R.C.E. 49302 P.L.S. 6368

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HYDROLOGY STUDY

DeCRISTO FAMILY TRUST
109 Ellis Street
Petaluma, California
APN : 007-361-003

Job No.: 181983

December 2018

Prepared by: ADF

TABLE OF CONTENTS

GENERAL STATEMENTS

The purpose of this report is to provide confirmation that the Proposed Project is preliminarily designed to offset the fill volume in the 100-year flood plain as shown on the FEMA flood risk mapping.

There are a couple of complicating issues with the above stated design. One complication is the removal of pollutants from the stormwater run-off prior to it reaching the existing flood control channel and another is for the ability of flood waters to migrate into the bioretention/mitigation basin during times of heavy stormwater run-off.

Fill in the flood plain is proposed to be mitigated by constructing a detention basin at the rear of the property adjacent to Washington Creek. The capacity of the detention basin is designed to equal or exceed the volume of flood waters being displaced by the fill within the flood plain. Given that the "No Net Fill" mitigation area (detention basin) is not within or immediately adjacent to the flood plain, the methodology being proposed to fill the detention basin is to allow rising flood waters within Washington Creek to be diverted into the basin. A detention basin inlet culvert shall be set within Washington Creek to an elevation just below the 100-year base flood elevation. The culvert, base and top elevations of the detention basin are designed to allow the flood waters to be conveyed hydraulically from Washington Creek into the basin.

The removal of pollutants is via Best Management Practices and the use of a Bio-Retention basin at the rear of the Lot. See the BASMAA Stormwater Mitigation Plan prepared by this office for calculations and exhibits. The stormwater overflow outlet is equipped with a check valve so that flood waters will not backflow into the bioretention basin. At the abeyance of heavy flood waters the hydraulic grade line (HGL) in Washington Creek lowers, the excess waters in the bioretention/mitigation basin will then be able to discharge through the overflow pipe. Screening will be attached to the creek side of each pipe outfall to inhibit any migration of fish or other wildlife into the bioretention basin and becoming trapped when flood waters fall.

The base flood elevation (21.0 NAVD 88) is shown on the Existing Conditions Exhibit (Sheet C-2) and the Grading, Drainage and Utility Plans (Sheets C-4 and C-5). The lowest habitable floor elevation has been set at 22.0' with the remaining site being filled to above the base flood elevation.

The volumetric mitigation for the 100-year flood begins at an elevation of 19.96 in the bioretention basin. This elevation can be adjusted at the time of construction documents based on needs as determined by the City or the Sonoma County Water Agency. This is the estimated 25-year storm event HGL in Washington Creek. Mitigation is via backflow through a 12-inch PVC culvert between Washington Creek and the Bioretention Basin on the project site. At an HGL of 21-feet in Washington Creek the Bioretention Basin will have reached capacity and the mitigation volume for meeting the No Net Fill requirement.

Once the flood waters begin to recede in Washing Creek the detention basin will begin to drain through the drainage outlet assembly located at the bottom of the bioretention basin.

See SPAR Civil Engineering Drawings C-4, C-5 and C-6 for bioretention basin plan view, sections and details.

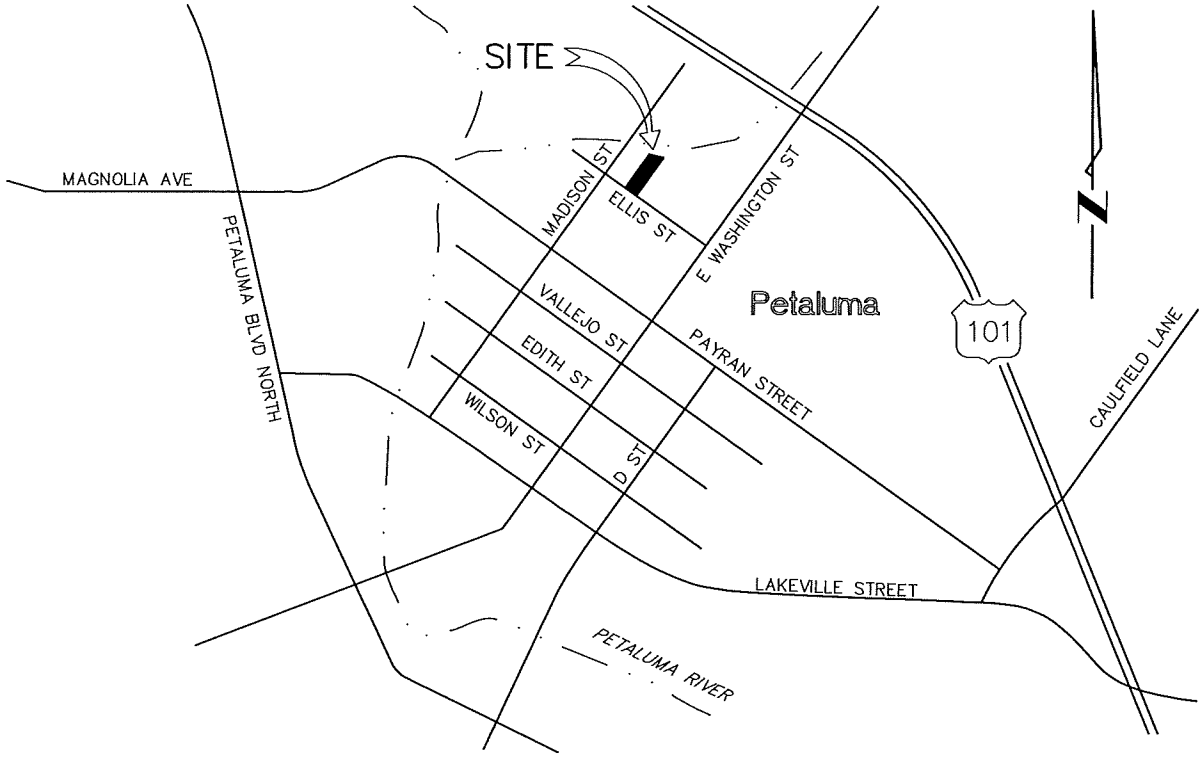
CALCULATION METHODOLOGY

A Digital Terrain Model (DTM) was generated from field survey data for the project site using the terrain features in Autodesk Land Desktop 2009 (LDD). A plane was created at elevation 21.0 and the storage volume

on site during a 100-year flood was calculated using the DTM tools within LDD. Based on the program calculations there is 4,588 cubic feet of flood waters stored on the site. The bioretention basin with the added depth provides 4,708 cubic feet of storage volume including the void spaces in the gravel and top soil layers.

For preliminary purposes the volume of water in Washington Creek during a 100-year storm event was taken from the 2003 Petaluma River Watershed Master Drainage Plan, Map 25 by Winzler and Kelly, Q_{100}= 1,406cfs. Geometry of Washington Creek, the 100-year HGL from FEMA Mapping and the flow rate from the Winzler and Kelly study where utilized in modeling for the 10-year and 25-year storm events.

