TENTATIVE TRACT 20348

County of San Bernardino, CA

DRAINAGE STUDY

April 17, 2020

Reference 900-900.105

PREPARED BY:

Encompass Associates, Inc.

5699 Cousins Place
Rancho Cucamonga, CA 91737
909-684-0093
Fax-909-586-6979
askeers@encompasscivil.com
www.encompasscivil.com

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Aaron T. Skeers Date

R.C.E. 62183 Exp. 9/30/21

askeers@encompasscivil.com

www.encompasscivil.com

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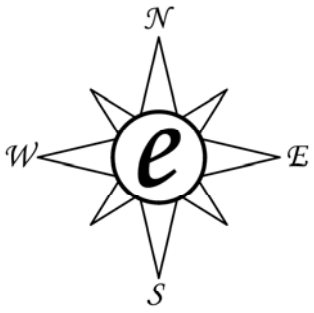


VICINITY MAP

SCALE: N.T.S

DISCUSSION

The purpose of this drainage study is to determine the drainage facility requirements for Tentative Tract 20348 in County of San Bernardino.

The proposed project is a subdivision of 60 detached condominium units on one lot, on three existing parcels, comprised of vacant land and a mobile home community on a 4.1 acre property at 5611, 5639 and 5681 Mission Boulevard, on the south side between Vernon Avenue and Benson Avenue. A condominium project is under development on the west side, with single-family residences to the south, Benson Avenue to the east, and light industrial across Mission to the north.

In addition to the residential buildings, the condo site will be comprised of drives, parking, a private park with tot lot, and paseos throughout. There will be one DA (DA 1), 179,162 sf, with 45,000 sf pervious and 101,314 sf impervious (66,250 sf buildings, 35,064 sf pavement, sidewalks and driveways).

All runoff drains to Benson Avenue via surface flows. Condominium unit runoff will be collected via area drains inlets and pipes and conveyed to an underground perforated pipe infiltration system. Discharge in excess of the water quality volume will surface drain out to Benson Avenue to the southeast.

The 100-year storm event was modeled in the rational method hydrology calculations in this study. The developed condition does not exceed the existing condition due to the partially developed nature of the existing property, and because proposed runoff will be lengthened and flattened, increasing the time of concentration.

The rational method hydrologic model, as defined by Flood Control for San Bernardino County, was followed in the determination of storm runoff.

RATIONAL METHOD

HYDROLOGY

SWC Mission/benson Date: 4/11/2020

100 -year storm runoff

Antecedent Moisture Condition Used: AMC III

1-hour point rainfall from Isohyet Map is 1.51 inches per hour.

Slope of Intensity-Duration Curve is 0.6.

0.1	To	0.2	Initial flow through Subarea

Initial Flow through Subarea 1
Upstream Elevation at Node 0.1 is 43 ft.
Downstream Elevation at Node 0.2 is 39 ft.
Flow length is 297 ft.

Land Use	Soil Type	Area (AC)
grass poor	A	2.4
mobile home park	A	1.7

Time of Concentration = Tc = K * (length^3 / Delta_EL)^0.2 = 0.525 * (297^3 / 4)^0.2 = 12.117 minutes.
Rainfall Intensity = e^(-Slope*Log(desT)+Log(refI)+Slope*Log(refT))
= e^(-0.6*Log(12.117)+Log(1.51)+0.6*Log(60)) = 3.943 in/hr.
Peak Runoff = 0.9*(I-Ap*Fp)*Area = 0.9*(3.943 - 0.78 * 0.4) * 4.1 = 13.39 cfs.

Peak Flow (cfs):	13.39	TC (min):	12.12

1	To	1.1	Initial flow through Subarea

Initial Flow through Subarea 3
Upstream Elevation at Node 1 is 42 ft.
Downstream Elevation at Node 1.1 is 40.5 ft.
Flow length is 507 ft.

Land Use	Soil Type	Area (AC)
condominiums	A	1.2

Time of Concentration = Tc = K * (length^3 / Delta_EL)^0.2 = 0.3592 * (507^3 / 1.5)^0.2 = 13.903 minutes.
Rainfall Intensity = e^(-Slope*Log(desT)+Log(refI)+Slope*Log(refT))
= e^(-0.6*Log(13.903)+Log(1.51)+0.6*Log(60)) = 3.631 in/hr.
Peak Runoff = 0.9*(I-Ap*Fp)*Area = 0.9*(3.631 - 0.35 * 0.74) * 1.2 = 3.64 cfs.

