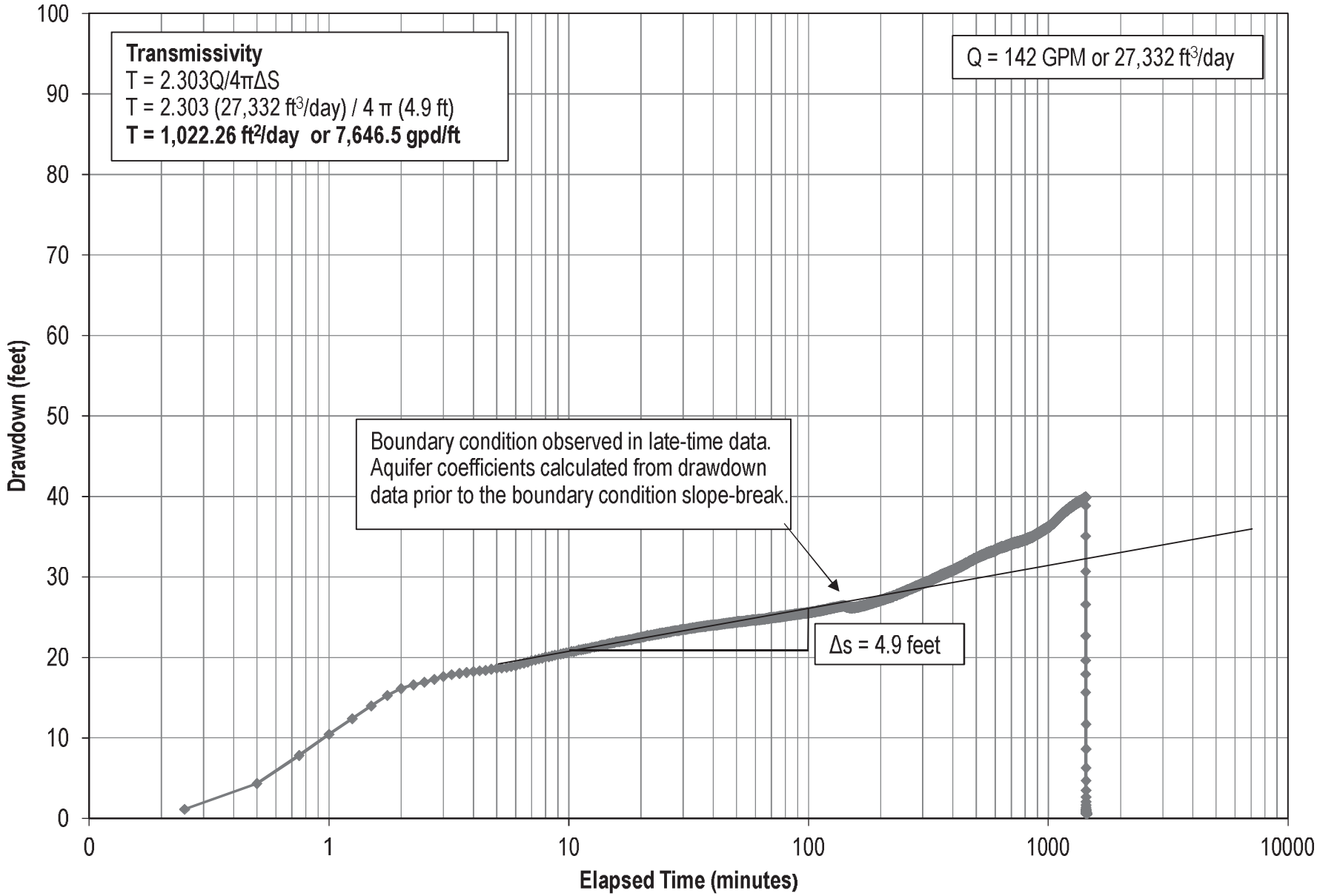
Figure 17. Well OM-19 Constant Rate Test Drawdown



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APPENDIX A

Well Video Survey Reports

Pacific Surveys

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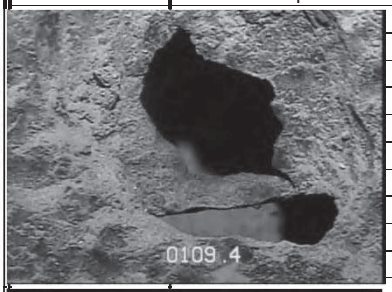
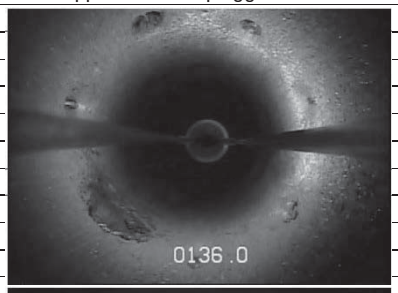
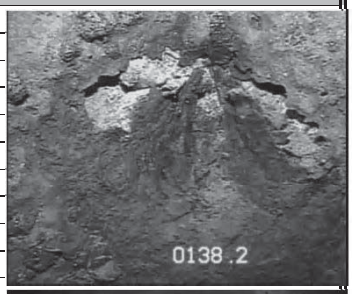
Video Survey Report

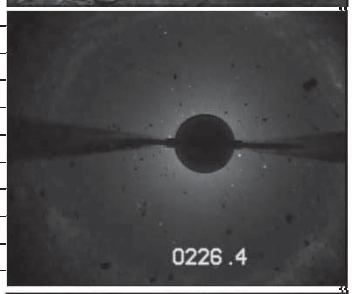
Company:	Dudek Engineering + Environmental		**Date:**	14-Apr-16	
Well:	OM-5		**Run No.**	One	**Truck** PS-9
Field:	Lucerne Valley		**Job Ticket:**	21231	
State:	California		**Total Depth:**	319.9 ft	
			Water Level:	154.9 ft	SWL
Location:	Near Fern Rd & Desert Ln		**Oil on Water:**	No	**Amount:** N/A
	GPS N 34˚33'22" W 116˚56'14"		**Operator:**	Villalobos	
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan		**Dead Space** 2.50 ft
Reason for Survey:	General Inspection		**Guides Set @**	12.5 in	

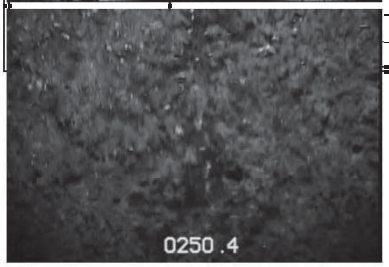
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
0.9 ft	Sounding port enters well casing. Practice Mills Knife hole observed.	Mills Knife	134.10 ft to ?
20.0 ft	Casing appears normal and in good condition.		
109.4 ft	Observed two holes in well casing. Original bore-hole observed behind holes.		
134.1 ft	Top of perforations. Appear plugged.		
138.2 ft	Observed damage to perforations.		
139.6 ft	Peforations appear slightly open. Gravel pack visible behind several perfs.		
149.9 ft	Heavy scaling observed on well casing.		
154.9 ft	SWL: water is cloudy. Visibility is fair.		
155.7 ft	A piece of bridged wood observed in well casing.		
160.0 ft	Perforations appear plugged. Heavy bio-growth on casing.		
161.0 ft	Water is very cloudy. Visibility is poor.	**Casing Size**	**From Survey**
200.0 ft	Moderate growth nodules observed on well casing.	13.25 in ID	0.00 ft to 319.90ft
226.0 ft	Slight increase in water clarity. Visibility is fair.		
243.0 ft	Increase in size of growth nodules. At 258.7 ft, heavy bio-growth on perfs.		
258.0 ft	Increase in water clarity and visibility. Heavy suspended solids in water column.		
277.3 ft	High reflection on well casing, light level becomes very bright until 278.4 ft.		
308.9 ft	Large growth nodules observed on well casing.		
319.9 ft	Top of fill. End survey. NOTE: could not find bottom of perfs due to heavy bio-growth.	**Casing Material**	Mild Steel
	NOTE: entire perforated interval appeared to be plugged.	**Screen Material**	Mild Steel

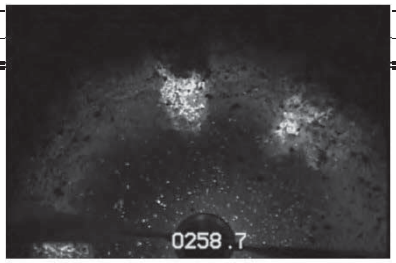


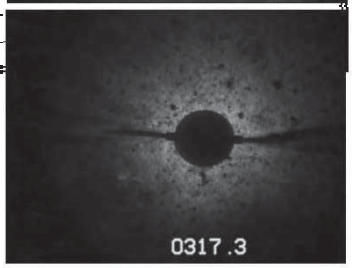












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fax: 909.399.3180

Pacific Surveys

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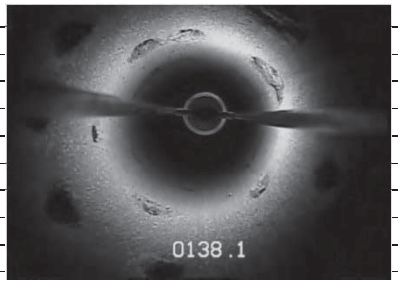
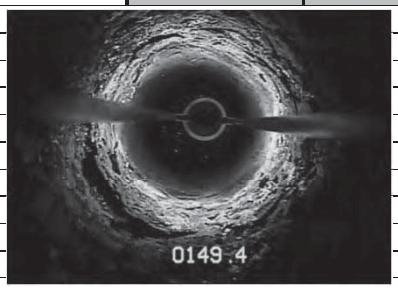
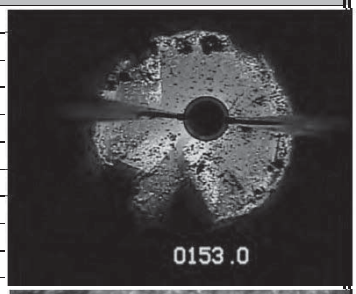
Video Survey Report

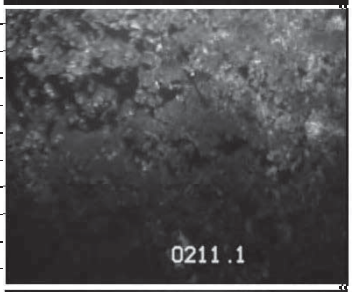
Company:	Dudek Engineering + Environmental		**Date:**	14-Apr-16	
Well:	OM-6		**Run No.**	One	**Truck** PS-9
Field:	Lucerne Valley		**Job Ticket:**	21231	
State:	California		**Total Depth:**	265.6 ft	
			Water Level:	154.8 ft	SWL
Location:	Near Fern Rd & Desert Ln		**Oil on Water:**	No	**Amount:**
	GPS N 34˚ 33'22" W 116˚56'14"		**Operator:**	Villalobos	
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan	**Dead Space**	2.50 ft
Reason for Survey:	General Inspection		**Guides Set @**	9 in	

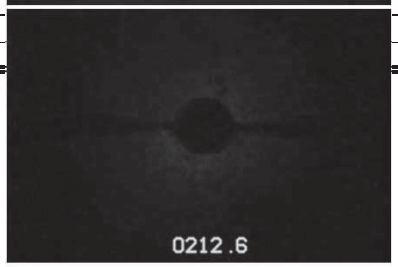
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
0.9 ft	Sounding port enters well casing. Practice Mill's Knife perforation observed.	Mills Knife	53.00 ft to 57.00ft
53.0 ft	Several Mills Knife perforations are observed. Perforations cease at 57 ft.		117.30 ft to ?
107.5 ft	Small crack in well casing.		
117.3 ft	Top of Perforations: appear open. Borehole is visible.		
148.8 ft	Heavy scaling on well casing.		
154.8 ft	SWL: water is cloudy. Visibility is fair. Three pieces of wood floating on SWL.		
160.0 ft	Heavy bio-growth on casing. Moderate size growth nodules observed.		
168.0 ft	Water is very cloudy. Visibility is poor.		
	NOTE: unable to identify perforations due to heavy bio-growth and nodules.		
187.0 ft	Increase in the size of the growth nodules from moderate to large.		
191.0 ft	Visibility decreases to very poor. Heavy suspended solids in water column.	**Casing Size**	**From Survey**
242.0 ft	Piece of wood observed in water column.	10 in ID	0.00 ft to 265.60ft
257.0 ft	Well casing looks distorted in down-view due to very heavy bio-growth.		
262.7 ft	Piece of wood observed in water column.		
265.6 ft	Top of fill. End survey.		
	NOTE: unable to observe any perforations below static water level due to growth.		
		Casing Material	Mild Steel
		Screen Material	Mild Steel

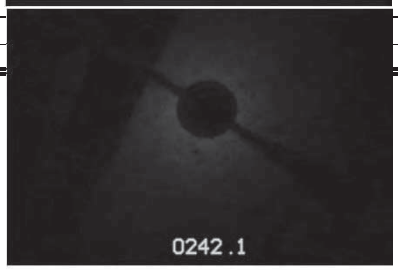


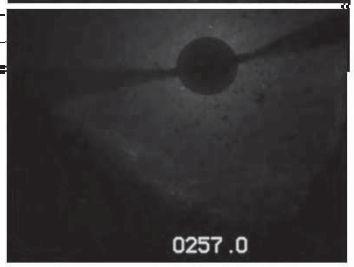












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Pacific Surveys

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Video Survey Report

Company:	Dudek Engineering + Environmental	**Date:**	19-Aug-16		
Well:	OM-8	**Run No.**	One	**Truck**	PS-6
Field:	Lucerne Valley	**Job Ticket:**	21811		
State:	California	**Total Depth:**	127.8 ft		
		Water Level:	N/A	SWL	
Location:	33321 Desert Ln.	**Oil on Water:**	No	**Amount:**	N/A
	GPS N 34˚ 33'22.6" W 116˚ 56'90.9"	**Operator:**	Conner		
Zero Datum:	Top of Cement Pad	**Tool Zero:**	Side-Scan	**Dead Space**	1.25 ft
Reason for Survey:	General Inspection	**Guides Set @**	11 in		

Depth	Observations	Perforation:	From Survey
0.0 ft	Began survey at top of cement pad.	Torch-cut	120.20 ft to Unknown
18.7 ft	Heavy spalling on casing walls that continues throughout well casing.		
23.3 ft	Casing is missing/damaged to 25.2 ft.		
43.1 ft	Casing is missing/damaged to 43.9 ft.		
50.9 ft	Casing is split/damaged on opposite sides of each other to 70 ft.		
79.3 ft	Casing is missing/damaged to 80.7 ft.		
90.0 ft	Casing is split/damaged to 97 ft.		
116.6 ft	A large void behind split in casing.		
120.2 ft	Possible start of perforated interval.		
126.0 ft	Casing is missing/damaged to 127.8 ft.		
127.8 ft	Camera rests on bridged pieces of casing; does not pass. Survey ends.		
		Casing Size	**From Survey**
		12.25 in	0.00 ft to 127.80ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel

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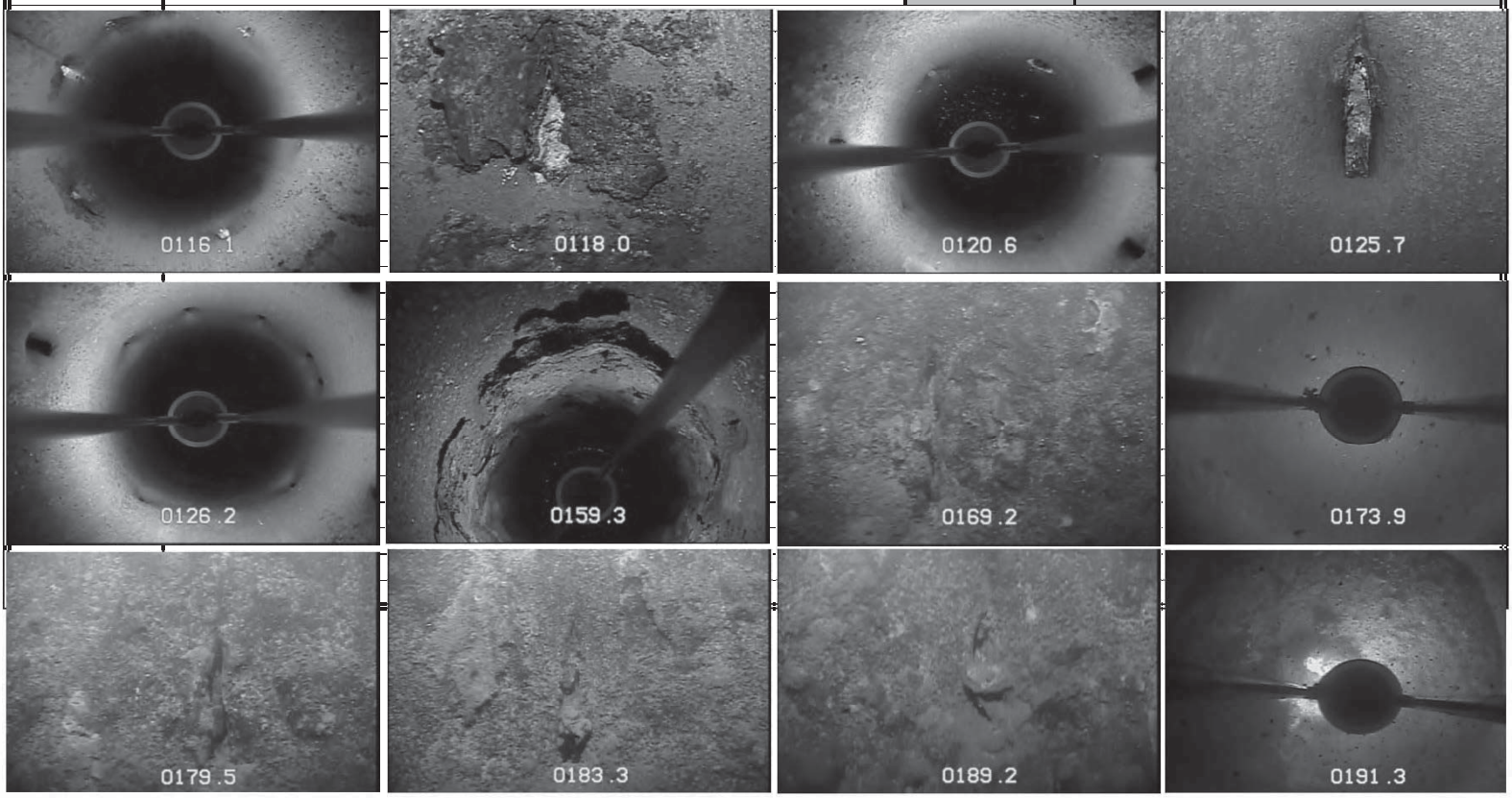
Video Survey Report

