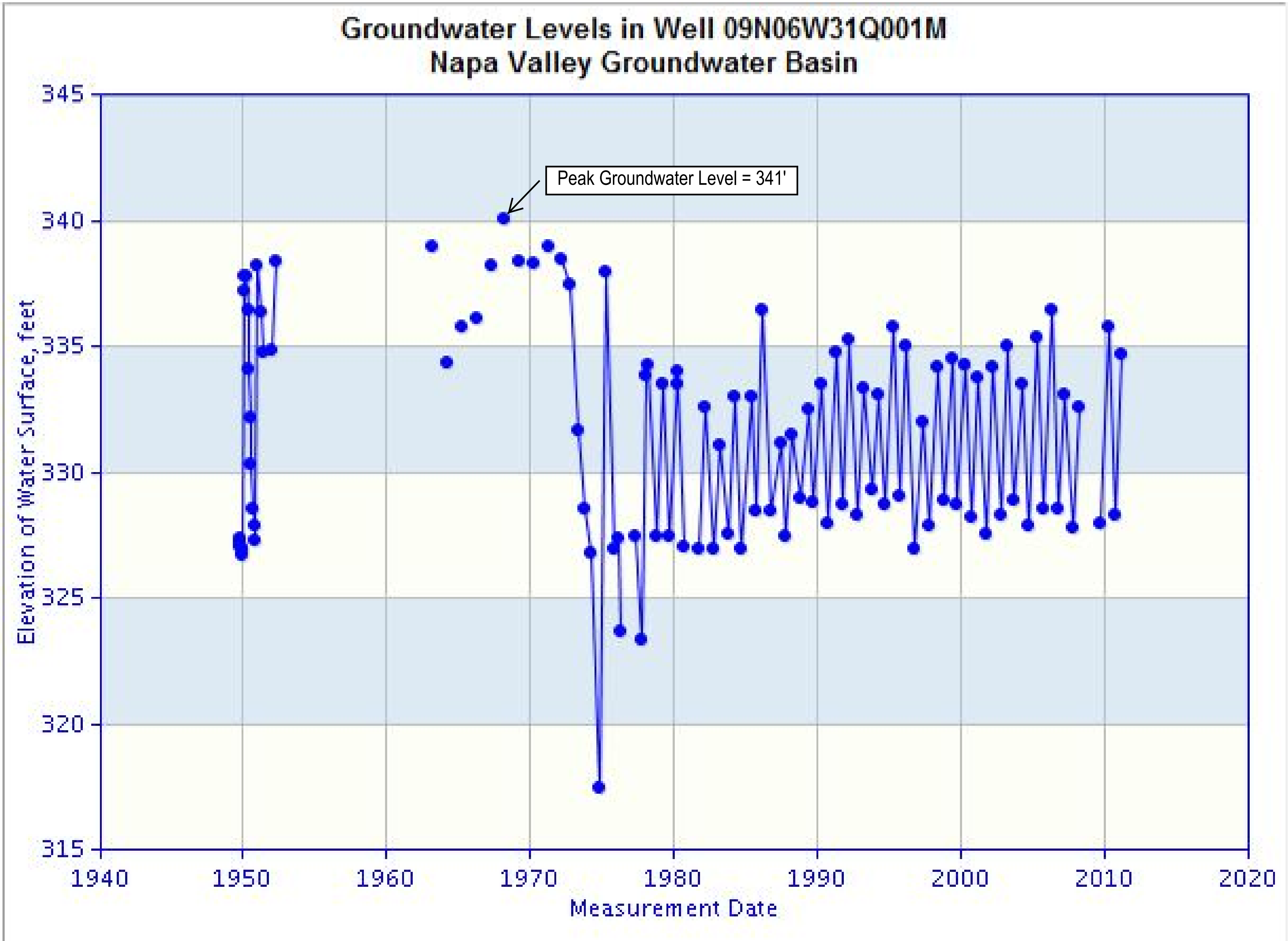
APPENDIX F

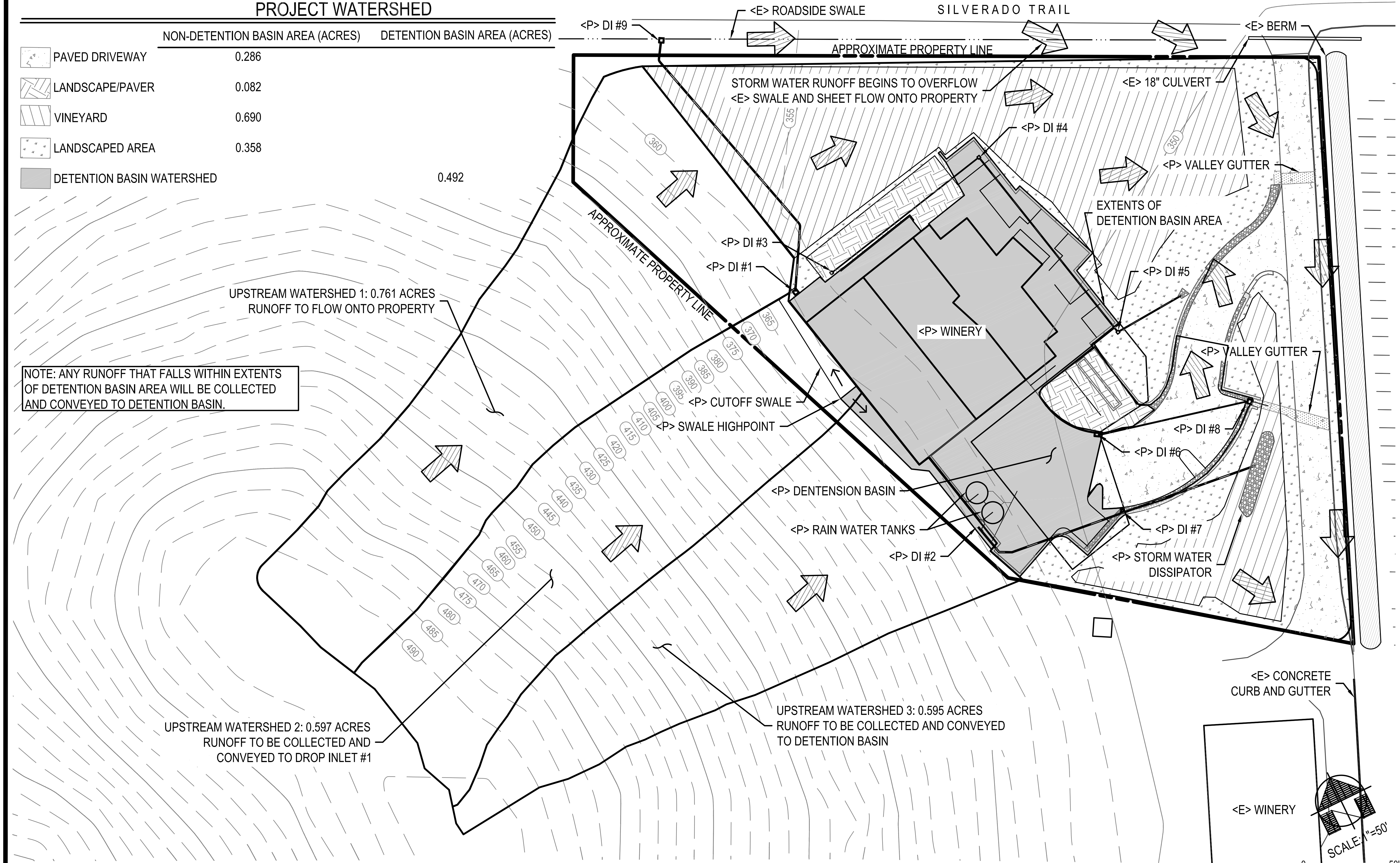

Groundwater Levels in Well 09N06W31Q001M
Napa Valley Groundwater Basin
Peak Groundwater Level = 341'
Elevation of Water Surface, feet
345
340
335
330
325
320
315
1940
1950
1960
1970
1980
1990
2000
2010
2020
Measurement Date


Map
Hybrid
Silverado Trail
Rosedale Rd
Rosedale Rd
Pickett Rd
Project Site
Existing Well Location
09N06W31Q001M
Silverado Trail
Silverado Trail
Iris Dr
Magnolia Dr
Holly Dr
Wisteria Dr
Champagne W
Champagne N
Champagne E
Champagne S
Champagne
400'
29
1000 ft
200 m
Map data ©2011 Google - Terms of Use