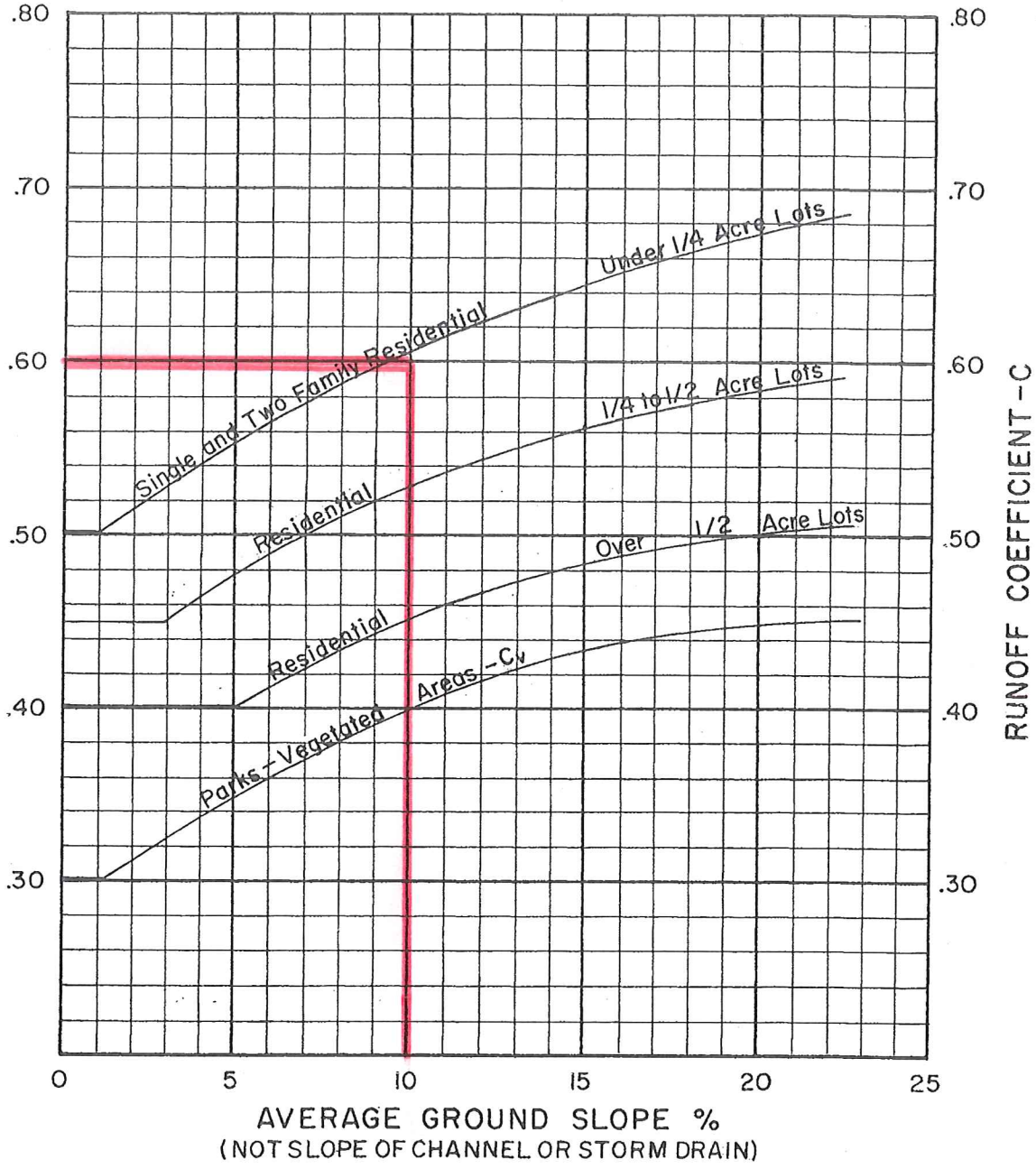
The Sonoma County Water Agency Flood Control Design Criteria was used in backward estimating the drainage area using a coefficient of infiltration 'C' equal to 0.60 from Plate B-1 of the Design Criteria. The estimated drainage basin for Washington Creek in the vicinity of the Project is 1,345 acres.



VICINITY MAP

NTS

RUNOFF COEFFICIENTS FOR RATIONAL FORMULA



NOTE: Commercial, Industrial & Multiple Residential Areas

$C_P = 0.9$ (Based on paving, roofs, etc.)

When vegetated area exceeds 20% of total, C_V from vegetated curve may be used to reduce above C_P as follows:

$$C_T = C_V \frac{A_V}{A_T} + C_P \frac{A_P}{A_T}$$

SONOMA COUNTY WATER AGENCY

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PLATE No. B-1

118-2
7/64

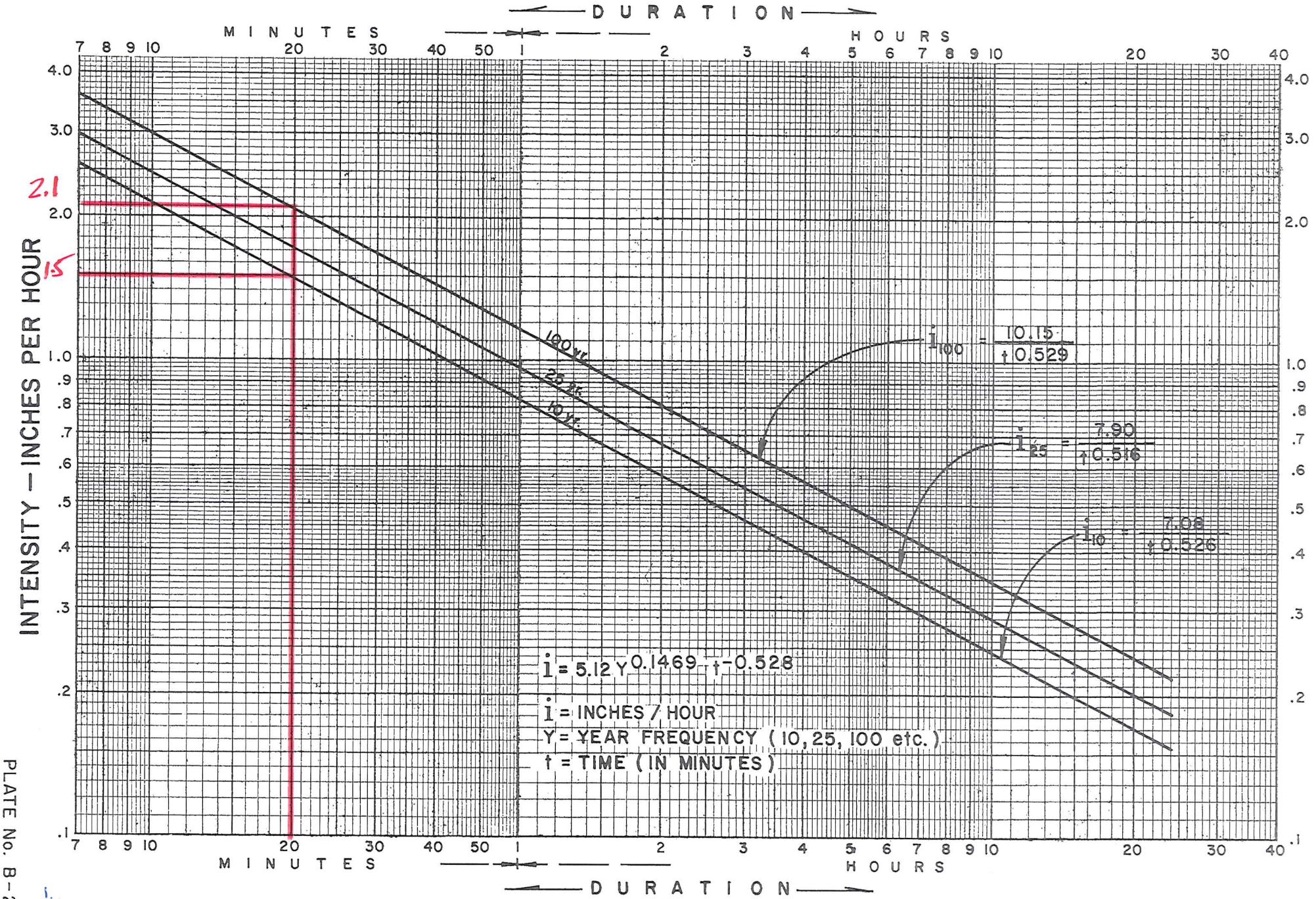
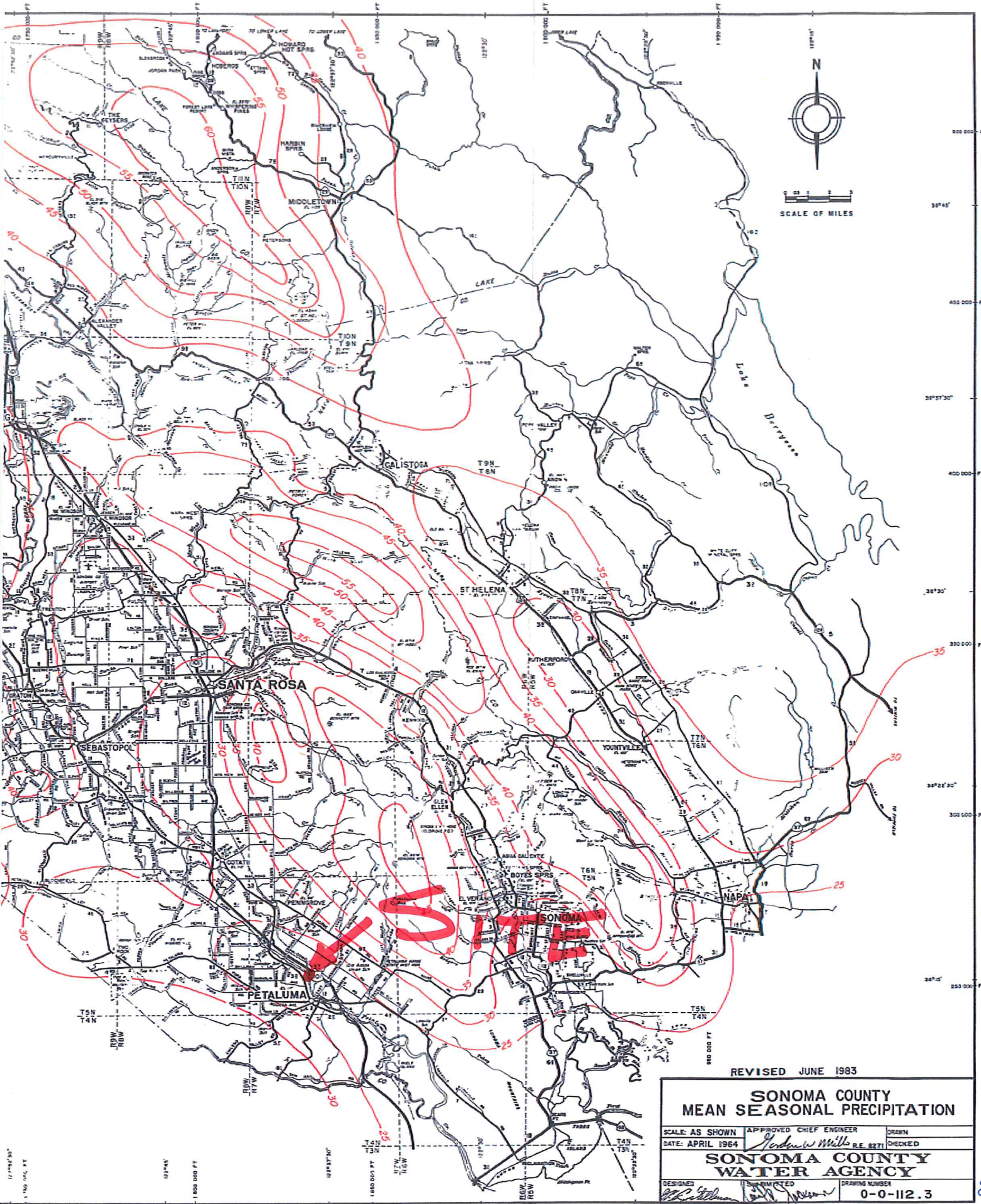


