Drainage Study Report
for the Cui Family Land Subdivision in Point Reyes Station
Marin County, California

Project ID P4403

Tentative Map Application

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Executive Summary

This drainage study is prepared to address the potential stormwater impacts associated with the Cui Family Land Subdivision (Project) of the 82.32-acre vacant property near 11798 State Route 1, Point Reyes Station in Marin County. This Project is considered a “Regulated Project” since it will create a total of approximately 312,482 square-feet (sf) impervious areas, exceeding the impervious area criterion of 5,000 sf for the Regulated Project. Accordingly, the project is required to meet the following typical hydrology-related requirements:

a) not increasing the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions;
b) not reducing the water quality of stormwater leaving the site, compared to existing conditions; and
c) not increasing erosion potential of stormwater leaving the site for relatively frequent storm events by hydromodification management[1].

This drainage study report is prepared for the Tentative Map application, the first phase of a land subdivision. The next phase is the Final Map application[2]. The purpose of this drainage study report is to:

1) determine the peak discharges of stormwater runoff generated pre- and post-development from the site for the 100-year storm event (Q100) and evaluate the hydraulic adequacy of the existing drainage facilities.
2) demonstrate that the Q100 peak discharge under the post-development condition would be mitigated to below the pre-development level.
3) document the sizing of strategically located/designed 11 bioretention facilities (BF) by collecting and conveying the stormwater from all the <u>impervious</u> areas into these BFs. The BFs will serve conjunctive use purposes to satisfy both the stormwater management (water quality pollutant control) and hydromodification management for relatively frequent storm events with a required rainfall intensity equal to 0.2 inches per hour[3].
4) document the sizing of the stormwater collection and conveyance system.
5) Document the sizing of ripraps for energy dissipation and erosion control at appropriate locations.

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[1] Hydromodification management is an additional requirement for Regulated Projects (It is not required for non-Regulated Projects). The purpose of hydromodification management is to minimize the potential of storm water discharges from causing altered flow regimes (in terms of flow rate and duration) and excessive downstream erosion in receiving waters, i.e., mimic existing condition hydrographs. The required design storm for hydromodification management is 2-year, 24-hour storm.

[2] The County Development Code (Title 22) specifies that a land subdivision for 4 or fewer parcels will have two phases: (1) Tentative Map and (2) Parcel Map. The two phases for a land subdivision for more than 4 parcels are specified as: (1) Tentative Map and (2) Final Map.

[3] Measured over years, these low-intensity storms produce most of the total volume of runoff (80% or more).

The required design storm for stormwater quality control is a storm with a rainfall intensity of 0.2 inches per hour. The required design storm for hydromodification management is 2-year, 24-hour storm. As shown in Appendix A, the 2-year, 24-hour storm has a total rainfall of about 3.59 inches with a rainfall intensity of about 0.15 inches per hour. Using a rainfall intensity of 0.2 inches per hour for both stormwater quality control and hydromodification management is justified. This is the rainfall intensity specified in the BASMAA Post-Construction Manual (January 2019).

This report mainly documents the following items:

1) Explanations of the pre- and post-development drainage conditions, including the field-surveyed drainage culverts under existing conditions and eleven (11) strategically located BFs under post-development conditions. A map showing the FEMA flood zone and the project site is also included. The effect of future sea level rise is also discussed.
2) Hydrology analysis following the 2000 Marin County Hydrology Manual (Rational Method $Q = C \cdot I \cdot A$) to estimate the 100-year peak discharges under both pre-and post-development conditions. The calculations for the time of concentration (T_c), rainfall intensity (I) corresponding to the T_c, and the C-factor are documented. Considering that the rainfall data in the 2000 Hydrology Manual was based on the 1941-1971 data, the current rainfall data at the project area from NOAA Atlas 14 was used to conduct the hydrology analysis. In addition to the 100-year peak discharge estimation, the 100-year stormwater runoff volume was also estimated.
3) Hydraulic analysis to evaluate the adequacy of the existing culverts for conveying 100-year peak discharges.
4) Sizing of the eleven (11) BFs so that the BFs can meet both the stormwater quality management and hydromodification management objectives.
5) Analysis of additional storage volume for flood detention at the top of the selected BFs (above the BF volume for water quality control and hydromodification management) for attenuation/ detention of the 100-year flood flow so that the Project will not increase the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions.
6) Sizing of the stormwater collection and conveyance system including new storm drain pipes and street gutters.
7) Sizing of riprap for energy dissipation based on flow velocities at concentrated discharges into the BFs, and from the discharge locations out of the BFs.

Below is a summary of major findings:

- The entire subject property is outside of the FEMA 100-year flood zone. The property elevation is at least 11 ft higher than the Base Flood Elevation (BFE) of the adjacent Lagunitas Creek. Future sea level rise would not have any effect on the project area since the 100-year water level along the adjacent Lagunitas Creek is much higher than the current 100-year sea level (10 ft NAVD88).
- The project would increase the 100-year peak discharge from the pre-development condition of about 169.7 cubic feet per second (cfs) to the post-development condition of about 177.7 cfs, an increase of 8.0 cfs. The project would increase the 100-year stormwater runoff volume from the pre-development condition of about 145,242 cubic feet (cf) to the post-development condition of about 147,733 cf, an increase of 2,491 cf.

Mitigation to the increase in Q100 will be provided by designing additional storage volume at the top of selected BFs. Analysis indicates that less than 0.6 ft additional depths at the top of all selected BFs will provide adequate mitigation. This is easy to accommodate at the selected BFs.

- All existing culverts have adequate hydraulic capacities to convey the 100-year peak discharges received from respective sub-basins under both existing and post-development conditions.
- The total required minimum surface area of the proposed 11 BFs is estimated to be about 12,499 sf, ranging from 453 sf for BF11 to 1,601 sf for BF2. The proposed 11 BFs have sufficient surface area spaces to achieve both stormwater quality management and the hydromodification management objectives.
- The stormwater collection and conveyance system were conservatively sized using the representative facilities that convey the estimated maximum stormwater flows during the 100-year flood. The stormwater collection and conveyance system mainly include (1) stormdrain culverts/pipes conveying stormwater from buildings to street gutters, (2) stormdrain culverts crossing streets, and (3) street gutters. All stormdrain culverts conveying stormwater from buildings to street gutters were sized to be 4 inches. All stormdrain culverts crossing streets were sized to be 8 inches. All street gutters were designed as half V-shaped with standard curb height of 0.5 ft or 6 inches. The maximum water depth in the designed street gutters is estimated to be about 0.22 ft or about 3 inches during the 100-year flood.
- Ripraps were designed to adequately dissipate energy at the concentrated discharges into the 11 BFs and from the discharge locations out of the 11 BFs. All the ripraps would be No.2 Backing in rock size (2 to 3 inches) and the minimum thickness would be 1.1 ft.

