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Preliminary Hydrology Report

Proposed 7-Lot Residential Subdivision
APN: 508-091-039
McKinleyville, California 95519

Prepared for:
Stephanie & David Ruffino
308 St. Michael Court #B
Chico, CA 95973

Prepared by:
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12/20/2022

REV 1 ~ 7.10.23

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Acronyms and Abbreviations

APN	Assessor's Parcel Number
INC	Incorporated
NOAA	National Oceanic and Atmospheric Administration
WDR	Waste Discharge Requirement
cfs	Cubic Feet Per Second
ft	feet
ft^3	Cubic feet
T_C	Time of Concentration
SF	square feet

1. Existing Site Conditions

The project site consists of a single parcel located on Anderson Ave in McKinleyville, California (APN: 508-091-039). The existing parcel is proposed to be subdivided into 6 parcels. The existing site is a relatively flat, 4.1-acre lot. The western property line is located along the centerline of Anderson Avenue. There is approximately 705 ft^2 of asphalt paving on the project parcel. The remainder of the ground cover is grazed pasture and some small patches of brambles. There are no existing structures located on the project parcel (See Appendix A: Existing Site Conditions).

The existing project site generally slopes to the north east corner of the lot at slopes of approximately 2%-10%. There are no drainage structures located on the project parcel and all runoff occurs as sheet flow. Runoff leaves the site at the northeast corner of the parcel and enters an existing drainage swale located between the project parcel and Highway 101, within Caltrans Right-of-Way. This report will, therefore, consider the northeast property corner the point of stormwater discharge into the Caltrans Highway 101 Right-of-Way.

2. Proposed Site Conditions

The proposed (<P>) project consists of the subdivision of the existing parcel into 6 parcels with the same Single-Family Residential zoning. The proposed subdivision includes the construction of a 20 ft-wide asphalt paved access road, a 5 ft-wide concrete sidewalk, as well as the future residential development of each of the 6 parcels (See Appendix B: Conceptual Site Plan). For the purposes of this report, it is assumed that each parcel will result be developed to include a single 2,000 ft^2 single family home as well as 5,000 ft^2 of associated concrete and asphalt paving. The existing and proposed ground cover types and their respective areas are shown in Table 1.

Table 1: Existing and Proposed ground cover areas due to Proposed Subdivision

	Total Area (ft^2)		Total Area (acres)	
Ground Cover Type	**Pre-Construction**	**Post-Construction**	**Pre-Construction**	**Post-Construction**
Grass/Pasture	177,201	116,058	4.07	2.66
Asphalt Paving	705	16,175	0.02	0.37
Concrete Paving	0	3,675	0	0.08
Structures	0	12,000	0	0.28
Driveways	0	30,000	0	0.69
Total	**177,906**	**177,906**	**4.1**	**4.1**

The proposed development will include the installation of curb, gutter, and conveyance swale along the new access road, which will collect and convey runoff from the proposed access road as well as the

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individual lots. This curb and gutter will convey runoff into a vegetated swale that will then discharge into a new detention pond located near the Northeastern property corner. This detention pond will be sized such that any increase in runoff is contained and site runoff is maintained at the pre-development 100-year storm conditions. Upon reaching storage capacity, additional runoff will overflow from this pond into the existing Caltrans drainage swale that flows north along the US 101 via a storm drain sized to accommodate a 100-year storm.

3. Runoff Calculations

Time of concentration of a given site is calculated using the Kerby Method, as follows:

$$T_c = 0.828(r * L/S^{0.5})^{0.467} \tag{1}$$

Where

T_c = time of concentration (min)

r = roughness coefficient (dimensionless)

L = flow length (ft)

S = slope (ft/ft)

Runoff flow rate is calculated using the Rational Method. The Rational method is as follows.

$$Q = C * i * A \tag{2}$$

Where

Q = flow rate of runoff (cfs)

C = Rational Method Runoff coefficient (dimensionless)

i = rainfall intensity (in/hr)

A = site area (acre)

Runoff coefficients represent the percentage of precipitation that will runoff of a given ground cover type. The runoff coefficients are found in Appendix C.

Using the project site drainage areas, in combinations with the weighted runoff coefficients generated using the coefficients from the California State Water Resources Control Board (SWRCB), Equation 3 is used to calculate the flowrate of runoff resulting from the design storms.

$$Q_{pre/post} = C_{1,pre/post} * i * \mathrm{A}_{1,pre/post} \ldots + C_{n,pre/post} * i * \mathrm{A}_{n,pre/post} \quad (3)$$

Where:

$Q_{pre/post}$ = runoff flowrate pre/post construction (cfs)

$C_{n,pre/post}$ = runoff coefficient for the n^{th} surface type pre/post construction

i = rainfall intensity (in/hr)

$A_{n,pre/post}$ = area of the n^{th} surface type pre/post construction (acres)

The volume is then calculated for the post development conditions based on the impervious area and a higher runoff coefficient for the developed site using Equation 4.

$$V_{pre/post} = Q_{\,pre/post} * t \quad (4)$$

where:

$V_{pre/post}$ = runoff volume pre/post-construction (ft^3)

t = duration of storm (seconds)

Alternatively, volumetric runoff can be calculated using project site drainage areas, weighted runoff coefficients, and design storm rainfall depth, as shown in Equation 5.

$$V_{pre/post} = \; A_{1,pre/post} * C_{1,\frac{pre}{post}} * d \ldots + A_{i,\frac{pre}{post}} * C_{i,pre/post} * d \quad (5)$$

where:

$A_{pre/post}$ = area of the n^{th} surface type pre/post construction (ft^2)

$C_{n,pre/post}$ = runoff coefficient for the n^{th} surface type pre/post construction

d = rainfall depth (in)

The increase in volume of runoff is calculated as follows in Equation 6.

$$V_{increase} = V_{post} - V_{pre} \quad (6)$$

4.1 Manning's Equation

Manning's equation is used to determine the maximum flow rate possible through an open channel or pipe given a velocity of flow and a cross sectional area.

$$Q = VA = \left(\frac{1.49}{n}\right) A R_h^{\frac{2}{3}} \sqrt{S} \quad (7)$$

Where

Q = Flow Rate (CFS)

v = Velocity (ft/s)

A = Flow Area (ft^2)

n = Manning's Roughness Coefficient

R_h = Hydraulic Radius (ft)

S = Channel Slope (ft/ft)

This equation requires several other equations to calculate the flow rate through a trapezoidal open channel or circular pipe, including a specific equation for hydraulic radius and flow area. These equations are automatically calculated within FlowMaster. Information on the storm drain size and normal depth levels can found in Appendix E: Conveyance Structure Calculations.