Company:	Dudek Engineering + Environmental	**Date:**	15-Jul-16		
Well:	OM-9	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21626		
State:	California	**Total Depth:**	193.4 ft		
		Water Level:	164.6 ft	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	No	**Amount:**	
	GPS N 34˚33.636' W116˚56.187'	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	1.75 ft
Reason for Survey:	General Inspection	**Guides Set @**	10.5 in		

Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
60.0 ft	Casing appears normal and in good condition.	Mills Knife	118.00 ft to 193.40ft
118.0 ft	Top of Mills Knife perforations: appear slightly open.		
120.0 ft	Perforations appear open.		
141.0 ft	Slight increase in bio-growth on casing.		
160.5 ft	Very heavy scaling observed on casing.		
164.6 ft	SWL: water is cloudy. Visibility is poor. Heavy bio-growth on casing.		
170.0 ft	Heavy suspended fines. Perforations appear slightly open.		
193.4 ft	Camera touches top of hard bottom. Still in perforations: appear mostly plugged.		
	End survey.		
		Casing Size	**From Survey**
		11.5 in ID	0.00 ft to 193.40ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel



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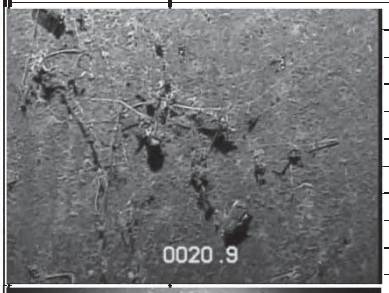
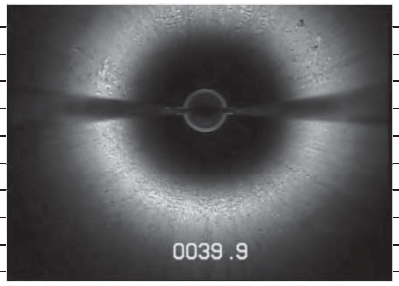
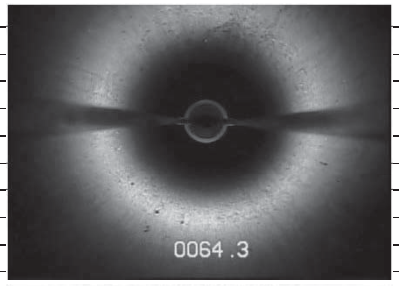
Video Survey Report

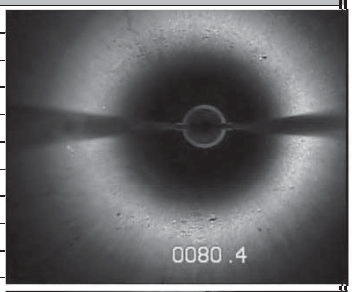
Company:	Dudek Engineering + Environmental	**Date:**	14-Apr-16		
Well:	OM-10	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21231		
State:	California	**Total Depth:**	100.6 ft		
		Water Level:	N/A	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	N/A	**Amount:**	N/A
	GPS N 34˚33'36.4" W 116˚56'06.8"	**Operator:**	Villalobos		
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan	**Dead Space**	2.50 ft
Reason for Survey:	General Inspection	**Guides Set @**	7 in		

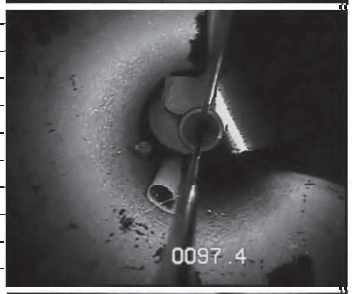
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
50.0 ft	Observed heavy amount of spider webs on well casing.	N/A	
100.6 ft	Observed what appears to be a large piece of wood a pice of PVC and large stones.		
	Camera cannot pass. End survey.		
		Casing Size	**From Survey**
		8 in ID	0.00 ft to 100.6 ft.
		Casing Material	Mild Steel
		Screen Material	Mild Steel

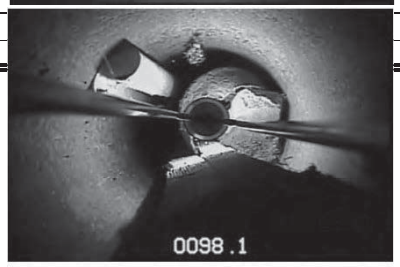


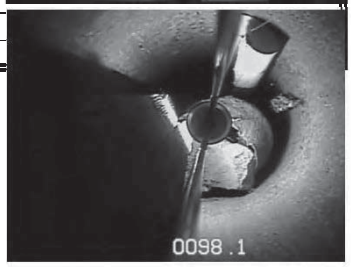












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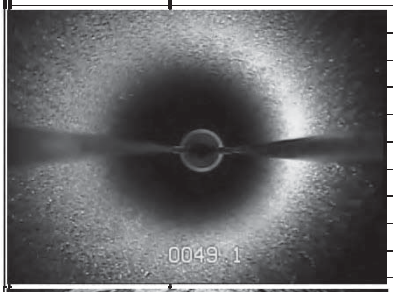
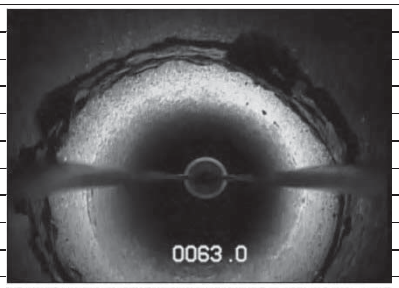
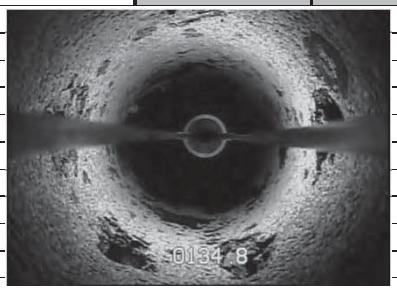
Video Survey Report

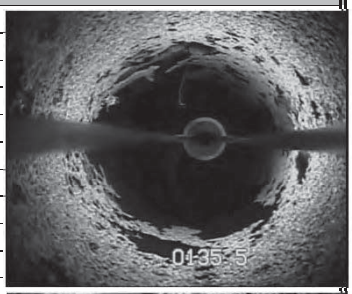
Company:	Dudek Engineering + Environmental	**Date:**	14-Apr-16		
Well:	OM-11	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21231		
State:	California	**Total Depth:**	141.9 ft		
		Water Level:	N/A	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	N/A	**Amount:**	N/A
	GPS N 34˚33'37" W 116˚55'58"	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	2.50 ft
Reason for Survey:	General Inspection	**Guides Set @**	11		

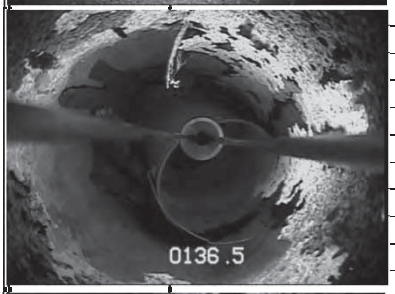
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
50.0 ft	Casing appears normal and in good condition.	N/A	
64.5 ft	Heavy scaling observed at joint.		
122.0 ft	Piece of very heavy scale observed.		
136.5 ft	Top of perforations: appear open. Bore-hole visible.		
138.1 ft	It appears as though the casing has torn off at the perforations. The weld between		
	the two separate casings has dislodged. Refer to pictures.		
141.9 ft	End survey.		
		Casing Size	**From Survey**
		12.25 in ID	0.00 ft to 141.90ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel

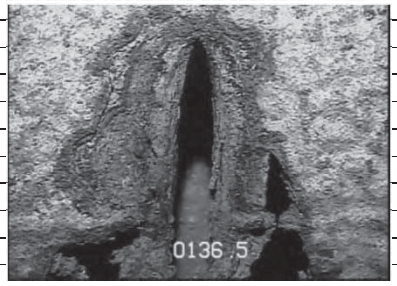


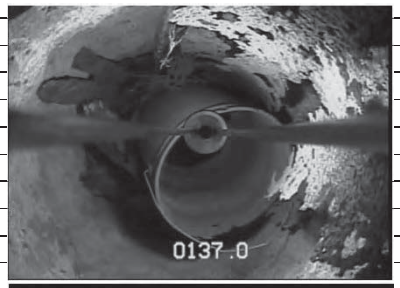


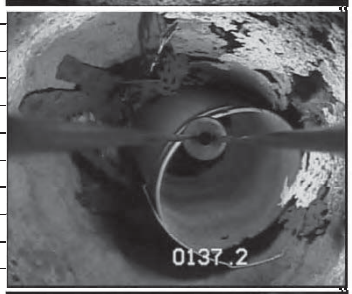


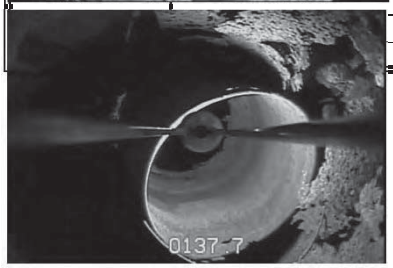


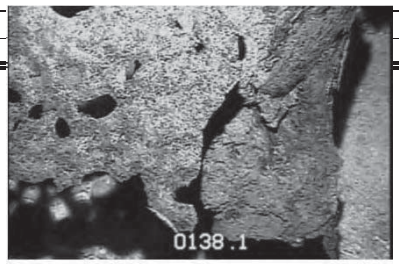


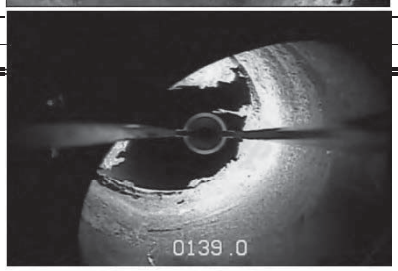


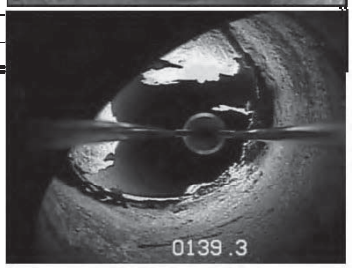












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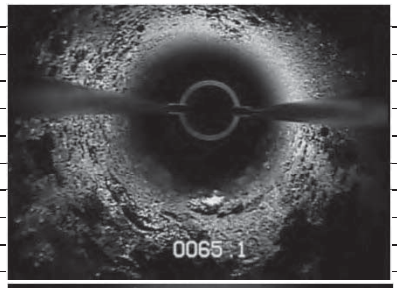
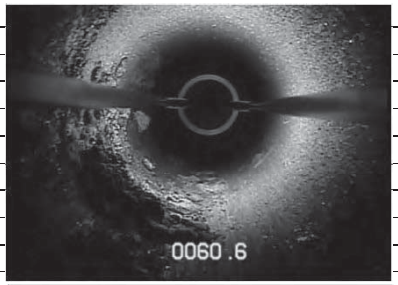
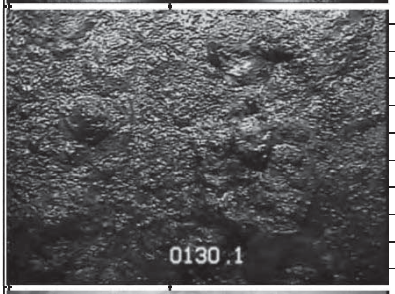
Video Survey Report

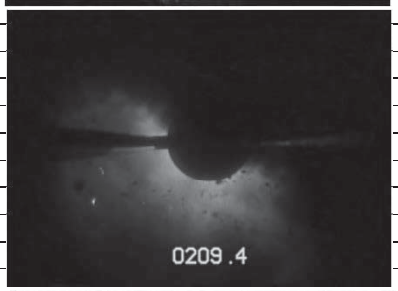
Company:	Dudek Engineering + Environmental	**Date:**	14-Apr-16		
Well:	OM-12	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21231		
State:	California	**Total Depth:**	257.0 ft		
		Water Level:	190.4 ft	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	No	**Amount:**	N/A
	GPS N 34.560158 W -116.92783	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	1.75 ft
Reason for Survey:	General Inspection	**Guides Set @**	7 in		

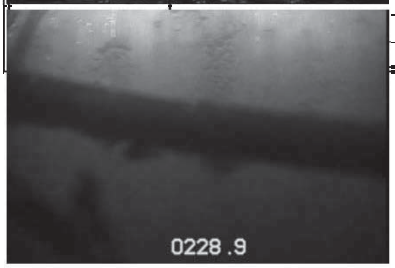
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
32.0 ft	Minor scaling on well casing.	Horizontal Mill Slot	236.30 ft to 237.20ft
48.0 ft	Joint: appears normal and in good condition.		
53.0 ft	Scaling increases from minor to moderate.		
62.0 ft	Scaling increases from moderate to heavy.		
190.4 ft	SWL: water is cloudy. Visibility is poor. Heavy bio-growth on well casing.		
203.0 ft	Observed sparkling on well casing.		
209.4 ft	Observed large intrusion. Camera light bar touches it and it falls. Visibility turns poor.		
210.0 ft	Picture turns black in down-view. In side-view it is very cloudy. Visibility is very poor.		
215.0 ft	Picture begins to clear up.		
224.8 ft	In down-view the visibility is very poor.		
227.0 ft	In down-view the picture turns black.	**Casing Size**	**From Survey**
228.9 ft	What appear to be wooden sticks bridged in well casing.	8.25 in ID	0.00 ft to 257.00ft
232.0 ft	Possible perforations. Difficult to see due to heavy bio-growth and very poor visibility.		
236.3 ft	Perforations observed: appear completely plugged.		
237.2 ft	What appears to be a perforation. Completely plugged.		
248.5 ft	In side-view the water clarity becomes completely cloudy.		
253.9 ft	In both side-view and down-view the picture turns black.		
257.0 ft	End survey. Applied sounder and found hard bottom at 258.8 ft.	**Casing Material**	Mild Steel
	NOTE: unable to find the beginning and end of perfs due to growth and visibility.	**Screen Material**	Mild Steel

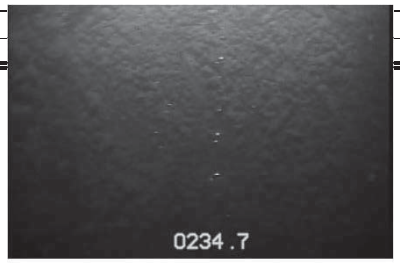












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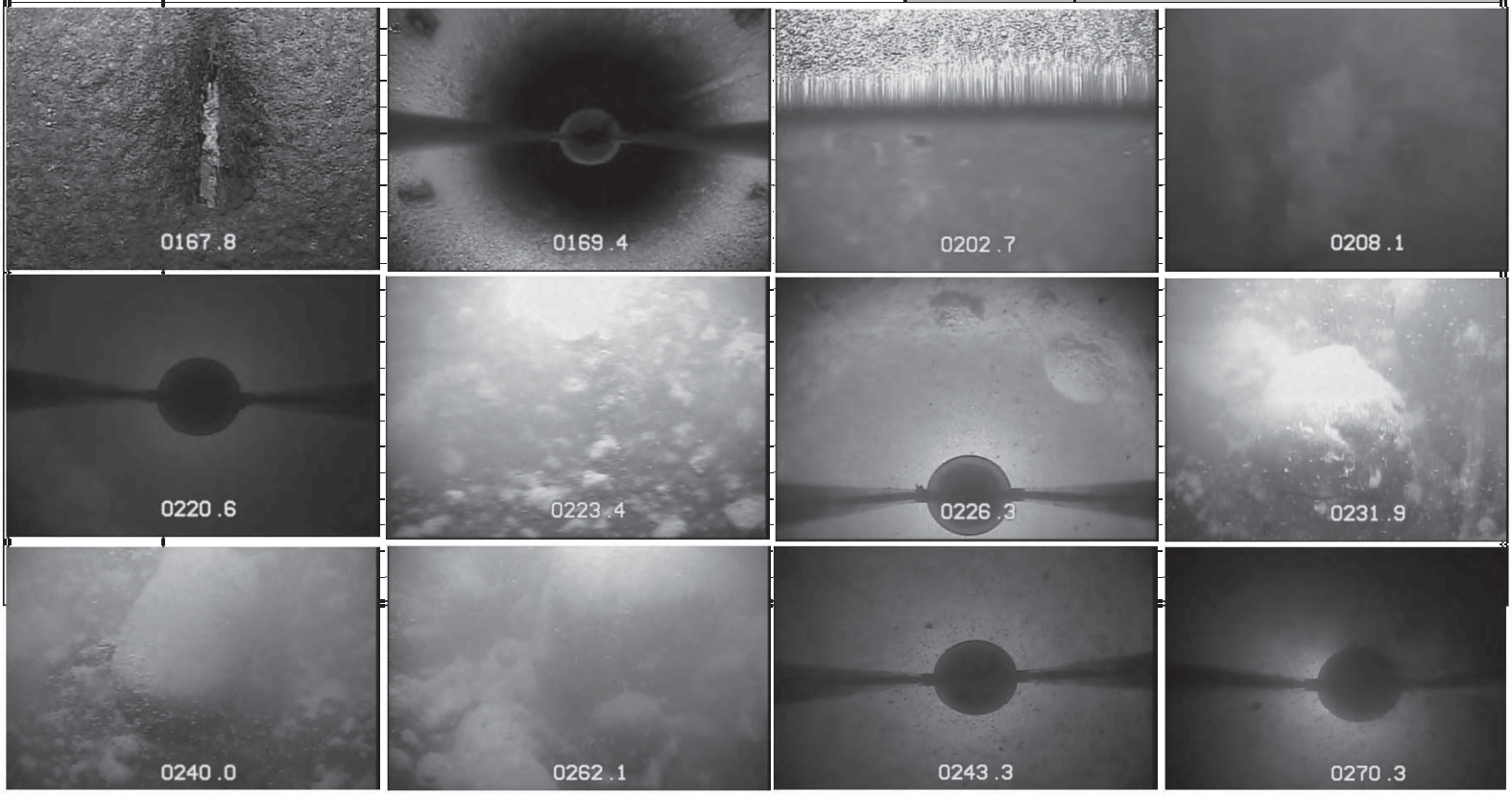
Video Survey Report

