LANDS OF BUTLER

New Vineyard Development Hydrologic Analysis

Property Information:

Owner: Jeff Butler
Parcel No.: 033-190-006

Report Preparer Information:

Civil Engineer: Omar Reveles, PE R.C.E. 74723
Acme Engineering Inc.
Contact: 1700 Soscol Avenue, Suite 9
Napa, CA 94559
(707) 253-2263
Date: November 5, 2020

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Project Narrative

Introduction and Scope of Project

This project proposes the development of approximately 5.1 acres of vineyard (comprised of 3.3 acres of vineyard and 1.8 acres of vineyard avenues) at APN: 033-190-006 in Napa, CA. The property is owned by Jeff Butler and measures approximately 10.1 acres. Vineyard development activities shall consist of: land clearing and tree removal, ripping, incorporation of soil amendments, disking, installation of deer fence, vineyard planting, trellising, installation of a drip irrigation system and cover cropping. The proposed development activities shall begin upon approval from the Napa County Department of Planning, Building & Environmental Services and shall be completed by October 15, 2021.

Existing Conditions

The project site is located within the Suisun Creek watershed. The project site lies immediately east and west of Twin Sisters Road. The project site currently consists mostly of oak woodland and non-native grassland. Portions of the property in the immediate vicinity consist mostly of trees, grasses and herbaceous weeds. The project site consists of moderate to strong sloping terrain (13-26%). Slopes surrounding the development areas are similar to those inside.

The project site is part of an overall watershed (watersheds A-H) that measures approximately 8.54 acres and consists of approximately 2.52 acres of tree canopy, approximately 5.77 acres of grass/weeds, and approximately 0.25 acres of gravel roadways. The overall watershed consists of three sub-watersheds that combine and drain into a seasonal drainage path downslope from the proposed development area. The remaining five watersheds leave the overall watershed separately, either as sheet flow, shallow concentrated flow or through existing culverts. Eventually runoff from the overall watershed makes its way to Wooden Valley Creek, then to Suisun Creek and finally drains into Suisun Marsh.

In watersheds A, B, C, E and F, runoff occurs as sheet flow, shallow concentrated flow and channel flow. Additionally, in watersheds D, G, and H, runoff occurs as sheet flow and shallow concentrated flow only. The runoff from watersheds A and F leaves through existing culverts. The runoff from watersheds D and H leaves the site as shallow concentrated flow. The runoff from watershed G leaves the site as sheet flow. The runoff from watersheds B, C and E combine and leave the site as channel flow.

Methodologies

In order to evaluate the hydrologic impact of the proposed development, two watershed runoff models were developed using the NRCS United States Department of Agriculture (USDA) Technical Release 55 (TR-55) methodology (USDA-NRCS 2003). WinTR-55 is single-event rainfall-runoff, small watershed hydrologic model. The model generates hydrographs from both urban and agricultural areas and at selected points along the stream system. Hydrographs are routed downstream through channels and/or reservoirs. Multiple sub-areas can be modeled within the watershed. The WinTR-55 methodology was used to generate peak flow estimates for the project site.

TR-55 only allows the modeling of reaches with trapezoidal flow areas. In order to model the drainage mainline addition, the bottom width and average side slopes for Reach 2 were modified such that the flow velocity at 0.5 ft depth matched the velocity of a 12” corrugated plastic pipe with a flow depth of 0.5 ft.

This methodology was applied to the entire effective watersheds. It was used to determine the pre-development and post-development peak flow rates for the 2, 5, 10, 25, 50 and 100 year return period 24 hour storm events.

Assumptions

As previously mentioned there are several existing drainage swales and culverts along Twin Sisters Road. The intent of this project is to maintain the existing flow regimes to the maximum extent practicable. As a result all existing drainage swales and culverts shall be maintained or replaced if needed.

Hydrologic soil groups are based on estimates of runoff potential. This parameter is based on the type of soil encountered. Based on the interactive web soil survey found at: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm there is only one soil type within the project site. The soil type present is Hambright Loam (HaFso). Hambright Loam is classified as a soil in hydrologic group "D". Additionally, within the overall watershed boundaries there is an additional soil type present. This soil type is Sobrante Loam. Sobrante Loam is classified as a soil in hydrologic group "C". In an effort to simplify the analysis, hydrologic soil group "D" was used for the overall watershed, including the small portion that extends into the Sobrante Loam. This assumption is justified because the area in question is outside of the proposed development boundary and will remain unchanged between pre and post development conditions.

The determination of the hydrologic soil conditions was based on the observed canopy and surface cover conditions. For watersheds A, B, C and D a "good" hydrologic soil condition was selected for "pasture, grasslands or range" and "woods - grass combination" within the areas that are currently not developed. For watersheds E, F, G and H a "fair" hydrologic soil condition was selected for "pasture, grasslands or range" and "woods - grass combination" within the areas that are currently not developed. A "good" hydrologic soil condition was selected for "pasture, grasslands or range" within the areas of the proposed vineyard. A good hydrologic soil condition for the proposed and existing vineyard is justified by all the land preparation, cover cropping and straw mulching associated with the proposed development.

Finally, based on the hydrologic soil-cover complex definitions: "pasture, grasslands or range" land use was selected for the proposed vineyard areas. The selected land use is the one that most closely resembles the proposed cover crop seed mix and anticipated farming practices.

Impacts

The proposed development project shall not have any negative impacts on the project site. This is due to the fact that the proposed development shall not adversely affect any of the hydrologic characteristics. Currently, runoff flows across the project site as sheet flow, shallow concentrated flow and channel flow.

Currently, a culvert conveys runoff from watersheds B to watershed C and an additional culvert conveys runoff from watersheds B and C under Twin Sisters Road and discharges as shallow concentrated flow at watershed E. There is not any evidence of erosive cutting within the proposed development area. In order to prevent any long term erosion, a 12" S/W CPP pipe shall be installed to convey this runoff through the proposed vineyard. The installation of this drainage mainline shall result in no net increase in peak flow rates at the outfall of watersheds B, C and E or at the inlets of any of the existing culverts.

Finally, with all the land preparation, cover cropping and straw mulching associated with the proposed vineyard development, the hydrologic condition at the project site will actually improve at watersheds E,

G and H. The enhancement of hydrologic soil condition within the proposed development boundaries will result in no net increase in peak flow rates.

While the proposed vineyard development could potentially lead to pollutants entering the nearby waterways, the project incorporates several measures to minimize the potential for erosion and transport of pollutants during and after the proposed vineyard development. These measures include:

1. Establishment of a 75% minimum ground cover, by means of a tilled cover crop in combination with straw roll installation and straw mulch, will minimize the amount of sediment leaving the project site during the soil building period. This will also maintain the volume and probability of rainfall generated runoff at or below pre-development conditions.
2. A no-till cover crop on all vineyard blocks will minimize the amount of sediment leaving the project site throughout the life of the proposed vineyard. This will also maintain the volume and probability of rainfall generated runoff at or below pre-development conditions.
3. Incorporation of setbacks to the nearby streams, and the use of grassy turnaround avenues shall help filter sediment from surface runoff before it enters the streams. These setbacks and grassy turnaround avenues shall also trap and hold dust and fertilizers (from vineyard operations), before they can enter the streams.
4. Proposed outfall locations shall have a rock apron installed to minimize erosion and ensure that runoff exits the project site as surface sheet flow.

Conclusions and statement addressing adequacy of design

Based on the results from TR-55, the proposed development will not have any adverse effects on the existing hydrology of the watershed. The majority of the runoff shall leave the project as sheet flow or through existing culverts, which shall be maintained and/or replaced. The proposed drainage improvement shall divert potential runoff away from the proposed vineyard area and direct it to more stabilized outfall location. This outfall location shall have rock outlet protection installed to minimize erosion and ensure that runoff exits the project site as surface sheet flow. The proposed cover crop, farming practices and drainage improvements shall maintain peak runoff flow rates at or below pre-development conditions.

References

See the attached TR-55 report print outs for watersheds A-H pre-development and post-development.

See the attached sheets labeled "Pre-Development Site Plan and Curve Numbers" and "Post-Development Site Plan and Curve Numbers" for references to watershed areas and features mentioned in this report.

Land use selection was based on "Hydrologic Soil-Cover Complexes" National Engineering Handbook (NEH), Part 650, (EFH), Amend. IA50, Nov. 2007.

Hydrologic soil conditions are based on a field visits conducted by Omar Reveles of Acme Engineering, Inc. on March 20, 2019, April 1, 2019, and August 6, 2020.

Manning's roughness coefficients were obtained from Civil Engineering Reference Manual Appendix 19A and ADS product literature.