4. Runoff Analysis

Runoff analysis for this project was conducted per Humboldt County requirements. This plan requires that Post-Construction runoff volumes not exceed Pre-Construction conditions for a 100-year storm. A detention pond will be sized based on the increase in runoff due to development. Additionally, the storm drain acting as an overflow from the pond will be sized to convey a 25-Year storm.

4.1 Pre- and Post-Development Runoff Volume

The pre- and post- development site conditions were investigated and values for times of concentration (T_c) were determined using Equation 1 (See Table 3). The pre-development rainfall intensity was then interpolated from NOAA rainfall intensity values for the site (See Table 4). Equations 2 through Equations 5 were used to calculate runoff volumes for both Pre- and Post-development conditions using these interpolated rainfall intensities, ground cover types, areas, and runoff coefficients. These values are shown in Table 5.

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Table 2: Time of Concentration for Pre- and Post-Development Site Conditions

Site Condition	Time of Concentration (min)
Pre-Development	26
Post-Development	20

*Table 3: Rainfall Intensity based on and interpolated from NOAA Data. *Denotes interpolated value.*

Rainfall Intensity (in/hr)	
25-Year, 15-Minute Storm	2.19
25-Year, 20- Minute Storm*	1.95
25-Year, 26-Minute Storm*	1.66
25-Year, 30-Minute Storm	1.47
100-Year, 15-Minute Storm	2.92
100-Year, 20-Minute Storm*	2.60
100-Year, 26-Minute Storm*	2.22
100-Year, 30-Minute Storm	1.96

See Appendix D: NOAA Rainfall data for values listed in Table 3.

Table 4: Pre/Post Construction Runoff Flowrates for 25-year and 100-year design storms.

	25-Year Runoff (cfs)		100-Year Runoff (cfs)	
	Pre-Dev	**Post-Dev**	**Pre-Dev**	**Post-Dev**
Grass/Pasture	1.35	1.04	1.80	1.28
Asphalt Paving	0.02	0.65	0.03	0.94
Concrete Paving	0	0.15	0	0.22
Structures	0	0.48	0	0.75
Driveways	0	1.21	0	1.88
TOTAL	**1.38**	**3.53**	**1.84**	**5.07**

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Table 5: Pre/Post Construction Runoff Volumes

	100-Year Runoff Volume (ft^3)	
	Pre-Dev	**Post-Dev**
Grass/Pasture	2,813	1,663
Asphalt Paving	50	1,043
Concrete Paving	-	237
Structures	-	774
Driveways	-	1,934
TOTAL	2,863	5,650
Storage Required	**-**	**2,787**

Runoff from the eastern portion of the development will be directed to a retention pond with a footprint of approximately 2,200 ft^2. This pond will be 3.0 feet deep with an overflow located 2.5 feet from the bottom. This will provide a storage depth of 2.5 feet and a corresponding storage volume of 3,000 ft^3 or 22,440 gallons.

4.2 Swale Capacity Check

Runoff from the site will enter the proposed roadway and will then be routed into a swale. This swale will convey the runoff to a detention pond. This swale will need to be of adequate size to convey the design flows without causing flooding. Per Section 4.1, the swale will need to convey both a Post Construction 25-year and 100-year design storm flows.

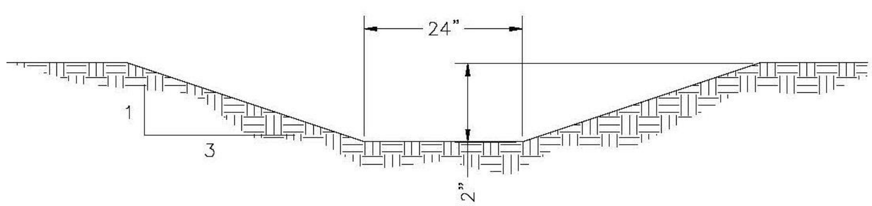

Figure 1: Proposed Conveyance Swale cross-section.

Table 6: Post Construction Runoff normal flow depths of design flows in proposed conveyance swale.

Storm Event	Total Flow Rate (cfs)	Swale Slope (%)	Normal Flow Depth (in)
25-Year, 20 Minute	3.80	1.0	7.10
100-Year, 20-Minute	5.07	1.0	8.60

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As seen in Table 6, the design swale is capable of conveying the design flows without flooding or failure. These values were computed using FlowMaster Software (See Appendix E: Conveyance Sizing Reports)

4.3 Detention Capacity Check

Per the analysis presented in Section 4.1, the proposed project will require that approximately 2,750 ft^3 of runoff be detained. This will be accomplished through the use of a detention pond. Runoff from the proposed development will be routed via the swale described in Section 4.2, which ultimately discharges the collected runoff into a swale/pond. This swale will be designed such that it will act as a detention pond and be equipped with a drain inlet that acts as an overflow. Once runoff generated by the site exceeds the volume of the storage pond, additional runoff will be discharged from the pond via overflow into the existing Caltrans drainage swale located adjacent to the eastern extents of the project. A cross section of this proposed swale/ detention pond is shown in Figure 1. This design provides approximately 25 ft^3 of storage volume per linear foot. Based on the design analysis in Section 4.1, this would require a detention pond approximately 18'-wide and 160'-long. This design would provide approximately 3,810 ft^3 of storage volume.

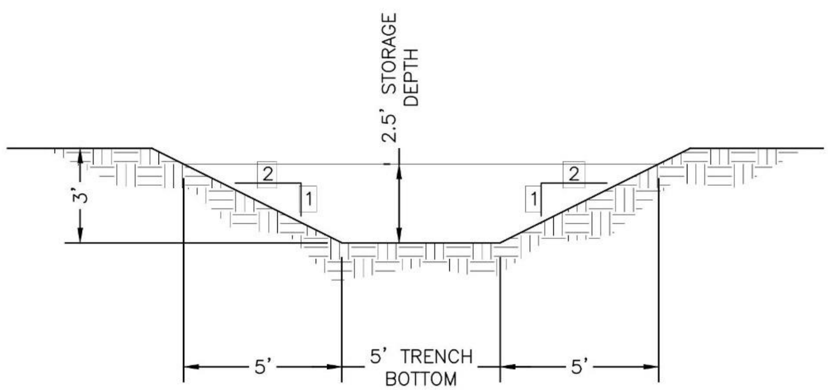

Figure 2: Proposed Drainage Swale/Detention Pond cross-section.

