Preliminary Hydrology and Hydraulics Study for

PVL Lime Plant

Panamint Valley Limestone, Inc.

The purpose of this report is to estimate the hydrologic and hydraulic impacts from construction of a chemical manufacturing facility at APN 0485-031-12 in the unincorporated community of Trona, San Bernardino County, California.

San Bernardino County Application No. P201800138

By:

AECOM
5001 E. Commercenter Drive, Suite 100
Bakersfield, California 93309

Project No. 60579711

June 20, 2018

Daniel S. Cronquist, P.E.

Table of Contents

Acronyms & Abbreviations

AMC	Antecedent Moisture Condition
ACE	Argus Cogeneration Expansion
APN	Assessor's Parcel Number
cfs	cubic feet per second
FEMA	Federal Emergency Management Agency
HEC-RAS	Hydrologic Engineering Center's River Analysis System
F_p	Infiltration Rate for Pervious Areas
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PVL	Panamint Valley Limestone, Inc.
CN	Soil-Complex Curve Number
T_c	Time of Concentration
USGS	United States Geological Survey

1.0 General

1.1 Introduction

Panamint Valley Limestone, Inc. (PVL) is applying for a Conditional Use Permit from the County of San Bernardino for a proposed chemical manufacturing facility referred to as "PVL lime plant". The facility is proposed to be located at Accessor's Parcel Number (APN) 0485-031-12, north of the former Argus Cogeneration Expansion (ACE) power plant in the unincorporated community of Trona, California. See **Figures 1** and **2** for project location.

The purpose of this study is to evaluate impacts from off-site drainage to the project site and conceptually size on-site drainage facilities in conformance with San Bernardino County requirements.

This study is not intended for use in determining impacts to wildlife habitat or delineation of areas of federal or state jurisdiction. Likewise, this study is not intended to revise Flood Insurance Rate Maps.

1.2 Project Description

The PVL lime plant will convert limestone rock to quick lime (calcium oxide) and hydrated lime (calcium hydroxide) products. The facility will operate 24 hours per day to produce approximately 120,000 tons per year of combined lime products.

Limestone will be delivered to a stockpile at the site by truck from the Panamint Valley limestone quarry owned by PVL. Mechanized equipment and conveyors will size and deliver the limestone from the stockpile into a natural gas-fired kiln which will discharge lime. The quick lime will then be conveyed to the tops of vertical silos which will discharge through the bottoms into delivery trucks. A variable portion of the lime will be conveyed to the hydration plant for conversion to hydrated lime which also will be siloed and then delivered by trucks to customers.

The PVL lime plant will occupy about thirty (30) acres of the 61.65 acre site. The facility will be located on top of the closed ACE boiler ash landfill. According to the property owner, the advantages offered by this site are a very favorable soil structure created by the solidified boiler ash which was deposited as wet slurry and a beneficial reuse of a highly disturbed site. The site, which is zoned as regional industrial (San Bernardino County zoning code IR), is adjacent to the Searles Valley Minerals chemical manufacturing complex and is consistent in appearance and process with current activities in the area. **Figure 3** provides a conceptual rendering for the proposed facility[1].

[1] Please note that this figure is based upon preliminary data and assumptions which are subject to change based upon final conditions from the County and state agencies.

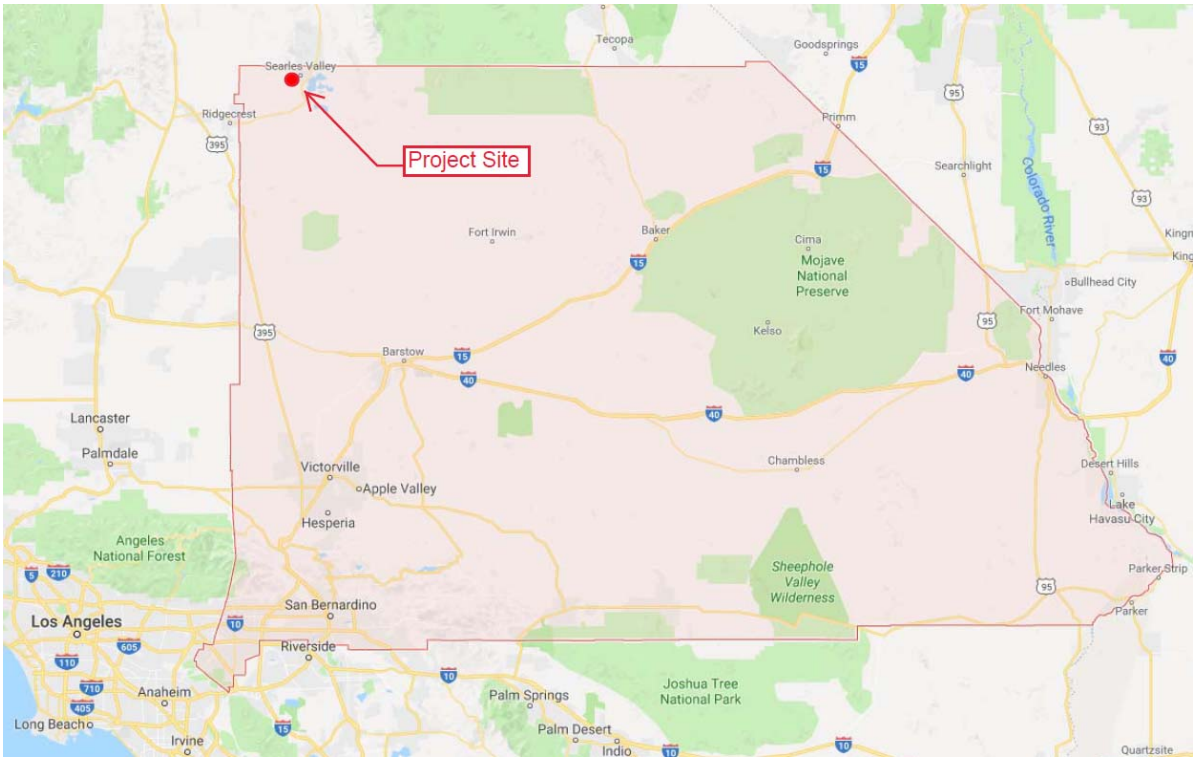


Figure 1 - Vicinity Map
Source: Google Maps

Figure 2 - Location Map
Source: Google Earth

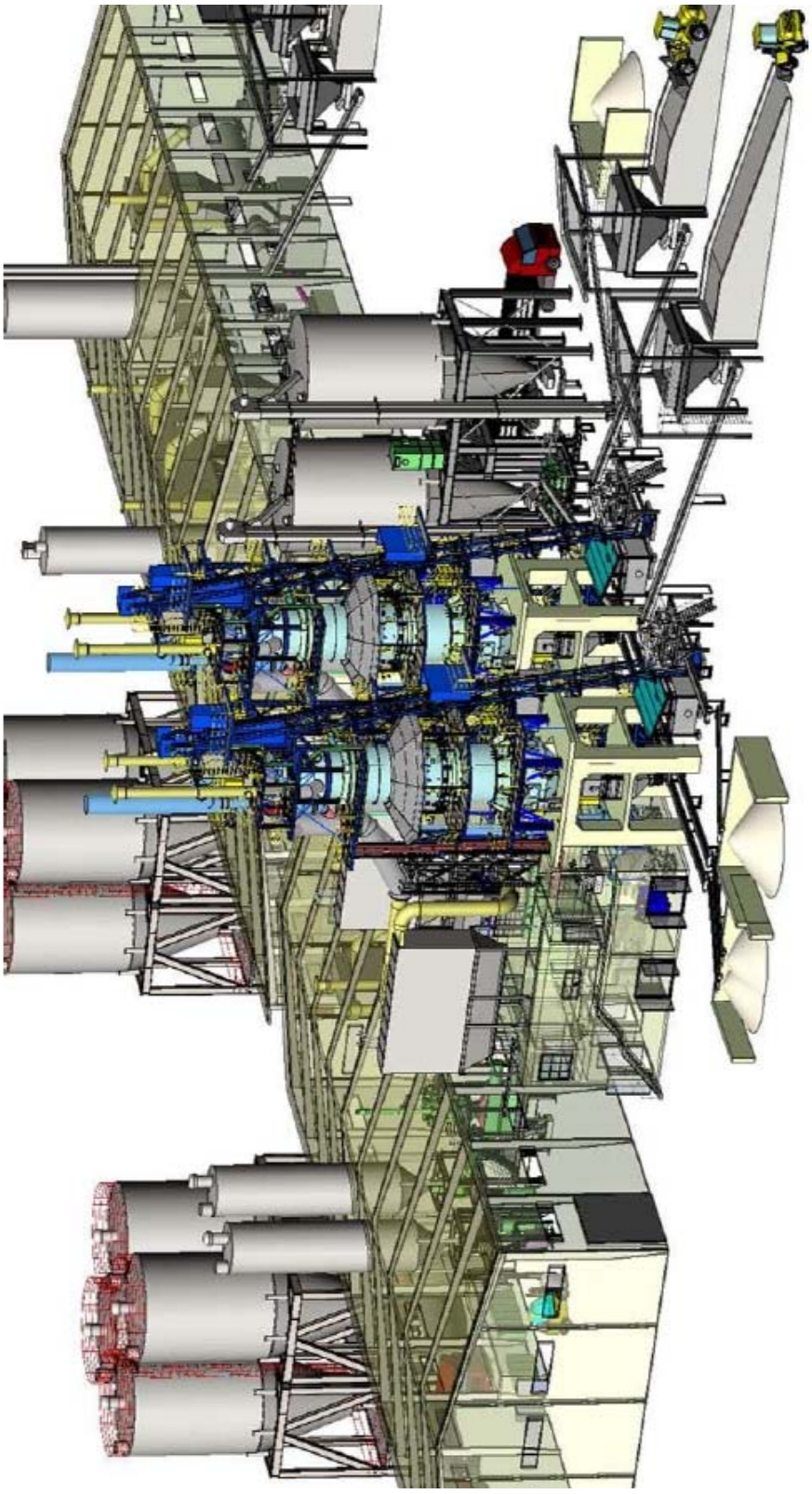


Figure 3 – Conceptual Artist's Rendering of PVL Lime Plant Facility
Source: PVL

1.3 Description of Watershed

1.3.1 Project Area Characteristics

The project site is located on the on the alluvial fan of Rockcrusher Channel[2], immediately upstream of Trona on the east side of the Argus Range. This ephemeral stream is tributary to approximately 11.7 square miles, which is normally dry. Flows occur during periods of precipitation that typically occur with high intensity and short duration (i.e. flash floods); see **Figure 4**.

Figure 4 – Flooding at Trona in the 1930's.
Source: www.trona-ca.com

According to research performed by the Water Resources Institute, the last major flood within Trona occurred in July 1965 with flows 6 feet deep. To prevent further floods, San Bernardino County Flood Control District constructed a levee that diverts flows north of the town to Searles Dry Lake. This levee is approximately 10 feet high and 16 feet wide at the top. A trapezoidal channel is located adjacent to the upstream side of the levee with a bottom width of approximately 45 feet and a depth of 5 feet. Based on discussions with the property owner's representative and cursory research, the community has not flooded since.

The project site is proposed to be located on top of the closed ACE boiler ash landfill. The finish elevation of this landfill is approximately 15 feet above the top of the levee. The area between the landfill and the downstream side of the levee were filled. Photographs of the project site and levee are included in **Appendix A**.

---

[2] Stream name appears on Flood Insurance Rate Map #06071C0075H prepared by FEMA. The stream is unnamed on USGS quadrangle maps.

Please note that the closed ACE boiler ash landfill is separate and distinct from the functioning boiler ash landfill located to the west of the project site, which is operated by Searles Valley Minerals.

1.3.2 Existing Vegetation

Vegetation present at the project site and surrounding area is an Allscale Shrubland Alliance (Sawyer, Keeler-Wolf and Evens 2009) dominated by allscale (*Atriplex polycarpa*), desert holly (*Atriplex hymenelytra*), and shadscale (*Atriplex confertifolia*). Cover is generally less than 50%.

1.3.3 FEMA Flood Zones

The Federal Emergency Management Agency (FEMA), through the National Flood Insurance Program, creates and maintains Flood Insurance Rate Maps. These maps show flood zones based upon the probability of flooding in any given year. Zone A represents an area that can be flooded by the 1% annual chance storm (100-year). Zone X represents an area with a 0.2% annual chance storm (500-year). Zone D represents areas of undetermined flood hazard.

Panel No. 06071C0075H includes the project site and that area northwest of Trona. The map indicates that a hydrologic study was performed for the levee, the boundary of which bisects the project site. The trapezoidal channel upstream of the levee is classified as Zone A, whereas the downstream side of the levee was classified as Zone X. The area outside the study limits is classified as Zone D, which means no analysis of flood hazards have been at this location (see **Figure 4**).

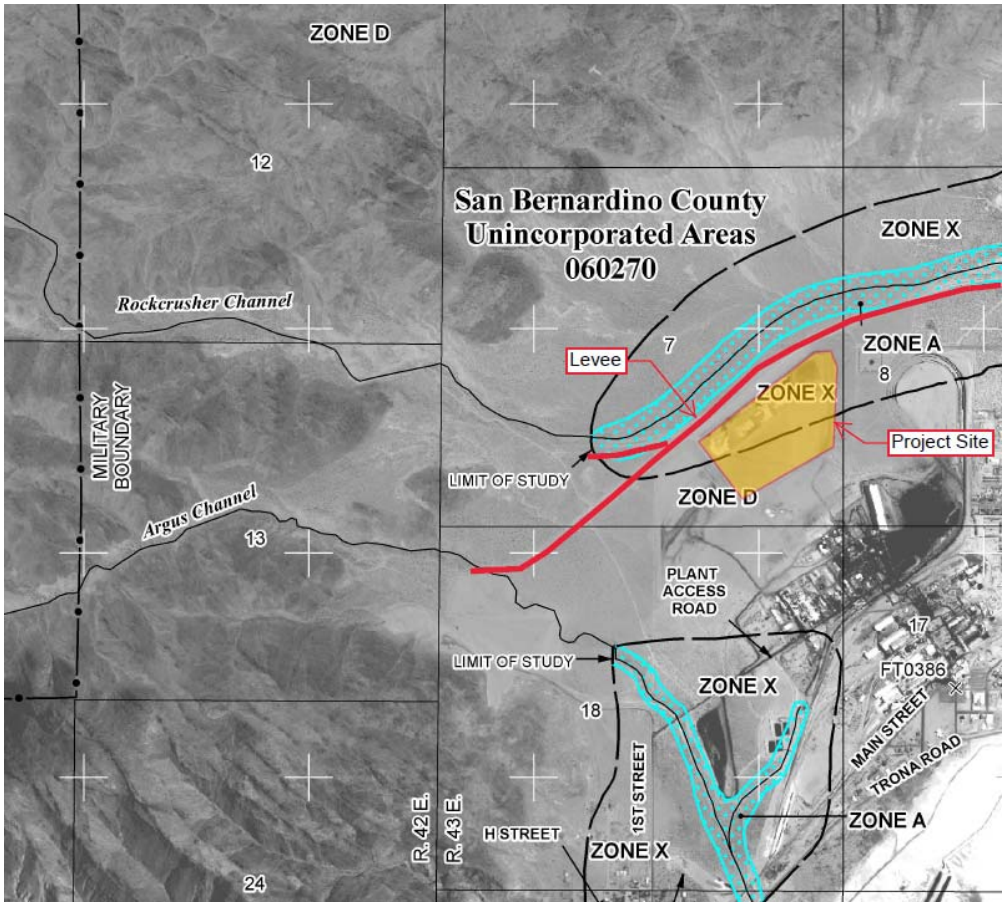


Figure 4 – FEMA Floodzones
Source: Flood Insurance Rate Map #06071C0075H

1.3.4 Soil Conditions

The Natural Resources Conservation Service (NRCS), a division of the U.S. Department of Agriculture (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx), does not have any data within the area surrounding Trona. The "Trona Sheet" of the *Geologic Map of California* states:

- Argus Range is comprised of Mesozoic granitic rocks that include granite, adamellite, granodiorite, tonalite, and diorite.
- The floor of the canyons upstream of the project site are Quaternary lake depsoits, which date to the Pliestocene.
- The project site itself and the town of Trona are on recent alluvium which is derived from the sources above.

The San Bernardino County Hydrology Manual (Manual) states that the soils at the project site are Hydrologic Soil Group "D", which is an indication of poor infiltration. See **Figure 5** for a map of hydrologic soil classifications.