WinTR-55 Current Data Description

--- Identification Data ---

User: O. Reveles
Project: Butler Vineyards
SubTitle: Pre-Development
State: California
County: Napa
Filename: Z:\Jobs 2018\180901 Butler Vineyards\0121 New Vineyard Development ECP\Calc\01\TR-55\Butler Pre

Date: 9/8/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
A		Outlet	2.21	80	0.1
D		Outlet	0.42	80	0.1
F		Outlet	0.62	83	0.1
G		Outlet	0.63	82	0.1
H		Outlet	0.6	84	0.1

Total area: 4.48 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Storm Data

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

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Pre-Development
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 1-Yr (cfs)	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS							
A	0.64	1.10	1.74	2.27	3.00	3.56	4.12
D	0.12	0.21	0.33	0.43	0.57	0.68	0.79
F	0.22	0.36	0.55	0.70	0.91	1.06	1.22
G	0.21	0.34	0.53	0.69	0.89	1.05	1.21
H	0.23	0.36	0.55	0.70	0.90	1.05	1.20
REACHES							
OUTLET	1.41	2.37	3.69	4.79	6.27	7.40	8.55

O. Reveles

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Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period						
	1-Yr (cfs) (hr)	2-Yr (cfs) (hr)	5-Yr (cfs) (hr)	10-Yr (cfs) (hr)	25-Yr (cfs) (hr)	50-Yr (cfs) (hr)	100-Yr (cfs) (hr)
SUBAREAS							
A	0.64 8.00	1.10 7.93	1.74 7.93	2.27 7.93	3.00 7.93	3.56 7.92	4.12 7.92
D	0.12 8.00	0.21 7.93	0.33 7.93	0.43 7.93	0.57 7.93	0.68 7.92	0.79 7.92
F	0.22 7.94	0.36 7.93	0.55 7.92	0.70 7.92	0.91 7.92	1.06 7.92	1.22 7.91
G	0.21 7.94	0.34 7.93	0.53 7.93	0.69 7.92	0.89 7.92	1.05 7.92	1.21 7.91
H	0.23 7.93	0.36 7.93	0.55 7.92	0.70 7.92	0.90 7.92	1.05 7.91	1.20 7.92
REACHES							
OUTLET	1.41	2.37	3.69	4.79	6.27	7.40	8.55

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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
A	2.21	0.100	80	Outlet	
D	.42	0.100	80	Outlet	
F	.62	0.100	83	Outlet	
G	.63	0.100	82	Outlet	
H	.60	0.100	84	Outlet	

Total Area: 4.48 (ac)

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Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
A							
SHEET	100	0.1700	0.130				0.055
SHALLOW	692	0.3000	0.050				0.022
CHANNEL	164	0.0500	0.035	2.00	4.47	5.694	0.008
					Time of Concentration		0.1
D							
SHEET	100	0.2100	0.130				0.051
SHALLOW	302	0.2300	0.050				0.011
					Time of Concentration		0.1
F							
SHEET	100	0.1700	0.130				0.055
SHALLOW	111	0.1600	0.050				0.005
CHANNEL	233	0.0900	0.035	2.00	4.47	7.191	0.009
					Time of Concentration		0.1
G							
SHEET	100	0.2500	0.130				0.047
					Time of Concentration		0.1
H							
SHEET	100	0.1900	0.130				0.053
SHALLOW	30	0.3000	0.050				0.001
					Time of Concentration		0.1

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Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
A	Pasture, grassland or range	(good)	D	1.74	80
	Woods - grass combination	(good)	D	.47	79
	Total Area / Weighted Curve Number			2.21	80
D	Gravel (w/ right-of-way)		D	.01	91
	Pasture, grassland or range	(good)	D	.27	80
	Woods - grass combination	(good)	D	.14	79
	Total Area / Weighted Curve Number			.42	80
F	Pasture, grassland or range	(fair)	D	.38	84
	Woods - grass combination	(fair)	D	.24	82
	Total Area / Weighted Curve Number			.62	83
G	Pasture, grassland or range	(fair)	D	.12	84
	Woods - grass combination	(fair)	D	.51	82
	Total Area / Weighted Curve Number			.63	82
H	Gravel (w/ right-of-way)		D	.01	91
	Pasture, grassland or range	(fair)	D	.53	84
	Woods - grass combination	(fair)	D	.06	82
	Total Area / Weighted Curve Number			.6	84

WinTR-55 Current Data Description

--- Identification Data ---

User: O. Reveles
Project: Butler Vineyards
SubTitle: Pre-Development
State: California
County: Napa
Filename: Z:\Jobs 2018\180901 Butler Vineyards\0121 New Vineyard Development ECP\Calc\01\TR-55\Butler Pre

Date: 9/8/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
B		Reach 1	1.31	80	0.1
C		Reach 2	0.38	81	0.1
E		Reach 3	2.37	84	0.1

Total area: 4.06 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Storm Data

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Butler Vineyards
Pre-Development
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 1-Yr (cfs)	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS							
B	0.38	0.65	1.03	1.35	1.78	2.11	2.45
C	0.12	0.20	0.31	0.40	0.53	0.62	0.72
E	0.89	1.43	2.15	2.74	3.53	4.14	4.74
REACHES							
Reach 1	0.38	0.65	1.03	1.35	1.78	2.11	2.45
Down	0.38	0.65	1.03	1.35	1.78	2.11	2.45
Reach 2	0.50	0.85	1.34	1.75	2.31	2.73	3.17
Down	0.50	0.85	1.34	1.75	2.31	2.73	3.17
Reach 3	1.39	2.28	3.49	4.49	5.84	6.87	7.91
Down	1.39	2.28	3.49	4.49	5.84	6.87	7.91
OUTLET	1.39	2.28	3.49	4.49	5.84	6.87	7.91

Butler Vineyards
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Napa County, California

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 1-Yr (cfs)	(hr)	2-Yr (cfs)	(hr)	5-Yr (cfs)	(hr)	10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)	50-Yr (cfs)	(hr)	100-Yr (cfs)	(hr)
SUBAREAS														
B	0.38	8.00	0.65	7.93	1.03	7.93	1.35	7.93	1.78	7.93	2.11	7.92	2.45	7.92
C	0.12	8.00	0.20	7.94	0.31	7.93	0.40	7.93	0.53	7.92	0.62	7.92	0.72	7.92
E	0.89	7.93	1.43	7.93	2.15	7.92	2.74	7.92	3.53	7.92	4.14	7.91	4.74	7.92
REACHES														
Reach 1	0.38	8.00	0.65	7.93	1.03	7.93	1.35	7.93	1.78	7.93	2.11	7.92	2.45	7.92
Down	0.38	8.01	0.65	7.94	1.03	7.94	1.35	7.93	1.78	7.93	2.11	7.92	2.45	7.92
Reach 2	0.50	8.01	0.85	7.94	1.34	7.93	1.75	7.93	2.31	7.93	2.73	7.92	3.17	7.92
Down	0.50	8.02	0.85	7.95	1.34	7.94	1.75	7.94	2.31	7.94	2.73	7.93	3.17	7.93
Reach 3	1.39	7.95	2.28	7.93	3.49	7.93	4.49	7.93	5.84	7.92	6.87	7.92	7.91	7.92
Down	1.39	7.77	2.28	7.94	3.49	7.93	4.49	7.93	5.84	7.92	6.87	7.92	7.91	7.92
OUTLET	1.39		2.28		3.49		4.49		5.84		6.87		7.91	

Butler Vineyards
Pre-Development
Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
B	1.31	0.100	80	Reach 1	
C	.38	0.100	81	Reach 2	
E	2.37	0.100	84	Reach 3	

Total Area: 4.06 (ac)

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Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
Reach 1	Reach 2	78	CHANNEL
Reach 2	Reach 3	333	CHANNEL
Reach 3	Outlet	1	CHANNEL

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Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
B							
SHEET	100	0.2200	0.130				0.050
SHALLOW	516	0.2200	0.050				0.019
CHANNEL	96	0.1300	0.035	2.00	4.47	8.889	0.003
					Time of Concentration		0.1
C							
SHEET	100	0.2600	0.130				0.046
SHALLOW	400	0.2130	0.050				0.015
CHANNEL	78	0.1500	0.035	2.00	4.47	10.833	0.002
					Time of Concentration		0.1
E							
SHEET	100	0.1600	0.130				0.056
SHALLOW	324	0.2400	0.050				0.011
					Time of Concentration		0.1

Butler Vineyards
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Napa County, California