Peak Flow (cfs):	3.64	TC (min):	13.9

1.1	To	1.1	Catch Basin Flow Interception

Sump Catch Basin Sizing Calculation at Node 1.1.
User-Defined Sump Depth at Catch Basin = 0.2.
Sump Depth Exceeds 1.4 x Opening Height: using Orifice Formula:
Q = C*(OpeningHt*Length)*Sqrt(2*G*H), 3.64 = 0.6 * (0 * Length) * SQRT(2 * 32.2 * 0.2).
Partial Flow Interception in 4 ft. inlet is 0 cfs.
Catch Basin Length = 4 ft.

Peak Flow (cfs):	3.64	TC (min):	13.9

1.1	To	1.2	Pipe flow through Subarea

Pipe Flow From Node 1.1 to Node 1.2.
Upstream Elevation at Node 1.1 is 35 ft. Downstream Elevation at Node 1.2 is 34 ft.
Flow length is 146 ft.
Average Pipe Slope = (35 - 34) / 146 = 0.007 ft/ft.
Pipe Diameter = ((Q * N) / (1.486 * So ^ 0.5 * 0.31169))^(3/8)
= ((3.64 * 0.01) / (1.486 * 0.007^0.5 * 0.31169))^(3/8) = 1.5 ft.
Flow Depth, Iterate: Q = (1.486 / N) * Area * (Area / WetPer) ^ (2 / 3) * s ^ 0.5
Try: 0.59 ft., Flow Area = Dia ^ 2 / 8 * (Angle - Sin(Angle)),
where Angle = 2 * Acos(1 - 2 * Depth / Dia) = 2 * Acos(1 - 2 * 0.59 / 1.5) = 2.71
Flow Area = 1.5 ^ 2 / 8 * (2.71 - Sin(2.71)) = 0.65 sf.
Pipe Velocity = Q / Area = 3.64 / 0.65 = 5.64 ft/sec.
Pipe Travel Time = Length / Velocity = 146 / 5.64 = 25.89 sec., Mainstream TC = 14.33 minutes.

				Peak Flow (cfs): 3.64	TC (min): 14.33

1.2	To	1.2	Add Subarea at Node

Add Flow from Subarea 4

Land Use	Soil Type	Area (AC)
condominiums	A	2.9

At Node 1.2: Time of Concentration = 14.33 minutes, Rainfall Intensity = 3.565 in/hr.
Subarea Peak Runoff = 0.9*(I-Ap*Fp)*Area = 0.9*(3.565 - 0.35 * 0.74) * 2.9 = 8.62 cfs.
Area-Averaged Ap = 0.35, Area-Averaged Fp = 0.74 in/hr, Total Area = 4.1 ac, Effective Area = 4.1 ac
Total Peak Runoff = 0.9*(I-Ap*Fp)*Area = 0.9*(3.565 - 0.35 * 0.74) * 4.1 = 12.18 cfs.

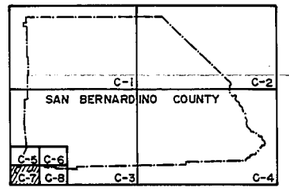
				Peak Flow (cfs): 12.18	TC (min): 14.33