APPENDIX G

PROJECT WATERSHED

	NON-DETENTION BASIN AREA (ACRES)	DETENTION BASIN AREA (ACRES)
PAVED DRIVEWAY	0.286	
LANDSCAPE/PAVER	0.082	
VINEYARD	0.690	
LANDSCAPED AREA	0.358	
DETENTION BASIN WATERSHED		0.492



POST-CONSTRUCTION RUNOFF MAP

PROPOSED SITE PLAN PER USE PERMIT PLANS PREPARED BY JIM CASSAYRE AND DATED DECEMBER 28, 2011

CONTOURS BASED ON NAPA COUNTY 2002 DIGITAL TERRAIN MODEL AND TOPOGRAPHIC MAPPING

PLEASE REFER TO USE PERMIT PLANS PREPARED BY JIM CASSAYRE DATED JANUARY 18, 2012 FOR UPDATED SITE PLAN

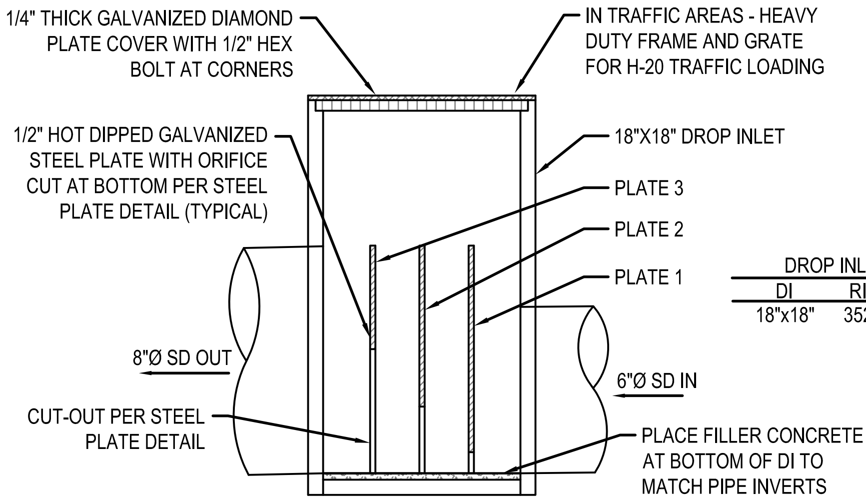
HYDROLOGY REPORT
POST-CONSTRUCTION RUNOFF MAP
CALISTOGA CALIFORNIA

DELTA CONSULTING & ENGINEERING OF ST. HELENA
1104 ADAMS STREET, SUITE 203 - ST. HELENA, CALIFORNIA 94574
707-963-8456 + 707-963-8528 FAX

DATE: 01/12/12
SCALE: 1"=50'
JOB #: K-149
APN: 011-050-030

1 OF 1

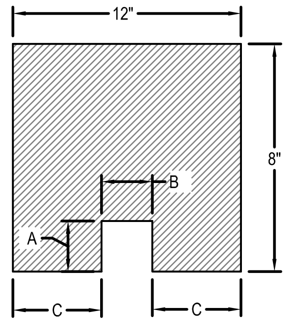
APPENDIX H



SECTION A-A

DROP INLET INFO

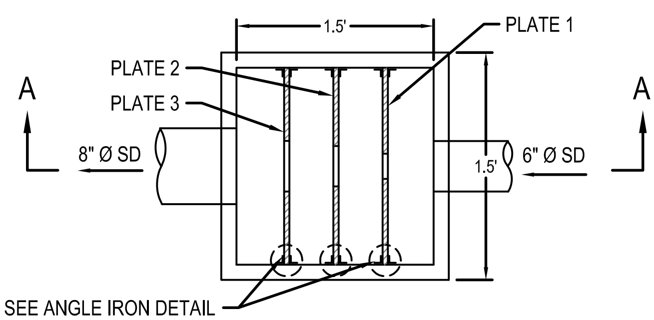
DI	RIM	INV
18"x18"	352.00	348.60



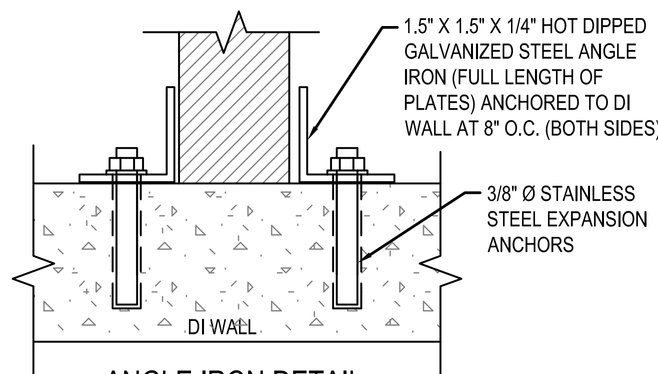
STEEL PLATE DETAIL

STEEL PLATE ORIFICE DIMS

	A	B	C
PLATE 1:	1.46"	1.46"	8.27"
PLATE 2:	3.53"	3.53"	7.2"
PLATE 3:	5.15"	5.15"	6.4"



PLAN VIEW



ANGLE IRON DETAIL

STORM WATER DETENTION METERING STRUCTURE

NOT TO SCALE

BRIAN ARDEN WINERY

METERING BOX DETAIL

Delta Consulting & Engineering
of St. Helena
1104 Adams Street, Suite 203 - St. Helena, California 94574
707-963-8456 + 707-963-8528 fax

DATE:	01-31-12	JOB #	K-149
SCALE:	NTS	APN:	011-050-030

SHEET 1 OF 1

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

Metering Box Design Calculations

2-Year Design Storm

Size of Metering Orifice In Drop Inlet

Knowns:

Peak Flow, Q: 0.06 cfs
Peak Flow, Q: 26.93 gpm

Equation:

Q = A*V*C

A = Area of Orifice
V = Velocity of Storm Water
C = Orifice Coefficient

Solve For Velocity:

V = (2*g*h)0.5

Gravity,G = 32.20 ft/s^2

Solve For System Head, H

H = Detention Basin Peak WSE - Invert of Metering Orifice
Peak WSE in Metering Box = 349.27 ft *8" Above Invert per Metering Box Detail*
Invert of Metering Box = 348.6 ft
H = 0.67 ft

V = 6.57 ft/s

Orifice Coefficient:

Orifice Coefficients

Orifice Shape	C
Circular	0.614
Triangular	0.615
Square with Vertical Walls	0.616
Rectangular	
Side ratio of 4:1, long side in vertical direction	0.626
Side ratio of 4:1, long side in horizontal direction	0.627
Side ratio of 10:1, long side in vertical direction	0.637
Side ratio of 10:1, long side in horizontal direction	0.637

Source: Brater and King, 1976.

Assumption:

Type of Orifice: Square with Vertical Walls

C = 0.616

Solve For Orifice Size:

Q = A*V*C

Rearrange Equation

A = Q / (V*C)

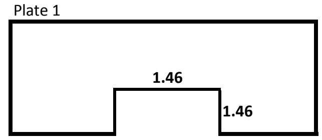
Inserting Above Values

A = 0.015 sq. ft
A = 2.14 sq. in

Conforming to Assumption of: Square with Vertical Walls

$A = (x)^2 =$ 2.14 sq. in
x = 1.46 in

Plate 1



Size of Rectangular Metering Orifice:

Base = 1.46 **in**
Height = 1.46 **in**

* Units are in inches

1104 ADAMS STREET, SUITE 203 – ST. HELENA, CALIFORNIA 94574
707-963-8456 TELE + 707-963-8528 FAX

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

10-Year Design Storm

Size of Metering Orifice In Drop Inlet

Knowns:

Peak Flow, Q: 0.35 cfs
Peak Flow, Q: 157.1 gpm

Equation:

Q = A*V*C

A = Area of Orifice
V = Velocity of Storm Water
C = Orifice Coefficient

Solve For Velocity:

V = (2*g*h)0.5

Gravity,G = 32.2 ft/s^2

Solve For System Head, H

H = Detention Basin Peak WSE - Invert of Metering Orifice
Peak WSE in Metering Box = 349.27 ft *8" Above Invert per Metering Box Detail*
Invert of Metering Box = 348.6 ft
H = 0.67 ft

V = 6.57

Orifice Coefficient:

Orifice Coefficients	
Orifice Shape	**C**
Circular	0.614
Triangular	0.615
Square with Vertical Walls	0.616
Rectangular	
Side ratio of 4:1, long side in vertical direction	0.626
Side ratio of 4:1, long side in horizontal direction	0.627
Side ratio of 10:1, long side in vertical direction	0.637
Side ratio of 10:1, long side in horizontal direction	0.637

Source: Brater and King, 1976.