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
B	Pasture, grassland or range	(good)	D	1.17	80
	Woods - grass combination	(good)	D	.14	79
	Total Area / Weighted Curve Number			1.31	80
C	Gravel (w/ right-of-way)		D	.02	91
	Pasture, grassland or range	(good)	D	.33	80
	Woods - grass combination	(good)	D	.03	79
	Total Area / Weighted Curve Number			.38	81
E	Gravel (w/ right-of-way)		D	.21	91
	Pasture, grassland or range	(fair)	D	1.23	84
	Woods - grass combination	(fair)	D	.93	82
	Total Area / Weighted Curve Number			2.37	84

Butler Vineyards
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Napa County, California

Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
Reach 1	78	0.035	0.14	0	2 :1
Reach 2	333	0.035	0.15	0	10 :1
Reach 3	1	0.035	0.15	0	2 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
Reach 1	0.0	0.000	0	0	0.14
	0.5	2.966	0.5	2	
	1.0	18.708	2	4	
	2.0	118.382	8	8	
	5.0	1360.094	50.1	20	
	10.0	8630.154	200.1	40	
	20.0	54779.323	800.2	80	
Reach 2	0.0	0.000	0	0	0.15
	0.5	16.304	2.5	10	
	1.0	103.383	10	20	
	2.0	656.003	40	40	
	5.0	7549.275	250.1	100	
	10.0	47928.508	1000.1	200	
	20.0	304306.748	4000.2	400	
Reach 3	0.0	0.000	0	0	0.15
	0.5	3.070	0.5	2	
	1.0	19.364	2	4	
	2.0	122.537	8	8	
	5.0	1407.831	50.1	20	
	10.0	8933.058	200.1	40	
	20.0	56701.987	800.2	80	

WinTR-55 Current Data Description

--- Identification Data ---

User: O. Reveles
Project: Butler Vineyards
SubTitle: Post-Development
State: California
County: Napa
Filename: Z:\Jobs 2018\180901 Butler Vineyards\0121 New Vineyard Development ECP\Calc\01\TR-55\Butler Post

Date: 9/11/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
A		Outlet	2.21	80	0.1
D		Outlet	0.42	80	0.100
F		Outlet	0.62	83	0.1
G		Outlet	0.63	80	0.1
H		Outlet	0.6	80	0.1

Total area: 4.48 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Butler Vineyards
Post-Development
Napa County, California

Storm Data

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Butler Vineyards
Post-Development
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 1-Yr (cfs)	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS							
A	0.64	1.10	1.74	2.27	3.00	3.56	4.12
D	0.12	0.21	0.33	0.43	0.57	0.68	0.79
F	0.22	0.36	0.55	0.70	0.91	1.06	1.22
G	0.18	0.31	0.49	0.65	0.85	1.01	1.17
H	0.17	0.30	0.47	0.62	0.82	0.97	1.12
REACHES							
OUTLET	1.34	2.28	3.58	4.67	6.15	7.28	8.43

Butler Vineyards
Post-Development
Napa County, California

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 1-Yr (cfs)	(hr)	2-Yr (cfs)	(hr)	5-Yr (cfs)	(hr)	10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)	50-Yr (cfs)	(hr)	100-Yr (cfs)	(hr)
SUBAREAS														
A	0.64	8.00	1.10	7.93	1.74	7.93	2.27	7.93	3.00	7.93	3.56	7.92	4.12	7.92
D	0.12	8.00	0.21	7.93	0.33	7.93	0.43	7.93	0.57	7.93	0.68	7.92	0.79	7.92
F	0.22	7.94	0.36	7.93	0.55	7.92	0.70	7.92	0.91	7.92	1.06	7.92	1.22	7.91
G	0.18	8.00	0.31	7.93	0.49	7.93	0.65	7.93	0.85	7.93	1.01	7.92	1.17	7.92
H	0.17	8.00	0.30	7.93	0.47	7.93	0.62	7.93	0.82	7.93	0.97	7.92	1.12	7.92
REACHES														
OUTLET	1.34		2.28		3.58		4.67		6.15		7.28		8.43	

Butler Vineyards
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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
A	2.21	0.100	80	Outlet	
D	.42	0.100	80	Outlet	
F	.62	0.100	83	Outlet	
G	.63	0.100	80	Outlet	
H	.60	0.100	80	Outlet	

Total Area: 4.48 (ac)

Butler Vineyards
Post-Development
Napa County, California

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
A							
SHEET	100	0.1700	0.130				0.055
SHALLOW	692	0.3000	0.050				0.022
CHANNEL	164	0.0500	0.035	2.00	4.47	5.694	0.008
					Time of Concentration		0.1
D							
SHEET	100	0.2100	0.130				0.051
SHALLOW	302	0.2300	0.050				0.011
					Time of Concentration		0.100
F							
SHEET	100	0.1700	0.130				0.055
SHALLOW	111	0.1600	0.050				0.005
CHANNEL	233	0.0900	0.035	2.00	4.47	7.191	0.009
					Time of Concentration		0.1
G							
SHEET	100	0.2500	0.170				0.058
					Time of Concentration		0.1
H							
SHEET	100	0.1900	0.170				0.065
SHALLOW	30	0.3000	0.050				0.001
					Time of Concentration		0.1

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Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
A	Pasture, grassland or range	(good)	D	1.74	80
	Woods - grass combination	(good)	D	.47	79
	Total Area / Weighted Curve Number			2.21	80
D	Pasture, grassland or range	(good)	D	.28	80
	Woods - grass combination	(good)	D	.14	79
	Total Area / Weighted Curve Number			.42	80
F	Pasture, grassland or range	(fair)	D	.37	84
	Pasture, grassland or range	(good)	D	.02	80
	Woods - grass combination	(fair)	D	.23	82
	Total Area / Weighted Curve Number			.62	83
G	Pasture, grassland or range	(good)	D	.63	80
	Total Area / Weighted Curve Number			.63	80
H	Gravel (w/ right-of-way)		D	.01	91
	Pasture, grassland or range	(fair)	D	.01	84
	Pasture, grassland or range	(good)	D	.58	80
	Total Area / Weighted Curve Number			.6	80

WinTR-55 Current Data Description

--- Identification Data ---

User: O. Reveles
Project: Butler Vineyards
SubTitle: Post-Development
State: California
County: Napa
Filename: Z:\Jobs 2018\180901 Butler Vineyards\0121 New Vineyard Development ECP\Calc\01\TR-55\Butler Post

Date: 9/11/2020
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
B		Reach 1	1.31	80	0.100
C		Reach 2	0.38	80	0.1
E		Reach 4	2.37	81	0.1

Total area: 4.06 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Butler Vineyards
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Napa County, California

Storm Data

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
3.08	4.05	5.29	6.28	7.6	8.6	9.61

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type IA
Dimensionless Unit Hydrograph: <standard>

Butler Vineyards
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Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 1-Yr (cfs)	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS							
B	0.38	0.65	1.03	1.35	1.78	2.11	2.45
C	0.11	0.19	0.30	0.39	0.51	0.61	0.70
E	0.73	1.24	1.94	2.51	3.30	3.90	4.50
REACHES							
Reach 1	0.38	0.65	1.03	1.35	1.78	2.11	2.45
Down	0.38	0.65	1.03	1.35	1.78	2.11	2.45
Reach 2	0.49	0.84	1.33	1.74	2.29	2.72	3.15
Down	0.49	0.84	1.33	1.74	2.29	2.72	3.15
Reach 3	0.49	0.84	1.33	1.74	2.29	2.72	3.15
Down	0.49	0.84	1.33	1.74	2.29	2.72	3.15
Reach 4	1.22	2.08	3.26	4.25	5.59	6.62	7.65
Down	1.22	2.08	3.26	4.25	5.59	6.62	7.65
OUTLET	1.22	2.08	3.26	4.25	5.59	6.62	7.65

O. Reveles

Butler Vineyards
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Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period						
	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)
SUBAREAS							
B	0.38 8.00	0.65 7.93	1.03 7.93	1.35 7.93	1.78 7.93	2.11 7.92	2.45 7.92
C	0.11 8.00	0.19 7.93	0.30 7.93	0.39 7.93	0.51 7.93	0.61 7.92	0.70 7.92
E	0.73 8.00	1.24 7.94	1.94 7.93	2.51 7.93	3.30 7.92	3.90 7.92	4.50 7.92
REACHES							
Reach 1	0.38 8.00	0.65 7.93	1.03 7.93	1.35 7.93	1.78 7.93	2.11 7.92	2.45 7.92
Down	0.38 8.01	0.65 7.94	1.03 7.94	1.35 7.93	1.78 7.93	2.11 7.92	2.45 7.92
Reach 2	0.49 8.01	0.84 7.94	1.33 7.93	1.74 7.93	2.29 7.93	2.72 7.92	3.15 7.92
Down	0.49 8.01	0.84 7.94	1.33 7.94	1.74 7.93	2.29 7.93	2.72 7.93	3.15 7.93
Reach 3	0.49 8.01	0.84 7.94	1.33 7.94	1.74 7.93	2.29 7.93	2.72 7.93	3.15 7.93
Down	0.49 8.02	0.84 7.95	1.33 7.94	1.74 7.93	2.29 7.93	2.72 7.93	3.15 7.93
Reach 4	1.22 8.01	2.08 7.94	3.26 7.93	4.25 7.93	5.59 7.93	6.62 7.92	7.65 7.92
Down	1.22 8.01	2.08 7.94	3.26 7.94	4.25 7.93	5.59 7.93	6.62 7.92	7.65 7.92
OUTLET	1.22	2.08	3.26	4.25	5.59	6.62	7.65