PLATE No. B-2

NOTE: THE INFORMATION SHOWN IS SUBJECT TO ANNUAL REVISION AS ADDITIONAL RAINFALL DATA BECOMES AVAILABLE

RAINFALL
INTENSITY vs DURATION



REVISED JUNE 1983

SONOMA COUNTY MEAN SEASONAL PRECIPITATION

SCALE: AS SHOWN	APPROVED CHIEF ENGINEER	DRAWN
DATE: APRIL 1964	R.E. 8271	CHECKED

SONOMA COUNTY WATER AGENCY

DESIGNED	SUBMITTED	DRAWING NUMBER
		0-0-112.3

PLATE No. B-3

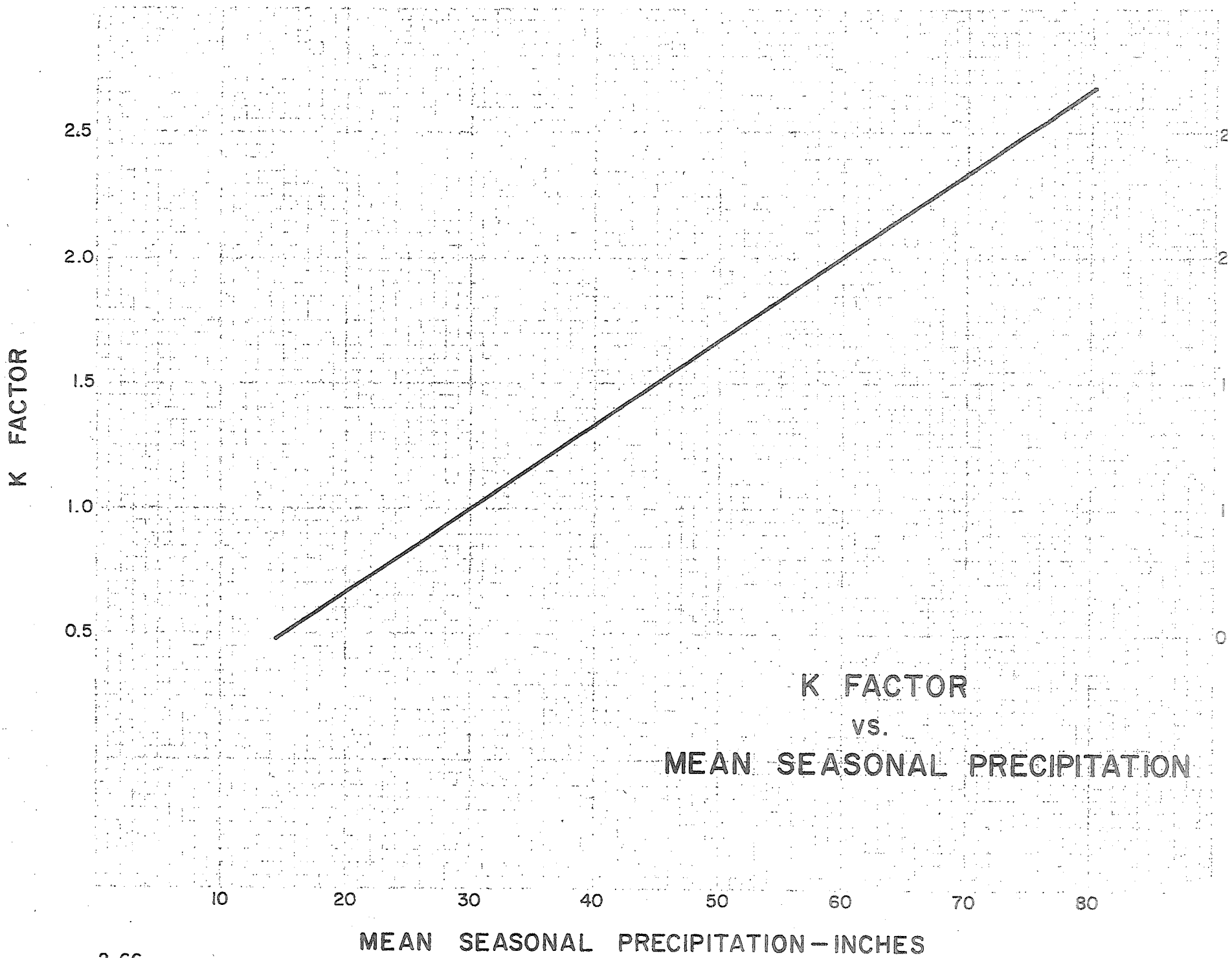


PLATE No. B-4

2-66

DeCristo

From 2003 Petaluma Flood Study

$Q_{100} = 1,406$ cfs

Say $T_c = 20$ min

So, $I_{100} = 2.10$

$I_{10} = 1.50$

$K = 0.83$

$Q = CIAK$

Say $C = 0.60$ (10% slope, SFR under 1/4 Ac.) Plate B-1

$$A = \frac{Q}{CIK} \Rightarrow \frac{1406}{(0.60)(2.10)(0.83)} \Rightarrow 1,345 \text{ Ac.} \pm$$

