HYDROLOGY
AND
HYDRAULIC CALCULATIONS

Lake County Development:
Highlands Farms Site

Highland Springs Road
Lakeport, CA, 95453

REGISTERED PROFESSIONAL ENGINEER
JASPER GEHRING
No. C 67232
CIVIL
STATE OF CALIFORNIA

SUMMIT
CIVIL STRUCTURAL ELECTRICAL WATER|WASTEWATER

Project No.: 2021038
Date: November 12, 2021

463 AVIATION BLVD SUITE 200 | SANTA ROSA, CA |95403
707.527.0775

TABLE OF CONTENTS

PURPOSE

This report describes the drainage improvements and stormwater conveyance systems associated with the proposed improvements at Highland Farms. The purpose of the drainage improvements is to provide protection from flooding and reduce maintenance and erosion damage, as well as to size the post construction stormwater runoff or Low Impact Development (LID) measures, required by the County of Lake. Analyses include: peak runoff calculations for 100-year storm events, sizing of stormwater conveyance systems, and sizing of LID measures.

PROJECT OVERVIEW

The Highlands Farms project site is located on Highland Springs Road outside of Lakeport, in the County of Lake, California (see Vicinity Map, Appendix A). The site consists primarily of existing grasslands and low brushy foliage, with small defined channels running through the site, and existing structures. One located at the southwest extent of the proposed improvements and one located near the proposed building E site. The proposed project improvements include Development of 4 outdoor cannabis cultivation areas identified as A, B, C, and D, as well as a processing building (E), a greenhouse (H), a Processing Building (I), and a Nursery Building (J), as well as access roads, and parking areas. The proposed improvements are located as shown on the Project Improvement Plans.

The project anticipates a total of 162,100 square feet of future impervious surfacing (this value does not account for previously developed areas being returned to pervious surfacing). Impervious surfacing will consist of future building rooftops (110,970 square feet) and future paved roads and parking areas (51,130 square feet). Some gravel areas have been quantified as impervious for these hydrology calculations in the event that they are later resurfaced and become impervious.

The site is located up stream of Highland Springs Reservoir and upstream of an unnamed tributary to Highland Creek, which ultimately discharges to Clear Lake, by way of Adobe Creek. The average slope between the project footprint and the onsite drainage is approximately 2-5%. The existing area is moderately sloped, the drainage appears to primarily sheet flowing across the proposed developed area, it collects in loosely defined channels, sloping down to the southeast of the proposed development area where the drainage collects into a more well defined channel. Beyond the limits of the proposed improvements, further to the southeast, the channel is illustrated on the USGS mapping as an unnamed blue line steam. The proposed improvements, for the most part, avoid disturbance to the loosely defined channels. The cultivation and buildings planned in locations intended to avoid disturbance of concentrated flow paths. There are proposed crossing locations where access roads are required to cross the drainage flow lines and culverts are proposed. The proposed, new impervious surfaces are planned to be mitigated with LID measures sized per the Bay Area Stormwater Management Agencies Association (BASMAA) methodology.

This project disturbs over 1 acre of land, therefore a Storm Water Pollution Prevention Plan (SWPPP) will be required. A Notice of Intent (NOI) will be filed with the State Water Resource control Board (SWRCB) and a SWPPP for the construction activity associated with the project is anticipated to be prepared.

RAINFALL DATA/DESIGN PARAMETERS

Hydraulic Analysis for this project was performed using the Lake County Hydrology Design Standards with the Rational Method in order to appropriately size swales, storm drain pipes, and drainage inlets.

The location of the site and review of these standards provides the following mathematical models and constant values used in the hydraulic analysis. All supporting information for the parameters given in this section can be found in Appendix B.

RATIONAL METHOD

The Rational Method was used to size the swale and storm drain conveyances as shown on the Hydrology Maps in Appendix C. All swales and pipes were sized using the flow rate from the 100-year storm event.

Drainage areas for the constructed conditions were developed and are presented in maps in Appendix D. Flow rate calculations for each area were developed based on the Rational Method formula.

Rational Method : $Q = CiAK$

Q= Flowrate (cubic feet per second)
A= Drainage Area (acres)
C= Runoff Coefficient
K= coefficient of intensity
i= Rainfall Intensity

Runoff Coefficients were determined with reference to the Lake County Hydrology Design Standards, Table 1 and Table 2 see Appendix B for reference.

Impervious Area	:	0.90
Gravel Driveways	:	0.85
Pervious/Landscaped Areas	:	0.40

A weighted runoff coefficient is calculated per the equation included in the Lake County Hydrology Design Standards:

$$Ct = (Ap/At)(Cp) + (Av/At)(Cv)$$

Where:

Ap = area covered by impermeable surfaces, such as paving and buildings
Av = area planted or vegetated
At = total area
Cp = coefficient of runoff of paved area
Cv = coefficient of runoff for planted or vegetated areas
Ct = weighted average coefficient for drainage area

LAKE COUNTY HYDROLOGY DESIGN STANDARDS

The Lake County Hydrology Standards gives the following parameters for the project location. The following parameters were used with the Rational Method for hydraulic calculations of the storm drain network. See Appendix D for supporting calculations.

Mean Seasonal Precipitation	:	36 in/yr
K Factor:	:	K=36/35 = 1.03

Time of Concentration

Minimum Initial Time of Concentration	:	T_C = 10 min
Calculated time of Concentration	:	Tc= 10 min + Overland Flow Time + Channel Flow Time
Longest Time of Concentration	:	Tc=10 min + Toc +Tch
Time of overland flow (Toc)	:	(Distance/ Velocity)/(60 sec/min)
		(V from Figure 2)
	:	(500/0.8)/60 =
	:	10.41 min
Time of Channel Flow (Tch)	:	(Distance/ Velocity)/(60 sec/min)
		(V from Mannings Equation)
	:	(Distance/ (1.49/n)x(R)^(2/3)xS^(1/2))/60
	:	(2000/((1.49/0.035)x(0.5)^(2/3)x0.015^(1/2))/60
	:	(2000/(3.279)/60
	:	10.19 min
Longest Time of Concentration	:	Tc=10 + 10.41 +10.19
	:	Tc=30.6 or approximately 30 Mins

Figure 1 of the Lake County Hydrology Design Standards provides storm intensities based on various water shed time of concentrations and storm recurrence intervals. The following value will be used for the calculations in this report.

10-YEAR STORM EVENT

Rainfall Intensity		
Tc_{10}	:	1.62 in/hr
Tc_{30}	:	0.95 in/hr

100-YEAR STORM EVENT

Rainfall Intensity		
Tc_{10}	:	2.0 in/hr
Tc_{30}	:	1.4 in/hr

STORMWATER TREATMENT: BASMAA

This project will follow the Bay Area Stormwater Management Agencies Association (BASMAA) manual. As such, all bio-retention LID facilities are sized at a minimum of 4% of the equivalent tributary area for which they serve, in order to satisfy the Lake County requirements for stormwater mitigation. Many of the following design strategies are also implemented per the BASMAA manual.

LOW IMPACT DEVELOPMENT DESIGN STRATEGIES

OPTIMIZATION OF SITE LAYOUT

LIMITATION OF DEVELOPMENT ENVELOPE

Project is limited in the development envelope due to the adjacent waterway's proximity to the property.

PRESERVATION OF NATURAL DRAINAGE FEATURES

The existing drainage pattern for the site shall be preserved where feasible. Disturbance within the existing drainage areas is avoided.

SETBACKS FROM CREEKS, WETLANDS, AND RIPARIAN HABITATS

No development nor disturbance is proposed to be performed within the adjacent Petaluma River.

MINIMIZATION OF IMPERVIOUSNESS

Impervious surfacing of the site shall be minimized with landscaped areas and permeable pavers adjacent to proposed improvements.

USE OF DRAINAGE AS A DESIGN ELEMENT

Bio infiltration areas adjacent to the new buildings shall be utilized for both treatment and aesthetics.

DISPERSAL OF RUNOFF TO PERVIOUS AREAS

All new or reworked impervious areas will be directed to vegetated bioretention facilities.

STORMWATER CONTROL MEASURES

Storm drains shall be utilized throughout the project to direct stormwater from impervious areas, to the bioretention facilities at locations specified in the attached maps. The capacities of new pipes shall be sized adequately to handle post project flow rates.

DMA Regions	DMA Area (ft^2)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor (ft^2)	Facility Name: BIO #1A		
					Sizing factor	Minimum BIO Size (ft^2)	Proposed BIO Size (ft^2)
1A	47,270	Rooftop	1.0	47,270			
1C	28,100	Rooftop	1.0	28,100			
1D	7,357	Parking	1.0	7,357			
1E	12,489	Parking	1.0	12,489			
1I	16,714	Parking	1.0	16,714			
Total				111,930	0.04	4,477.2	5,117

DMA Regions	DMA Area (ft^2)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor (ft^2)	Facility Name: BIO #1B		
					Sizing factor	Minimum BIO Size (ft^2)	Proposed BIO Size (ft^2)
1B	29,600	Rooftop	1.0	29,600			
Total				29,600	0.04	1,184	1,495

DMA Regions	DMA Area (ft^2)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor (ft^2)	Facility Name: BIO #2		
					Sizing factor	Minimum BIO Size (ft^2)	Proposed BIO Size (ft^2)
2A	6,000	Rooftop	1.0	6,000			
2B	14,571	Parking and Access Road	1.0	14,571			
2C	16,691	Pervious Hillside	0.1	1,669			
Total				22,240	0.04	889.6	1,000

HYDRAULICS

Hydraulic analysis was performed using a combination of Hydraflow Express, Hydraflow Storm Sewers, Hydraflow and Excel Software. Summary tables are provided below. Refer to Appendix D for support calculations.

STORM DRAIN SIZING

The storm drains were designed to convey the 100-year storm event flow rate calculated using the Rational Method. The pipe sizes were calculated using Manning's Equation as shown below. See Appendix D for flow calculations.

Manning's Equation : $Q= \frac{1.49}{n} AR^{2/3}S^{1/2}$

$$P = \pi\left(D - \left(\left(\frac{D}{2}\right)\theta^2\right)\right)$$

$$A = \pi\left(D - \left(\frac{\left(\frac{D}{2}\right)^2(\theta - sin\theta)}{2}\right)\right)$$

$$R = \frac{A}{P}$$

$$\theta = 4\cos^{-1}\frac{d}{D}^{0.5}$$

D = diameter of pipe (feet)
n = 0.014 (Manning's Roughness Coefficient)
S = Varies (Slope)
θ = Central Angle
d= depth of flow (must have d ≥ D/2)

Pipe sizes were selected based on the sub-region flow rate for the 100-year flow being conveyed with the pipe at or less than 90% full. See Appendix D for pipe size calculations.

CROSS-CULVERT SIZING

The capacities of the culverts that cross under the roadway were checked to see if they were large enough to handle post project flow rates without causing any undesirable headwater or tailwater conditions. If the existing culverts were too small, then larger culverts were designed and proposed as replacements. Napa County Road and Street Standards require culverts to be designed to pass the 10-year runoff without head on the inlet under free outfall conditions, and a 100-year runoff with head not higher than the nearest edge of the travel way. The culverts were modeled in Hydraflow Express which follows the procedures outlined in the Federal Highway Administration's Hydraulic Design of Highway Culverts (HDS-5).

The hydrology maps in Appendix C shows each contributing area used in the cross culvert sizing. See Appendix D for supporting flow calculations and a summary of culvert sizes.

DRAIN INLET SIZING

Drop inlets and area drains were sized to handle the 100-year storm event from contributing drainage areas and upstream conveyance systems.

For inlets in a sag configuration, the inlet will act as a weir up until the point where water has ponded above the grate to the Controlling Depth, determined by the equation: H = 0.08D + 0.35' (where 'D' is the diameter or width of the inlet.) For this situation, the weir equation will provide the highest level of accuracy for predicting flow rates entering the inlet. Water ponding above the controlling depth will make the inlet operate as an orifice, and thus the orifice equation is used. By decreasing the available inlet perimeter or area by half, all inlets were designed to account for clogging and grate thickness.

For inlets with a side opening in a sag configuration, the controlling depth is the same as the height of the side opening. For incoming flows with a depth less than the height of the side opening, the inlet will act as a weir and the weir equation will provide the highest level of accuracy for predicting flow rates entering the inlet. Incoming water with a depth between 1.0x and 1.4x the height of the side opening will be in a transitional flow, and the orifice equation is considered a conservative prediction of flow rates entering the inlet. Any water with a depth of 1.5x the height of the side opening or greater is considered an orifice condition.

Weir Equation : $Q = C_W P h^{3/2}$

Q = Flow capacity (cfs)
C_W = Weir Coefficient = 3.3
P = ½ of the Inlet Perimeter (ft)
H = Maximum headwater depth = 0.17 ft

Orifice Equation : $Q = A C_O \sqrt{2gh}$

Q = Flow capacity (cfs)
C_O = Weir Coefficient = 0.67
A = Area of Orifice (sf)
H = Maximum headwater depth = 0.25 ft

The supporting calculations for drop inlets, area drains, and planter drains are shown in Appendix D.

SWALE AND DITCH DESIGN

The swales were designed to handle the 100-year storm event. Hydraflow Express was used to calculate the depth and velocity of the channel based on the calculated post construction flow rate. Swales were sized to allow for a minimum freeboard of 2 inches to ensure that the swale will not overflow onto the adjacent roadway. The slope of the swale varied and typically matched the adjacent roadway profile. All swales were designed using a roughness coefficient of 0.035 for a cobble lining or 0.025 for vegetated swale. All swales were v-shaped with 2:1 (horizontal to vertical) side slopes. Swales materials were determined based on Figure 5 of the Napa County Road and Street Standards, see Appendix B.

