Civil Engineering

Land Planning

Hydrology/ Flood Control

Geotechnical Engineering

Public Works Services

Storm Water Management

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ON-SITE HYDROLOGY AND DRAINAGE ANALYSIS
CHIEF FARMS
50 W. NINE MILE CANYON ROAD
INYO COUNTY, CALIFORNIA

Prepared For:

ZAMORA DESIGN WORKSHOP
3215 San Marino Street, #7
Los Angeles, California 90006

Date: November 2020

Project: 6082.60

Approved: ______________________________
Robert W. Anderson, PE, JD, CPESC, CPSWQ, CMS4S, CESSWI
RCE 58383, Exp. 12-31-20

ON-SITE HYDROLOGY AND DRAINAGE STUDY
50 W. NINE MILE ROAD
PEARSONVILLE, CALIFORNIA

EXECUTIVE SUMMARY

RJR Engineering Group (RJR) has prepared this Hydrology and Drainage study in regard to the proposed agricultural improvements located at 50 W. Nine Mile Road, Pearsonville, California.

The scope of this drainage study is to characterize the hydrologic and hydraulic conditions of the onsite drainage scheme based on the proposed site improvements and the conveyance of storm flows from the proposed project. As part of this study, RJR has prepared Grading and Drainage plans outlining the proposed improvements.

The proposed site improvements will consist of minor grading to create a flat pad, construction of 5 green houses on concrete slabs, two pre-manufactured buildings placed on concrete slabs, a trash enclosure, underground agricultural runoff tank, a septic system and gravel parking area. Onsite drainage improvements include earthen swales, catch basins, PVC pipes, and biofiltration planters.

The proposed storm water facilities and improvements have all been designed for the interception and conveyance of the surface water runoff for a 100-year storm event in accordance with the County requirements. Runoff from the buildings is conveyed by roof down drains through pvc drainage pipes to the biofiltration planter. Runoff collected in the drive aisle and parking lot will sheet flow to the permeable pavers. Overall surface drainage surrounding the property will be improved to limit the risk of flooding and ponding during significant rainfall events.

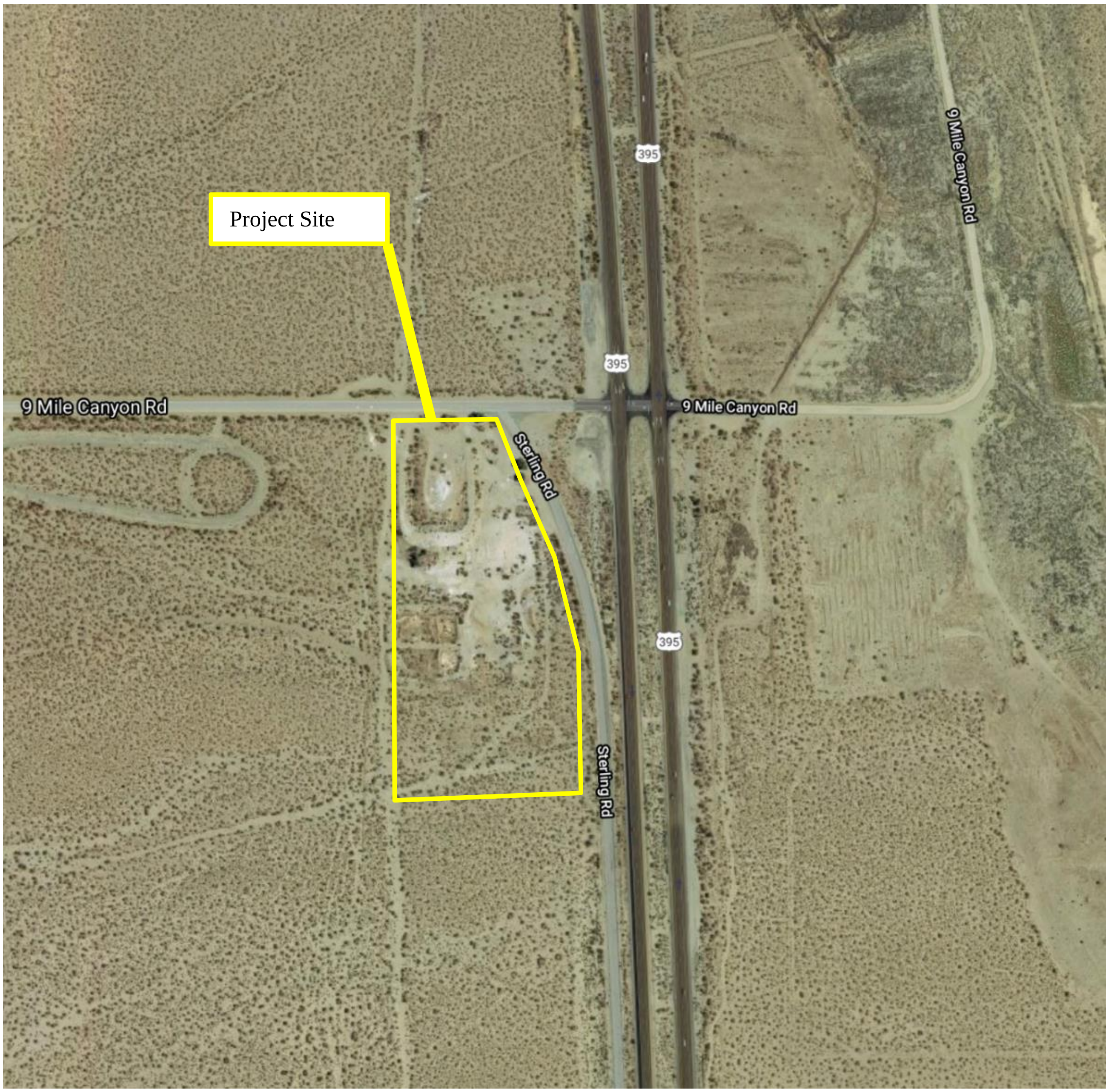
It should be noted that this report has been prepared solely as a hydrologic and hydraulic analysis for the proposed site and drainage improvements. This analysis pertains solely to the conveyance of surface water, the related drainage devices and the storm water management system and does not include any analysis or assumptions relating to downstream conditions. All recommendations described herein are based on hydraulic and hydrologic analysis. Any changes in design or failure to address the outlined recommendations can alter the subsequent calculations and render this report void.

1.0. SITE DESCRIPTION

1.1 Existing Site

The property is located at the southwest corner of 9 Mile Canyon Road and Highway 395 approximately three (3) miles north of Peasrsonville, California.

Image #1: Existing Site



The history of the property is unknown, however there is evidence of previous grading activities, piles of dirt, built up berms, piles of gravel and portions of old concrete structures. The site has no drainage structures and overall is undeveloped and consists of natural desert vegetation.

1.2 Regional Alluvial Flows

The project is situated near the base of an alluvial fan on the east side of the Sierra Nevada mountains. Alluvial fans are gently sloping, fan shaped landforms created by the deposition of rock and sediment from the adjacent mountain range. Hydraulic characteristics can vary between fans, due to headwaters, slopes, location etc. Alluvial fans may experience high-intensity short duration storms, and longer duration events due to snow back melt, etc. In addition, the soil within the fans is generally high mobile and runoff continuously changes direction and channelization of flows.

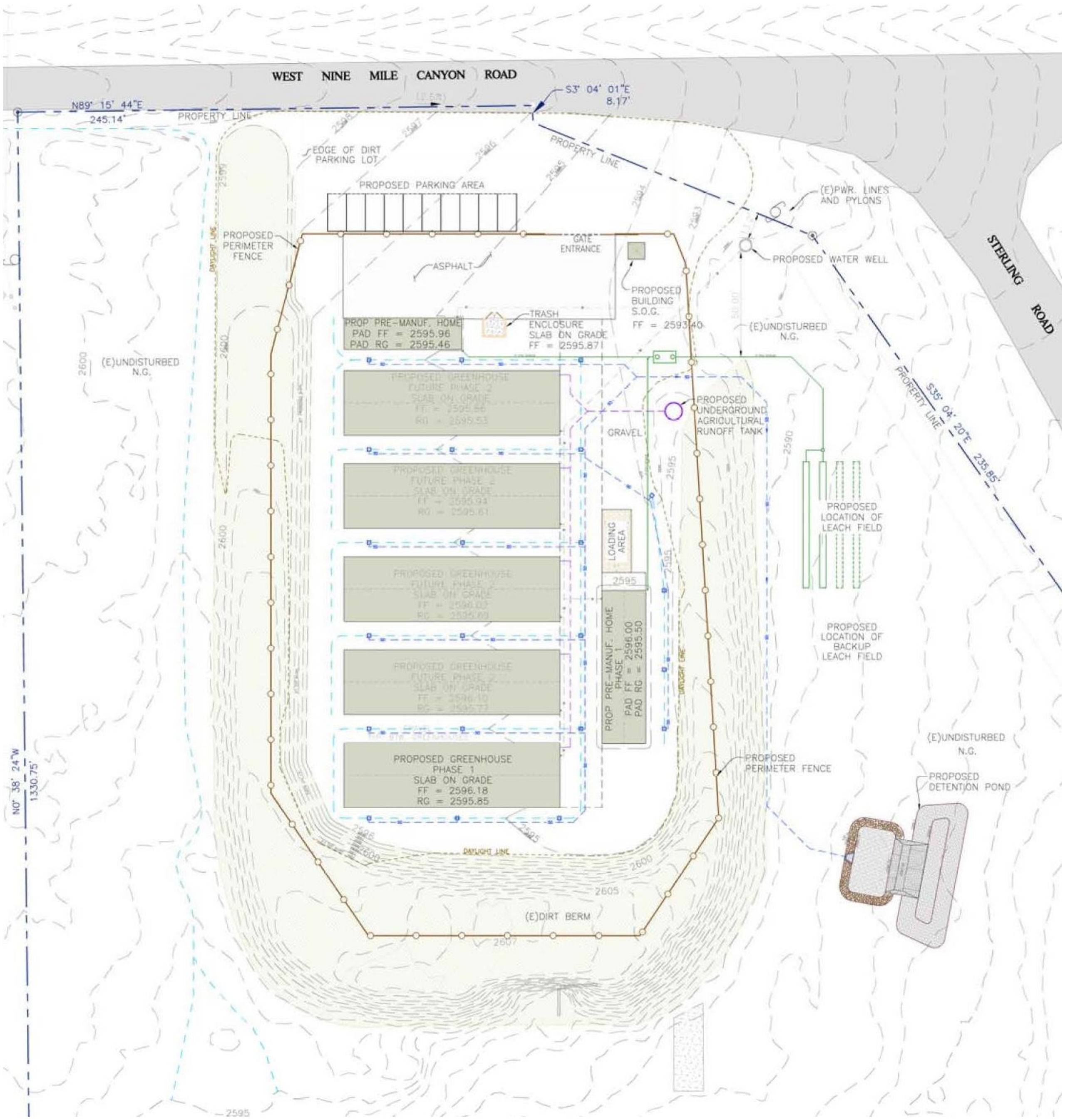
Due to the continuous braiding and meandering of flow paths through the alluvial fans, hydrologic impacts are difficult to predict and flood risk can change often. RJR analyzed the arial photography from the area as well as the site topography to determine if the subject site was in the direct line of an existing major runoff channel. (See the Regional Tributary Map provided in Appendix C for reference.) Based on the visible braiding and channels in the aerial photos, it was determined that the project site is located along a topographic expression which reduces the overall flood risk to the property. Alluvial runoff is directed both north and south around the pad.