1.0 Introduction

1.1 Purpose of the Drainage Study

This drainage study is prepared to address the potential stormwater impacts associated with the Cui Family Land Subdivision (Project) of the 82.32-acre vacant property near 11798 State Route 1, Point Reyes Station in Marin County, in accordance with the following guidelines, regulations, and policies:

- The BASMAA Post-Construction Manual (January 2019);
- The Marin County Code regarding hydrology study (§24.04.520 and (§24.04.530), drainage plan (§24.04.550), and stormwater control plan (§24.04.627);
- The Marin Countywide Plan (CWP) Polices regarding water resources (WR-2.1, WR-2.2, and WR-2.3);
- The Marin County Local Coastal Program Land Use Plan's Water Resources policies;
- The Marin County Hydrology Manual Simplified Instructions (August 2000); and
- Low Impact Development (LID) practices.

This Project is considered a "Regulated Project" since it will create a total of approximately 312,482 square-feet (sf) impervious areas, exceeding the impervious area criterion of 5,000 sf for the Regulated Project. Accordingly, the project is required to meet the following typical hydrology-related requirements:

a) not increasing the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions;
b) not reducing the water quality of stormwater leaving the site, compared to existing conditions; and
c) not increasing erosion potential of stormwater leaving the site for relatively frequent storm events by hydromodification management[4].

The purpose of this drainage study report is to:

1) determine the peak discharges of stormwater runoff generated pre- and post-development from the site for the 100-year storm event (Q100) and evaluate the hydraulic adequacy of the existing drainage facilities.
2) demonstrate that the Q100 peak discharge under the post-development condition would be mitigated to below the pre-development level.
3) document the sizing of strategically located/designed 11 bioretention facilities (BF) by collecting and conveying the stormwater from all the impervious areas into these BFs. The BFs will serve conjunctive use purposes to satisfy both the stormwater management (water quality pollutant control) and hydromodification management for relatively frequent storm events with a required rainfall intensity equal to 0.2 inches per hour[5].
4) document the sizing of stormwater collection and conveyance system.
5) Document the sizing of ripraps for energy dissipation and erosion control at appropriate locations.

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[4] The purpose of hydromodification management for Regulated Projects is to minimize the potential of storm water discharges from causing altered flow regimes and excessive downstream erosion in receiving waters.

[5] Measured over years, these low-intensity storms produce most of the total volume of runoff (80% or more).

1.2 Project Location and Description

The subject property (82.32 acres) is located near 11798 State Route 1, Point Reyes Station in the unincorporated area of Marin County (APN: 119-050-04, 119-050-09, 119-140-03, and 119-140-09). It is within the village limit boundaries of the community of Point Reyes Station and located within the Coastal Zone. Figure 1a shows the property location in Marin County and Figure 1b shows the project vicinity and the existing property parcels (4 parcels). The property is bounded by Point Reyes-Petaluma Road and Lagunitas Creek on the south, State Route 1 to the west, rural residential housing to the north, and open pastureland to the east. The project site is currently vacant and undeveloped.

The subject property consists of four (4) lots (69, 79, 80, and 81). Refer to Figure 2 for the Record of Survey prepared by Adobe Associates in 2022. Table 1 is a summary of the four lots.

Table 1 Summary of the Four Lots of the Subject Property

Lot ID	Document Number (DN)	Assessor's Parcel Number (APN)	Area (acre)
69	1999-0091165	119-140-03 119-140-09	8.01
79		119-050-04	25.78
79		119-050-09	14.89
80			14.89
81			18.75
Total			**82.32**

Figure 3a shows the Coastal Zone land use zoning and the property location. The property is within the zoning of C-ARP-3 -- Coastal, Agricultural, Residential Planned (1 unit per 3 acres). The C-ARP land use zoning is designed to preserve productive lands for agricultural use through the clustering of allowed residential development.

The project site is subject to the Marin Countywide Plan (CWP)'s C-AG3 (Coastal Agricultural 3; 1 unit per 1 – 9 acres) land use designation. The C-AG3 land use category was established for residential use within the context of small-scale agricultural and agriculturally related uses. According to Map 19e Point Reyes Station Land Use Policy Map, the density associated with C-AG3 is 1 unit per every 1 to 9 acres (see Figure 3b).

The 82.32-acre subject property is proposed to be subdivided into 37 parcels for future single-family residential development (see Figure 4). Of the 37 parcels, 5 parcels are designated as affordable housing. The subdivision considered a density bonus of 35% after meeting the 20%

affordable housing requirement. Preliminary plan shown in Figure 4 indicates that individual lots will range between about 1.02- and 8.2-acres, meeting the density requirement for the C-AG3 land use designation (1 unit per 1 to 9 acres).

The land subdivision proposal includes conceptual plans for new driveways to access all the new parcels and driveway tie-in aprons at State Route 1 and Point Reyes-Petaluma Road, roadway improvements to Point Reyes-Petaluma Road at the southeast corner, utility installation and maintenance areas, onsite wastewater treatment systems, limited tree removal, and general grading to accommodate site improvements such as new driveways.

Access to the development will be provided via an eastward extension of the existing Water Tank Road, via a new access driveway from State Route 1 a few hundred yards north of the existing Water Tank Road, and a new driveway extending from Point Reyes-Petaluma Road in the southeast corner of the site (see Figure 4).

1.3 Existing Site Conditions and Drainage

The site is positioned in a topographically steep section of Point Reyes Station surrounded by rural residential development, pastureland, and light commercial development. The majority of the project site is undeveloped and consists of pastureland with several seasonal drainages, stock ponds, and wetland seeps based on the Huffman & Associates' reconnaissance of the site in 2023 (see Figure 5). A small parcel near the southwestern end consists of a farmhouse with attendant features. Current land use is limited to cattle and horse grazing.

Figure 6a shows the topographical contours based on the 2023 topographic survey using the Real-Time Kinematic (RTK) Observations method. The site elevation ranges from about 40 ft NAVD88 near Point Reyes-Petaluma Road in the south to about 400 ft NAVD88 in the northeast. Below is a summary of site slopes based on a preliminary slope analysis (see also Figure 6b). The site has an average slope of approximately 28.5%.

Slope Range	Acres	% of Site
< 15%	13.09	15.9
15% - 25%	22.10	26.9
25% - 45%	39.24	47.7
>45%	7.75	9.5
Total	**82.18**	**100**

Existing drainage patterns and drainage facilities at/near the project site are shown in Figure 7. In general, the southeast portion of the site drains to Lagunitas Creek and the northwest portion of the site drains to Tomasini Canyon (refer to Figure 1b for Tomasini Canyon). Both creeks eventually discharge into Tomales Bay. The Lagunitas Creek watershed is the largest drainage into Tomales Bay and Tomasini Canyon is one of the small tributaries draining the east side of Tomales Bay (Tomales Bay's eastshore).

There are eight (8) existing culverts along the Point Reyes-Petaluma Road that drain the southeast portion of the site into Lagunitas Creek. The roadside ditch along the Point Reyes-Petaluma Road on the west side helps convey the stormwater runoff from the site into the 8 culverts. Culvert #8 is located offsite and drains a small portion from the site (Sub-Basin 3-1 in Figure 8).