$Q_{10} = (0.60)(1.5)(1,345)(0.83)$

$Q_{10} = 1,005$ cfs

100-year Depth = 9.1 ft

10-year Depth = 7.55 ft

$\Delta H = 9.10 - 7.55$

$\Delta H = 1.55'$

$HGL_{10} = 21.6 - 1.55 = 19.45$

Hydrology Report

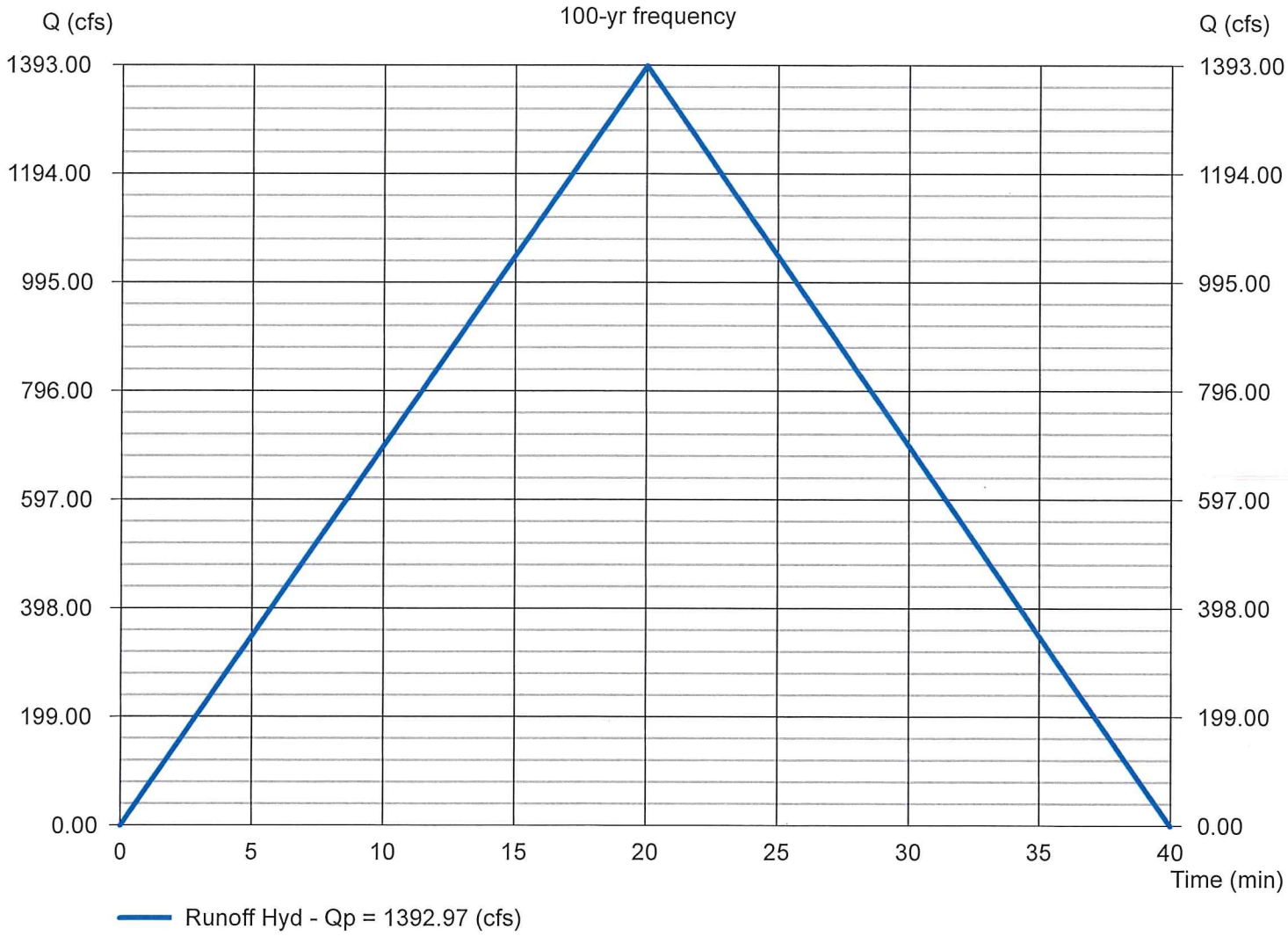
Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Dec 11 2018

100-year Storm

Hydrograph type	= Rational	Peak discharge (cfs)	= 1392.97
Storm frequency (yrs)	= 100	Time interval (min)	= 1
Drainage area (ac)	= 1345.000	Runoff coeff. (C)	= 0.6
Rainfall Inten (in/hr)	= 1.726	Tc by User (min)	= 20
IDF Curve	= Petaluma 0.83.IDF	Rec limb factor	= 1.00

Hydrograph Volume = 1,671,560 (cuft); 38.374 (acft)

Runoff Hydrograph



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Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Oct 16 2018

DeCristo 100-year

User-defined

Invert Elev (ft)	= 12.00
Slope (%)	= 0.30
N-Value	= 0.055

Calculations

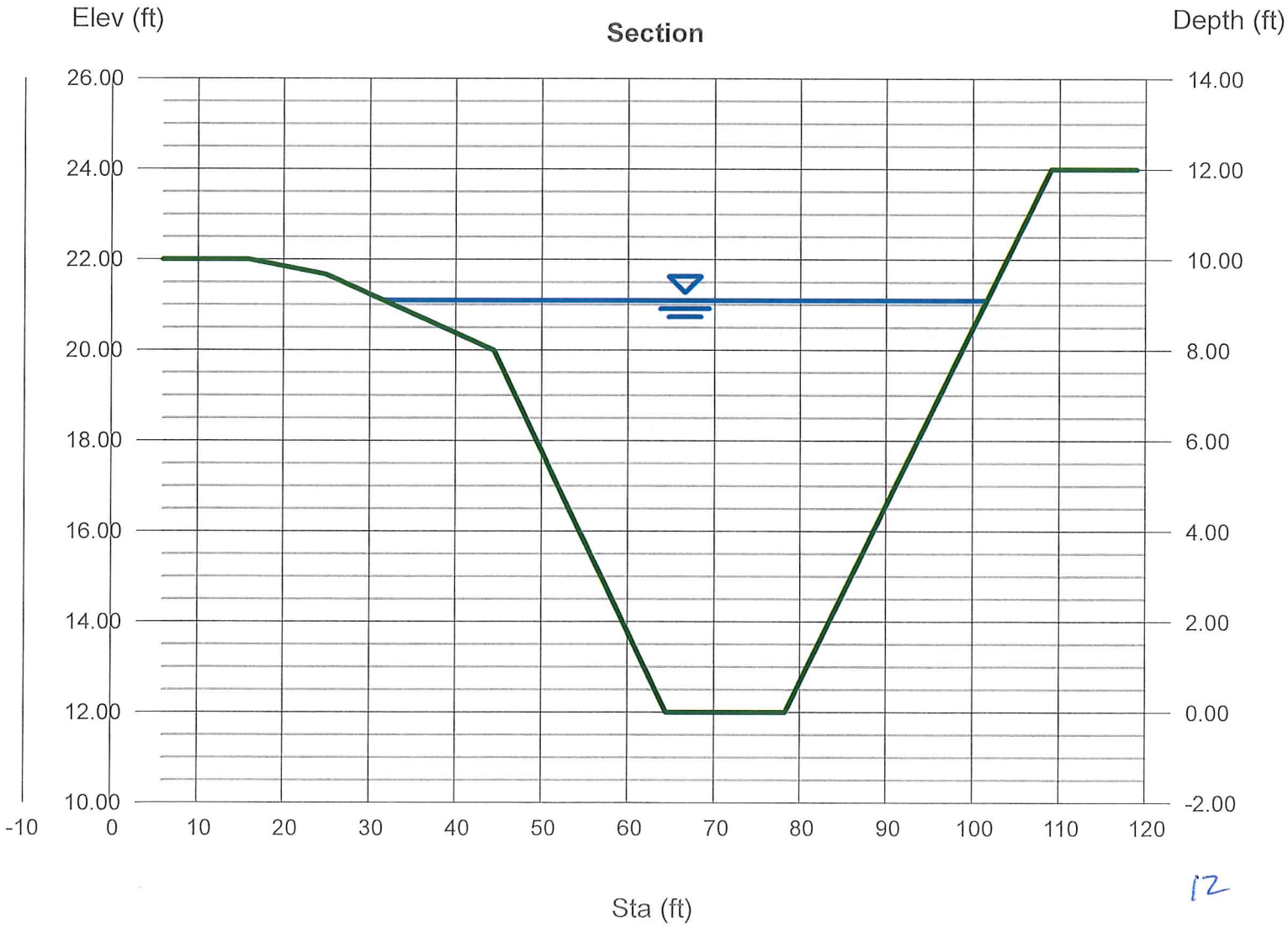
Compute by:	Known Q
Known Q (cfs)	= 1406.00

Highlighted

Depth (ft)	= 9.10
Q (cfs)	= 1,406
Area (sqft)	= 340.58
Velocity (ft/s)	= 4.13
Wetted Perim (ft)	= 73.23
Crit Depth, Yc (ft)	= 5.06
Top Width (ft)	= 69.93
EGL (ft)	= 9.37

(Sta, El, n)-(Sta, El, n)...