The proposed site will also be designed as a raised pad with a large berm around 3 sides of pad. The pad design will deflect flows to the south around the site. Due to the soil types, erosion potential is high and regular continuous maintenance of the berms and pad perimeter are essential to limiting flooding potential.

1.3 Proposed Site

The project will consist of seven (7) buildings, including five (5) premanufactured greenhouses, one (1) premanufactured building for living quarters and one (1) premanufactured headhouse. Associated improvements include a gravel parking lot, an agricultural runoff tank, septic tank, leach fields and associated surface drainage facilities.

Image #2: Proposed Site Plan



2.0. HYDROLOGY INFORMATION

Inyo County does not have published hydrology standards and therefore RJR has implemented industry standards by utilizing the Soil Conservation Service (SCS) method and the County of San Bernardino standards as a basis of this study. The County of San Bernardino Hydrology Manual was utilized as a reference for the hydrologic conditions and rainfall data was gathered from the National Oceanic Atmospheric Administration (NOAA) for the project site to determine the applicable rainfall intensities.

Table 1– Precipitation Frequency Table

NOAA Atlas 14, Volume 6, Version 2
Location name: Inyokern, California, USA*
Latitude: 35.8416°, Longitude: -117.8766°
Elevation: 2598.65 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	0.064 (0.052-0.079)	0.087 (0.071-0.109)	0.122 (0.098-0.153)	0.152 (0.122-0.192)	0.198 (0.154-0.257)	0.236 (0.180-0.313)	0.279 (0.208-0.377)	0.325 (0.237-0.452)	0.395 (0.276-0.569)	0.453 (0.307-0.674)
10-min	0.091 (0.074-0.114)	0.125 (0.101-0.156)	0.175 (0.141-0.219)	0.218 (0.175-0.275)	0.284 (0.221-0.369)	0.339 (0.258-0.449)	0.399 (0.298-0.541)	0.466 (0.339-0.648)	0.565 (0.396-0.816)	0.649 (0.440-0.967)
15-min	0.110 (0.089-0.138)	0.152 (0.123-0.189)	0.211 (0.171-0.265)	0.264 (0.212-0.333)	0.343 (0.267-0.446)	0.410 (0.313-0.543)	0.483 (0.360-0.654)	0.564 (0.410-0.783)	0.684 (0.479-0.987)	0.785 (0.532-1.17)
30-min	0.151 (0.122-0.188)	0.208 (0.168-0.259)	0.290 (0.234-0.362)	0.362 (0.290-0.456)	0.470 (0.366-0.611)	0.561 (0.428-0.743)	0.662 (0.494-0.896)	0.773 (0.562-1.07)	0.937 (0.656-1.35)	1.08 (0.730-1.60)
60-min	0.207 (0.168-0.259)	0.285 (0.231-0.356)	0.397 (0.321-0.497)	0.496 (0.398-0.626)	0.645 (0.501-0.838)	0.770 (0.587-1.02)	0.908 (0.677-1.23)	1.06 (0.771-1.47)	1.29 (0.900-1.85)	1.48 (1.00-2.20)
2-hr	0.305 (0.247-0.380)	0.404 (0.327-0.504)	0.547 (0.441-0.684)	0.672 (0.538-0.847)	0.857 (0.666-1.11)	1.01 (0.772-1.34)	1.18 (0.881-1.60)	1.37 (0.993-1.90)	1.63 (1.14-2.36)	1.86 (1.26-2.77)
3-hr	0.373 (0.302-0.465)	0.491 (0.397-0.612)	0.657 (0.530-0.822)	0.803 (0.643-1.01)	1.02 (0.791-1.32)	1.20 (0.913-1.59)	1.39 (1.04-1.88)	1.60 (1.17-2.22)	1.91 (1.34-2.75)	2.16 (1.47-3.22)
6-hr	0.509 (0.413-0.635)	0.667 (0.539-0.832)	0.888 (0.717-1.11)	1.08 (0.866-1.36)	1.36 (1.06-1.77)	1.59 (1.21-2.11)	1.84 (1.37-2.49)	2.11 (1.53-2.93)	2.50 (1.75-3.60)	2.81 (1.91-4.19)
12-hr	0.651 (0.528-0.812)	0.872 (0.706-1.09)	1.18 (0.952-1.48)	1.44 (1.16-1.82)	1.83 (1.42-2.37)	2.13 (1.63-2.83)	2.47 (1.84-3.34)	2.82 (2.05-3.92)	3.33 (2.33-4.80)	3.74 (2.54-5.57)
24-hr	0.844 (0.750-0.969)	1.17 (1.03-1.34)	1.61 (1.43-1.86)	1.99 (1.75-2.31)	2.53 (2.14-3.04)	2.96 (2.46-3.64)	3.42 (2.77-4.31)	3.92 (3.08-5.08)	4.62 (3.48-6.24)	5.18 (3.78-7.26)
2-day	0.992 (0.881-1.14)	1.40 (1.24-1.61)	1.96 (1.74-2.26)	2.44 (2.14-2.83)	3.10 (2.63-3.73)	3.64 (3.02-4.47)	4.20 (3.40-5.29)	4.80 (3.78-6.22)	5.63 (4.25-7.62)	6.31 (4.60-8.83)
3-day	1.07 (0.946-1.22)	1.52 (1.35-1.75)	2.15 (1.90-2.48)	2.68 (2.35-3.12)	3.42 (2.90-4.11)	4.01 (3.33-4.92)	4.62 (3.74-5.82)	5.27 (4.15-6.84)	6.19 (4.67-8.37)	6.92 (5.05-9.70)
4-day	1.12 (0.994-1.29)	1.61 (1.43-1.85)	2.29 (2.02-2.64)	2.85 (2.50-3.32)	3.65 (3.09-4.39)	4.28 (3.55-5.26)	4.94 (4.00-6.22)	5.64 (4.44-7.31)	6.62 (4.99-8.95)	7.40 (5.39-10.4)
7-day	1.20 (1.07-1.38)	1.73 (1.54-1.99)	2.47 (2.19-2.85)	3.10 (2.72-3.61)	3.99 (3.38-4.80)	4.70 (3.90-5.77)	5.44 (4.40-6.85)	6.22 (4.90-8.06)	7.32 (5.53-9.90)	8.20 (5.98-11.5)
10-day	1.24 (1.10-1.42)	1.79 (1.59-2.06)	2.57 (2.27-2.96)	3.23 (2.84-3.76)	4.18 (3.55-5.03)	4.94 (4.10-6.07)	5.73 (4.64-7.22)	6.58 (5.18-8.53)	7.78 (5.87-10.5)	8.73 (6.36-12.2)
20-day	1.38 (1.23-1.59)	2.02 (1.79-2.32)	2.93 (2.59-3.37)	3.71 (3.25-4.31)	4.84 (4.11-5.83)	5.76 (4.79-7.08)	6.74 (5.46-8.49)	7.78 (6.13-10.1)	9.25 (6.98-12.5)	10.4 (7.60-14.6)
30-day	1.56 (1.39-1.79)	2.28 (2.02-2.62)	3.32 (2.94-3.83)	4.23 (3.71-4.92)	5.56 (4.71-6.68)	6.63 (5.51-8.15)	7.78 (6.30-9.80)	9.00 (7.08-11.7)	10.7 (8.09-14.5)	12.1 (8.82-16.9)
45-day	1.77 (1.57-2.04)	2.60 (2.31-2.99)	3.80 (3.36-4.38)	4.85 (4.26-5.64)	6.41 (5.44-7.71)	7.69 (6.39-9.45)	9.04 (7.32-11.4)	10.5 (8.25-13.6)	12.5 (9.44-16.9)	14.1 (10.3-19.8)
60-day	1.97 (1.75-2.27)	2.88 (2.55-3.31)	4.21 (3.72-4.85)	5.37 (4.72-6.25)	7.10 (6.02-8.54)	8.52 (7.07-10.5)	10.0 (8.13-12.6)	11.6 (9.15-15.1)	13.9 (10.5-18.8)	15.7 (11.4-21.9)

[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.

A copy of the Precipitation Data from NOAA, graphs and maps have been provided in Appendix A for reference.

2.1. Soil Cover & Hydraulic Conditions

The runoff coefficient for the subject site is dependent on the rainfall intensity, drainage area slope, type and amount of vegetative cover and infiltration capacity of the ground surface. Surface type descriptions and cover conditions are based on SCS standards and were pulled from the County of San Bernardino Hydrology Manual.

2.1.1 Soil Group

The largest factor affecting infiltration rates is the nature of the soil. Soils are classified by the Soil Conservation Service (SCS) in groups A through D based on water transmission rate.

Group A: Low runoff potential. Soils have high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well-drained sands or gravels. These soils have a high rate of water transmission. (greater than 1.42 inches per hour)

Group B: Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained sandy-loam soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. (greater than 0.57 inches per hour, but less than 1.42 inches per hour)

Group C: Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of silty-loam soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission. (greater than 0.06 inches per hour, but less than 0.57 inches per hour)

Group D: High runoff potential. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission. (less than 0.06 inches per hour)

The site specific Geotechnical Engineering Investigation, prepared by BSK Associates, September 30, 2020, found that the site soils consist of silty sands. BSK Associates also conducted percolation testing and found that the site soils percolated at a rate of 4.44 inches per hour and 5.71 inches per hour. Therefore the site has high infiltration rates of greater than 1.42 inches per hour and is classified as *Group A* soils.