Assumption:

Type of Orifice: Square with Vertical Walls

C = 0.616

Solve For Orifice Size:

Q = A*V*C

Rearrange Equation

A = Q / (V*C)

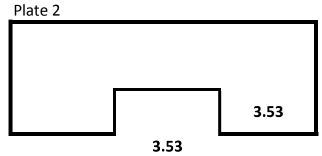
Inserting Above Values

A = 0.086 sq. ft
A = 12.46 sq. in

Conforming to Assumption of: Square with Vertical Walls

$A = (x)^2 =$ 12.46 sq. in
x = 3.53 in

Plate 2



* Units are in inches

Size of Rectangular Metering Orifice:

Base = 3.53 **in**
Height = 3.53 **in**

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

100-Year Design Storm

Size of Metering Orifice In Drop Inlet

Knowns:

Peak Flow, Q:	0.7	cfs
Peak Flow, Q:	334.26	gprm

Equation:

Q = A*V*C

A = Area of Orifice
V = Velocity of Storm Water
C = Orifice Coefficient

Solve For Velocity:

V = (2*g*h)0.5

Gravity,G = 32.2 ft/s^2

Solve For System Head, H

H = Detention Basin Peak WSE - Invert of Metering Orifice

Peak WSE in Metering Box =	349.27	ft	*8" Above Invert per Metering Box Detail*
Invert of Metering Box =	348.6	ft	
H =	0.67	ft	

V = 6.57

Orifice Coefficient:

Orifice Coefficients

Orifice Shape	C
Circular	0.614
Triangular	0.615
Square with Vertical Walls	0.616
Rectangular	
Side ratio of 4:1, long side in vertical direction	0.626
Side ratio of 4:1, long side in horizontal direction	0.627
Side ratio of 10:1, long side in vertical direction	0.637
Side ratio of 10:1, long side in horizontal direction	0.637

Source: Brater and King, 1976.

Assumption:

Type of Orifice: Square with Vertical Walls

C = 0.616

Solve For Orifice Size:

Q = A*V*C

Rearrange Equation

A = Q / (V*C)

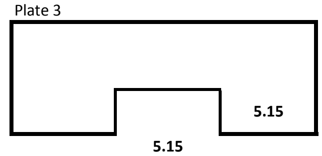
Inserting Above Values

A =	0.18	sq. ft
A =	26.51	sq. in

Conforming to Assumption of: Square with Vertical Walls

$A = (x)^2$ =	26.51	sq. in
x =	5.15	in

Plate 3



* Units are in inches

APPENDIX I

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

100 Year Design Storm: Peak Runoff at South Corner of Property

Total Site Runoff: Pre Construction 100-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Watershed	37.2	63.9	1.97
Upper Watershed	48.4	77.0	2.73
	Total:		4.70

Q_{PEAK} Determined at t = 8.58 hours

Total Site Runoff: Post Construction 100-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Minus Detention Basin	33.3	73.1	1.99
Upper Watershed 1	55.8	77.0	0.94
Upper Watershed 2	34.3	77.0	0.91
Outflow from Detention Basin*	-	-	0.69
	Total:		4.53

Q_{PEAK} Determined at t = 8.33 hours

**Based on the Metering Box Design from the Detention Basin*

$Q_{PRE,\ 100\ YEAR}$ =	4.70	cfs
$Q_{POST,\ 100\ YEAR}$ =	4.53	cfs
$Q_{POST,\ 100\ YEAR} < Q_{PRE,\ 100\ YEAR}$:	**0.17**	**cfs**
$Q_{POST,\ 100\ YEAR} < Q_{PRE,\ 100\ YEAR}$	**76**	**gpm**

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

10 Year Design Storm: Peak Runoff at South Corner of Property

Total Site Runoff: Pre Construction 10-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Watershed	37.2	63.9	0.92
Upper Watershed	48.4	77.0	1.54
	Total:		2.46

Q_{PEAK} Determined at t = 8.67 hours

Total Site Runoff: Post Construction 10-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Minus Detention Basin	36.0	73.1	0.90
Upper Watershed 1	55.8	77.0	0.53
Upper Watershed 2	34.3	77.0	0.52
Outflow from Detention Basin*	-	-	0.27
	Total:		2.22

Q_{PEAK} Determined at t = 8.33 hours

**Based on the Metering Box Design from the Detention Basin*

$Q_{PRE, 10 YEAR}$ =	2.46	cfs
$Q_{POST, 10 YEAR}$ =	2.22	cfs
$Q_{POST, 10 YEAR} < Q_{PRE, 10 YEAR}$:	**0.24**	**cfs**
$Q_{POST, 10 YEAR} < Q_{PRE, 10 YEAR}$	**108**	**gpm**

DELTA CONSULTING & ENGINEERING
OF ST. HELENA

2 Year Design Storm: Peak Runoff at South Corner of Property

Total Site Runoff: Pre Construction 2-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Watershed	37.2	63.9	0.30
Upper Watershed	48.4	77.0	0.74
	Total:		1.04

Q_{PEAK} Determined at t = 8.416 hours

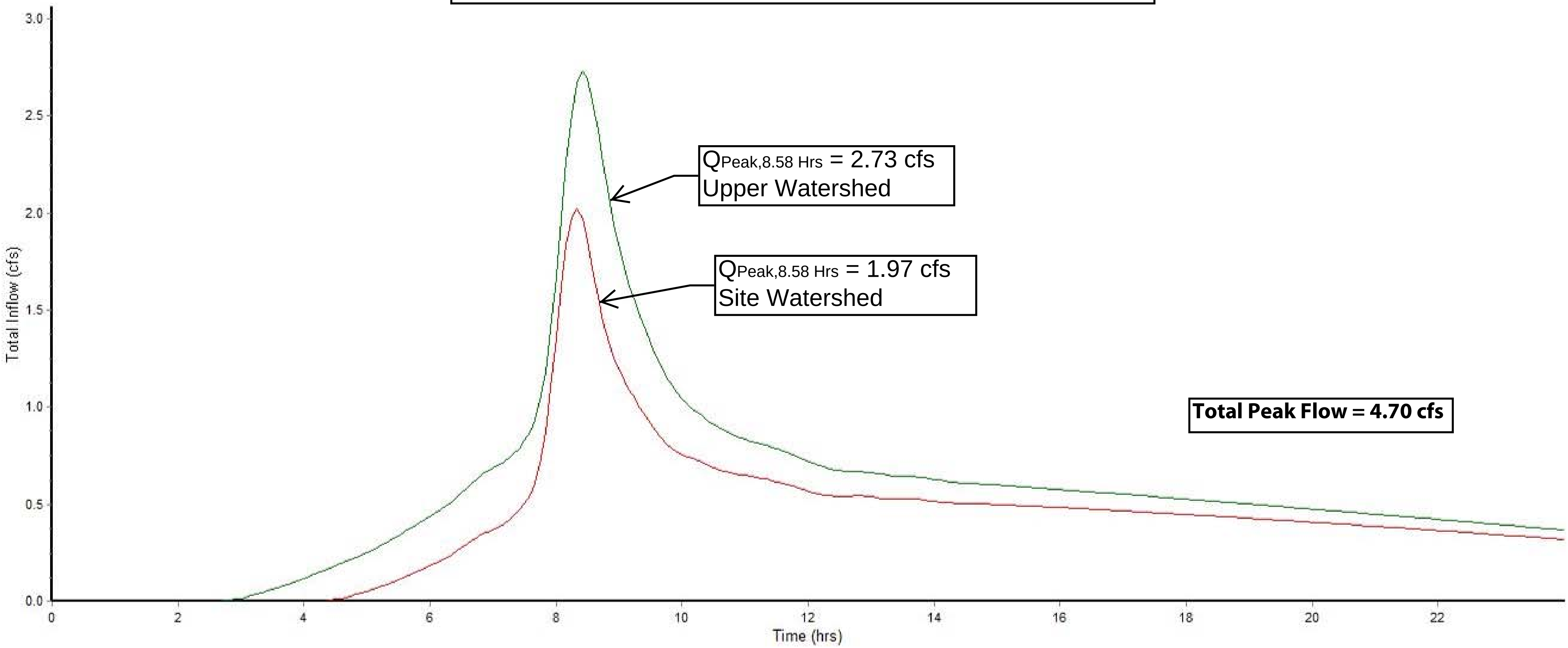
Total Site Runoff: Post Construction 2-Year Design Storm			
Watersheds	Tc (min)	CN	Q (cfs)
Site Minus Detention Basin	41.3	73.1	0.45
Upper Watershed 1	55.8	77.0	0.26
Upper Watershed 2	34.3	77.0	0.24
Outflow from Detention Basin*	-	-	0.05
	Total:		1.00