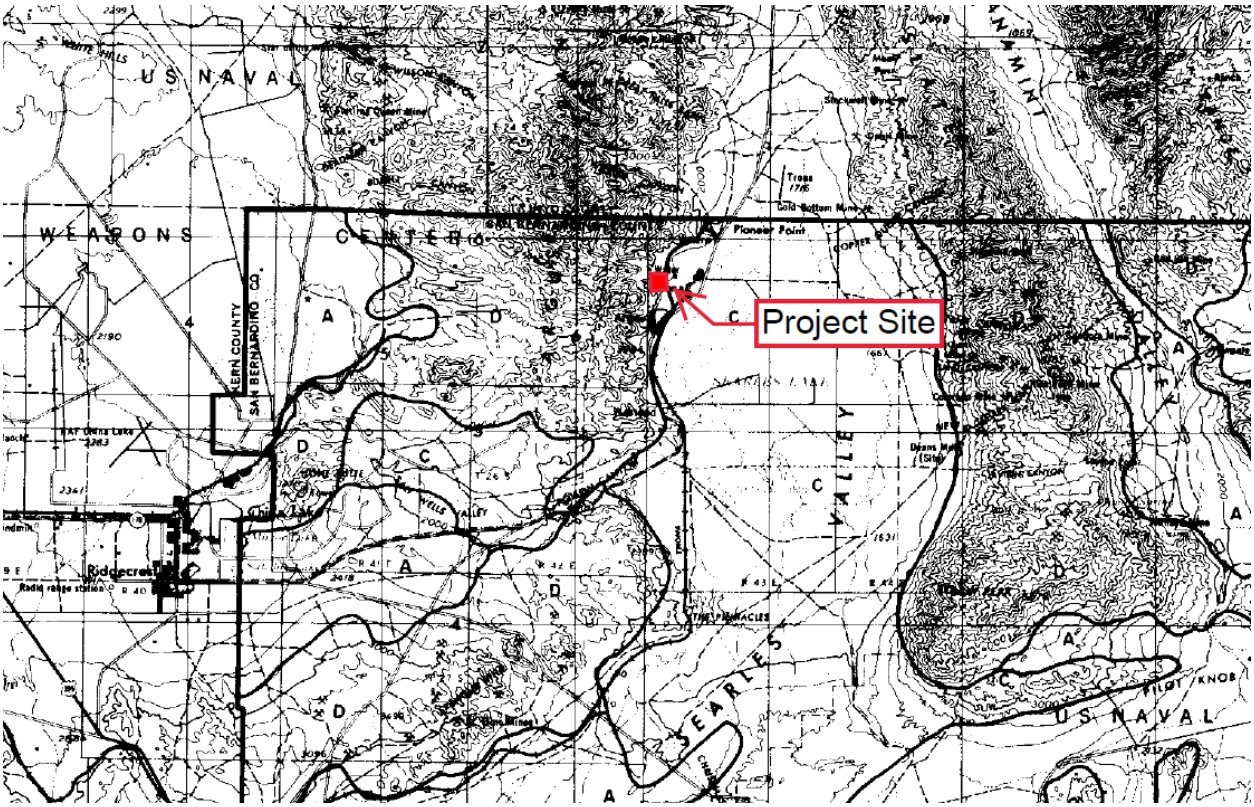


Figure 5 – Hydrologic Soils Map
Source: San Bernardino County Hydrology Manual

1.4 Study Methodology

Flows tributary to the site are estimated using the Manual, which is required for projects located in the unincorporated area of San Bernardino, California.

The tributary area of the watershed is greater than 1 square mile. Because of this, peak flow is estimated using the Unit Hydrograph Method as described in Section “E” of the Manual. The time of concentration used in the Unit Hydrograph was obtained using the Rational Method as described in Section “D” of the Manual. The calculations associated with both the Rational Method and Unit Hydrograph Method were performed using the software “CivilDesign” by Joseph Bonadiman.

Hydraulic calculations at the levee were performed using the U.S. Army Corps of Engineers, Hydrologic Engineering Center's River Analysis System (HEC-RAS).

2.0 Hydrology

This section provides the techniques and calculations used in estimating the 100-year peak flow for the tributary watershed. The watershed delineation is shown in **Figure 6**.

2.1 Rational Method

For watersheds with tributary area less than 1 square mile, the Rational Method is used to estimate peak flow. For watersheds with tributary area greater than 1 square mile, the Unit Hydrograph Method is used to estimate peak flow. The Unit Hydrograph Method uses time of concentration in the calculation of lag time, which is then used to calibrate a synthetic hydrograph. The Manual recommends using the Rational Method to estimate time of concentration. Rational Method calculations were performed using the software "CivilDesign" by Joseph Bonadiman.

Antecedent moisture condition (AMC) 3 was used in these calculations to simulate runoff from saturated soils.

2.1.1 Time of Concentration Calculation

To calculate time of concentration using the Rational Method, each watershed is divided into subareas and points of concentration. Downstream points of concentration are spaced so that travel time is limited to less than the following (Section D.11 of the Manual):

- Travel Time < 3 minutes for Time of Concentration < 30 minutes
- Travel Time < 5 minutes for Time of Concentration < 60 minutes
- Travel Time < 10 minutes for Time of Concentration $\geq$ 1 hour

2.1.2 Runoff Coefficient

Direct runoff from the watersheds is inversely proportional to the infiltration rate for pervious areas (Fp). The value Fp is based on the Soil-Complex Curve Number (CN), which is a function of both hydrologic soil group designation and vegetation. CN's are determined using Figures C-3 and C-6 from the Manual. Table 1 contains a summary of watershed data used. Photographs of vegetation types are included in **Appendix A**.

Table 1 – Infiltration Rate for Pervious Areas

Cover		Soil Group	CN
Type	Density		
Chaparral, Narrowleaf	<50%	D	91

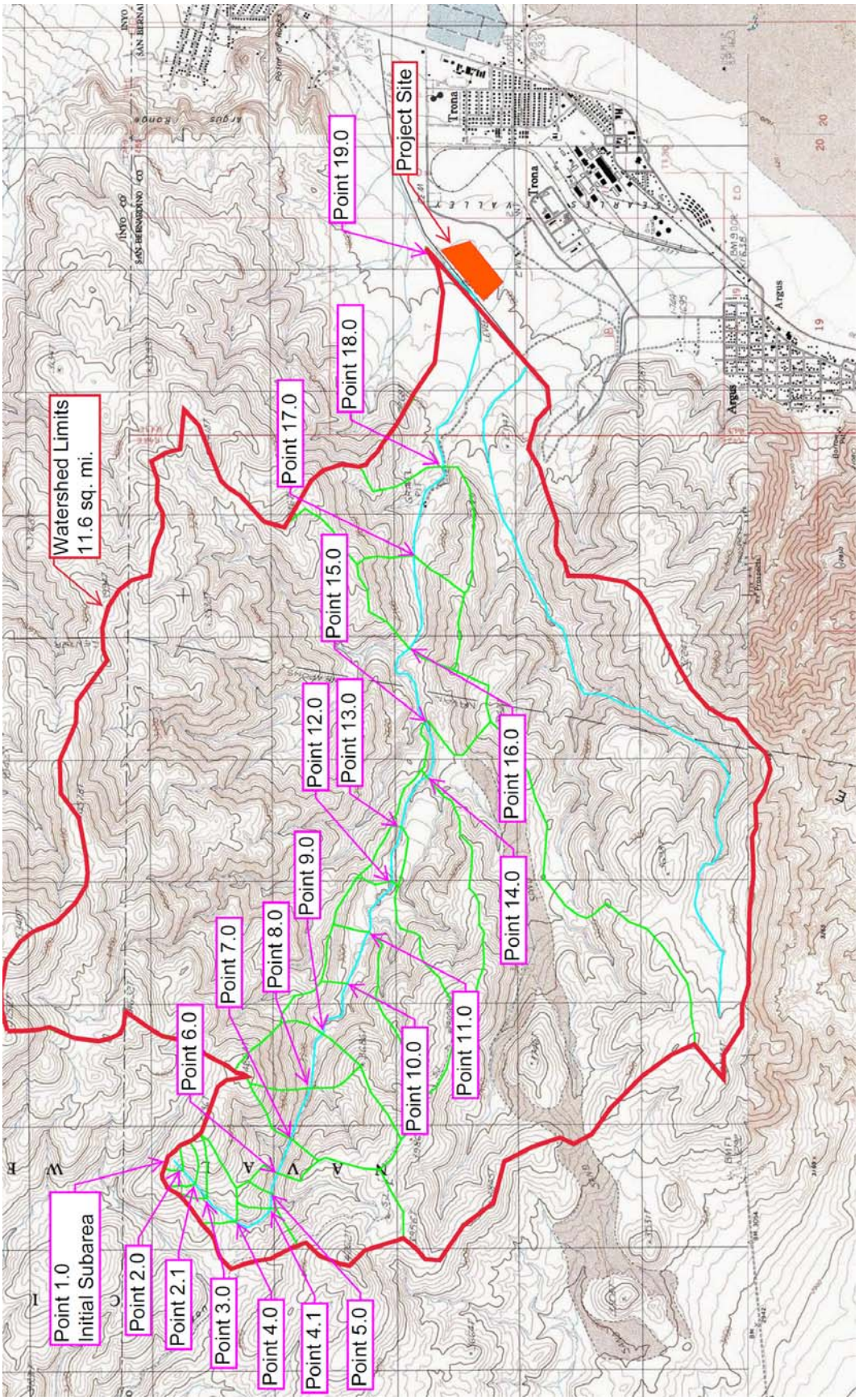


Figure 6 – Watershed Delineation Map

2.1.3 Rainfall Intensity

To calculate time of concentration using the Rational Method, rainfall intensity is estimated across the study area. Rainfall intensity is derived using National Oceanic and Atmospheric Administration (NOAA) Atlas 14 point precipitation frequency estimates. The precipitation data sheets from http://hdsc.nws.noaa.gov/hdsc/pfds/ are included in **Appendix B**. The 100-year intensity curve used in the Rational Method calculations is shown in **Table 2**.

Table 2 - Rainfall intensity data from NOAA Atlas 14 (100-year).

Duration (Minutes)	Depth (inches)	Intensity (in/hr)
5	0.23	2.71
30	0.54	1.08
60	0.74	0.74
180	1.19	0.40
360	1.59	0.27
1,440	2.80	0.12

2.1.4 Channel Velocity

A cross section was assumed for each section of channel based on data from USGS maps and field observations. **Figure 7** shows a typical cross section.

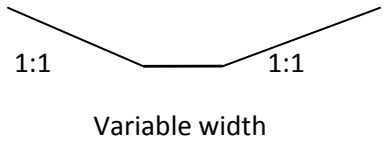


Figure 7 – Typical channel cross section used in velocity calculations.

2.1.5 Rational Method Analysis

Using the channel velocity data, rainfall intensity, and runoff coefficients, the time of concentration was estimated using the Rational Method per Section "D" of the Manual. Flow path length and elevations were determined using USGS quadrangle contour maps. Detailed calculations are provided in **Appendix B**. The results of the Rational Method analysis are shown in **Table 3**.

Table 3 – Estimated time of concentration for watersheds using the Rational Method.

Area (acres)	Flowpath (ft)	Change in Elevation (ft)	T_c (min)
7,465	31,800	2,360	75.44

2.2 Unit Hydrograph Calculation

Unit Hydrograph Method calculations were performed using the software "CivilDesign" by Joseph Bonadiman. Table 5 contains input data used with CivilDesign software. The peak flow is 3,794 cubic feet per second (cfs). A complete set of Unit Hydrograph results is provided in **Appendix C**.

3.0 Hydraulics

The hydraulic capacity of the existing levee was evaluated using the software HEC-RAS. Five (5) cross-sections spaced at 500 foot intervals were developed for the analysis based upon topographic survey data prepared by AECOM in 2014. The trapezoidal channel is unlined and includes rip rap, so a Manning's n-value of 0.05 was used. A steady flow analysis was performed using supercritical flow within the trapezoidal channel.

The results show that the 100-year flow rate (3,794 cfs) can be conveyed within the trapezoidal channel upstream of the levee. The hydraulic calculations do not indicate the levee would be overtopped or that the finish grade of the closed landfill would be inundated. See **Appendix D** for a complete set of HEC-RAS calculation results.

4.0 On-Site Retention Requirements

The property owner has stated that storm water runoff originating from the project site will be retained in basins and allowed to infiltrate into the ground. The following is a gross estimation of the amount of retention that could be required.

Runoff Volume = C x I x A

A = Area = 30 acres
C = Runoff Coefficient = 0.95
I = 100-year, 24-hour Rainfall Depth = 2.80 inches = 0.23 feet

Runoff Volume = 6.6 acre-feet

Assuming a water depth of 10-feet, a basin with this capacity would be 170 feet square (0.66 acres). Please note that to be a retention basin; it would need to be located on pervious soils that would allow the basin to completely drain within the time period required by the County. If such soil is not present on the site then a detention system would be required.

5.0 Conclusions

This section summarizes key conclusions based on the hydrologic and hydraulic analyses performed for the site and documented in this report.

a. The existing levee is sufficient to divert the 100-year, 24-hour flow from Rockcrusher Channel north of the project site. As a result that portion of the project classified as Zone "D" is unlikely to experience a flood hazard.
b. The USGS 7.5 minute Quadrangle map titled "Trona West, CA" includes a blue line stream bisecting the project site (under the ash landfill). It appears that this stream represents the original location of Rockcrusher Channel before the levee was constructed. Because the levee has diverted flow from the stream and the ash landfill has obliterated the original swale, it appears that the stream at this location no longer exists.

c. Runoff originating within the project site can be retained in basins, provided that soil with sufficient infiltration rates can be located. Alternatively, flow can be detained on-site and then discharged in conformance with San Bernardino County requirements.

5.0 References

AECOM. 2015. “Topographic Map of Ash Landfill” [map].

Blakeslee, Kevin. 2010. “Addendum to County of San Bernardino Hydrology Manual”.

Federal Emergency Management Agency. “Flood Insurance Rate Map #06071C0075H” [map]. 2008.

Hromadka II, T.V. 1986. “County of San Bernardino Hydrology Manual”.

Jennings, Charles, John Burnett, and Bennie Troxel. 1962. “Trona Sheet” [map]. Geologic Map of California. State of California, Department of Conservation.

Natural Resources Conservation Service. “Web Soil Survey”. Accessed June 13, 2018. Available at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

National Weather Service, National Oceanic and Atmospheric Administration. “Precipitation Frequency Data Server (PFDS).” Accessed on June 13, 2018. Available at: http://hdsc.nws.noaa.gov/hdsc/pfds/.

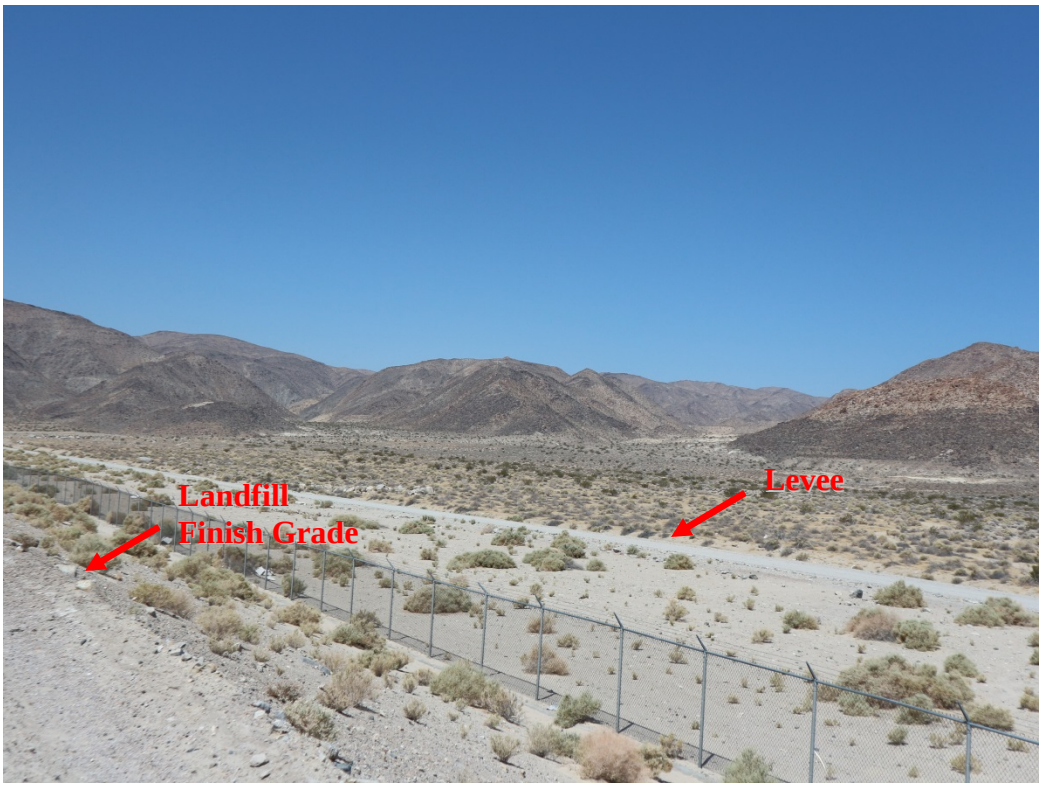
U.S. Geological Survey. “Trona West, CA” [map]. Photorevised 2012. 1:24,000. 7.5 Minute Series. Reston, VA: United States Department of the Interior, USGS, 2015.

Water Resources Institute at California State University and Alluvial Fan Task Force (AFTF). 2010. “AFTF Study Area Flood History.” July.

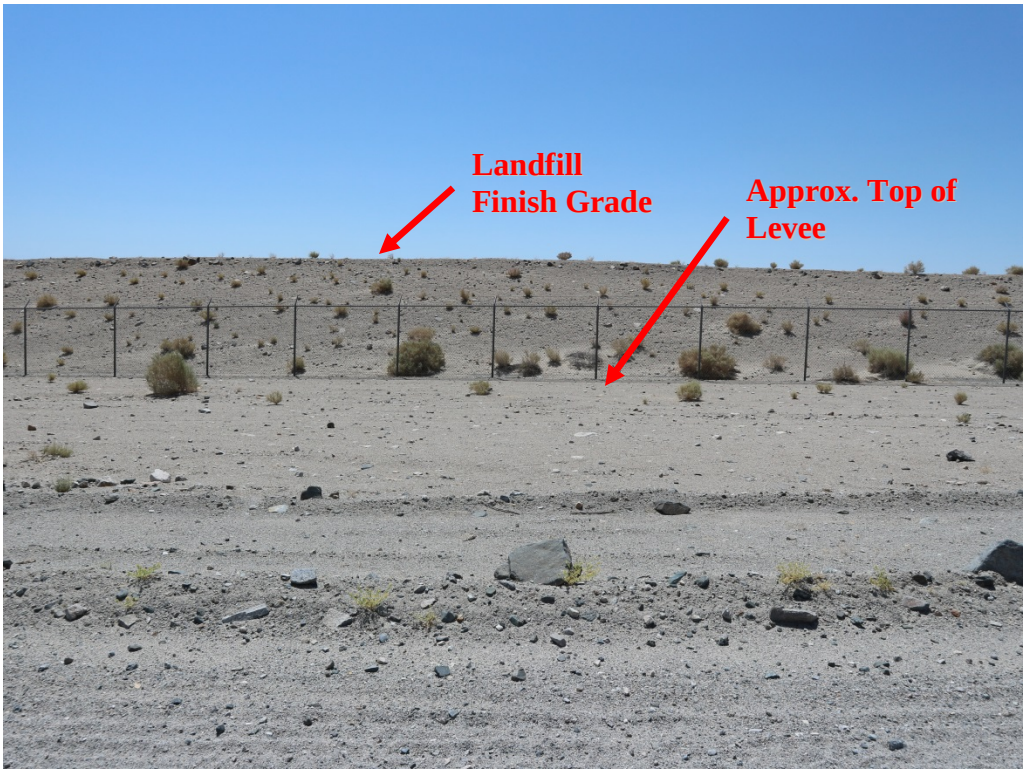
Appendix A
Photographs

Pictures were taken on June 8, 2018.