2.1.2 Soil Condition

The quality and density of ground cover has a major impact on the infiltration capacity of a given soil. Cover type descriptions as provided by the County of San Bernardino Hydrology Manual are as follows:

Poor: Heavily grazed or regularly burned areas. Less than 50 percent of the ground surface is protected by plant cover or brush tree canopy.

Fair: moderate cover with 50 percent to 75 percent of the ground surface protected by vegetation.

Good: Heavy or dense cover with more than 75% of the ground surface protected by vegetation.

About 40% of the subject site has had past surface activity/grading and plants have been removed. This area would be considered as *Poor* cover condition. The remaining portion of the site has natural desert sage cover and would be considered *Fair*. Since the proposed site improvements will be concentrated in the disturbed soil area, a *Poor* condition has been selected.

2.1.3 Cover Type

The undeveloped cover type impacts the infiltration capacity of the underlying soil. The proposed site has growth of desert sage and grasses typical of the area. A curve number (CN) was pulled from the "Curve Numbers for Pervious Areas" chart (Figure C-3) of the San Bernardino County Hydrology Manual. A copy of Figure C-3 has been provided in Appendix A for reference.

CN for Open Brush, Poor, Type A = 62

Table 2– Hydrology Summary Table

Location	Soil Group	Soil Type	Cover Type	Cover Condition	CN (AMC II)
Project Site	A	Silty Sand	Open Brush (sage, etc.)	Poor	62

2.1.3 Cover Type

The undeveloped cover type impacts the infiltration capacity of the underlying soil. The proposed site has growth of desert sage and grasses typical of the area. A curve number (CN) was pulled from the "Curve Numbers for Pervious Areas" chart (Figure C-3) of the San Bernardino County Hydrology Manual. A copy of Figure C-3 has been provided in Appendix A for reference.

CN for Open Brush, Poor, Type A = 62

3.0 Rational Method Calculations

Using the above data RJR calculated the corresponding flow per acre values utilizing the Modified Rational Method.

$$Q = CIA$$

Computations for the runoff coefficient (C) and the rainfall intensity (I) are based on the data gathered in Section 2.0 and the calculations provided in the County of San Bernardino County Hydrology Manual.

3.0.1 Time of Concentration

The time of concentration (Tc) is the interval of time (in minutes) required for the flow at a given point to become a maximum under a uniform rainfall intensity. In general, the time of concentration is the interval of time from the beginning of rainfall for water from the hydraulically most remote portion of the drainage area to reach the point of concentration.

Tc values were determined based on the Time of Concentration Nomograph provided in the San Bernardino County Hydrology Manual. Copies of the nomographs are provided in Appendix A for reference.

Table 1 – Time of Concentration Summary

Sub-Area	Length (L)	∆ Elevation (H)	Tc Undeveloped	Tc Developed
A	265’	6’	11 min.	-
A_{DEV}	400’	3’	-	9.5 min.
B	830	15’	17 min.	-
C	760	20’	15.5 min.	-

3.0.2 Runoff Coefficient

Rainfall intensity (I) was determined utilizing the Participation Frequency Table (See Table 1.0) sourced from NOAA as well as the San Bernardino County log-log paper (See Figure D-3 within the San Bernardino County Hydrology Manual). A copy of the log-log chart has been provided in Appendix A for reference.

The 1-hour point rainfall value from the NOAA data on Table-1 was plotted on the log-log chart. A straight line was then drawn through the 1-hour value, parallel to the required slope line. The San Bernardino County Hydrology Manual, Section D.4 provides a slope of the intensity duration curve to be 0.70.

A copy of the chart has been provided in Appendix A for reference.

Table 2 – Rainfall Intensity Summary

Sub-Area	Tc (min.)	Log-Log Slope (s)	10-year Intensity (in/hr)	100-year Intensity (in/hr)
A	11	.70	1.6	2.3
A_{DEV}	9.5	.70	1.8	2.5
B	17	.70	1.35	3.1
C	15.5	.70	1.25	3.3

3.0.3 Runoff Coefficient

The runoff coefficient (C) is the ratio of rate of runoff to the rate of rainfall at an average intensity (I) when the total drainage area is contributing. The runoff coefficient depends on rainfall intensity, drainage area slope, type and amount of vegetative cover, infiltration capacity of the ground surface and various factors.

$$C = 0.90\frac{(a_i + (I - F_p)a_p)}{I}$$

Where:

C	=	*runoff coefficient*
I	=	*rainfall intensity (inches/hour)*
F_p	=	*infiltration rate for pervious areas (inches/hour)*
a_i	=	*ratio of impervious area*
A_p	=	*ration of pervious area*

Infiltration rates (Fp) are based on SCS curve numbers provided in the San Bernardino County hydrology manual, Figure C-6. A copy of Figure C-6 has been provided in Appendix A for reference. The CN number for AMC II soils are applied to a table to achieve the infiltration rate in inches per hour. The resulting infiltration rate for the watershed are is 0.66 inches per hour. In order to provide a conservative analysis, RJR utilized the lowest intensities to determine the existing condition C values. The lower intensities allow for a greater Δ value when accounting for the increase impervious area due to the proposed development.

Design Storm = 100 Year (Pre-developed)

$$C = 0.90 \frac{(.01 + (2.3 - .66).99)}{2.3}$$

C = 0.64

Design Storm = 10 Year (Pre-developed)

$$C = 0.90 \frac{(.01 + (1.6 - .66).99)}{1.8}$$

C = 0.57

Design Storm = 10 Year (Developed)

$$C = 0.90 \frac{(.22 + (1.8 - .66).88)}{1.8}$$

C = 0.59

Design Storm = 100 Year (Developed)

$$C = 0.90 \frac{(.22 + (2.5 - .66).88)}{2.5}$$

C = 0.66

Developed C values are based on the Time of Concentration for the developed pad as well as the increase impervious are ratio from the proposed improvements.

The proposed site improvements will be contained entirely within Sub Area ‘A’. The Site will be graded, green houses installed, and the pad will then be covered in gravel. Compaction of the subgrade, vehicle/equipment traffic and the addition of buildings will alter the characteristics of the soil and the ratio of impervious area.

Proposed Impermeable Area = 18,466 sq.ft. (22%)

3.0.4 Sub Area Runoff Calculations

$$Q = CIA$$

The following table has been comprised to illustrate the resulting flows:

Table 3 - Sub-Area Breakout Table

Sub-Area	Area (acre)	C (10yr/100yr)	10-year Intensity (in/hr)	100-year Intensity (in/hr)	Q10 (cfs)	Q100 (cfs)
A	1.9	0.57/0.64	1.6	2.3	1.7	2.8
A_{DEV}	1.9	0.59/0.66	1.8	2.5	2.0	3.1
B	2.7	0.57/0.64	1.35	3.1	2.1	5.4
C	5.3	0.57/0.64	1.25	3.3	3.8	11.2

4.0. STORMWATER MITIGATION

The addition of the proposed buildings will increase the impermeable area on the site by approximately 22%. The increase of impervious surface area will also increase the storm water runoff from the property during 10 year and 100 year storm events. Therefore, storm water runoff from the developed site will cause an increase in stormwater runoff from the site. Although there are no storm drain facilities in the area, the drainage from the alluvial fans on the east side of the Sierra Nevada mountains must cross under highway 395 at installed culvert crossings. The impact form the development on any downstream culverts will be minimal however, an impact may occur by development over time. Therefore in order to mitigate the increase stormwater runoff, a proposed surface basin will be utilized to capture the increased runoff and allow for infiltration into the ground.

4.1 Basin Sizing

Existing Condition

Sub-Area A	100 year flow rate	= 2.8 cfs
	Volume over Tc	= (2.8 cfs x 60 sec) 9.5 min = 1,596 cubic feet

Proposed Condition

Sub-Area A	100 year flow rate	= 3.1cfs
	Volume over Tc	= (3.1 cfs x 60 sec) 9.5 min = 1,767 cubic feet

Basin Volume = Proposed Flow Volume – Existing Flow Volume
= 1767cf – 1596cf
= 171 cubic feet

The basin will be sized a minimum storage capacity of 175 cubic feet to meet the detention requirements. In addition, the basin will be sized to treat the 0.75 in storm event to meet Post Construction Stormwater Mitigation requirements. See Post Construction Stormwater Mitigation report prepared as part of this design.

4.0. HYDRAULIC ANALYSIS

Storm Drain Facility Design

One dimensional supportive calculation for various drainage structures (PVC pipes, area drains, v-ditches etc.) are included in Appendix B. All the drainage structures have been sufficiently designed to convey the Q_{100} flows to the corresponding storm drain system.

The Hydrology Map in Appendix C illustrates the total drainage areas and the corresponding flow rates (Q's) for the specific conditions and flood frequencies, as well as the proposed permeable paving, pipes, detention basins and bio-filtration planter locations and any other relevant information.

5.0. CONCLUSION

Based on the available data and analysis, it is of the opinion of RJR that the proposed storm drain system is hydraulically adequate to provide the necessary conveyance of stormwater from the 100 year storm event. In addition, the proposed system will mitigate any potential issues with downstream properties.

Again, it should be noted that this report has been prepared solely as a surficial hydrology and hydraulic analysis for the grading and drainage improvements. The hydrology and hydraulic calculations are based on the survey provided, visual field measurements, civil plans designed by RJR, and the architectural and landscape structures designed by others. All recommendations described herein are based on hydraulic analysis associated with the above referenced grading and drainage design and any changes in design or failure to address the outlined recommendations can alter the subsequent calculations and render this report void.