Q_{PEAK} Determined at t = 8.417 hours

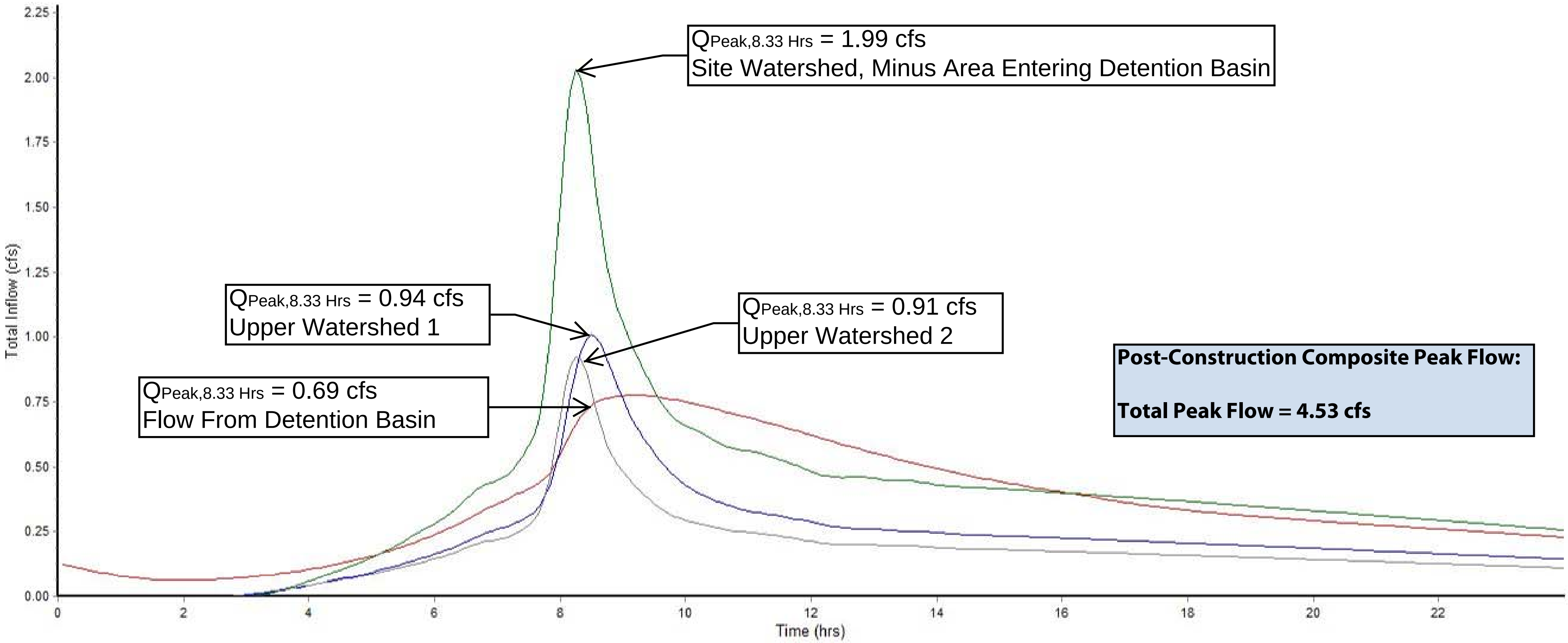
**Based on the Metering Box Design from the Detention Basin*

$Q_{PRE,\ 2\ YEAR}$ =	1.04	cfs
$Q_{POST,\ 2\ YEAR}$ =	1.00	cfs
$Q_{POST,\ YEAR} < Q_{PRE,\ YEAR}$:	**0.04**	**cfs**
$Q_{POST,\ 2\ YEAR} < Q_{PRE,\ 2\ YEAR}$	**18**	**gpm**

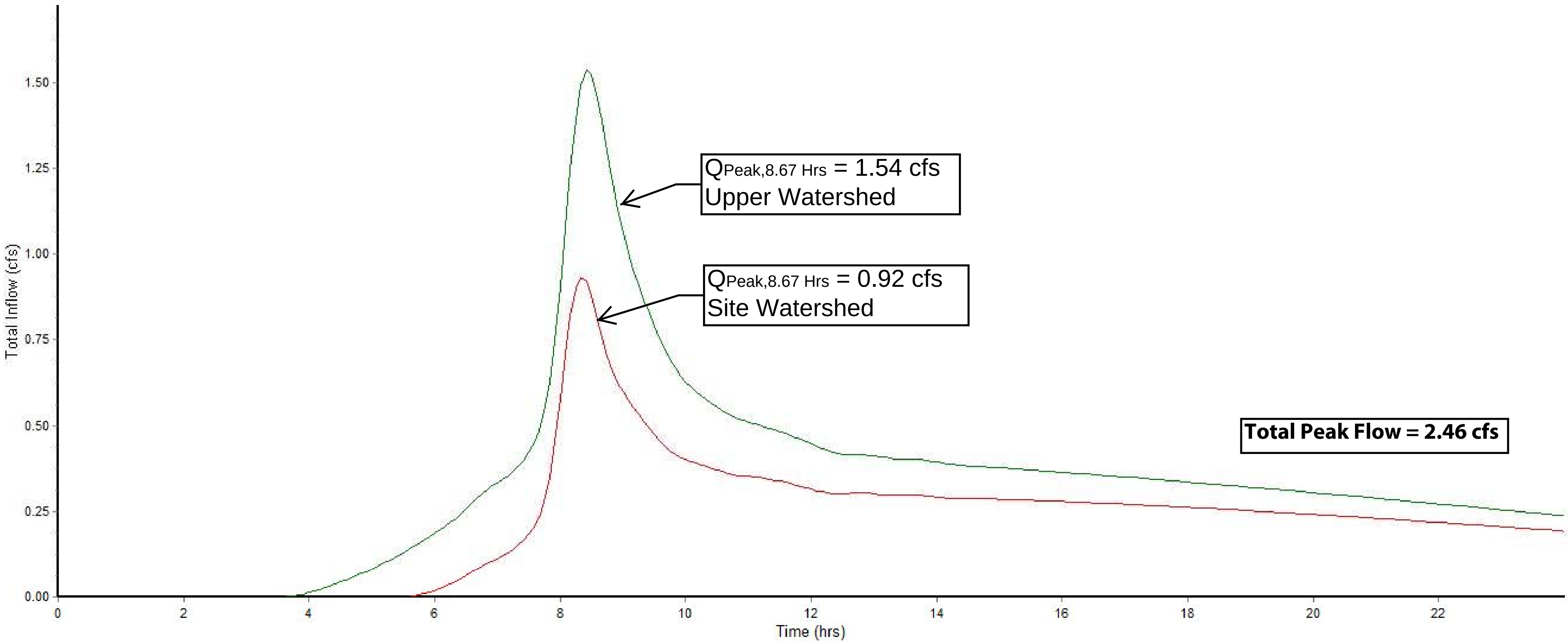
100-Year Design Storm
Pre Construction Peak Flow at Southern Corner of Property
QPEAK @ t = 8.58 Hours