Butler Vineyards
Post-Development
Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
B	1.31	0.100	80	Reach 1	
C	.38	0.100	80	Reach 2	
E	2.37	0.100	81	Reach 4	

Total Area: 4.06 (ac)

Butler Vineyards
Post-Development
Napa County, California

Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
Reach 1	Reach 2	78	CHANNEL
Reach 2	Reach 3	206	CHANNEL
Reach 3	Reach 4	118	CHANNEL
Reach 4	Outlet	1	CHANNEL

Butler Vineyards
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Napa County, California

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
B							
SHEET	100	0.2200	0.130				0.050
SHALLOW	516	0.2200	0.050				0.019
CHANNEL	96	0.1300	0.035	2.00	4.47	8.889	0.003
					Time of Concentration		0.100
C							
SHEET	100	0.2600	0.130				0.046
SHALLOW	400	0.2100	0.050				0.015
CHANNEL	78	0.1500	0.035	2.00	4.47	10.833	0.002
					Time of Concentration		0.1
E							
SHEET	100	0.1600	0.170				0.070
SHALLOW	324	0.2400	0.050				0.011
					Time of Concentration		0.1

Butler Vineyards
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Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
B	Pasture, grassland or range	(good)	D	1.17	80
	Woods - grass combination	(good)	D	.14	79
	Total Area / Weighted Curve Number			1.31	80
C	Pasture, grassland or range	(good)	D	.35	80
	Woods - grass combination	(good)	D	.03	79
	Total Area / Weighted Curve Number			.38	80
E	Gravel (w/ right-of-way)		D	.21	91
	Pasture, grassland or range	(fair)	D	.13	84
	Pasture, grassland or range	(good)	D	1.72	80
	Woods - grass combination	(fair)	D	.31	82
	Total Area / Weighted Curve Number			2.37	81

Butler Vineyards
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Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
Reach 1	78	0.035	0.14	0	2 :1
Reach 2	206	0.018	0.19	0.2	2.6 :1
Reach 3	118	0.035	0.09	0	10 :1
Reach 4	1	0.035	0.15	0	2 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
Reach 1	0.0	0.000	0	0	0.14
	0.5	2.966	0.5	2	
	1.0	18.708	2	4	
	2.0	118.382	8	8	
	5.0	1360.094	50.1	20	
	10.0	8630.154	200.1	40	
	20.0	54779.323	800.2	80	
Reach 2	0.0	0.000	0	0.2	0.19
	0.5	10.745	0.8	2.8	
	1.0	62.211	2.8	5.4	
	2.0	376.142	10.8	10.6	
	5.0	4200.856	66	26.2	
	10.0	26400.604	262	52.2	
	20.0	166767.272	1044	104.2	
Reach 3	0.0	0.000	0	0	0.09
	0.5	12.629	2.5	10	
	1.0	80.080	10	20	
	2.0	508.138	40	40	
	5.0	5847.643	250.1	100	
	10.0	37125.263	1000.1	200	
	20.0	235714.993	4000.2	400	
Reach 4	0.0	0.000	0	0	0.15
	0.5	3.070	0.5	2	
	1.0	19.364	2	4	
	2.0	122.537	8	8	
	5.0	1407.831	50.1	20	
	10.0	8933.058	200.1	40	
	20.0	56701.987	800.2	80	

Subject: Lands of Butler - New Vineyard Development
Project #: 180901-0121
By: Omar Reveles
Date: 11/5/2020

Drop Inlet Riser and Sump Design										
Point of Concentration	**Qw Peak Flow (cfs)**	**Drop Inlet Riser Diameter (inches)**	**Inlet Riser Diameter (ft)**	**Inlet Weir Head Required (ft)**	**Inlet Sump Diameter (inches)**	**Inlet Sump Diameter (ft)**	**Head Required for Sump Inlet (ft)**	**Design**		**Remarks**
1	3.15	8	0.67	0.62	15	1.3	0.41	8" riser	15" sump*	Set riser invert to 1' below sump invert. Use an earthen berm to create required head at sump.

* Sump shall be a runoff collector, therefore the whole circumference of the sump pipe shall funtion as a weir

Equations Used:

Circular Riser Weir Flow Equation: $Qw = 9.73 \times d \times h^{(3/2)}$
where Qw = weir flow, in cfs
d = pipe diameter, in feet
h = height of water above riser, in feet

rearranging terms, and solving for h, yields:
$h = (Qw/(9.73 \times d))^{(2/3)}$

when only half of the circumference of the circular riser behaves as a weir
$h = (Qw/(4.87 \times d))^{(2/3)}$

Setting the Circular Riser Weir Flow Equation equal to the Standard Weir Equation yields: $9.73 \times d \times h^{(3/2)} = C \times b \times h^{(3/2)}$

substituting circumference ($\pi \times d$) for "b" yields:

$9.73 \times d \times h^{(3/2)} = C \times (\pi \times d) \times h^{(3/2)}$

simplifying the equation yields: $9.73 = c \times \pi$

Solving for C yields: C = 3.10

Weir coefficient is on the conservative side of the acceptable range (3.0 - 3.9)

Standard Weir Equation: $Qw = C \times b \times h^{(3/2)}$
where C = weir coefficient (3.0 - 3.9)
b = effective weir length, in feet
h = height of water above weir, in feet

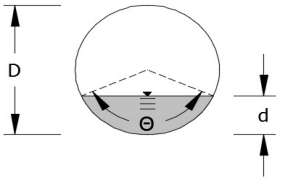
This equation calculates the flow in terms of the effective length of the weir and the height of the water above the weir. If a circular pipe riser is used, the effective weir length is equal to the circumference of that circular pipe

Subject: Lands of Butler - New Vineyard Development
Project #: 180901-0121
By: Omar Reveles
Date: 11/5/2020

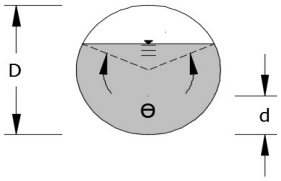
Drainage Mainline

Using Mannings Equation Q=(((1.49/n) x A x R^(2/3)) x s^(1/2))

where: Q= flow, in cfs
n = Mannings Roughness Coefficient
A =area in flow, in square feet
R = hydraulic radius, in feet
s = slope, in ft/ft



CIRCLE



CIRCLE

From the previous illustration:

θ (RAD) = 2 x arccos((D/2-d)/(D/2))

Area = 1/8(θ-sinθ)D^2 (θ in radians)

Wetted Perimeter = θD/2 (θ in radians)

Hydraulic Radius = (1-(sin(θ)/θ)) x (D/4) (θ in radians)

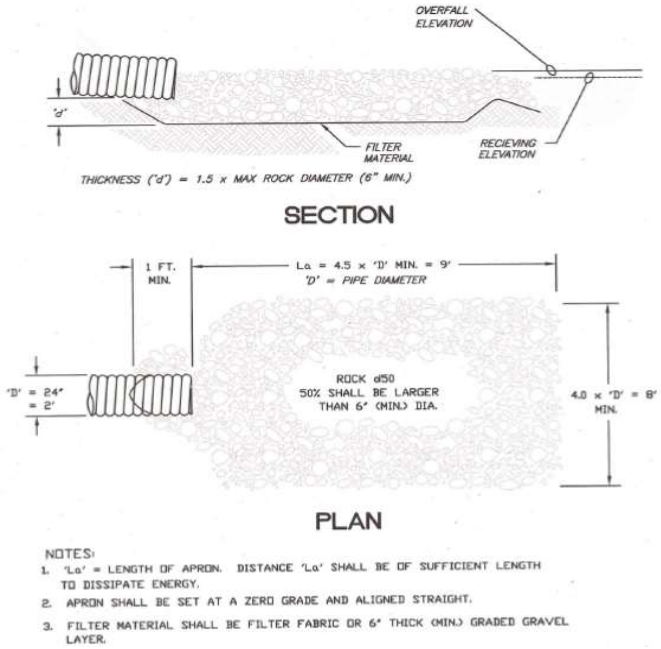
Drainage Mainline Sizing Table

Section	Spanned DI's	Pipe Slope (ft/ft)	HDPE Pipe Size (inches)	HDPE Pipe S/W or D/W	Mannings "n" value	% Full (d/D)	Flow Capacity (cfs)	Peak Anticipated Flow (cfs)	Notes
A	N/A	0.19	12	Single Wall	0.018	70%	9.42	3.15	OK

Notes:
1.) Mannings roughness coefficients (n values) for smooth wall pipe were acquired from ADS product literature
2.) Peak anticipated flows were obtained from TR-55 hydrologic modeling for post-development conditions.