The hydrology map(s) in Appendix C show each contributing area used for swale sizing. See Appendix D for supporting flow calculations and a summary of swale sizing.

RIP RAP SIZING

Rock rip-rap will be used to dissipate the flow from all swale and storm drain outlets.

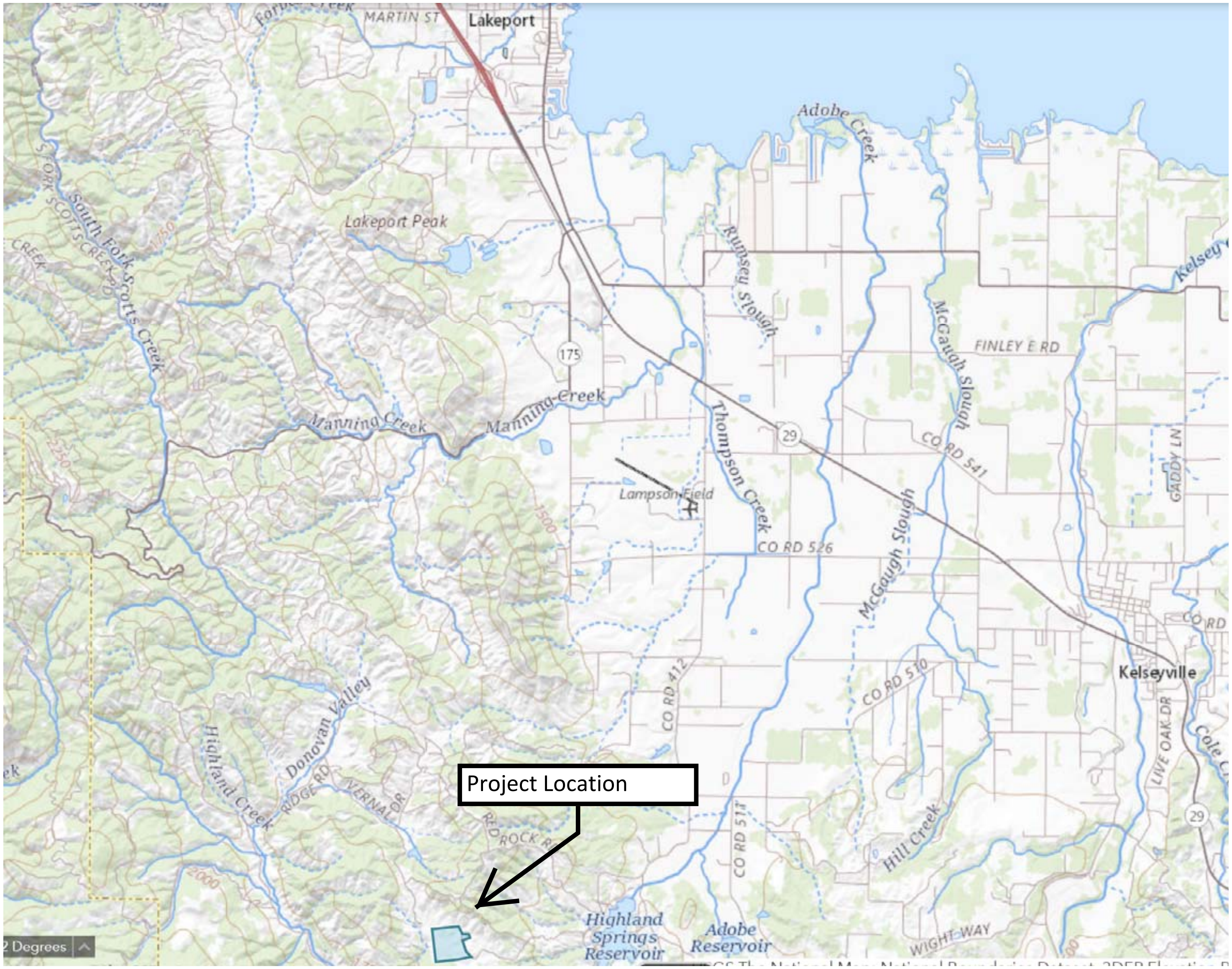
Larger storm drain outlets are sized in accordance with the Federal Highway Administration (FHWA) criteria as outlined in their HEC-14 Circular (3rd Edition), Chapter 10.2. The results from the weir calculation include: median rock size, weight of median rock size, equivalent rip-rap class per Caltrans Standard Specification Section 72-2. The rip-rap was sized based on the 100-year flow and velocity of the source swale or pipe. Hydraflow Express was used to calculate the velocity in each swale and pipe based on the flow rates and dimensions. See Appendix D for rip rap calculations.

CONCLUSION

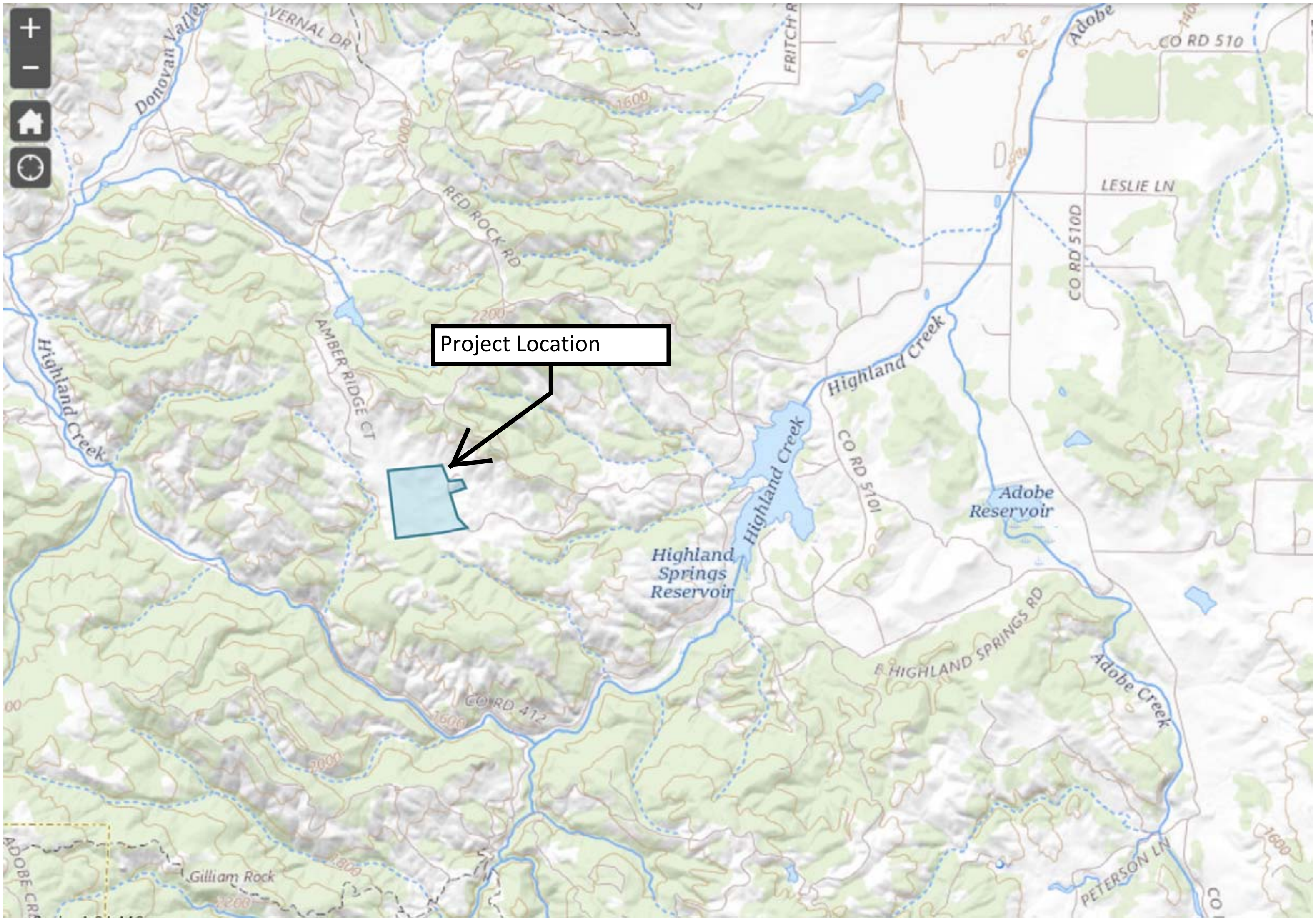
Based on this investigation, all pipes and associated drainage inlet structures have been adequately sized to convey the 100-year storm event. The improvements have been designed to preserve the natural hydrology of the site, and bio-infiltration areas have been implemememented for all impervious surfacing

APPENDIX A: VICINITY MAP

SUMMIT ENGINEERING, INC.
463 Aviation Blvd., Suite 200
Santa Rosa, CA 95403
707 527-0775
www.summit-sr.com