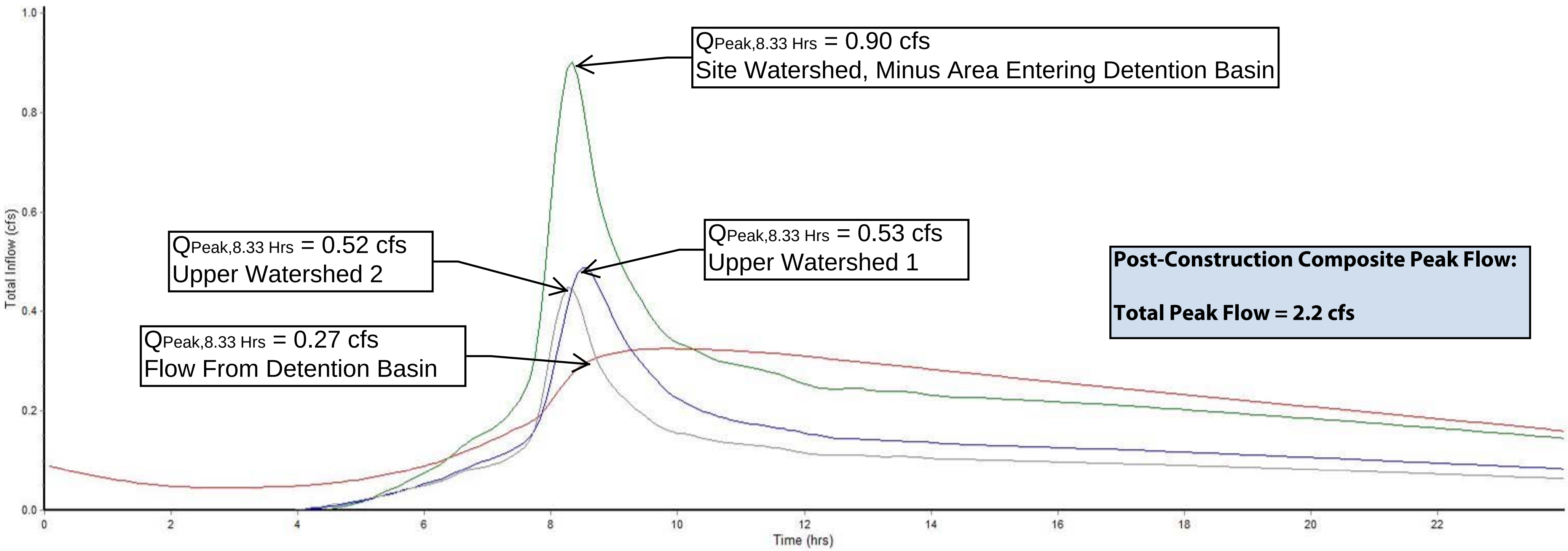
100-Year Design Storm
Post Construction Peak Flow at Southern Corner of Property
Q_{PEAK} @ t = 8.33 Hours



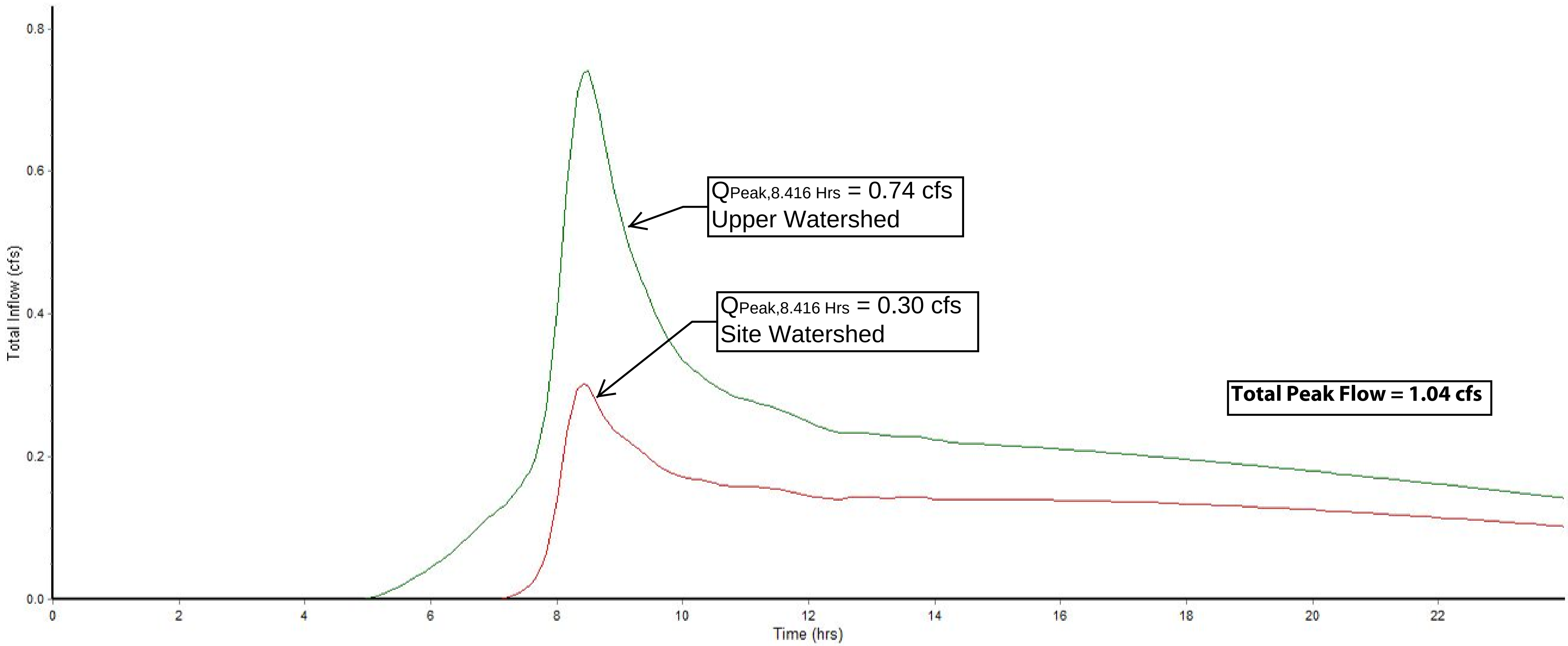
10-Year Design Storm
Pre Construction Peak Flow at Southern Corner of Property
Q_{PEAK} @ t = 8.67 Hours



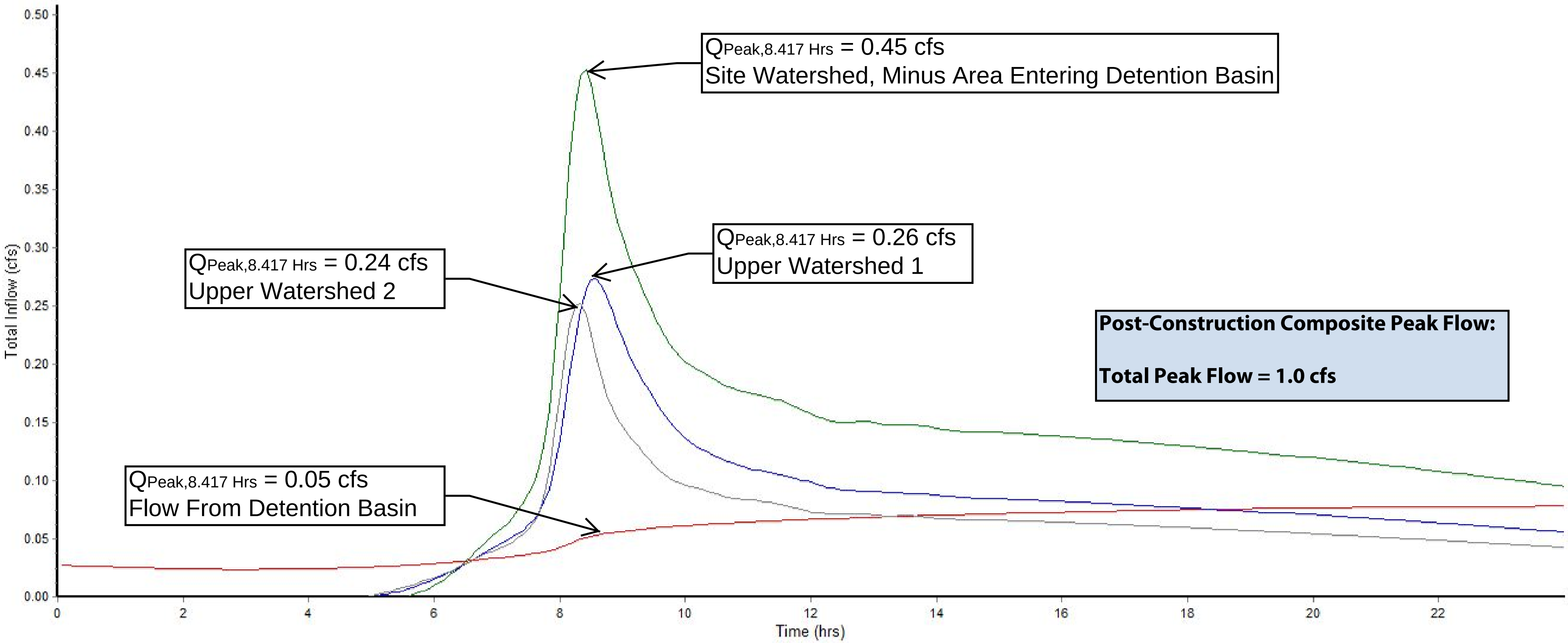
10-Year Design Storm
Post Construction Peak Flow at Southern Corner of Property
Q_{PEAK} @ t = 8.33 Hours