Photograph 1. Looking up Rockcrusher Channel from the northwest corner of the project site.



Photograph 2. Facing Rockcrusher Channel from the northeast corner of the project site.



Photograph 3. Facing the project site at the same elevation at the adjacent levee.

Photograph 4. Top of existing landfill facing the former ACE facilities and Searles Valley Minerals.

Appendix B
Rational Method Calculations

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 (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)

NOAA Atlas 14, Volume 6, Version 2 TRONA
Station ID: 04-9035
Location name: Trona, California, USA*
Latitude: 35.7636°, Longitude: -117.3908°
Elevation:
Elevation (station metadata): 1695 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.061** (0.049–0.076)	**0.084** (0.068–0.105)	**0.115** (0.092–0.143)	**0.139** (0.112–0.176)	**0.173** (0.135–0.225)	**0.199** (0.152–0.264)	**0.226** (0.169–0.306)	**0.254** (0.185–0.352)	**0.291** (0.204–0.420)	**0.321** (0.218–0.477)
10-min	**0.087** (0.071–0.109)	**0.121** (0.098–0.151)	**0.164** (0.132–0.205)	**0.200** (0.160–0.252)	**0.248** (0.193–0.323)	**0.286** (0.218–0.378)	**0.324** (0.242–0.439)	**0.364** (0.265–0.505)	**0.418** (0.293–0.602)	**0.460** (0.312–0.684)
15-min	**0.106** (0.086–0.132)	**0.146** (0.118–0.182)	**0.199** (0.160–0.248)	**0.242** (0.194–0.305)	**0.300** (0.234–0.390)	**0.346** (0.264–0.458)	**0.392** (0.293–0.531)	**0.440** (0.320–0.611)	**0.505** (0.354–0.728)	**0.556** (0.378–0.827)
30-min	**0.146** (0.118–0.182)	**0.202** (0.163–0.252)	**0.274** (0.222–0.343)	**0.334** (0.268–0.421)	**0.415** (0.323–0.539)	**0.478** (0.365–0.633)	**0.542** (0.405–0.734)	**0.608** (0.443–0.844)	**0.698** (0.489–1.01)	**0.769** (0.522–1.14)
60-min	**0.200** (0.162–0.250)	**0.276** (0.224–0.345)	**0.376** (0.303–0.470)	**0.458** (0.367–0.577)	**0.569** (0.442–0.739)	**0.655** (0.500–0.867)	**0.742** (0.554–1.00)	**0.833** (0.606–1.16)	**0.957** (0.670–1.38)	**1.05** (0.715–1.57)
2-hr	**0.288** (0.233–0.359)	**0.386** (0.313–0.482)	**0.516** (0.417–0.646)	**0.623** (0.499–0.785)	**0.770** (0.599–1.00)	**0.884** (0.675–1.17)	**1.00** (0.748–1.36)	**1.12** (0.818–1.56)	**1.29** (0.905–1.86)	**1.42** (0.967–2.12)
3-hr	**0.350** (0.284–0.437)	**0.465** (0.377–0.581)	**0.618** (0.499–0.774)	**0.744** (0.596–0.938)	**0.918** (0.714–1.19)	**1.05** (0.803–1.39)	**1.19** (0.889–1.61)	**1.34** (0.972–1.85)	**1.53** (1.08–2.21)	**1.69** (1.15–2.52)
6-hr	**0.476** (0.386–0.593)	**0.630** (0.509–0.786)	**0.833** (0.672–1.04)	**1.00** (0.802–1.26)	**1.23** (0.956–1.60)	**1.41** (1.08–1.87)	**1.59** (1.19–2.15)	**1.78** (1.30–2.47)	**2.04** (1.43–2.95)	**2.25** (1.53–3.35)
12-hr	**0.617** (0.500–0.770)	**0.821** (0.664–1.02)	**1.09** (0.878–1.36)	**1.31** (1.05–1.65)	**1.60** (1.25–2.08)	**1.83** (1.40–2.42)	**2.06** (1.54–2.79)	**2.30** (1.68–3.20)	**2.63** (1.84–3.79)	**2.89** (1.96–4.29)
24-hr	**0.821** (0.729–0.945)	**1.11** (0.980–1.27)	**1.48** (1.30–1.70)	**1.77** (1.56–2.07)	**2.18** (1.85–2.62)	**2.49** (2.06–3.05)	**2.80** (2.27–3.52)	**3.11** (2.45–4.03)	**3.54** (2.68–4.78)	**3.87** (2.83–5.41)
2-day	**0.964** (0.855–1.11)	**1.33** (1.18–1.54)	**1.81** (1.60–2.09)	**2.18** (1.91–2.54)	**2.68** (2.27–3.23)	**3.06** (2.54–3.76)	**3.43** (2.78–4.32)	**3.80** (3.00–4.92)	**4.30** (3.25–5.80)	**4.68** (3.42–6.53)
3-day	**1.04** (0.927–1.20)	**1.47** (1.30–1.69)	**2.00** (1.77–2.31)	**2.43** (2.13–2.82)	**2.99** (2.53–3.59)	**3.40** (2.82–4.18)	**3.81** (3.09–4.80)	**4.22** (3.33–5.47)	**4.77** (3.61–6.44)	**5.18** (3.78–7.23)
4-day	**1.11** (0.983–1.27)	**1.56** (1.38–1.79)	**2.13** (1.88–2.46)	**2.59** (2.27–3.01)	**3.19** (2.70–3.84)	**3.64** (3.02–4.47)	**4.08** (3.31–5.14)	**4.53** (3.57–5.87)	**5.13** (3.88–6.92)	**5.57** (4.07–7.79)
7-day	**1.20** (1.06–1.37)	**1.65** (1.46–1.90)	**2.24** (1.98–2.59)	**2.73** (2.39–3.18)	**3.39** (2.88–4.08)	**3.91** (3.24–4.80)	**4.43** (3.59–5.58)	**4.97** (3.92–6.44)	**5.71** (4.32–7.71)	**6.29** (4.59–8.78)
10-day	**1.25** (1.11–1.43)	**1.70** (1.51–1.96)	**2.31** (2.04–2.67)	**2.82** (2.47–3.28)	**3.53** (2.99–4.25)	**4.10** (3.40–5.03)	**4.68** (3.80–5.90)	**5.31** (4.18–6.87)	**6.18** (4.67–8.34)	**6.88** (5.02–9.60)
20-day	**1.37** (1.21–1.57)	**1.87** (1.66–2.15)	**2.57** (2.27–2.96)	**3.17** (2.77–3.68)	**4.02** (3.41–4.84)	**4.72** (3.92–5.81)	**5.47** (4.43–6.89)	**6.28** (4.95–8.13)	**7.45** (5.63–10.1)	**8.41** (6.14–11.7)
30-day	**1.52** (1.35–1.75)	**2.11** (1.87–2.43)	**2.93** (2.59–3.39)	**3.65** (3.20–4.24)	**4.67** (3.96–5.62)	**5.52** (4.58–6.78)	**6.42** (5.20–8.08)	**7.41** (5.84–9.59)	**8.83** (6.68–11.9)	**10.0** (7.32–14.0)
45-day	**1.70** (1.51–1.96)	**2.43** (2.15–2.79)	**3.43** (3.03–3.96)	**4.30** (3.77–5.00)	**5.55** (4.70–6.67)	**6.57** (5.45–8.07)	**7.66** (6.21–9.65)	**8.86** (6.98–11.5)	**10.6** (8.00–14.3)	**12.0** (8.77–16.8)
60-day	**1.85** (1.64–2.12)	**2.69** (2.39–3.10)	**3.86** (3.41–4.45)	**4.86** (4.26–5.65)	**6.29** (5.34–7.57)	**7.46** (6.19–9.16)	**8.70** (7.05–11.0)	**10.1** (7.92–13.0)	**12.0** (9.07–16.2)	**13.6** (9.94–19.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

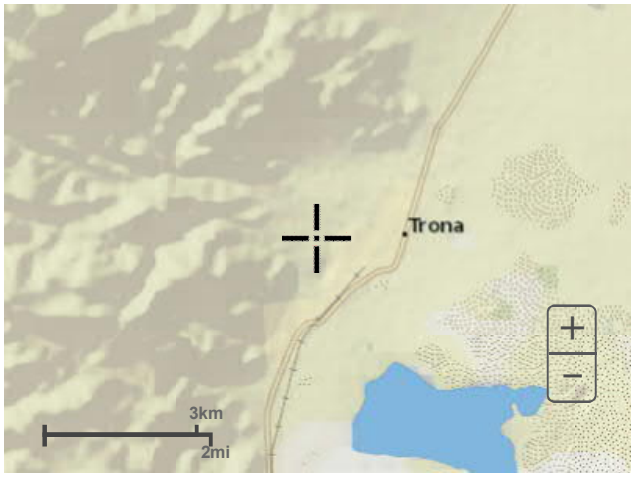
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

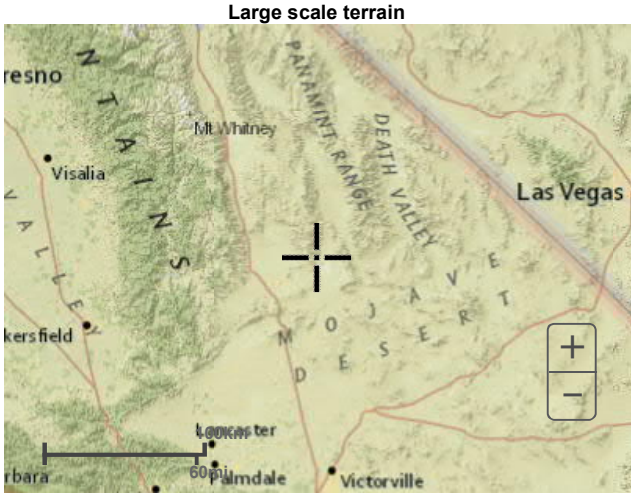
Back to Top

Maps & aerials

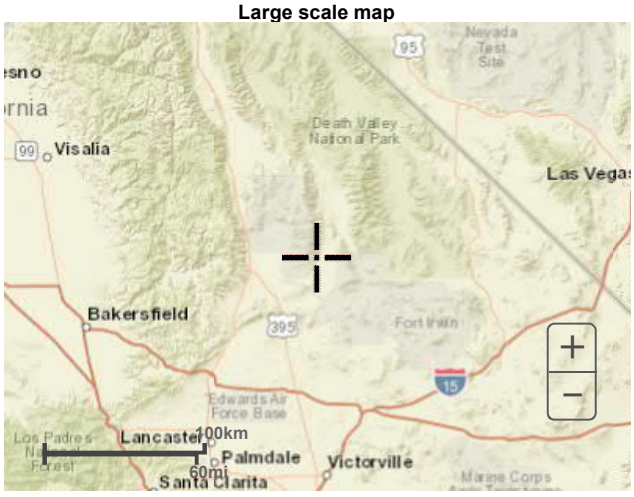
Small scale terrain



Large scale terrain



Large scale map



San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2018 Version 9.0
Rational Hydrology Study Date: 06/19/18

Program License Serial Number 6431

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

Rational hydrology study storm event year is 100.0
Computed rainfall intensity:
Storm year = 100.00 1 hour rainfall = 0.742 (In.)
Slope used for rainfall intensity curve b = 0.7000
Soil antecedent moisture condition (AMC) = 3

++
Process from Point/Station 1.000 to Point/Station 2.000
**** 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) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Initial subarea data:
Initial area flow distance = 500.000(Ft.)
Top (of initial area) elevation = 4120.000(Ft.)
Bottom (of initial area) elevation = 3950.000(Ft.)
Difference in elevation = 170.000(Ft.)
Slope = 0.34000 s(%)= 34.00
TC = k(0.465)*[(length^3)/(elevation change)]^0.2
Initial area time of concentration = 6.931 min.
Rainfall intensity = 3.362(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.890
Subarea runoff = 13.769(CFS)
Total initial stream area = 4.600(Ac.)
Pervious area fraction = 1.000
Initial area Fm value = 0.036(In/Hr)

++
Process from Point/Station 2.000 to Point/Station 2.100
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3950.000(Ft.)
Downstream point elevation = 3850.000(Ft.)
Channel length thru subarea = 500.000(Ft.)
Channel base width = 20.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 30.594(CFS)
Manning's 'N' = 0.110
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 30.594(CFS)
Depth of flow = 0.440(Ft.), Average velocity = 3.404(Ft/s)

Channel flow top width = 20.879(Ft.)
Flow Velocity = 3.40(Ft/s)
Travel time = 2.45 min.
Time of concentration = 9.38 min.
Critical depth = 0.414(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 2.720(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.888
Subarea runoff = 33.585(CFS) for 15.000(Ac.)
Total runoff = 47.355(CFS)
Effective area this stream = 19.60(Ac.)
Total Study Area (Main Stream No. 1) = 19.60(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 0.572(Ft.), Average velocity = 4.026(Ft/s)
Critical depth = 0.555(Ft.)

++
Process from Point/Station 2.100 to Point/Station 3.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3850.000(Ft.)
Downstream point elevation = 3760.000(Ft.)
Channel length thru subarea = 500.000(Ft.)
Channel base width = 20.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 59.732(CFS)
Manning's 'N' = 0.110
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 59.732(CFS)
Depth of flow = 0.679(Ft.), Average velocity = 4.257(Ft/s)
Channel flow top width = 21.357(Ft.)
Flow Velocity = 4.26(Ft/s)
Travel time = 1.96 min.
Time of concentration = 11.34 min.
Critical depth = 0.641(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 2.382(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.886
Subarea runoff = 24.658(CFS) for 14.500(Ac.)
Total runoff = 72.013(CFS)
Effective area this stream = 34.10(Ac.)
Total Study Area (Main Stream No. 1) = 34.10(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 0.759(Ft.), Average velocity = 4.569(Ft/s)
Critical depth = 0.727(Ft.)

++
Process from Point/Station 3.000 to Point/Station 4.000

**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3760.000(Ft.)
Downstream point elevation = 3600.000(Ft.)
Channel length thru subarea = 1000.000(Ft.)
Channel base width = 20.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 99.238(CFS)
Manning's 'N' = 0.090
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 99.238(CFS)
Depth of flow = 0.846(Ft.), Average velocity = 5.630(Ft/s)
Channel flow top width = 21.691(Ft.)
Flow Velocity = 5.63(Ft/s)
Travel time = 2.96 min.
Time of concentration = 14.30 min.
Critical depth = 0.906(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 2.025(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.884
Subarea runoff = 54.392(CFS) for 36.500(Ac.)
Total runoff = 126.405(CFS)
Effective area this stream = 70.60(Ac.)
Total Study Area (Main Stream No. 1) = 70.60(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 0.978(Ft.), Average velocity = 6.162(Ft/s)
Critical depth = 1.055(Ft.)

++
Process from Point/Station 4.000 to Point/Station 4.100
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3600.000(Ft.)
Downstream point elevation = 3580.000(Ft.)
Channel length thru subarea = 375.000(Ft.)
Channel base width = 50.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 132.187(CFS)
Manning's 'N' = 0.065
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 132.187(CFS)
Depth of flow = 0.661(Ft.), Average velocity = 3.945(Ft/s)
Channel flow top width = 51.323(Ft.)
Flow Velocity = 3.95(Ft/s)
Travel time = 1.58 min.
Time of concentration = 15.88 min.
Critical depth = 0.602(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 1.881(In/Hr) for a 100.0 year storm

Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.883
Subarea runoff = 11.472(CFS) for 12.400(Ac.)
Total runoff = 137.878(CFS)
Effective area this stream = 83.00(Ac.)
Total Study Area (Main Stream No. 1) = 83.00(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 0.678(Ft.), Average velocity = 4.011(Ft/s)
Critical depth = 0.617(Ft.)

++
Process from Point/Station 4.100 to Point/Station 5.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3580.000(Ft.)
Downstream point elevation = 3560.000(Ft.)
Channel length thru subarea = 575.000(Ft.)
Channel base width = 50.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 261.151(CFS)
Manning's 'N' = 0.050
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 261.151(CFS)
Depth of flow = 0.967(Ft.), Average velocity = 5.299(Ft/s)
Channel flow top width = 51.934(Ft.)
Flow Velocity = 5.30(Ft/s)
Travel time = 1.81 min.
Time of concentration = 17.69 min.
Critical depth = 0.938(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 1.745(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.882
Subarea runoff = 246.476(CFS) for 166.900(Ac.)
Total runoff = 384.354(CFS)
Effective area this stream = 249.90(Ac.)
Total Study Area (Main Stream No. 1) = 249.90(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 1.220(Ft.), Average velocity = 6.151(Ft/s)
Critical depth = 1.219(Ft.)