Company:	Dudek Engineering + Environmental	**Date:**	15-Jul-16		
Well:	OM-13	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21626		
State:	California	**Total Depth:**	272.0 ft		
		Water Level:	202.7 ft	SWL	
Location:	Near Fern Rd & Desert Ln.	**Oil on Water:**	No	**Amount:**	N/A
	GPS N 34˚33.847' W116˚55.663'	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	1.75 ft
Reason for Survey:	General Inspection	**Guides Set @**	11.5 in		

Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
7.0 ft	Light scaling appears on casing.	Mills Knife	0.00 ft to 272.00ft
50.0 ft	Casing appears normal and in good condition.		
110.0 ft	Light bio-growth appears on casing.		
167.8 ft	Top of Mills Knife perforations: appear open. Light bio-growth on casing.		
179.8 ft	Perforations appear covered in bio-growth.		
202.7 ft	SWL: water is very cloudy. Visibility is very poor. Unable to see perforations due to		
	very poor visibility.		
208.0 ft	Very heavy bio-growth observed on casing.		
227.0 ft	Increase in visibility. Very large bio-growth nodules observed.		
272.0 ft	Camera touches top of hard bottom. Visibility is poor. The side of the casing is covered		
	in bio-growth. Large nodules appear sporadically. Unable to see perforations.	**Casing Size**	**From Survey**
	End survey.		0.00 ft to 272.00ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel



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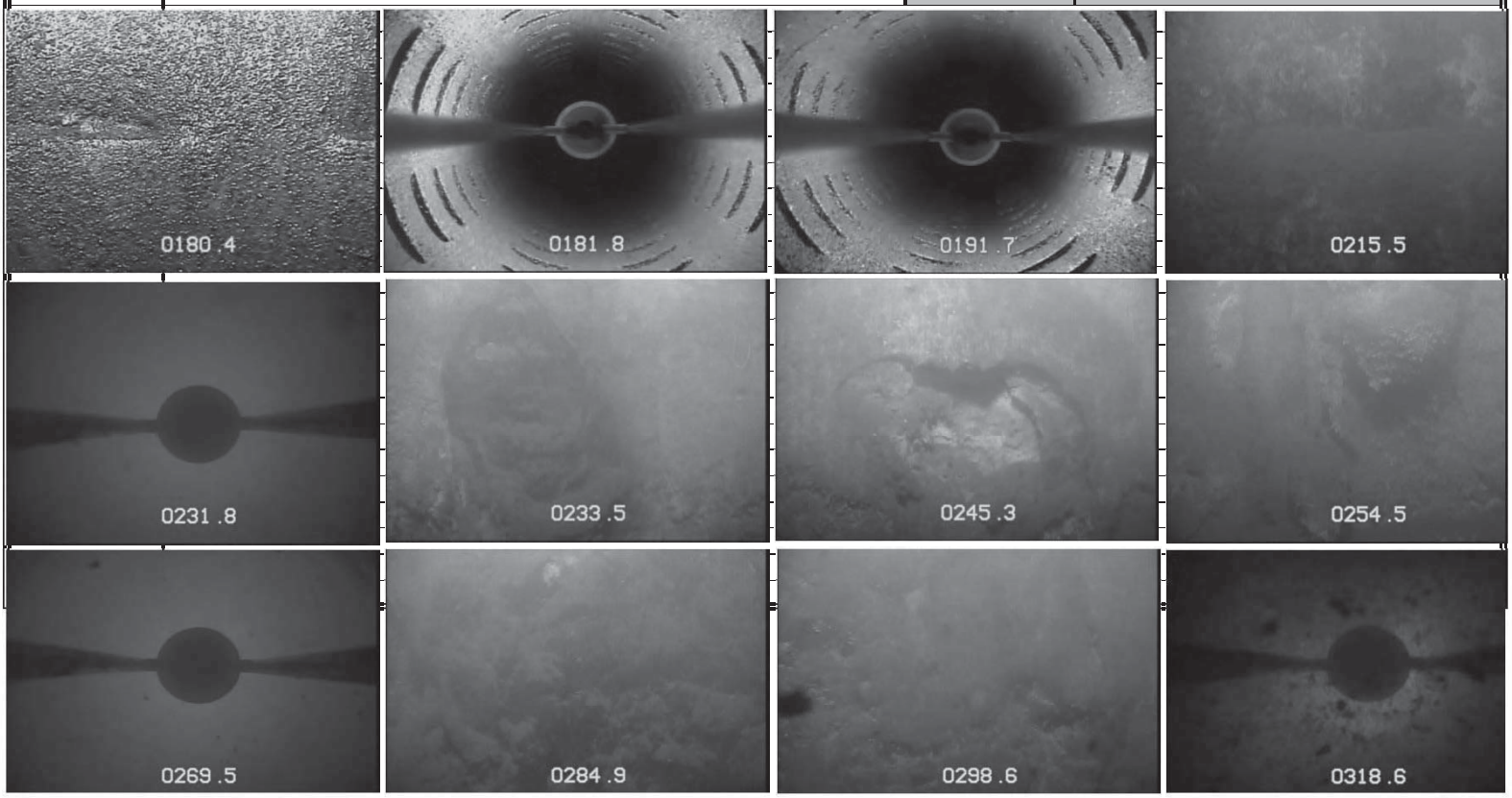
Video Survey Report

Company:	Dudek Engineering + Environmental	**Date:**	15-Jul-16		
Well:	OM-14	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21626		
State:	California	**Total Depth:**	323.5 ft		
		Water Level:	207.7 ft	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	No	**Amount:**	
	GPS N 34˚33.934' W 115˚55.661'	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	1.75 ft
Reason for Survey:	General Inspection	**Guides Set @**	12.5 in		

Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
85.0 ft	Casing appears normal and in good condition.	Standard Louvers	180.40 ft to ?
100.0 ft	Light bio-growth appears on casing.		
180.4 ft	Top of perforations: appear open.		
207.7 ft	SWL: water is very cloudy. Visibility is very poor. Unable to see perfs.		
213.6 ft	Moderate to heavy bio-growth on screen. Perforations appear plugged.		
233.5 ft	Slight increase in water clarity. Large to very large growth nodules observed.		
235.0 ft	Minor to moderate scaling observed on screen.		
245.3 ft	Small hole observed in casing.		
255.0 ft	Unable to see perforations due to heavy bio-growth and large nodules on casing.		
319.0 ft	Down-view turns black. Side-scan is very cloudy. Unable to see perfs. Heavy bio-growt		
321.0 ft	Top of soft fill.	**Casing Size**	**From Survey**
323.5 ft	Camera touches top of hard bottom. End survey.	13.5 in ID	0.00 ft to 323.50ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel



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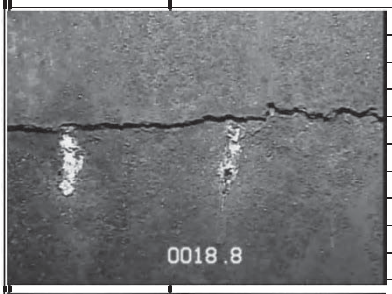
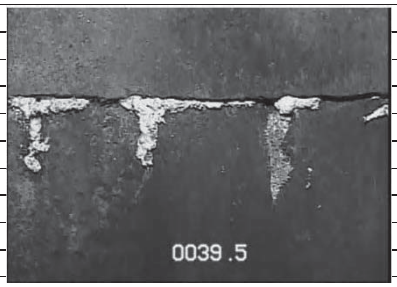
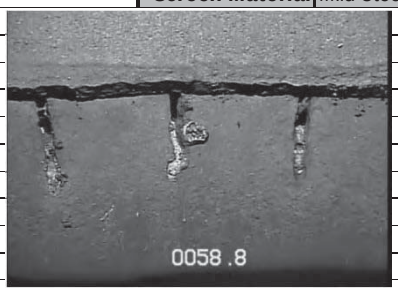
Video Survey Report

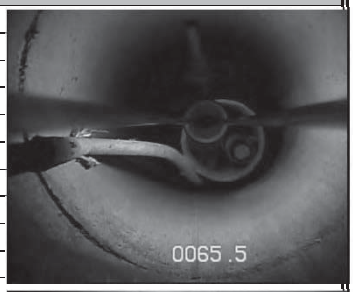
Company:	Dudek Engineering + Environmental	**Date:**	15-Apr-16		
Well:	OM-15	**Run No.**	One	**Truck**	PS-9
Field:	Lucerne Valley	**Job Ticket:**	21232		
State:	California	**Total Depth:**	69.1 ft		
		Water Level:	N/A	SWL	
Location:	Near Fern Rd & Desert Ln	**Oil on Water:**	N/A	**Amount:**	N/A
	GPS N 34˚33'56" W 116˚56'10"	**Operator:**	Villalobos		
Zero Datum:	Top of CSG **Tool Zero:**	Side-Scan		**Dead Space**	2.50 ft
Reason for Survey:	General Inspection	**Guides Set @**	14.5 in		

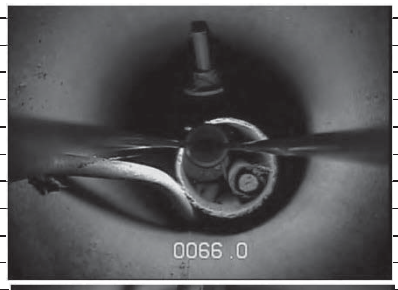
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
10.0 ft	Casing appears normal and in good condition.	Torch-cut	One row at 18.8 ft, 39.5 ft, and 58.8 ft.
18.8 ft	Observed row of perforations. Appear plugged. Cracking observed in well casing.		
39.5 ft	Observed row of perforations. Appear plugged. Cracking observed in well casing.		
58.8 ft	Observed row of perforations. Appear plugged. Cracking observed in well casing.		
69.1 ft	What appears to be a column with pipes and tubing in it. Refer to pictures.		
69.1 ft	Camera cannot pass. End survey.		
		Casing Size	**From Survey**
		15.5 in ID	0.00 ft to 69.10ft
		Casing Material	Mild Steel
		Screen Material	Mild Steel

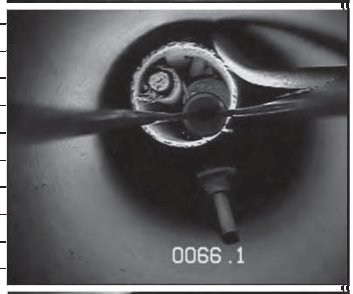


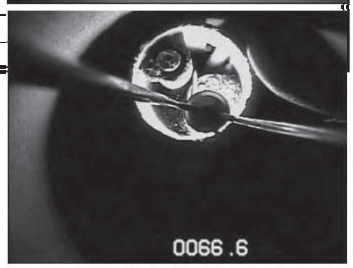












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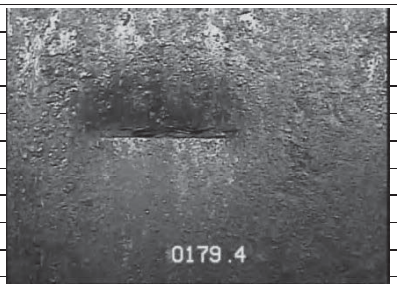
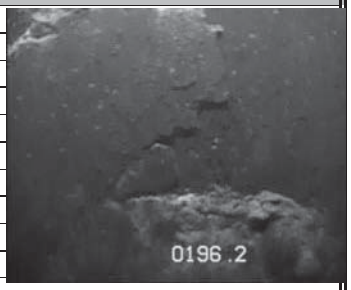
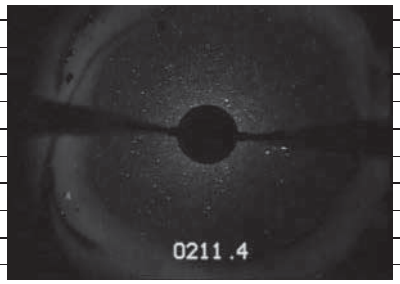
Video Survey Report

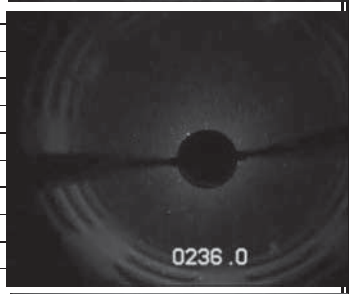
Company:	Dudek Engineering + Environmental		**Date:**	15-Apr-16	
Well:	OM-16		**Run No.**	One	**Truck** PS-9
Field:	Lucerne Valley		**Job Ticket:**	21232	
State:	California		**Total Depth:**	319.8 ft	
			Water Level:	183.6 ft	SWL
Location:	Near Fern Rd & Desert Ln		**Oil on Water:**	No	**Amount:** N/A
	GPS N 34.56562 W -116.93616		**Operator:**	Villalobos	
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan		**Dead Space** 2.50 ft
Reason for Survey:	General Inspection		**Guides Set @**	12.5 in	

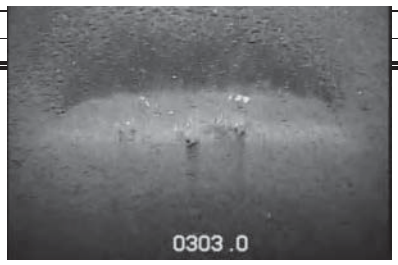
Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
22.0 ft	Light scaling observed on well casing.	Standard Louvers	179.40 ft to 222.50ft
179.4 ft	Top of perforations: appear open and in good condition.		232.10 ft to 319.80ft
183.6 ft	SWL: water is cloudy. Visibility is poor. Minor bio-growth on well casing.		
184.0 ft	Perforations appear mostly plugged.		
192.5 ft	Perforations appear plugged.		
195.0 ft	Decrease in visibility to very poor.		
196.2 ft	Moderate scaling observed on well casing.		
205.2 ft	Heavy suspended solids in water column.		
207.1 ft	Heavy bio-growth on well casing.		
210.0 ft	Increase in water clarity. Visibility is fair.		
219.0 ft	Moderate nodules appear on well casing.	**Casing Size**	**From Survey**
222.5 ft	Bottom of perforations: appear mostly plugged.	13.5 in ID	0.00 ft to 319.80ft
226.2 ft	Decrease in bio-growth on well casing.		
232.1 ft	Top of perforations: appear open. Upward flow noticed in water column.		
240.0 ft	Heavy amount of suspended fines in water column.		
290.0 ft	Decrease in water clarity and visibility from fair to very poor.		
294.4 ft	Perforations appear plugged.		
319.8 ft	Encountered object bridged in casing. Camera tries to pass. Picture turns black.	**Casing Material**	Mild Steel
	Applied sounder and found hard bottom at 338.8 ft.	**Screen Material**	Mild Steel