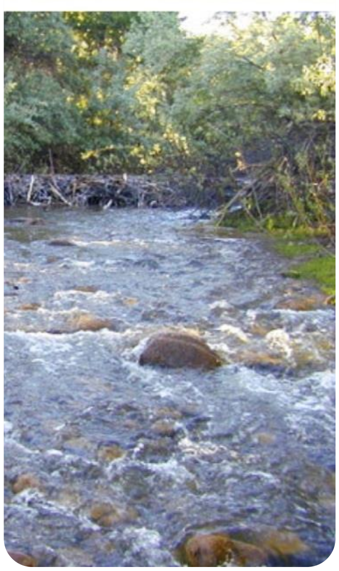
REFERENCES

1. NOAA Atlas 14, Volume 6, Version 2.0

2. Hydrology Manual, San Bernardino County, August 1986

3. Urban Hydrology for Small Watersheds TR-55, United States Department of Agriculture, June 1986.



APPENDIX A

Hydrology Information

1. NOAA Precipitation Data
2. Time of Concentration Plates
3. Intensity-Duration Curves

NOAA Atlas 14, Volume 6, Version 2
Location name: Inyokern, California, USA*
Latitude: 35.8416°, Longitude: -117.8766°
Elevation: 2598.65 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	0.064 (0.052-0.079)	0.087 (0.071-0.109)	0.122 (0.098-0.153)	0.152 (0.122-0.192)	0.198 (0.154-0.257)	0.236 (0.180-0.313)	0.279 (0.208-0.377)	0.325 (0.237-0.452)	0.395 (0.276-0.569)	0.453 (0.307-0.674)
10-min	0.091 (0.074-0.114)	0.125 (0.101-0.156)	0.175 (0.141-0.219)	0.218 (0.175-0.275)	0.284 (0.221-0.369)	0.339 (0.258-0.449)	0.399 (0.298-0.541)	0.466 (0.339-0.648)	0.565 (0.396-0.816)	0.649 (0.440-0.967)
15-min	0.110 (0.089-0.138)	0.152 (0.123-0.189)	0.211 (0.171-0.265)	0.264 (0.212-0.333)	0.343 (0.267-0.446)	0.410 (0.313-0.543)	0.483 (0.360-0.654)	0.564 (0.410-0.783)	0.684 (0.479-0.987)	0.785 (0.532-1.17)
30-min	0.151 (0.122-0.188)	0.208 (0.168-0.259)	0.290 (0.234-0.362)	0.362 (0.290-0.456)	0.470 (0.366-0.611)	0.561 (0.428-0.743)	0.662 (0.494-0.896)	0.773 (0.562-1.07)	0.937 (0.656-1.35)	1.08 (0.730-1.60)
60-min	0.207 (0.168-0.259)	0.285 (0.231-0.356)	0.397 (0.321-0.497)	0.496 (0.398-0.626)	0.645 (0.501-0.838)	0.770 (0.587-1.02)	0.908 (0.677-1.23)	1.06 (0.771-1.47)	1.29 (0.900-1.85)	1.48 (1.00-2.20)
2-hr	0.305 (0.247-0.380)	0.404 (0.327-0.504)	0.547 (0.441-0.684)	0.672 (0.538-0.847)	0.857 (0.666-1.11)	1.01 (0.772-1.34)	1.18 (0.881-1.60)	1.37 (0.993-1.90)	1.63 (1.14-2.36)	1.86 (1.26-2.77)
3-hr	0.373 (0.302-0.465)	0.491 (0.397-0.612)	0.657 (0.530-0.822)	0.803 (0.643-1.01)	1.02 (0.791-1.32)	1.20 (0.913-1.59)	1.39 (1.04-1.88)	1.60 (1.17-2.22)	1.91 (1.34-2.75)	2.16 (1.47-3.22)
6-hr	0.509 (0.413-0.635)	0.667 (0.539-0.832)	0.888 (0.717-1.11)	1.08 (0.866-1.36)	1.36 (1.06-1.77)	1.59 (1.21-2.11)	1.84 (1.37-2.49)	2.11 (1.53-2.93)	2.50 (1.75-3.60)	2.81 (1.91-4.19)
12-hr	0.651 (0.528-0.812)	0.872 (0.706-1.09)	1.18 (0.952-1.48)	1.44 (1.16-1.82)	1.83 (1.42-2.37)	2.13 (1.63-2.83)	2.47 (1.84-3.34)	2.82 (2.05-3.92)	3.33 (2.33-4.80)	3.74 (2.54-5.57)
24-hr	0.844 (0.750-0.969)	1.17 (1.03-1.34)	1.61 (1.43-1.86)	1.99 (1.75-2.31)	2.53 (2.14-3.04)	2.96 (2.46-3.64)	3.42 (2.77-4.31)	3.92 (3.08-5.08)	4.62 (3.48-6.24)	5.18 (3.78-7.26)
2-day	0.992 (0.881-1.14)	1.40 (1.24-1.61)	1.96 (1.74-2.26)	2.44 (2.14-2.83)	3.10 (2.63-3.73)	3.64 (3.02-4.47)	4.20 (3.40-5.29)	4.80 (3.78-6.22)	5.63 (4.25-7.62)	6.31 (4.60-8.83)
3-day	1.07 (0.946-1.22)	1.52 (1.35-1.75)	2.15 (1.90-2.48)	2.68 (2.35-3.12)	3.42 (2.90-4.11)	4.01 (3.33-4.92)	4.62 (3.74-5.82)	5.27 (4.15-6.84)	6.19 (4.67-8.37)	6.92 (5.05-9.70)
4-day	1.12 (0.994-1.29)	1.61 (1.43-1.85)	2.29 (2.02-2.64)	2.85 (2.50-3.32)	3.65 (3.09-4.39)	4.28 (3.55-5.26)	4.94 (4.00-6.22)	5.64 (4.44-7.31)	6.62 (4.99-8.95)	7.40 (5.39-10.4)
7-day	1.20 (1.07-1.38)	1.73 (1.54-1.99)	2.47 (2.19-2.85)	3.10 (2.72-3.61)	3.99 (3.38-4.80)	4.70 (3.90-5.77)	5.44 (4.40-6.85)	6.22 (4.90-8.06)	7.32 (5.53-9.90)	8.20 (5.98-11.5)
10-day	1.24 (1.10-1.42)	1.79 (1.59-2.06)	2.57 (2.27-2.96)	3.23 (2.84-3.76)	4.18 (3.55-5.03)	4.94 (4.10-6.07)	5.73 (4.64-7.22)	6.58 (5.18-8.53)	7.78 (5.87-10.5)	8.73 (6.36-12.2)
20-day	1.38 (1.23-1.59)	2.02 (1.79-2.32)	2.93 (2.59-3.37)	3.71 (3.25-4.31)	4.84 (4.11-5.83)	5.76 (4.79-7.08)	6.74 (5.46-8.49)	7.78 (6.13-10.1)	9.25 (6.98-12.5)	10.4 (7.60-14.6)
30-day	1.56 (1.39-1.79)	2.28 (2.02-2.62)	3.32 (2.94-3.83)	4.23 (3.71-4.92)	5.56 (4.71-6.68)	6.63 (5.51-8.15)	7.78 (6.30-9.80)	9.00 (7.08-11.7)	10.7 (8.09-14.5)	12.1 (8.82-16.9)
45-day	1.77 (1.57-2.04)	2.60 (2.31-2.99)	3.80 (3.36-4.38)	4.85 (4.26-5.64)	6.41 (5.44-7.71)	7.69 (6.39-9.45)	9.04 (7.32-11.4)	10.5 (8.25-13.6)	12.5 (9.44-16.9)	14.1 (10.3-19.8)
60-day	1.97 (1.75-2.27)	2.88 (2.55-3.31)	4.21 (3.72-4.85)	5.37 (4.72-6.25)	7.10 (6.02-8.54)	8.52 (7.07-10.5)	10.0 (8.13-12.6)	11.6 (9.15-15.1)	13.9 (10.5-18.8)	15.7 (11.4-21.9)

[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.

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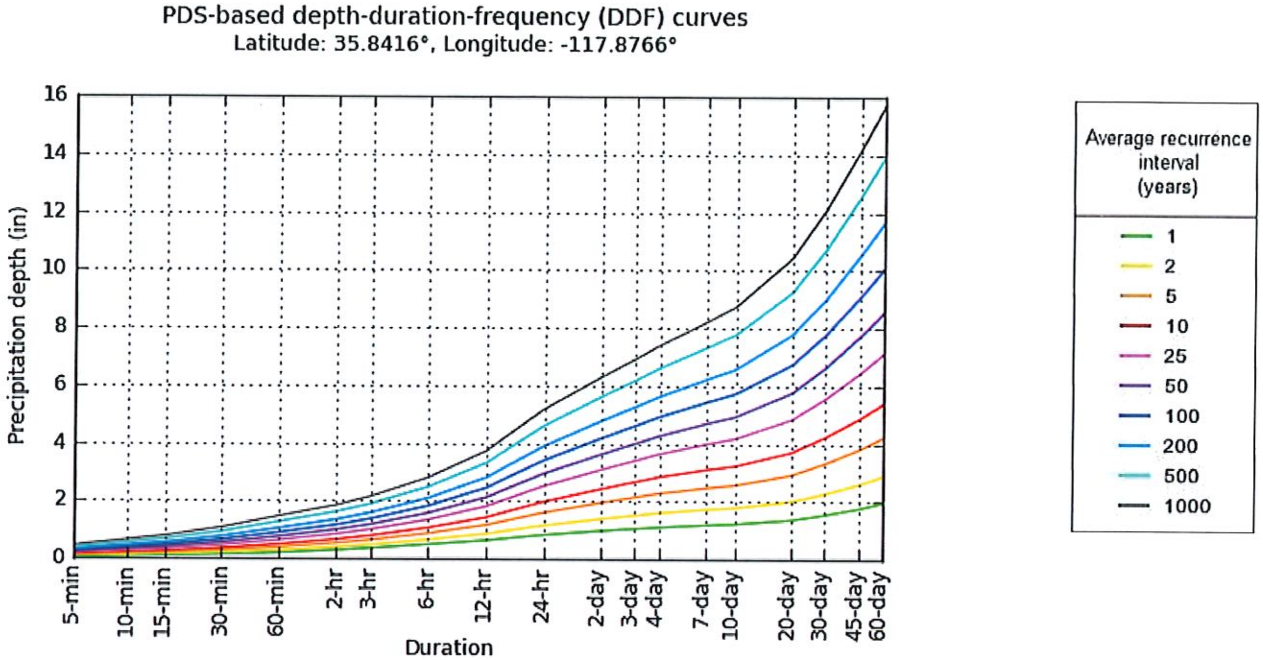
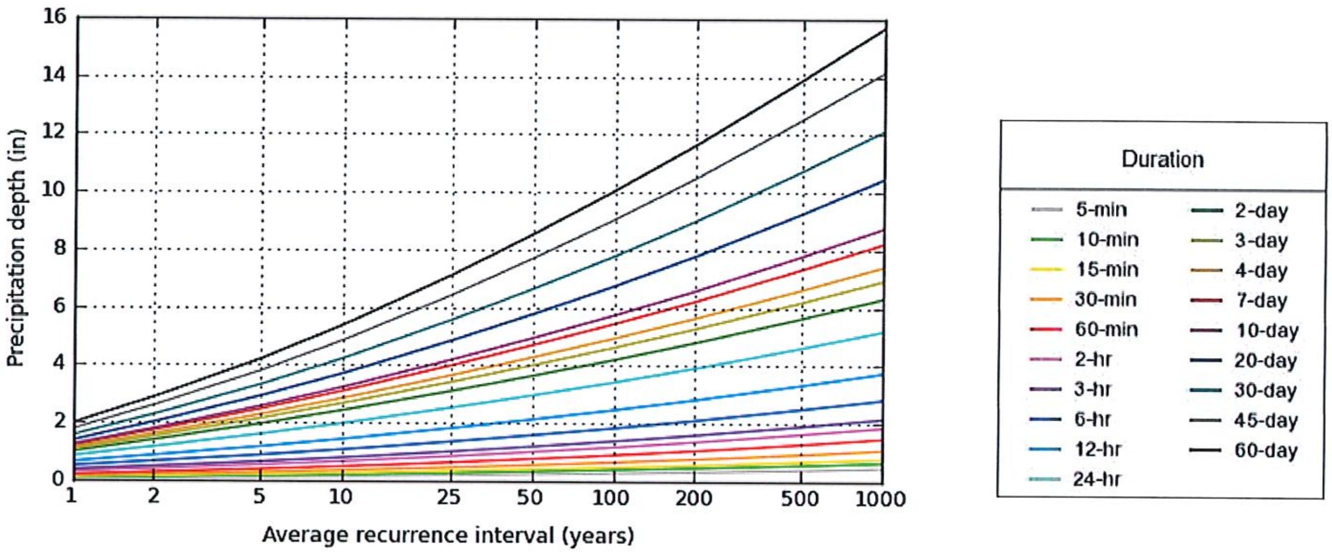
PF graphical