++
Process from Point/Station 5.000 to Point/Station 6.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3560.000(Ft.)
Downstream point elevation = 3440.000(Ft.)
Channel length thru subarea = 1000.000(Ft.)
Channel base width = 50.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 491.633(CFS)
Manning's 'N' = 0.100
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 491.633(CFS)

```
Depth of flow =   1.479(Ft.), Average velocity =   6.458(Ft/s)
Channel flow top width =   52.958(Ft.)
Flow Velocity =    6.46(Ft/s)
Travel time  =    2.58 min.
Time of concentration =   20.27 min.
Critical depth =      1.438(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      1.586(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.880
Subarea runoff =    214.487(CFS) for  179.300(Ac.)
Total runoff =    598.841(CFS)
Effective area this stream =      429.20(Ac.)
Total Study Area (Main Stream No. 1) =      429.20(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.665(Ft.), Average velocity =   6.961(Ft/s)
Critical depth =      1.625(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        6.000 to Point/Station        7.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  3440.000(Ft.)
Downstream point elevation =  3350.000(Ft.)
Channel length thru subarea  =  1000.000(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    645.324(CFS)
Manning's 'N'    = 0.095
Maximum depth of channel  =   50.000(Ft.)
Flow(q) thru subarea =    645.324(CFS)
Depth of flow =   1.841(Ft.), Average velocity =   6.760(Ft/s)
Channel flow top width =   53.683(Ft.)
Flow Velocity =    6.76(Ft/s)
Travel time  =    2.47 min.
Time of concentration =   22.74 min.
Critical depth =      1.719(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      1.464(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.878
Subarea runoff =     92.900(CFS) for  109.100(Ac.)
Total runoff =    691.741(CFS)
Effective area this stream =      538.30(Ac.)
Total Study Area (Main Stream No. 1) =      538.30(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.920(Ft.), Average velocity =   6.940(Ft/s)
Critical depth =      1.781(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
Process from Point/Station        7.000 to Point/Station        8.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  3350.000(Ft.)
Downstream point elevation =  3160.000(Ft.)
Channel length thru subarea  =  1500.000(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    746.842(CFS)
Manning's 'N'    = 0.088
Maximum depth of channel  =   50.000(Ft.)
Flow(q) thru subarea =    746.842(CFS)
Depth of flow =   1.733(Ft.), Average velocity =   8.333(Ft/s)
Channel flow top width =   53.465(Ft.)
Flow Velocity =    8.33(Ft/s)
Travel time  =    3.00 min.
Time of concentration =   25.74 min.
Critical depth =      1.875(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      1.342(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 =    110.118(CFS) for  143.800(Ac.)
Total runoff =    801.858(CFS)
Effective area this stream =      682.10(Ac.)
Total Study Area (Main Stream No. 1) =      682.10(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.808(Ft.), Average velocity =   8.560(Ft/s)
Critical depth =      1.969(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        8.000 to Point/Station        9.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  3160.000(Ft.)
Downstream point elevation =  3040.000(Ft.)
Channel length thru subarea  =  1500.000(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    822.534(CFS)
Manning's 'N'    = 0.073
Maximum depth of channel  =   50.000(Ft.)
Flow(q) thru subarea =    822.534(CFS)
Depth of flow =   1.884(Ft.), Average velocity =   8.414(Ft/s)
Channel flow top width =   53.768(Ft.)
Flow Velocity =    8.41(Ft/s)
Travel time  =    2.97 min.
Time of concentration =   28.71 min.
Critical depth =      2.000(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
```

```
Rainfall intensity =      1.243(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.874
Subarea runoff =     41.274(CFS) for   93.800(Ac.)
Total runoff =    843.132(CFS)
Effective area this stream =      775.90(Ac.)
Total Study Area (Main Stream No. 1) =      775.90(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.912(Ft.), Average velocity =   8.493(Ft/s)
Critical depth =      2.031(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        9.000 to Point/Station       10.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  3040.000(Ft.)
Downstream point elevation =  2940.000(Ft.)
Channel length thru subarea  =  1720.000(Ft.)
Channel base width      =   50.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    879.475(CFS)
Manning's 'N'    = 0.070
Maximum depth of channel  =   50.000(Ft.)
Flow(q) thru subarea =    879.475(CFS)
Depth of flow =   2.105(Ft.), Average velocity =   8.018(Ft/s)
Channel flow top width =   54.210(Ft.)
Flow Velocity =    8.02(Ft/s)
Travel time  =    3.58 min.
Time of concentration =   32.28 min.
Critical depth =      2.094(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      1.145(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.872
Subarea runoff =     72.596(CFS) for  141.300(Ac.)
Total runoff =    915.728(CFS)
Effective area this stream =      917.20(Ac.)
Total Study Area (Main Stream No. 1) =      917.20(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   2.157(Ft.), Average velocity =   8.140(Ft/s)
Critical depth =      2.156(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       10.000 to Point/Station       11.000
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  2940.000(Ft.)
Downstream point elevation =  2880.000(Ft.)
Channel length thru subarea  =  1720.000(Ft.)
Channel base width      =  100.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    915.777(CFS)
Manning's 'N'    = 0.060
Maximum depth of channel  =   50.000(Ft.)
```

```
Flow(q) thru subarea =    915.777(CFS)
Depth of flow =   1.509(Ft.), Average velocity =   5.978(Ft/s)
Channel flow top width =  103.018(Ft.)
Flow Velocity =    5.98(Ft/s)
Travel time  =    4.80 min.
Time of concentration =   37.08 min.
Critical depth =      1.375(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q =    873.823(CFS)
therefore the upstream flow rate of Q =    915.728(CFS) is being used
Rainfall intensity =      1.039(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 =      0.000(CFS) for   50.300(Ac.)
Total runoff =    915.728(CFS)
Effective area this stream =      967.50(Ac.)
Total Study Area (Main Stream No. 1) =      967.50(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.509(Ft.), Average velocity =   5.978(Ft/s)
Critical depth =      1.375(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       11.000 to Point/Station       12.000
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  2880.000(Ft.)
Downstream point elevation =  2790.000(Ft.)
Channel length thru subarea  =  1500.000(Ft.)
Channel base width      =  100.000(Ft.)
Slope or 'Z' of left channel bank =   1.000
Slope or 'Z' of right channel bank =   1.000
Estimated mean flow rate at midpoint of channel =    941.522(CFS)
Manning's 'N'    = 0.070
Maximum depth of channel  =   50.000(Ft.)
Flow(q) thru subarea =    941.522(CFS)
Depth of flow =   1.430(Ft.), Average velocity =   6.490(Ft/s)
Channel flow top width =  102.861(Ft.)
Flow Velocity =    6.49(Ft/s)
Travel time  =    3.85 min.
Time of concentration =   40.93 min.
Critical depth =      1.391(Ft.)
 Adding area flow to channel
Soil classification AP and SCS  values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2)  = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000     Max loss rate(Fm)=     0.036(In/Hr)
Rainfall intensity =      0.970(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.867
Subarea runoff =     51.521(CFS) for  183.100(Ac.)
Total runoff =    967.248(CFS)
Effective area this stream =     1150.60(Ac.)
Total Study Area (Main Stream No. 1) =     1150.60(Ac.)
Area averaged Fm value =    0.036(In/Hr)
Depth of flow =   1.454(Ft.), Average velocity =   6.559(Ft/s)
```

Critical depth = 1.422(Ft.)

++
Process from Point/Station 12.000 to Point/Station 13.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2790.000(Ft.)
Downstream point elevation = 2680.000(Ft.)
Channel length thru subarea = 1500.000(Ft.)
Channel base width = 100.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 967.294(CFS)
Manning's 'N' = 0.075
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 967.294(CFS)
Depth of flow = 1.427(Ft.), Average velocity = 6.685(Ft/s)
Channel flow top width = 102.853(Ft.)
Flow Velocity = 6.69(Ft/s)
Travel time = 3.74 min.
Time of concentration = 44.67 min.
Critical depth = 1.422(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q = 929.322(CFS)
therefore the upstream flow rate of Q = 967.248(CFS) is being used
Rainfall intensity = 0.912(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.865
Subarea runoff = 0.000(CFS) for 27.500(Ac.)
Total runoff = 967.248(CFS)
Effective area this stream = 1178.10(Ac.)
Total Study Area (Main Stream No. 1) = 1178.10(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 1.427(Ft.), Average velocity = 6.685(Ft/s)
Critical depth = 1.422(Ft.)

++
Process from Point/Station 13.000 to Point/Station 14.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2680.000(Ft.)
Downstream point elevation = 2560.000(Ft.)
Channel length thru subarea = 1500.000(Ft.)
Channel base width = 100.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 1005.533(CFS)
Manning's 'N' = 0.080
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 1005.533(CFS)
Depth of flow = 1.479(Ft.), Average velocity = 6.701(Ft/s)
Channel flow top width = 102.958(Ft.)
Flow Velocity = 6.70(Ft/s)
Travel time = 3.73 min.
Time of concentration = 48.40 min.

Critical depth = 1.453(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 0.862(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.863
Subarea runoff = 76.509(CFS) for 224.800(Ac.)
Total runoff = 1043.758(CFS)
Effective area this stream = 1402.90(Ac.)
Total Study Area (Main Stream No. 1) = 1402.90(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 1.512(Ft.), Average velocity = 6.799(Ft/s)
Critical depth = 1.500(Ft.)

++
Process from Point/Station 14.000 to Point/Station 15.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2560.000(Ft.)
Downstream point elevation = 2360.000(Ft.)
Channel length thru subarea = 1500.000(Ft.)
Channel base width = 100.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 1436.975(CFS)
Manning's 'N' = 0.110
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 1436.975(CFS)
Depth of flow = 1.903(Ft.), Average velocity = 7.408(Ft/s)
Channel flow top width = 103.807(Ft.)
Flow Velocity = 7.41(Ft/s)
Travel time = 3.37 min.
Time of concentration = 51.77 min.
Critical depth = 1.844(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 0.823(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.861
Subarea runoff = 786.384(CFS) for 1181.200(Ac.)
Total runoff = 1830.142(CFS)
Effective area this stream = 2584.10(Ac.)
Total Study Area (Main Stream No. 1) = 2584.10(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 2.201(Ft.), Average velocity = 8.135(Ft/s)
Critical depth = 2.156(Ft.)

++
Process from Point/Station 15.000 to Point/Station 16.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2360.000(Ft.)
Downstream point elevation = 2240.000(Ft.)

Channel length thru subarea = 2523.000(Ft.)
Channel base width = 100.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 2672.715(CFS)
Manning's 'N' = 0.070
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 2672.715(CFS)
Depth of flow = 2.872(Ft.), Average velocity = 9.048(Ft/s)
Channel flow top width = 105.743(Ft.)
Flow Velocity = 9.05(Ft/s)
Travel time = 4.65 min.
Time of concentration = 56.42 min.
Critical depth = 2.781(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 0.775(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.858
Subarea runoff = 1685.081(CFS) for 2702.000(Ac.)
Total runoff = 3515.222(CFS)
Effective area this stream = 5286.10(Ac.)
Total Study Area (Main Stream No. 1) = 5286.10(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 3.386(Ft.), Average velocity = 10.042(Ft/s)
Critical depth = 3.344(Ft.)

++
Process from Point/Station 16.000 to Point/Station 17.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2240.000(Ft.)
Downstream point elevation = 2100.000(Ft.)
Channel length thru subarea = 2240.000(Ft.)
Channel base width = 150.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 3515.264(CFS)
Manning's 'N' = 0.080
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 3515.264(CFS)
Depth of flow = 2.646(Ft.), Average velocity = 8.702(Ft/s)
Channel flow top width = 155.293(Ft.)
Flow Velocity = 8.70(Ft/s)
Travel time = 4.29 min.
Time of concentration = 60.71 min.
Critical depth = 2.563(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q = 3411.335(CFS)
therefore the upstream flow rate of Q = 3515.222(CFS) is being used
Rainfall intensity = 0.736(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified

rational method)(Q=KCIA) is C = 0.856
Subarea runoff = 0.000(CFS) for 127.600(Ac.)
Total runoff = 3515.222(CFS)
Effective area this stream = 5413.70(Ac.)
Total Study Area (Main Stream No. 1) = 5413.70(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 2.646(Ft.), Average velocity = 8.702(Ft/s)
Critical depth = 2.563(Ft.)

++
Process from Point/Station 17.000 to Point/Station 18.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 2100.000(Ft.)
Downstream point elevation = 1980.000(Ft.)
Channel length thru subarea = 2500.000(Ft.)
Channel base width = 150.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 3515.258(CFS)
Manning's 'N' = 0.080
Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 3515.258(CFS)
Depth of flow = 2.865(Ft.), Average velocity = 8.027(Ft/s)
Channel flow top width = 155.730(Ft.)
Flow Velocity = 8.03(Ft/s)
Travel time = 5.19 min.
Time of concentration = 65.90 min.
Critical depth = 2.563(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
The area added to the existing stream causes a
a lower flow rate of Q = 3346.286(CFS)
therefore the upstream flow rate of Q = 3515.222(CFS) is being used
Rainfall intensity = 0.695(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified
rational method)(Q=KCIA) is C = 0.854
Subarea runoff = 0.000(CFS) for 227.700(Ac.)
Total runoff = 3515.222(CFS)
Effective area this stream = 5641.40(Ac.)
Total Study Area (Main Stream No. 1) = 5641.40(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 2.865(Ft.), Average velocity = 8.027(Ft/s)
Critical depth = 2.563(Ft.)

++
Process from Point/Station 18.000 to Point/Station 19.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 1980.000(Ft.)
Downstream point elevation = 1840.000(Ft.)
Channel length thru subarea = 4100.000(Ft.)
Channel base width = 300.000(Ft.)
Slope or 'Z' of left channel bank = 1.000
Slope or 'Z' of right channel bank = 1.000
Estimated mean flow rate at midpoint of channel = 3761.027(CFS)
Manning's 'N' = 0.055

Maximum depth of channel = 50.000(Ft.)
Flow(q) thru subarea = 3761.027(CFS)
Depth of flow = 1.739(Ft.), Average velocity = 7.169(Ft/s)
Channel flow top width = 303.477(Ft.)
Flow Velocity = 7.17(Ft/s)
Travel time = 9.53 min.
Time of concentration = 75.44 min.
Critical depth = 1.688(Ft.)
Adding area flow to channel
Soil classification AP and SCS values input by user
USER INPUT of soil data for subarea
SCS curve number for soil(AMC 2) = 91.00
Adjusted SCS curve number for AMC 3 = 98.20
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.036(In/Hr)
Rainfall intensity = 0.632(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area,(total area with modified rational method)(Q=KCIA) is C = 0.849
Subarea runoff = 491.510(CFS) for 1823.500(Ac.)
Total runoff = 4006.732(CFS)
Effective area this stream = 7464.90(Ac.)
Total Study Area (Main Stream No. 1) = 7464.90(Ac.)
Area averaged Fm value = 0.036(In/Hr)
Depth of flow = 1.806(Ft.), Average velocity = 7.351(Ft/s)
Critical depth = 1.766(Ft.)
End of computations, Total Study Area = 7464.90 (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 = 91.0

Appendix C
Unit Hydrograph 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 - 2018, Version 9.0

Study date 06/19/18

++

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

Program License Serial Number 6431

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 100		
7345.20	1	0.74
Rainfall data for year 100		
7345.20	6	1.59
Rainfall data for year 100		
7345.20	24	2.80

++

******** 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	7345.20	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
7345.20	1.000	91.0	98.2	0.18	0.926

Area-averaged catchment yield fraction, Y = 0.926

Area-averaged low loss fraction, Yb = 0.074
User entry of time of concentration = 1.257 (hours)
++
Watershed area = 7345.20(Ac.)
Catchment Lag time = 1.006 hours
Unit interval = 5.000 minutes
Unit interval percentage of lag time = 8.2869
Hydrograph baseflow = 0.00(CFS)
Average maximum watershed loss rate(Fm) = 0.036(In/Hr)
Average low loss rate fraction (Yb) = 0.074 (decimal)
DESERT S-Graph Selected
Computed peak 5-minute rainfall = 0.352(In)
Computed peak 30-minute rainfall = 0.603(In)
Specified peak 1-hour rainfall = 0.742(In)
Computed peak 3-hour rainfall = 1.184(In)
Specified peak 6-hour rainfall = 1.590(In)
Specified peak 24-hour rainfall = 2.800(In)

Rainfall depth area reduction factors:
Using a total area of 7345.20(Ac.) (Ref: fig. E-4)

5-minute factor = 0.727 Adjusted rainfall = 0.256(In)
30-minute factor = 0.729 Adjusted rainfall = 0.440(In)
1-hour factor = 0.730 Adjusted rainfall = 0.542(In)
3-hour factor = 0.959 Adjusted rainfall = 1.135(In)
6-hour factor = 0.980 Adjusted rainfall = 1.558(In)
24-hour factor = 0.989 Adjusted rainfall = 2.770(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 = 88831.01 (CFS))	
1	0.365	323.900
2	1.174	718.961
3	2.481	1160.601
4	4.193	1521.352
5	6.330	1898.553
6	9.014	2384.074
7	12.975	3518.415
8	18.611	5006.484
9	26.629	7122.833
10	34.488	6980.439
11	41.409	6148.138
12	46.992	4959.524
13	51.863	4326.957
14	56.073	3739.741
15	59.442	2992.610
16	62.373	2604.405
17	64.928	2269.262
18	67.186	2005.400
19	69.293	1871.974
20	71.258	1745.139
21	72.976	1526.912
22	74.556	1403.491
23	76.012	1292.702
24	77.417	1248.248
25	78.697	1137.428
26	79.794	974.093

27	80.888	971.700
28	81.910	908.057
29	82.807	797.046
30	83.702	795.027
31	84.563	764.453
32	85.360	707.937
33	86.155	706.691
34	86.907	667.555
35	87.572	590.920
36	88.235	588.909
37	88.845	541.984
38	89.346	444.673
39	89.843	441.682
40	90.330	432.688
41	90.795	412.938
42	91.259	412.236
43	91.703	395.013
44	92.103	354.974
45	92.501	353.345
46	92.889	345.108
47	93.255	324.835
48	93.620	323.900
49	93.962	304.221
50	94.247	252.946
51	94.529	250.286
52	94.810	250.286
53	95.092	250.286
54	95.374	250.286
55	95.640	235.957
56	95.858	194.088
57	96.073	191.395
58	96.289	191.395
59	96.504	191.395
60	96.720	191.395
61	96.921	178.413
62	97.074	135.829
63	97.223	132.504
64	97.372	132.504
65	97.521	132.504
66	97.670	132.504
67	97.806	120.803
68	97.894	77.636
69	97.977	73.614
70	98.059	73.614
71	98.142	73.614
72	98.225	73.614
73	98.311	76.236
74	98.409	87.140
75	98.509	88.336
76	98.608	88.336
77	98.707	88.336
78	98.807	88.336
79	98.906	88.336
80	99.006	88.336
81	99.105	88.336
82	99.205	88.336
83	99.304	88.336
84	99.404	88.336
85	99.496	82.400
86	99.553	50.692
87	99.605	46.009
88	99.657	46.009
89	99.709	46.009