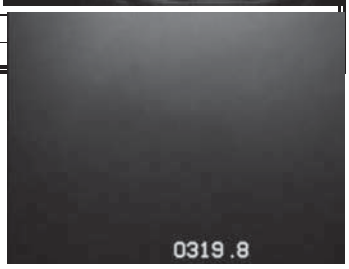












800.919.7555
909.626.6262

4456 via st ambrose
claremont ca 91711
www.pacificsurveys.com

fax: 909.399.3180

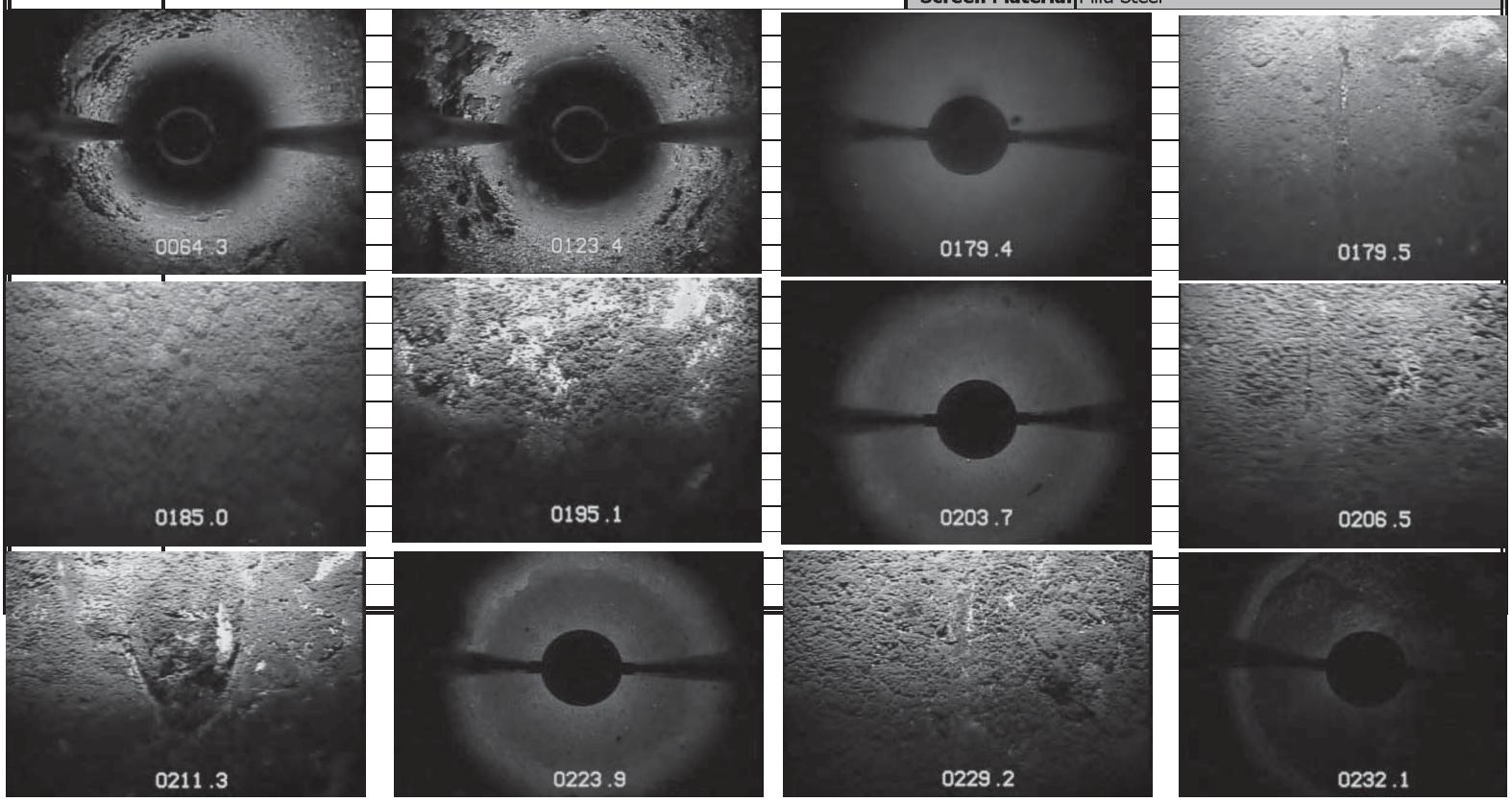
Pacific Surveys

a full service geophysical well logging company

Video Survey Report

Company:	Dudek Engineering + Environmental		**Date:**	15-Apr-16	
Well:	OM-17		**Run No.**	One	**Truck** PS-9
Field:	Lucerne Valley		**Job Ticket:**	21232	
State:	California		**Total Depth:**	234.6 ft	
			Water Level:	176.9 ft	SWL
Location:	Near Fern Rd & Desert Ln		**Oil on Water:**	No	**Amount:** N/A
	GPS N 34°33'48" W 116°56'9"		**Operator:**	Villalobos	
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan		**Dead Space** 2.50 ft
Reason for Survey:	General Inspection		**Guides Set @**	7.5 in	

Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
12.0 ft	Minor scaling and small nodules observed on well casing.	Horizontal Mill Slot	164.50 ft to 234.60ft
35.0 ft	Increase in size of nodules from small to moderate.		
41.5 ft	Increase in scaling on well casing from minor to moderate.		
60.0 ft	Increase in scaling on well casing from moderate to heavy.		
164.5 ft	Top of perforations: appear open. Gravel pack is visible.		
176.9 ft	SWL: water is cloudy. Visibility is poor. Heavy suspended solids in water column.		
177.0 ft	Perforations appear mostly plugged.		
179.8 ft	Moderate nodules and bio-growth observed on screen.		
185.0 ft	Perforations appear plugged.		
190.0 ft	Heavy bio-growth on screen. Perforations are no longer visible.		
206.5 ft	Located a perforation: appears plugged.	**Casing Size**	**From Survey**
229.3 ft	Located a perforation: appears plugged.	8.5 in ID	0.00 ft to 234.60ft
232.1 ft	Located a perforation: appears plugged.		
234.6 ft	Top of hard fill. Still in perforations. End survey.		
		Casing Material	Mild Steel
		Screen Material	Mild Steel



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fax: 909.399.3180

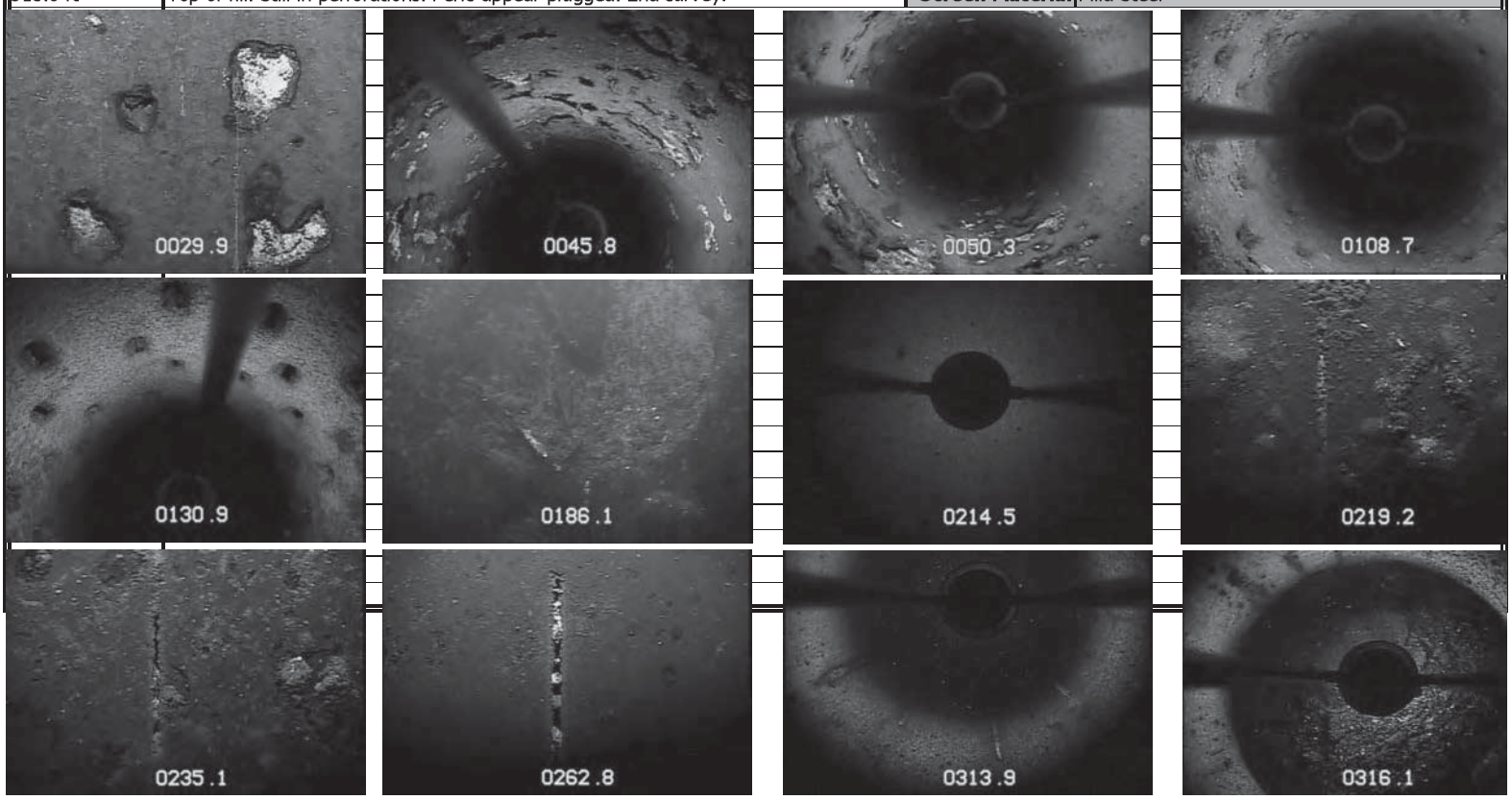
Pacific Surveys

a full service geophysical well logging company

Video Survey Report

Company:	Dudek Engineering + Environmental		**Date:**	15-Apr-16	
Well:	OM-19		**Run No.**	One	**Truck** PS-9
Field:	Lucerne Valley		**Job Ticket:**	21232	
State:	California		**Total Depth:**	318.6 ft	
			Water Level:	183.6 ft	SWL
Location:	Near Fern Rd & Desert Ln		**Oil on Water:**	No	**Amount:** N/A
	GPS N 34°33'55" W 116°55'55"		**Operator:**	Villalobos	
Zero Datum:	Top of CSG	**Tool Zero:**	Side-Scan		**Dead Space** 2.50 ft
Reason for Survey:	General Inspection		**Guides Set @**	12.5 in & 8 in	

Depth	Observations		
0.0 ft	Begin survey from top of well casing.	**Perforation:**	**From Survey**
26.8 ft	Holes appear in well casing from 26.8 ft to 85 ft. Casing appears damaged.	Horizontal Mill Slot	107.00 ft to 318.60ft
48.4 ft	Damage on well casing increases to heavy.		
71.1 ft	Heavy scaling on well casing.		
107.0 ft	Top of perforations: appear plugged.		
109.7 ft	Perforations appear slightly open.		
110.8 ft	Perforations appear open.		
140.0 ft	Moderate scaling on screen. At 147.1 ft. perforations appear plugged.		
183.6 ft	SWL: water is cloudy. Visibility is very poor. Perforations appear plugged.		
184.0 ft	Heavy bio-growth on well casing.		
189.7 ft	Camera becomes wedged in heavy bio-growth, cannot pass.		
	NOTE: Reduced centralizers from 12.5 inches to 8 inches.	**Casing Size**	**From Survey**
196.0 ft	Massive growth observed on well casing.	13.5 in ID	0.00 ft to 318.6 ft.
219.2 ft	Perforations visible, appear plugged.		
227.9 ft	Decrease of bio-growth on well casing. At 228.5 ft. several perfs appear slightly open.		
242.2 ft	Perforations appear plugged.		
245.0 ft	Increase in water clarity and visibility. At 249.1 ft. perforations appear mostly open.		
255.8 ft	Gravel pack is visible behind perforations. At 262.8 ft. perforations appear open.		
266.9 ft	Perforations appear plugged. Screen is covered in bio-growth.	**Casing Material**	Mild Steel
318.6 ft	Top of fill. Still in perforations. Perfs appear plugged. End survey.	**Screen Material**	Mild Steel



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APPENDIX B

Available DWR On-Site Well Completion Reports

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. _____

Date Work Began 4-20-98, Ended 4-20-98

Local Permit Agency E H S

Permit No. 04149851 Permit Date 4-9-98

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 571571

DWR USE ONLY — DO NOT FILL IN

05N01W01G02

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
	clean out to 280'. indicates cased 10" well to 26 0'. White clay to 280'

TOTAL DEPTH OF BORING 280 (Feet)

TOTAL DEPTH OF COMPLETED WELL _____ (Feet)

WELL OWNER

CITY STATE ZIP

WELL LOCATION

Address 33321 Desert Lane

City Lucerne Valley, Ca. 92356

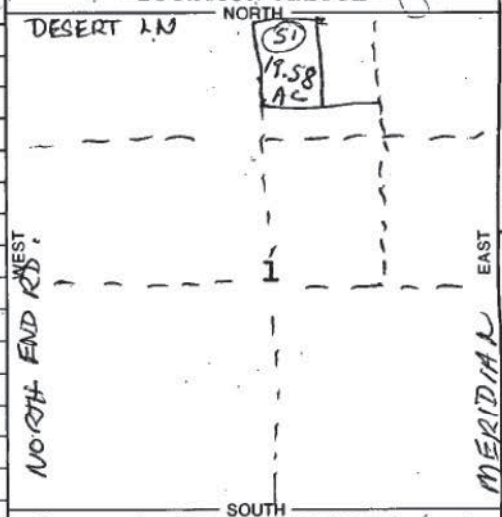
County San Bernardino

APN Book ___ Page ___ Parcel 453-091-51

Township 5N Range 1W Section 1

Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH



Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.
PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

___ NEW WELL

MODIFICATION/REPAIR

___ Deepen

X Other (Specify) clean out

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD air rotary FLUID water & foam

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED _____

ESTIMATED YIELD* _____ (GPM) & TEST TYPE _____

TEST LENGTH _____ (Hrs.) TOTAL DRAWDOWN _____ (Ft.)

* *May not be representative of a well's long-term yield.*

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	CASING(S) TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

DEPTH FROM SURFACE Ft. to Ft.	ANNULAR MATERIAL TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME McDougall's Well Drilling, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS P.O. Box 351, Lucerne Valley, Ca. 92356 CITY STATE ZIP

Signed R. McDougall by Gert
WELL DRILLER/AUTHORIZED REPRESENTATIVE

5-19-98
DATE SIGNED

332221
C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM.

NOT FOR PUBLIC INSPECTION
CONFIDENTIAL
WATER CODE SECTION 13752

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 093746

State Well No. 6N/1W 36H-1

Other Well No.

Notice of Intent No. 199002

Local Permit No. or Date 10-10-80 #10138003

(2) LOCATION OF WELL (See instructions):

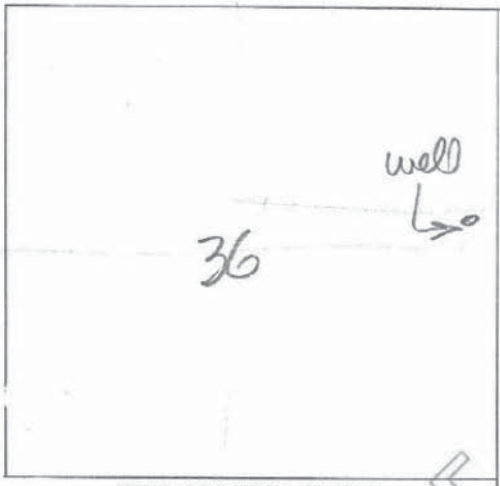
County San Bernardino Owner's Well Number 1

Well address if different from above Parcel No. 453-091-31

Township 6N Range 1W Section 36, SBBM

Distance from cities, roads, railroads, fences, etc.

Lucerne Valley, Calif.



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other Agricultural ☒

(5) EQUIPMENT:

Rotary ☐ Reverse ☒
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size #5
Diameter of bore 24"
Packed from 0 to 330 ft.

(7) CASING INSTALLED:

Steel ☒ Plastic ☐ Concrete ☐

(8) PERFORATIONS:

Type of perforation or size of screen yes Roscoe Moss standard

From ft.	To ft.	Dia. in.	Cage or Wall	From ft.	To ft.	Slot size
0	20	40		180	330 ft	3/32" x
0	180	14"	1/4"			2-3/8"

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☒ No ☐ Interval 0-20 ft.
Method of sealing 9 sack grout mix

(10) WATER LEVELS:

Depth of first water, if known 221 ft.
Standing level after well completion 221 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Beylik Drilling
Type of test Pump ☒ Bailer ☐ Air lift ☐
Depth to water at start of test 221 ft. At end of test 221 ft
Yield/Discharge 1200 gal/min after 30 hours *** Water temperature —
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Water electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 330 ft. Depth of completed well 330 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	50 ft.	coarse gravel, broken rock
50	60 ft.	clay, small rock and gravel
60	90 ft.	sticky clay, small rock & gravel
90	100 ft.	clay, coarse gravel, small rocks
100	130 ft.	coarse gravel, sandy clay, rocks
130	160 ft.	sandy clay, coarse gravel
160	200 ft.	sandy clay, gravel
200	220 ft.	sandy clay, fine gravel, some rock
220	230 ft.	clay, gravel small rocks
230	260 ft.	gravel, small hard rocks
260	262 ft.	fractured rock and gravel
262	268 ft.	sandy clay, some gravel
268	270 ft.	gravel and hard rock, some sandy clay
270	280 ft.	small amt. gravel, sandy clay
280	300 ft.	gravel, rock sandy clay
300	308 ft.	sandy clay, small amt. gravel
308	310 ft.	gravel, small rock
310	320 ft.	coarse gravel, small rock
320	330 ft.	coarse gravel
end...	end....	

Work started April 20, 19 81 Completed May 6th, 19 81

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED John R. Beylik (Well Driller)

NAME BEYLIK DRILLING, INC. (Person, firm, or corporation) (Typed or printed)

Address 591 South Walnut Street

City La Habra, California Zip 90731

License No. 306291-C-57&SC-61 Date of this report May 18, 1981

DO NOT DETACH FOR PUBLIC USE
WATER CODE SEC. 13752

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

*** Drawdown of 56 ft. after 30 hours
yield of 1200 GPM

F/C G or H

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 093747

State Well No. 6N/1W 36H-2

Other Well No.