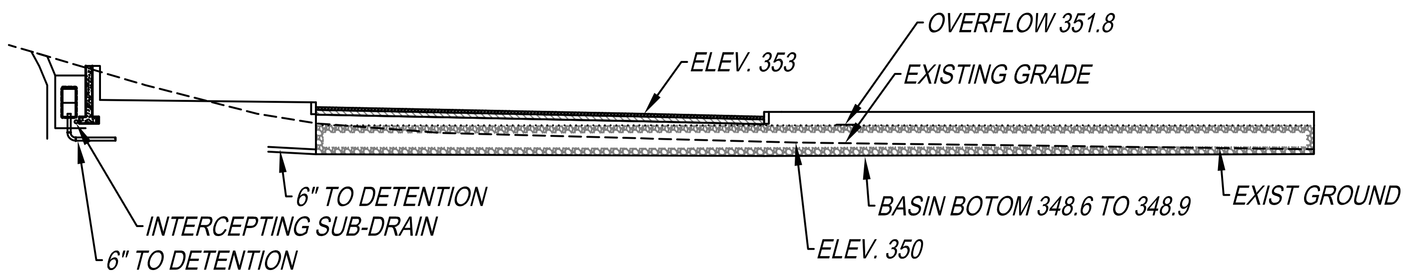
2-Year Design Storm
Pre Construction Peak Flow at Southern Corner of Property
Q_{PEAK} @ t = 8.416 Hours



2-Year Design Storm
Post Construction Peak Flow at Southern Corner of Property
QPEAK @ t = 8.417 Hours



APPENDIX J



DETENTION BASIN CROSS SECTION

BASIN CROSS SECTION PREPARED BY JIM CASSAYRE

SCALE: 1"=20'

BRIAN ARDEN WINERY

DETENTION BASIN CROSS SECTION

DELTA CONSULTING & ENGINEERING
OF ST. HELENA
1104 ADAMS STREET, SUITE 203 - ST. HELENA, CALIFORNIA 94574
707-963-8456 + 707-963-8528 FAX

DATE: 01/16/12	JOB # K-149	SHEET 1 OF 1
SCALE: 1"=20'	APN: 011-050-030	

APPENDIX K

CITY OF SANTA ROSA

PUBLIC STORM DRAIN STANDARDS

Adopted by the Santa Rosa City Council
Resolution No. _26247_
Date: _4/26/2005_

EXHIBIT A

QUICK REFERENCE SHEET
HYDROLOGY

Waterway classification	***Drainage area, square miles***	***Recurrence interval, years***
Major	≥4	100
Secondary	1–4	25
Minor	≤1	10
Diversion	Not applicable	100

Q = CIAK

where:

Q = flow (cubic feet per second)
C = runoff coefficient from Table I-1 (dimensionless)
I = rainfall intensity from Figure I-1 (inches per hour)
A = drainage area (acres)
K = mean seasonal precipitation from Figure I-2 ÷ 30 inches

Initial Time of Concentration (Tc)

Land use	***Tc***
Commercial/industrial/residential with more than 8 units per acre	7 minutes
Residential, 2 to 8 units per acre	10 minutes
Residential, less than 2 units per acre	15 minutes
Open Space	15 minutes

Page

discharging into a 10-year flow in the secondary downstream waterways. In such cases, the ground elevation along the secondary or minor system shall be above the 100-year water surface elevation in the major or secondary downstream waterway.

If a closed conduit (i.e., pipe or culvert) is used as a secondary or minor waterway, sufficient additional surface routes for flood flows shall be made available to carry the added flow increment up to the 100-year design flow with no more than nuisance damage to improvements or proposed improvements and with no flooding of finished floor of present and proposed future buildings. If such surface routes cannot be made available, the secondary or minor conduit shall be designed to carry the 100-year design flow.

The Manning equation shall be used for hydraulic design of storm drain facilities. The Manning equation is stated as follows:

$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

where

Q = flow in cubic feet per second

A = cross-sectional area of flow in square feet

R = hydraulic radius in feet

S = slope of the pipe or channel (dimensionless)

n = Manning equation roughness coefficient (dimensionless)

The values of the Manning equation roughness coefficient "n" shall be as follows:

Material	***n***
Storm Drain Pipe: Smooth walled high density polyethylene, reinforced concrete, or cast-in-place	0.014
Concrete-lined channel	0.015
Asphaltic concrete	0.017
Sack concrete and grouted rock rip rap	0.030
Loose rock rip rap	0.035
Grass-lined channels	0.035 minimum
Constructed natural waterways	0.050 minimum

QUICK REFERENCE SHEET
HYDRAULICS

Design waterway classification	*Downstream waterway classification*	*Design flow in downstream waterway, years*
Secondary	Major	25
Minor	Major or secondary	10
Surface (ground)	Major or secondary	100
Diversion	Not applicable	100

Manning's formula

$$Q = (1.486/n)AR^{2/3}S^{1/2}$$

Manning's formula coefficient (n)

Material	*Mannings "n"*
Storm drain pipe [high density polyethylene pipe (HDPE), cast-in-place concrete (CIPP), and reinforced concrete pipe (RCP)]	0.014
Concrete-lined channel	0.015
Asphaltic concrete	0.017
Grouted rock rip rap	0.030
Loose rock rip rap	0.035
Grass-lined channel	0.035 minimum
Constructed natural waterway	0.050 minimum

Minimum design flow velocity = 2.5 feet per second

Waterway classification	*Waterway type*	*Minimum freeboard*
All	Open channel	1.5 feet or 20 percent of specific energy (whichever is greater)
Major and secondary	Closed conduit	0.2 x diameter
Minor	Closed conduit	1 foot below top of curb or adjacent ground surface
Gutter	Open channel with 6-inch curb	0.4 feet maximum depth

PUBLIC STORM DRAIN DESIGN STANDARDS

PURPOSE:

The purpose of this document is to provide standards for design of public storm drain system improvements in the City of Santa Rosa (City). These standards consist of:

(1) hydrologic design criteria,
(2) hydraulic design criteria, and
(3) physical design requirements.

These standards do not include (but may reference) additional requirements established by other departments of the City and other government agencies. These standards are intended to impose **minimum** acceptable design criteria. More stringent requirements may be imposed by the City Engineer based on specific project conditions. Developers and their design engineers are responsible for complying with these standards and all other requirements for design of storm drain facilities within the City. Design engineers are responsible for initiating written requests for approval of any design concepts that differ from these standards, verifying additional requirements set forth by other departments of the City or other government agencies, performing any necessary calculations or studies, and resolving any problems with the appropriate department or agency. Developers and design engineers should be aware that Section 402(p) of the federal Clean Water Act establishes requirements for National Pollutant Discharge Elimination System permits for certain industrial and construction-related storm water discharges.

POLICY:

The policy of the City is to safely collect and convey storm water to the nearest public flood control facility in a storm drain system approved by the City of Santa Rosa Public Works Department (PWD), while achieving water quality objectives to the maximum extent practicable in the City's creeks as defined in the City’s Storm Water Management Plan.

HYDROLOGY CONCEPTS:

The Rational Method is widely used for determining design flows in urban and small watersheds. The method assumes that the maximum rate of runoff for a given rainfall intensity occurs when the duration of the storm is such that all parts of the watershed are contributing to the runoff at the interception point. The formula used is an empirical equation that relates the quantity of runoff from a given area to the total rainfall falling at a uniform rate on the same area and is expressed as:

$$Q = CIAK$$

in which

Q is the design flow in cubic feet per second.
C is a dimensionless runoff coefficient based upon type of ultimate development (i.e., land use) from Table I-1 for the drainage area.