REFERENCES & MAPS

SITE

SOURCE: USDA SCS SURVEY

SOURCE: USDA SCS SURVEY



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LEGEND

SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

SCALE REDUCED BY 1/2

SAN BERNARDINO COUNTY

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP FOR SOUTHWEST-C AREA

FIGURE C-15

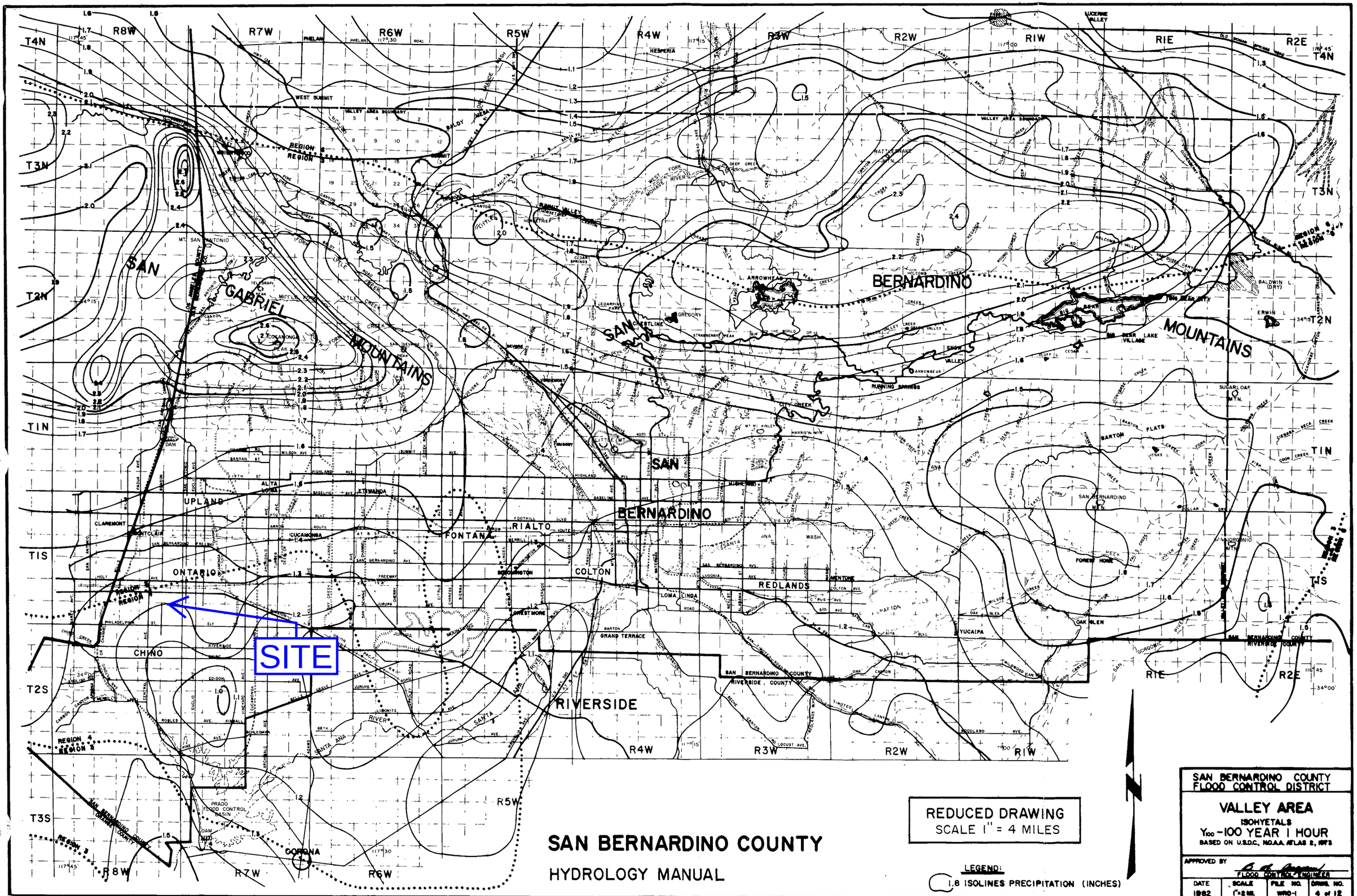
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
SAN BERNARDINO
UPLAND
ONTARIO
CHINO
CLAREMONT
ALTA LOMA
ETIWANDA
RANCHO CUCAMONGA
FONTANA
RIALTO
COLTON
LOMA LINDA
REDLANDS
YUCAIPA
CALIMESA
BANNING
BEAUMONT
RIVERSIDE
CORONA
NORCO
MENTONE
GRAND TERRACE
LOMA LINDA
CRESTLINE
LAKE ARROWHEAD
BIG BEAR LAKE
BIG BEAR CITY
BIG BEAR VILLAGE
RUNNING SPRINGS
SNOW VALLEY
ARROWBEAR
OAK GLEN
FORREST HOME
SAN BERNARDINO MTN.
SUGARLOAF MTN.
MT. SAN ANTONIO
COUCAMONGA PEAK
HARRISON MTN.
MT. MC KINLEY
STRAWBERRY PEAK
BALDWIN L. (DRY)
ERWIN L.
SAN ANDREAS FAULT
SAN JACINTO FAULT
CUCAMONGA CREEK
DEVIL CANYON
CAJON PASS
SAN SEVAINE DAM
PRADO FLOOD CONTROL BASIN
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
REGION 4
REGION 5
REGION 6
SITE
T4N
T3N
T2N
T1N
T1S
T2S
T3S
R8W
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
REDUCED DRAWING
SCALE 1" = 4 MILES
LEGEND:
1.6 ISOLINES PRECIPITATION (INCHES)
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
VALLEY AREA
ISOHYETALS
Y100 - 100 YEAR 1 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 4 of 12