Subject: Lands of Butler - New Vineyard Development
Project #: 180901-0121
By: Omar Reveles
Date: 11/5/2020

Energy Dissipater Sizing



Pipe Geometry		
Diameter (in)	**Diameter (ft)**	**Area (sq. ft.)**
3	0.25	0.05
4	0.33	0.09
6	0.50	0.20
8	0.67	0.35
10	0.83	0.55
12	1.00	0.79
15	1.25	1.23
18	1.50	1.77
24	2.00	3.14

Channel Geometry (assuming 2:1 side slopes)				
Depth (in)	**Depth (ft)**	**Width (ft)**	**Area (sq. ft.)**	**Equivalent Pipe Size (in)**
4	0.33	1.33	0.22	8
6	0.50	2.00	0.50	10
8	0.67	2.67	0.89	15
10	0.83	3.33	1.39	18
12	1.00	4.00	2.00	24

Energy Dissipater Geometry								
Outfall Location	**Outfall Type**	**Channel Depth (in)**	**Equivalent Pipe Size (in)**	**Min Apron Width "Wa" (ft)**	**Min Apron Length "La" (ft)**	**d50 Rock Size (in)**	**Largest Stone Size (in)**	**Rock Layer Depth "d" (in)**
Reach 3	Pipe	-	12	4.0	4.5	6	9	14

HYDROLOGIC SOIL-COVER COMPLEXES

A combination of the effects of hydrologic soil group (soil) and the land use and treatment class (cover) is used to determine the runoff curve number (CN). The CN indicates the runoff potential of a soil-cover complex during periods when the soil is not frozen. The higher the CN, the higher the potential for runoff.

Land Use

Fallow is the land use with the highest potential for runoff because the land is kept as bare as possible to conserve moisture for use by a succeeding crop.

A row crop is any field crop planted in rows far enough apart that most of the soil surface is exposed to rainfall impact during the early growing season (i.e.: corn, soybeans, sorghum).

Small grain is planted in rows close enough together that the soil surface is not exposed except during planting and shortly thereafter.

Close-seeded legumes or rotation meadow are either planted in close rows or broadcast. This cover may be allowed to remain for more than a year so that year-round protection is given to the soil.

Pasture is a long term stand of forage plants which gives year-round protection to the soil.

Meadow is a field in which grass is continually grown, protected from grazing, and generally mowed for hay.

Woods are forested areas that have at least 30 percent canopy coverage as viewed by aerial photography.

Farmsteads include the area surrounding the farm headquarters including buildings, lots, driveways, etc.

Roads are improved travelways (not farm lanes). Hard surface roads include any type of asphalt or concrete paving. Road right-of-way is included in the total road area used to determine CN.

Treatment or Practice

Straight row fields are those farmed in straight rows either up and down hill or across the slope.

Contoured fields are those farmed as nearly as possible on the contour. The hydrologic effect of contouring is due to the surface storage provided by the furrows because the storage prolongs the time during which infiltration can take place. The magnitude of the storage depends not only on the dimensions of the furrows but also on the land slope, crop, and manner of planting and cultivation. See Contour Farming (330) in the Field Office Technical Guide for additional guidance.

The contoured and terraced condition is to be used for systems containing open-end level or graded terraces with grassed waterway outlets where all tillage is done on the contour between the terraces. The area above closed-end level terraces and terraces with tile outlets is to be included with the contoured area for runoff curve number computations.

Hydrologic Condition

Ratings as to “poor” or “good” are based largely on the proportion of dense vegetation in the rotation.

Pasture is considered poor if it is heavily grazed and has no mulch or has plant cover on less than half of the area. Fair pasture has plant cover on 50 to 75 percent of the area. Heavily grazed pasture in Iowa is generally considered to be fair pasture. Good pasture is lightly grazed and has plant cover on more than 75 percent of the area.

Poor woods are heavily grazed or are regularly burned and have no litter or new young growth. Fair woods are grazed but not burned. There may be some litter but these woods are not protected. Good woods are protected from grazing and have litter and shrubs covering the soil.

Table IA2-1 gives CN’s for agricultural land uses and for selected suburban and urban land uses.

Effects of Conservation Tillage

Cropland with conservation tillage and residue management practices will be considered to be in good hydrologic condition.

RUNOFF CURVE NUMBERS[1/]

TABLE IA2-1

COVER TYPE	LAND USE AND TREATMENT[2/]	HYDROLOGIC CONDITION[3/]	A	CN	B	CN	C	CN	D	CN
1	**FULLY DEVELOPED URBAN AREAS (Veg Est)**									
2	Open space (Lawns, parks, etc.)									
3	Poor condition; grass cover < 50%			68		79		86		89
4	Fair condition; grass cover 50% to 75%			49		69		79		84
5	Good condition; grass cover > 75%			39		61		74		80
6										
7	***Impervious Areas:***									
8	Paved parking lots, roofs, driveways			98		98		98		98
9										
10	Streets and roads:									
11	Paved; curbs and storm sewers			98		98		98		98
12	Paved; open ditches (w/ right-of-way)			83		89		92		93
13	Gravel (w/ right-of-way)			76		85		89		91
14	Dirt (w/ right-of-way)			72		82		87		89
15										
16	***Urban Districts***	Avg % Imperv								
17	Commercial & business	85		89		92		94		95
18	Industrial	72		81		88		91		93
19										
20	***Residential districts (by average lot size)***	Avg % Imperv								
21	1/8 acre (town houses)	65		77		85		90		92
22	1/4 acre	38		61		75		83		87
23	1/3 acre	30		57		72		81		86
24	1/2 acre	25		54		70		80		85
25	1 acre	20		51		68		79		84
26	2 acre	12		46		65		77		82
27										
28	***Western Desert Urban Areas***									
29	Natural desert (pervious areas only)			63		77		85		88
30	Artificial desert landscaping			96		96		96		96
31										
32	***User defined urban (Click button to define)***	Custom CN								
33	% Impervious Area:									
34	% Unconnected Impervious Area:									
35	Pervious Curve Number:									
36										
37	**DEVELOPING URBAN AREA (NO VEGETATION)**									
38	Newly graded area (pervious only)			77		86		91		94
39										
40	**CULTIVATED AGRICULTURAL LANDS**									
41	Fallow Bare soil	——		77		86		91		94
42	Fallow Crop residue (CR)	poor		76		85		90		93
43	Fallow Crop residue (CR)	good		74		83		88		90
44										
45	Row crop Straight row (SR)	poor		72		81		88		91
46	Straight row (SR)	good		67		78		85		89
47	SR + Crop residue	poor		71		80		87		90
48	SR + Crop residue	good		64		75		82		85
49	Contoured (C)	poor		70		79		84		88
50	Contoured (C)	good		65		75		82		86
51	C + Crop residue	poor		69		78		83		87
52	C + Crop residue	good		64		74		81		85
53	Cont & terraced (C&T)	poor		66		74		80		82
54	Cont & terraced (C&T)	good		62		71		78		81
55	C&T + Crop residue	poor		65		73		79		81
56	C&T + Crop residue	good		61		70		77		80
57										
58	Small grain Straight row (SR)	poor		65		76		84		88
59	Straight row (SR)	good		63		75		83		87
60										