Notice of Intent No. 199005

Permit No. or Date 05218102

(2) LOCATION OF WELL (See instructions):

County San Bernardino Owner's Well Number 2

Well address if different from above

Township 6N Range 1W Section 36, SBBM

Distance from cities, roads, railroads, fences, etc.
assessors parcel No. 453-091-31, Lucerne Valley, Ca

WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☑
Municipal ☐
Other agricultural ☒

(5) EQUIPMENT:

Rotary ☐ Reverse ☒
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size #5
Diameter of bore 24"
Packed from 0 to 340 ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☐ Concrete ☐

(8) PERFORATIONS: Moss Co.

Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	50	40		187	340	3/32"
0	340	14"	1/4"			2-3/8"

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 50 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval 0-50 ft.
Method of sealing 9 sack grout

(10) WATER LEVELS:

Depth of first water, if known 187ft.
Standing level after well completion 187 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Beylik Drilling,
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test 187 ft. At end of test 187 ft
Discharge 25 gal/min after 36 hours Water temperature 87°
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG:

Total depth 340 ft. Depth of completed well 340 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	60 ft.	gravel and small rocks
60	70 ft.	gravel and sand
70	100 ft.	small amt. clay, sand
100	120 ft.	clay, sand and small rocks
120	220 ft.	gravel, boulders small rocks
220	240 ft.	small rock, gravel, some boulders
240	273 ft.	gravel, clay, small amt., hard rock
273	285 ft.	chunks of hard rock, gravel
285	288 ft.	sandy clay, gravel
288	290 ft.	small rock, gravel
290	296 ft.	small rock, gravel, some clay
296	300 ft.	rock and gravel
300	310 ft.	broken rock, hard clay
310	320 ft.	gravel and hard [redacted] clay
320	330 ft.	clay, gravel and some boulders
330	340 ft.	granite
	end	end

Work started May 7 1981 Completed June 16 1981

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED John R. Beylik (Well Driller)

NAME BEYLIK DRILLING, INC. (Person, firm, or corporation) (Typed or printed)

Address 591 South Walnut Street

City La Habra, California Zip 90631

License No. 306291-C-57&SC61 Date of this report June 17, 1981

ONLY FOR PUBLIC USE NOT FOR PUBLIC USE WATER CODE SEC. 13752

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

453-091-29

NI 12454 6N/1W-36

ORIGINAL
File with DWR

WATER WELL DRILLERS REPORT

(Sections 7079, 7080, 7081, 7082, Water Code)

THE RESOURCES AGENCY OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

R 23 1970

Do Not Fill In

№ 32955

State Well No. 6N/1W-36J1

Other Well No.

(1) OWNER:

(2) LOCATION OF WELL:

County San Bernardino Owner's number, if any

Township, Range, and Section NE4, SE4, sec.36, T6N, R1W.

Distance from cities, roads, railroads, etc. 6mi.N.of Lucerne Vall. on Barstow Hi-way.2mi E. Approx.

(3) TYPE OF WORK *(check)*:

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE *(check)*:

Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☐
Other ☐

(6) CASING INSTALLED:

STEEL: SINGLE ☒ DOUBLE ☐ OTHER:

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	If gravel packed From ft.	To ft.
0	266	8 5/8 OD	3/16	12¼	0	266

Size of shoe or well ring:

Size of gravel: pea gravel

Describe joint Butt Weld

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen Machine perforations

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
226	266	100 mesh liner		

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☐ No ☒ To what depth ft.

Were any strata sealed against pollution? Yes ☐ No ☐ If yes, note depth of strata

From ft. to ft.

From ft. to ft.

Method of sealing

(9) WATER LEVELS:

Depth at which water was first found, if known 186 ft.

Standing level before perforating, if known ft.

Standing level after perforating and developing 186 ft.

(10) WELL TESTS:

Was pump test made? Yes ☐ No ☒ If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☒

Was electric log made of well? Yes ☐ No ☒ If yes, attach copy

(11) WELL LOG:

Total depth ft. Depth of completed well ft.

Formation: *Describe by color, character, size of material, and structure*

ft.	to	
0	186	Dry sand & Boulders
186	200	Sandy clay
200	266	Rock sand & Boulders

Work started Feb.24 19 70, Completed Feb.13 19 70

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Santa Rosa Drilling Co.
(Person, firm, or corporation) (*Typed or printed*)

Address P.O. Box 633
Apple Valley, California 92307

[SIGNED] J.B. Brooks
(*Well Driller*)

SC-61

License No. #C57-131508 Dated 3/21, 19 70

CONFIDENTIAL - NOT FOR PUBLIC RELEASE

SKETCH LOCATION OF WELL ON REVERSE SIDE

453-091-29

DUPLICATE
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No. 7
(Insert appropriate number)

WATER WELL DRILLERS REPORT
(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA

Do Not Fill In
No. 47112
State Well No. 06N/01W-36K7
Other Well No.

(2) LOCATION OF WELL:
County San Bernardino Owner's number, if any—
R. F. D. or Street No. Katy Ranch, Lucerne Valley
Barstow Road about 6 miles.
Section SE 1/4 of Sec 36 T-6N R1W

(3) TYPE OF WORK (*check*):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (*check*):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☒ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☒
Cable ☐
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☐ DOUBLE ☐
From 0 ft. to 230 ft. Diam. 3/16 Gage or Wall
46ft. Luvre Perforations

If gravel packed
Diameter of Bore 20" from ft. 0-230 to ft.
230-250-12 1/4"

Type and size of shoe or well ring Bull Nose
Size of gravel: 3/8-1/2"
Describe joint Welded collars

(7) PERFORATIONS:
Type of perforator used Luvre Perforations
Size of perforations in., length, by in.
From 190 ft. to 230 ft. Perf. per row Rows per ft.

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☐ Yes ☒ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, note depth of strata
From ft. to ft.
Method of Sealing

(9) WATER LEVELS:
Depth at which water was first found 138 ft. ft.
Standing level before perforating ft.
Standing level after perforating ft.

(10) WELL TESTS:
Was a pump test made? ☒ Yes ☐ No If yes, by whom? Victorville Bruce E. Alexander 15073 LaPaz Dr.
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☒ No

(11) WELL LOG:
Total depth 250 ft. ft. Depth of completed well 230ft. ft.
Formation: *Describe by color, character, size of material, and structure.*

0	ft. to	130	ft.	Dry sand
130	"	150	"	Medium water sand
150	"	160	"	Coarse gravel
160	"	200	"	Medium water sand
200	"	230	"	Coarse water sand
230	"	250	"	Rock & Boulders

MICROFILMED

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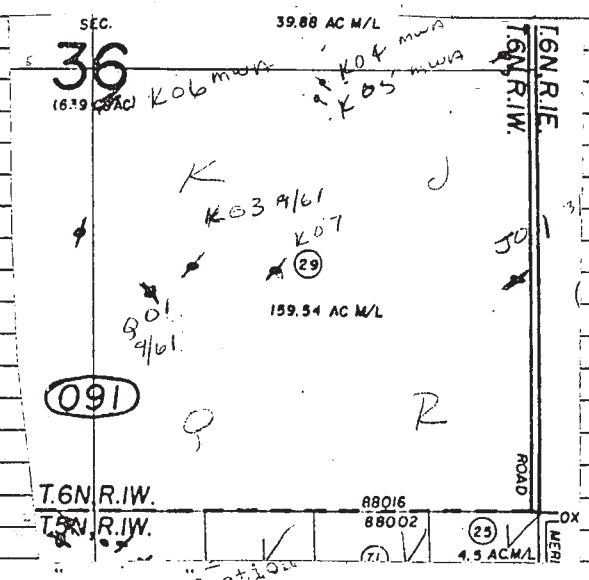

Work started Aug. 30 19 63 Completed Sept. 10 19 63

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Santa Rosa Drilling Co.
(Person, firm, or corporation) (Typed or printed)
Address P.O. Box 633
Apple Valley, California

[SIGNED] E. B. Brooks
Well Driller
License No. 131508 Dated Sept. 18, 1963

95689 3-54 50M QUIN ® SPO DWR FORM NO. 246 (REV. 3-54)

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APPENDIX C

Laboratory Groundwater Quality Results

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Client Name:	Dudek & Associates	Analytical Report:	Page 1 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Attached is the analytical report for the sample(s) received for your project. Below is a list of the individual sample descriptions with the corresponding laboratory number(s). Also, enclosed is a copy of the Chain of Custody document (if received with your sample(s)). Please note any unused portion of the sample(s) may be responsibly discarded after 30 days from the above report date, unless you have requested otherwise.

Thank you for the opportunity to serve your analytical needs. If you have any questions or concerns regarding this report please contact our client service department.

Sample Identification

Lab Sample #	Client Sample ID	Matrix	Date Sampled	By	Date Submitted	By
B6G2858-01	OM-14	Water	07/29/16 04:25	Patrick Rentz	07/29/16 13:25	Courier (R. Cervantes)-DE
B6G2858-02	OM-14 (Dissolved)	Water	07/29/16 04:25	Patrick Rentz	07/29/16 13:25	Courier (R. Cervantes)-DE

The following samples were split from an unpreserved container at the laboratory after submittal and subsequently preserved. If the analyte is identified as 'Dissolved', then the sample was filtered at the lab prior to preservation. Federal guidelines (40CFR Parts 136 and 141) instruct preservation be performed on a separate container collected at site:

B6G2858-01 250 mL Poly NaOH - Split from Unpres

The following samples were split from an unpreserved container at the laboratory after submittal and subsequently preserved. If the analyte is identified as 'Dissolved', then the sample was filtered at the lab prior to preservation. Federal guidelines (40CFR Parts 136 and 141) instruct preservation be performed on a separate container collected at site:

B6G2858-02 Poly - Filtered - Split from Unpres

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Laboratory Reference Number

B6G2858-01

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-14	Water	07/29/16 04:25	07/29/16 13:25

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Cations							
Total Hardness	200	3.0	mg/L	SM 2340B/EPA 2(	08/02/16 12:54	mel	
Calcium	47	1.0	mg/L	EPA 200.7	08/02/16 12:54	mel	
Magnesium	19	1.0	mg/L	EPA 200.7	08/02/16 12:54	mel	
Sodium	75	1.0	mg/L	EPA 200.7	08/02/16 12:54	mel	
Sodium Percentage	45	0.10	%	EPA 200.7	08/02/16 12:54	mel	
Potassium	3.7	1.0	mg/L	EPA 200.7	08/02/16 12:54	mel	
Total Cations	7.3	0.05	me/L	Calculation			
Sodium Adsorption Ratio	2.3	0.20	N/A	EPA 200.7	08/02/16 12:54	mel	
Adjusted Sodium Adsorption Ratio	4.1	0.20	N/A	EPA 200.7	08/02/16 12:54	mel	
Anions							
Total Alkalinity	110	3.0	mg/L	SM 2320B	08/01/16 17:20	nc	
Hydroxide	ND	3.0	mg/L	SM 2320B	08/01/16 17:20	nc	
Carbonate	ND	3.0	mg/L	SM 2320B	08/01/16 17:20	nc	
Bicarbonate	130	3.0	mg/L	SM 2320B	08/01/16 17:20	nc	
Chloride	73	1.0	mg/L	EPA 300.0	07/29/16 23:42	dcb	
Sulfate	120	0.50	mg/L	EPA 300.0	07/29/16 23:42	dcb	
Nitrate as N	5.0	0.20	mg/L	EPA 300.0	07/29/16 23:42	dcb	
Fluoride	1.2	0.1	mg/L	SM 4500F C	08/01/16 18:45	cmr	
Nitrate	22	1.0	mg/L	EPA 300.0	07/29/16 23:42	dcb	
Total Anions	7.18	0.05	me/L	Calculation			
Aggregate Properties							
pH	7.7	1.0	pH Units	SM 4500H+ B	08/01/16 17:40	nhb	
Specific Conductance	800	1.0	umhos/cm	SM 2510 B	08/01/16 17:40	nhb	
Aggressive Index	11.8	1.0	N/A	Calculation			
Langlier Index @ 25 C	0.02		N/A	SM 2330 B	08/02/16 11:42		

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Laboratory Reference Number

B6G2858-01

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-14	Water	07/29/16 04:25	07/29/16 13:25

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Solids							
Total Dissolved Solids	510	20	mg/L	SM 2540C	08/01/16 11:00	nhb	
General Physical							
Color	10	3.0	Color Units	SM 2120B	07/29/16 17:20	kl	
Odor	ND	1.0	T.O.N.*	SM 2150	07/29/16 17:20	kl	
Turbidity	4.0	0.10	NTU	SM 2130 B	07/29/16 17:20	kl	
Surfactants							
MBAS	ND	0.08	mg/L	SM 5540C	07/29/16 18:00	krv	
General Inorganics							
Cyanide	ND	100	ug/L	SM 4500CN E	08/02/16 15:14	sll	
Perchlorate	ND	4.0	ug/L	EPA 314.0	08/01/16 00:16	ara	
Nutrients							
Nitrite as N	ND	0.10	mg/L	SM 4500NO2 B	07/29/16 20:45	nc	

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Client Name: Dudek & Associates
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Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Laboratory Reference Number

B6G2858-02

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-14 (Dissolved)	Water	07/29/16 04:25	07/29/16 13:25

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Metals and Metalloids							
Aluminum	ND	50	ug/L	EPA 200.7	08/02/16 12:56	mel	N_pFilt
Antimony	ND	6.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Arsenic	ND	2.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Barium	48	20	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Beryllium	ND	1.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Boron	290	100	ug/L	EPA 200.7	08/02/16 12:56	mel	N_pFilt
Cadmium	ND	1.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Total Chromium	ND	1.0	ug/L	EPA 200.8	08/03/16 11:14	AP	N_pFilt
Copper	ND	50	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Iron	ND	100	ug/L	EPA 200.7	08/02/16 12:57	mel	N_pFilt
Lead	ND	5.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Manganese	ND	20	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Mercury	ND	1.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Nickel	ND	10	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Selenium	ND	5.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Silver	ND	10	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Thallium	ND	1.0	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt
Zinc	ND	50	ug/L	EPA 200.8	08/01/16 22:15	AP	N_pFilt

* NELAP does not offer accreditation for this analyte/method/matrix combination

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Client Name:	Dudek & Associates	Analytical Report:	Page 5 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Cations - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H02091 - 200.7/ No Digest M07										
Blank (6H02091-BLK1)				Prepared & Analyzed: 08/02/16						
Calcium	ND	1.0	mg/L							
Magnesium	ND	1.0	mg/L							
Sodium	ND	1.0	mg/L							
Potassium	ND	1.0	mg/L							
LCS (6H02091-BS1)				Prepared & Analyzed: 08/02/16						
Calcium	45.3	1.0	mg/L	44.0		103	85-115			
Magnesium	22.7	1.0	mg/L	22.3		102	85-115			
Sodium	44.9	1.0	mg/L	44.0		102	85-115			
Potassium	23.0	1.0	mg/L	22.3		103	85-115			
LCS Dup (6H02091-BSD1)				Prepared & Analyzed: 08/02/16						
Calcium	45.0	1.0	mg/L	44.0		102	85-115	0.647	20	
Magnesium	22.6	1.0	mg/L	22.3		101	85-115	0.756	20	
Sodium	44.4	1.0	mg/L	44.0		101	85-115	1.07	20	
Potassium	22.6	1.0	mg/L	22.3		101	85-115	1.60	20	
Matrix Spike (6H02091-MS1)		**Source: B6G2360-02**		Prepared & Analyzed: 08/02/16						
Calcium	166	1.0	mg/L	44.0	121	101	70-130			
Magnesium	48.0	1.0	mg/L	22.3	25.7	100	70-130			
Sodium	239	1.0	mg/L	44.0	195	99.2	70-130			
Potassium	31.8	1.0	mg/L	22.3	8.48	105	70-130			

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Client Name:	Dudek & Associates	Analytical Report:	Page 6 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Anions - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G29052 - Analyzed as Received IC										
Blank (6G29052-BLK1)				Prepared & Analyzed: 07/29/16						
Sulfate	ND	0.50	mg/L							
Chloride	ND	1.0	mg/L							
Nitrate	ND	1.0	mg/L							
Nitrate as N	ND	0.20	mg/L							
LCS (6G29052-BS1)				Prepared & Analyzed: 07/29/16						
Sulfate	48.0	0.50	mg/L	50.0		95.9	90-110			
Chloride	51.1	1.0	mg/L	50.0		102	90-110			
Nitrate	49.3	1.0	mg/L	50.0		98.5	90-110			
Nitrate as N	11.1	0.20	mg/L	11.3		98.4	90-110			
Duplicate (6G29052-DUP1)		**Source: B6G1252-76**		Prepared & Analyzed: 07/29/16						
Sulfate	74.6	0.50	mg/L		75.1			0.633	20	
Chloride	ND	1.0	mg/L		ND				20	
Nitrate	ND	1.0	mg/L		ND				20	
Nitrate as N	ND	0.20	mg/L		ND				20	
Matrix Spike (6G29052-MS1)		**Source: B6G2858-01**		Prepared & Analyzed: 07/29/16						
Sulfate	212	0.50	mg/L	100	121	91.3	75-128			
Chloride	122	1.0	mg/L	50.0	72.8	99.1	84-129			
Nitrate	39.8	1.0	mg/L	20.0	22.3	87.5	75-131			
Nitrate as N	8.99	0.20	mg/L	4.52	5.04	87.4	75-131			
Matrix Spike (6G29052-MS2)		**Source: B6G2894-01**		Prepared & Analyzed: 07/30/16						
Sulfate	226	0.50	mg/L	100	127	98.8	75-128			
Chloride	100	1.0	mg/L	50.0	45.1	110	84-129			
Nitrate	21.2	1.0	mg/L	20.0	3.68	87.9	75-131			
Nitrate as N	4.79	0.20	mg/L	4.52	0.830	87.8	75-131			