NOAA Atlas 14, Volume 6, Version 2

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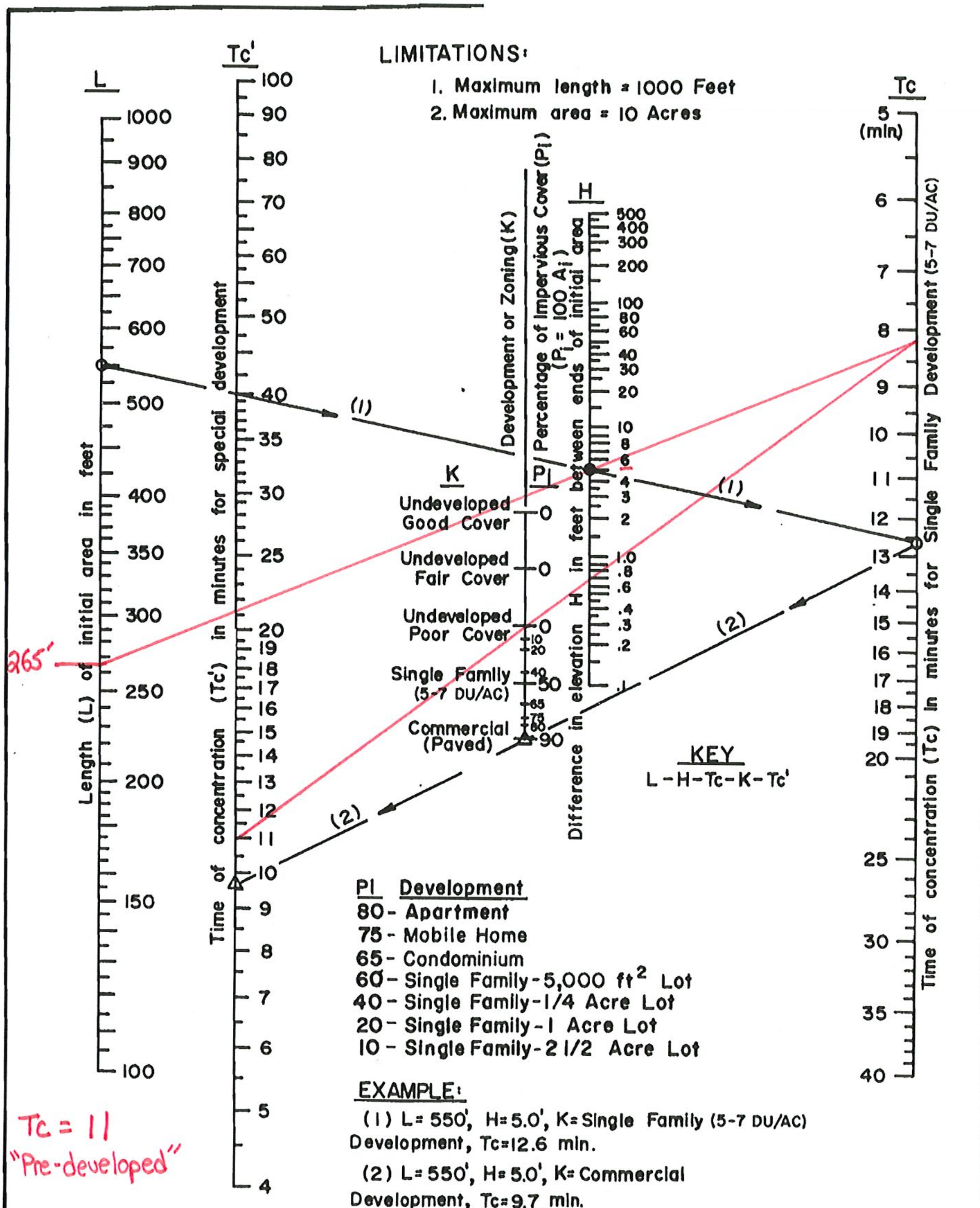
Maps & aerials

Small scale terrain

Existing Condition - Area 'A'



SAN BERNARDINO COUNTY

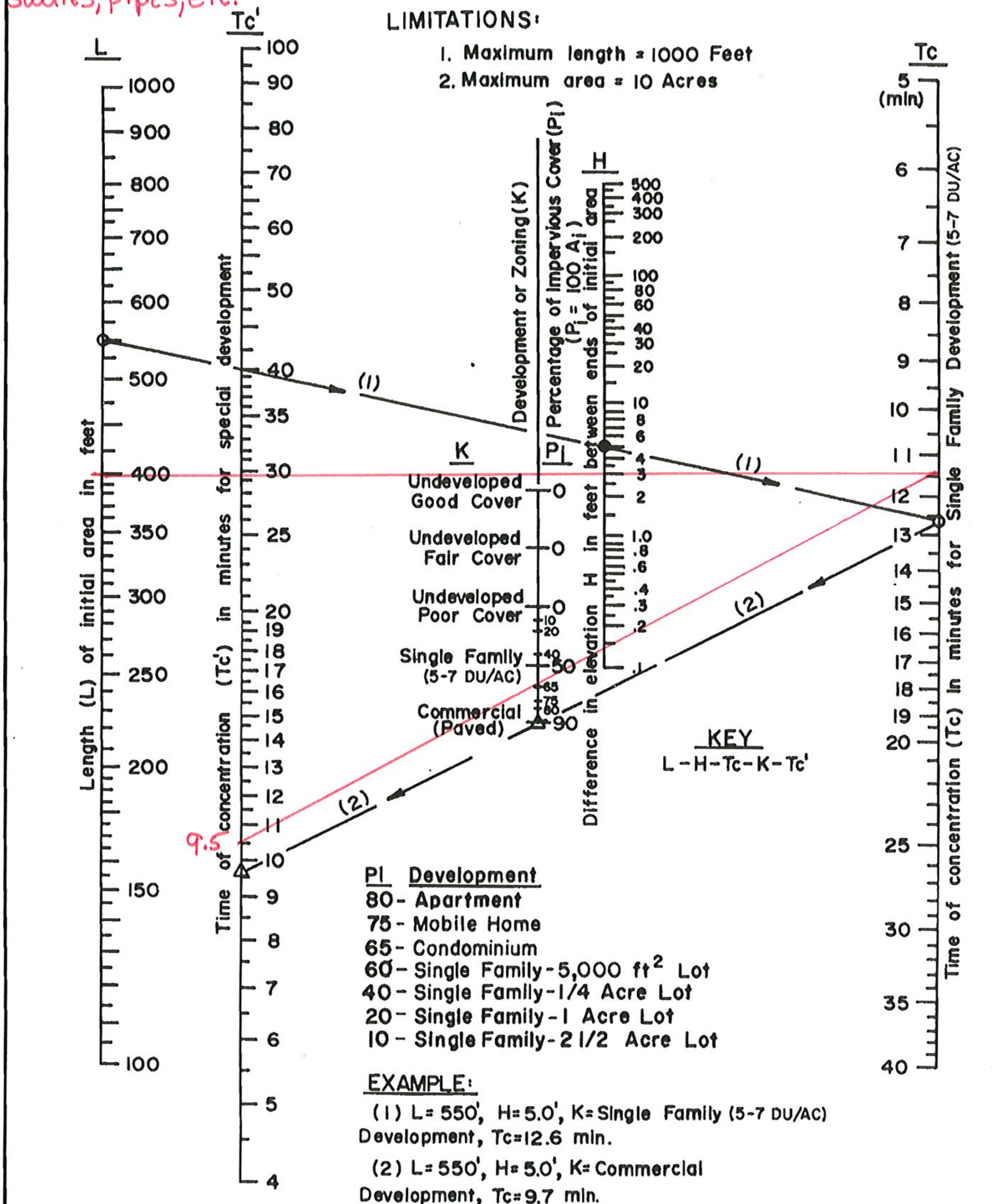
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

Developed Condition - Area 'A'
"proposed"

Length increased due grading, swales, pipes, etc.