4.4 Storm Drain Pipe Sizing

The proposed detention pond detailed in Section 4.2 of this report is designed such that a drain inlet will be installed to act as an overflow for storm events where runoff exceeds the design storage capacity. This drain inlet will be constructed such that the top of grate elevation is approximately 2.5' above the pond bottom, which provides a storage depth of 2.5'. Runoff entering the drain inlet will be routed to the existing Caltrans drainage swale to the east of the project through storm drain sized to accommodate.

Per the analysis in Section 4.1, the above-mentioned pipe shall be sized to convey a post-development 25-year storm event, as well as convey a 100-year storm event without failure (Table 7). These values were computed using FlowMaster Software (See Appendix E: Conveyance Sizing Reports)

Table 7: Pipe sizing based on Post Development 25-Year and 100-Year storm events

Storm Event	Pipe Diameter (in)	Total Flow Rate (cfs)	Pipe Slope (%)	Normal Flow Depth (in)	Percentage Full (%)
25-Year, 20 Minute	18	3.80	1.0	7.20	39.9
100-Year, 20-Minute	18	5.07	1.0	8.40	46.9

As seen in Table 7, an 18” diameter storm drain is capable of conveying the on-site design storm runoff flows. This pipe is also shown to convey a 100-Year storm without failure.

5. Conclusion

In conclusion:

- The project consists of the subdivision of a single parcel into 6 parcels with associated access road, accessible sidewalk, and associated utilities. Future residential structures and associated driveways are assumed.
- This project will result in the construction of approximately 19,145 ft^2 of impervious surfaces for the access road and sidewalk. The future residential structures and associated driveways are estimated to result in an increase of approximately 42,000 ft^2 of impervious surface.
- The Pre-Construction, 100-Year storm event results in an estimated runoff flowrate of 1.38 cfs and a runoff volume of 2,863 ft^3.
- The Post-Construction, 100-Year storm event will result in an estimated runoff flowrate of 4.71 cfs and a runoff volume of 5,650 ft^3.
- This project will result in an increase in runoff of 2,787 ft based on this 100-Year event of
- A conveyance swale will be installed that is adequately sized to convey this 100-year storm event to the detention pond without failure.
- Runoff will be routed to a detention basin sized to retain 3,000 ft^3 of stormwater.
- This detention basin will be equipped with a drain inlet acting as an overflow from the pond. This inlet will route any runoff exceeding the design storage capacity to an existing drainage swale located within the Caltrans Right-of-Way through an 18” HDPE storm drain.

Engineer of Record Signature

8/31/2023
Date

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Appendix A: Existing Site Conditions

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EXISTING CONDITIONS SITE PLAN

SCALE: 1"=50'

PROJECT DESCRIPTION

THE PURPOSE OF THE TENTATIVE IMPROVEMENTS SHOWN IN THIS MAP IS TO SUBDIVIDE THE TRACT OF LAND OWNED BY DAVID AND STEPHANIE RUFFINO AS APN 508-091-039 AND SHOWN HERIN, INTO 7 PARCELS OF VARIED SIZE FOR RESIDENTIAL USE WITH AN ACCESS EASEMENT FROM ANDERSON AVENUE TO THE REAR MOST PROPOSED PARCEL, IMPROVE AND DEDICATE LAND TO THE COUNTY AS DEEMED NECESSARY SUBJECT TO PUBLIC REVIEW AND TO FURNISH AND RECORD A FINAL MAP AS AN INSTRUMENT FOR FUTURE CONVEYANCE THROUGH SALE OF THE ABOVE MENTIONED IMPROVEMENTS AND LOTS.

TOPOGRAPHIC SURVEY NOTES

1. THIS IS NOT A BOUNDARY SURVEY. NO LIABILITY IS ASSUMED BY WHITCHURCH ENGINEERING, INC. FOR THE EXISTENCE OF ANY ENCUMBRANCES AND DISCREPANCIES IN BOUNDARY OR TITLE DEFECTS.

2. PHYSICAL ITEMS SHOWN ON THIS TOPOGRAPHIC SURVEY ARE LIMITED TO THOSE ITEMS VISIBLE BY SURFACE INSPECTION AS OF THE DATE OF THIS SURVEY. SUBSURFACE STRUCTURES, IF ANY, ARE NOT SHOWN.

3. THE TYPES, LOCATIONS, SIZES AND/OR DEPTHS OF EXISTING UNDERGROUND UTILITIES AS SHOWN ON THIS TOPOGRAPHIC SURVEY WERE OBTAINED FROM SURFACE FEATURES AND SOURCES OF VARYING RELIABILITY. ONLY ACTUAL EXCAVATION WILL REVEAL THE TYPES, EXTENT, SIZES, LOCATIONS AND DEPTHS OF SUCH UNDERGROUND UTILITIES. WHITCHURCH ENGINEERING, INC. ASSUMES NO RESPONSIBILITY FOR THE COMPLETENESS OR ACCURACY OF THE DELINEATION OF SUCH UNDERGROUND UTILITIES WHICH MAY BE ENCOUNTERED.

4. BENCHMARK: VERTICAL DATUM IS ASSUMED.

5. FIELD SURVEY COMPLETED ON 12/21/2021.

ABREVIATIONS

(E)	EXISTING
(P)	PROPOSED
APN	ASSESSORS PARCEL NUMBER

LEGEND

- EXISTING SANITARY SEWER MANHOLE
- EXISTING UTILITY POLE
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE
- SUBJECT PARCEL BOUNDARY LINE
- NEIGHBORING PARCEL BOUNDARY LINE
- CENTERLINE OF ROADWAY
- EASEMENT LINE
- W — EXISTING UNDERGROUND WATER LINE
- SS — EXISTING UNDERGROUND SANITARY SEWER LINE
- GAS — EXISTING UNDERGROUND GAS LINE
- OH — EXISTING OVERHEAD UTILITY LINE
- X — EXISTING FENCE LINE
- 100 — EXISTING MAJOR CONTOUR AT 5' INTERVALS
- 101 — EXISTING MINOR CONTOUR AT 1' INTERVALS
- EXISTING ASPHALT

THESE PLANS ARE ORIGINALLY PRINTED ON 22"x34" PAPER.