FIGURE B-4

NOAA Atlas 14, Volume 6, Version 2
Location name: Ontario, California, USA*
Latitude: 34.0548°, Longitude: -117.6835°
Elevation: 938.64 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	**0.119** (0.100-0.145)	**0.157** (0.131-0.190)	**0.207** (0.172-0.251)	**0.248** (0.204-0.304)	**0.304** (0.242-0.386)	**0.348** (0.271-0.451)	**0.393** (0.298-0.523)	**0.440** (0.324-0.603)	**0.505** (0.356-0.722)	**0.556** (0.379-0.825)
10-min	**0.171** (0.143-0.207)	**0.225** (0.188-0.273)	**0.297** (0.246-0.360)	**0.355** (0.293-0.435)	**0.436** (0.347-0.553)	**0.498** (0.388-0.647)	**0.563** (0.427-0.749)	**0.630** (0.465-0.864)	**0.723** (0.511-1.03)	**0.797** (0.543-1.18)
15-min	**0.207** (0.173-0.251)	**0.272** (0.227-0.330)	**0.359** (0.298-0.436)	**0.429** (0.354-0.526)	**0.527** (0.419-0.669)	**0.603** (0.469-0.782)	**0.681** (0.517-0.906)	**0.762** (0.562-1.05)	**0.875** (0.617-1.25)	**0.964** (0.656-1.43)
30-min	**0.307** (0.256-0.372)	**0.404** (0.337-0.490)	**0.532** (0.442-0.646)	**0.637** (0.525-0.781)	**0.781** (0.622-0.992)	**0.894** (0.696-1.16)	**1.01** (0.766-1.34)	**1.13** (0.833-1.55)	**1.30** (0.916-1.86)	**1.43** (0.973-2.12)
60-min	**0.458** (0.382-0.554)	**0.602** (0.502-0.730)	**0.793** (0.659-0.964)	**0.950** (0.782-1.16)	**1.17** (0.927-1.48)	**1.33** (1.04-1.73)	**1.51** (1.14-2.00)	**1.69** (1.24-2.31)	**1.93** (1.37-2.77)	**2.13** (1.45-3.16)
2-hr	**0.689** (0.575-0.834)	**0.902** (0.751-1.09)	**1.18** (0.978-1.43)	**1.40** (1.15-1.72)	**1.70** (1.35-2.16)	**1.93** (1.50-2.50)	**2.16** (1.64-2.88)	**2.40** (1.77-3.29)	**2.73** (1.92-3.90)	**2.98** (2.03-4.42)
3-hr	**0.872** (0.728-1.06)	**1.14** (0.948-1.38)	**1.48** (1.23-1.80)	**1.75** (1.44-2.15)	**2.12** (1.69-2.69)	**2.40** (1.87-3.12)	**2.69** (2.04-3.57)	**2.98** (2.19-4.08)	**3.37** (2.38-4.82)	**3.67** (2.50-5.45)
6-hr	**1.23** (1.03-1.49)	**1.60** (1.33-1.94)	**2.07** (1.72-2.52)	**2.45** (2.02-3.01)	**2.96** (2.36-3.76)	**3.35** (2.61-4.34)	**3.74** (2.84-4.97)	**4.13** (3.05-5.67)	**4.67** (3.29-6.68)	**5.08** (3.46-7.54)
12-hr	**1.62** (1.35-1.96)	**2.11** (1.76-2.56)	**2.75** (2.28-3.34)	**3.26** (2.69-4.00)	**3.95** (3.15-5.02)	**4.48** (3.49-5.81)	**5.01** (3.81-6.68)	**5.56** (4.10-7.62)	**6.30** (4.45-9.02)	**6.87** (4.68-10.2)