Vicinity Map 1



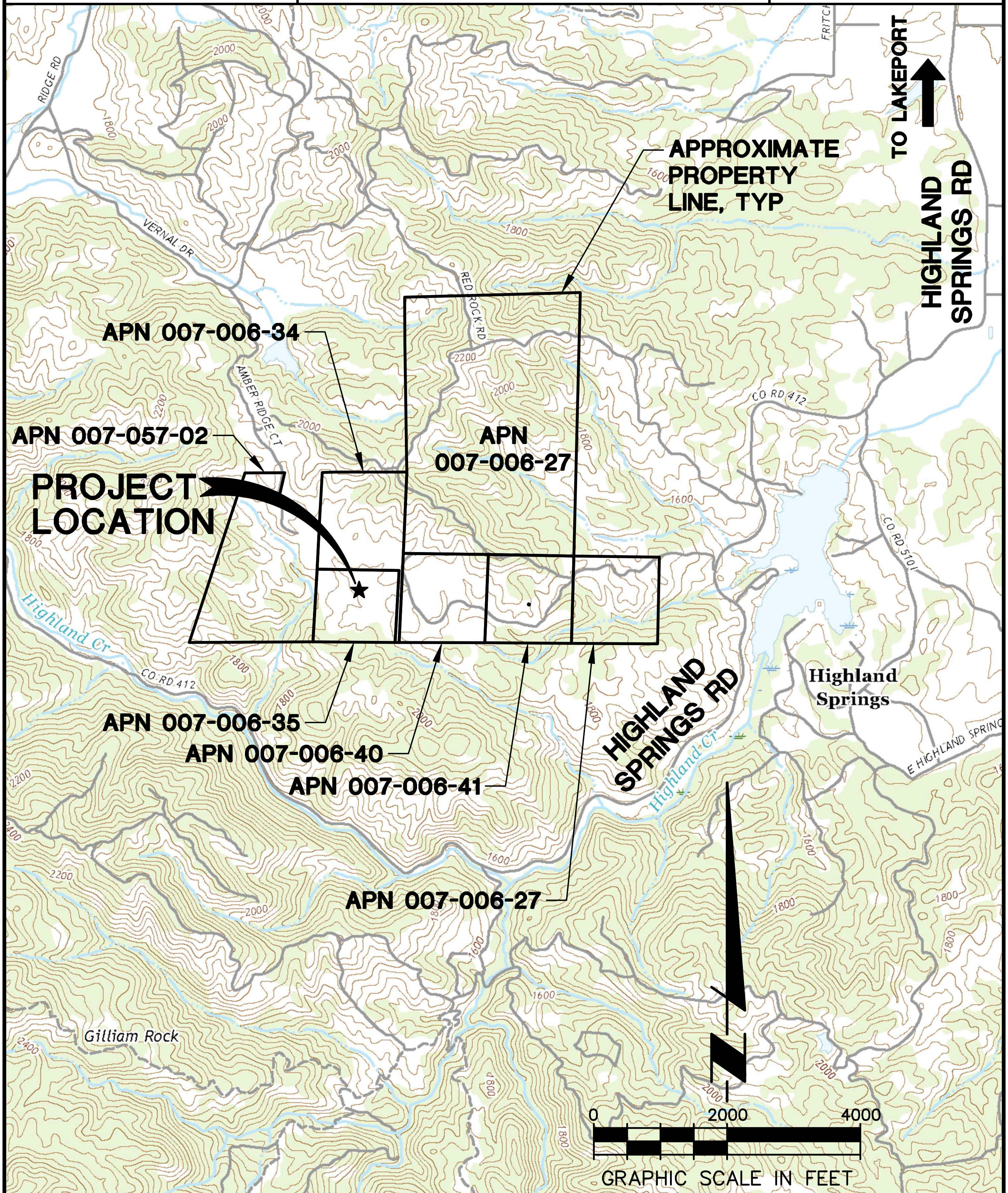
Vicinity Map 2

SUMMIT

LAKE COUNTY DEVEOPEMENT CO.
HIGHLAND SPRINGS ROAD
LAKEPORT, CA 95453
APNS: 007-006-40, 35, 34, 27, 41 & 007-057-01 & 02

HIGHLAND FARMS VICINITY MAP

PROJECT NO. 2021038
DATE 2021-07-30
SHT NO 1 OF 1
BY TF CHK JG

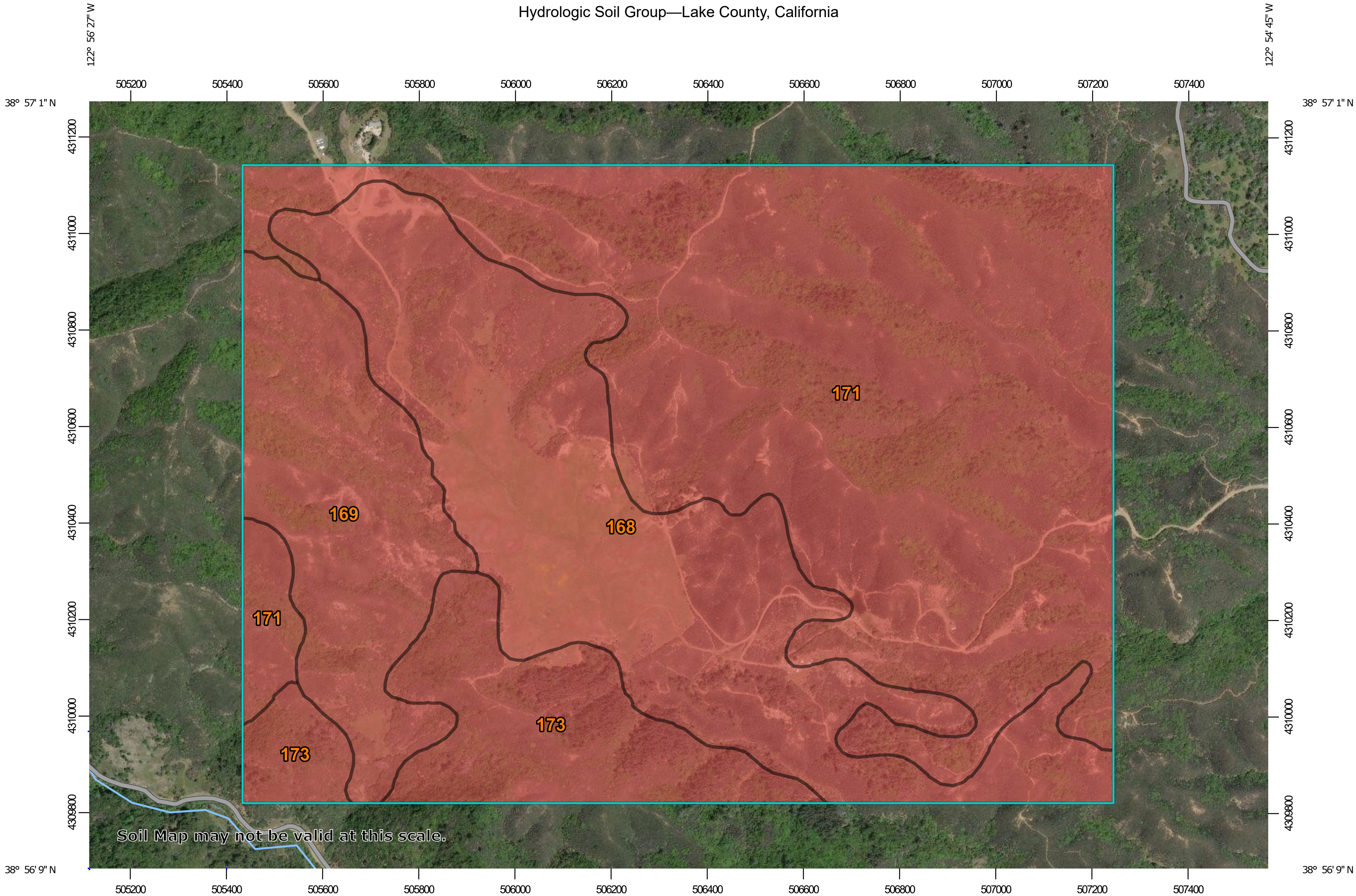


PLOTTED ON: 8/6/2021 3:21 PM
P:\2021\2021038 LAKE COUNTY CULTIVATION\CAD\CIVIL\HIGHLAND FARMS\VICINITY MAP\21038-HF-VICINITY MAP.DWG

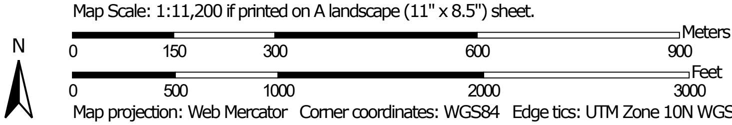
Summit Engineering, Inc
463 Aviation Blvd., Suite 200 • Santa Rosa, CA 95403 • 707-527-0775 • www.summit-sr.com

APPENDIX B: PARAMETER SUPPORT

SUMMIT ENGINEERING, INC.
463 Aviation Blvd., Suite 200
Santa Rosa, CA 95403
707 527-0775
www.summit-sr.com



Map Scale: 1:11,200 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lake County, California
Survey Area Data: Version 17, Jun 1, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 18, 2016—Nov 4, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
168	Maymen-Etsel-Snook complex, 15 to 30 percent slopes	D	164.3	27.6%
169	Maymen-Etsel-Snook complex, 30 to 75 percent slopes	D	75.1	12.6%
171	Maymen-Hopland-Etsel association, 15 to 50 percent slopes	D	291.9	49.1%
173	Maymen-Hopland-Mayacama association, 20 to 60 percent slopes, MLRA 15	D	63.0	10.6%
Totals for Area of Interest			**594.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Cultivation Areas A & B — Cultivation Areas C & D

Table 1: Runoff Coefficients For Undeveloped Areas

	Watershed Type				
	Extreme	**High**	**Normal**	**Low**	
Relief	0.28-0.35 Steep Rugged terrain with average slopes above 30%	0.20-0.28 Hilly, with average slopes of 10 to 30%	0.14-0.20 Rolling with average slopes of 5 to 10%	0.08-0.14 Relatively flat land, with average slopes of 0 to 5%	0.14
Soil infiltration	0.12-0.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	0.08-0.12 Slow to take up water, clay or shallow loam soils of low soil infiltration capacity, imperfectly or poorly drained	0.06-0.08 Normal, well drained light or medium textured soils, sandy loams, silt and silt loams	0.04-0.06 High, deep sand or other soil that takes up water readily, very light well drained soils	0.10
Vegetal Cover	0.12-0.16 No effective plant cover, bare or very sparse cover	0.08-0.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	0.06-0.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	0.04-0.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover	0.07
Surface Storage	0.10-0.12 Negligible surface storage, depressions few and shallow; drainageways steep and small, no marshes	0.08-0.10 Low; well defined system of small drainageways; no ponds or marshes	0.06-0.08 Normal; considerable surface depression storage; lakes and pond marshes	0.04-0.06 High; surface storage high; drainage system not sharply defined; large floodplain storage or large number of ponds and marshes	0.09
Given: An undeveloped watershed consisting of 1) rolling terrain with average slopes of 5%, 2) clay type soils, 3) good grassland area, and 4) normal surface depressions Find: The runoff coefficient, C, for the above watershed		Solution: Relief 0.14 Soil Infiltration 0.08 Vegetal Cover 0.04 Surface Storage 0.06 C = 0.32			C= 0.40

Table 2: Typical Ranges of Impermeable Area

Development Type	Low, %	High, %
Suburban Residential (SR)	5	15
Single-Family Residential (R1)	45	65
Two-Family Residential (R2)	50	70
Multi-Family Residential (R3)	50	75
Commercial	50	100

Table 3: Typical Runoff Coefficients for Developed Areas

Type of Drainage Area	Runoff Coefficient	Type of Drainage Area	Runoff Coefficient
Business:		Residential	
Downtown Areas	0.70-0.95	Single Family Areas	0.30-0.50
Neighborhood Areas	0.50-0.70	Multi-units, detached	0.40-0.60
Industrial		Multi-units, attached	0.60-0.75
Light industrial areas	0.50-0.80	Suburban	0.25-0.40
Heavy industrial areas	0.60-0.90	Apartment dwelling areas	0.50-0.70
Parks, cemeteries	0.10-0.25	Playgrounds	0.20-0.40

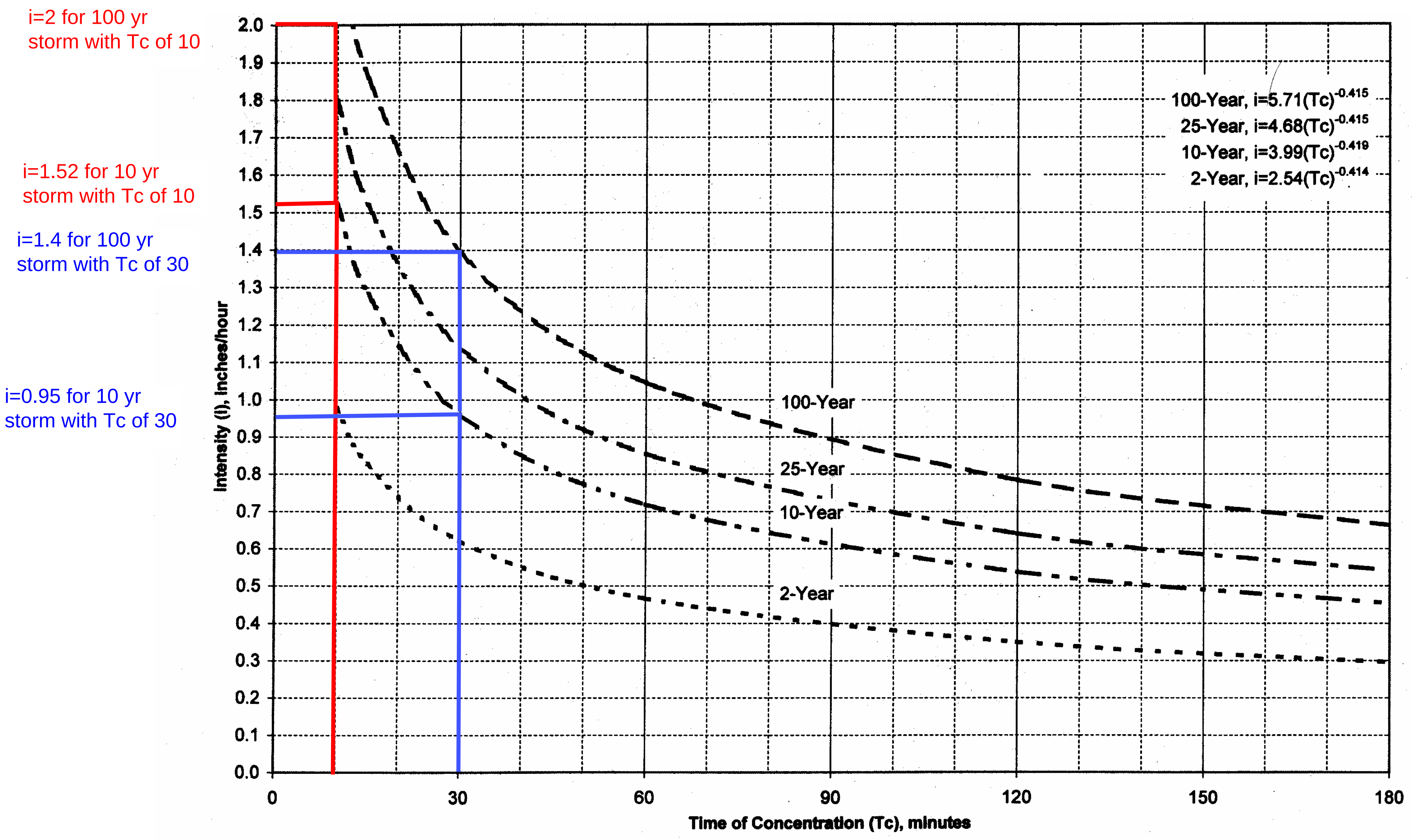


Figure 1: Rainfall Duration-Intensity Curves

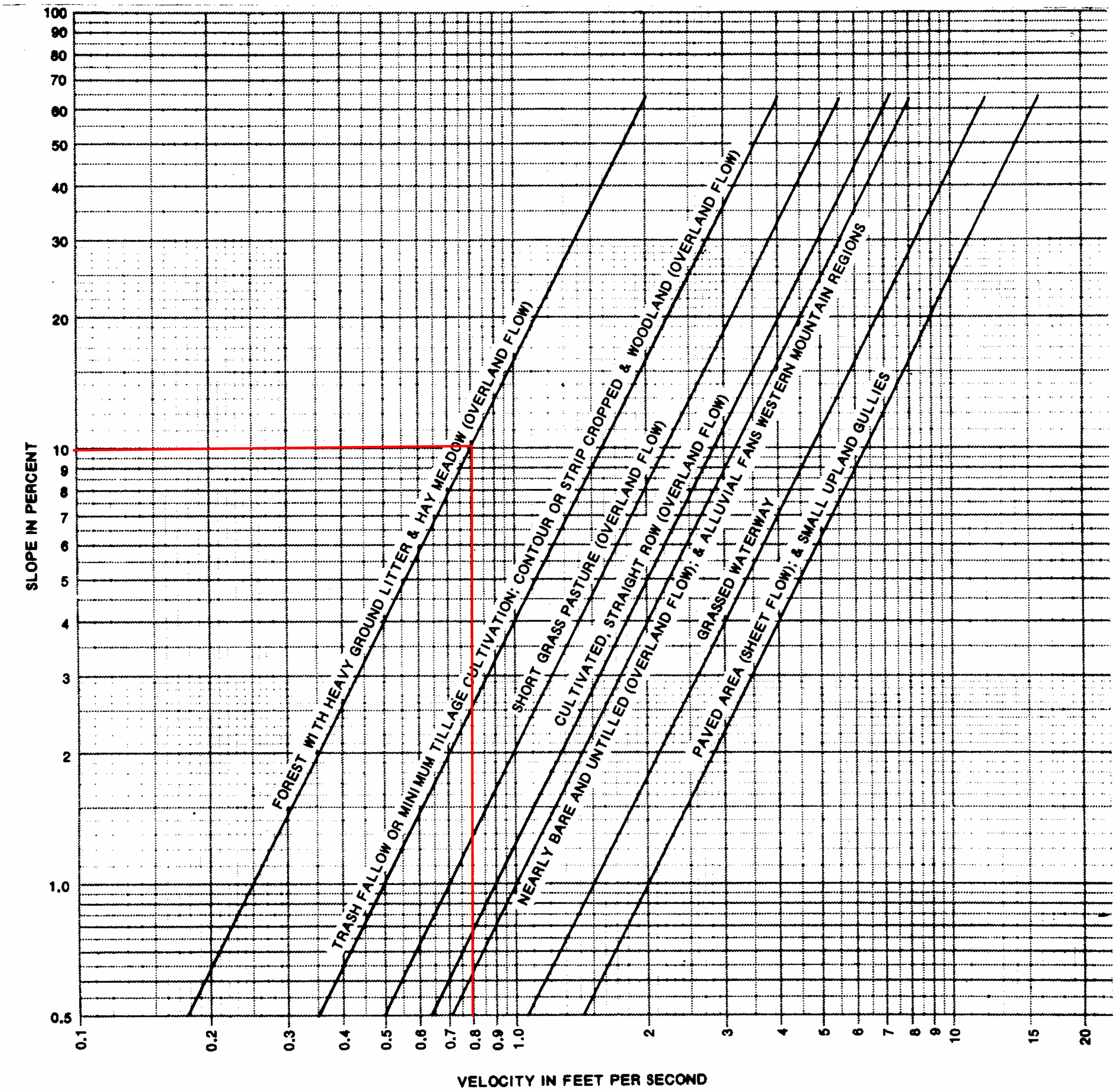


Figure 2: Overland Flow Velocities

From: USDA Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, March 1985, p. 15-8