1 INCH

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PROPOSED RESIDENTIAL RUFFINO SUBDIVISION
ANDERSON AVENUE, McKINLEYVILLE, CA 95519 APN: 508-091-039

EXISTING SITE CONDITIONS

For: Stephanie & David Ruffino, 308B St. Michael Ct, Chico, CA 95973

Date	
Scale	AS NOTED
Design	
Drawn	
Job	RUF2101.1
Sheet	

Appendix B: Conceptual Site Plan

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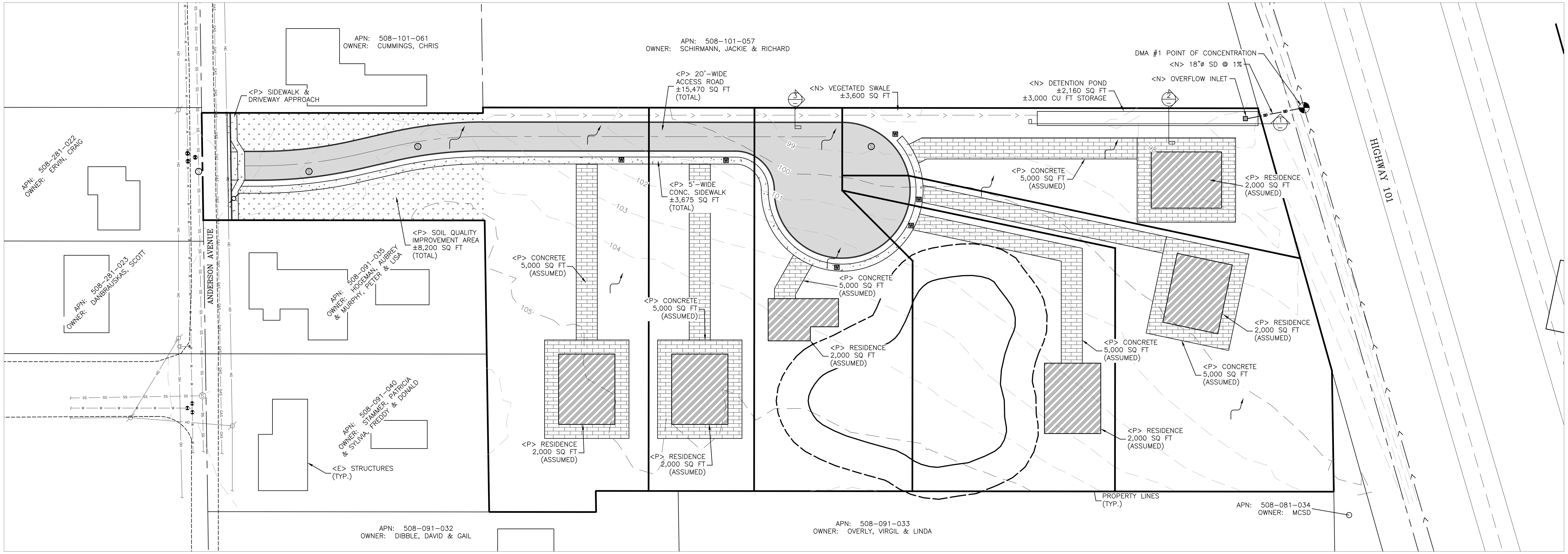


CONCEPTUAL LOW IMPACT DEVELOPMENT PLAN

SCALE: 1"=50'

0 50 50

NORTH

LID NOTES

LOW IMPACT DEVELOPMENT DESIGNS/BEST MANAGEMENT PRACTICES MEET THE REQUIREMENTS SET FORTH IN THE STATE WATER RESOURCE CONTROL BOARD MS4 POST-CONSTRUCTION MEASURES AND HUMBOLDT COUNTY REQUIREMENTS.

TOTAL PROJECT AREA:	±177,906 (4.1 AC)
<E> ASPHALT PAVING AREA:	±705 SQ FT
<E> CONCRETE PAVING AREA:	±0 SQ FT
<E> STRUCTURE AREA:	±0 SQ FT
TOTAL <E> IMPERVIOUS AREA:	±705 SQ FT
<N> AC PAVING AREA:	±15,470 SQ FT
<N> CONCRETE PAVING AREA:	±33,675 SQ FT
<N> STRUCTURE AREA:	±12,000 SQ FT
TOTAL <N> IMPERVIOUS AREA:	±61,145 SQ FT

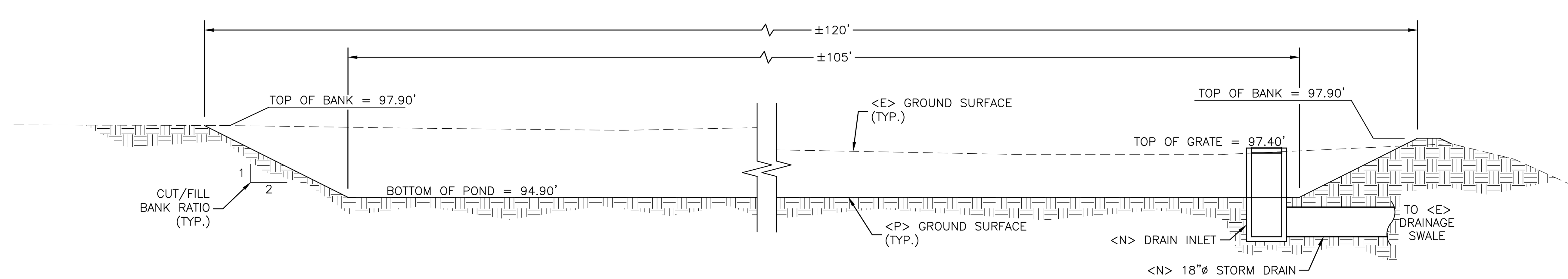
DRAINAGE MANAGEMENT AREA 1

TOTAL AREA:	177,906 SQ FT
TOTAL IMPERVIOUS AREA:	61,850 SQ FT
RETENTION POND/CISTERN VOLUME:	3,000 CU FT
RETENTION POND/CISTERN VOLUME:	22,440 GAL.
RETENTION POND/CISTERN CREDIT:	55,651 SQ FT
VEGETATED SWALE AREA:	3,600 SQ FT
VEGETATED SWALE CREDIT:	3,600 SQ FT
SOIL QUALITY IMPROVEMENT AREA:	8,200 SQ FT
SOILS QUALITY IMPROVEMENT CREDIT:	8,200 SQ FT
TOTAL BMP CREDIT:	82,569 SQ FT
RUNOFF REDUCTION:	109.1%

INCLUDES A 2.5 FT DEEP, 2,160 SQ FT STORAGE POND.