90	99.760	46.009
91	99.812	46.009
92	99.864	46.009
93	99.916	46.009
94	99.968	46.009
95	100.000	28.717

Peak Unit Number	Adjusted mass rainfall (In)	Unit rainfall (In)
1	0.2558	0.2558
2	0.3154	0.0596
3	0.3566	0.0411
4	0.3889	0.0324
5	0.4161	0.0271
6	0.4397	0.0236
7	0.4606	0.0209
8	0.4795	0.0189
9	0.4968	0.0173
10	0.5129	0.0160
11	0.5278	0.0149
12	0.5418	0.0140
13	0.5718	0.0300
14	0.6011	0.0293
15	0.6297	0.0286
16	0.6577	0.0280
17	0.6851	0.0274
18	0.7119	0.0269
19	0.7383	0.0264
20	0.7643	0.0259
21	0.7898	0.0255
22	0.8150	0.0251
23	0.8397	0.0248
24	0.8641	0.0244
25	0.8882	0.0241
26	0.9120	0.0238
27	0.9355	0.0235
28	0.9587	0.0232
29	0.9816	0.0229
30	1.0042	0.0227
31	1.0267	0.0224
32	1.0489	0.0222
33	1.0708	0.0220
34	1.0926	0.0217
35	1.1141	0.0215
36	1.1354	0.0213
37	1.1497	0.0143
38	1.1638	0.0141
39	1.1776	0.0139
40	1.1913	0.0137
41	1.2048	0.0135
42	1.2181	0.0133
43	1.2313	0.0131
44	1.2443	0.0130
45	1.2571	0.0128
46	1.2697	0.0127
47	1.2823	0.0125
48	1.2946	0.0124
49	1.3069	0.0122
50	1.3190	0.0121
51	1.3309	0.0120
52	1.3428	0.0118
53	1.3545	0.0117
54	1.3661	0.0116

55	1.3776	0.0115
56	1.3889	0.0114
57	1.4002	0.0113
58	1.4113	0.0112
59	1.4224	0.0110
60	1.4333	0.0109
61	1.4442	0.0108
62	1.4549	0.0108
63	1.4656	0.0107
64	1.4762	0.0106
65	1.4866	0.0105
66	1.4970	0.0104
67	1.5073	0.0103
68	1.5175	0.0102
69	1.5277	0.0101
70	1.5377	0.0101
71	1.5477	0.0100
72	1.5576	0.0099
73	1.5666	0.0089
74	1.5754	0.0089
75	1.5843	0.0088
76	1.5930	0.0087
77	1.6017	0.0087
78	1.6103	0.0086
79	1.6188	0.0085
80	1.6273	0.0085
81	1.6357	0.0084
82	1.6441	0.0084
83	1.6524	0.0083
84	1.6606	0.0082
85	1.6688	0.0082
86	1.6769	0.0081
87	1.6850	0.0081
88	1.6930	0.0080
89	1.7010	0.0080
90	1.7089	0.0079
91	1.7167	0.0079
92	1.7246	0.0078
93	1.7323	0.0078
94	1.7400	0.0077
95	1.7477	0.0077
96	1.7553	0.0076
97	1.7629	0.0076
98	1.7704	0.0075
99	1.7779	0.0075
100	1.7853	0.0074
101	1.7927	0.0074
102	1.8001	0.0074
103	1.8074	0.0073
104	1.8146	0.0073
105	1.8219	0.0072
106	1.8291	0.0072
107	1.8362	0.0071
108	1.8433	0.0071
109	1.8504	0.0071
110	1.8574	0.0070
111	1.8644	0.0070
112	1.8714	0.0070
113	1.8783	0.0069
114	1.8852	0.0069
115	1.8920	0.0069
116	1.8988	0.0068
117	1.9056	0.0068

118	1.9124	0.0067
119	1.9191	0.0067
120	1.9258	0.0067
121	1.9324	0.0066
122	1.9390	0.0066
123	1.9456	0.0066
124	1.9522	0.0066
125	1.9587	0.0065
126	1.9652	0.0065
127	1.9717	0.0065
128	1.9781	0.0064
129	1.9845	0.0064
130	1.9909	0.0064
131	1.9972	0.0063
132	2.0035	0.0063
133	2.0098	0.0063
134	2.0161	0.0063
135	2.0223	0.0062
136	2.0285	0.0062
137	2.0347	0.0062
138	2.0409	0.0062
139	2.0470	0.0061
140	2.0531	0.0061
141	2.0592	0.0061
142	2.0652	0.0061
143	2.0713	0.0060
144	2.0773	0.0060
145	2.0832	0.0060
146	2.0892	0.0060
147	2.0951	0.0059
148	2.1010	0.0059
149	2.1069	0.0059
150	2.1128	0.0059
151	2.1186	0.0058
152	2.1244	0.0058
153	2.1302	0.0058
154	2.1360	0.0058
155	2.1417	0.0057
156	2.1475	0.0057
157	2.1532	0.0057
158	2.1589	0.0057
159	2.1645	0.0057
160	2.1702	0.0056
161	2.1758	0.0056
162	2.1814	0.0056
163	2.1870	0.0056
164	2.1925	0.0056
165	2.1981	0.0055
166	2.2036	0.0055
167	2.2091	0.0055
168	2.2146	0.0055
169	2.2201	0.0055
170	2.2255	0.0054
171	2.2309	0.0054
172	2.2364	0.0054
173	2.2417	0.0054
174	2.2471	0.0054
175	2.2525	0.0054
176	2.2578	0.0053
177	2.2631	0.0053
178	2.2684	0.0053
179	2.2737	0.0053
180	2.2790	0.0053

181	2.2842	0.0053
182	2.2895	0.0052
183	2.2947	0.0052
184	2.2999	0.0052
185	2.3051	0.0052
186	2.3102	0.0052
187	2.3154	0.0052
188	2.3205	0.0051
189	2.3256	0.0051
190	2.3307	0.0051
191	2.3358	0.0051
192	2.3409	0.0051
193	2.3460	0.0051
194	2.3510	0.0050
195	2.3560	0.0050
196	2.3610	0.0050
197	2.3660	0.0050
198	2.3710	0.0050
199	2.3760	0.0050
200	2.3809	0.0050
201	2.3859	0.0049
202	2.3908	0.0049
203	2.3957	0.0049
204	2.4006	0.0049
205	2.4055	0.0049
206	2.4103	0.0049
207	2.4152	0.0049
208	2.4200	0.0048
209	2.4249	0.0048
210	2.4297	0.0048
211	2.4345	0.0048
212	2.4392	0.0048
213	2.4440	0.0048
214	2.4488	0.0048
215	2.4535	0.0047
216	2.4583	0.0047
217	2.4630	0.0047
218	2.4677	0.0047
219	2.4724	0.0047
220	2.4771	0.0047
221	2.4817	0.0047
222	2.4864	0.0047
223	2.4910	0.0046
224	2.4957	0.0046
225	2.5003	0.0046
226	2.5049	0.0046
227	2.5095	0.0046
228	2.5141	0.0046
229	2.5187	0.0046
230	2.5232	0.0046
231	2.5278	0.0046
232	2.5323	0.0045
233	2.5368	0.0045
234	2.5414	0.0045
235	2.5459	0.0045
236	2.5504	0.0045
237	2.5548	0.0045
238	2.5593	0.0045
239	2.5638	0.0045
240	2.5682	0.0044
241	2.5727	0.0044
242	2.5771	0.0044
243	2.5815	0.0044

244	2.5859	0.0044
245	2.5903	0.0044
246	2.5947	0.0044
247	2.5991	0.0044
248	2.6034	0.0044
249	2.6078	0.0044
250	2.6121	0.0043
251	2.6165	0.0043
252	2.6208	0.0043
253	2.6251	0.0043
254	2.6294	0.0043
255	2.6337	0.0043
256	2.6380	0.0043
257	2.6423	0.0043
258	2.6465	0.0043
259	2.6508	0.0043
260	2.6550	0.0042
261	2.6593	0.0042
262	2.6635	0.0042
263	2.6677	0.0042
264	2.6719	0.0042
265	2.6761	0.0042
266	2.6803	0.0042
267	2.6845	0.0042
268	2.6887	0.0042
269	2.6928	0.0042
270	2.6970	0.0042
271	2.7011	0.0041
272	2.7053	0.0041
273	2.7094	0.0041
274	2.7135	0.0041
275	2.7176	0.0041
276	2.7217	0.0041
277	2.7258	0.0041
278	2.7299	0.0041
279	2.7340	0.0041
280	2.7380	0.0041
281	2.7421	0.0041
282	2.7461	0.0040
283	2.7502	0.0040
284	2.7542	0.0040
285	2.7582	0.0040
286	2.7622	0.0040
287	2.7663	0.0040
288	2.7703	0.0040

Unit Period (number)	Unit Rainfall (In)	Unit Soil-Loss (In)	Effective Rainfall (In)
1	0.0040	0.0003	0.0037
2	0.0040	0.0003	0.0037
3	0.0040	0.0003	0.0037
4	0.0040	0.0003	0.0037
5	0.0040	0.0003	0.0037
6	0.0041	0.0003	0.0038
7	0.0041	0.0003	0.0038
8	0.0041	0.0003	0.0038
9	0.0041	0.0003	0.0038
10	0.0041	0.0003	0.0038
11	0.0041	0.0003	0.0038
12	0.0041	0.0003	0.0038
13	0.0042	0.0003	0.0038

14	0.0042	0.0003	0.0039
15	0.0042	0.0003	0.0039
16	0.0042	0.0003	0.0039
17	0.0042	0.0003	0.0039
18	0.0042	0.0003	0.0039
19	0.0042	0.0003	0.0039
20	0.0042	0.0003	0.0039
21	0.0043	0.0003	0.0039
22	0.0043	0.0003	0.0040
23	0.0043	0.0003	0.0040
24	0.0043	0.0003	0.0040
25	0.0043	0.0003	0.0040
26	0.0043	0.0003	0.0040
27	0.0044	0.0003	0.0040
28	0.0044	0.0003	0.0040
29	0.0044	0.0003	0.0041
30	0.0044	0.0003	0.0041
31	0.0044	0.0003	0.0041
32	0.0044	0.0003	0.0041
33	0.0044	0.0003	0.0041
34	0.0045	0.0003	0.0041
35	0.0045	0.0003	0.0041
36	0.0045	0.0003	0.0042
37	0.0045	0.0003	0.0042
38	0.0045	0.0003	0.0042
39	0.0046	0.0003	0.0042
40	0.0046	0.0003	0.0042
41	0.0046	0.0003	0.0042
42	0.0046	0.0003	0.0043
43	0.0046	0.0003	0.0043
44	0.0046	0.0003	0.0043
45	0.0047	0.0003	0.0043
46	0.0047	0.0003	0.0043
47	0.0047	0.0003	0.0043
48	0.0047	0.0004	0.0044
49	0.0047	0.0004	0.0044
50	0.0047	0.0004	0.0044
51	0.0048	0.0004	0.0044
52	0.0048	0.0004	0.0044
53	0.0048	0.0004	0.0045
54	0.0048	0.0004	0.0045
55	0.0049	0.0004	0.0045
56	0.0049	0.0004	0.0045
57	0.0049	0.0004	0.0045
58	0.0049	0.0004	0.0045
59	0.0049	0.0004	0.0046
60	0.0050	0.0004	0.0046
61	0.0050	0.0004	0.0046
62	0.0050	0.0004	0.0046
63	0.0050	0.0004	0.0047
64	0.0050	0.0004	0.0047
65	0.0051	0.0004	0.0047
66	0.0051	0.0004	0.0047
67	0.0051	0.0004	0.0047
68	0.0051	0.0004	0.0048
69	0.0052	0.0004	0.0048
70	0.0052	0.0004	0.0048
71	0.0052	0.0004	0.0048
72	0.0052	0.0004	0.0048
73	0.0053	0.0004	0.0049
74	0.0053	0.0004	0.0049
75	0.0053	0.0004	0.0049
76	0.0053	0.0004	0.0049

77	0.0054	0.0004	0.0050
78	0.0054	0.0004	0.0050
79	0.0054	0.0004	0.0050
80	0.0054	0.0004	0.0050
81	0.0055	0.0004	0.0051
82	0.0055	0.0004	0.0051
83	0.0055	0.0004	0.0051
84	0.0056	0.0004	0.0051
85	0.0056	0.0004	0.0052
86	0.0056	0.0004	0.0052
87	0.0057	0.0004	0.0052
88	0.0057	0.0004	0.0053
89	0.0057	0.0004	0.0053
90	0.0057	0.0004	0.0053
91	0.0058	0.0004	0.0054
92	0.0058	0.0004	0.0054
93	0.0059	0.0004	0.0054
94	0.0059	0.0004	0.0054
95	0.0059	0.0004	0.0055
96	0.0060	0.0004	0.0055
97	0.0060	0.0004	0.0056
98	0.0060	0.0004	0.0056
99	0.0061	0.0005	0.0056
100	0.0061	0.0005	0.0056
101	0.0062	0.0005	0.0057
102	0.0062	0.0005	0.0057
103	0.0062	0.0005	0.0058
104	0.0063	0.0005	0.0058
105	0.0063	0.0005	0.0058
106	0.0063	0.0005	0.0059
107	0.0064	0.0005	0.0059
108	0.0064	0.0005	0.0060
109	0.0065	0.0005	0.0060
110	0.0065	0.0005	0.0060
111	0.0066	0.0005	0.0061
112	0.0066	0.0005	0.0061
113	0.0067	0.0005	0.0062
114	0.0067	0.0005	0.0062
115	0.0068	0.0005	0.0063
116	0.0068	0.0005	0.0063
117	0.0069	0.0005	0.0064
118	0.0069	0.0005	0.0064
119	0.0070	0.0005	0.0065
120	0.0070	0.0005	0.0065
121	0.0071	0.0005	0.0066
122	0.0071	0.0005	0.0066
123	0.0072	0.0005	0.0067
124	0.0073	0.0005	0.0067
125	0.0074	0.0005	0.0068
126	0.0074	0.0006	0.0068
127	0.0075	0.0006	0.0069
128	0.0075	0.0006	0.0070
129	0.0076	0.0006	0.0071
130	0.0077	0.0006	0.0071
131	0.0078	0.0006	0.0072
132	0.0078	0.0006	0.0072
133	0.0079	0.0006	0.0073
134	0.0080	0.0006	0.0074
135	0.0081	0.0006	0.0075
136	0.0081	0.0006	0.0075
137	0.0082	0.0006	0.0076
138	0.0083	0.0006	0.0077
139	0.0084	0.0006	0.0078

140	0.0085	0.0006	0.0078
141	0.0086	0.0006	0.0080
142	0.0087	0.0006	0.0080
143	0.0088	0.0007	0.0082
144	0.0089	0.0007	0.0082
145	0.0099	0.0007	0.0092
146	0.0100	0.0007	0.0092
147	0.0101	0.0008	0.0094
148	0.0102	0.0008	0.0095
149	0.0104	0.0008	0.0096
150	0.0105	0.0008	0.0097
151	0.0107	0.0008	0.0099
152	0.0108	0.0008	0.0099
153	0.0109	0.0008	0.0101
154	0.0110	0.0008	0.0102
155	0.0113	0.0008	0.0104
156	0.0114	0.0008	0.0105
157	0.0116	0.0009	0.0107
158	0.0117	0.0009	0.0108
159	0.0120	0.0009	0.0111
160	0.0121	0.0009	0.0112
161	0.0124	0.0009	0.0115
162	0.0125	0.0009	0.0116
163	0.0128	0.0010	0.0119
164	0.0130	0.0010	0.0120
165	0.0133	0.0010	0.0123
166	0.0135	0.0010	0.0125
167	0.0139	0.0010	0.0128
168	0.0141	0.0010	0.0130
169	0.0213	0.0016	0.0197
170	0.0215	0.0016	0.0199
171	0.0220	0.0016	0.0203
172	0.0222	0.0017	0.0205
173	0.0227	0.0017	0.0210
174	0.0229	0.0017	0.0212
175	0.0235	0.0017	0.0217
176	0.0238	0.0018	0.0220
177	0.0244	0.0018	0.0226
178	0.0248	0.0018	0.0229
179	0.0255	0.0019	0.0236
180	0.0259	0.0019	0.0240
181	0.0269	0.0020	0.0249
182	0.0274	0.0020	0.0254
183	0.0286	0.0021	0.0265
184	0.0293	0.0022	0.0271
185	0.0140	0.0010	0.0130
186	0.0149	0.0011	0.0138
187	0.0173	0.0013	0.0160
188	0.0189	0.0014	0.0175
189	0.0236	0.0018	0.0218
190	0.0271	0.0020	0.0251
191	0.0411	0.0030	0.0381
192	0.0596	0.0030	0.0566
193	0.2558	0.0030	0.2528
194	0.0324	0.0024	0.0300
195	0.0209	0.0016	0.0194
196	0.0160	0.0012	0.0148
197	0.0300	0.0022	0.0278
198	0.0280	0.0021	0.0259
199	0.0264	0.0020	0.0244
200	0.0251	0.0019	0.0233
201	0.0241	0.0018	0.0223
202	0.0232	0.0017	0.0215