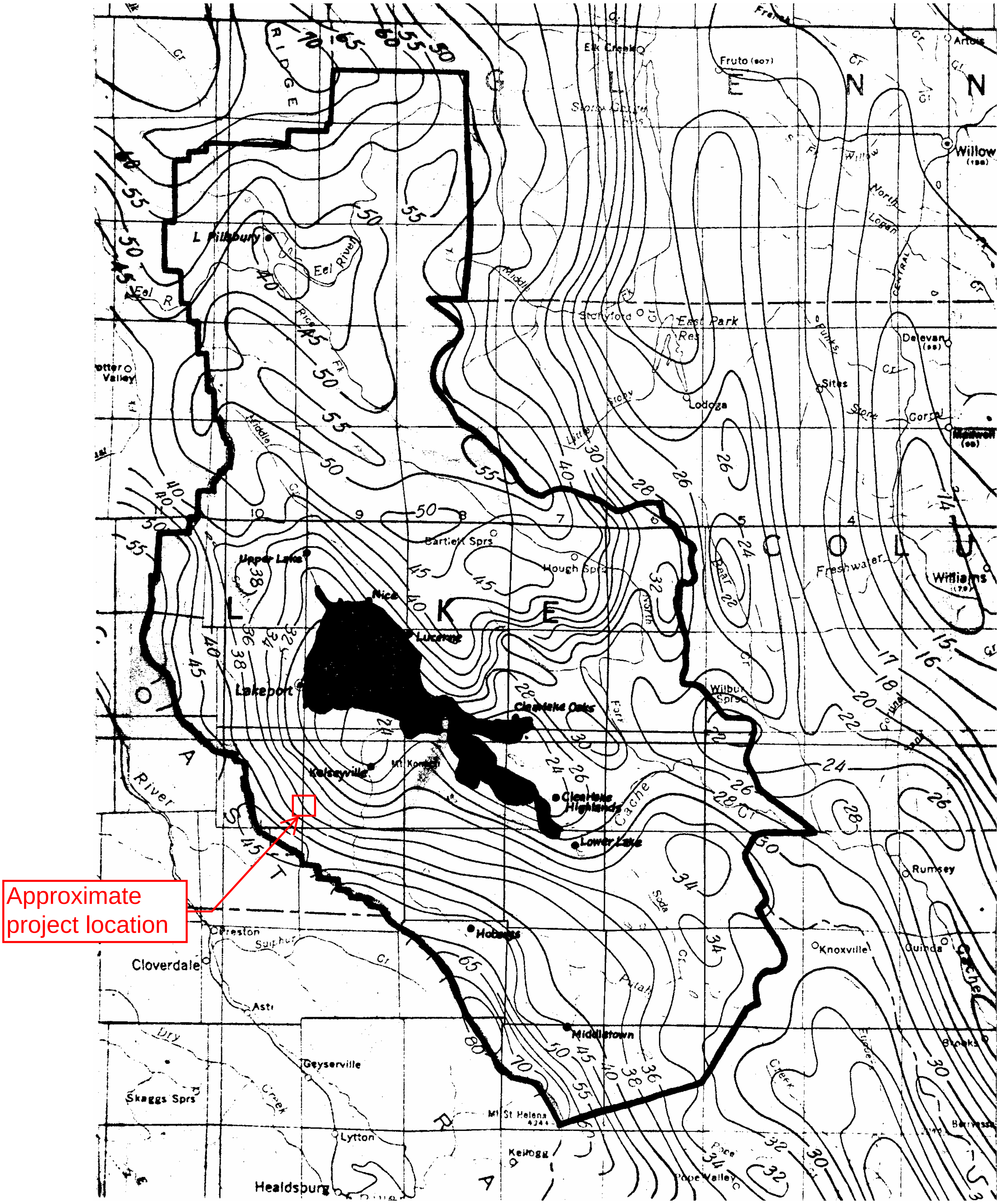


Figure 3: Average Annual Precipitation for Lake County

From: Calif. Department of Water Resources, Lines of Average Yearly Precipitation in the Central Valley, April 1966

APPENDIX C: HYDROLOGY AND DRAINAGE MAPS

SUMMIT

SUMMIT ENGINEERING, INC.
463 Aviation Blvd., Suite 200
Santa Rosa, CA 95403
707 527-0775
www.summit-sr.com

BUILDINGS & OUTDOOR CULTIVATION AREAS

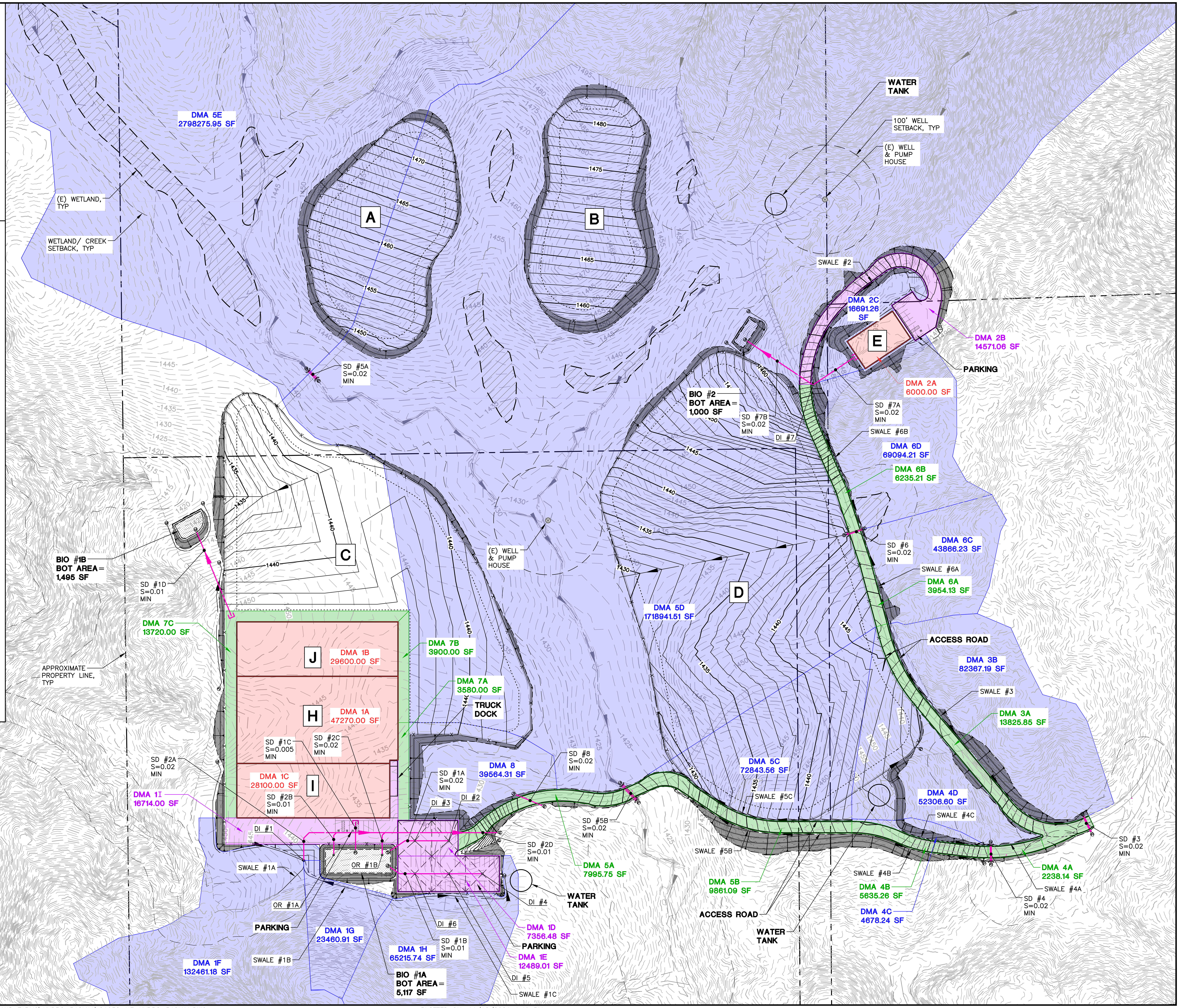
A: OUTDOOR CULTIVATION AREA
B: OUTDOOR CULTIVATION AREA
C: OUTDOOR CULTIVATION AREA
D: OUTDOOR CULTIVATION AREA
E: PROCESSING BUILDING
H: MIXED LIGHT CULTIVATION BUILDING (GREENHOUSE)
I: PROCESSING BUILDING
J: NURSERY BUILDING

ABBREVIATIONS:

AD	AREA DRAIN
APN	ASSESSOR'S PARCEL NUMBER
BASMAA	BAY AREA STORMWATER MANAGEMENT AGENCIES ASSOCIATION
BLDG	BLDG
BOT	BOTTOM
CN	CURVE NUMBER
CO	CLEANOUT
DI	DRAIN INLET
DS	DOWNSPOUT
DMA	DRAINAGE MANAGEMENT AREA
(E)	EXISTING
FF	FINISH FLOOR
FH	FIRE HYDRANT
GB	GRADE BREAK
LIDF	LOW IMPACT DEVELOPMENT FACILITY
OR	OVERFLOW RISER
PD	PLANTER DRAIN
PIP	PROTECT IN PLACE
PU	PUBLIC UTILITIES
RD	ROOF DRAIN
SB	SETBACK
SD	STORM DRAIN
SF	SQUARE FEET
SRA	SELF-RETAINING AREA
SRD	SECONDARY ROOF DRAIN
TYP	TYPICAL

LEGEND

STORM DRAIN
DOWNSPOUT (DS)
SLOPE
GRADE BREAK
BIORETENTION FACILITY
RIPRAP
DMA – PERVIOUS (GROUND LEVEL)
DMA – GRAVEL (GROUND LEVEL)
DMA – IMPERVIOUS (GROUND LEVEL)
DMA – IMPERVIOUS (ROOF LEVEL)



SUMMIT
Summit Engineering, Inc
463 Aviation Blvd., Suite 200 • Santa Rosa, CA 95403
707-527-0775 • www.summit-sr.com

LAKE COUNTY DEVEOPEMENT CO.
HIGHLAND SPRINGS ROAD
LAKEPORT, CA 95453
APNS: 007-006-40, 35, 34, 27, 41 & 007-057-01 & 02

HIGHLAND FARMS

DRAINAGE MAP (PROJECT SITE)

2021-11-12 PERMIT SUBMITTAL

DATE:	2021-09-23
JOB NO:	2021038
SCALE:	AS SHOWN
DRAWN:	TAF
CHECKED:	JTG
SHEET	H1

SHEET 1 OF 2

ABBREVIATIONS:

AD	AREA DRAIN
APN	ASSESSOR'S PARCEL NUMBER
BASMAA	BAY AREA STORMWATER MANAGEMENT AGENCIES ASSOCIATION
BLDG	BLDG
BOT	BOTTOM
CN	CURVE NUMBER
CO	CLEANOUT
DI	DRAIN INLET
DS	DOWNSPOUT
DMA	DRAINAGE MANAGEMENT AREA
(E)	EXISTING
FF	FINISH FLOOR
FH	FIRE HYDRANT
GB	GRADE BREAK
LIDF	LOW IMPACT DEVELOPMENT FACILITY
OR	OVERFLOW RISER
PD	PLANTER DRAIN
PIP	PROTECT IN PLACE
PU	PUBLIC UTILITIES
RD	ROOF DRAIN
SB	SETBACK
SD	STORM DRAIN
SF	SQUARE FEET
SRA	SELF-RETAINING AREA
SRD	SECONDARY ROOF DRAIN
TYP	TYPICAL

LEGEND

STORM DRAIN

DOWNSPOUT (DS)