24-hr	**2.16** (1.91-2.49)	**2.84** (2.51-3.28)	**3.74** (3.29-4.32)	**4.47** (3.91-5.21)	**5.47** (4.63-6.59)	**6.24** (5.17-7.67)	**7.02** (5.69-8.85)	**7.84** (6.17-10.2)	**8.95** (6.77-12.1)	**9.82** (7.18-13.7)
2-day	**2.64** (2.34-3.04)	**3.54** (3.13-4.09)	**4.74** (4.18-5.49)	**5.74** (5.02-6.69)	**7.11** (6.02-8.57)	**8.19** (6.80-10.1)	**9.31** (7.54-11.7)	**10.5** (8.26-13.6)	**12.1** (9.16-16.3)	**13.4** (9.80-18.7)
3-day	**2.87** (2.54-3.30)	**3.89** (3.44-4.49)	**5.28** (4.65-6.11)	**6.43** (5.62-7.50)	**8.04** (6.81-9.69)	**9.31** (7.72-11.5)	**10.6** (8.61-13.4)	**12.0** (9.48-15.6)	**14.0** (10.6-18.9)	**15.5** (11.4-21.7)
4-day	**3.09** (2.74-3.57)	**4.24** (3.75-4.89)	**5.78** (5.10-6.69)	**7.07** (6.18-8.24)	**8.87** (7.51-10.7)	**10.3** (8.53-12.7)	**11.8** (9.53-14.8)	**13.3** (10.5-17.3)	**15.5** (11.7-21.0)	**17.3** (12.6-24.1)
7-day	**3.54** (3.13-4.08)	**4.89** (4.33-5.65)	**6.71** (5.92-7.77)	**8.23** (7.20-9.60)	**10.3** (8.76-12.5)	**12.0** (9.96-14.8)	**13.7** (11.1-17.3)	**15.6** (12.3-20.1)	**18.1** (13.7-24.4)	**20.1** (14.7-28.1)
10-day	**3.84** (3.40-4.43)	**5.34** (4.72-6.17)	**7.36** (6.49-8.51)	**9.03** (7.90-10.5)	**11.4** (9.62-13.7)	**13.2** (10.9-16.2)	**15.1** (12.2-19.0)	**17.1** (13.5-22.1)	**19.9** (15.0-26.8)	**22.1** (16.2-30.8)
20-day	**4.62** (4.09-5.32)	**6.49** (5.73-7.49)	**9.01** (7.94-10.4)	**11.1** (9.72-13.0)	**14.1** (11.9-17.0)	**16.4** (13.6-20.2)	**18.8** (15.3-23.7)	**21.4** (16.9-27.7)	**25.0** (18.9-33.7)	**27.9** (20.4-38.9)
30-day	**5.45** (4.83-6.29)	**7.66** (6.77-8.84)	**10.7** (9.40-12.3)	**13.2** (11.5-15.4)	**16.8** (14.2-20.2)	**19.6** (16.3-24.1)	**22.6** (18.3-28.5)	**25.8** (20.3-33.4)	**30.3** (22.9-40.8)	**33.9** (24.8-47.3)
45-day	**6.52** (5.77-7.52)	**9.08** (8.03-10.5)	**12.6** (11.1-14.6)	**15.6** (13.7-18.2)	**19.9** (16.9-24.0)	**23.4** (19.4-28.8)	**27.1** (22.0-34.2)	**31.1** (24.5-40.3)	**36.8** (27.8-49.6)	**41.4** (30.2-57.7)
60-day	**7.57** (6.70-8.73)	**10.4** (9.21-12.0)	**14.4** (12.7-16.7)	**17.8** (15.6-20.8)	**22.8** (19.3-27.5)	**26.8** (22.3-33.0)	**31.2** (25.3-39.3)	**35.9** (28.3-46.5)	**42.7** (32.3-57.6)	**48.3** (35.3-67.4)