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Anions - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G29052 - Analyzed as Received IC										
Matrix Spike Dup (6G29052-MSD1)		**Source: B6G2858-01**		Prepared & Analyzed: 07/30/16						
Sulfate	214	0.50	mg/L	100	121	93.7	75-128	1.14	20	
Chloride	123	1.0	mg/L	50.0	72.8	100	84-129	0.378	20	
Nitrate	40.1	1.0	mg/L	20.0	22.3	88.6	75-131	0.589	20	
Nitrate as N	9.04	0.20	mg/L	4.52	5.04	88.6	75-131	0.589	20	
Batch 6H01108 - Analyzed as received										
Blank (6H01108-BLK1)				Prepared & Analyzed: 08/01/16						
Total Alkalinity	ND	3.0	mg/L							
Hydroxide	ND	3.0	mg/L							
Carbonate	ND	3.0	mg/L							
Bicarbonate	ND	3.0	mg/L							
LCS (6H01108-BS1)				Prepared & Analyzed: 08/01/16						
Total Alkalinity	454	3.0	mg/L	472		96.2	95-105			
Carbonate	271	3.0	mg/L	278		97.5	95-105			
Duplicate (6H01108-DUP1)		**Source: B6G2312-02**		Prepared & Analyzed: 08/01/16						
Total Alkalinity	328	3.0	mg/L		325			0.919	20	
Hydroxide	ND	3.0	mg/L		ND				20	
Carbonate	ND	3.0	mg/L		ND				20	
Bicarbonate	400	3.0	mg/L		397			0.753	20	
Duplicate (6H01108-DUP2)		**Source: B6H0001-01**		Prepared & Analyzed: 08/01/16						
Total Alkalinity	157	3.0	mg/L		155			1.28	20	
Hydroxide	ND	3.0	mg/L		ND				20	
Carbonate	ND	3.0	mg/L		ND				20	
Bicarbonate	192	3.0	mg/L		189			1.57	20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 8 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Anions - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01120 - Analyzed as received										
Blank (6H01120-BLK1)				Prepared & Analyzed: 08/01/16						
Fluoride	ND	0.1	mg/L							
LCS (6H01120-BS1)				Prepared & Analyzed: 08/01/16						
Fluoride	0.740	0.1	mg/L	0.800		92.5	90-110			
LCS (6H01120-BS2)				Prepared & Analyzed: 08/01/16						
Fluoride	0.740	0.1	mg/L	0.800		92.5	90-110			
LCS (6H01120-BS3)				Prepared & Analyzed: 08/01/16						
Fluoride	0.746	0.1	mg/L	0.800		93.2	90-110			
LCS (6H01120-BS4)				Prepared & Analyzed: 08/01/16						
Fluoride	0.749	0.1	mg/L	0.800		93.6	90-110			
Matrix Spike (6H01120-MS1)		**Source: B6G2245-04**		Prepared & Analyzed: 08/01/16						
Fluoride	1.18	0.1	mg/L	0.400	0.725	114	75-125			
Matrix Spike Dup (6H01120-MSD1)		**Source: B6G2245-04**		Prepared & Analyzed: 08/01/16						
Fluoride	1.17	0.1	mg/L	0.400	0.725	111	75-125	0.851	20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 9 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Aggregate Properties - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01111 - Analyzed as received										
LCS (6H01111-BS1)				Prepared & Analyzed: 08/01/16						
pH	4.0	1.0	pH Units	4.00		99.8	97.5-102.5			
Specific Conductance	1400	1.0	umhos/cm	1410		99.5	90-110			
Duplicate (6H01111-DUP1)		**Source: B6G2685-06**		Prepared & Analyzed: 08/01/16						
pH	7.3	1.0	pH Units		7.3			0.274	5	
Specific Conductance	603	1.0	umhos/cm		601			0.332	20	
Duplicate (6H01111-DUP2)		**Source: B6G2685-07**		Prepared & Analyzed: 08/01/16						
pH	7.4	1.0	pH Units		7.4			0.00	5	
Specific Conductance	591	1.0	umhos/cm		588			0.509	20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 10 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Solids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01076 - Analyzed as received										
Blank (6H01076-BLK1)				Prepared & Analyzed: 08/01/16						
Total Dissolved Solids	ND	10	mg/L							
LCS (6H01076-BS1)				Prepared & Analyzed: 08/01/16						
Total Dissolved Solids	735	20	mg/L	746		98.5	90-110			
Duplicate (6H01076-DUP1)		**Source: B6G2681-03**		Prepared & Analyzed: 08/01/16						
Total Dissolved Solids	183	20	mg/L		182			0.548	20	
Duplicate (6H01076-DUP2)		**Source: B6G2888-01**		Prepared & Analyzed: 08/01/16						
Total Dissolved Solids	472	20	mg/L		470			0.425	20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 11 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

General Physical - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G29051 - Analyzed as received										
Blank (6G29051-BLK1)				Prepared & Analyzed: 07/29/16						
Color	ND	3.0	Color Units							
Odor	ND	1.0	T.O.N.*							
Turbidity	ND	0.10	NTU							
LCS (6G29051-BS1)				Prepared & Analyzed: 07/29/16						
Color	5.00	3.0	Color Units	5.00		100	60-200			
Turbidity	0.820	0.10	NTU	0.800		102	90-110			
Duplicate (6G29051-DUP1)		**Source: B6G2852-01**		Prepared & Analyzed: 07/29/16						
Color	ND	3.0	Color Units		ND				50	
Odor	ND	1.0	T.O.N.*		ND				66.7	
Turbidity	ND	0.10	NTU		ND				20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 12 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Surfactants - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G29032 - Solvent Extraction.										
Blank (6G29032-BLK1)				Prepared & Analyzed: 07/29/16						
MBAS	ND	0.08	mg/L							
LCS (6G29032-BS1)				Prepared & Analyzed: 07/29/16						
MBAS	0.270	0.08	mg/L	0.320		84.4	52-141			
Matrix Spike (6G29032-MS1)		**Source: B6G2754-01**		Prepared & Analyzed: 07/29/16						
MBAS	0.315	0.20	mg/L	0.400	ND	78.8	35-142			
Matrix Spike Dup (6G29032-MSD1)		**Source: B6G2754-01**		Prepared & Analyzed: 07/29/16						
MBAS	0.288	0.20	mg/L	0.400	ND	71.9	35-142	9.13	20	

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

General Inorganics - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G31054 - Analyzed as Received IC										
Blank (6G31054-BLK1)				Prepared & Analyzed: 07/31/16						
Perchlorate	ND	4.0	ug/L							
LCS (6G31054-BS1)				Prepared & Analyzed: 07/31/16						
Perchlorate	23.9	4.0	ug/L	25.0		95.6	85-115			
Matrix Spike (6G31054-MS1)		**Source: B6G2454-01**		Prepared & Analyzed: 08/01/16						
Perchlorate	12.8	4.0	ug/L	12.5	2.68	80.9	80-120			
Matrix Spike Dup (6G31054-MSD1)		**Source: B6G2454-01**		Prepared & Analyzed: 08/01/16						
Perchlorate	12.6	4.0	ug/L	12.5	2.68	79.1	80-120	1.79	15	QMSD
Batch 6H02072 - Distillation										
Blank (6H02072-BLK1)				Prepared & Analyzed: 08/02/16						
Cyanide	ND	100	ug/L							
LCS (6H02072-BS1)				Prepared & Analyzed: 08/02/16						
Cyanide	110	100	ug/L	101		109	76-119			
Matrix Spike (6H02072-MS1)		**Source: B6G2852-01**		Prepared & Analyzed: 08/02/16						
Cyanide	100	100	ug/L	101	ND	99.7	66-124			
Matrix Spike Dup (6H02072-MSD1)		**Source: B6G2852-01**		Prepared & Analyzed: 08/02/16						
Cyanide	103	100	ug/L	101	ND	102	66-124	2.17	30	

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Client Name:	Dudek & Associates	Analytical Report:	Page 14 of 20
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Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Nutrients - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6G29061 - Filter if turbid.										
LCS (6G29061-BS1)				Prepared & Analyzed: 07/29/16						
Nitrite as N	0.960	0.10	mg/L	1.00		96.0	90-110			
Matrix Spike (6G29061-MS1)		**Source: B6G2852-01**		Prepared & Analyzed: 07/29/16						
Nitrite as N	0.960	0.10	mg/L	1.00	ND	96.0	80-120			
Matrix Spike Dup (6G29061-MSD1)		**Source: B6G2852-01**		Prepared & Analyzed: 07/29/16						
Nitrite as N	0.970	0.10	mg/L	1.00	ND	97.0	80-120	1.04	20	

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Client Name:	Dudek & Associates	Analytical Report:	Page 15 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01092 - 200.8/ No Digest M12										
Blank (6H01092-BLK1)				Prepared & Analyzed: 08/01/16						
Antimony	ND	6.0	ug/L							
Arsenic	ND	2.0	ug/L							
Barium	ND	20	ug/L							
Beryllium	ND	1.0	ug/L							
Cadmium	ND	1.0	ug/L							
Copper	ND	50	ug/L							
Lead	ND	5.0	ug/L							
Manganese	ND	20	ug/L							
Mercury	ND	1.0	ug/L							
Nickel	ND	10	ug/L							
Selenium	ND	5.0	ug/L							
Silver	ND	10	ug/L							
Thallium	ND	1.0	ug/L							
Zinc	ND	50	ug/L							
Blank (6H01092-BLK2)				Prepared & Analyzed: 08/01/16						
Antimony	ND	6.0	ug/L							QBfil
Arsenic	ND	2.0	ug/L							QBfil
Barium	ND	20	ug/L							QBfil
Beryllium	ND	1.0	ug/L							QBfil
Cadmium	ND	1.0	ug/L							QBfil
Copper	ND	50	ug/L							QBfil
Lead	ND	5.0	ug/L							QBfil
Manganese	ND	20	ug/L							QBfil
Mercury	ND	1.0	ug/L							QBfil
Nickel	ND	10	ug/L							QBfil
Selenium	ND	5.0	ug/L							QBfil
Silver	ND	10	ug/L							QBfil
Thallium	ND	1.0	ug/L							QBfil
Zinc	ND	50	ug/L							QBfil

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Client Name:	Dudek & Associates	Analytical Report:	Page 16 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01092 - 200.8/ No Digest M12										
LCS (6H01092-BS1)				Prepared & Analyzed: 08/01/16						
Antimony	48.1	6.0	ug/L	50.0		96.1	85-115			
Arsenic	51.8	2.0	ug/L	50.0		104	85-115			
Barium	48.3	20	ug/L	50.0		96.6	85-115			
Beryllium	48.6	1.0	ug/L	50.0		97.2	85-115			
Cadmium	47.5	1.0	ug/L	50.0		95.0	85-115			
Copper	48.9	50	ug/L	50.0		97.8	85-115			
Lead	47.0	5.0	ug/L	50.0		93.9	85-115			
Manganese	48.2	20	ug/L	50.0		96.4	85-115			
Mercury	4.96	1.0	ug/L	5.00		99.1	85-115			
Nickel	48.3	10	ug/L	50.0		96.6	85-115			
Selenium	49.2	5.0	ug/L	50.0		98.3	85-115			
Silver	48.3	10	ug/L	50.0		96.6	85-115			
Thallium	45.4	1.0	ug/L	50.0		90.7	85-115			
Zinc	51.0	50	ug/L	50.0		102	85-115			
LCS Dup (6H01092-BSD1)				Prepared & Analyzed: 08/01/16						
Antimony	47.2	6.0	ug/L	50.0		94.3	85-115	1.87	20	
Arsenic	49.9	2.0	ug/L	50.0		99.8	85-115	3.77	20	
Barium	47.1	20	ug/L	50.0		94.1	85-115	2.57	20	
Beryllium	47.1	1.0	ug/L	50.0		94.3	85-115	3.09	20	
Cadmium	46.9	1.0	ug/L	50.0		93.7	85-115	1.30	20	
Copper	46.8	50	ug/L	50.0		93.5	85-115	4.50	20	
Lead	46.7	5.0	ug/L	50.0		93.3	85-115	0.656	20	
Manganese	47.1	20	ug/L	50.0		94.2	85-115	2.40	20	
Mercury	4.95	1.0	ug/L	5.00		99.0	85-115	0.101	20	
Nickel	46.9	10	ug/L	50.0		93.7	85-115	3.00	20	
Selenium	48.1	5.0	ug/L	50.0		96.1	85-115	2.30	20	
Silver	47.3	10	ug/L	50.0		94.6	85-115	2.06	20	
Thallium	45.8	1.0	ug/L	50.0		91.6	85-115	0.941	20	
Zinc	49.0	50	ug/L	50.0		98.1	85-115	3.90	20	

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H01092 - 200.8/ No Digest M12										
Matrix Spike (6H01092-MS1)		**Source: B6G2370-01**		Prepared & Analyzed: 08/01/16						
Antimony	50.8	6.0	ug/L	50.0	ND	102	70-130			
Arsenic	53.2	2.0	ug/L	50.0	ND	106	70-130			
Barium	55.0	20	ug/L	50.0	5.52	99.0	70-130			
Beryllium	50.1	1.0	ug/L	50.0	ND	100	70-130			
Cadmium	48.9	1.0	ug/L	50.0	ND	97.8	70-130			
Copper	210	50	ug/L	50.0	156	108	70-130			
Lead	49.4	5.0	ug/L	50.0	0.676	97.5	70-130			
Manganese	49.3	20	ug/L	50.0	0.967	96.7	70-130			
Mercury	5.21	1.0	ug/L	5.00	ND	104	70-130			
Nickel	129	10	ug/L	50.0	78.2	102	70-130			
Selenium	50.2	5.0	ug/L	50.0	3.66	93.2	70-130			
Silver	48.8	10	ug/L	50.0	ND	97.7	70-130			
Thallium	47.3	1.0	ug/L	50.0	ND	94.6	70-130			
Zinc	248	50	ug/L	50.0	189	119	70-130			
Matrix Spike (6H01092-MS2)		**Source: B6G2370-02**		Prepared & Analyzed: 08/01/16						
Antimony	50.1	6.0	ug/L	50.0	ND	100	70-130			
Arsenic	52.1	2.0	ug/L	50.0	ND	104	70-130			
Barium	53.5	20	ug/L	50.0	4.43	98.1	70-130			
Beryllium	49.8	1.0	ug/L	50.0	ND	99.7	70-130			
Cadmium	48.8	1.0	ug/L	50.0	ND	97.6	70-130			
Copper	69.1	50	ug/L	50.0	21.5	95.2	70-130			
Lead	49.1	5.0	ug/L	50.0	ND	98.2	70-130			
Manganese	49.3	20	ug/L	50.0	ND	98.6	70-130			
Mercury	5.33	1.0	ug/L	5.00	ND	107	70-130			
Nickel	47.8	10	ug/L	50.0	ND	95.6	70-130			
Selenium	49.0	5.0	ug/L	50.0	ND	98.1	70-130			
Silver	49.1	10	ug/L	50.0	ND	98.2	70-130			
Thallium	47.1	1.0	ug/L	50.0	ND	94.3	70-130			
Zinc	50.0	50	ug/L	50.0	ND	100	70-130			

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 03-Aug-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6G2858

Received on Ice (Y/N): Yes Temp: 5 °C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H02091 - 200.7/ No Digest M07										
Blank (6H02091-BLK1)				Prepared & Analyzed: 08/02/16						
Aluminum	ND	50	ug/L							
Boron	ND	100	ug/L							
Iron	ND	100	ug/L							
Blank (6H02091-BLK2)				Prepared & Analyzed: 08/02/16						
Aluminum	ND	50	ug/L							QBfil
Boron	ND	100	ug/L							QBfil
Iron	ND	100	ug/L							QBfil
LCS (6H02091-BS1)				Prepared & Analyzed: 08/02/16						
Aluminum	533	50	ug/L	544		97.9	85-115			
Boron	664	100	ug/L	652		102	85-115			
Iron	2090	100	ug/L	2060		101	85-115			
LCS Dup (6H02091-BSD1)				Prepared & Analyzed: 08/02/16						
Aluminum	522	50	ug/L	544		95.8	85-115	2.11	20	
Boron	661	100	ug/L	652		101	85-115	0.548	20	
Iron	2070	100	ug/L	2060		100	85-115	0.938	20	
Matrix Spike (6H02091-MS1)		**Source: B6G2360-02**		Prepared & Analyzed: 08/02/16						
Aluminum	534	50	ug/L	544	ND	98.1	70-130			
Boron	969	100	ug/L	652	277	106	70-130			
Iron	2340	100	ug/L	2060	175	105	70-130			
Batch 6H02127 - EPA 200.2 SOP M02C										
Blank (6H02127-BLK1)				Prepared: 08/02/16 Analyzed: 08/03/16						
Total Chromium	ND	1.0	ug/L							

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Client Name:	Dudek & Associates	Analytical Report:	Page 19 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Metals and Metalloids - Batch Quality Control

Analyte(s)	Result	RDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch 6H02127 - EPA 200.2 SOP M02C										
Blank (6H02127-BLK2)				Prepared: 08/02/16	Analyzed: 08/03/16					
Total Chromium	ND	1.0	ug/L							QBfil
LCS (6H02127-BS1)				Prepared: 08/02/16	Analyzed: 08/03/16					
Total Chromium	34.3	1.0	ug/L	33.3		103	85-115			
LCS Dup (6H02127-BSD1)				Prepared: 08/02/16	Analyzed: 08/03/16					
Total Chromium	33.6	1.0	ug/L	33.3		101	85-115	1.95	20	
Matrix Spike (6H02127-MS1)		**Source: B6G2583-01**		Prepared: 08/02/16	Analyzed: 08/03/16					
Total Chromium	39.7	1.0	ug/L	33.3	4.70	105	70-130			
Matrix Spike (6H02127-MS2)		**Source: B6G2852-01**		Prepared: 08/02/16	Analyzed: 08/03/16					
Total Chromium	39.4	1.0	ug/L	33.3	5.79	101	70-130			

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Client Name:	Dudek & Associates	Analytical Report:	Page 20 of 20
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

Notes and Definitions

pH: Regulatory 15 minute holding time exceeded B6G2858-01

N_pScr: Cyanide Determination: Sample screened for interference and preserved upon receipt at the lab B6G2858-01

N_pFilt Sample filtered and preserved upon receipt to the laboratory.