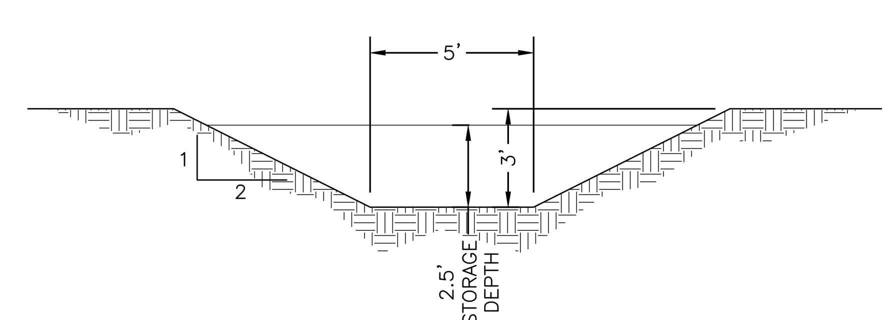
RUNOFF VALUES HAVE BEEN CALCULATED USING HUMBOLDT COUNTRY LID WORKSHEET FOR REGULATED PROJECTS.

SEE STORM WATER CONTROL PLAN, DATED 12.20.22.



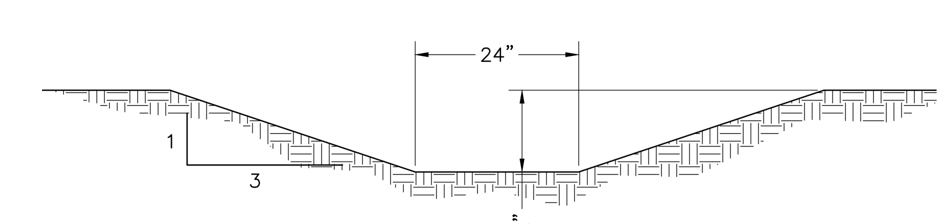
1 <P> DETENTION POND SECTION

NO SCALE



2 TYPICAL POND SECTION

NO SCALE



3 TYPICAL SWALE SECTION

NO SCALE

ABREVIATIONS

(E)	EXISTING
(P)	PROPOSED
APN	ASSESSORS PARCEL NUMBER

LID PLAN LEGEND

- PROJECT SITE/DMA CONTROL POINT
- <P> PHASE 1 AC PAVING
- <P> PHASE 1 CONCRETE PAVING
- <P> PHASE 2 CONCRETE PAVING (ASSUMED)
- <P> PHASE 2 STRUCTURES (ASSUMED)
- <P> SOIL QUALITY IMPROVEMENT AREA

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Phone (707) 725-6926

PROPOSED RUFFINO RESIDENTIAL SUBDIVISION
ANDERSON AVENUE, McKINLEYVILLE, CA 95519 APN: 508-091-039

CONCEPTUAL SITE PLAN

For: Stephanie & David Ruffino, 3088 St. Michael Ct, Chico, CA 95973

Date	
Scale	AS NOTED
Design	
Drawn	
Job	RUF2101.1
Sheet	

Appendix C: Drainage Calculation Tables of Coefficients

Table C1: Runoff Rational Method coefficients for surface conditions on site post-construction.

Surface Type	Runoff Coefficient
Unimproved/Grass Areas	0.2
Concrete	0.90
Asphalt	0.9
Roof	0.90

Table C2: Manning's Pipe Roughness Coefficients for proposed post-development Ground Coverage

Surface Type	Manning's Roughness coefficient (n)
Clean Vegetated Swale	0.030
HDPE PIPE	0.013

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Appendix D: NOAA Rainfall Data