203	0.0224	0.0017	0.0208
204	0.0217	0.0016	0.0201
205	0.0143	0.0011	0.0132
206	0.0137	0.0010	0.0127
207	0.0131	0.0010	0.0122
208	0.0127	0.0009	0.0117
209	0.0122	0.0009	0.0113
210	0.0118	0.0009	0.0110
211	0.0115	0.0009	0.0106
212	0.0112	0.0008	0.0103
213	0.0108	0.0008	0.0100
214	0.0106	0.0008	0.0098
215	0.0103	0.0008	0.0095
216	0.0101	0.0007	0.0093
217	0.0089	0.0007	0.0083
218	0.0087	0.0007	0.0081
219	0.0085	0.0006	0.0079
220	0.0084	0.0006	0.0077
221	0.0082	0.0006	0.0076
222	0.0080	0.0006	0.0074
223	0.0079	0.0006	0.0073
224	0.0077	0.0006	0.0071
225	0.0076	0.0006	0.0070
226	0.0074	0.0006	0.0069
227	0.0073	0.0005	0.0068
228	0.0072	0.0005	0.0067
229	0.0071	0.0005	0.0065
230	0.0070	0.0005	0.0064
231	0.0069	0.0005	0.0063
232	0.0067	0.0005	0.0062
233	0.0066	0.0005	0.0062
234	0.0066	0.0005	0.0061
235	0.0065	0.0005	0.0060
236	0.0064	0.0005	0.0059
237	0.0063	0.0005	0.0058
238	0.0062	0.0005	0.0057
239	0.0061	0.0005	0.0057
240	0.0061	0.0005	0.0056
241	0.0060	0.0004	0.0055
242	0.0059	0.0004	0.0055
243	0.0058	0.0004	0.0054
244	0.0058	0.0004	0.0053
245	0.0057	0.0004	0.0053
246	0.0056	0.0004	0.0052
247	0.0056	0.0004	0.0052
248	0.0055	0.0004	0.0051
249	0.0055	0.0004	0.0051
250	0.0054	0.0004	0.0050
251	0.0054	0.0004	0.0050
252	0.0053	0.0004	0.0049
253	0.0053	0.0004	0.0049
254	0.0052	0.0004	0.0048
255	0.0052	0.0004	0.0048
256	0.0051	0.0004	0.0047
257	0.0051	0.0004	0.0047
258	0.0050	0.0004	0.0046
259	0.0050	0.0004	0.0046
260	0.0049	0.0004	0.0046
261	0.0049	0.0004	0.0045
262	0.0048	0.0004	0.0045
263	0.0048	0.0004	0.0044
264	0.0048	0.0004	0.0044
265	0.0047	0.0004	0.0044

266	0.0047	0.0003	0.0043
267	0.0046	0.0003	0.0043
268	0.0046	0.0003	0.0043
269	0.0046	0.0003	0.0042
270	0.0045	0.0003	0.0042
271	0.0045	0.0003	0.0042
272	0.0045	0.0003	0.0041
273	0.0044	0.0003	0.0041
274	0.0044	0.0003	0.0041
275	0.0044	0.0003	0.0040
276	0.0043	0.0003	0.0040
277	0.0043	0.0003	0.0040
278	0.0043	0.0003	0.0040
279	0.0043	0.0003	0.0039
280	0.0042	0.0003	0.0039
281	0.0042	0.0003	0.0039
282	0.0042	0.0003	0.0039
283	0.0041	0.0003	0.0038
284	0.0041	0.0003	0.0038
285	0.0041	0.0003	0.0038
286	0.0041	0.0003	0.0038
287	0.0040	0.0003	0.0037
288	0.0040	0.0003	0.0037

Total soil rain loss = 0.19(In)
Total effective rainfall = 2.58(In)
Peak flow rate in flood hydrograph = 3793.53(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

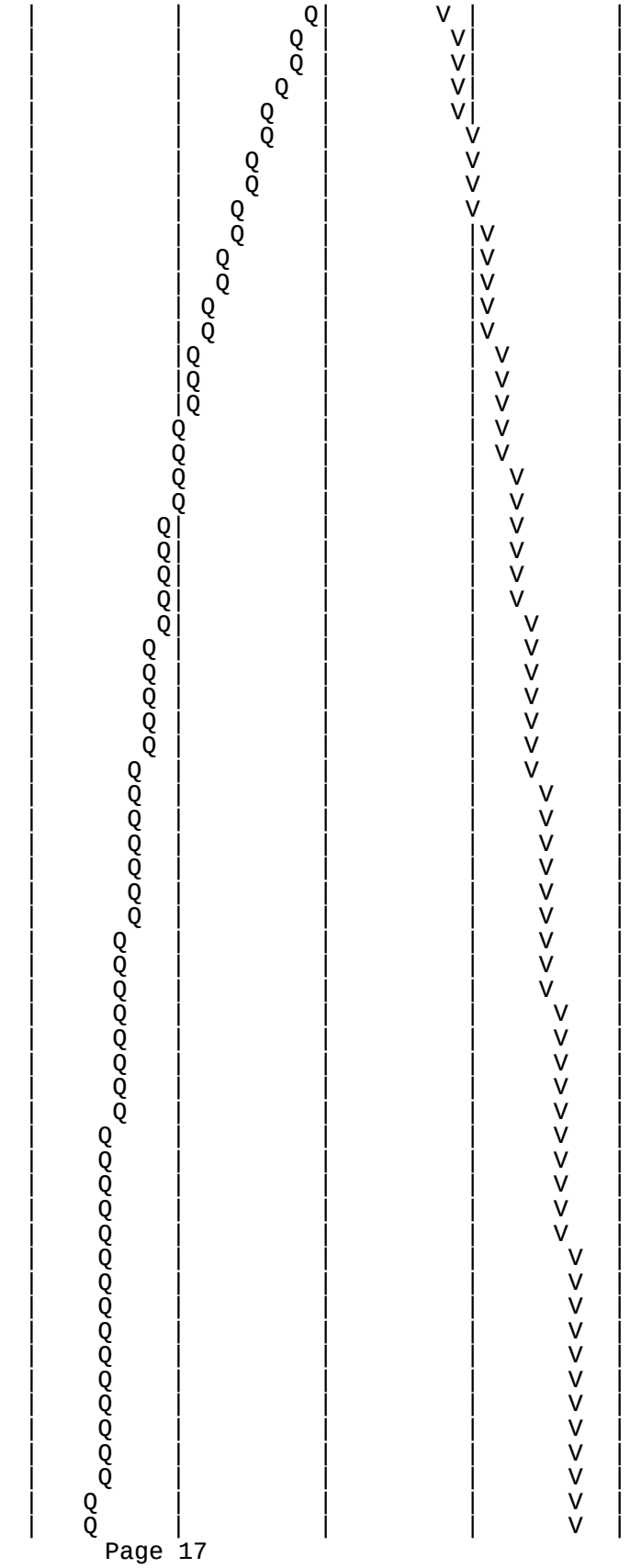
Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	950.0	1900.0	2850.0	3800.0
0+ 5	0.0083	1.20	Q				
0+10	0.0349	3.86	Q				
0+15	0.0911	8.17	Q				
0+20	0.1863	13.82	Q				
0+25	0.3302	20.89	Q				
0+30	0.5352	29.77	Q				
0+35	0.8305	42.88	Q				
0+40	1.2543	61.54	Q				
0+45	1.8610	88.08	Q				
0+50	2.6473	114.17	VQ				
0+55	3.5927	137.27	VQ				
1+ 0	4.6673	156.04	VQ				
1+ 5	5.8556	172.54	VQ				
1+10	7.1429	186.91	VQ				
1+15	8.5104	198.57	V Q				
1+20	9.9486	208.82	V Q				
1+25	11.4492	217.88	V Q				
1+30	13.0056	225.99	V Q				
1+35	14.6147	233.64	V Q				
1+40	16.2733	240.84	V Q				
1+45	17.9762	247.26	V Q				
1+50	19.7204	253.25	V Q				
1+55	21.5031	258.86	V Q				
2+ 0	23.3235	264.31	V Q				
2+ 5	25.1788	269.39	V Q				

2+10	27.0650	273.87	V Q	|	|	|	|
2+15	28.9821	278.38	V Q	|	|	|	|
2+20	30.9288	282.65	V Q	|	|	|	|
2+25	32.9023	286.55	V Q	|	|	|	|
2+30	34.9026	290.44	V Q	|	|	|	|
2+35	36.9291	294.25	V Q	|	|	|	|
2+40	38.9805	297.86	V Q	|	|	|	|
2+45	41.0569	301.49	|V Q	|	|	|	|
2+50	43.1574	304.99	|V Q	|	|	|	|
2+55	45.2801	308.22	|V Q	|	|	|	|
3+ 0	47.4252	311.46	|V Q	|	|	|	|
3+ 5	49.5915	314.55	|V Q	|	|	|	|
3+10	51.7767	317.29	|V Q	|	|	|	|
3+15	53.9808	320.04	|V Q	|	|	|	|
3+20	56.2037	322.76	|V Q	|	|	|	|
3+25	58.4449	325.43	|V Q	|	|	|	|
3+30	60.7047	328.11	|V Q	|	|	|	|
3+35	62.9826	330.75	|V Q	|	|	|	|
3+40	65.2777	333.25	|V Q	|	|	|	|
3+45	67.5902	335.77	|V Q	|	|	|	|
3+50	69.9198	338.26	|V Q	|	|	|	|
3+55	72.2663	340.71	|V Q	|	|	|	|
4+ 0	74.6296	343.16	|V Q	|	|	|	|
4+ 5	77.0095	345.56	|V Q	|	|	|	|
4+10	79.4046	347.77	| VQ	|	|	|	|
4+15	81.8152	350.01	| VQ	|	|	|	|
4+20	84.2411	352.25	| VQ	|	|	|	|
4+25	86.6827	354.51	| VQ	|	|	|	|
4+30	89.1399	356.79	| VQ	|	|	|	|
4+35	91.6126	359.03	| VQ	|	|	|	|
4+40	94.0997	361.13	| VQ	|	|	|	|
4+45	96.6014	363.25	| VQ	|	|	|	|
4+50	99.1178	365.37	| VQ	|	|	|	|
4+55	101.6489	367.52	| VQ	|	|	|	|
5+ 0	104.1949	369.68	| VQ	|	|	|	|
5+ 5	106.7557	371.82	| VQ	|	|	|	|
5+10	109.3301	373.81	| VQ	|	|	|	|
5+15	111.9183	375.81	| VQ	|	|	|	|
5+20	114.5204	377.82	| VQ	|	|	|	|
5+25	117.1366	379.87	| VQ	|	|	|	|
5+30	119.7669	381.92	| VQ	|	|	|	|
5+35	122.4112	383.95	| VQ	|	|	|	|
5+40	125.0684	385.84	| VQ	|	|	|	|
5+45	127.7388	387.74	| VQ	|	|	|	|
5+50	130.4223	389.65	| VQ	|	|	|	|
5+55	133.1192	391.59	| VQ	|	|	|	|
6+ 0	135.8295	393.54	| VQ	|	|	|	|
6+ 5	138.5535	395.53	| VQ	|	|	|	|
6+10	141.2916	397.57	| VQ	|	|	|	|
6+15	144.0439	399.65	| VQ	|	|	|	|
6+20	146.8107	401.73	| VQ	|	|	|	|
6+25	149.5921	403.86	| VQ	|	|	|	|
6+30	152.3882	405.99	| VQ	|	|	|	|
6+35	155.1992	408.16	| VQ	|	|	|	|
6+40	158.0253	410.34	| Q	|	|	|	|
6+45	160.8666	412.56	| Q	|	|	|	|
6+50	163.7233	414.79	| Q	|	|	|	|
6+55	166.5956	417.06	| Q	|	|	|	|
7+ 0	169.4836	419.34	| Q	|	|	|	|
7+ 5	172.3875	421.64	| Q	|	|	|	|
7+10	175.3065	423.84	| Q	|	|	|	|
7+15	178.2408	426.06	| Q	|	|	|	|
7+20	181.1904	428.29	| Q	|	|	|	|

7+25	184.1557	430.56	Q			
7+30	187.1368	432.85	Q			
7+35	190.1339	435.19	Q			
7+40	193.1472	437.53	Q			
7+45	196.1771	439.93	Q			
7+50	199.2235	442.34	QV			
7+55	202.2864	444.73	QV			
8+ 0	205.3652	447.04	QV			
8+ 5	208.4602	449.40	QV			
8+10	211.5715	451.77	QV			
8+15	214.6996	454.19	QV			
8+20	217.8445	456.64	QV			
8+25	221.0065	459.13	QV			
8+30	224.1859	461.65	QV			
8+35	227.3831	464.22	QV			
8+40	230.5981	466.82	QV			
8+45	233.8313	469.47	QV			
8+50	237.0830	472.15	Q V			
8+55	240.3536	474.89	Q V			
9+ 0	243.6432	477.65	QV			
9+ 5	246.9522	480.47	QV			
9+10	250.2809	483.33	QV			
9+15	253.6298	486.25	QV			
9+20	256.9989	489.20	QV			
9+25	260.3888	492.22	QV			
9+30	263.7997	495.27	QV			
9+35	267.2322	498.39	QV			
9+40	270.6863	501.55	QV			
9+45	274.1628	504.78	QV			
9+50	277.6618	508.05	Q V			
9+55	281.1839	511.41	Q V			
10+ 0	284.7293	514.79	Q V			
10+ 5	288.2987	518.27	Q V			
10+10	291.8922	521.79	Q V			
10+15	295.5107	525.40	Q V			
10+20	299.1543	529.05	Q V			
10+25	302.8238	532.80	Q V			
10+30	306.5194	536.60	Q V			
10+35	310.2419	540.50	Q V			
10+40	313.9916	544.46	Q V			
10+45	317.7692	548.52	Q V			
10+50	321.5753	552.64	Q V			
10+55	325.4104	556.87	Q V			
11+ 0	329.2752	561.16	Q V			
11+ 5	333.1704	565.58	Q V			
11+10	337.0965	570.07	Q V			
11+15	341.0543	574.68	Q V			
11+20	345.0445	579.37	Q V			
11+25	349.0679	584.20	Q V			
11+30	353.1251	589.11	Q V			
11+35	357.2172	594.17	Q V			
11+40	361.3446	599.31	Q V			
11+45	365.5087	604.62	Q V			
11+50	369.7099	610.02	Q V			
11+55	373.9496	615.60	Q V			
12+ 0	378.2284	621.28	Q V			
12+ 5	382.5495	627.42	Q V			
12+10	386.9158	633.99	Q V			
12+15	391.3313	641.13	Q V			
12+20	395.7989	648.70	Q V			
12+25	400.3223	656.80	Q V			
12+30	404.9052	665.44	Q V			
12+35	409.5557	675.26	Q V			

12+40	414.2834	686.45	Q V
12+45	419.1019	699.65	Q V
12+50	424.0119	712.93	Q V
12+55	429.0107	725.83	Q V
13+ 0	434.0932	737.97	Q V
13+ 5	439.2580	749.93	Q |V
13+10	444.5034	761.64	Q |V
13+15	449.8279	773.11	Q |V
13+20	455.2308	784.51	Q |V
13+25	460.7132	796.04	Q |V
13+30	466.2755	807.65	Q |V
13+35	471.9201	819.60	Q |V
13+40	477.6486	831.77	Q | V
13+45	483.4631	844.28	Q | V
13+50	489.3657	857.05	Q| V
13+55	495.3596	870.32	Q| V
14+ 0	501.4476	883.98	Q| V
14+ 5	507.6478	900.27	Q| V
14+10	513.9799	919.42	Q| V
14+15	520.4682	942.11	Q| V
14+20	527.1319	967.57	Q V
14+25	533.9926	996.17	Q V
14+30	541.0756	1028.45	Q V
14+35	548.4368	1068.84	|Q V
14+40	556.1453	1119.28	|Q V
14+45	564.3006	1184.15	| Q V
14+50	572.9009	1248.76	| QV
14+55	581.9170	1309.14	| QV
15+ 0	591.3030	1362.85	| Q
15+ 5	601.0408	1413.93	| QV
15+10	611.1124	1462.38	| Q
15+15	621.4974	1507.91	| Q
15+20	632.1899	1552.54	| Q
15+25	643.1568	1592.40	| Q
15+30	654.3593	1626.60	| VQ
15+35	665.7670	1656.39	| VQ
15+40	677.3577	1682.97	| Q
15+45	689.1177	1707.55	| Q
15+50	701.0292	1729.55	| VQ
15+55	713.0414	1744.17	| Q
16+ 0	725.1090	1752.22	| Q
16+ 5	737.5735	1809.85	| VQ
16+10	750.6090	1892.75	| Q
16+15	764.4103	2003.95	| V|Q
16+20	779.0189	2121.17	| V| Q
16+25	794.6543	2270.27	| V Q
16+30	811.7202	2477.96	| V Q
16+35	831.3836	2855.13	| |V Q
16+40	854.0965	3297.90	| |V | Q
16+45	880.2227	3793.53	| | V | Q
16+50	905.9625	3737.42	| | V | Q
16+55	930.0395	3495.99	| | V | Q
17+ 0	952.0085	3189.90	| | V | Q
17+ 5	972.8831	3030.99	| | V |Q
17+10	992.7138	2879.42	| | V Q
17+15	1011.2451	2690.74	| | V Q |
17+20	1028.9316	2568.09	| | VQ |
17+25	1045.8535	2457.06	| | QV |
17+30	1062.1165	2361.38	| | Q V |
17+35	1077.8190	2280.00	| | Q V |
17+40	1092.8884	2188.08	| | Q V |
17+45	1107.1063	2064.44	| |Q V |
17+50	1120.6174	1961.81	| Q V |