There is a twin culvert along State Route 1 (CA-1) at the entrance of the site. This twin culvert along with the roadside ditch conveys the stormwater from the northwest portion of the site to Tomasini Canyon.

Field survey was performed to inspect and locate the existing culverts, survey the culverts invert and top elevations, measure the culvert sizes, and measure the dimensions of the roadside ditches. These surveyed data are summarized in Table 2.

The site generally consists of narrow ridgelines, typically inclined between about 5:1 (horizontal: vertical), flanked by steep slopes. Incised drainage channels at the base of the slopes are typically bounded by channel banks inclined between about 2:1 and near vertical.

Vegetation in the ridgeline and upper slopes is typically limited to native grasses and ground cover, while the lower slopes and many of the channel areas are vegetated with mature oak, bay and laurel trees along with dense poison oak, broom, and other shrubs.

Table 2 Surveyed Data of Existing Culverts and Roadside Ditches

ID	PM Sign	Existing Culvert	Diameter/Size (in)	Length (ft)	Inlet Area (ft^2)	Allowable Inlet Water Level without Overtopping (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Slope
1	PM 13.97	Inlet Portion 18” RCP and Outlet Portion 24” CMP	18”	37	1.77	89.38	87.71	84.85	7.7%
2	PM 13.87	Inlet Portion 18” RCP and Outlet Portion 24” HDPE	18”	45	1.77	50.05	47.30	45.54	3.9%
3	PM 13.78	18” CMP	18”	49	1.77	40.14	35.68	NV	10.0%
4	PM 13.71	18” RCP	18”	40	1.77	33.97	28.13	23.42	11.8%
5	PM 13.70	18” RCP	18”	40	1.77	33.74	29.51	26.39	7.8%
6	PM 13.67	12” CMP	12”	42	0.79	32.86	29.17	26.34	6.7%
7	PM 13.63	20” RCP	20”	54	2.18	32.00	28.97	NV	10.0%
8	PM 13.51	20” RCP	20”	73	2.18	28.00	19.50	NV	10.0%
		CA-1: Two 14” CMP	14”×2	24	1.07				2.7%
		CA-1 Ditch	Bottom width: 1 ft Depth: 2.5 ft Side slope: 1:1		8.8				2.7%
		Point Reyes–Petaluma Rd Ditch	Bottom width: 1 ft Depth: 1 ft Side slope = 1:1.5		2.5				0.6%

PM: Post Mile; NV: Not Visible. The slopes in red are assumed slopes based on judgement in the field.

Figure 8 shows the delineated drainage sub-basins under existing conditions based on the site topography (or flow directions) and the locations of the existing culverts. The sub-basins inside the property are numbered with a postfix of 1 (e.g., Sub-Basin 1-1, Sub-Basin 2-1) and the sub-basins outside of the property are numbered with a postfix greater than 1 (e.g., Sub-Basin 1-2, Sub-Basin 2-2, Sub-Basin 2-3). The 100-year peak flow calculations based on this drainage sub-basin delineation are intended to evaluate the hydraulic adequacy of the existing drainage culverts.

Note that the total site area shown in the table insert in Figure 8 is about 81.51 acres, which is a little smaller than the total property area of 82.32 acres (see Table 2) from the boundary survey. The reason for this is that the boundary line shown in Figure 8 is not exactly the same as the surveyed property boundary which includes a portion of the Point Reyes-Petaluma Road at the southeast corner (0.81 acres). There is no need to include the portion of the Point Reyes-Petaluma Road in the drainage analysis.

As shown in Figure 8, Sub-basins 1-1 and 2-1 inside the property drain to Tomasini Canyon with a total drainage area of about 41.40 acres (5.68 + 35.72 = 41.40; see the table insert in Figure 8). All other sub-basins inside the property drain to Lagunitas Creek.

Table 3 summarizes the existing condition drainage sub-basins and hydrologic characteristics. Under existing conditions, the entire property site has no impervious areas. There are about 3.12-acre impervious areas adjacent to the property site. These impervious areas include residential buildings, storage tanks, and paved areas (see Figure 9).

Table 3 Existing Condition Drainage Sub-Basins and Hydrologic Characteristics

Basin	Sub-Basin	Area (sf)	Area (ac)	Top Elev (ft NAVD88)	Bottom Elev (ft NAVD88)	Flow Length **L** (ft)	Average Slope **S**	Pervious Area (ac)	Impervious Area (ac)
1	1-1	247,393	5.68	404	234	578	29.4%	5.68	0.00
	1-2	2,788,512	64.02					64.02	0.00
2	2-1	1,556,051	35.72	404	68	2,103	16.0%	35.72	0.00
	2-2	34,613	0.79					0.79	0.00
	2-3	261,952	6.01					5.82	0.19
	2-4	156,287	3.59					3.49	0.10
3	3-1	78,057	1.79	368	304	168	38.1%	1.79	0.00
	3-2	1,064,736	24.44					24.44	0.00
4	4-1	17,359	0.40	276	256	266	7.5%	0.40	0.00
	4-2	794,932	18.25					15.64	2.61
5	5-1	551,671	12.66	368	32	1,434	23.4%	12.66	0.00
	5-2	39,982	0.92					0.92	0.00
6	6-1	355,619	8.16	308	34	1,068	25.7%	8.16	0.00
7	7-1	417,763	9.59	280	34	1,004	24.5%	9.59	0.00
	7-2	111,014	2.55					2.44	0.11
8	8-1	227,285	5.22	130	40	355	25.4%	5.22	0.00
	8-2	173,643	3.99					3.95	0.04
9	9-1	89,895	2.06	128	58	289	24.2%	2.06	0.00
	9-2	43,767	1.00					1.00	0.00
10	10-1	9,676	0.22	110	90	139	14.4%	0.22	0.00
	10-2	47,036	1.08					1.01	0.07
	Total	9,067,242	208.16					205.04	3.12
	Total Inside Property	**3,550,769**	**81.51**					**81.51**	**0.00**

Note: The sub-basins in red represent the sub-basins inside the property.

1.4 Post-Development Drainage Conditions

The Project proposes to subdivide the land into 37 parcels for future single-family residential development. Of the 37 parcels, 5 parcels are designated as affordable housing. This subdivision considered a density bonus of 35% after meeting the 20% affordable housing requirement.

Figure 10 shows the post-development drainage conditions. The post-development conditions will preserve all the existing environmentally sensitive habitat areas (ESHA) with 100 ft buffers. No structures and construction activities will encroach into the ESHA 100 ft buffer areas. Most of the existing hydrologic features will be maintained except the paved driveways and the buildings that have a building footprint of about 4,000 sf each based on the County code. All driveways are designed to have slopes not more than 18% and meet the following width requirements specified in the Marin Coastal Zoning Code section 20.65.030.A.