RUNOFF CURVE NUMBERS[1/]
TABLE IA2-1

COVER TYPE	LAND USE AND TREATMENT[2/]	HYDROLOGIC CONDITION[3/]	A	CN	B	CN	C	CN	D	CN
61	SR + Crop residue	poor		64		75		83		86
62	SR + Crop residue	good		60		72		80		84
63	Contoured (C)	poor		63		74		82		85
64	Contoured (C)	good		61		73		81		84
65	C + Crop residue	poor		62		73		81		84
66	C + Crop residue	good		60		72		80		83
67	Cont & terraced (C&T)	poor		61		72		79		82
68	Cont & terraced (C&T)	good		59		70		78		81
69	C&T + Crop residue	poor		60		71		78		81
70	C&T + Crop residue	good		58		69		77		80
71										
72	Close-seeded Straight Row	poor		66		77		85		89
73	legumes or Straight Row	good		58		72		81		85
74	rotation Contoured	poor		64		75		83		85
75	meadow Contoured	good		55		69		78		83
76	Cont & terraced	poor		63		73		80		83
77	Cont & terraced	good		51		67		76		80
78										
79	**OTHER AGRICULTURAL LANDS**									
80	Pasture, grassland or range[4/]	poor		68		79		86		89
81	Pasture, grassland or range	fair		49		69		79		84
82	Pasture, grassland or range	good		39		61		74		80
83										
84	Meadow - cont. grass (non grazed)			30		58		71		78
85										
86	Brush - brush, weed, grass mix[5/]	poor		48		67		77		83
87	Brush - brush, weed, grass mix	fair		35		56		70		77
88	Brush - brush, weed, grass mix	good		30[6/]		48		65		73
89										
90	Woods - grass combination[7/]	poor		57		73		82		86
91	Woods - grass combination	fair		43		65		76		82
92	Woods - grass combination	good		32		58		72		79
93										
94	Woods[8/]	poor		45		66		77		83
95	Woods	fair		36		60		73		79
96	Woods	good		30		55		70		77
97										
98	Farmsteads	——		59		74		82		86
99	Feedlots									
100	Earthen	——		90		90		90		90
101	Paved			98		98		98		98

1/ Average runoff condition, and I_a=0.2s.

2/ Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

3/ Hydrologic condition is based on combinations of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥20%), and (e) degree of surface toughness.
Poor: factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.
For conservation tillage poor hydrologic condition, 5 to 20% of the surface is covered with residue (less than 750 pounds per acre for row crops or 300 pounds per acre for small grain).
For conservation tillage good hydrologic condition, more than 20% of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain).

4/ Poor: <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

5/ Poor: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

6/ If actual curve number is less than 30, use CN = 30 for runoff computation.

7/ CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

8/ Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed, but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and letter and brush adequately cover the soil.

APPENDIX 19.A
Manning's Roughness Coefficient[a,b]
(design use)

channel material	n
plastic (PVC and ABS)	0.009
clean, uncoated cast iron	0.013–0.015
clean, coated cast iron	0.012–0.014
dirty, tuberculated cast iron	0.015–0.035
riveted steel	0.015–0.017
lock-bar and welded steel pipe	0.012–0.013
galvanized iron	0.015–0.017
brass and glass	0.009–0.013
wood stave	
small diameter	0.011–0.012
large diameter	0.012–0.013
concrete	
average value used	0.013
typical commercial, ball and spigot rubber gasketed end connections	
– full (pressurized and wet)	0.010
– partially full	0.0085
with rough joints	0.016–0.017
dry mix, rough forms	0.015–0.016
wet mix, steel forms	0.012–0.014
very smooth, finished	0.011–0.012
vitrified sewer	0.013–0.015
common-clay drainage tile	0.012–0.014
asbestos	0.011
planed timber (flume)	0.012 (0.010–0.014)
canvas	0.012
unplaned timber (flume)	0.013 (0.011–0.015)
brick	0.016
rubble masonry	0.017
smooth earth	0.018
firm gravel	0.023
corrugated metal pipe (CMP)	0.024 (see App. 17.F)
natural channels, good condition	0.025
rip rap	0.035
natural channels with stones and weeds	0.035
very poor natural channels	0.060

[a] Compiled from various sources.
[b] Values outside these ranges have been observed, but these values are typical.

Support Material

Table 3-1
Conveyance Factors (Standard Units)

Design Manning's Values for ADS Thermoplastic Pipe *		
Product	**Diameter**	**Design Manning's "n"**
N-12, MEGA GREEN, N-12 STIB, N-12 WTIB, HP STORM, SaniTite, SaniTite HP, N-12 Low Head	4" - 60"	"n" = 0.012
Single Wall Highway and Heavy Duty *	18" - 24" 12" - 15" 10" 8" 3" - 6"	"n" = 0.020 "n" = 0.018 "n" = 0.017 "n" = 0.016 "n" = 0.015
TripleWall and Smoothwall Sewer & Drain	3" - 6"	"n" = 0.009 **
Conveyance Equations: k = Q/(s^0.5) Q = k s^0.5		

Conveyance Factors for Circular Pipe Flowing Full																		
Manning's "n" Values																		
Dia. (in.)	**Area (sq. ft.)**	**0.009**	**0.010**	**0.011**	**0.012**	**0.013**	**0.014**	**0.015**	**0.016**	**0.017**	**0.018**	**0.019**	**0.020**	**0.021**	**0.022**	**0.023**	**0.024**	**0.025**
3	0.05	1.3	1.1	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5
4	0.09	2.7	2.5	2.2	2.1	1.9	1.8	1.6	1.5	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.0	1.0
6	0.20	8.1	7.3	6.6	6.1	5.6	5.2	4.9	4.6	4.3	4.1	3.8	3.6	3.5	3.3	3.2	3.0	2.9
8	0.35	17.5	15.7	14.3	13.1	12.1	11.2	10.5	9.8	9.2	8.7	8.3	7.9	7.5	7.1	6.8	6.5	6.3
10	0.55	31.6	28.5	25.9	23.7	21.9	20.3	19.0	17.8	16.8	15.8	15.0	14.2	13.6	12.9	12.4	11.9	11.4
12	0.79	51.5	46.3	42.1	38.6	35.6	33.1	30.9	28.9	27.2	25.7	24.4	23.2	22.1	21.1	20.1	19.3	18.5
15	1.23	93.3	84.0	76.3	70.0	64.6	60.0	56.0	52.5	49.4	46.7	44.2	42.0	40.0	38.2	36.5	35.0	33.6
18	1.77	151.7	136.6	124.1	113.8	105.0	97.5	91.0	85.3	80.3	75.9	71.9	68.3	65.0	62.1	59.4	56.9	54.6
21	2.41	228.9	206.0	187.3	171.6	158.4	147.1	137.3	128.7	121.2	114.4	108.4	103.0	98.1	93.6	89.6	85.8	82.4
24	3.14	326.8	294.1	267.3	245.1	226.2	210.1	196.1	183.8	173.0	163.4	154.8	147.0	140.0	133.7	127.9	122.5	117.6
27	3.98	447.3	402.6	366.0	335.5	309.7	287.6	268.4	251.6	236.8	223.7	211.9	201.3	191.7	183.0	175.0	167.8	161.0
30	4.91	592.5	533.2	484.7	444.3	410.2	380.9	355.5	333.3	313.7	296.2	280.6	266.6	253.9	242.4	231.8	222.2	213.3
33	5.94	763.9	687.5	625.0	572.9	528.9	491.1	458.3	429.7	404.4	382.0	361.9	343.8	327.4	312.5	298.9	286.5	275.0
36	7.07	963.4	867.1	788.2	722.6	667.0	619.3	578.0	541.9	510.0	481.7	456.4	433.5	412.9	394.1	377.0	361.3	346.8
42	9.62	1453.2	1307.9	1189.0	1089.9	1006.1	934.2	871.9	817.5	769.4	726.6	688.4	654.0	622.8	594.5	568.7	545.0	523.2
45	11.04	1746.8	1572.1	1429.2	1310.1	1209.3	1122.9	1048.1	982.6	924.8	873.4	827.4	786.1	748.6	714.6	683.5	655.0	628.8
48	12.57	2074.8	1867.4	1697.6	1556.1	1436.4	1333.8	1244.9	1167.1	1098.4	1037.4	982.8	933.7	889.2	848.8	811.9	778.1	746.9
54	15.90	2840.5	2556.4	2324.0	2130.4	1966.5	1826.0	1704.3	1597.8	1503.8	1420.2	1345.5	1278.2	1217.4	1162.0	1111.5	1065.2	1022.6
60	19.63	3762.0	3385.8	3078.0	2821.5	2604.4	2418.4	2257.2	2116.1	1991.6	1881.0	1782.0	1692.9	1612.3	1539.0	1472.1	1410.7	1354.3
72	28.27	6117.3	5505.6	5005.1	4588.0	4235.1	3932.6	3670.4	3441.0	3238.6	3058.7	2897.7	2752.8	2621.7	2502.5	2393.7	2294.0	2202.2

* Corrugated Polyethylene Pipe Association (2000) "Hydraulic Considerations for Corrugated Polyethylene Pipe"
** "Lingedburg, Michael, "Civil Engineer Reference Manual"[4]