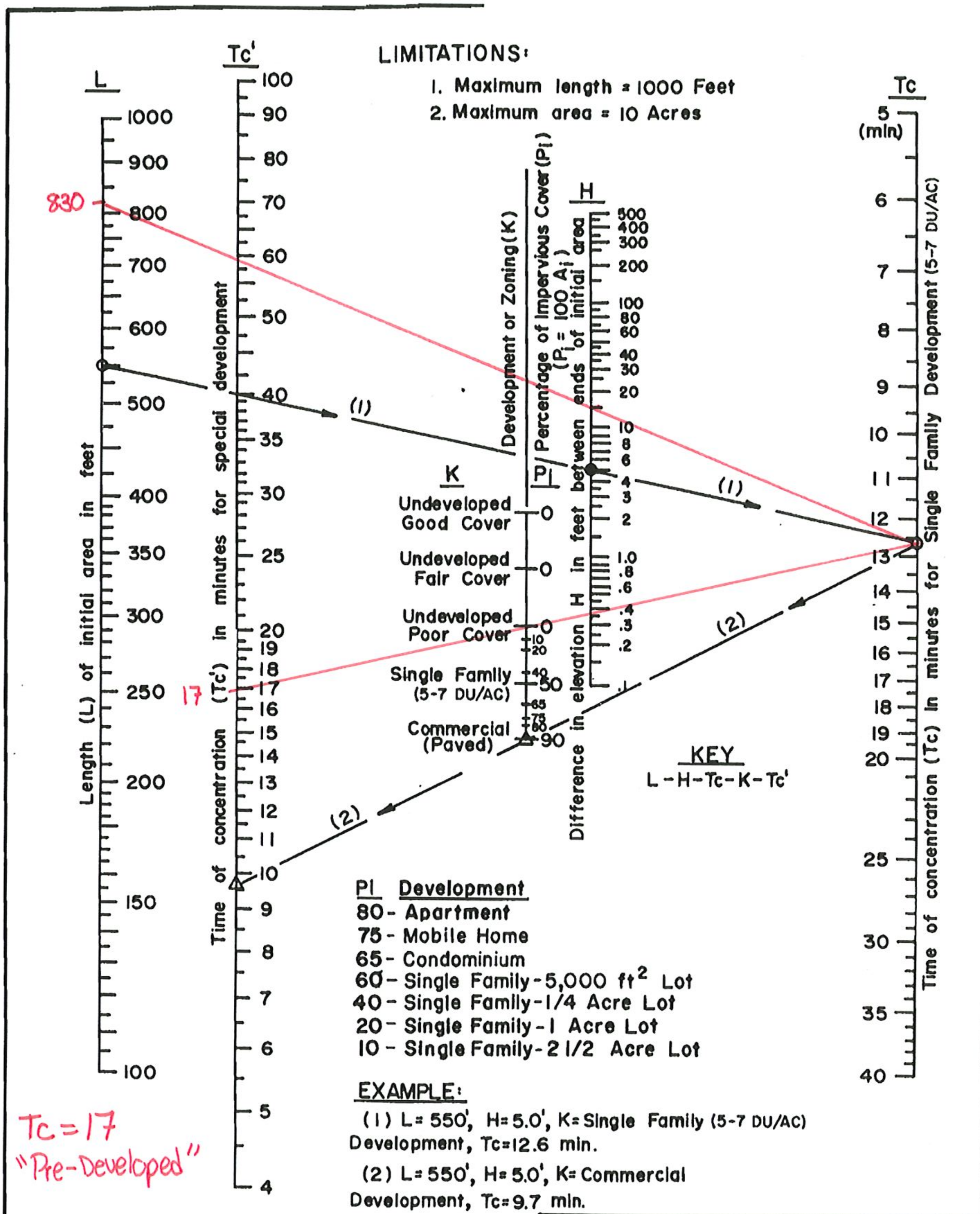


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1

Existing Condition - Area 'B'



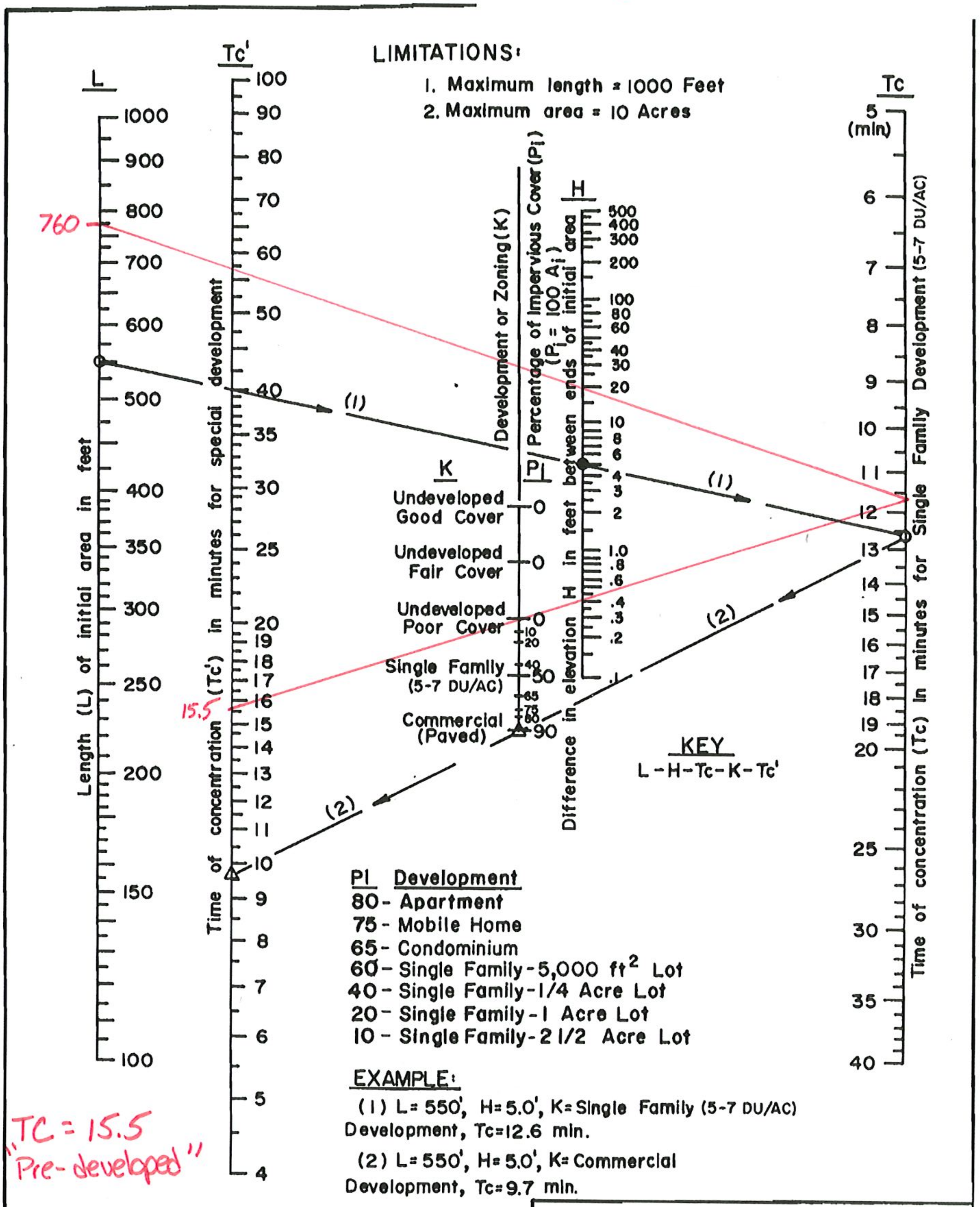
SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION
NOMOGRAPH
FOR INITIAL SUBAREA

Figure D-1

Existing Condition - Area 'C'