17+55	1133.4947	1869.79	
18+ 0	1145.8862	1799.24	
18+ 5	1157.7091	1716.68	
18+10	1168.9326	1629.65	
18+15	1179.8303	1582.35	
18+20	1190.3370	1525.57	
18+25	1200.4146	1463.26	
18+30	1210.2357	1426.03	
18+35	1219.7682	1384.11	
18+40	1228.9762	1337.00	
18+45	1237.9290	1299.96	
18+50	1246.5798	1256.09	
18+55	1254.8941	1207.24	
19+ 0	1262.9874	1175.15	
19+ 5	1270.8055	1135.18	
19+10	1278.2991	1088.07	
19+15	1285.6168	1062.54	
19+20	1292.7647	1037.88	
19+25	1299.7388	1012.63	
19+30	1306.5648	991.13	
19+35	1313.2221	966.65	
19+40	1319.6859	938.54	
19+45	1326.0156	919.07	
19+50	1332.2069	898.98	
19+55	1338.2500	877.46	
20+ 0	1344.1717	859.84	
20+ 5	1349.9475	838.64	
20+10	1355.5453	812.80	
20+15	1361.0416	798.07	
20+20	1366.4463	784.75	
20+25	1371.7618	771.81	
20+30	1376.9844	758.33	
20+35	1382.0925	741.69	
20+40	1387.0546	720.50	
20+45	1391.9337	708.44	
20+50	1396.7380	697.58	
20+55	1401.4696	687.03	
21+ 0	1406.1253	676.01	
21+ 5	1410.6848	662.03	
21+10	1415.1125	642.90	
21+15	1419.4711	632.88	
21+20	1423.7694	624.11	
21+25	1428.0069	615.29	
21+30	1432.1749	605.19	
21+35	1436.2539	592.27	
21+40	1440.2068	573.97	
21+45	1444.0972	564.88	
21+50	1447.9362	557.44	
21+55	1451.7257	550.23	
22+ 0	1455.4630	542.65	
22+ 5	1459.1550	536.08	
22+10	1462.8160	531.59	
22+15	1466.4322	525.07	
22+20	1470.0017	518.29	
22+25	1473.5258	511.70	
22+30	1477.0095	505.83	
22+35	1480.4543	500.18	
22+40	1483.8624	494.86	
22+45	1487.2341	489.57	
22+50	1490.5688	484.21	
22+55	1493.8658	478.72	
23+ 0	1497.1216	472.75	
23+ 5	1500.3243	465.03	

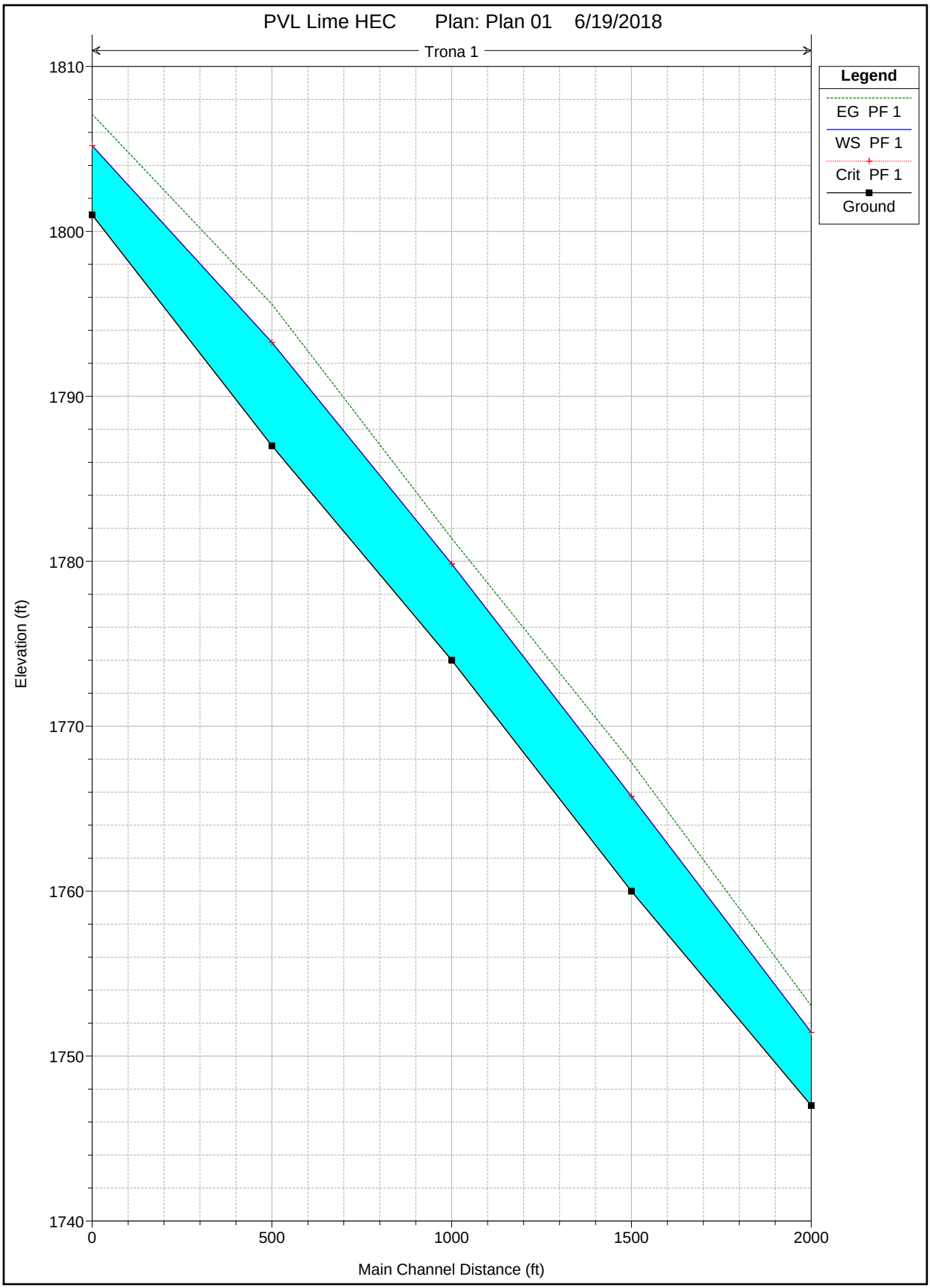
23+10	1503.4396	452.34	| Q	|	|	V |
23+15	1506.5123	446.16	| Q	|	|	V |
23+20	1509.5553	441.85	| Q	|	|	V |
23+25	1512.5697	437.68	| Q	|	|	V |
23+30	1515.5525	433.12	| Q	|	|	V |
23+35	1518.5038	428.52	| Q	|	|	V |
23+40	1521.4232	423.91	| Q	|	|	V |
23+45	1524.3095	419.09	| Q	|	|	V |
23+50	1527.1586	413.68	| Q	|	|	V |
23+55	1529.9440	404.45	| Q	|	|	V |
24+ 0	1532.6542	393.52	| Q	|	|	V |
24+ 5	1535.3270	388.09	| Q	|	|	V |
24+10	1537.9569	381.86	| Q	|	|	V |
24+15	1540.5328	374.02	| Q	|	|	V|
24+20	1543.0439	364.61	| Q	|	|	V|
24+25	1545.4818	353.99	| Q	|	|	V|
24+30	1547.8354	341.73	| Q	|	|	V|
24+35	1550.0767	325.45	| Q	|	|	V|
24+40	1552.1693	303.84	| Q	|	|	V|
24+45	1554.0606	274.61	| Q	|	|	V|
24+50	1555.7558	246.15	| Q	|	|	V|
24+55	1557.2785	221.09	| Q	|	|	V|
25+ 0	1558.6615	200.81	| Q	|	|	V|
25+ 5	1559.9220	183.03	|Q	|	|	V|
25+10	1561.0763	167.60	|Q	|	|	V|
25+15	1562.1442	155.06	|Q	|	|	V|
25+20	1563.1364	144.06	|Q	|	|	V|
25+25	1564.0620	134.40	|Q	|	|	V|
25+30	1564.9284	125.80	|Q	|	|	V|
25+35	1565.7395	117.77	|Q	|	|	V|
25+40	1566.4989	110.27	|Q	|	|	V|
25+45	1567.2128	103.65	|Q	|	|	V|
25+50	1567.8846	97.55	|Q	|	|	V|
25+55	1568.5177	91.92	Q	|	|	V|
26+ 0	1569.1137	86.53	Q	|	|	V|
26+ 5	1569.6757	81.60	Q	|	|	V|
26+10	1570.2081	77.32	Q	|	|	V|
26+15	1570.7115	73.08	Q	|	|	V|
26+20	1571.1875	69.12	Q	|	|	V|
26+25	1571.6393	65.60	Q	|	|	V|
26+30	1572.0671	62.12	Q	|	|	V|
26+35	1572.4720	58.79	Q	|	|	V|
26+40	1572.8555	55.69	Q	|	|	V|
26+45	1573.2179	52.62	Q	|	|	V|
26+50	1573.5604	49.73	Q	|	|	V|
26+55	1573.8851	47.14	Q	|	|	V|
27+ 0	1574.1922	44.59	Q	|	|	V|
27+ 5	1574.4830	42.23	Q	|	|	V|
27+10	1574.7602	40.25	Q	|	|	V|
27+15	1575.0239	38.29	Q	|	|	V|
27+20	1575.2746	36.39	Q	|	|	V|
27+25	1575.5127	34.58	Q	|	|	V|
27+30	1575.7385	32.79	Q	|	|	V|
27+35	1575.9525	31.07	Q	|	|	V|
27+40	1576.1558	29.52	Q	|	|	V|
27+45	1576.3485	27.98	Q	|	|	V|
27+50	1576.5309	26.49	Q	|	|	V|
27+55	1576.7037	25.09	Q	|	|	V|
28+ 0	1576.8669	23.70	Q	|	|	V|
28+ 5	1577.0212	22.39	Q	|	|	V|
28+10	1577.1678	21.29	Q	|	|	V|
28+15	1577.3070	20.20	Q	|	|	V|
28+20	1577.4387	19.13	Q	|	|	V|

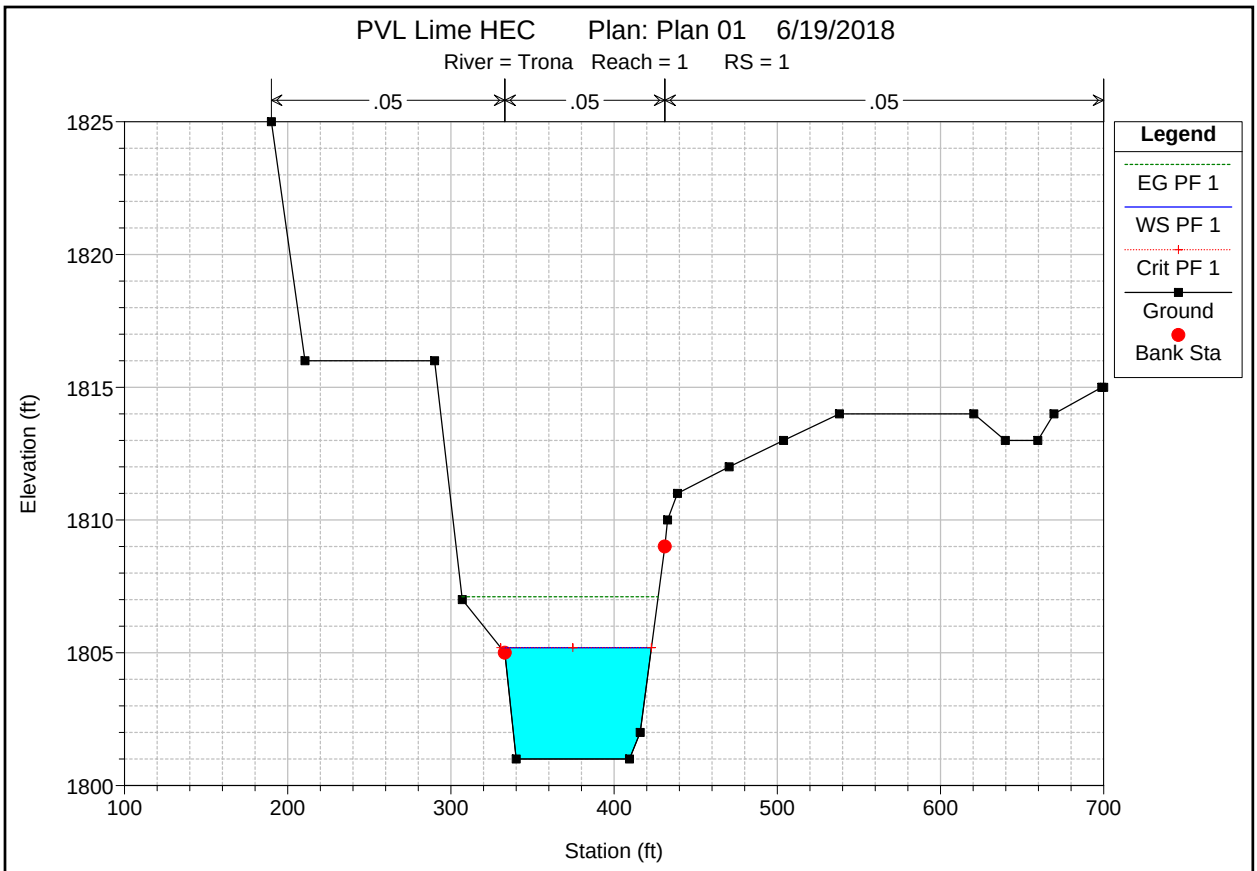
28+25	1577.5631	18.06	Q	|	|	|	V|
28+30	1577.6802	17.00	Q	|	|	|	V|
28+35	1577.7904	16.00	Q	|	|	|	V|
28+40	1577.8948	15.17	Q	|	|	|	V|
28+45	1577.9936	14.35	Q	|	|	|	V|
28+50	1578.0869	13.54	Q	|	|	|	V|
28+55	1578.1745	12.73	Q	|	|	|	V|
29+ 0	1578.2567	11.93	Q	|	|	|	V|
29+ 5	1578.3337	11.18	Q	|	|	|	V|
29+10	1578.4067	10.60	Q	|	|	|	V|
29+15	1578.4758	10.04	Q	|	|	|	V|
29+20	1578.5411	9.47	Q	|	|	|	V|
29+25	1578.6025	8.92	Q	|	|	|	V|
29+30	1578.6601	8.36	Q	|	|	|	V|
29+35	1578.7142	7.86	Q	|	|	|	V|
29+40	1578.7660	7.52	Q	|	|	|	V|
29+45	1578.8155	7.19	Q	|	|	|	V|
29+50	1578.8629	6.87	Q	|	|	|	V|
29+55	1578.9080	6.55	Q	|	|	|	V|
30+ 0	1578.9509	6.23	Q	|	|	|	V|
30+ 5	1578.9916	5.91	Q	|	|	|	V|
30+10	1579.0298	5.55	Q	|	|	|	V|
30+15	1579.0656	5.19	Q	|	|	|	V|
30+20	1579.0988	4.82	Q	|	|	|	V|
30+25	1579.1295	4.47	Q	|	|	|	V|
30+30	1579.1578	4.11	Q	|	|	|	V|
30+35	1579.1837	3.76	Q	|	|	|	V|
30+40	1579.2072	3.41	Q	|	|	|	V|
30+45	1579.2282	3.06	Q	|	|	|	V|
30+50	1579.2469	2.71	Q	|	|	|	V|
30+55	1579.2632	2.37	Q	|	|	|	V|
31+ 0	1579.2772	2.03	Q	|	|	|	V|
31+ 5	1579.2890	1.71	Q	|	|	|	V|
31+10	1579.2994	1.51	Q	|	|	|	V|
31+15	1579.3085	1.33	Q	|	|	|	V|
31+20	1579.3165	1.15	Q	|	|	|	V|
31+25	1579.3232	0.98	Q	|	|	|	V|
31+30	1579.3287	0.80	Q	|	|	|	V|
31+35	1579.3330	0.62	Q	|	|	|	V|
31+40	1579.3361	0.45	Q	|	|	|	V|
31+45	1579.3380	0.28	Q	|	|	|	V|
31+50	1579.3388	0.11	Q	|	|	|	V|