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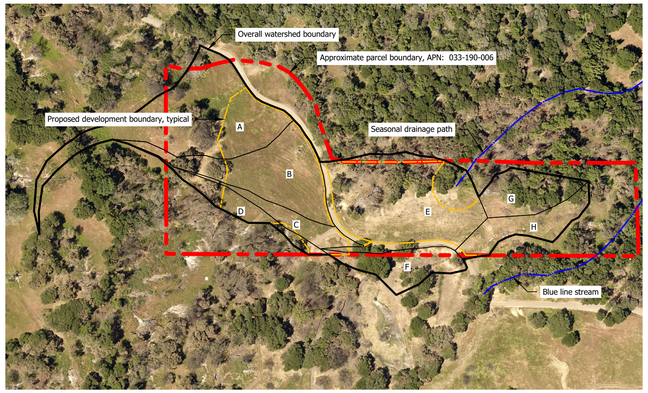
Legend

- 1600 — Major contour (50' interval)
- Minor contour (10' interval)
- Approximate parcel boundary
- Overall watershed boundary
- Sub-watershed boundary
- HaFso / 179 — Soil type boundary
- Blue line stream
- Seasonal drainage
- Roadway
- Proposed development boundary
- Pasture area
- Woodland area
- Developed area (gravel road)
- Sheet flow along critical path
- Shallow concentrated flow along critical path
- Chanel flow along critical path
- Existing swale
- Existing culvert
- Runoff flow direction arrow

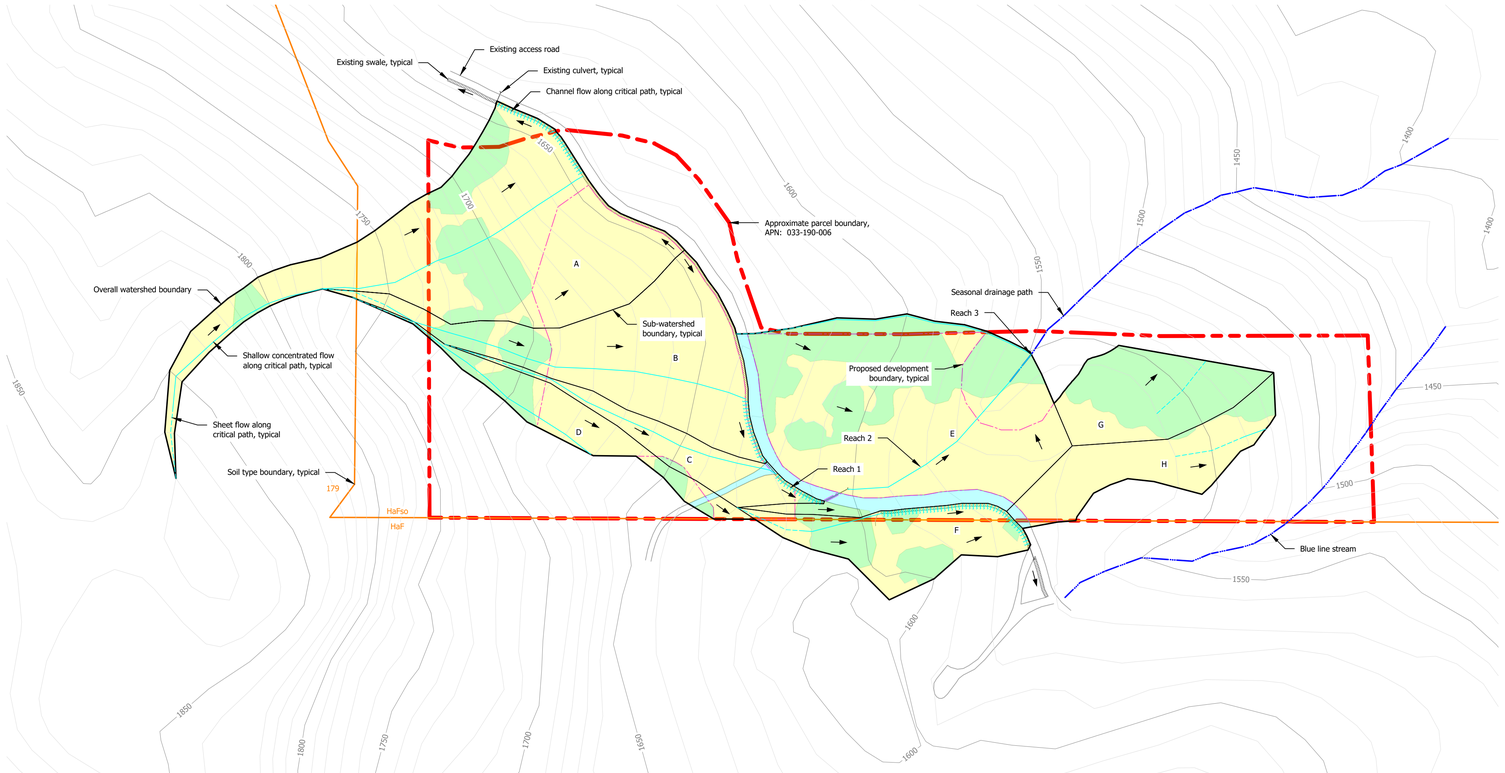
Summary Table Of Pre-Development Hydrologic Characteristics For Lands of Butler

Watershed	Land Use	Hydrologic Condition	Hydrologic Soil Group	Acres	Curve Number
A	Pasture, grassland or range	Good	D*	1.74	80
	Woods - grass combination	Good	D*	0.47	79
	Total			**2.21**	**80**
B	Pasture, grassland or range	Good	D	1.17	80
	Woods - grass combination	Good	D	0.14	79
	Total			**1.31**	**80**
C	Gravel (w/ right-of-way)		D	0.02	91
	Pasture, grassland or range	Good	D	0.33	80
	Woods - grass combination	Good	D	0.03	79
	Total			**0.38**	**81**
D	Gravel (w/ right-of-way)		D	0.01	91
	Pasture, grassland or range	Good	D	0.27	80
	Woods - grass combination	Good	D	0.14	79
	Total			**0.42**	**80**
E	Gravel (w/ right-of-way)		D	0.21	91
	Pasture, grassland or range	Fair	D	1.23	84
	Woods - grass combination	Fair	D	0.93	82
	Total			**2.37**	**84**
F	Pasture, grassland or range	Fair	D	0.38	84
	Woods - grass combination	Fair	D	0.24	82
	Total			**0.62**	**83**
G	Pasture, grassland or range	Fair	D	0.12	84
	Woods - grass combination	Fair	D	0.51	82
	Total			**0.63**	**82**
H	Gravel (w/ right-of-way)		D	0.01	91
	Pasture, grassland or range	Fair	D	0.53	84
	Woods - grass combination	Fair	D	0.06	82
	Total			**0.60**	**84**

* The majority of the overall watershed rests on Hambright Loam. Hambright Loam is classified as Hydrologic Soil Group D. A small portion of sub-watershed A extends into the Sobrante Loam. Sobrante Loam is classified as Hydrologic Soil Group C. In an effort to simplify the analysis hydrologic soil group D was used for the overall watershed, including the small portion that extends into the Sobrante Loam. This assumption is justified because the area in question is outside of the proposed development boundary and will remain unchanged between pre/post development conditions.



Watershed Aerial Map
Scale: 1" = 200'



0' 100' 200'

Notes:
1. Topographic information provided by Napa County GIS database from 2002.
2. Datum: North American Vertical Datum of 1988 (NAVD 88).
3. Aerial image is from 2018 and was provided by Napa County.

Soil Types on Site:
179 - Sobrante loam, Hydrologic Soil Group C
HaFso, HaF - Hambright loam, Hydrologic Soil Group D

Pre-Development Site Plan
Scale: 1" = 100'

DESIGNED BY OR
DRAWN BY OR
CHECKED BY OR
NOTES/ REMARKS:

REGISTERED PROFESSIONAL ENGINEER
CHAD REJCES
No. C 74723
EXPIRES 12/21
STATE OF CALIFORNIA
CIVIL ENGINEERING

ACME Engineering
www.acmeng.com
1700 Soscol Avenue
Ste. 9, Napa, CA 94559
707-253-ACME

LANDS OF BUTLER
NEW VINEYARD DEVELOPMENT
PRE-DEVELOPMENT SITE PLAN AND CURCVE NUMBERS

PROJECT NO. 180901-0121
DRAWING NO. 01 01
SCALE AS SHOWN
DATE 11/5/2020
SHEET 1 OF 2

Z:\Jobs 2018\180901 Butler Vineyards\01 New Vineyard Development\07\Dwg\02\Butler TBOS Site Plans Pre.dwg, 11/5/2020 2:05:18 PM, Copyright ACME Engineering Dec.