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NOAA Atlas 14, Volume 6, Version 2
Location name: McKinleyville, California, USA*
Latitude: 40.9306°, Longitude: -124.1154°
Elevation: 63.41 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**1.58** (1.39-1.84)	**1.99** (1.75-2.30)	**2.57** (2.24-2.98)	**3.07** (2.65-3.59)	**3.79** (3.16-4.61)	**4.39** (3.56-5.47)	**5.04** (3.98-6.46)	**5.76** (4.40-7.61)	**6.79** (4.96-9.42)	**7.67** (5.38-11.1)
10-min	**1.14** (0.996-1.31)	**1.43** (1.25-1.65)	**1.84** (1.61-2.13)	**2.20** (1.90-2.57)	**2.72** (2.26-3.31)	**3.15** (2.56-3.92)	**3.62** (2.85-4.63)	**4.13** (3.15-5.45)	**4.87** (3.55-6.76)	**5.50** (3.85-7.92)
15-min	**0.916** (0.804-1.06)	**1.15** (1.01-1.33)	**1.48** (1.30-1.72)	**1.77** (1.53-2.07)	**2.19** (1.82-2.66)	**2.54** (2.06-3.16)	**2.92** (2.30-3.73)	**3.33** (2.54-4.40)	**3.93** (2.86-5.44)	**4.43** (3.10-6.38)
30-min	**0.618** (0.540-0.712)	**0.776** (0.678-0.896)	**0.998** (0.870-1.16)	**1.19** (1.03-1.39)	**1.47** (1.23-1.79)	**1.71** (1.39-2.13)	**1.96** (1.55-2.51)	**2.24** (1.71-2.96)	**2.64** (1.93-3.66)	**2.98** (2.09-4.29)
60-min	**0.433** (0.379-0.499)	**0.544** (0.476-0.628)	**0.700** (0.611-0.811)	**0.836** (0.722-0.977)	**1.03** (0.859-1.26)	**1.20** (0.972-1.49)	**1.38** (1.09-1.76)	**1.57** (1.20-2.07)	**1.85** (1.35-2.57)	**2.09** (1.46-3.01)
2-hr	**0.334** (0.292-0.385)	**0.410** (0.360-0.474)	**0.518** (0.452-0.600)	**0.612** (0.528-0.715)	**0.747** (0.621-0.908)	**0.858** (0.696-1.07)	**0.978** (0.772-1.25)	**1.11** (0.847-1.47)	**1.30** (0.946-1.80)	**1.46** (1.02-2.10)
3-hr	**0.287** (0.252-0.331)	**0.350** (0.306-0.404)	**0.438** (0.382-0.507)	**0.513** (0.444-0.600)	**0.623** (0.518-0.757)	**0.712** (0.578-0.887)	**0.808** (0.638-1.03)	**0.912** (0.697-1.21)	**1.06** (0.774-1.47)	**1.19** (0.832-1.71)
6-hr	**0.219** (0.192-0.253)	**0.265** (0.232-0.305)	**0.327** (0.285-0.379)	**0.380** (0.329-0.445)	**0.457** (0.380-0.555)	**0.518** (0.420-0.645)	**0.583** (0.460-0.747)	**0.653** (0.499-0.864)	**0.754** (0.549-1.05)	**0.835** (0.585-1.20)
12-hr	**0.161** (0.141-0.186)	**0.194** (0.170-0.224)	**0.239** (0.209-0.277)	**0.277** (0.239-0.324)	**0.330** (0.274-0.401)	**0.372** (0.302-0.463)	**0.416** (0.328-0.533)	**0.463** (0.353-0.612)	**0.528** (0.385-0.732)	**0.580** (0.407-0.837)
24-hr	**0.117** (0.104-0.133)	**0.141** (0.126-0.161)	**0.174** (0.155-0.200)	**0.202** (0.178-0.232)	**0.239** (0.205-0.284)	**0.268** (0.226-0.325)	**0.298** (0.246-0.369)	**0.330** (0.265-0.419)	**0.373** (0.289-0.492)	**0.408** (0.306-0.555)
2-day	**0.078** (0.070-0.089)	**0.095** (0.085-0.109)	**0.118** (0.105-0.135)	**0.136** (0.120-0.157)	**0.161** (0.138-0.191)	**0.180** (0.151-0.217)	**0.199** (0.164-0.246)	**0.219** (0.176-0.278)	**0.246** (0.190-0.324)	**0.267** (0.200-0.363)
3-day	**0.061** (0.054-0.069)	**0.074** (0.066-0.085)	**0.092** (0.082-0.105)	**0.106** (0.094-0.122)	**0.125** (0.108-0.149)	**0.140** (0.118-0.170)	**0.155** (0.128-0.192)	**0.170** (0.137-0.216)	**0.191** (0.147-0.251)	**0.206** (0.155-0.281)
4-day	**0.051** (0.046-0.058)	**0.063** (0.056-0.071)	**0.078** (0.069-0.089)	**0.090** (0.079-0.103)	**0.106** (0.091-0.126)	**0.118** (0.099-0.143)	**0.130** (0.107-0.161)	**0.143** (0.115-0.181)	**0.160** (0.124-0.211)	**0.173** (0.129-0.235)
7-day	**0.037** (0.033-0.042)	**0.045** (0.041-0.052)	**0.056** (0.050-0.065)	**0.065** (0.058-0.075)	**0.077** (0.066-0.091)	**0.086** (0.072-0.104)	**0.094** (0.078-0.117)	**0.103** (0.083-0.131)	**0.115** (0.089-0.152)	**0.124** (0.093-0.169)
10-day	**0.030** (0.027-0.034)	**0.037** (0.033-0.042)	**0.046** (0.041-0.053)	**0.053** (0.047-0.061)	**0.063** (0.054-0.075)	**0.070** (0.059-0.084)	**0.077** (0.063-0.095)	**0.084** (0.067-0.106)	**0.093** (0.072-0.122)	**0.100** (0.075-0.136)
20-day	**0.020** (0.018-0.023)	**0.025** (0.023-0.029)	**0.031** (0.028-0.036)	**0.036** (0.032-0.042)	**0.042** (0.036-0.050)	**0.047** (0.039-0.057)	**0.051** (0.042-0.063)	**0.055** (0.045-0.070)	**0.061** (0.047-0.081)	**0.065** (0.049-0.089)
30-day	**0.017** (0.015-0.019)	**0.021** (0.019-0.024)	**0.026** (0.023-0.030)	**0.030** (0.026-0.034)	**0.035** (0.030-0.041)	**0.038** (0.032-0.046)	**0.041** (0.034-0.051)	**0.045** (0.036-0.057)	**0.049** (0.038-0.065)	**0.052** (0.039-0.071)
45-day	**0.015** (0.013-0.017)	**0.018** (0.016-0.021)	**0.022** (0.020-0.025)	**0.025** (0.022-0.029)	**0.029** (0.025-0.035)	**0.032** (0.027-0.039)	**0.035** (0.029-0.043)	**0.037** (0.030-0.047)	**0.040** (0.031-0.053)	**0.043** (0.032-0.058)
60-day	**0.013** (0.012-0.015)	**0.016** (0.014-0.018)	**0.019** (0.017-0.022)	**0.022** (0.020-0.026)	**0.025** (0.022-0.030)	**0.028** (0.023-0.034)	**0.030** (0.025-0.037)	**0.032** (0.026-0.041)	**0.035** (0.027-0.046)	**0.037** (0.027-0.050)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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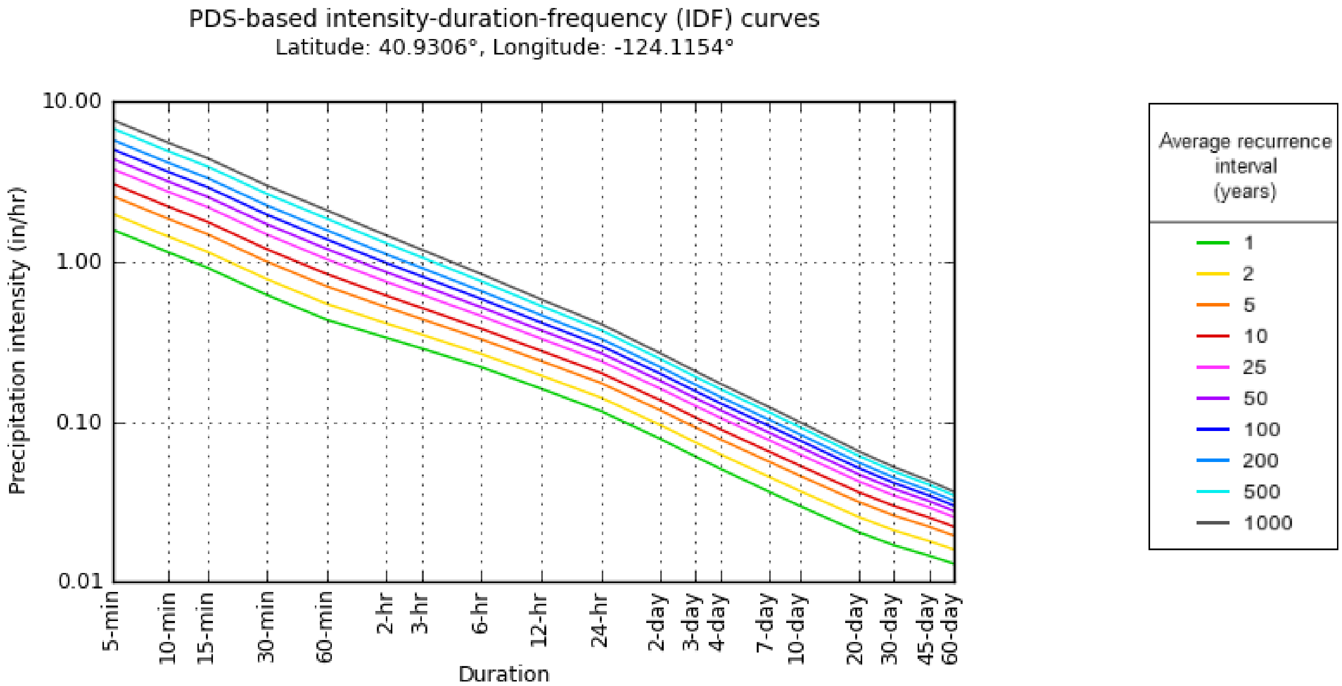
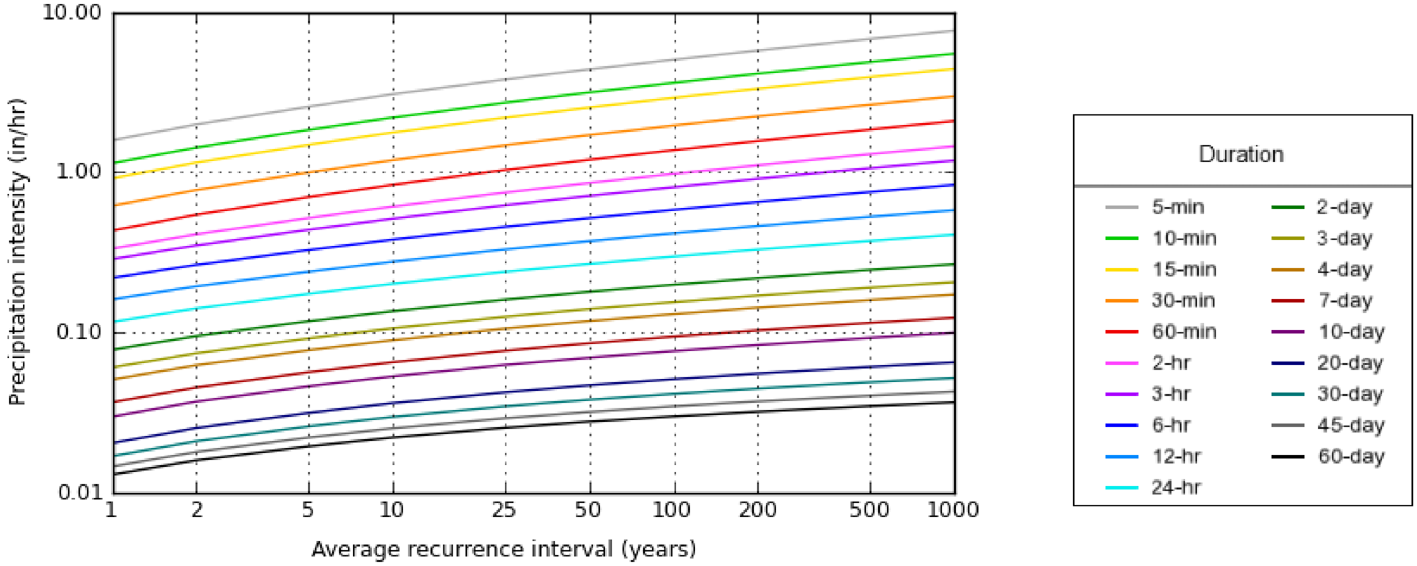
PF graphical