(16.00, 22.00)-(25.00, 21.67, 0.055)-(44.50, 20.00, 0.055)-(64.50, 12.00, 0.055)-(78.30, 12.00, 0.055)-(109.00, 24.00, 0.055)



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Hydrology Report

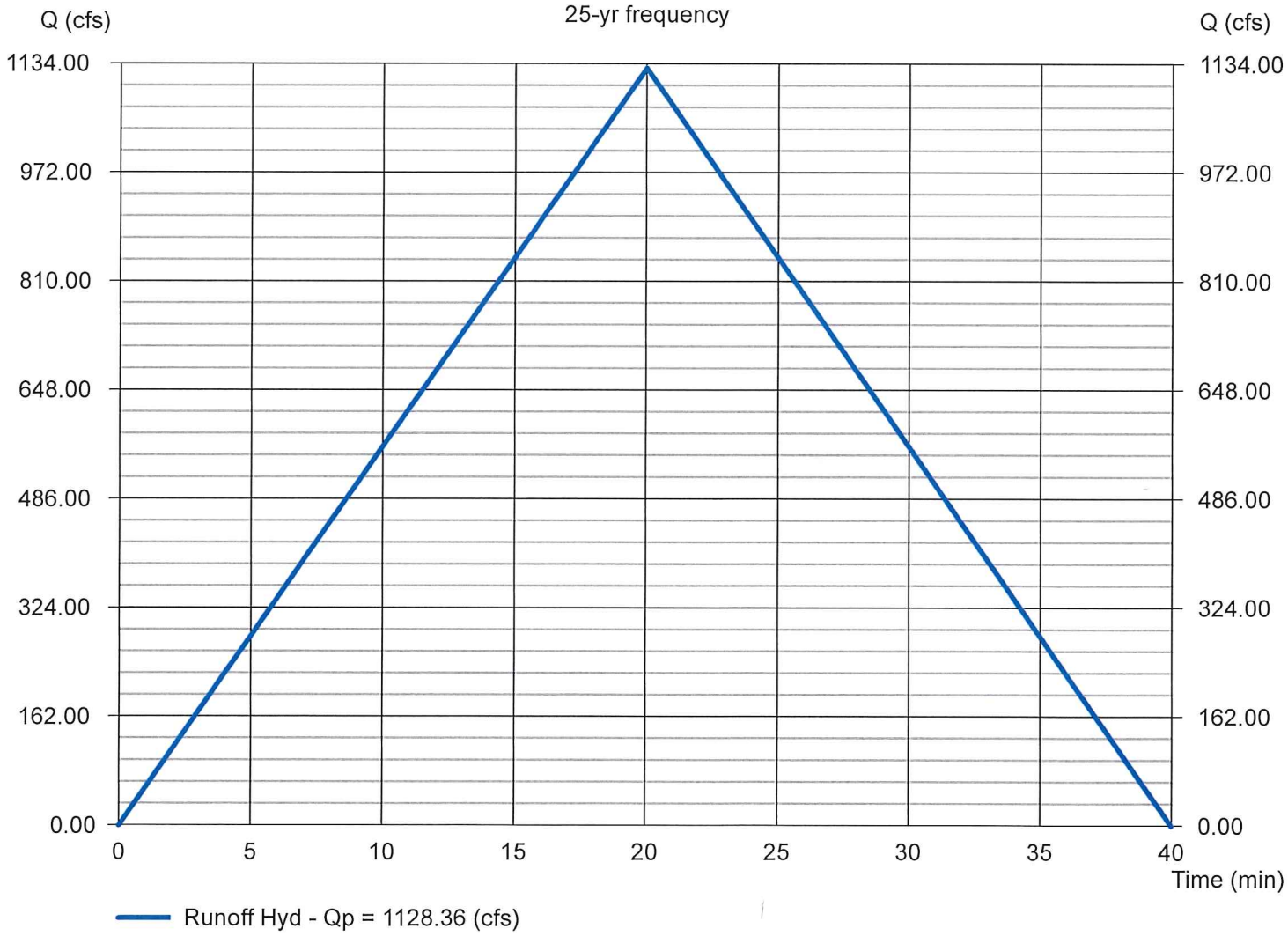
Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Dec 11 2018

25-year Storm

Hydrograph type	= Rational	Peak discharge (cfs)	= 1128.36
Storm frequency (yrs)	= 25	Time interval (min)	= 1
Drainage area (ac)	= 1345.000	Runoff coeff. (C)	= 0.6
Rainfall Inten (in/hr)	= 1.398	Tc by User (min)	= 20
IDF Curve	= Petaluma 0.83.IDF	Rec limb factor	= 1.00

Hydrograph Volume = 1,354,027 (cuft); 31.084 (acft)

Runoff Hydrograph



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Dec 11 2018

DeCristo 25-year

User-defined

Invert Elev (ft)	= 12.00
Slope (%)	= 0.30
N-Value	= 0.055

Calculations

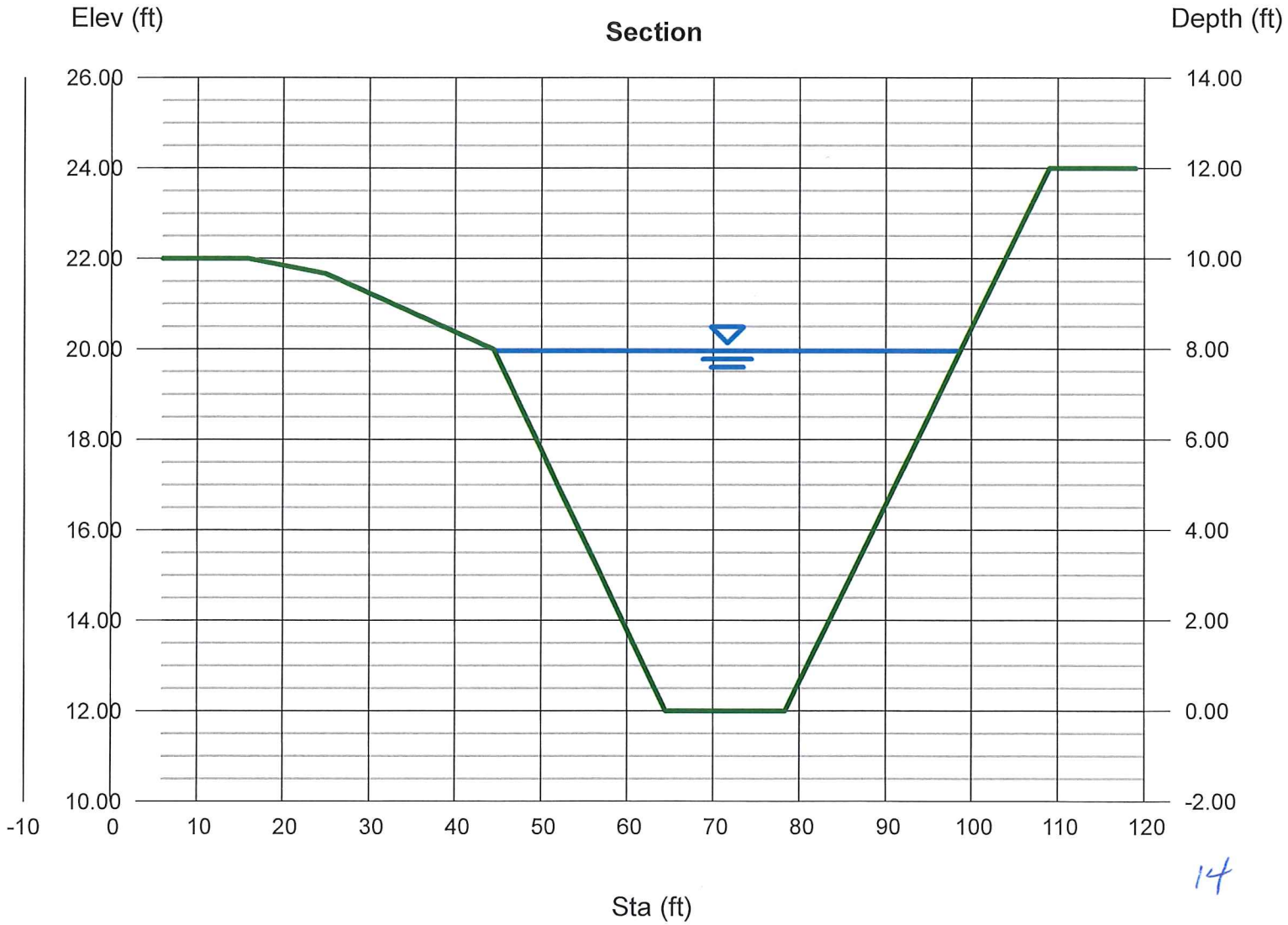
Compute by:	Known Q
Known Q (cfs)	= 1128.00

Highlighted

Depth (ft)	= 7.96
Q (cfs)	= 1,128
Area (sqft)	= 270.10
Velocity (ft/s)	= 4.18
Wetted Perim (ft)	= 57.10
Crit Depth, Yc (ft)	= 4.50
Top Width (ft)	= 54.06
EGL (ft)	= 8.23

(Sta, El, n)-(Sta, El, n)...