- The minimum improved width of a driveway serving a single dwelling unit is 12 feet.
- The minimum improved width of a driveway serving two to six dwelling units is 16 feet.
- A driveway which serves more than six dwelling units shall be considered equivalent to a private road and designed accordingly. The minimum width is 20 ft.

Figure 11 shows the drainage sub-basins under project conditions. Stormwater generated from all and only the impervious areas is collected and conveyed by culverts/pipes and street gutters into 11 bioretention facilities (BF) that are strategically located/designed. For a pervious area where stormwater flows toward a street gutter segment due to the natural topography, the designed street curb along the gutter segment would prevent the stormwater from flowing into the gutter. The BFs will serve conjunctive use purposes to satisfy both the stormwater management (water quality pollutant control) and hydromodification management. Additional storage volume at the top of selected BFs will be provided for attenuation/detention of the 100-year flood flow so that the Project will not increase the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions. This way the Project design will meet the following typical hydrology-related requirements:

a) not increasing the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions;
b) not reducing the water quality of stormwater leaving the site, compared to existing conditions; and
c) not increasing erosion potential of stormwater leaving the site for relatively frequent storm events by hydromodification management.

In locating the BFs, the following factors were considered:

- High-visibility, well-trafficked places
- Common, publicly accessible areas for inspection and maintenance
- Dispersed throughout the site
- Drain only impervious building roofs and pavement
- Use surface drainage; keep runs short
- Make facilities flat and level
- Make top of soil elevation high as possible

Table 4 summarizes the project condition drainage sub-basins and hydrologic characteristics. The project condition will create about 7.17 acres of new impervious areas.

Table 4 Project Condition Drainage Sub-Basins and Hydrologic Characteristics

Basin	Sub-Basin	Area (sf)	Area (ac)	Top Elev (ft NAVD88)	Bottom Elev (ft NAVD88)	Flow Length **L** (ft)	Average Slope **S**	Pervious Area (ac)	Impervious Area (ac)
1	1-1	247,393	5.68	404	234	578	29.4%	5.68	0.00
	1-2	2,788,512	64.02					64.02	0.00
2	2-1	1,556,051	35.72	404	68	2,103	16.0%	32.68	3.04
	2-2	34,613	0.79					0.79	0.00
	2-3	261,952	6.01					5.82	0.19
	2-4	156,287	3.59					3.49	0.10
3	3-1	78,057	1.79	368	304	168	38.1%	1.18	0.61
	3-2	1,064,736	24.44					24.44	0.00
4	4-1	17,359	0.40	276	256	266	7.5%	0.40	0.00
	4-2	794,932	18.25					15.64	2.61
5	5-1	551,671	12.66	368	32	1,434	23.4%	11.38	1.29
	5-2	39,982	0.92					0.92	0.00
6	6-1	355,619	8.16	308	34	1,068	25.7%	7.29	0.87
7	7-1	417,763	9.59	280	34	1,004	24.5%	9.05	0.55
	7-2	111,014	2.55					2.44	0.11
8	8-1	227,285	5.22	130	40	355	25.4%	4.66	0.55
	8-2	173,643	3.99					3.95	0.04
9	9-1	89,895	2.06	128	58	289	24.2%	1.80	0.26
	9-2	43,767	1.00					1.00	0.00
10	10-1	9,676	0.22	110	90	139	14.4%	0.22	0.00
	10-2	47,036	1.08					1.01	0.07
	Total	9,067,242	208.16					197.86	10.29
	Total Inside Property	**3,550,769**	**81.51**					**74.34**	**7.17**

Note: The sub-basins in red represent the sub-basins inside the property.

1.5 FEMA Flood Zone Information

The entire subject property is outside of the FEMA 100-year flood zone (see Figure 12). Figure 12 shows that the adjacent Lagunitas Creek has a 100-year base flood elevation (BFE) of 25 ft NAVD88 at the downstream end of the property. The FEMA flood map does not establish the BFE at the upstream end of the property. Using the same downstream water surface elevation profile slope shown in Figure 12, the BFE at the upstream end of the property is estimated at about 29 ft NAVD88. The property elevation along Lagunitas Creek is about 40 ft and is separated from the creek by Point Reyes-Petaluma Road. The property elevation is at least 11 ft higher than the BFE of the adjacent Lagunitas Creek.

According to the FEMA effective Flood Insurance Study, the current 100-year sea level at Tomales Bay is 10 ft NAVD88. The adjacent Lagunitas Creek is not a tidal-affected reach. Future sea level rise would not affect this reach since the 100-year water level along the adjacent Lagunitas Creek is much higher than the current 100-year sea level.

2.0 Hydrology Analysis

The 100-year peak flows (Q100) from pre- and post-development were analyzed using the Rational Method documented in the 2000 County of Marin Hydrology Manual Simplified Instructions. The Rational Method is the most commonly used method, but due to its simplicity in application, it is limited to drainage areas smaller than 200 acres. The entire project site is less than 200 acres and the Rational Method is applicable.

The Rational Method is expressed by the following equation:

$$Q = C \cdot I \cdot A \qquad (1)$$

where:
Q = The peak runoff rate in cubic feet per second at the point of analysis.
C = A runoff coefficient representing the area – averaged ratio of runoff to rainfall intensity.
I = The time-averaged rainfall intensity in inches per hour corresponding to the time of concentration (T_c)
A = The drainage basin area.

The Rational Method requires determination of three important parameters; runoff coefficient (C); time of concentration (T_c), and rainfall intensity corresponding to the T_c.

2.1 Runoff Coefficient

The 2000 Hydrology Manual recommends a minimum runoff coefficient (C) of 0.7 be used for large storm events such as the 100-year storm event due to saturated ground condition prior to the event. In this 100-year peak flow analysis, a runoff coefficient of 0.7 was used for pervious areas and runoff coefficient of 0.95 was used for impervious areas.

2.2 Time of Concentration

The time of concentration (T_c) is the time required for water to flow from the most remote point of the basin to the location being analyzed. The 2000 Hydrology Manual recommends the following formula for the T_c estimation:

$$T_c = \frac{1.8 \cdot (1.1 - C)\sqrt{L}}{\sqrt[3]{S(100)}} + 5\,\text{min} \qquad (2)$$

where:
C = runoff coefficient
L = longest flow path length
S = slope

2.3 Rainfall Intensity

The rainfall intensity-duration-frequency data in the 2000 Hydrology Manual were based on the 1941-1971 rainfall data. Given the current NOAA Atlas 14 available, it would be better to use the current rainfall data.

The rainfall intensity-duration-frequency data from NOAA Atlas 14 for the project area is shown in Figure 13 (refer to Appendix A for more detailed data). These data were used in this 100-year peak flow analysis.