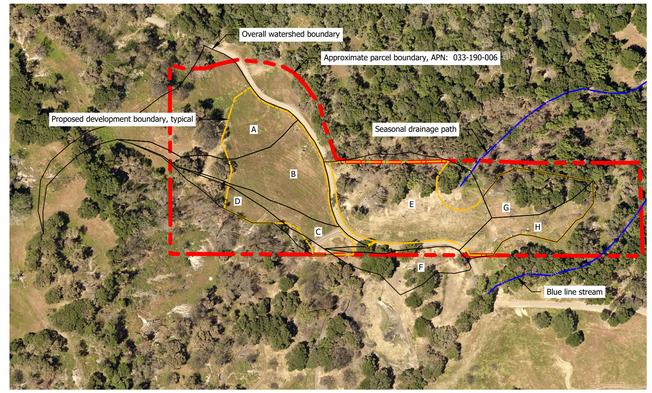
Legend

- 1600 — Major contour (50' interval)
- Minor contour (10' interval)
- Approximate parcel boundary
- Watershed area boundary
- Watershed sub-area boundary
- HaFso / 179 — Soil type boundary
- Blue line stream
- Seasonal drainage
- Roadway
- Proposed development area (vineyard)
- Pasture area
- Woodland area
- Developed area (gravel road)
- Sheet flow along critical path
- Shallow concentrated flow along critical path
- Chanel flow along critical path
- Existing swale
- Existing culvert
- Runoff flow direction arrow

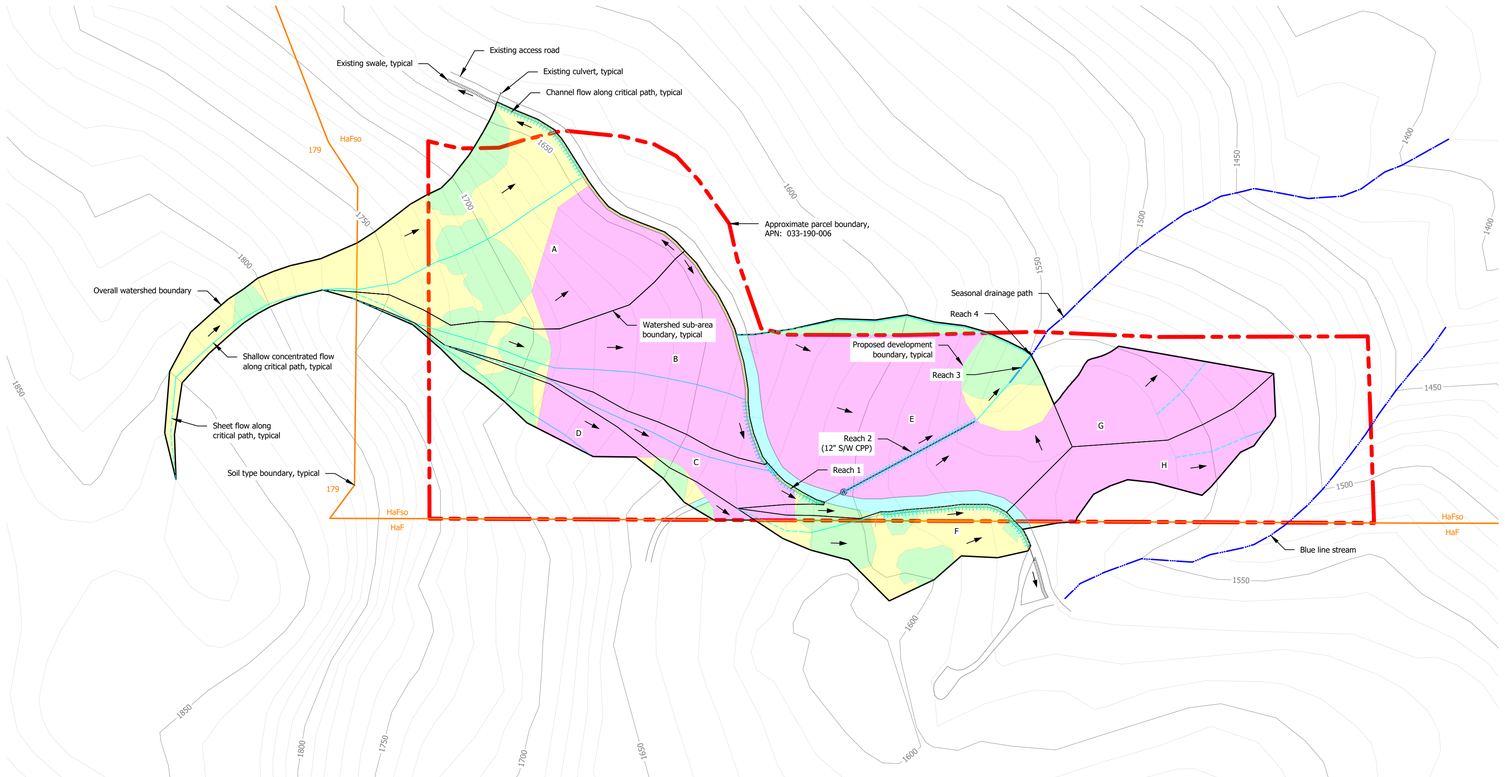
Summary Table Of Post-Development Hydrologic Characteristics For Lands of Butler

Watershed	Land Use	Hydrologic Condition	Hydrologic Soil Group	Acres	Curve Number
A	Pasture, grassland or range	Good	D*	1.74	80
	Woods - grass combination	Good	D*	0.47	79
	Total			**2.21**	**80**
B	Pasture, grassland or range	Good	D	1.17	80
	Woods - grass combination	Good	D	0.14	79
	Total			**1.31**	**80**
C	Pasture, grassland or range	Good	D	0.35	80
	Woods - grass combination	Good	D	0.03	79
	Total			**0.38**	**80**
D	Pasture, grassland or range	Good	D	0.28	80
	Woods - grass combination	Good	D	0.14	79
	Total			**0.42**	**80**
E	Gravel (w/ right-of-way)		D	0.21	91
	Pasture, grassland or range	Fair	D	0.13	84
	Pasture, grassland or range	Good	D	1.72	80
	Woods - grass combination	Fair	D	0.31	82
	Total			**2.37**	**81**
F	Pasture, grassland or range	Fair	D	0.37	84
	Pasture, grassland or range	Good	D	0.02	80
	Woods - grass combination	Fair	D	0.23	82
	Total			**0.62**	**83**
G	Pasture, grassland or range	Good	D	0.63	80
	Total			**0.63**	**80**
H	Gravel (w/ right-of-way)		D	0.01	91
	Pasture, grassland or range	Fair	D	0.01	84
	Pasture, grassland or range	Good	D	0.58	80
	Total			**0.60**	**80**

* The majority of the overall watershed rests on Hambright Loam. Hambright Loam is classified as Hydrologic Soil Group D. A small portion of sub-watershed A extends into the Sobrante Loam. Sobrante Loam is classified as Hydrologic Soil Group C. In an effort to simplify the analysis hydrologic soil group D was used for the overall watershed, including the small portion that extends into the Sobrante Loam. This assumption is justified because the area in question is outside of the proposed development boundary and will remain unchanged between pre/post development conditions.



Watershed Aerial Map
Scale: 1" = 200'



0' 100' 200'

Notes:
1. Topographic information provided by Napa County GIS database from 2002.
2. Datum: North American Vertical Datum of 1988 (NAVD 88).
3. Aerial image is from 2018 and was provided by Napa County.

Soil Types on Site:
179 - Sobrante loam, Hydrologic Soil Group C
HaFso, HaF - Hambright loam, Hydrologic Soil Group D

Post-Development Site Plan
Scale: 1" = 100'

OR — CHECKED BY
OR — DRAWN BY
OR — DESIGNED BY
NOTES/ REMARKS:

REGISTERED PROFESSIONAL ENGINEER — CHAD REJCES — No. C 74723 — EXPIRES 12/21 — CIVIL — STATE OF CALIFORNIA

ACME Engineering
www.acmeng.com
1700 Soscol Avenue
Ste. 9, Napa, CA 94559
707-253-ACME

LANDS OF BUTLER

NEW VINEYARD DEVELOPMENT

POST-DEVELOPMENT SITE PLAN AND CURVE NUMBERS

PROJECT NO.	DRAWING NO.	SCALE	DATE
180901-0121	01 02	AS SHOWN	11/5/2020

SHEET 2 OF 2

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