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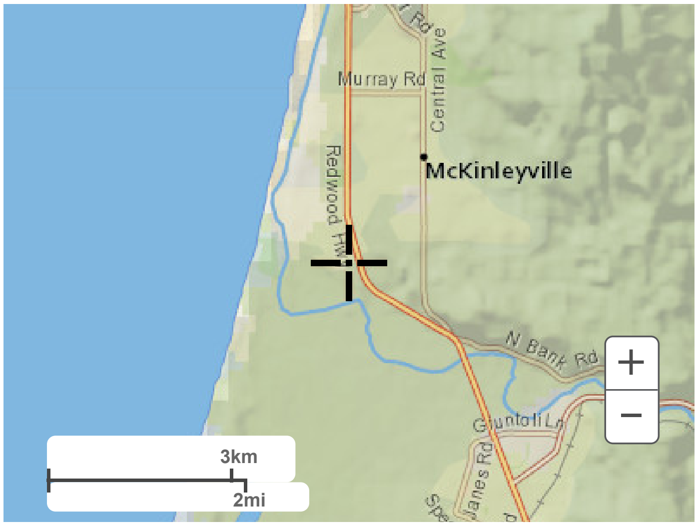
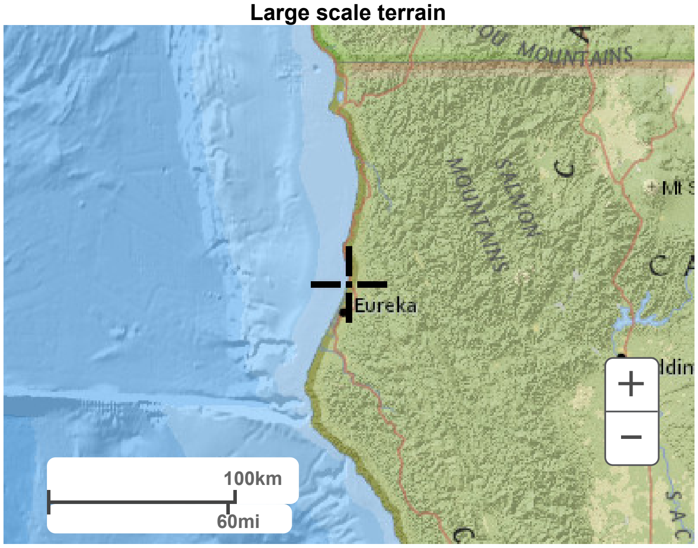
Maps & aerials