I is the intensity of rainfall in inches per hour from Figure I-1 or computed as:

$$I = 5.12\, Y^{0.1469}\, t^{-0.528}$$

in which

Y = recurrence interval (10, 25 or 100 year, etc.)
t = time of concentration (duration in minutes)

A is the tributary drainage area in acres.

K is the dimensionless ratio of the average annual rainfall for the drainage area to the average annual rainfall for the overall area for which the rainfall intensity/duration/recurrence interval relationships have been established.

$$K = \frac{\text{average annual rainfall in inches from Figure I-2}}{\text{30 inches}}$$

The runoff coefficient (C), the drainage area (A), and the average annual rainfall ratio (K) are all constant for a given area at a given time. (Note that some agencies do not include the factor K when using the Rational Method.) Rainfall intensity (I), however, is determined by using an appropriate storm frequency (i.e., recurrence interval) and duration which are selected on the basis of economics and engineering judgment. Storm drains are designed on the basis that they will flow nearly full during the design storms. Storm frequency is selected through consideration of the size of drainage area, probable flooding, possible flood damage, and anticipated future development for the drainage area.

Runoff Coefficient. The runoff coefficient (C) normally ranges between 0.30 and 0.90. The soil characteristics, such as porosity, permeability, and whether or not it is saturated from preceding storms are important considerations. Another factor to consider is ground cover, i.e., whether the area is paved, grassy or wooded. In certain areas, the coefficient depends upon the slope of the terrain. Duration of rainfall and shape of area are also important factors in special instances. Of primary importance is the percent of land covered with impervious surfaces such as asphalt.

Rainfall Intensity. Rainfall intensity (I) is the amount of rainfall measured in inches per hour that would be expected to occur during a storm of a certain duration. The storm frequency is the time in years in which a certain storm would be expected again and is determined statistically from available rainfall data. (See Figure I-1.)

Time of Concentration. The time of concentration at any point in a storm drain segment is the time required for runoff from the most hydraulically remote portion of the drainage area to reach that point. The most hydraulically remote portion provides the longest time of concentration but is not necessarily the most distant point in the drainage area. Since a basic assumption of the Rational Method is that all portions of the area are contributing runoff, the time of concentration is used as the storm duration in calculating the intensity. The time of concentration consists of the initial time of concentration, which depends on the anticipated future land use for the drainage area, plus the sum of the additional overland flow time, if any, and the times of travel in street gutters, roadside swales, storm drains, drainage channels, and other drainageways. The time of concentration is affected by the rainfall intensity, topography, and ground conditions.

HYDROLOGIC DESIGN:

Hydrologic design shall be based on the ultimate development and slope of the tributary watershed. All storm drain facilities shall be designed for flows resulting from 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the proposed development is approved by the appropriate City approval body. Drainage boundaries and basin slope shall be determined from the most current topographic information available. In flat areas, drainage basin boundaries shall be verified with those for other adjacent developments to eliminate gaps or overlaps and maintain consistency. Only areas which do not flow towards the proposed development may be excluded. The design must demonstrate that the excluded areas do not flow into the proposed development.

Flows from tributary areas upstream of the proposed development shall be included in the hydrologic design for the proposed development. The hydrology for the proposed project will be based on a pattern of upstream development which delivers the ultimate development storm runoff to the proposed project. Upstream area flows shall be based on 100 percent build-out of the land uses designated in the latest adopted edition of the City's General Plan in effect at the time the project is designed. Rezoning often results in significantly higher densities than were used in design calculations for existing downstream storm drain facilities. The design of the storm drain system for the proposed development shall be based on the assumption that storm flows from upstream areas will be conveyed in conduits, thereby resulting in lower times of concentration than for undeveloped conditions. The design of the storm drain facilities for the proposed development shall be such that the design flow from the proposed development and the upstream areas is less than or equal to the hydraulic capacity of the downstream storm drain facilities unless otherwise approved. In cases where the design flow exceeds the hydraulic capacity of the downstream storm drain facilities, improvements to the downstream facilities may be required as part of the development.

Developed public areas, including but not limited to public parks and golf courses, may be considered to be vegetated to the extent that they are actually vegetated, unless publicly proposed plans indicate that the governing body having jurisdiction over the area intends to alter the existing use of the area so as to make the surface less pervious. The developer shall confirm future plans for park lands with the City Recreation and Parks Department Park Planner. Other public lands must be considered developed for the intended use (e.g., Caltrans right-of-way for extension of Highway 12 will be considered paved).

Drainage systems shall be designed to accommodate flows from storms with specific recurrence intervals. Recurrence interval is defined as the average number of years, over a long period of time, in which the magnitude of discharge from a given flood event is equaled or exceeded. Flows to be used for the design of waterways shall be calculated using the following minimum recurrence intervals:

Waterway classification	***Drainage area, square miles***	***Recurrence interval for design flow, years***
Major	≥4	100
Secondary	1–4	25
Minor	≤1	10
Diversion	NA	100

A given waterway, therefore, will be classed as minor in its upper reaches, then change to the secondary classification at a point where the drainage area exceeds 1 square mile, and then change again to the major classification at a point where the drainage area exceeds 4 square miles.

Design flow shall be determined by the use of the Rational Method formula: $Q = CIAK$

To use Figure I-1, determine the proper duration of the design storm event. The proper duration is equal to the time of concentration, which is the time required for flow from the most distant location in a drainage basin to reach the point of discharge from the basin.

Drainage areas larger than 2 acres are too large for application of the Rational Method formula in an initial step. The designer shall compute the time of concentration by determining the initial time of concentration. This is the time of concentration at the basin(s) which is furthest upstream. It is based on land use according to the table below. The Rational Method formula shall be applied to each subarea, step by step, and the flow shall be hydraulically routed from subbasin to subbasin to properly accumulate the design discharge for the entire watershed. For further details and sample calculations, refer to the latest edition of the SCWA Flood Control Design Criteria Manual.

Land use	***Initial time of concentration*, minutes***
Commercial, industrial, and residential with more than eight units per acre	7
Residential, two to eight units per acre	10
Residential, less than two units per acre	15
Open Space	15

*initial basins shall be of two acres or less

HYDRAULIC DESIGN CRITERIA:

General. For hydraulic design for commonly encountered situations, refer to the latest edition of SCWA Flood Control Design Criteria Manual and supplemental information. For hydraulic design for situations not covered by the SCWA manual, the design engineer shall provide specific references, model study reports, or prototype test results, as necessary to confirm the hydraulic design. Design engineers shall submit design calculations for all public storm drain facilities. As a minimum, the submittal shall include the items shown on the checklist in Appendix A. Examples of acceptable calculations are included in the appendix to the SCWA Flood Control Design Criteria.

Secondary waterways discharging into major downstream waterways shall be designed to operate while discharging into a 25-year flow in the major downstream waterways. Minor waterways discharging into secondary downstream waterways shall be designed to operate while

Table I-1 Rational Method Runoff Coefficients (C)