SLOPE

GRADE BREAK

BIORETENTION FACILITY

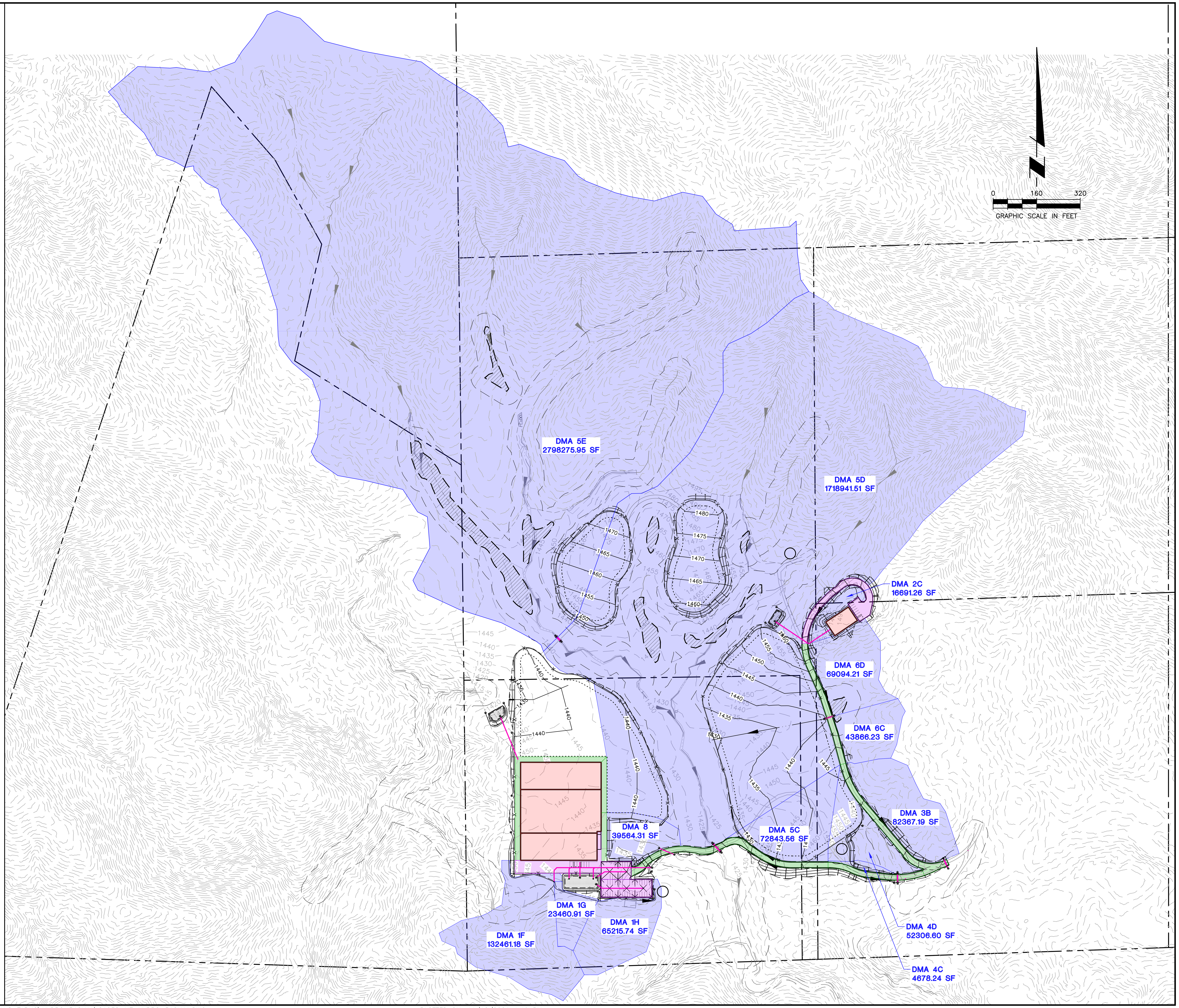
RIPRAP

DMA – PERVIOUS (GROUND LEVEL)

DMA – GRAVEL (GROUND LEVEL)

DMA – IMPERVIOUS (GROUND LEVEL)

DMA – IMPERVIOUS (ROOF LEVEL)



SUMMIT

Summit Engineering, Inc
463 Aviation Blvd., Suite 200 • Santa Rosa, CA 95403
707-527-0775 • www.summit-sr.com

LAKE COUNTY DEVEOPEMENT CO.
HIGHLAND SPRINGS ROAD
LAKEPORT, CA 95453
APNS: 007-006-40, 35, 34, 27, 41 & 007-057-01 & 02

HIGHLAND FARMS

DRAINAGE MAP (SITE RUN-ON)

2021-11-12	PERMIT SUBMITTAL

DATE: 2021-09-23
JOB NO: 2021038
SCALE: AS SHOWN
DRAWN: TAF
CHECKED: JTG

SHEET **H2**
SHEET 2 OF 2

APPENDIX D: HYDRAULIC SUPPORT CALCULATIONS

SUMMIT ENGINEERING, INC.
463 Aviation Blvd., Suite 200
Santa Rosa, CA 95403
707 527-0775
www.summit-sr.com

SUMMIT	Lake County Cultivation		HYDROLOGY & HYDRAULIC CALCULATION PACKAGE			
	Highlands Farms		PROJECT NO: 2021038		BY: JTG/TAF	CHK: JLG
			DATE: 11/12/2021		SHT: 1	OF: 5

STORMWATER CONVEYANCE HYDROLOGY

EQUATIONS

Intensity Equation

100-Year, $i=5.71(Tc)^{-0.415}$

25-Year, $i=4.68(Tc)^{-0.415}$

10-Year, $i=3.99(Tc)^{-0.419}$

2-Year, $i=2.54(Tc)^{-0.414}$

Where:

i = Intensity (in/hr)

T_c = Time of Concentration (min)

Rational Method Equation

Q=CiAK

Where:

Q = Flow (cfs)
C = Runoff Coefficient
i = Intensity (in/hr)
A = Watershed Area (ac)
K= Intensity coefficient

PARAMETERS

Intensity

i = 0.95 in/hr *(10 yr, T_C = 30 min)*
i = 1.40 in/hr *(100 yr, T_C = 30 min)*
i = 1.52 in/hr *(10 yr, T_C = 10 min)*
i = 2.00 in/hr *(100 yr, T_C = 10 min)*

Runoff Coefficient

$C_{impervious}$ = 0.90
$C_{gravel\ road}$ = 0.85
$C_{pervious}$ = 0.4

Intensity Coefficient

K= 1.03

FLOW CALCULATION

Region	Pervious Area		Gravel Roads		Impervious Area (ac)		Total Area (ac)	Weighted C	i_{10}	i_{100}	Q_{10yr} (cfs)	Q_{100yr} (cfs)
	sf	ac	sf	ac	sf	ac						
1A					47270.0	1.09	1.09	0.90	1.52	2.00	1.53	2.01
1B					29600.0	0.68	0.68	0.90	1.52	2.00	0.96	1.26
1C					28100.0	0.65	0.65	0.90	1.52	2.00	0.91	1.20
1D					7356.5	0.17	0.17	0.90	1.52	2.00	0.24	0.31
1E					12489.0	0.29	0.29	0.90	1.52	2.00	0.40	0.53
1F	132461.2	3.04					3.04	0.40	1.52	2.00	1.90	2.51
1G	23460.9	0.54					0.54	0.40	1.52	2.00	0.34	0.44
1H	65215.7	1.50					1.50	0.40	1.52	2.00	0.94	1.23
1I					16714.0	0.38	0.38	0.90	1.52	2.00	0.54	0.71
2A					6000.0	0.14	0.14	0.90	1.52	2.00	0.19	0.26
2B					14571.1	0.33	0.33	0.90	1.52	2.00	0.47	0.62
2C	16691.3	0.38					0.38	0.40	1.52	2.00	0.24	0.32
3A			13825.9	0.32			0.32	0.85	1.52	2.00	0.42	0.56
3B	82367.2	1.89					1.89	0.40	1.52	2.00	1.18	1.56
4A			2238.1	0.05			0.05	0.85	1.52	2.00	0.07	0.09
4B			5635.3	0.13			0.13	0.85	1.52	2.00	0.17	0.23
4C	4678.2	0.11					0.11	0.40	1.52	2.00	0.07	0.09
4D	52306.6	1.20					1.20	0.40	1.52	2.00	0.75	0.99
5A			7995.8	0.18			0.18	0.85	1.52	2.00	0.24	0.32
5B			9861.1	0.23			0.23	0.85	1.52	2.00	0.30	0.40
5C	72843.6	1.67					1.67	0.40	1.52	2.00	1.05	1.38
5D	1718941.5	39.46					39.46	0.40	1.52	2.00	24.71	32.52
5E	2798276.0	64.24					64.24	0.40	0.95	1.40	40.23	52.93
6A			3954.1	0.09			0.09	0.85	1.52	2.00	0.12	0.16
6B			6235.21	0.14			0.14	0.85	1.52	2.00	0.19	0.25
6C	43866.2	1.01					1.01	0.40	1.52	2.00	0.63	0.83
6D	69094.2	1.59					1.59	0.40	1.52	2.00	0.99	1.31
7A			3580.0	0.08			0.08	0.85	1.52	2.00	0.11	0.14
7B			3900.0	0.09			0.09	0.85	1.52	2.00	0.12	0.16
7C			13720.0	0.31			0.31	0.85	1.52	2.00	0.42	0.55
8	39564.3	0.91					0.91	0.40	1.52	2.00	0.57	0.75
Bio #1A	5117.0	0.12					0.12	0.40	1.52	2.00	0.07	0.10
Bio #1B	1495.0	0.03					0.03	0.40	1.52	2.00	0.02	0.03
Bio #2	1475.0	0.03					0.03	0.40	1.52	2.00	0.02	0.03

SUMMIT	Lake County Cultivation	HYDROLOGY & HYDRAULIC CALCULATION PACKAGE	
	Highlands Farms	PROJECT NO: 2021038	BY: JTG/TAF CHK: JLG
		DATE: 11/12/2021	SHT: 2 OF: 5

STORM DRAIN PIPE SIZING

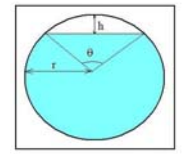
EQUATIONS

Manning's Equation

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad R = \frac{A}{P}$$

$$P = \pi * D - ((D/2) * \Theta^2)$$

$$A = \pi * D - ((D/2)^2 * (\Theta - \text{SIN } \Theta))/2$$



Partially Full Pipe Flow Parameters (More Than Half Full)

Where:

- **Q =** Flow (cfs)
- **A =** Flow Area (ft^2)
- **P =** Wetted Perimeter (ft)
- **n =** Manning's Roughness Coefficient
- **S =** Longitudinal Slope (ft/ft)
- **D =** Pipe Diameter (ft)
- **d =** Depth of Flow (must have d ≥ D/2)
- **Θ =** Central Angle 4arccos*((d/D)^0.5)

PARAMETERS & STANDARD CALCULATIONS

Central Angle	**Θ=**	73.74	degrees
Manning's Roughness	**n**full =	0.012	
Slope	S =	0.02	ft/ft
	n/nfull =	1.05	**n/n**full=1.25-(d/D-0.5)*0.5
	npartial	0.0126	

Part of calculation - Do not change

D (in)	D (ft)	d (ft)	A (ft^2)	P	R	Q (cfs) 90%full
4	0.33	0.30	0.08	0.83	0.10	0.30
6	0.50	0.45	0.19	1.25	0.15	0.87
8	0.67	0.60	0.33	1.67	0.20	1.88
10	0.83	0.75	0.52	2.08	0.25	3.42
12	1.00	0.90	0.74	2.50	0.30	5.56
15	1.25	1.13	1.16	3.12	0.37	10.07
18	1.50	1.35	1.68	3.75	0.45	16.38
24	2.00	1.80	2.98	5.00	0.60	35.28
36	3.00	2.70	6.70	7.49	0.89	104.00

The following table uses the rational method Q=CiA to back calculate the Maximum contributing Area for a given pipe size using the flow rate (Q) calculated in the table above.

Where: i= 2.00 in/hr; C= 0.9

d (in)	Q (cfs) 90% full	Max area (acres)	Max area (sf)
4	0.30	0.16	7,181
6	0.87	0.49	21,173
8	1.88	1.05	45,600
10	3.42	1.90	82,677
12	5.56	3.09	134,443
15	10.07	5.60	243,761
18	16.38	9.10	396,382
24	35.28	19.60	853,658

PARAMETERS & STANDARD CALCULATIONS

Central Angle	**Θ=**	73.74	degrees
Manning's Roughness	**n**full =	0.012	
Slope	S =	0.01	ft/ft
	n/nfull =	1.05	**n/n**full=1.25-(d/D-0.5)*0.5
	npartial	0.0126	

Part of calculation - Do not change

D (in)	D (ft)	d (ft)	A (ft^2)	P	R	Q (cfs) 90%full
4	0.33	0.30	0.08	0.83	0.10	0.21
6	0.50	0.45	0.19	1.25	0.15	0.62
8	0.67	0.60	0.33	1.67	0.20	1.33
10	0.83	0.75	0.52	2.08	0.25	2.42
12	1.00	0.90	0.74	2.50	0.30	3.93
15	1.25	1.13	1.16	3.12	0.37	7.12
18	1.50	1.35	1.68	3.75	0.45	11.58
24	2.00	1.80	2.98	5.00	0.60	24.94
36	3.00	2.70	6.70	7.49	0.89	73.54

The following table uses the rational method Q=CiA to back calculate the Maximum contributing Area for a given pipe size using the flow rate (Q) calculated in the table above.