QBfil Method blank was filtered prior to processing.

QMSD The MS recovery and MS/MSD RPD met laboratory acceptance criteria. MSD recovery was not within range. MSD performed to assess precision data only.

ND: Analyte NOT DETECTED at or above the Method Detection Limit **(if MDL is reported)**, otherwise at or above the Reportable Detection Limit (RDL)

NR: Not Reported

RDL: Reportable Detection Limit

MDL: Method Detection Limit

* / ''' : NELAP does not offer accreditation for this analyte/method/matrix combination

Approval

Enclosed are the analytical results for the submitted sample(s). Babcock Laboratories certify the data presented as part of this report meet the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. Babcock Laboratories and its officers and employees assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intended or unintended, of this report.

cc:

e-Standard_No Alias.rpt

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Client Name:	Dudek & Associates	Analytical Report:	Page 1 of 1
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	03-Aug-2016	**Work Order Number:**	**B6G2858**

Received on Ice (Y/N): Yes Temp: 5 °C

DUDEK
605 Third Street
Encinitas, CA 92024
Tel: 760-942-5147
Fax: 760-942-5206

Chain - of - Custody Form

Project Name: Lucerne Valley Bad Mtn
Job Number: 9191-02
Sampled by: Patrick Rentz
Sampler Signature:

Sample ID	Date	Time	Sample Collection	Matrix	Method Preserved	Number of Sample Container
OM-14	7/20	4:25	X	Water	HCL	
				Soil	HNO_3	X
					NONE	X
					Filtered (Y/ N)	
					40 mL glass VOA	
					___oz. Glass Jar	
					_____ Amber	
					poly bottles	4

Laboratory:
Lab Contact:
Project Manager: Patrick Rentz
Lab Job #:
Shipping Method:
PM Email: prentz@dudek.com
Page ___ of ___

Type of Analysis to be Performed

VOCs	EPA 8260B
1,4-Dioxane	EPA 8270C
SVOCs	EPA 8270
Chlorinated Pesticides	EPA 8081A
TPH (CC / GRO / DRO / Motor Oil)	EPA 8015M
TDS	
Metals	6010B/ 7471

TAT: Standard Turn-Around Time; Other: 24 hr 48 hr 72 hr X results by Wed, 8/3

Special Instructions: PER Quote 16-C1700 Aggressive hold Boron Gen. Min. + Inorganic Gen. Physical Langelier Index SAR Na %

Total # of containers per type

Total # of containers

Please return original COC to Dudek

Relinquished by:	Company	Date	Time	Received by:	Company	Date	Time
[signature]	DUDEK	7/29	1140	[signature]	SAHY BK	7/29	11:20
[signature]	DE	7/29	13:25	[signature]	ESLS	7/29	13:25

Sample Receipt: ☐ Samples Intact ☐ Cooler Temp: 5 °C ☐ Conforms to COC

B6G2858 (NG)

JUL 29 2016

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 19-Sep-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6I0709

Received on Ice (Y/N): Yes Temp: 11 °C

Attached is the analytical report for the sample(s) received for your project. Below is a list of the individual sample descriptions with the corresponding laboratory number(s). Also, enclosed is a copy of the Chain of Custody document (if received with your sample(s)). Please note any unused portion of the sample(s) may be responsibly discarded after 30 days from the above report date, unless you have requested otherwise.

Thank you for the opportunity to serve your analytical needs. If you have any questions or concerns regarding this report please contact our client service department.

Sample Identification

Lab Sample #	Client Sample ID	Matrix	Date Sampled	By	Date Submitted	By
B6I0709-01	OM-19	Water	09/08/16 15:10	Patrick Rentz	09/08/16 17:10	Courier (Ray C.)
B6I0709-02	OM-19 (Dissolved)	Water	09/08/16 15:10	Patrick Rentz	09/08/16 17:10	Courier (Ray C.)

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 19-Sep-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6I0709

Received on Ice (Y/N): Yes Temp: 11 °C

Laboratory Reference Number

B6I0709-01

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-19	Water	09/08/16 15:10	09/08/16 17:10

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Cations							
Total Hardness	240	3.0	mg/L	SM 2340B/EPA 2(	09/14/16 19:05	kya	
Calcium	58	1.0	mg/L	EPA 200.7	09/14/16 19:05	kya	
Magnesium	22	1.0	mg/L	EPA 200.7	09/14/16 19:05	kya	
Sodium	69	1.0	mg/L	EPA 200.7	09/14/16 19:05	kya	
Sodium Percentage	38	0.10	%	EPA 200.7	09/14/16 19:05	kya	
Potassium	3.4	1.0	mg/L	EPA 200.7	09/14/16 19:05	kya	
Total Cations	7.8	0.05	me/L	Calculation			
Sodium Adsorption Ratio	3.6	0.20	N/A	EPA 200.7	09/14/16 19:05	kya	
Adjusted Sodium Adsorption Ratio	2.0	0.20	N/A	EPA 200.7	09/14/16 19:05	kya	
Anions							
Total Alkalinity	100	3.0	mg/L	SM 2320B	09/14/16 18:10	nc	
Hydroxide	ND	3.0	mg/L	SM 2320B	09/14/16 18:10	nc	
Carbonate	ND	3.0	mg/L	SM 2320B	09/14/16 18:10	nc	
Bicarbonate	120	3.0	mg/L	SM 2320B	09/14/16 18:10	nc	
Chloride	100	1.0	mg/L	EPA 300.0	09/09/16 01:29	dcb	
Sulfate	110	0.50	mg/L	EPA 300.0	09/09/16 01:29	dcb	
Nitrate as N	4.1	0.20	mg/L	EPA 300.0	09/09/16 01:29	dcb	
Fluoride	1.0	0.1	mg/L	SM 4500F C	09/15/16 18:55	jdw	
Nitrate	18	1.0	mg/L	EPA 300.0	09/09/16 01:29	dcb	
Total Anions	7.45	0.05	me/L	Calculation			
Aggregate Properties							
pH	7.8	1.0	pH Units	SM 4500H+ B	09/09/16 11:35	jdw	
Specific Conductance	800	1.0	umhos/cm	SM 2510 B	09/09/16 11:35	jdw	
Aggressive Index	12.0	1.0	N/A	Calculation			
Langlier Index @ 25 C	0.17		N/A	SM 2330 B	09/13/16 10:44		

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 19-Sep-2016

Project Name: Dudek - Lucerne Valley

Project Number: Dudek - Lucerne Valley

Work Order Number: B6I0709

Received on Ice (Y/N): Yes Temp: 11 °C

Laboratory Reference Number

B6I0709-01

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-19	Water	09/08/16 15:10	09/08/16 17:10

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Solids							
Total Dissolved Solids	510	20	mg/L	SM 2540C	09/14/16 12:45	aza	
General Physical							
Color	ND	3.0	Color Units	SM 2120B	09/08/16 22:25	nc	
Odor	ND	1.0	T.O.N.*	SM 2150	09/08/16 22:25	nc	
Turbidity	0.98	0.10	NTU	SM 2130 B	09/08/16 22:25	nc	
Surfactants							
MBAS	ND	0.08	mg/L	SM 5540C	09/08/16 18:40	krv	
General Inorganics							
Cyanide	ND	100	ug/L	SM 4500CN E	09/09/16 18:07	sll	
Perchlorate	ND	4.0	ug/L	EPA 314.0	09/14/16 16:49	ara	
Nutrients							
Nitrite as N	ND	0.10	mg/L	SM 4500NO2 B	09/08/16 22:05	nc	

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 19-Sep-2016

Project Name: Dudek - Lucerne Valley
Project Number: Dudek - Lucerne Valley

Work Order Number: B6I0709

Received on Ice (Y/N): Yes Temp: 11 °C

Laboratory Reference Number
B6I0709-02

Sample Description	Matrix	Sampled Date/Time	Received Date/Time
OM-19 (Dissolved)	Water	09/08/16 15:10	09/08/16 17:10

Analyte(s)	Result	RDL	Units	Method	Analysis Date	Analyst	Flag
Metals and Metalloids							
Aluminum	ND	50	ug/L	EPA 200.7	09/14/16 19:08	kya	N_pFilt
Antimony	ND	6.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Arsenic	2.0	2.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Barium	44	20	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Beryllium	ND	1.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Boron	210	100	ug/L	EPA 200.7	09/14/16 19:08	kya	N_pFilt
Cadmium	ND	1.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Total Chromium	ND	1.0	ug/L	EPA 200.8	09/15/16 16:40	AP	N_pFilt
Copper	ND	50	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Iron	ND	100	ug/L	EPA 200.7	09/14/16 19:08	kya	N_pFilt
Lead	ND	5.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Manganese	28	20	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Mercury	ND	1.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Nickel	ND	10	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Selenium	ND	5.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Silver	ND	10	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Thallium	ND	1.0	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt
Zinc	ND	50	ug/L	EPA 200.8	09/13/16 14:11	mel	N_pFilt

* NELAP does not offer accreditation for this analyte/method/matrix combination

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Client Name:	Dudek & Associates	Analytical Report:	Page 5 of 5
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	19-Sep-2016	**Work Order Number:**	**B6I0709**

Received on Ice (Y/N): Yes Temp: 11 °C

Notes and Definitions

pH: Regulatory 15 minute holding time exceeded B6I0709-01

N_pFilt Sample filtered and preserved upon receipt to the laboratory.

ND: Analyte NOT DETECTED at or above the Method Detection Limit **(if MDL is reported)**, otherwise at or above the Reportable Detection Limit (RDL)

NR: Not Reported

RDL: Reportable Detection Limit

MDL: Method Detection Limit

* / ''' : NELAP does not offer accreditation for this analyte/method/matrix combination

Approval

Enclosed are the analytical results for the submitted sample(s). Babcock Laboratories certify the data presented as part of this report meet the minimum quality standards in the referenced analytical methods. Any exceptions have been noted. Babcock Laboratories and its officers and employees assume no responsibility and make no warranty, express or implied, for uses or interpretations made by any recipients, intended or unintended, of this report.

Nancy H. Boulineau For Cindy A. Waddell

cc:

e-Short_No Alias.rpt

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Client Name: Dudek & Associates
Contact: Partrick Rentz
Address: 605 Third Street
Encinitas, CA 92024

Report Date: 19-Sep-2016

Analytical Report: Page 1 of 3
Project Name: Dudek - Lucerne Valley
Project Number: Dudek - Lucerne Valley

Work Order Number: B6I0709

Received on Ice (Y/N): Yes Temp: 11 °C

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6100 Quail Valley Court Riverside, CA 92507
(951) 653-3351 • FAX (951) 653-1662
www.babcocklabs.com

Chain of Custody & Sample Information Record

Client: Dudek
Contact: prentz@dudek.com Fax No.
Phone No. 9191
email: Patrick Rentz
Project Name: Lucerne Valley
Turn Around Time: Routine *72 Hour Rush *48 Hour Rush *24 Hour Rush
Project Location: Ord Mtn OM-19
*Lab TAT Approval: By: *Additional Charges Apply

Additional Reporting Requests
Include QC Data Package: ☐ Yes ☐ No
FAX Results: ☐ Yes ☐ No
Email Results: ☐ Yes ☐ No
State EDT: ☐ Yes ☐ No
(Include Source Number in Notes)

Sampler Information
Name: Patrick Rentz
Employer: Dudek
Signature: [signature]

Sample ID	Date	Time	Unpreserved 2G + 500	H_2SO_4	HCl	HNO_3	$Na_2S_2O_3$	NaOH	NaOH/Zn Acetate	NH_4Cl	PDC	Perchlorate	Total # of Containers	Routine	Resample	Special	Analysis Requested	Matrix	Notes
OM-19	9/8/16	15:10	2			1		1				1	5						Please run sample for same analysis as previous Lucerne sample, OM-14
																	See Back for analysis SR		Same as drop down for OM-14

Matrix: DW = Drinking Water, WW = Waste Water, GW = Ground Water, S = Source, SG = Sludge, L = Liquid, M = Miscellaneous

Relinquished By (sign)	Print Name / Company	Date / Time	Received By (sign)	Print Name / Company
Patrick Rentz	Dudek	9/8/16 15:15	[signature]	R. CERVANTES / DRIVER EXPRESS
[signature]	R. CERVANTES / BCE	9/8/16 17:15	[signature]	[signature] / ESB

By signing on behalf of your organization and relinquishing this chain of custody you agree to abide by the Babcock Laboratories, Inc. *Terms and Conditions.*

(For Lab Use Only) Sample Integrity Upon Receipt/Acceptance Criteria

Sample(s) Submitted on Ice? Yes No
Custody Seal(s) Intact? Yes No NA
Sample(s) Intact? Yes No
Temperature: 11 °C ☐ Cooler Blank
Sample meets laboratory acceptance criteria? Yes No
Permission to continue: Yes No
Deviation/Notes:
Signature/Date:

Lab No. B6I0709 SR
Logged in By/Date: SEP 08 2016
Page ____ of ____

Rev. 6/16

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Client Name:	Dudek & Associates	Analytical Report:	Page 2 of 3
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	19-Sep-2016	**Work Order Number:**	**B6I0709**

Received on Ice (Y/N): Yes Temp: 11 °C

Project Information

Dudek & Associates
605 Third Street
Encinitas, CA 92024
Laboratory PM: **Cindy A. Waddell**

Phone:(800) 450-1818
Fax:(760) 632-0164

0283M
9/9/2016

Project Name:	Dudek - Lucerne Valley	**Invoice To:**	Dudek & Associates
Project Number:	Dudek - Lucerne Valley	**Invoice Bid:**	Dudek - Lucerne Valley
Client PM:	Partrick Rentz	**Invoice Manager:**	Partrick Rentz
Comments:			

Analysis	Comment
Courier Services-150	
Lang Index-at 25 C	
GP	
GMIO-DW	
B_ICP_DW	
Aggressive Index	
SAR-ICP_DW	
SAR adj-ICP_DW	
Na percentage-DW	
GMIO-DW subanalyses:	
K_ICP_DW	
HG_ ICPMS_DW	
Hardness Total-DW	
Fluoride	
FE_ICP_DW	
EC	
AG_ICPMS_DW	
CR_ICPMS_DW	
MG_ICP_DW	
Cl	
CD_ICPMS_DW	
CA_ICP_DW	
BE_ICPMS_DW	
AS_ICPMS_DW	
Alkalinity	
AL_ICP_DW	
Cyanide Total	
xNI_ICP_DW	
xMN_ICP_DW	
xCU_ICP_DW	
xBA_ICP_DW	
Total Cations-ICP_DW	
Total Anions	
TL_ICPMS_DW	
Solids-Total Diss	
SO4	

Page 1 of 2

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Client Name:	Dudek & Associates	Analytical Report:	Page 3 of 3
Contact:	Partrick Rentz	Project Name:	Dudek - Lucerne Valley
Address:	605 Third Street Encinitas, CA 92024	Project Number:	Dudek - Lucerne Valley
Report Date:	19-Sep-2016	**Work Order Number:**	**B6I0709**

Received on Ice (Y/N): Yes Temp: 11 °C

Project Information

Dudek & Associates
605 Third Street
Encinitas, CA 92024
Laboratory PM: **Cindy A. Waddell**

Phone:(800) 450-1818
Fax:(760) 632-0164

0283M
9/9/2016

Project Name:	Dudek - Lucerne Valley	**Invoice To:**	Dudek & Associates
Project Number:	Dudek - Lucerne Valley	**Invoice Bid:**	Dudek - Lucerne Valley
Client PM:	Partrick Rentz	**Invoice Manager:**	Partrick Rentz
Comments:			

Analysis	Comment
MBAS	
SB_ICPMS_DW	
Metals-Turbidity	
pH	
Perchlorate-Aqueous	
PB_ICPMS_DW	
NO3-N	
Nitrite-N	
NA_ICP_DW	
xZN_ICP_DW	
SE_ICPMS_DW	
GP subanalyses:	
Color	
Turbidity	
Odor	