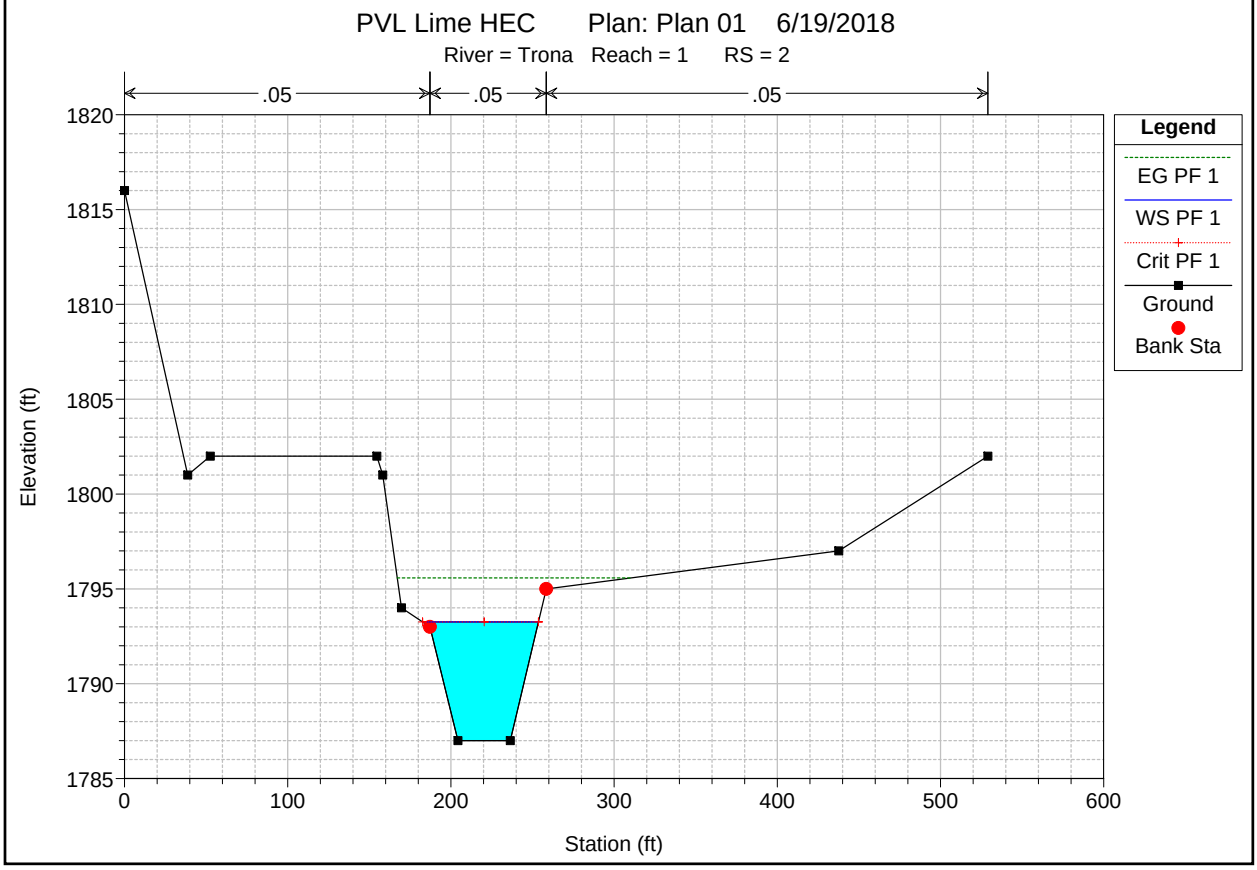
Appendix D
HEC-RAS Analysis

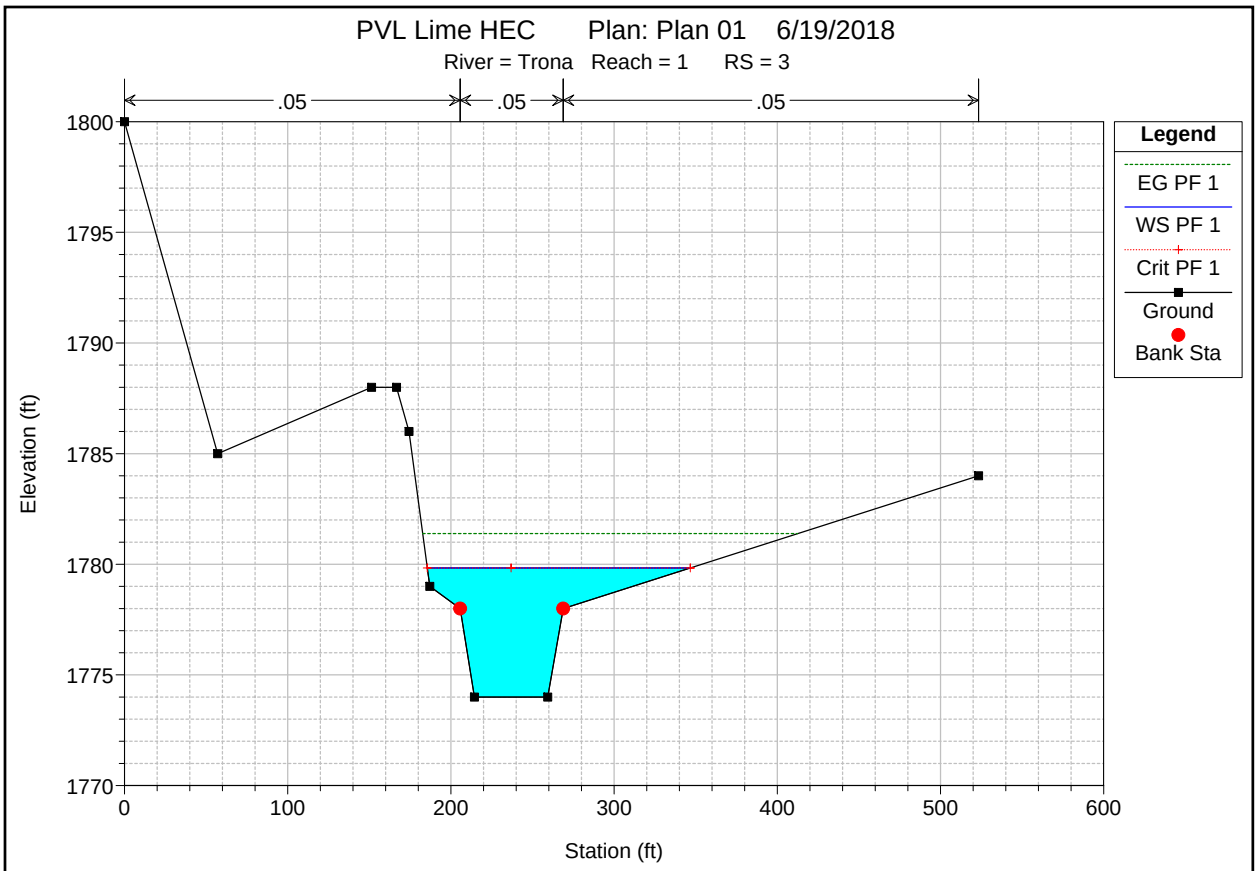
HEC-RAS Plan: Plan 01 River: Trona Reach: 1 Profile: PF 1

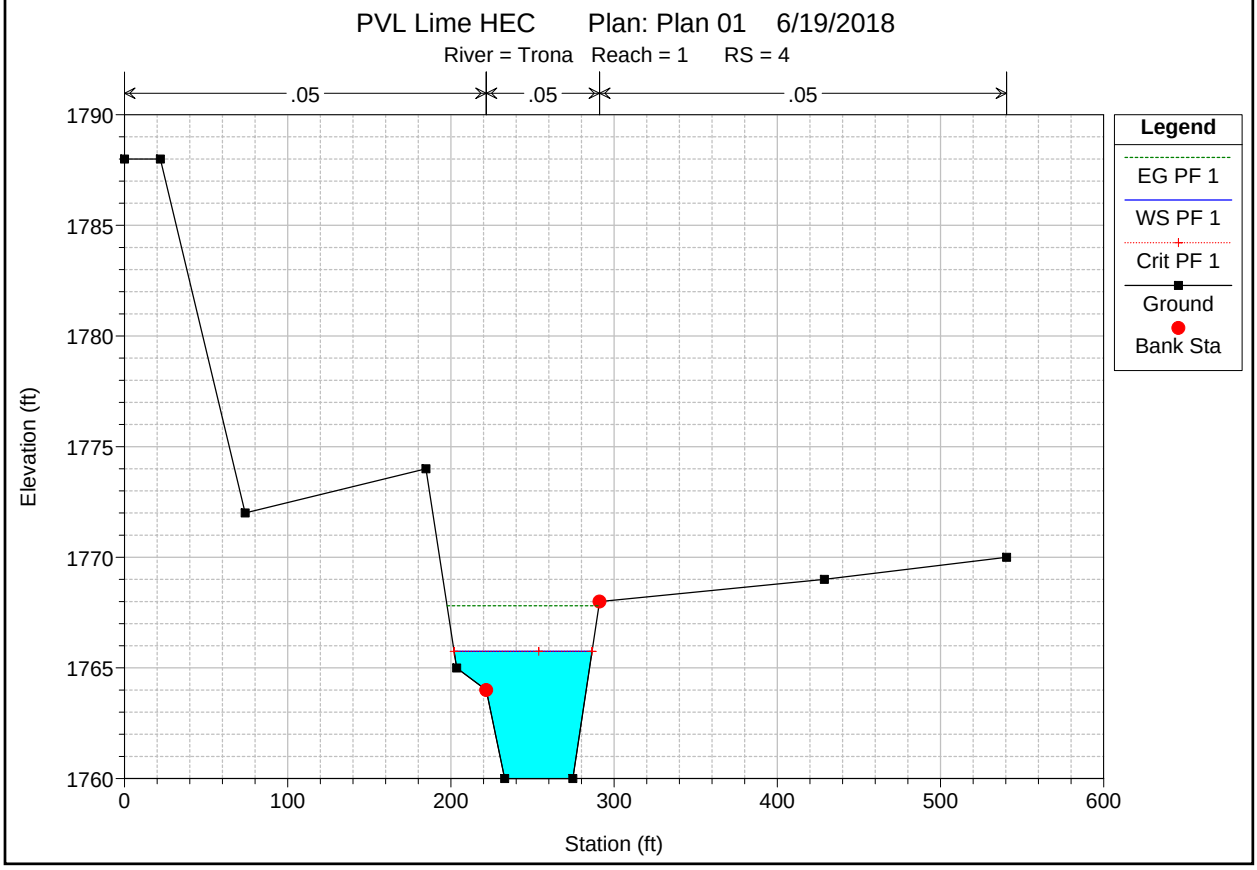
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	5	PF 1	3794.00	1747.00	1751.44	1751.44	1753.05	0.025047	10.18	372.62	115.79	1.00
1	4	PF 1	3794.00	1760.00	1765.75	1765.75	1767.81	0.019335	11.65	339.79	84.58	0.93
1	3	PF 1	3794.00	1774.00	1779.83	1779.83	1781.39	0.013909	10.41	428.66	161.12	0.80
1	2	PF 1	3794.00	1787.00	1793.26	1793.26	1795.58	0.022558	12.22	311.11	71.02	1.00
1	1	PF 1	3794.00	1801.00	1805.20	1805.20	1807.11	0.024128	11.10	342.13	92.43	1.00

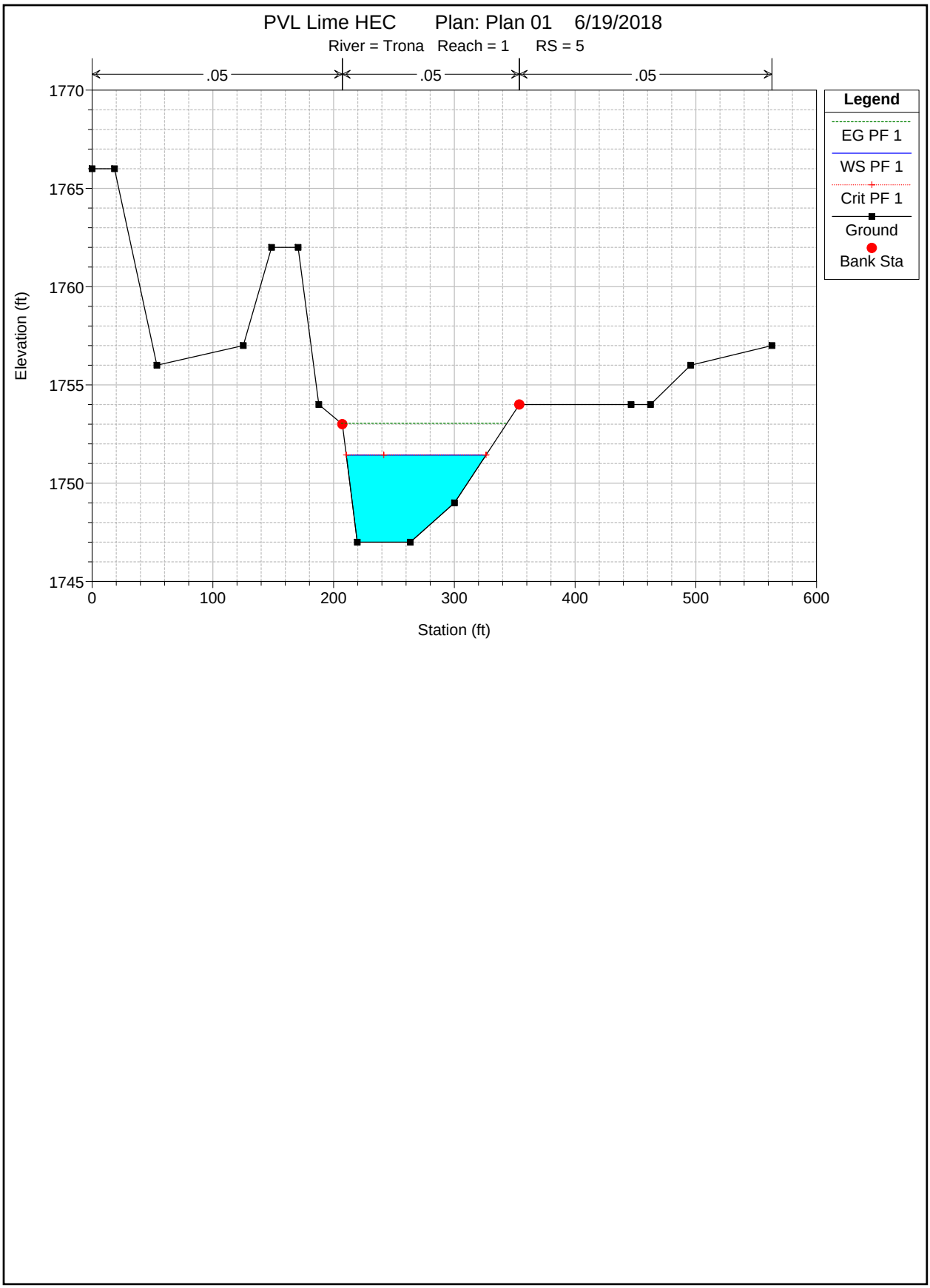

PVL Lime HEC Plan: Plan 01 6/19/2018
Trona 1
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Elevation (ft)
1810
1800
1790
1780
1770
1760
1750
1740
0
500
1000
1500
2000
Main Channel Distance (ft)

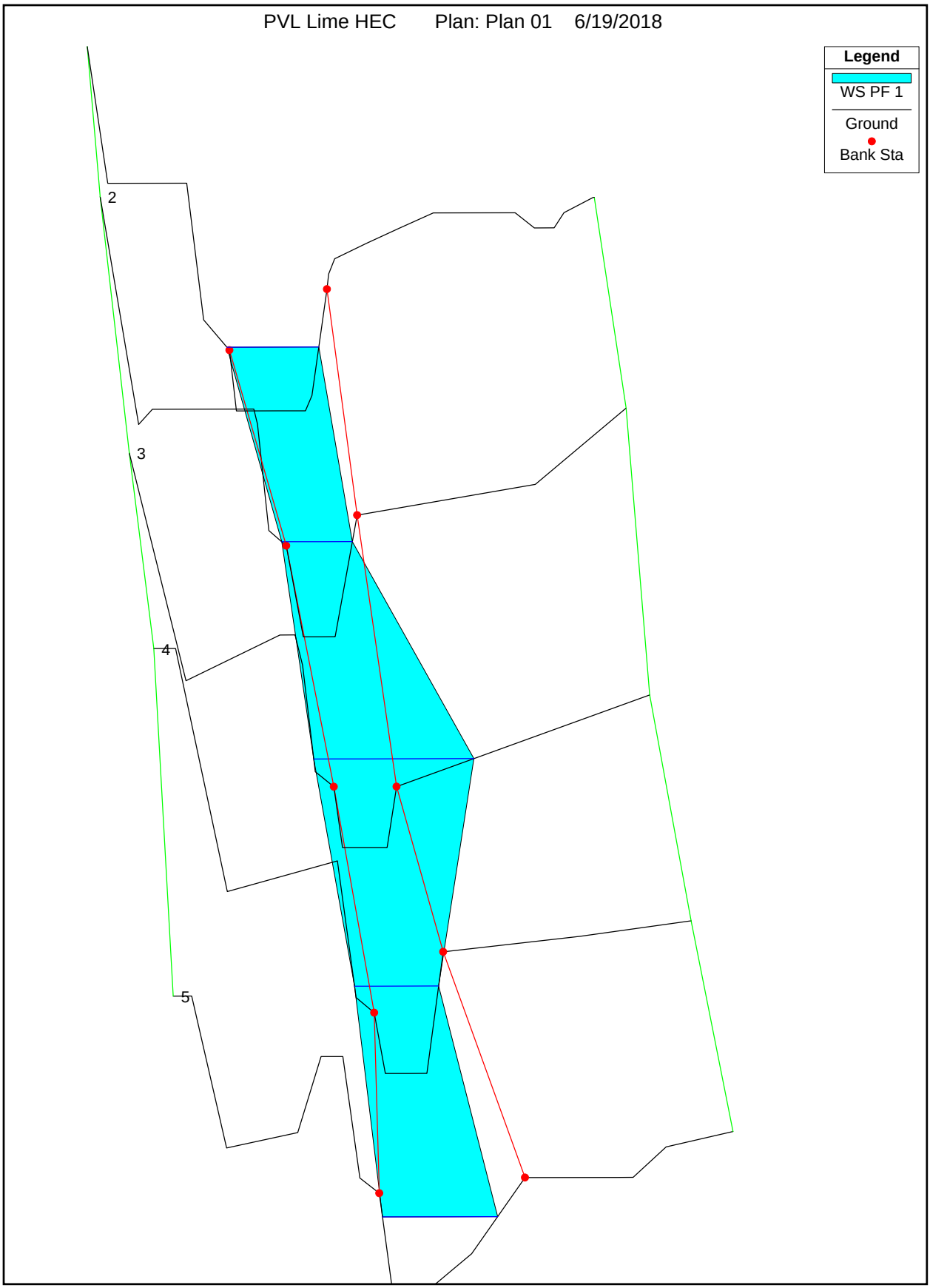

PVL Lime HEC Plan: Plan 01 6/19/2018
River = Trona Reach = 1 RS = 1
.05
.05
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
1825
1820
1815
1810
1805
1800
100
200
300
400
500
600
700


PVL Lime HEC Plan: Plan 01 6/19/2018
River = Trona Reach = 1 RS = 2
.05
.05
.05
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
1820
1815
1810
1805
1800
1795
1790
1785
0
100
200
300
400
500
600


PVL Lime HEC Plan: Plan 01 6/19/2018
River = Trona Reach = 1 RS = 3
.05
.05
.05
1800
1795
1790
1785
1780
1775
1770
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


PVL Lime HEC Plan: Plan 01 6/19/2018
River = Trona Reach = 1 RS = 4
.05
.05
.05
1790
1785
1780
1775
1770
1765
1760
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


PVL Lime HEC Plan: Plan 01 6/19/2018
River = Trona Reach = 1 RS = 5
.05
.05
.05
1770
1765
1760
1755
1750
1745
Elevation (ft)
0
100
200
300
400
500
600
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta


PVL Lime HEC Plan: Plan 01 6/19/2018
Legend
WS PF 1
Ground
Bank Sta
2
3
4
5