Where: i= 2.00 in/hr; C= 0.9

d (in)	Q (cfs) 90% full	Max area (acres)	Max area (sf)
4	0.21	0.12	5,078
6	0.62	0.34	14,972
8	1.33	0.74	32,244
10	2.42	1.34	58,462
12	3.93	2.18	95,065
15	7.12	3.96	172,365
18	11.58	6.43	280,284
24	24.94	13.86	603,627

PARAMETERS & STANDARD CALCULATIONS

Central Angle	**Θ=**	73.74	degrees
Manning's Roughness	**n**full =	0.012	
Slope	S =	0.005	ft/ft
	n/nfull =	1.05	**n/n**full=1.25-(d/D-0.5)*0.5
	npartial	0.0126	

Part of calculation - Do not change

D (in)	D (ft)	d (ft)	A (ft^2)	P	R	Q (cfs) 90%full
4	0.33	0.30	0.08	0.83	0.10	0.15
6	0.50	0.45	0.19	1.25	0.15	0.44
8	0.67	0.60	0.33	1.67	0.20	0.94
10	0.83	0.75	0.52	2.08	0.25	1.71
12	1.00	0.90	0.74	2.50	0.30	2.78
15	1.25	1.13	1.16	3.12	0.37	5.04
18	1.50	1.35	1.68	3.75	0.45	8.19
24	2.00	1.80	2.98	5.00	0.60	17.64
36	3.00	2.70	6.70	7.49	0.89	52.00

The following table uses the rational method Q=CiA to back calculate the Maximum contributing Area for a given pipe size using the flow rate (Q) calculated in the table above.

Where: i= 2.00 in/hr; C= 0.9

d (in)	Q (cfs) 90% full	Max area (acres)	Max area (sf)
4	0.15	0.08	3,591
6	0.44	0.24	10,587
8	0.94	0.52	22,800
10	1.71	0.95	41,339
12	2.78	1.54	67,221
15	5.04	2.80	121,880
18	8.19	4.55	198,191
24	17.64	9.80	426,829

STORM DRAIN PIPE SIZING CALCULATIONS

Pipe (SD)	Contributing DMA's	Q Contributing Area (cfs)	Upstream Pipe	Q Upstream Pipe (cfs)	$Q_{Contributing} + Q_{Upstream}$ (cfs)	d (in)	d (in) selected	Min Slope (ft/ft)
1A	1D	0.31			0.31	6	6	0.02
1B	1E	0.53			0.53	6	6	0.01
1C	1A, 1C & 1I	3.92			3.92	15	18	0.005
1D	1B	1.26			1.26	8	10	0.01
2A	1F & 1G	2.95			2.95	10	10	0.02
2B	1/2 of Bio Area #1	0.05	1/2 of SD 1A, 1B, 1C	2.38	2.43	12	12	0.01
2C	1/2 of Bio Area #1	0.05	1/2 of SD 1A, 1B, 1C	2.38	2.43	10	12	0.02
2D			SD 2A, 2B, 2C	7.81	7.81	18	18	0.01
3	3A & 3B	2.11			2.11	10	10	0.02
4	4C & 4D	1.08			1.08	8	12x12 BOX	0.02
5A	5E	52.93			52.93	36	36	0.02
5B	5D & 7B	32.67	SD 5A,6 & 7B	56.67	89.34	36	36	0.02
6	6A-6D	2.55			2.55	10	12x12 BOX	0.02
7A	2A	0.26			0.26	6	6	0.01
7B	2B & 2C	0.94	SD 7A	0.26	1.19	8	8	0.02
8	7A & 8	0.89			0.89	8	12	0.02

Pipes are shown on Figure H1.

SUMMIT	Lake County Cultivation	HYDROLOGY & HYDRAULIC CALCULATION PACKAGE	
	Highlands Farms	PROJECT NO: 2021038	BY: JTG/TAF CHK: JLG
		DATE: 11/12/2021	SHT: 3 OF: 5

DROP INLET SIZING

EQUATIONS

Rectangular Weir Equation

$$Q = C_W P h^{3/2}$$

Where:

Q = Flow (cfs)
C_W = Weir Coefficient
P = Weir Length (ft)
h = Depth (ft)

Orifice Equation

$$Q = A C_O \sqrt{2gh}$$

Where:

Q = Flow (cfs)
C_O = Orifice Coefficient
g = Gravitational Constant (ft/s^2)
h = Depth (ft)

PARAMETERS, ASSUMPTIONS, AND STANDARD SIZES

C_W =	3.33	
h =	2	inches*
P =	Half of Perimeter	

C_O =	0.67	
h =	2	inches*
g =	32.2	ft/s^2
A =	Half of Area	

** Adjust allowable depth based on site conditions (average range = 1 - 4 inches)*

Typical Grate Sizes and Flow Capacity*

Grate	P (ft)	Flow (cfs)
12x12	2	0.45
18x18	3	0.68
18x24	3.5	0.79
24x24	4	0.91
24x30	4.5	1.02
30x30	5	1.13
24x36	5	1.13
36x36	6	1.36
24x48	6	1.36
36x48	7	1.59
48x48	8	1.81

* Calculated using weir equation

DRAIN INLET SIZING CALCULATIONS

Drain Inlets in Sag Configuration*

Drain Inlet	Manufacturer	Model Number	P (ft)**	A (ft^2)	Q_{demand} (cfs)	Q_{weir} (cfs)	$Q_{orifice}$ (cfs)	Controlling Equation***
OR #1A & 1B	Central Precast	CP1818	3	2.25	2.43	0.68	4.94	Orifice
DI #2-6	Central Precast	CP1212	2	1	0.18	0.45	2.20	Weir

** For inlets on grade, model using Hydraflow Express*
*** For inlets against a curb, do not count length along the curb in Perimeter calcualtion (i.e. P for CP1212 would be 1.5 ft)*
*** The lower Q value determines under which condition the inlet is operating, and which value should be used for sizing

Inlets with Side Opening in Sag Configuration*

Drain Inlet	Manufacturer	Model Number	P (ft)**	A (ft^2)	h (ft)***	Q_{demand} (cfs)	Q_{weir} (cfs)	$Q_{orifice}$ (cfs)	Controlling Equation***	Side Openings
DI #1	Central Precast	CP1818	2.67	2.67	1.00	2.95	0.60	5.85	Orifice	2
DI #7	Central Precast	CP1818	1.33	1.33	1.00	0.94	0.30	2.93	Orifice	1

** For inlets on grade, model using Hydraflow Express*
*** Perimeter equals side opening width (typically grate width minus 2 inches), include additional sides inlet receives flow from multiple sides*
*** h varies depending on flow depth from upstream swale/ditch
**** The lower Q value determines under which condition the inlet is operating, and which value should be used for sizing

DITCH AND SWALE SIZING

EQUATIONS

Manning's Equation

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad R = \frac{A}{P}$$

Where:

Q = Flow (cfs)
A = Flow Area (ft^2)
P = Wetted Perimeter (ft)
n = Manning's Roughness Coefficient
S = Longitudinal Slope (ft/ft)

PARAMETERS & ASSUMPTIONS

Manning's Roughness			
	n =	0.013	Concrete
	n =	0.025	Vegetated Swales
	n =	0.035	Cobble Swales

DITCH AND SWALE SIZING CALCULATIONS

Ditch and Swale Summary Table

Swale #	PARAMETERS		DESIGN			CAPACITY		VELOCITY (ft/s)
	Contributing Areas	Flow Rate (cfs)	MinimumSlope %	Z :1 (ft)	Depth (ft)	Swale Capacity Max Depth (ft)	n	
1A	1F	2.51	0.5	2:1	1.00	0.78	0.025	2.06
1B	1G	0.44	0.5	2:1	1.00	0.41	0.025	1.31
1C	1H	1.23	0.5	2:1	1.00	0.60	0.025	1.71
2	2B, 2C	0.94	5.0	2:1	1.00	0.40	0.035	2.94
3	3A & 3B	2.11	0.5	2:1	1.00	0.73	0.025	1.98
4B	4B	0.23	0.5	2:1	1.00	0.36	0.035	2.61
4C	4C	0.04	0.5	2:1	1.00	0.19	0.035	1.65
5B	5B	0.40	5.0	2:1	1.00	0.29	0.035	2.38
5C	5C	1.38	5.0	2:1	1.00	0.46	0.035	3.26

SUMMIT	Lake County Cultivation	HYDROLOGY & HYDRAULIC CALCULATION PACKAGE			
	Highlands Farms	PROJECT NO:	2021038	BY: JTG/TAF	CHK: JLG
		DATE:	11/12/2021	SHT: 5	OF: 5

RIP RAP APRON SIZING

EQUATIONS

Weir Equation

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g}D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Where:

- **D_{50} =** Median Stone Diameter (ft)
- **Q =** Flow (cfs)
- **TW =** Tailwater Depth (ft)
- **D =** Pipe Diameter (ft)
- **Yc =** Critical Depth (ft)
- **Yn =** Normal Depth (ft)

PARAMETERS, ASSUMPTIONS, & SIZING CALCULATOR

Parameters

Q =	89.34	cfs
D =	3.00	ft
Tw* =	1.20	ft
Yc =	2.84	ft
Yn =	2.18	ft
D' (Adjusted) =	2.59	ft
D (controling) =	2.59	ft

* Tw is 0.4D by default to model a free outlet. Use actual Tw depth as applicable. This calculator is not applicable for a submerged outlet.

Rip Rap Stone Sizing

	Size (ft)	Size (in)	W (lbs)	Rip Rap Class[2,3]
d_{50} [1]	1.85	22.19	546.1	Half Ton

1. d_{50} is calcualted from Equation 10.4 of the Federal Highway Administration (FHWA) HEC-14 Circular, 3rd Edition (See above)
2. Rip Rap class is from Section 72-2 of the Caltrans Standard Specifications (Method B placement)
3. For outlet pipes 12" and greater that require rip rap, No. 2 backing is the minimum size of rip rap that is recommended

Rip Rap Pad Dimensions[4]

	Size (ft)
Min. Apron Length	12
Min. Thickness	3.7

4. Apron length and thickness, Table 10.1 of the Federal Highway Administration (FHWA) HEC-14 Circular, 3rd Edition

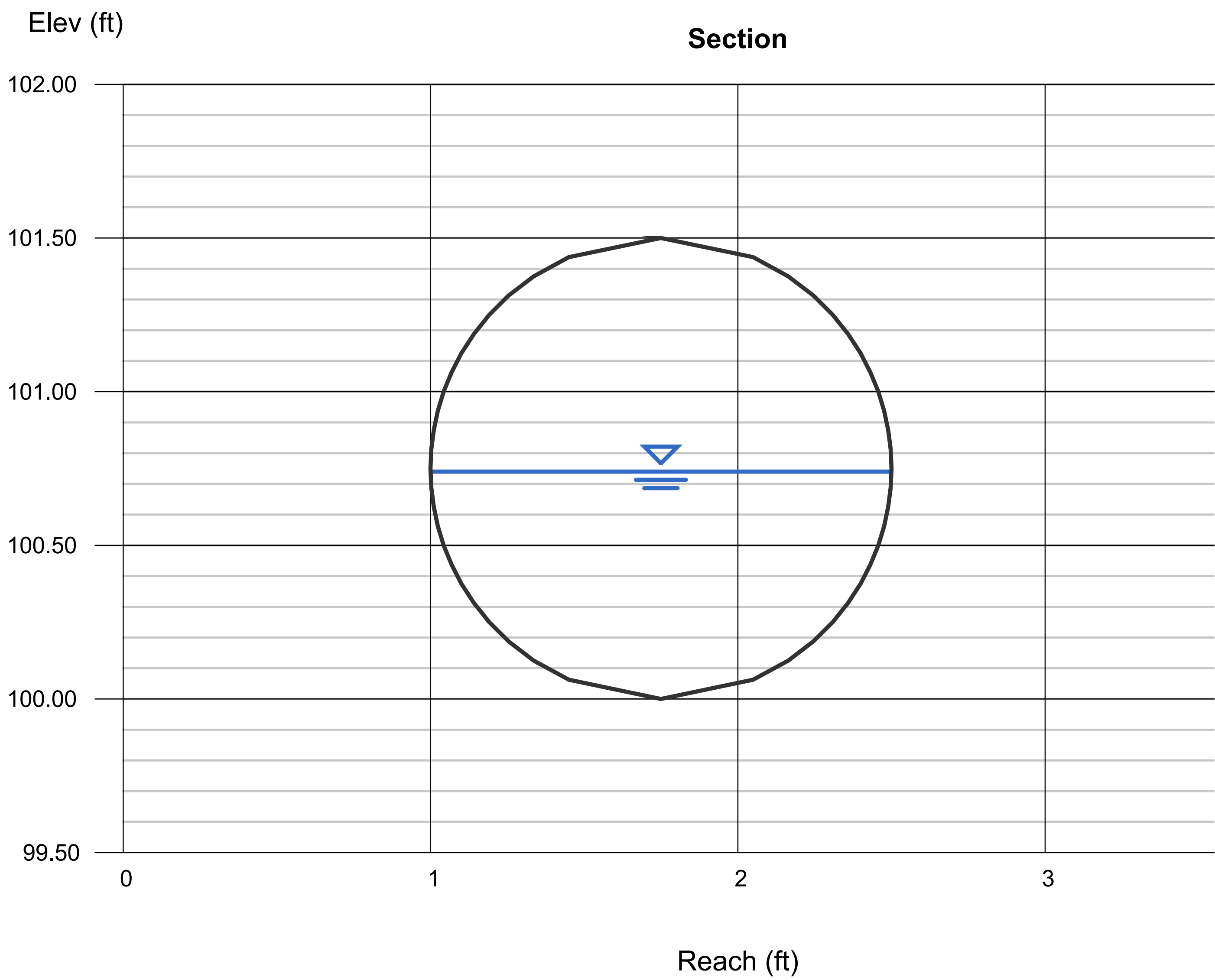
SUMMARY TABLE

Riprap ID #	Contributing Source	Flow Rate (cfs)	Rip Rap Class	Apron Length (ft)	Apron Thickness (ft)
1	SD 1C	3.92	No. 3	6	1.5
2	SD 1D	1.26	No. 3	6	1.5
3	SD 2D	7.81	No. 3	6	1.5
4	SD 3	2.11	No. 3	6	1.5
5	SD 4	1.08	No. 3	6	1.5
6	SD 5A	52.93	Light	9	2.6
7	SD 5B	89.34	Half Ton	12	3.7
8	SD 6	2.55	No. 3	6	1.5
9	SD 7B	1.19	No. 3	6	1.5