[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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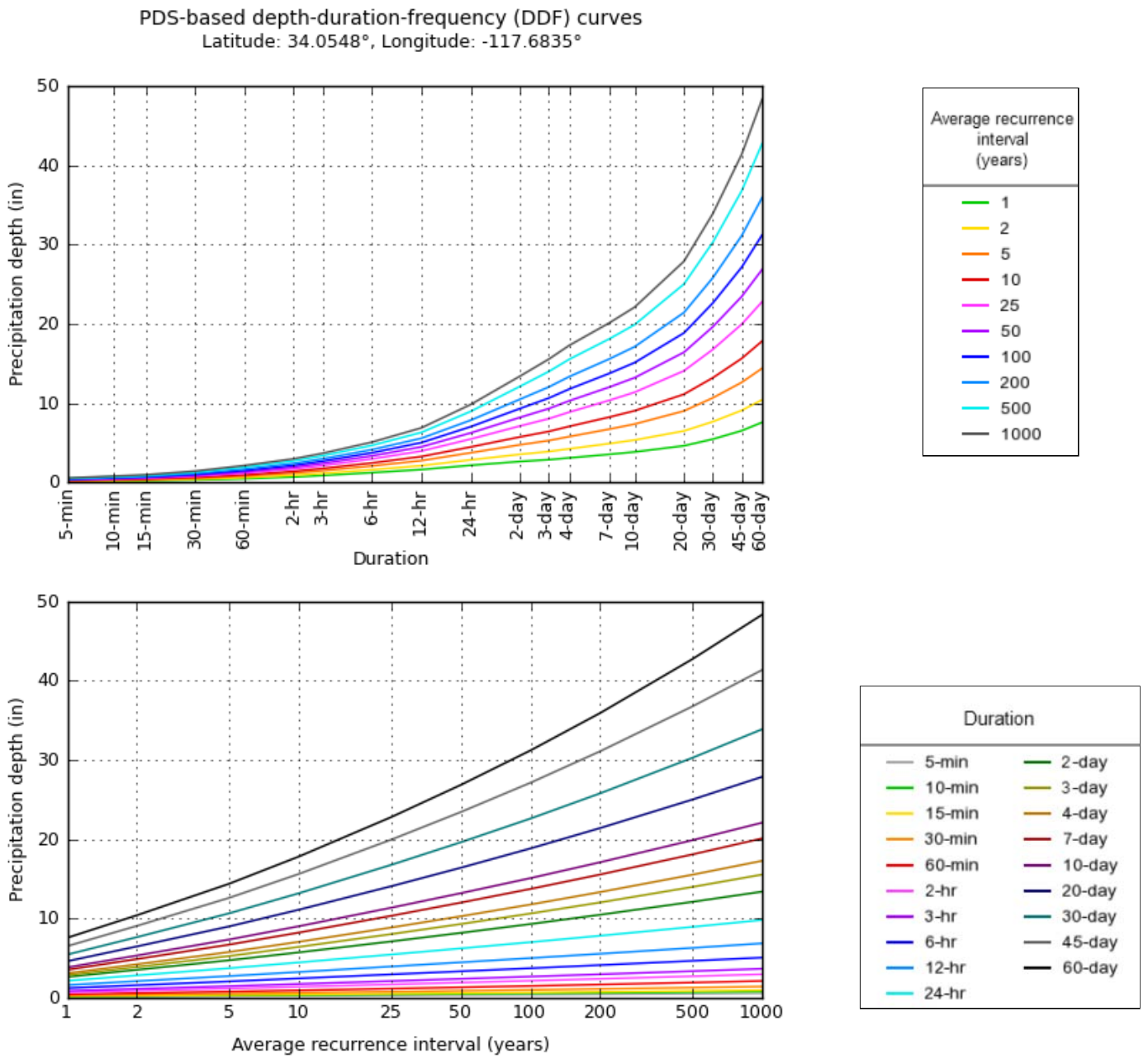
PF graphical