(16.00, 22.00)-(25.00, 21.67, 0.055)-(44.50, 20.00, 0.055)-(64.50, 12.00, 0.055)-(78.30, 12.00, 0.055)-(109.00, 24.00, 0.055)



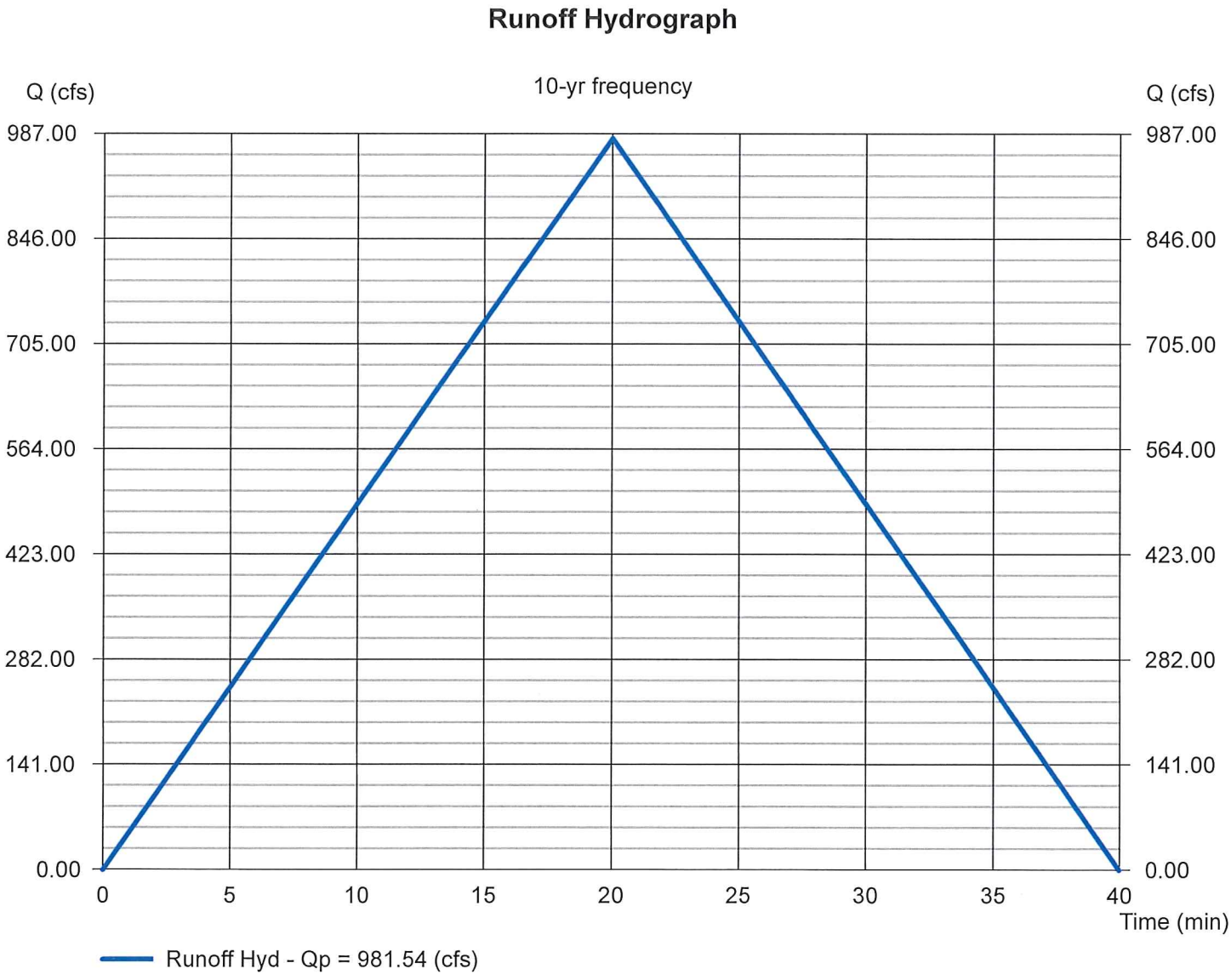
Hydrology Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Dec 11 2018

10-year Storm

Hydrograph type	= Rational	Peak discharge (cfs)	= 981.54
Storm frequency (yrs)	= 10	Time interval (min)	= 1
Drainage area (ac)	= 1345.000	Runoff coeff. (C)	= 0.6
Rainfall Inten (in/hr)	= 1.216	Tc by User (min)	= 20
IDF Curve	= Petaluma 0.83.IDF	Rec limb factor	= 1.00

Hydrograph Volume = 1,177,851 (cuft); 27.040 (acft)



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. Tuesday, Oct 16 2018

DeCristo 10-year

User-defined

Invert Elev (ft)	= 12.00
Slope (%)	= 0.30
N-Value	= 0.055

Calculations

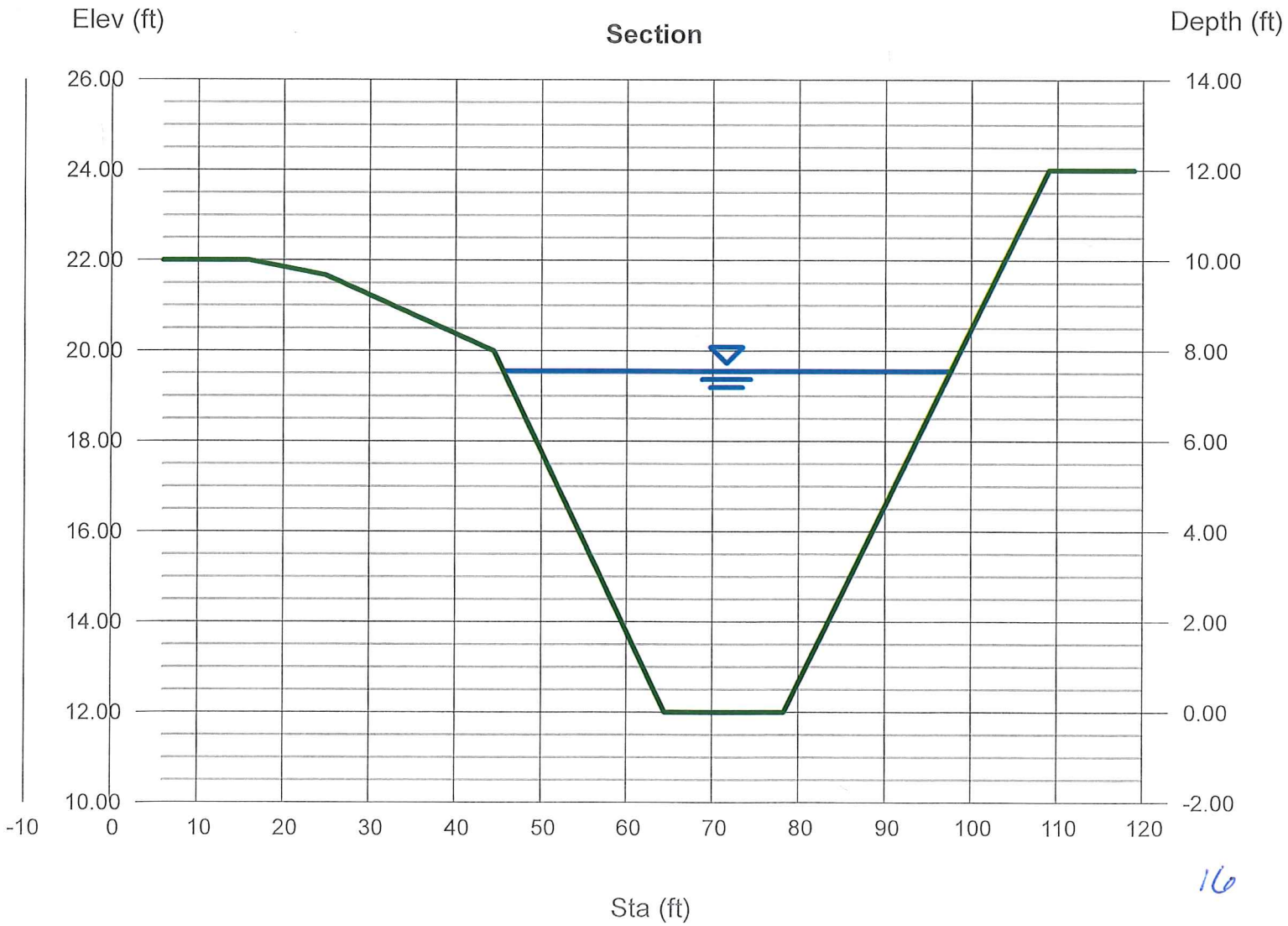
Compute by:	Known Q
Known Q (cfs)	= 1005.00

Highlighted

Depth (ft)	= 7.55
Q (cfs)	= 1,005
Area (sqft)	= 248.36
Velocity (ft/s)	= 4.05
Wetted Perim (ft)	= 54.87
Crit Depth, Yc (ft)	= 4.23
Top Width (ft)	= 51.99
EGL (ft)	= 7.80

(Sta, El, n)-(Sta, El, n)...