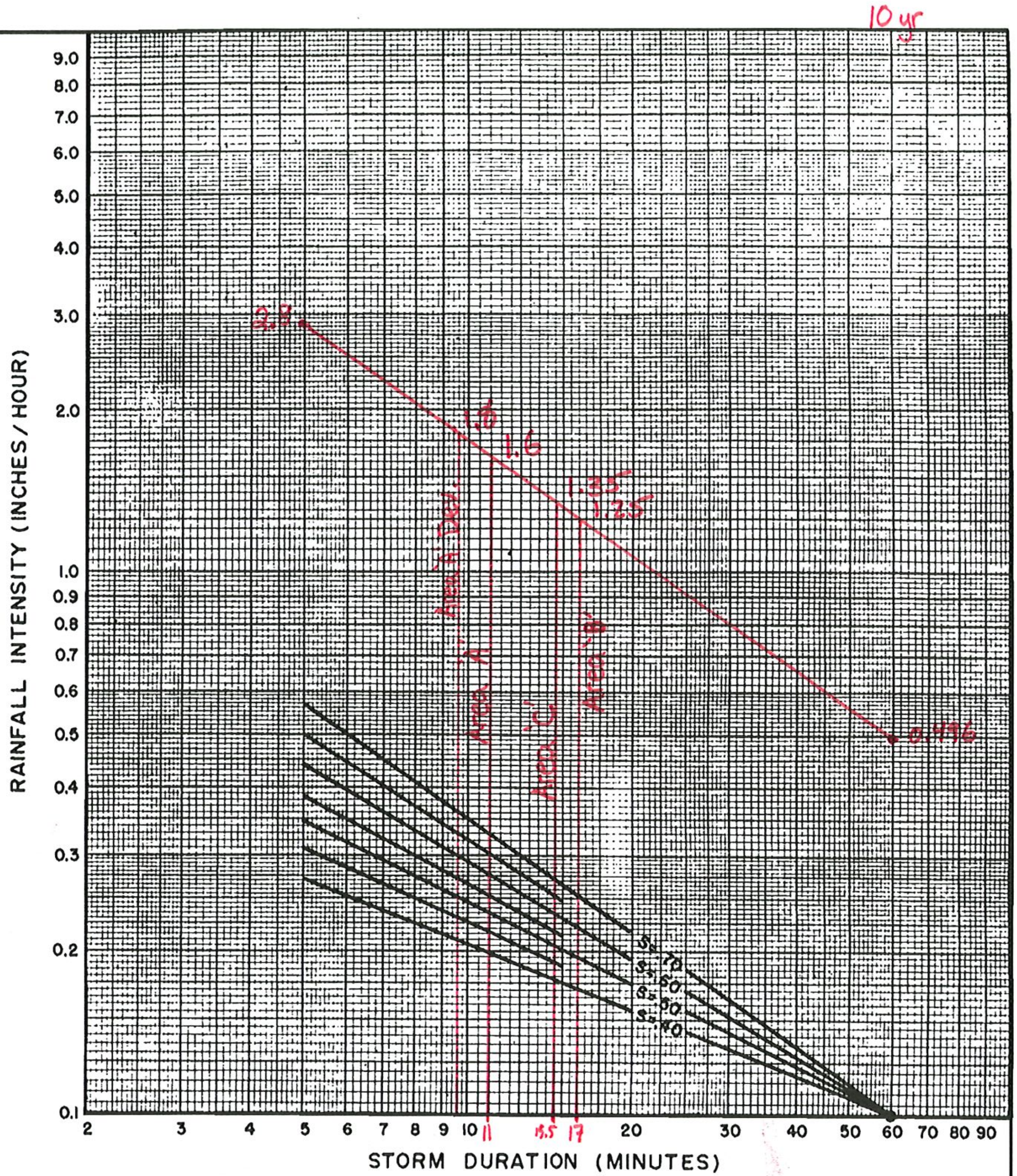


SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Figure D-1



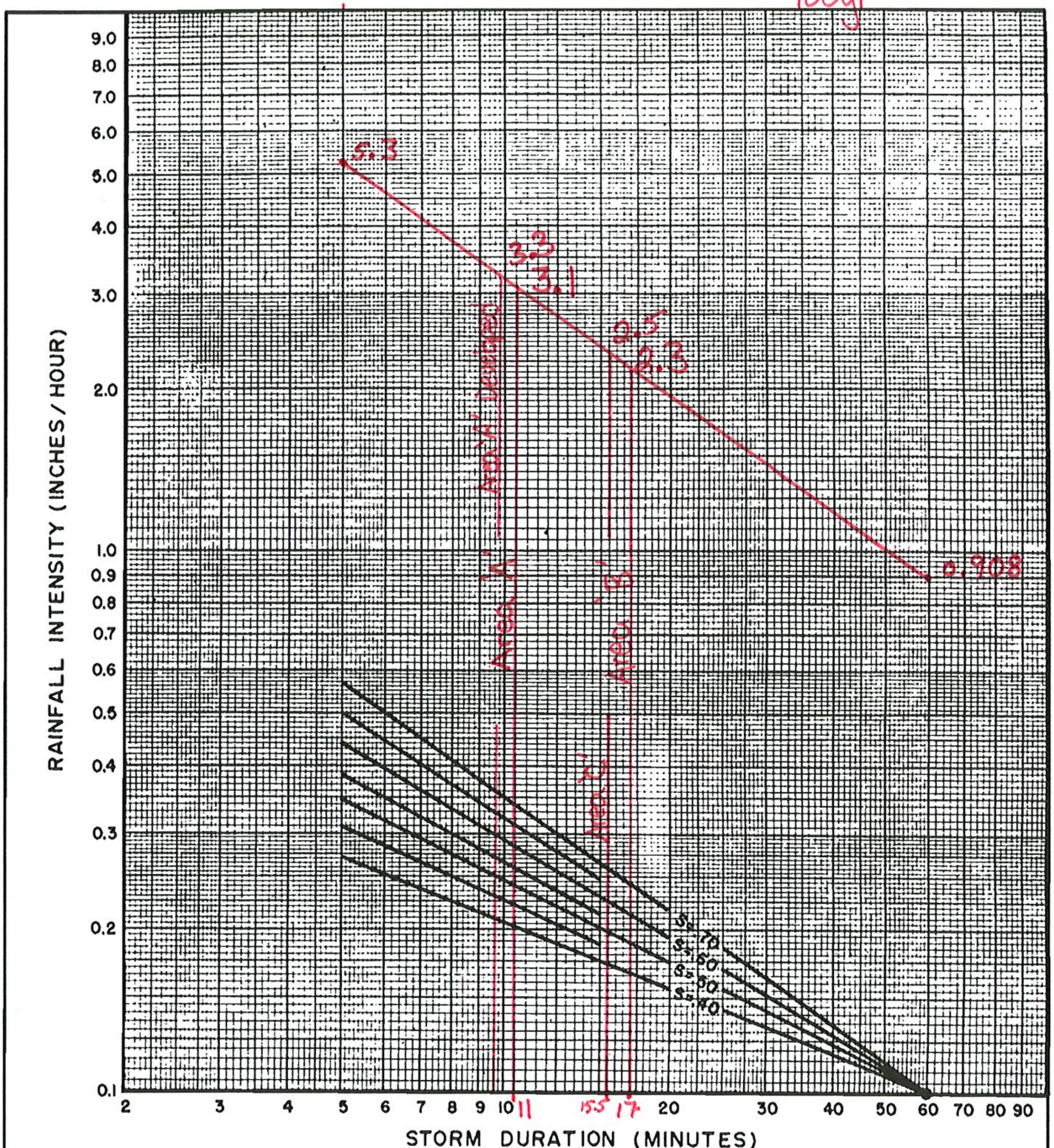
DESIGN STORM FREQUENCY = 10 YEARS

ONE HOUR POINT RAINFALL = .496 INCHES

LOG-LOG SLOPE = .70

PROJECT LOCATION = 9 mile canyon Rd

SAN BERNARDINO COUNTY HYDROLOGY MANUAL	INTENSITY – DURATION CURVES CALCULATION SHEET



DESIGN STORM FREQUENCY = 100 YEARS

ONE HOUR POINT RAINFALL = .908 INCHES

LOG-LOG SLOPE = .70

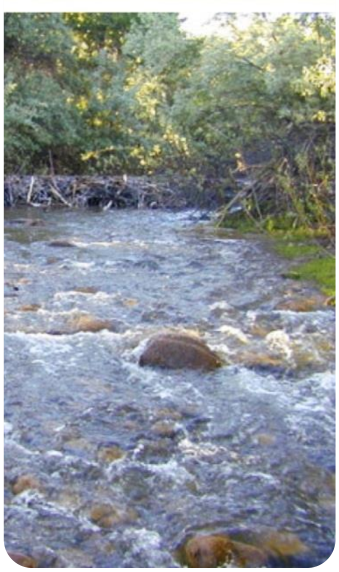
PROJECT LOCATION = 9 mile canyon rd

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

INTENSITY - DURATION CURVES CALCULATION SHEET



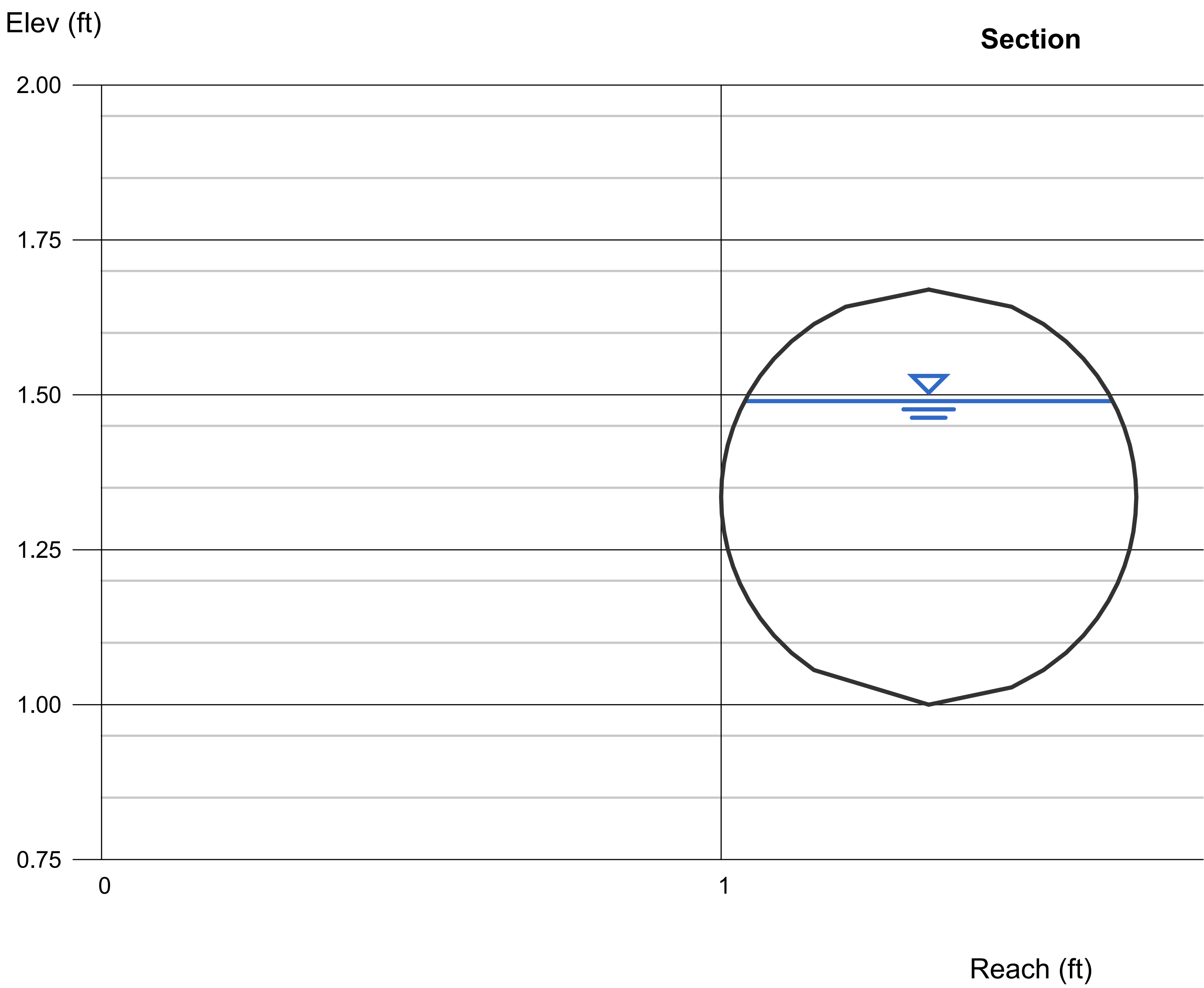
APPENDIX B

Hydraulic Data

Channel Report

8 Inch PVC - 100 1/4 site flow

Circular		**Highlighted**	
Diameter (ft)	= 0.67	Depth (ft)	= 0.49
		Q (cfs)	= 1.250
		Area (sqft)	= 0.28
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.51
Slope (%)	= 1.00	Wetted Perim (ft)	= 1.38
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.53
		Top Width (ft)	= 0.59
Calculations		EGL (ft)	= 0.81
Compute by:	Known Q		
Known Q (cfs)	= 1.25		