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Fri Feb 15 18:39:51 2019

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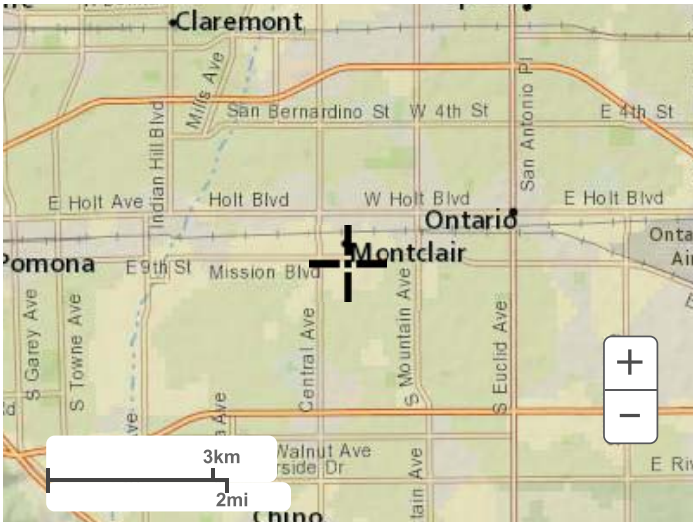
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

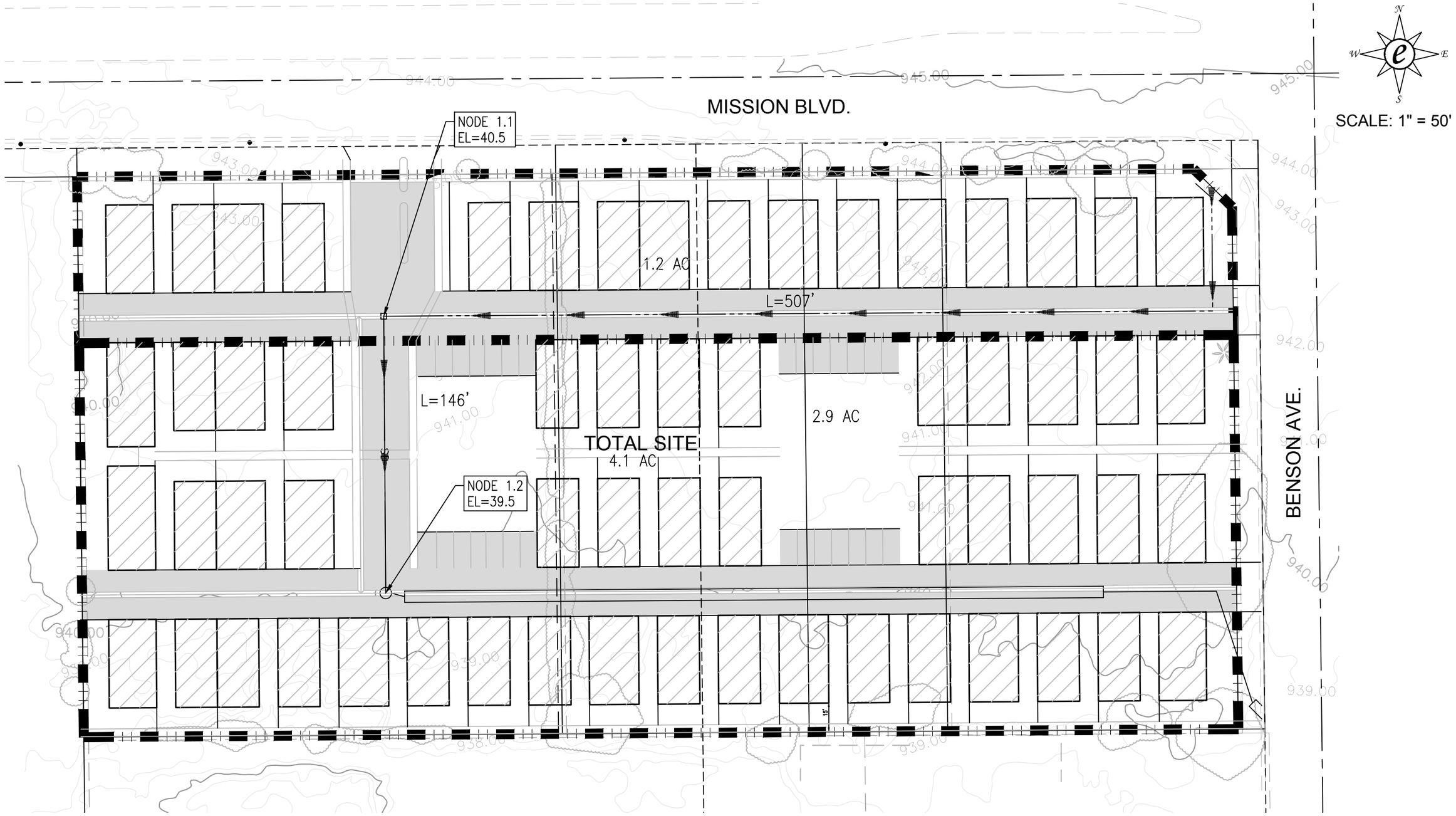
Disclaimer

N
W E
S

SCALE: 1" = 50'

ENCOMPASS ASSOCIATES, INC.

EXISTING CONDITION HYDROLOGY MAP
TTM20348



ENCOMPASS ASSOCIATES, INC.

DEVELOPED CONDITION HYDROLOGY MAP
TTM20348