(16.00, 22.00)-(25.00, 21.67, 0.055)-(44.50, 20.00, 0.055)-(64.50, 12.00, 0.055)-(78.30, 12.00, 0.055)-(109.00, 24.00, 0.055)



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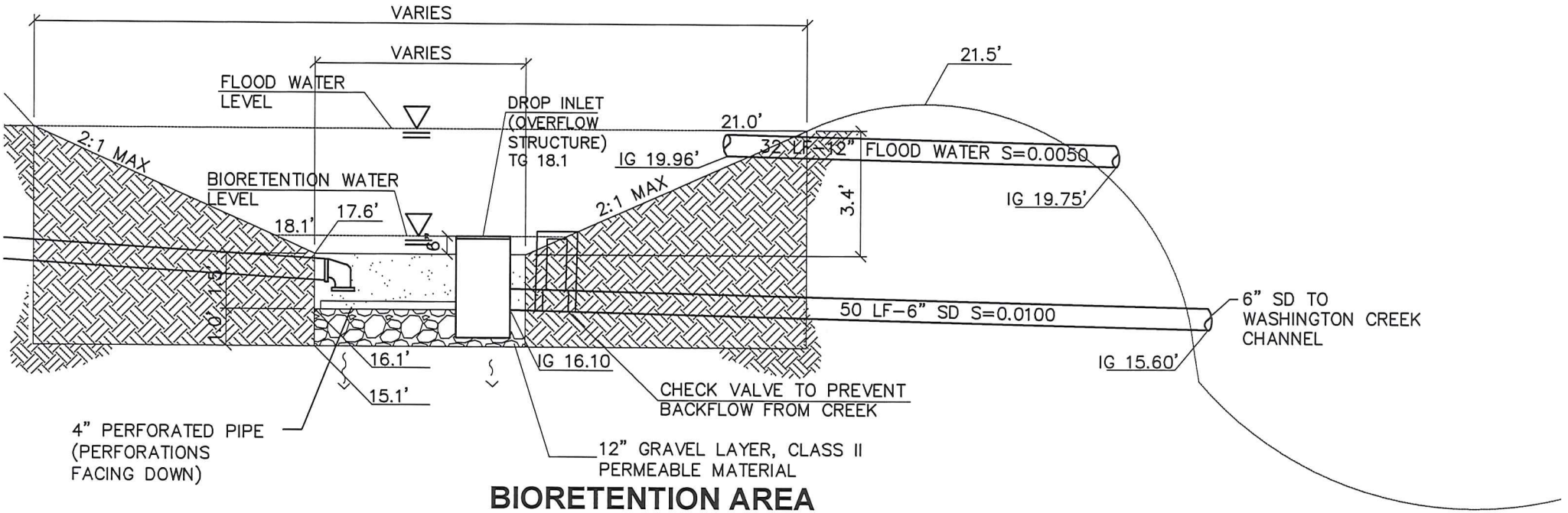
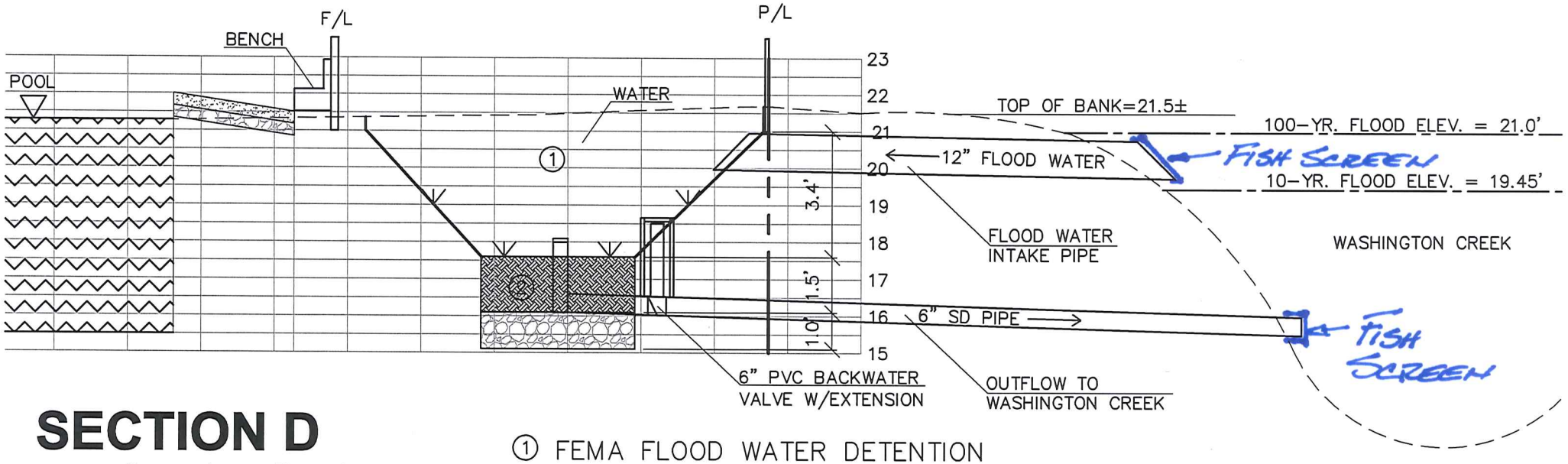


BIORETENTION AREA

N.T.S.

Item C-2

-11-



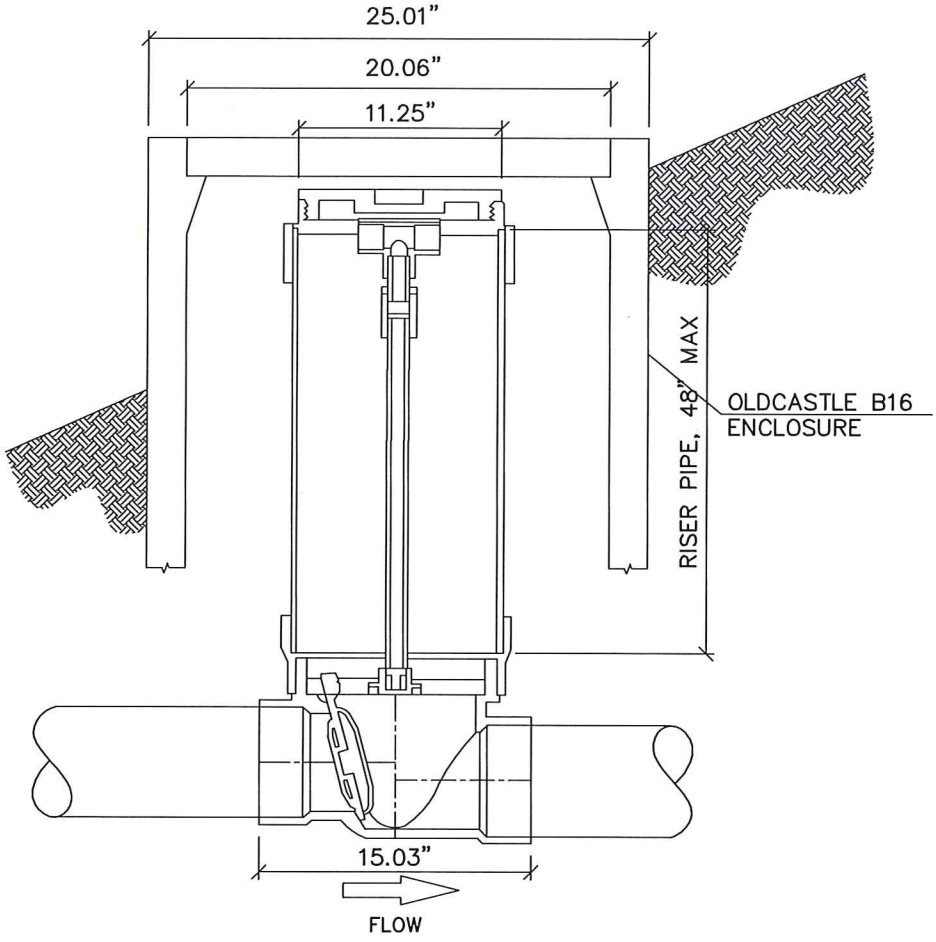
SECTION D

CALE 1"=10'H 1"=4'V

① FEMA FLOOD WATER DETENTION
(17.6' – 21.0', 4590 CU. FT.)