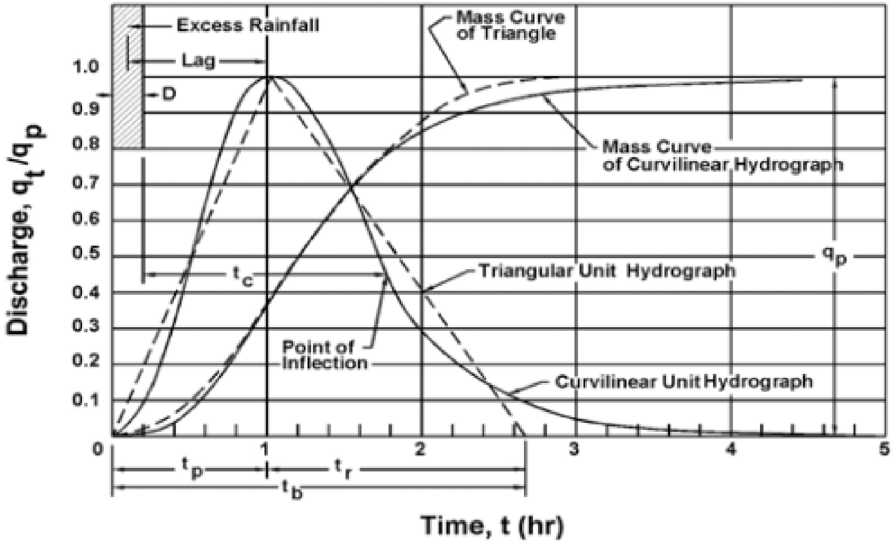
2.4 Estimation of 100-Year Peak Discharge

Using the C factor, the T_c estimation method, and the 100-year rainfall intensity-duration-frequency data described above, the 100-year peak discharges were estimated for both pre- and post-development conditions and the results are summarized in Table 5 and Table 6, respectively.

Table 5 and Table 6 show that the Project would increase the 100-year peak discharge inside the property from the pre-development condition of about 169.7 cubic feet per second (cfs) to the post-development condition of about 177.7 cfs, an increase of 8.0 cfs. Note that Table 6 shows the 100-year peak discharge inside the property under the post-project condition is 175.7 cfs. Comparison between Table 5 and Table 6 shows an increase of 8.0 cfs in the entire analysis area (434.4 - 426.4 = 8 cfs). This flow increase is attributable to the Project. The 100-year peak discharge inside the property under the post-project condition was then back-calculated to be 177.7 cfs (169.7 + 8.0 = 177.7 cfs).

2.5 Estimation of 100-Year Stormwater Volume

The Natural Resources Conservation Service (NRCS)'s equivalent triangular hydrograph (see below) was used to estimate the 100-year stormwater volume.



Dimensionless Curvilinear NRCS Synthetic Unit Hydrograph and Equivalent Triangular Hydrograph

The triangular hydrograph has the following time parameters:

- Time to peak $t_p = \frac{2}{3} t_c$
- Time base $t_b = \frac{8}{3} t_p = \frac{16}{9} t_c$

Where t_c is the time of concentration.

Given the estimated Q100 peak flow and the estimated time base (t_b), the volume (V) of the triangular hydrograph can be calculated using the equation below:

$$V = 0.5 \times \text{Q100 peak flow} \times t_b$$

Table 7 summarizes the 100-year stormwater volume estimates for both pre- and post-development conditions for the sub-basins inside the property. As shown in Table 7, the post-development condition would increase the 100-year stormwater volume by about 2,491 cubic feet (cf), from 145,242 cf to 147,733 cf. The increased stormwater volume would occur in the seven Sub-Basins 2-1, 3-1, 5-1, 6-1, 7-1, 8-1, and 9-1. Mitigation to the increase in Q100 to below pre-development level is analyzed in Section 5.0.

Table 5 Existing Condition Drainage Sub-Basins and 100-Year Peak Flow Estimation

Basin	Sub-Basin	Area (sf)	Area (ac)	Top Elev (ft NAVD88)	Bottom Elev (ft NAVD88)	Flow Length **L** (ft)	Average Slope **S**	Pervious Area (ac)	Impervious Area (ac)	Runoff Coefficient for Pervious Area	Runoff Coefficient for Impervious Area	Composite Runoff Coefficient **C**	Time of Concentration **Tc** (min)	100-Year Rainfall Intensity **I** (in/hr)	100-Year Peak Flow **Q100** (cfs)	Basin Total Q100 (cfs)	Receiving Culvert
1	1-1	247,393	5.68	404	234	578	16.4%	5.68	0.00	0.70	0.95	0.70	18.3	2.78	11.1		
	1-2	2,788,512	64.02	420	60	2,200		64.02	0.00						125.6	136.8	
2	2-1	1,556,051	35.72	404	68	2,103	15.4%	35.72	0.00	0.70	0.95	0.70	18.8	2.76	69.7		25% to Cvt CA-1
	2-2	34,613	0.79	420	404	190		0.79	0.00						1.6		
	2-3	261,952	6.01					5.82	0.19						11.7		
	2-4	156,287	3.59					3.49	0.10						7.0	90.0	
3	3-1	78,057	1.79	368	304	168	18.2%	1.79	0.00	0.70	0.95	0.70	17.5	2.82	3.6		
	3-2	1,064,736	24.44	420	40	2,090		24.44	0.00						48.6	52.1	Culvert 8
4	4-1	17,359	0.40	276	256	266	12.6%	0.40	0.00	0.70	0.95	0.73	14.7	3.01	0.9		
	4-2	794,932	18.25	256	128	910		15.64	2.61						40.8	41.7	
5	5-1	551,671	12.66	368	32	1,434	23.4%	12.66	0.00	0.70	0.95	0.70	14.5	3.03	27.1		Culvert 7
	5-2	39,982	0.92					0.92	0.00						2.0	29.0	
6	6-1	355,619	8.16	308	34	1,068	25.7%	8.16	0.00	0.70	0.95	0.70	13.0	3.20	18.4	18.4	Culvert 6
7	7-1	417,763	9.59	280	34	1,004	24.5%	9.59	0.00	0.70	0.95	0.70	12.8	3.22	21.9		
	7-2	111,014	2.55					2.44	0.11						5.8	27.7	Culverts 4&5
8	8-1	227,285	5.22	130	40	355	17.9%	5.22	0.00	0.70	0.95	0.70	13.2	3.17	11.7		
	8-2	173,643	3.99	200	130	540		3.95	0.04						8.9	20.6	Culvert 3
9	9-1	89,895	2.06	128	58	289	15.2%	2.06	0.00	0.70	0.95	0.70	12.5	3.26	4.8		
	9-2	43,767	1.00	160	128	380		1.00	0.00						2.3	7.1	Culvert 2
10	10-1	9,676	0.22	110	90	139	10.3%	0.22	0.00	0.70	0.95	0.71	13.3	3.16	0.5		
	10-2	47,036	1.08	160	90	680		1.01	0.07						2.5	3.0	Culvert 1
	Total	9,067,242	208.16					205.04	3.12						426.4	426.4	
	Total Inside Property	**3,550,769**	**81.51**					**81.51**	**0.00**						**169.7**		

Note: The blue numbers were used to calculate the average slope. Using Basin 2 as an example, the longest flow path includes the flow paths in Sub-Basins 2-1 and 2-2, which is 2103+190 = 2293 ft. The average slope = (420 - 68)/(2103+190) = 15.4%.