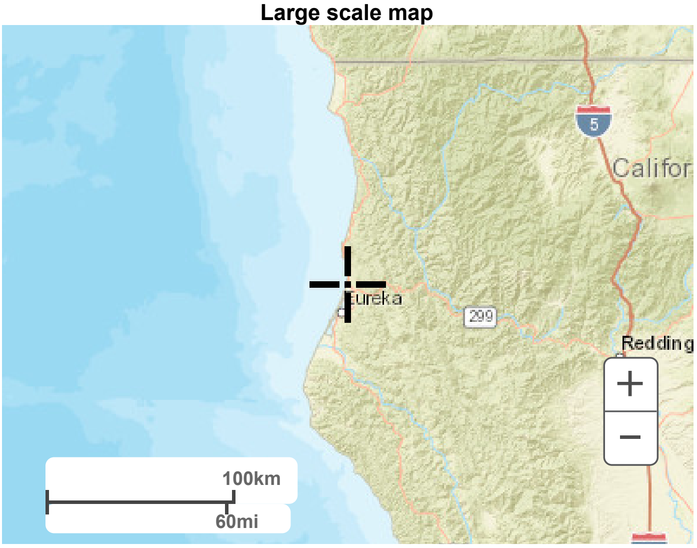
Small scale terrain



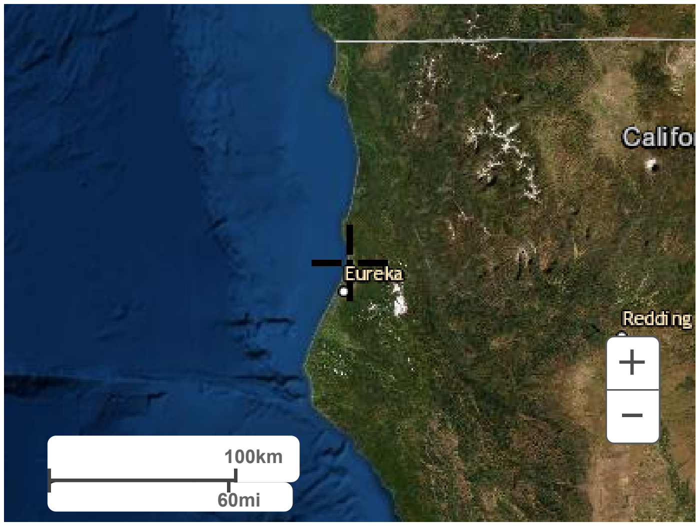
Large scale terrain



Large scale map



Large scale aerial



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

Appendix E: Conveyance Sizing Reports

www.whitchurchengineering.com
610 9th St. Fortuna, CA 95540
Phone: (707) 725-6926

RUF 25-Year, 20-Min Channel Flow Depth

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.030
Channel Slope	0.010 ft/ft
Left Side Slope	0.330 H:V
Right Side Slope	0.330 H:V
Bottom Width	2.00 ft
Discharge	3.53 cfs

Results	
Normal Depth	7.1 in
Flow Area	1.3 ft^2
Wetted Perimeter	3.3 ft
Hydraulic Radius	4.8 in
Top Width	2.39 ft
Critical Depth	5.4 in
Critical Slope	0.024 ft/ft
Velocity	2.70 ft/s
Velocity Head	0.11 ft
Specific Energy	0.71 ft
Froude Number	0.643
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	7.1 in
Critical Depth	5.4 in
Channel Slope	0.010 ft/ft
Critical Slope	0.024 ft/ft

RUF 100-Year, 20-Min Channel Flow Depth

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.030
Channel Slope	0.010 ft/ft
Left Side Slope	0.330 H:V
Right Side Slope	0.330 H:V
Bottom Width	2.00 ft
Discharge	4.71 cfs

Results	
Normal Depth	8.6 in
Flow Area	1.6 ft²
Wetted Perimeter	3.5 ft
Hydraulic Radius	5.5 in
Top Width	2.47 ft
Critical Depth	6.5 in
Critical Slope	0.024 ft/ft
Velocity	2.94 ft/s
Velocity Head	0.13 ft
Specific Energy	0.85 ft
Froude Number	0.644
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	8.6 in
Critical Depth	6.5 in
Channel Slope	0.010 ft/ft
Critical Slope	0.024 ft/ft

RUF 25-Year, 20-Min Pipe Flow Depth

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.010 ft/ft
Diameter	18.0 in
Discharge	3.53 cfs

Results	
Normal Depth	7.2 in
Flow Area	0.7 ft²
Wetted Perimeter	2.1 ft
Hydraulic Radius	3.9 in
Top Width	1.47 ft
Critical Depth	8.6 in
Percent Full	39.9 %
Critical Slope	0.005 ft/ft
Velocity	5.36 ft/s
Velocity Head	0.45 ft
Specific Energy	1.05 ft
Froude Number	1.411
Maximum Discharge	11.30 cfs
Discharge Full	10.50 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	39.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.2 in
Critical Depth	8.6 in
Channel Slope	0.010 ft/ft
Critical Slope	0.005 ft/ft

RUF 100-Year, 20-Min Pipe Flow Depth

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.010 ft/ft
Diameter	18.0 in
Discharge	4.71 cfs

Results	
Normal Depth	8.4 in
Flow Area	0.8 ft²
Wetted Perimeter	2.3 ft
Hydraulic Radius	4.3 in
Top Width	1.50 ft
Critical Depth	10.0 in
Percent Full	46.9 %
Critical Slope	0.006 ft/ft
Velocity	5.78 ft/s
Velocity Head	0.52 ft
Specific Energy	1.22 ft
Froude Number	1.382
Maximum Discharge	11.30 cfs
Discharge Full	10.50 cfs
Slope Full	0.002 ft/ft
Flow Type	Supercritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	46.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	8.4 in
Critical Depth	10.0 in
Channel Slope	0.010 ft/ft
Critical Slope	0.006 ft/ft