② BIO-RETENTION AREA 15.1'-17.6'
(SEE DETAIL ON C-8)

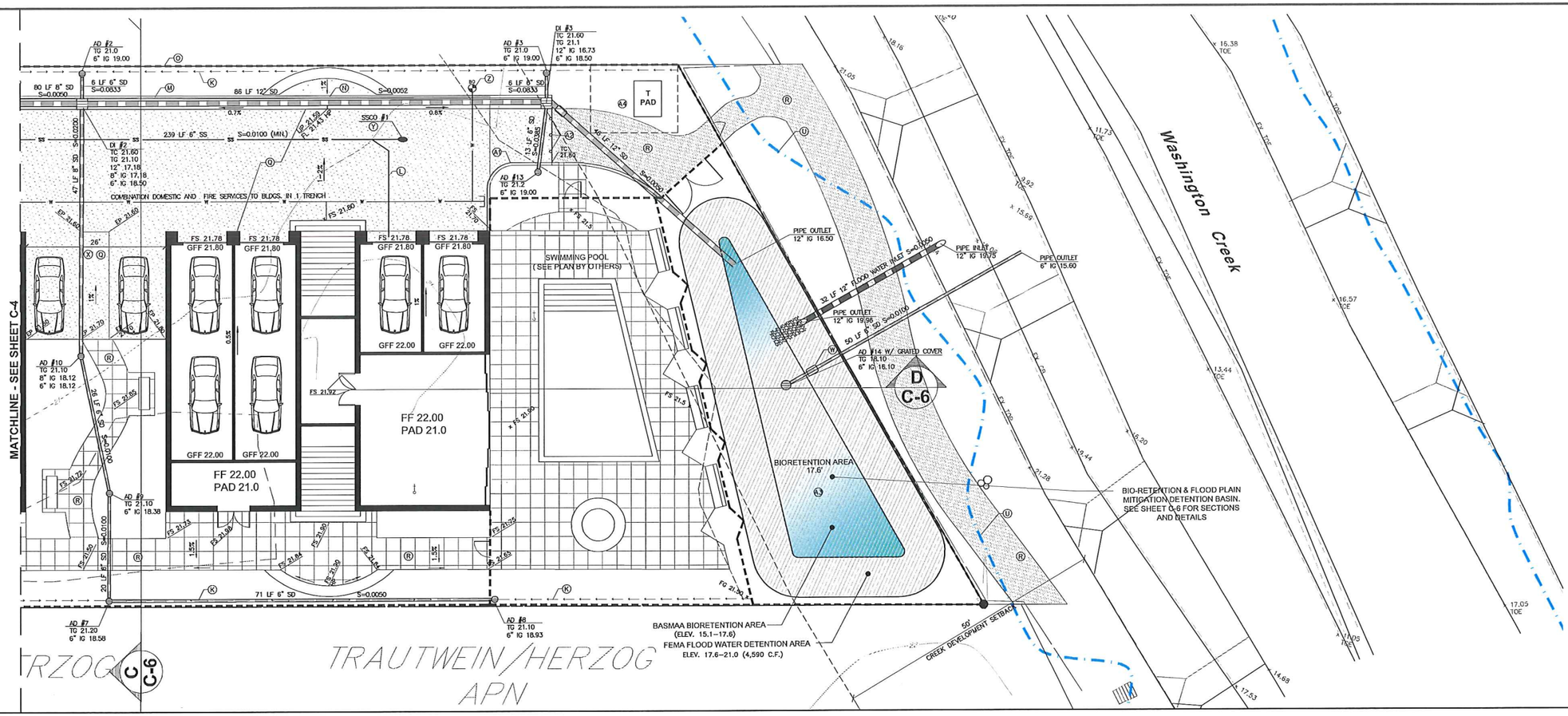
From C-6 -18-



SPEARS 6" PVC BACKWATER VALVE

(N.T.S.)

From C-6

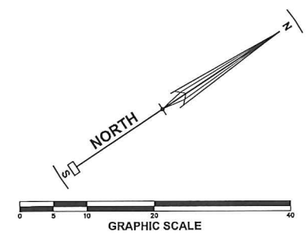


KEYNOTES

- (A) 20' WIDE DRIVEWAY CASE "B" PER CALTRANS STD. PLAN RSP A87A (SHEET C-4)
- (B) CURB, GUTTER AND SIDEWALK PER COP STD. 203
- (C) CONCRETE SIDEWALK PER COP STD. 202 & 203. (SHEET C-4)
- (D) EXISTING UTILITY POLE TO REMAIN (SHEET C-4)
- (E) NEW FIRE AND WATER SERVICE CONNECTIONS AND MANIFOLD. (SHEET C-4)
- (F) FIRE HYDRANT SHALL CONFORM TO THE APPROVED LIST OF APPROVED HYDRANTS PER COP STD. DETAILS 857.01 AND 890 WITH BREAKABLE AVF FLANGE. (SHEET C-4)
- (G) FIRE SPRINKLER CONNECTION. SEE DETAIL THIS SHEET (SHEET C-4)
- (H) 2" WATER METER PER CITY STD. 865. (SHEET C-4)
- (I) IRRIGATION METER. SEE IRRIGATION PLANS. (SHEET C-4)
- (J) REDUCED PRESSURE BACKFLOW PREVENTER. (SHEET C-4)
- (K) 2' WIDE 6" DEEP DRAINAGE/EARTH SWALE. SEE DETAIL ON SHEET C-6.
- (L) 6" SS LATERAL TO BLDG.
- (M) CURB AND GUTTER PER COP STD. 203
- (N) DEPRESSED CURB AT SITTING AREAS. LIP IS 1/2" ABOVE FL.
- (O) 1 OR 2 2"x12" PRESSURE TREATED 'KICKER' BOARD AS NEEDED TO MATCH NEW GRADE HEIGHTS.
- (P) ADA PARKING. GRADE AT 2% MAX. IN ALL DIRECTIONS. (SHEET C-4)
- (Q) PERMEABLE PAVING AT DRIVE AND SURFACE PARKING.
- (R) CONCRETE WALKWAY. COLOR AND PATTERN PER LANDSCAPE PLANS.
- (S) SANITARY SEWER MANHOLE PER CITY STD. NO. 500. (SHEET C-4)
- (T) PIPE HANDRAILS AT BOTH SIDES OF WALK WITH MORE THAN 5% LONGITUDINAL SLOPE. (SHEET C-4)
- (U) PRE DEVELOPMENT FLOOD BOUNDARY ELEVATION = 21.0'
- (V) POST DEVELOPMENT FLOOD BOUNDARY ELEVATION = 21.0'
- (W) SPEARS 6" PVC BACKWATER VALVE. SEE DETAIL ON SHEET C-6.
- (X) ADA COMPLIANT ELECTRIC VEHICLE CHARGING STATION.
- (Y) SANITARY SEWER CLEANOUT PER COP STD. 505.
- (Z) TYPICAL BLOW OFF PER COP STD. 862
- (A4) CURB & FALL AWAY GUTTER PER COP STD. 204
- (A3) BOLLARDS. TYPE AND MAKE TO BE DETERMINED
- (A2) BIORETENTION AREA. SEE SHEET C-6 FOR DETAIL.
- (A1) TRANSFORMER PAD OPTION B, SEE SHEET C-4 FOR OPTION A.

NOTES

1. TOPOGRAPHIC INFORMATION SHOWN IS BASED ON A FIELD SURVEY PERFORMED BY STEVEN J. LAFRANCHI & ASSOC., INC. IN AUGUST OF 2013 AND SUPPLEMENTAL SURVEY DONE IN APRIL 2018.
2. UNDERGROUND UTILITIES SHOWN ARE BASED ON SURFACE INDICATORS AND RECORD INFORMATION.
3. A TREE PRESERVATION AND MITIGATION REPORT WAS PREPARED BY BECKY DUCKLES DATED DECEMBER 2013.
4. 4 DOWNSPOUTS ARE LOCATED AT EACH CORNER OF THE BUILDING. THESE SHALL BE CONNECTED DIRECTLY TO THE AREA DRAINS. SEE DETAIL SHEET C-6.
5. SEE LANDSCAPE PLANS FOR PERIMETER AND POOL AREA FENCING.



11–30–2018

REVISIONS	BY

GRADING, DRAINAGE AND UTILITY PLAN 2

LANDS OF DE CRISTO FAMILY TRUST
109 ELLIS STREET APN 007-361-003
PETALUMA CALIFORNIA

STEVEN J. LAFRANCHI & ASSOCIATES, INC.
CIVIL ENGINEERS – LAND SURVEYORS
LAND PLANNERS – LANDSCAPE ARCHITECTS
PETALUMA THEATRE SQUARE
140 SECOND STREET SUITE 312
PETALUMA, CALIFORNIA 94952
(707) 762-3122 FAX (707) 762-3239

DATE:	2018.11.30
SCALE:	1"=10'
DESIGN:	ADF RRB
DRAWN:	RRB
CHECK:	SJL
JOB:	DeCRISTO FAM TRST
JOB No:	181983
SHEET	C-5
OF	7 SHEETS