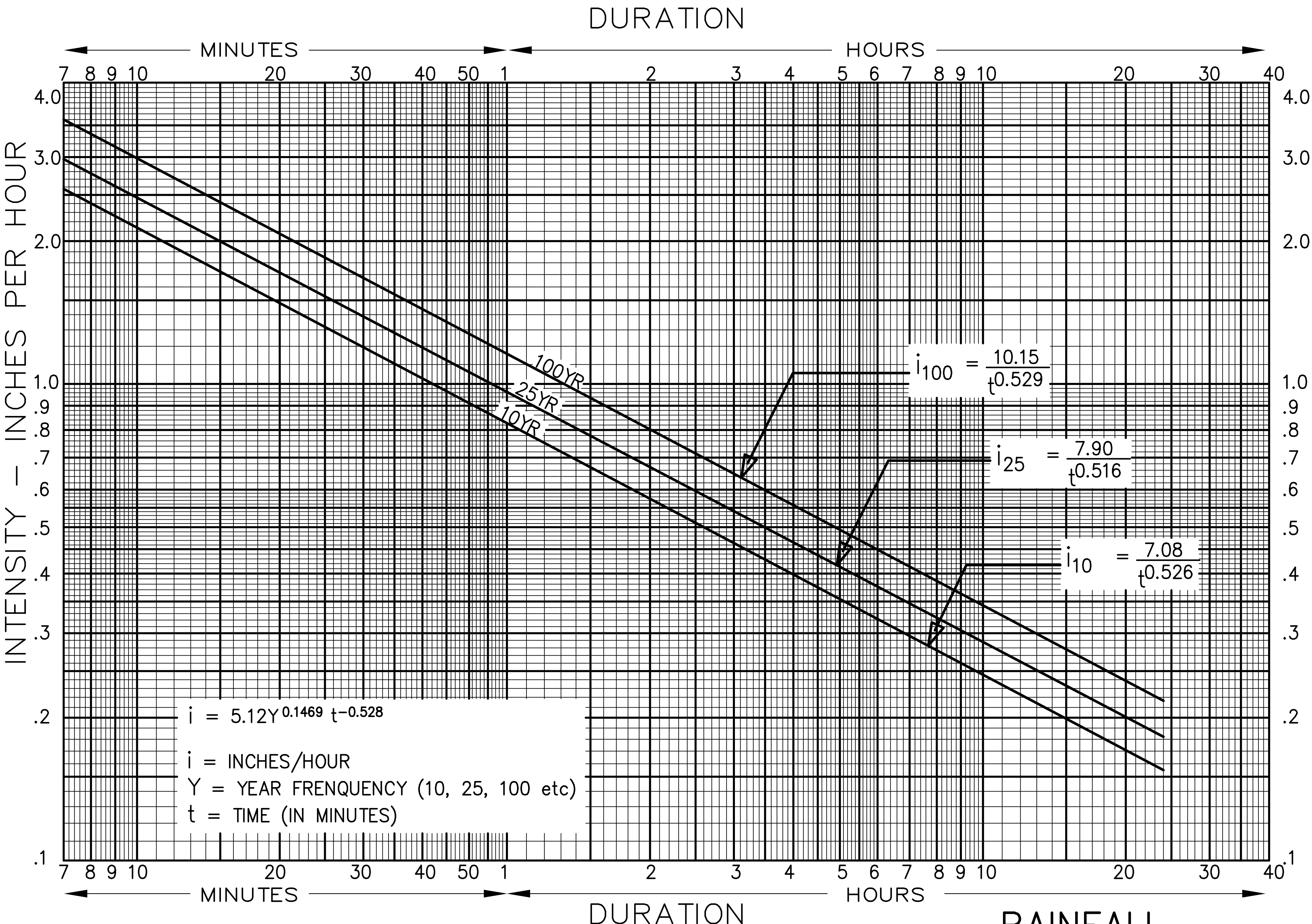
	Average slope, percent			
Land use	**0–2**	**>2–7**	**>7–15**	**>15**
Residential, Rural (1 unit per 5+ acres)	0.35	0.39	0.43	0.45
Residential, Very Low Density (1 unit per .5 to 5 acres)	0.40	0.43	0.46	0.50
Residential, Low Density (2 to 4 units per acre)	0.45	0.49	0.56	0.59
Residential, Medium-Low Density (4 to 8 units per acre)	0.50	0.56	0.64	0.70
Residential, Medium Density (8 to 18 units per acre)	0.70	0.74	0.77	0.80
Residential, Medium-High Density (18 to 30 units per acre)	0.90	0.90	0.90	0.90
Business, Commercial, Institutional and Schools	0.90	0.90	0.90	0.90
General Industrial	0.90	0.90	0.90	0.90
Parks and Recreation	0.31	0.37	0.42	0.45
Agricultural and Open Space	0.30	0.35	0.41	0.45

Note: Coefficients for developments with more than one land use shall be weighted in proportion to the areas of each land use using either the values from Table I-1 or the following formula in on-site design calculations. Off-site design calculations shall use the values from Table I-1.

$$C = Cv\,(Av/At) + 0.9(Ap/At)$$

Where:

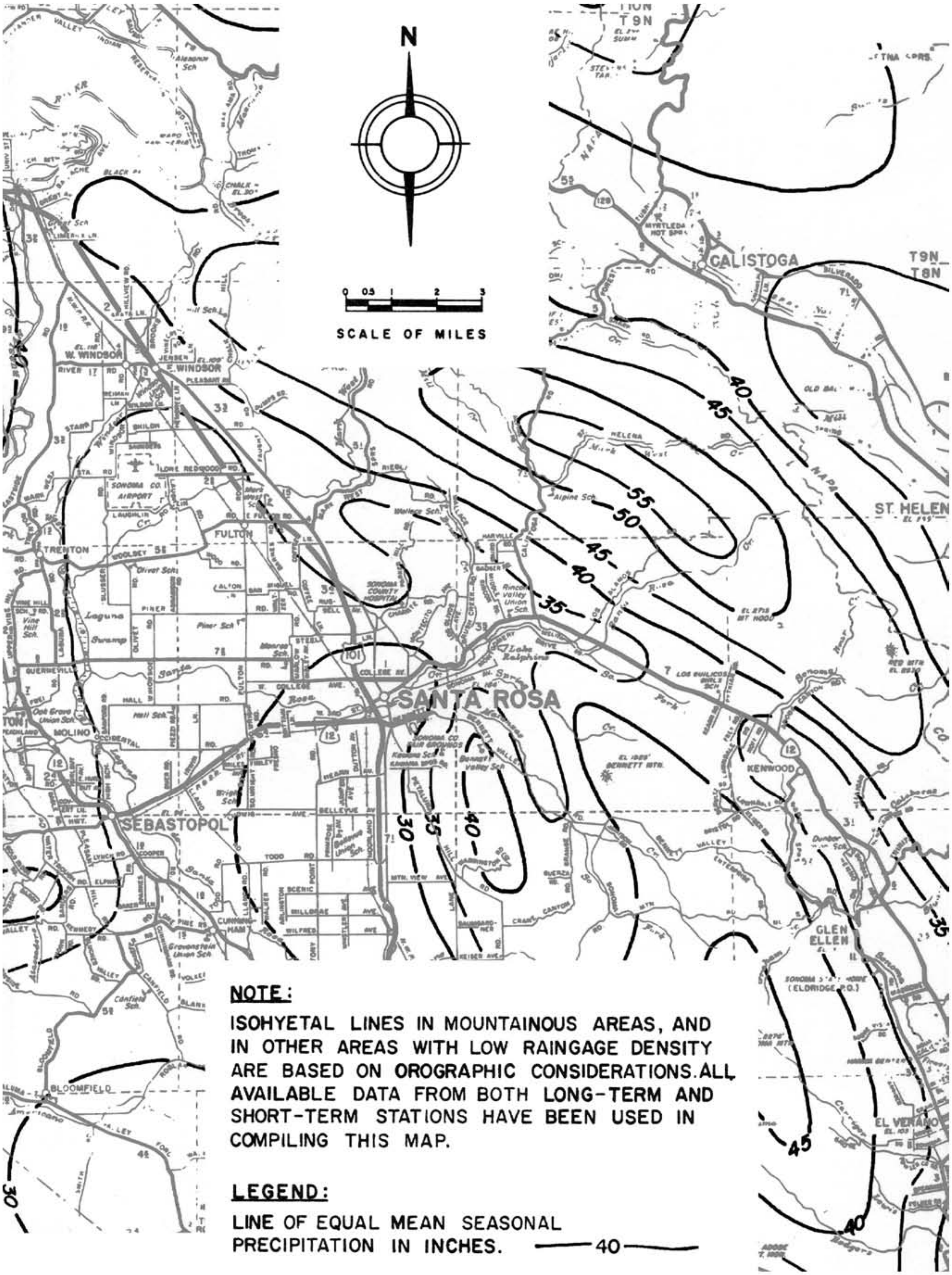
Cv = value from the vegetated area curve, SCWA Plate No. B1
Av = vegetated area
Ap = impervious area
At = total area



RAINFALL
INTENSITY vs DURATION

FIGURE I-1

Reproduced from the Sonoma County Water Agency's
Flood Control Design Criteria **Manual, August 1983 edition.**



Reproduced from the Sonoma County Water Agency's *Flood Control Design Criteria* Manual, August 1983 edition.

SANTA ROSA AREA MEAN SEASONAL PRECIPITATION MAP

FIGURE I-2