Channel Report

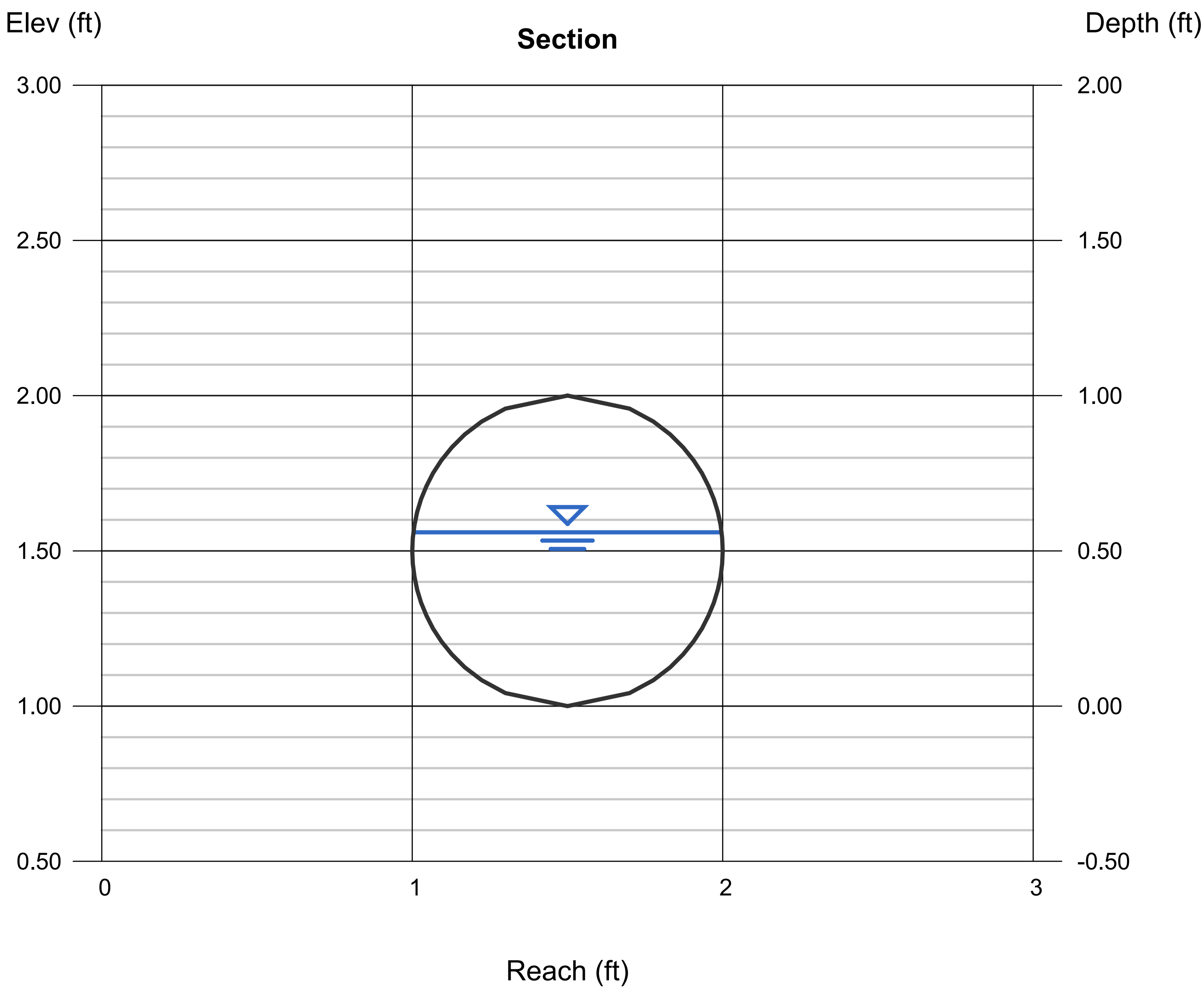
12 Inch PVC - 100 Year Full Site Flow

Circular
Diameter (ft) = 1.00

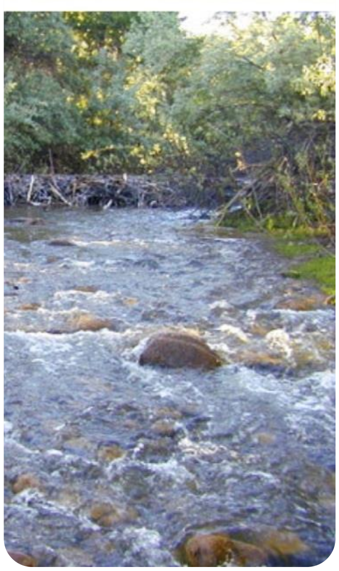
Invert Elev (ft) = 1.00
Slope (%) = 1.00
N-Value = 0.011

Calculations
Compute by: Known Q
Known Q (cfs) = 2.50

Highlighted
Depth (ft) = 0.56
Q (cfs) = 2.500
Area (sqft) = 0.45
Velocity (ft/s) = 5.50
Wetted Perim (ft) = 1.69
Crit Depth, Yc (ft) = 0.68
Top Width (ft) = 0.99
EGL (ft) = 1.03

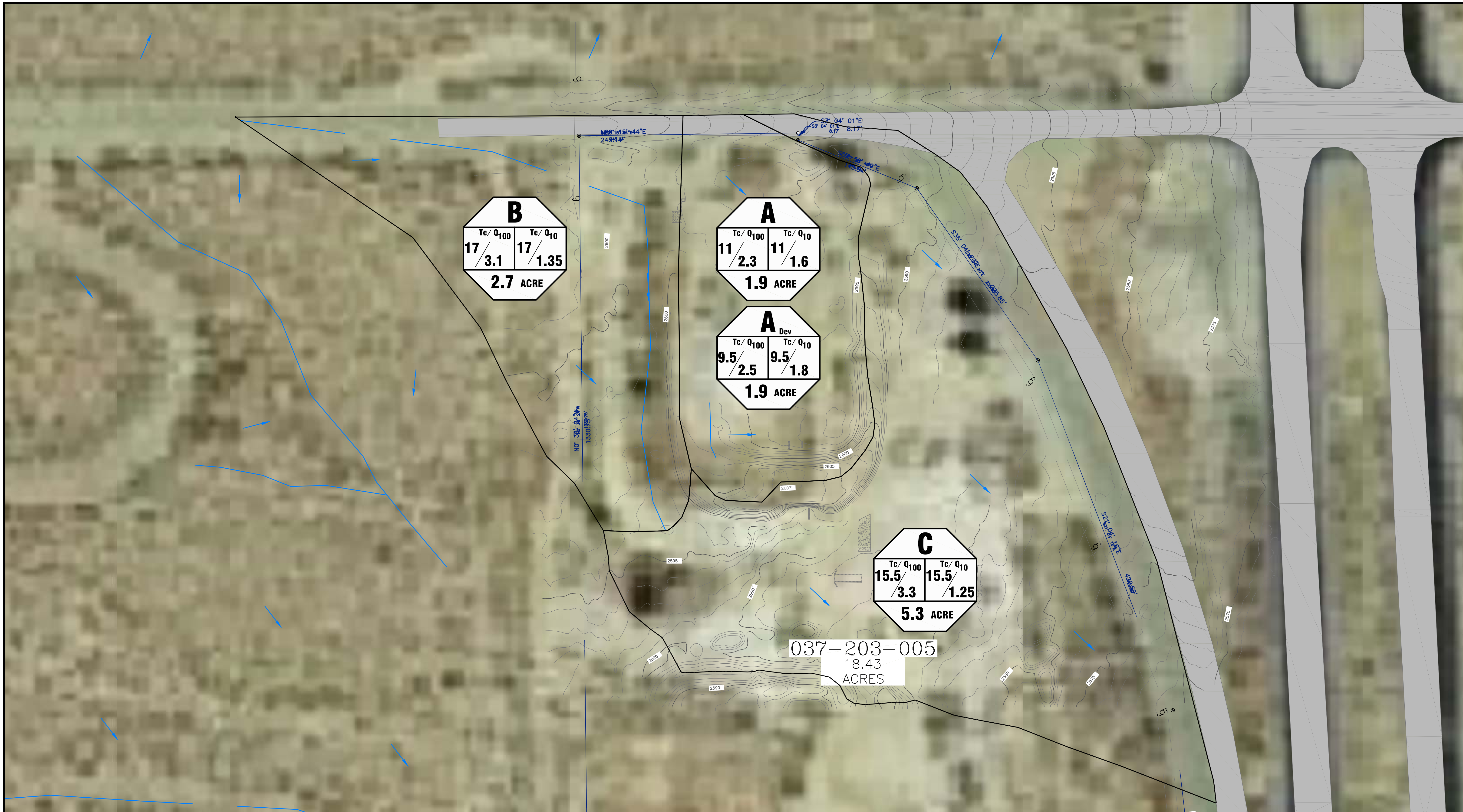




APPENDIX C

Hydrology Maps



RJR ENGINEERING & CONSULTING, INC
Planning · Civil Engineering · Flood Control/Hydrology
Storm Water Management · Land Planning/Entitlements
2340 Palma Drive, Suite 200, Ventura, CA 93003
(805) 485-3935
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ON-SITE HYDROLOGY MAP

BEV LAND
50 W. NINE MILE CANYON RD.
INYO COUNTY, CALIFORNIA

RJR ENGINEERING & CONSULTING, INC

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GRAPHIC SCALE

0 1"

0 250 500

1" = 500'

REGIONAL TRIBUTARY EXHIBIT

CHIEF FARMS
50 W. NINE MILE CANYON RD.
INYO COUNTY, CALIFORNIA