Table 6 Project Condition Drainage Sub-Basins and 100-Year Peak Flow Estimation

Basin	Sub-Basin	Area (sf)	Area (ac)	Top Elev (ft NAVD88)	Bottom Elev (ft NAVD88)	Flow Length **L** (ft)	Average Slope **S**	Pervious Area (ac)	Impervious Area (ac)	Runoff Coefficient for Pervious Area	Runoff Coefficient for Impervious Area	Composite Runoff Coefficient **C**	Time of Concentration **Tc** (min)	100-Year Rainfall Intensity **I** (in/hr)	100-Year Peak Flow **Q100** (cfs)	Basin Total Q100 (cfs)	Receiving Culvert
1	1-1	247,393	5.68	404	234	578	16.4%	5.68	0.00	0.70	0.95	0.70	18.3	2.78	11.1		
	1-2	2,788,512	64.02	420	60	2,200		64.02	0.00						125.6	136.8	
2	2-1	1,556,051	35.72	404	68	2,103	15.4%	32.68	3.04	0.70	0.95	0.72	18.2	2.78	72.0		25% to Cvt CA-1
	2-2	34,613	0.79	420	404	190		0.79	0.00						1.6		
	2-3	261,952	6.01					5.82	0.19						12.1		
	2-4	156,287	3.59					3.49	0.10						7.2	92.9	
3	3-1	78,057	1.79	368	304	168	18.2%	1.18	0.61	0.70	0.95	0.71	17.3	2.83	3.6		
	3-2	1,064,736	24.44	420	40	2,090		24.44	0.00						49.2	52.8	Culvert 8
4	4-1	17,359	0.40	276	256	266	12.6%	0.40	0.00	0.70	0.95	0.73	14.7	3.01	0.9		
	4-2	794,932	18.25	256	128	910		15.64	2.61						40.8	41.7	
5	5-1	551,671	12.66	368	32	1,434	23.4%	11.38	1.29	0.70	0.95	0.72	14.0	3.09	28.5		Culvert 7
	5-2	39,982	0.92					0.92	0.00						2.1	30.6	
6	6-1	355,619	8.16	308	34	1,068	25.7%	7.29	0.87	0.70	0.95	0.73	12.4	3.27	19.6	19.6	Culvert 6
7	7-1	417,763	9.59	280	34	1,004	24.5%	9.05	0.55	0.70	0.95	0.71	12.6	3.25	22.4		
	7-2	111,014	2.55					2.44	0.11						6.0	28.4	Culverts 4&5
8	8-1	227,285	5.22	130	40	355	17.9%	4.66	0.55	0.70	0.95	0.72	12.9	3.21	12.1		
	8-2	173,643	3.99	200	130	540		3.95	0.04						9.2	21.3	Culvert 3
9	9-1	89,895	2.06	128	58	289	15.2%	1.80	0.26	0.70	0.95	0.72	12.1	3.32	5.0		
	9-2	43,767	1.00	160	128	380		1.00	0.00						2.4	7.4	Culvert 2
10	10-1	9,676	0.22	110	90	139	10.3%	0.22	0.00	0.70	0.95	0.71	13.3	3.16	0.5		
	10-2	47,036	1.08	160	90	680		1.01	0.07						2.5	3.0	Culvert 1
	Total	9,067,242	208.16					197.86	10.29						434.4	434.4	
	Total Inside Property	**3,550,769**	**81.51**					**74.34**	**7.17**						**175.7**		

Note: The blue numbers were used to calculate the average slope. Using Basin 2 as an example, the longest flow path includes the flow paths in Sub-Basins 2-1 and 2-2, which is 2103+190 = 2293 ft. The average slope = (420 - 68)/(2103+190) = 15.4%.

Table 7 100-Year Stormwater Volume Estimation for Sub-Basins Inside Property

	Pre-Development Condition				Post-Development Condition				
Sub-Basin	**Q100 Peak Flow (cfs)**	**Time of Conc. t_c (min)**	**Base Time t_b (min)**	**Stormwater Volume (cf)**	**Q100 Peak Flow (cfs)**	**Time of Conc. t_c (min)**	**Base Time t_b (min)**	**Stormwater Volume (cf)**	**Increased Stormwater Volume (cf)**
1-1	11.1	18.3	32.5	10,834	11.1	18.3	32.5	10,834	0
2-1	69.7	18.8	33.4	69,886	72.6	18.2	32.4	70,470	585
3-1	3.6	17.5	31.1	3,360	4.3	17.3	30.8	3,967	607
4-1	0.9	14.7	26.1	706	0.9	14.7	26.1	706	0
5-1	27.1	14.5	25.8	20,957	28.7	14.0	24.9	21,429	472
6-1	18.4	13.0	23.1	12,757	19.6	12.4	22.0	12,962	205
7-1	21.9	12.8	22.8	14,950	22.6	12.6	22.4	15,187	237
8-1	11.7	13.2	23.5	8,237	12.4	12.9	22.9	8,531	294
9-1	4.8	12.5	22.2	3,200	5.1	12.1	21.5	3,291	91
10-1	0.5	13.3	23.6	355	0.5	13.3	23.6	355	0
Total	**169.7**			**145,242**	**177.7**			**147,733**	**2,491**

3.0 Hydraulic Evaluation of the Adequacy of Existing Culverts for Conveying 100-Year Peak Discharges

A hydraulic analysis was conducted to evaluate the adequacy of the existing culverts for conveying the Q100 peak discharges estimated in Section 2.0.

The Marin County Code, Section 24.04.520 sets the following criteria for hydrologic and hydraulic designs:

24.04.520 Hydrologic and hydraulic design

(a) Where, in the opinion of the agency, hydrologic and hydraulic design considerations exist, the design engineer shall provide calculations, references, model studies, reports, watershed topography, and other pertinent information as deemed necessary by the agency to confirm the design.

(b) Hydrologic and hydraulic designs shall be predicated upon the ultimate development of the tributary watershed as defined by the Marin Countywide Plan and/or any general, specific or community plan applicable to the watershed.

(c) Hydrologic and hydraulic analyses used in the design of waterways, channels and closed conduits shall be based upon the one hundred-year storm. Closed conduit systems must pass seventy percent of the one hundred-year flow as open channel flow with no head allowed at the inlet. The remaining thirty percent may be allowed to enter the conduit with head over the inlet provided that a minimum of two feet of freeboard is maintained in all inlet structures.

(d) Open channel systems shall be designed to carry the one hundred-year flow with a minimum freeboard equal to the velocity head. Bridges and utility crossings which span open channel waterways shall have a minimum clearance of two feet between soffit and the one hundred-year flow elevation.