Page 2 of 2

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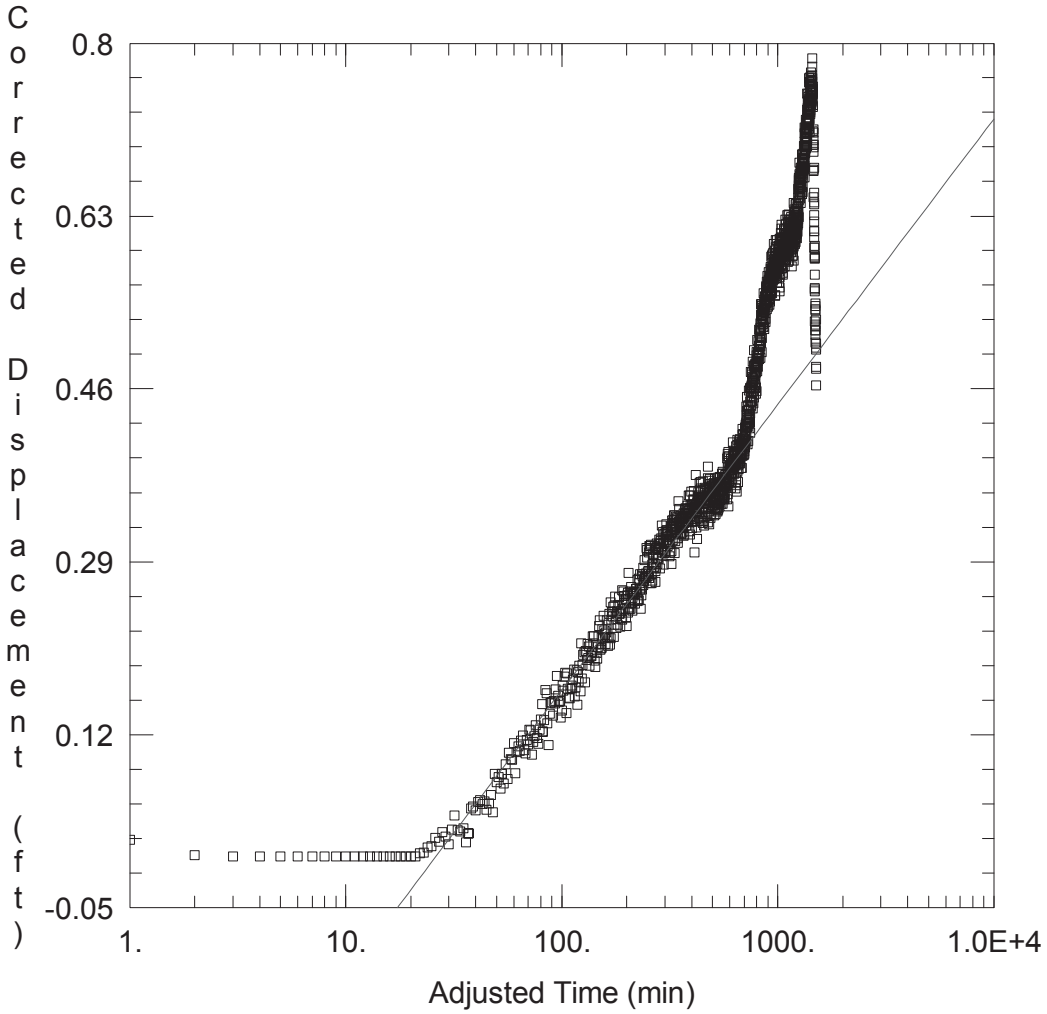
APPENDIX D

AQTSOLV Analysis



OM-14 CONSTANT RATE TEST

Data Set: P:\...\OM-14 pumping test.aqt
Date: 08/02/16 Time: 16:03:12

PROJECT INFORMATION

Company: Dudek
Project: 9191
Location: Ord Mountain
Test Well: OM-14
Test Date: 7/29/2016

AQUIFER DATA

Saturated Thickness: 115.8 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OM-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ OM-13	546	0

SOLUTION

Aquifer Model: Unconfined Solution Method: Cooper-Jacob

T = 3.113E+4 ft^2/day S = 0.00426

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Diagnostic Statistics

Estimation complete! RSS criterion (RTOL) reached.

Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	3.113E+4	173.8	+/- 341.4	179.1	ft^2/day
S	0.00426	3.676E-5	+/- 7.219E-5	115.9	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
Estimation window: 22 to 663 min

K = T/b = 268.9 ft/day (0.09485 cm/sec)
Ss = S/b = 3.679E-5 1/ft

Parameter Correlations

	T	S
T	1.00	-0.87
S	-0.87	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . 0.1145 ft^2
Variance . . . . . 0.0001778 ft^2
Std. Deviation . . . . 0.01334 ft
Mean . . . . . 8.659E-10 ft
No. of Residuals . 646
No. of Estimates. . 2

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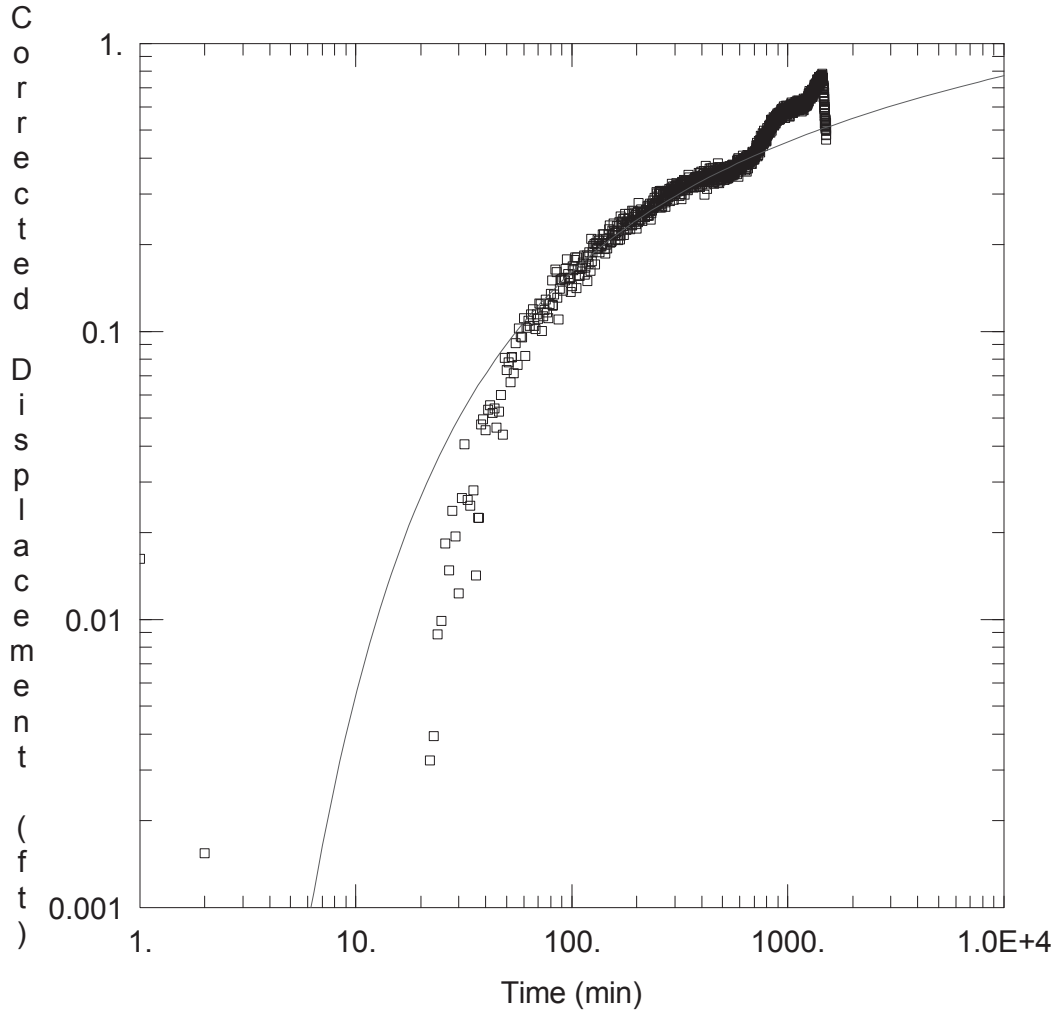

OM-14 CONSTANT RATE TEST

Data Set: P:\...\OM-14 pumping test.aqt
Date: 08/02/16 Time: 16:02:12

PROJECT INFORMATION

Company: Dudek
Project: 9191
Location: Ord Mountain
Test Well: OM-14
Test Date: 7/29/2016

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OM-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ OM-13	546	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 2.74E+4 ft^2/day
S = 0.005513
Kz/Kr = 1.
b = 115.8 ft

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Diagnostic Statistics

Estimation complete! RSS criterion (RTOL) reached.

Aquifer Model: Unconfined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	2.74E+4	264.5	+/- 519.5	103.6	ft^2/day
S	0.005513	7.653E-5	+/- 0.0001503	72.04	
Kz/Kr	1.	not estimated			
b	115.8	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
Estimation window: 22 to 663 min

K = T/b = 236.6 ft/day (0.08348 cm/sec)
Ss = S/b = 4.761E-5 1/ft

Parameter Correlations

	T	S
T	1.00	-0.94
S	-0.94	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . 0.1562 ft^2
Variance . . . . . 0.0002425 ft^2
Std. Deviation . . . . 0.01557 ft
Mean . . . . . -0.0005864 ft
No. of Residuals . 646
No. of Estimates. . 2

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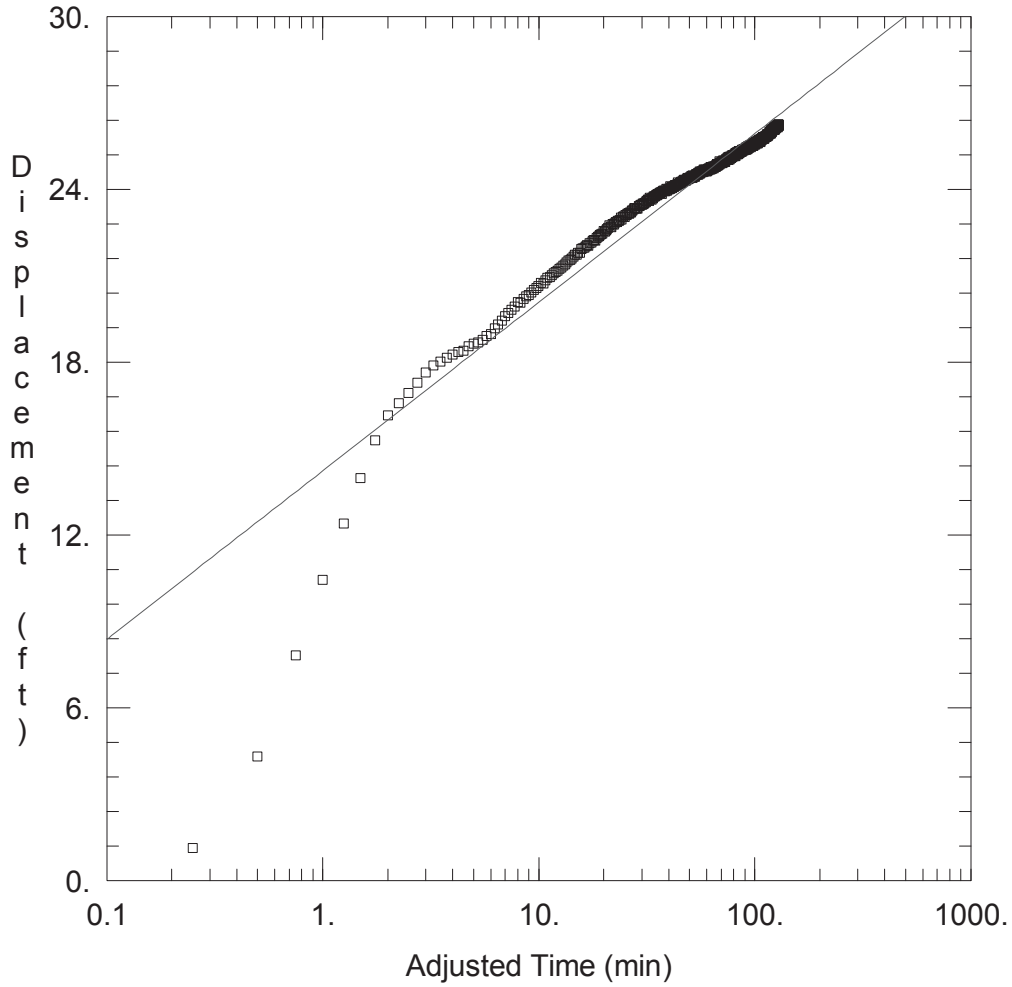

WELL TEST ANALYSIS

Data Set:
Date: 09/15/16 Time: 10:18:18

PROJECT INFORMATION

Company: Dudek
Project: 9191
Location: Ord Mountain
Test Well: OM-19
Test Date: 9/8/2016

AQUIFER DATA

Saturated Thickness: 135. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OM-19	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ OM-19	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 855.8 ft^2/day S = 0.003921

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Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Confined
Solution Method: Cooper-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	855.8	11.47	+/- 22.53	74.61	ft^2/day
S	0.003921	0.0004461	+/- 0.0008761	8.79	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 6.339 ft/day (0.002236 cm/sec)
Ss = S/b = 2.904E-5 1/ft

Parameter Correlations

	T	S
T	1.00	-0.99
S	-0.99	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . 291.7 ft^2
Variance . . . . . 0.563 ft^2
Std. Deviation . . . . 0.7504 ft
Mean . . . . . -2.571E-9 ft
No. of Residuals . 520
No. of Estimates. . 2

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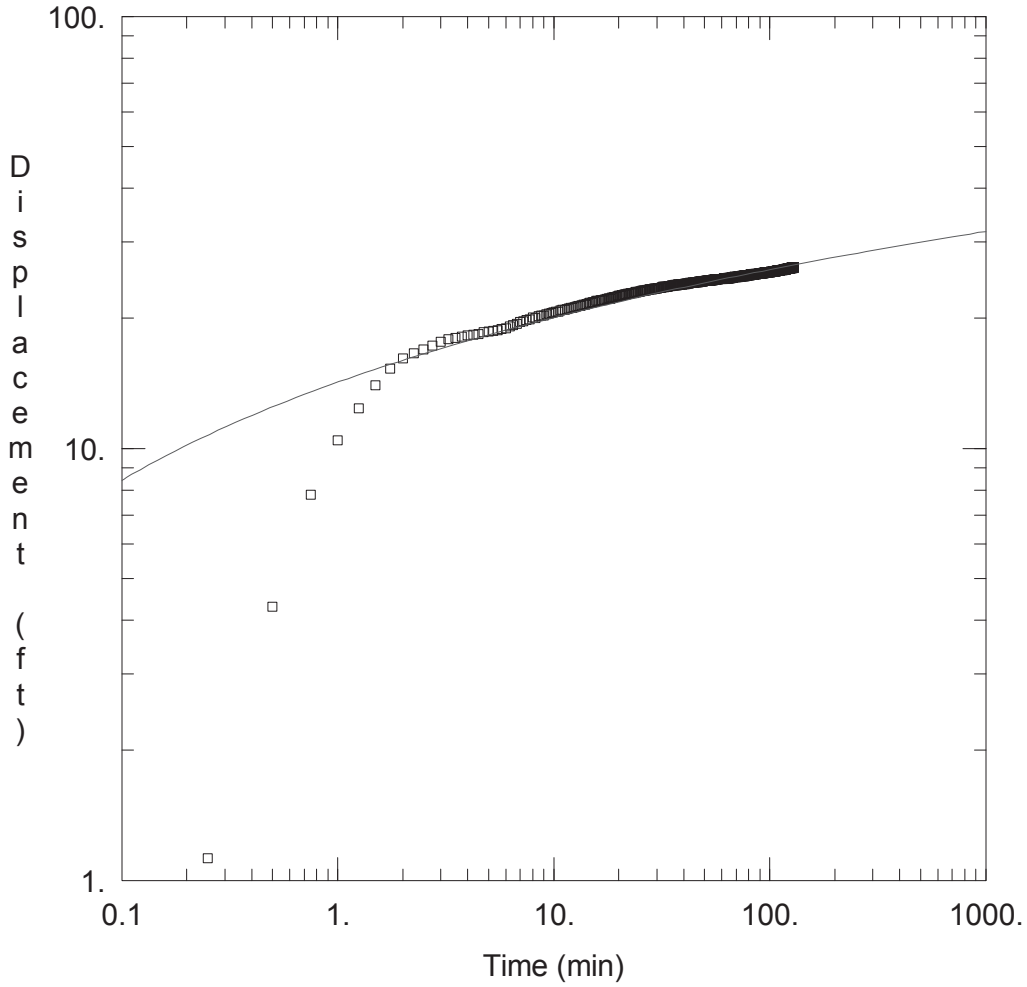

WELL TEST ANALYSIS

Data Set:
Date: 09/15/16 Time: 10:17:09

PROJECT INFORMATION

Company: Dudek
Project: 9191
Location: Ord Mountain
Test Well: OM-19
Test Date: 9/8/2016

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
OM-19	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ OM-19	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 856.5 ft^2/day
S = 0.003894
Kz/Kr = 1.
b = 135. ft

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Diagnostic Statistics

Estimation complete! RSS criterion (RTOL) reached.

Aquifer Model: Confined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	856.5	11.54	+/- 22.66	74.25	ft^2/day
S	0.003894	0.0004456	+/- 0.0008752	8.738	
Kz/Kr	1.	not estimated			
b	135.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 6.344 ft/day (0.002238 cm/sec)
Ss = S/b = 2.884E-5 1/ft

Parameter Correlations

	T	S
T	1.00	-0.99
S	-0.99	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . 292.3 ft^2
Variance . . . . . 0.5643 ft^2
Std. Deviation . . . . 0.7512 ft
Mean . . . . . -0.0002526 ft
No. of Residuals . 520
No. of Estimates. . 2

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