Channel Report

SD #1C

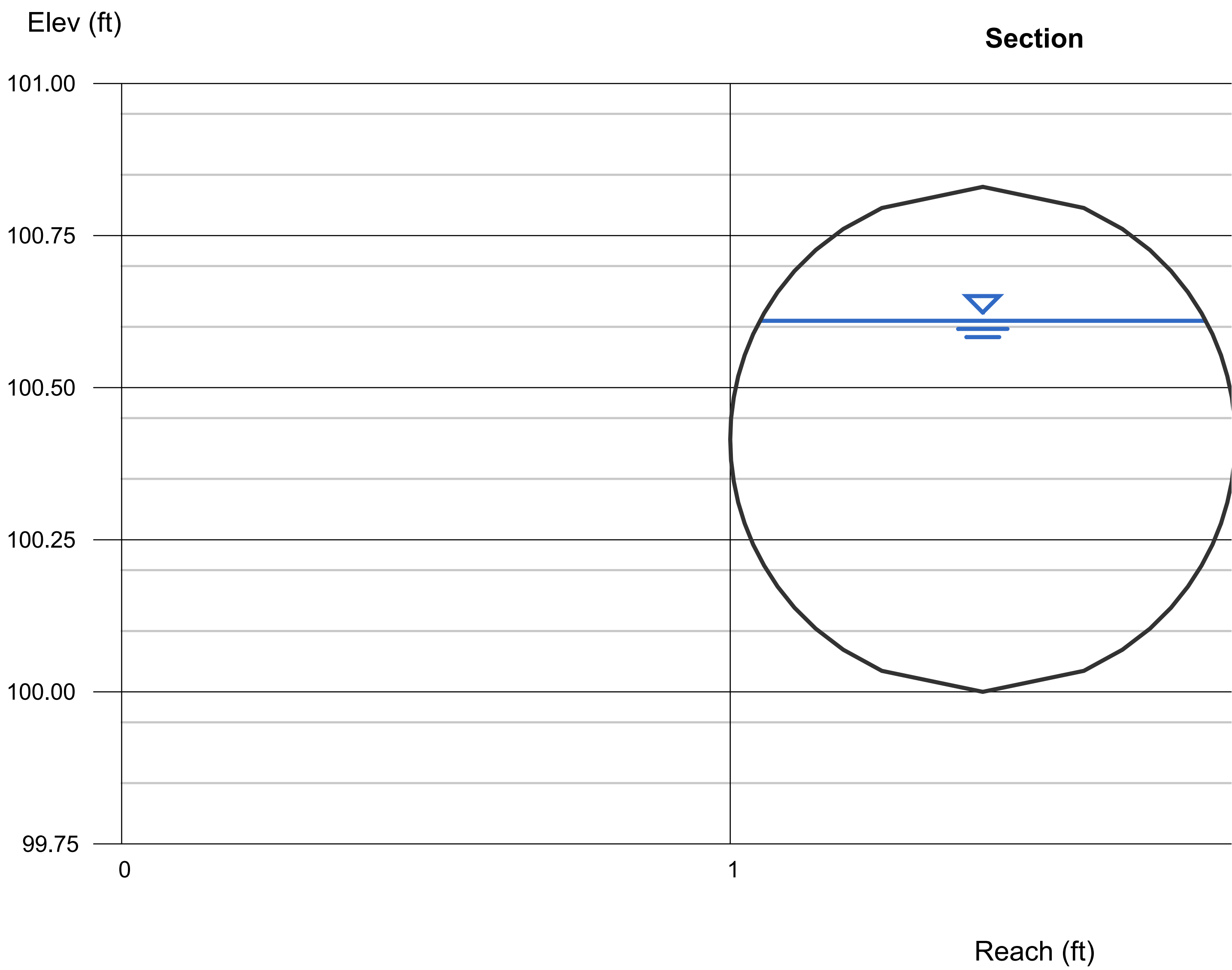
Circular		**Highlighted**	
Diameter (ft)	= 1.50	Depth (ft)	= 0.74
		Q (cfs)	= 3.920
		Area (sqft)	= 0.87
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 4.50
Slope (%)	= 0.50	Wetted Perim (ft)	= 2.34
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.76
		Top Width (ft)	= 1.50
Calculations		EGL (ft)	= 1.05
Compute by:	Known Q		
Known Q (cfs)	= 3.92		



Channel Report

SD #2A

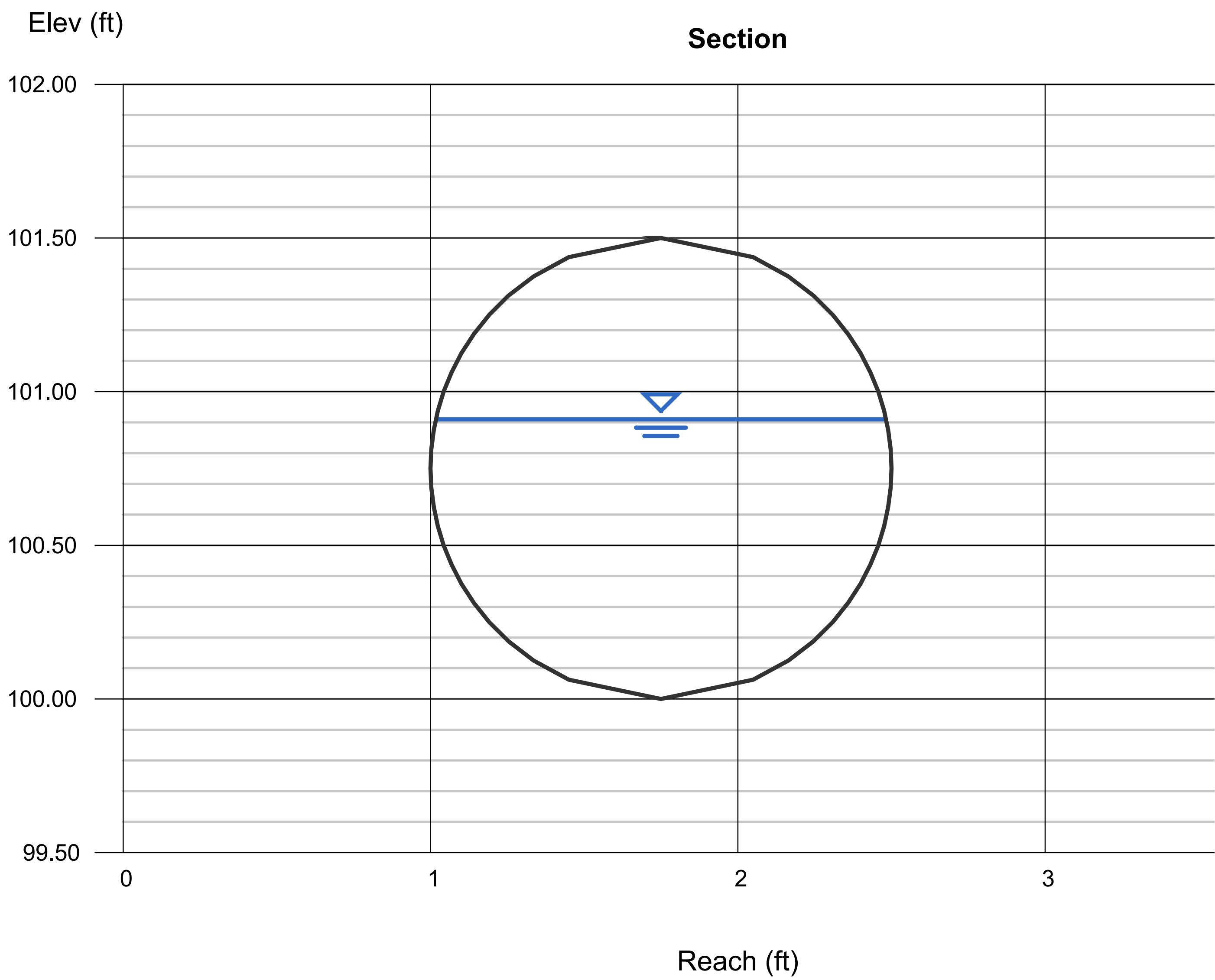
Circular		**Highlighted**	
Diameter (ft)	= 0.83	Depth (ft)	= 0.61
		Q (cfs)	= 2.950
		Area (sqft)	= 0.43
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 6.92
Slope (%)	= 2.00	Wetted Perim (ft)	= 1.71
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.75
		Top Width (ft)	= 0.73
Calculations		EGL (ft)	= 1.35
Compute by:	Known Q		
Known Q (cfs)	= 2.95		



Channel Report

SD #2D

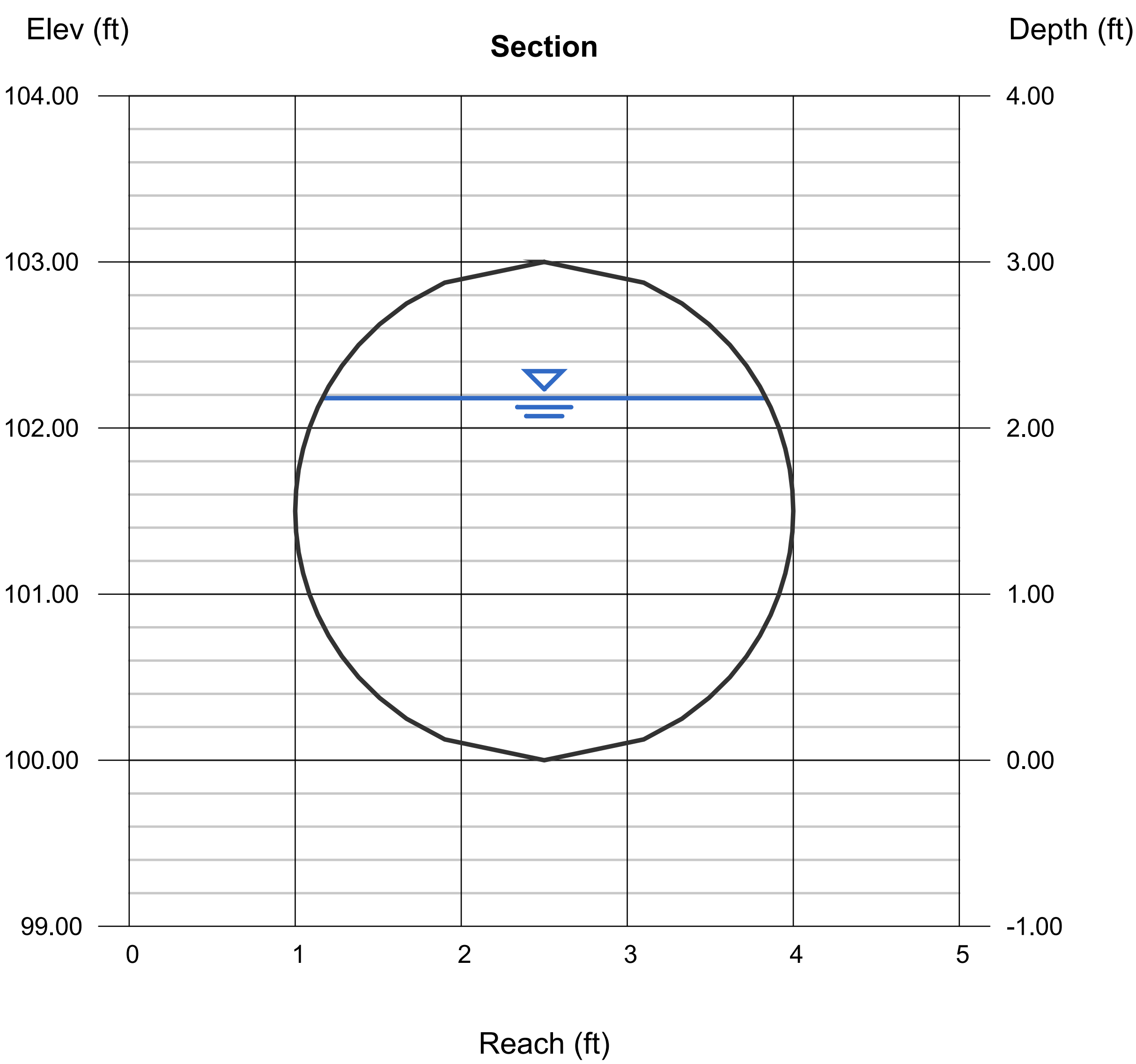
Circular		**Highlighted**	
Diameter (ft)	= 1.50	Depth (ft)	= 0.91
		Q (cfs)	= 7.810
		Area (sqft)	= 1.13
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 6.93
Slope (%)	= 1.00	Wetted Perim (ft)	= 2.68
N-Value	= 0.012	Crit Depth, Yc (ft)	= 1.09
		Top Width (ft)	= 1.46
Calculations		EGL (ft)	= 1.66
Compute by:	Known Q		
Known Q (cfs)	= 7.81		



Channel Report

SD #5B

Circular		**Highlighted**	
Diameter (ft)	= 3.00	Depth (ft)	= 2.18
		Q (cfs)	= 89.34
		Area (sqft)	= 5.52
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 16.20
Slope (%)	= 2.00	Wetted Perim (ft)	= 6.13
N-Value	= 0.012	Crit Depth, Yc (ft)	= 2.84
		Top Width (ft)	= 2.67
Calculations		EGL (ft)	= 6.26
Compute by:	Known Q		
Known Q (cfs)	= 89.34		