The criterion (c) above is particularly applicable for evaluating the hydraulic adequacy of the existing culverts.

Table 8 is a summary of the evaluation results. The last 4 columns in the table show the following information:

- Open channel capacity of the culvert with no head allowed at the inlet
- Culvert maximum capacity with allowable head at the inlet without overtopping
- Existing condition 100-year flow to the culvert
- 70% of the 100-year flow to the culvert

As shown in Table 8, all the 8 culverts along the Point Reyes-Petaluma have adequate capacity to convey the existing condition 100-year peak flows. All the 8 culverts also have adequate capacity to convey the unmitigated Project condition 100-year peak flows since the unmitigated Project condition 100-year peak flows are only a little higher than the existing condition 100-year peak flows. The twin culvert along CA-1 at the property entrance receives approximately 25% of the flow from Sub-Basin 2-1 and it has adequate capacity to pass the 100-year peak flow.

Table 8 Hydraulic Capacities of Existing Culverts and Roadside Ditches

ID	PM Sign	Existing Culvert	Diameter/Size (in)	Length (ft)	Inlet Area (ft^2)	Allowable Inlet Water Level (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Slope	Open Channel Capacity (cfs)	Culvert Max Capacity (cfs)	Existing 100yr Flow to Culvert (cfs)	70% of 100yr Flow (cfs)
1	PM 13.97	Inlet Portion 18” RCP and Outlet Portion 24” CMP	18”	37	1.77	89.38	87.71	84.85	7.7%	29	37	3.0	2.1
2	PM 13.87	Inlet Portion 18” RCP and Outlet Portion 24” HDPE	18”	45	1.77	50.05	47.30	45.54	3.9%	21	33	7.1	5.0
3	PM 13.78	18” CMP	18”	49	1.77	40.14	35.68	NV	10.0%	33	46	20.6	14.4
4	PM 13.71	18” RCP	18”	40	1.77	33.97	28.13	23.42	11.8%	36	54	27.7	19.4
5	PM 13.70	18” RCP	18”	40	1.77	33.74	29.51	26.39	7.8%	29	45	-	-
6	PM 13.67	12” CMP	12”	42	0.79	32.86	29.17	26.34	6.7%	9	14	18.4	12.9
7	PM 13.63	20” RCP	20”	54	2.18	32.00	28.97	NV	10.0%	44	56	29.0	20.3
8	PM 13.51	20” RCP	20”	73	2.18	28.00	19.50	NV	10.0%	44	65	52.1	36.5
		CA-1: Two 14” CMP	14”×2	24	1.07				2.7%	18		17.4	12.2
		CA-1 Ditch	Bottom width: 1 ft Depth: 2.5 ft Side slope: 1:1		8.8				2.7%	56			
		Point Reyes–Petaluma Rd Ditch	Bottom width: 1 ft Depth: 1 ft Side slope = 1:1.5		2.5				0.6%	5			

PM: Post Mile; NV: Not Visible. Assumed Manning’s n for culverts: 0.013; Assumed Manning’s n for roadside ditches: 0.04.

4.0 Sizing of Bioretention Facilities for Stormwater Quality Management and Hydromodification Management

The eleven (11) bioretention facilities (BF) were sized to meet the following two objectives based on the BASMAA Post-Construction Manual (January 2019):

- Provide the required stormwater quality management; and
- Provide the required hydromodification management.

The BASMAA Post-Construction Manual categorizes the drainage management areas (DMA) into the following four types:

- Self-treating areas
- Self-retaining areas
- Areas draining to self-retaining areas
- Areas draining to a bioretention facility

Self-treating areas are landscaped or turf areas that do not drain to bioretention facilities, but rather drain directly off site or to the existing storm drain system. In general, self-treating areas include no impervious areas.

Self-retaining areas are used where, because of site layout or topography, it is not possible to drain entirely pervious areas off-site separately. To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall.

Areas draining to self-retaining areas. Runoff from impervious areas, such as roofs, can be managed by routing it to self-retaining pervious areas. The maximum ratio is 2 parts impervious area for every 1 part pervious area.

Areas draining to a bioretention facility. Where possible, design site drainage so only impervious roofs and pavement drain to bioretention facilities. When only impervious areas are drained to a bioretention facility, the required minimum area of the bioretention facility is 4% of the total impervious area draining to the bioretention facility.

Only the third and fourth methods above are applicable methods for managing stormwater from impervious areas. For a given size of impervious area, the third method requires a minimum self-retaining area to be 50% of the impervious area, while the fourth method requires a minimum bioretention facility area to be 4% of the impervious area. The bioretention facility method has been verified by hydrologic routing modeling for its effectiveness in meeting the hydromodification management requirements (Dubin Environmental Consulting, 2014). It is unclear if the third method is able to meet the hydromodification management requirements.

The bioretention facility method is selected in this subdivision for managing stormwater from the impervious areas to meet the requirements for both stormwater quality control and hydromodification management. No stormwater from any pervious areas will be directed to the bioretention facilities. The project site is in a natural state with all areas pervious. The land subdivision will not affect the existing pervious areas except that the Project will create a total of

312,482 sf or 7.17 acres impervious areas that include 37 buildings (4,000 sf each) and paved driveways. This total impervious area is approximately 8.7 percent of the total land area (82.32 acres).

The drainage design strategically located 11 bioretention facilities (BF) by collecting and conveying stormwater from all the impervious areas into these BFs via stormdrain culverts/pipes and street gutters. These 11 BFs are shown in Figures 10 and 11.

Table 9 shows the sizing of these BFs. The total required minimum surface area of the 11 BFs is estimated to be about 12,499 sf, ranging from 453 sf for BF11 to 1,601 sf for BF2.