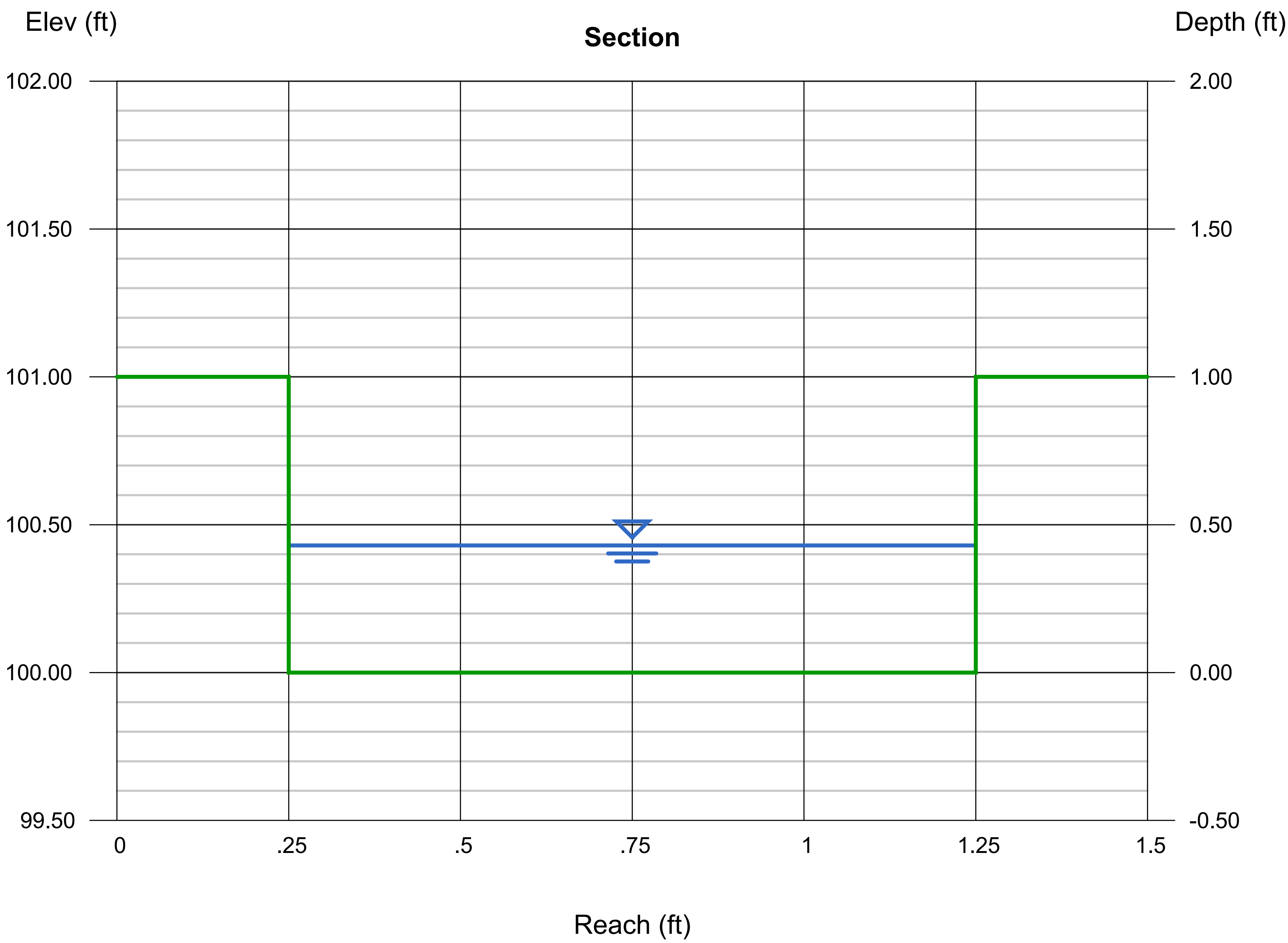


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Sep 21 2021

SD #6

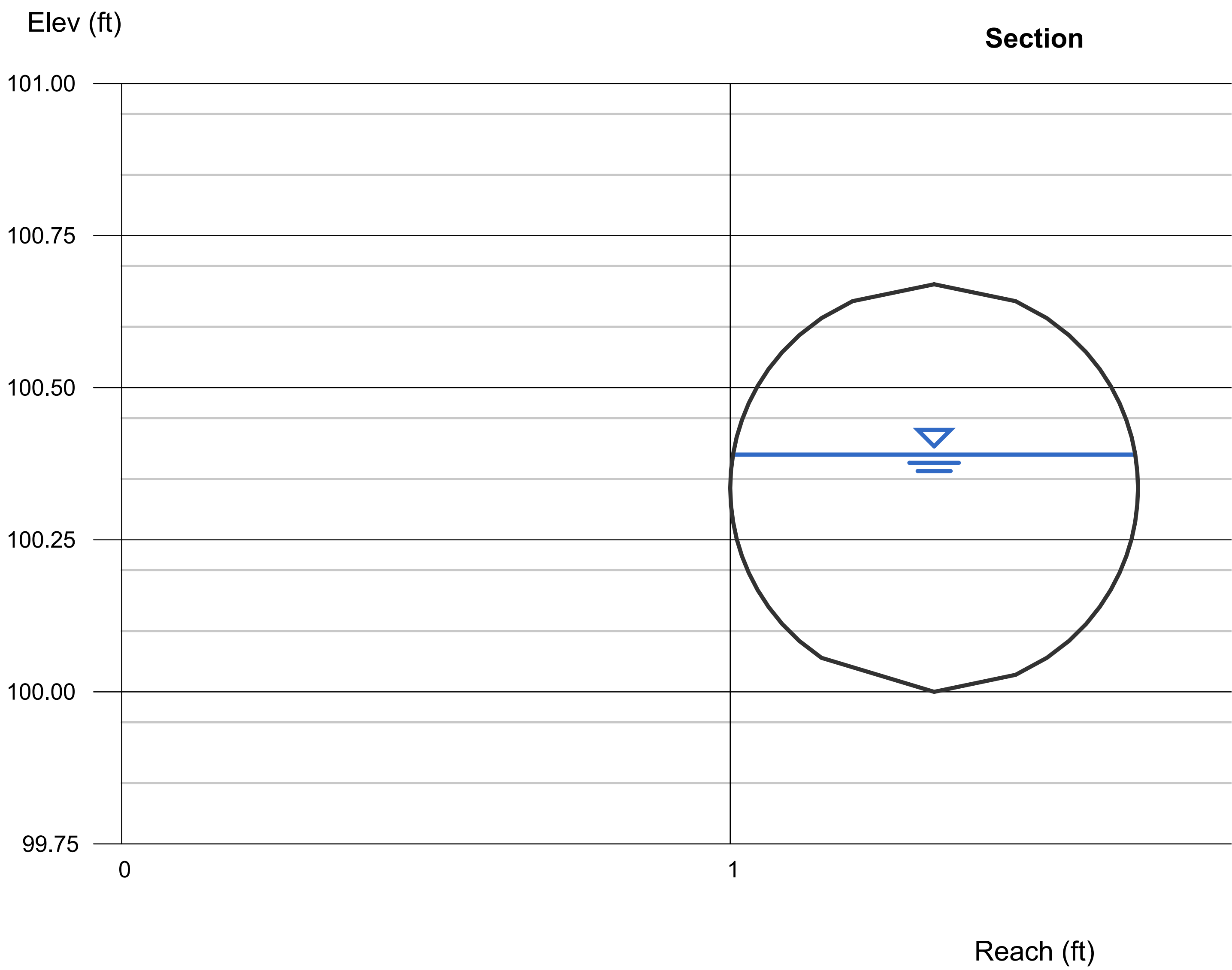
Rectangular			**Highlighted**		
Bottom Width (ft)	=	1.00	Depth (ft)	=	0.43
Total Depth (ft)	=	1.00	Q (cfs)	=	2.550
			Area (sqft)	=	0.43
Invert Elev (ft)	=	100.00	Velocity (ft/s)	=	5.93
Slope (%)	=	2.00	Wetted Perim (ft)	=	1.86
N-Value	=	0.013	Crit Depth, Yc (ft)	=	0.59
			Top Width (ft)	=	1.00
Calculations			EGL (ft)	=	0.98
Compute by:		Known Q			
Known Q (cfs)	=	2.55			



Channel Report

SD #7B

Circular			**Highlighted**		
Diameter (ft)	=	0.67	Depth (ft)	=	0.39
			Q (cfs)	=	1.190
			Area (sqft)	=	0.21
Invert Elev (ft)	=	100.00	Velocity (ft/s)	=	5.56
Slope (%)	=	2.00	Wetted Perim (ft)	=	1.17
N-Value	=	0.012	Crit Depth, Yc (ft)	=	0.52
			Top Width (ft)	=	0.66
Calculations			EGL (ft)	=	0.87
Compute by:		Known Q			
Known Q (cfs)	=	1.19			



Channel Report

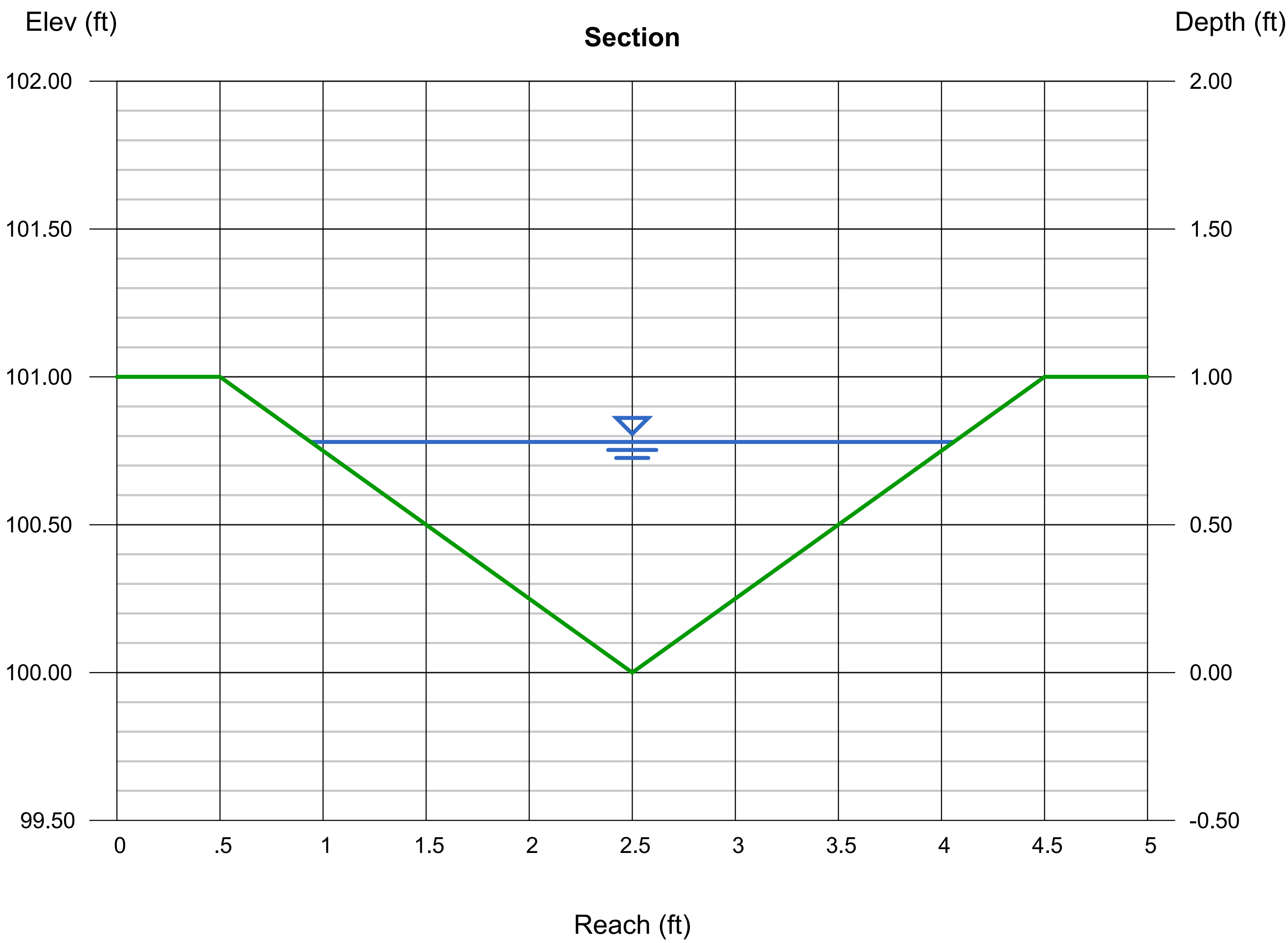
SWALE #1A

Triangular
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 1.00

Invert Elev (ft) = 100.00
Slope (%) = 0.50
N-Value = 0.025

Calculations
Compute by: Known Q
Known Q (cfs) = 2.51

Highlighted
Depth (ft) = 0.78
Q (cfs) = 2.510
Area (sqft) = 1.22
Velocity (ft/s) = 2.06
Wetted Perim (ft) = 3.49
Crit Depth, Yc (ft) = 0.63
Top Width (ft) = 3.12
EGL (ft) = 0.85



SUMMIT ENGINEERING, INC.
463 Aviation Blvd., Suite 200
Santa Rosa, CA 95403
707 527-0775
www.summit-sr.com