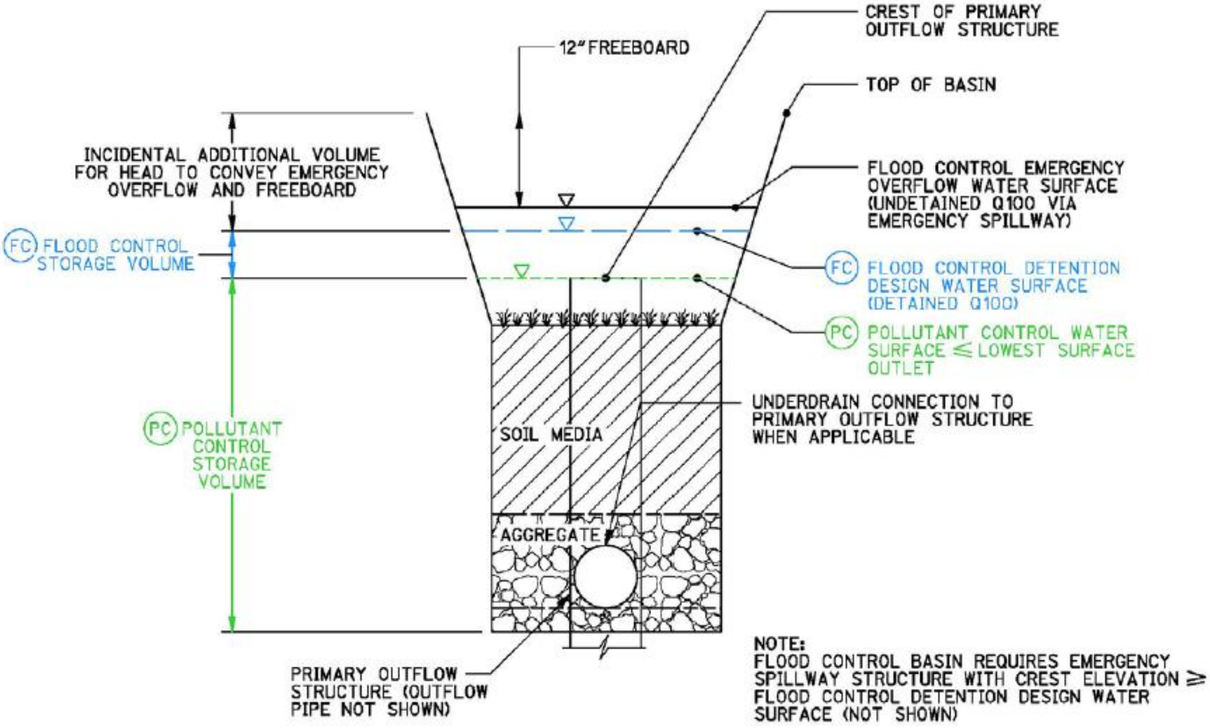
It is worth noting that this drainage plan considered stormwater from all the buildings will be directed to the BFs by stormdrain culverts/pipes and street gutters. When the future site-specific plans are developed for the individual buildings, additional bioretention facilities may be designed and installed at the individual lots by future property owners, beyond those proposed in this drainage plan, which will further manage stormwater onsite. Therefore, the sizing of the proposed BFs in this drainage plan would be conservative (oversized), providing some level of reliability and redundancy.

Table 9 Bioretention Facilities Sizing

Bioretention Facility (BF) ID	Road Area (sf)	Buildings	Number of Buildings	Building Area (sf)	Total Impervious Area (sf)	Required BF Minimum Surface Area (sf)
BF1	17,087	4, 5, 6, 7, 9	5	20,000	37,087	1,483
BF2	20,022	1, 2, 3 ,8,10	5	20,000	40,022	1,601
BF3	10,713	11, 12, 13, 14	4	16,000	26,713	1,069
BF4	10,600	21	1	4,000	14,600	584
BF5	25,529	15, 16, 17, 18	4	16,000	41,529	1,661
BF6	7,683	22, 23	2	8,000	15,683	627
BF7	22,097	19, 20, 24, 25	4	16,000	38,097	1,524
BF8	7,755	28, 29, 30, 31	4	16,000	23,755	950
BF9	23,562	26, 27, 32, 33	4	16,000	39,562	1,582
BF10	12,097	34, 35, 36	3	12,000	24,097	964
BF11	7,337	37	1	4,000	11,337	453
Total	**164,482**			**148,000**	**312,482**	**12,499**

5.0 Analysis of Detention Volume Needed to Attenuate the 100-Year Flood Flow to Pre-Development Level

In this drainage design, an additional storage volume for flood detention at the top of selected BFs (above the BF volume for water quality control and hydromodification management) will be provided for attenuation/detention of the 100-year flood flow so that the Project will not increase the 100-year peak flow magnitude of stormwater leaving the site, compared to existing conditions. The flood detention volume will be provided in addition to the pollutant control volume as shown in the schematics below.



NOTE:
FLOOD CONTROL BASIN REQUIRES EMERGENCY SPILLWAY STRUCTURE WITH CREST ELEVATION ≥ FLOOD CONTROL DETENTION DESIGN WATER SURFACE (NOT SHOWN)

Use of Bioretention Facility for Stormwater Quality Management and Flood Detention

Table 10 shows the selected BFs for the Q100 flood flow attenuation/retention for the sub-basins that would increase the Q100 stormwater volume due to the Project. The last column of the table shows the additional depths at the top of the selected BFs needed for detaining the increased Q100 stormwater volume. The estimated additional depth for flood detention is all within 0.6 ft, which is easy to accommodate at the BFs.

Table 10 Selected BFs and Estimated Additional Depths at the Top of BFs for 100-Year Flood Flow Attenuation

Sub-Basin	Increased Q100 Stormwater Volume due to Project (cf)	Selected BF for Q100 Flood Attenuation	Required BF Minimum Surface Area (sf)	Additional BF Depth Needed for Q100 Flood Attenuation (ft)
1-1	0	-	-	-
2-1	585	BF9	1,582	0.37
3-1	607	BF3	1,069	0.57
4-1	0	-	-	-
5-1	472	BF5	1,661	0.28
6-1	205	BF7	1,524	0.13
7-1	237	BF8	950	0.25
8-1	294	BF10	964	0.30
9-1	91	BF11	453	0.20
10-1	0	-	-	-
Total	**2,491**			

6.0 Sizing of the Stormwater Collection and Conveyance System

The stormwater collection and conveyance system mainly include (1) stormdrain culverts/pipes conveying stormwater from buildings to street gutters, (2) stormdrain culverts/pipes crossing streets, and (3) street gutters.

Sizing of stormdrain culverts/pipes conveying stormwater from buildings to street gutters

Sizing of the stormdrain culverts/pipes conveying stormwater from buildings to street gutters requires knowing the 100-year peak flow from an individual building. The Rational Method discussed in Section 2.0 was used to estimate the 100-year peak flow from each building.

The time of concentration formula in Section 2.2 indicates that the minimum time of concentration is 5 minutes. Considering the stormwater travel time from the roof top to the culvert, it was assumed that the time of concentration is about 6 minutes. The corresponding 100-year rainfall intensity is estimated to be about 4.82 inches per hour (see Figure 13).

For a designed building pad area of 4,000 sf, the 100-year peak flow is:

$$Q = C \cdot I \cdot A = 0.95 \times 4.82 \text{ inches per hour} \times 4{,}000 \text{ sf} = 0.4 \text{ cfs}$$

Assuming the designed slope for each culvert is 5% and a Manning's n for the culvert is 0.013, the culvert was sized to be **4 inches** using the following open channel Manning Equation.

$$Q = VA = \left(\frac{1.49}{n}\right) AR^{\frac{2}{3}} \sqrt{S}$$

Where:

Q = Flow Rate, (cfs)
v = Velocity, (fps)
A = Flow Area, (sf)
n = Manning's Roughness Coefficient
R = Hydraulic Radius, (ft)
S = Slope, (ft/ft)

Sizing of stormdrain culverts/pipes conveying stormwater to cross streets

As shown in Figure 10, the street crossing culvert that conveys stormwater collected from Building #11, #12, and #13 into BF3 would experience the maximum flood flow, compared to all other street crossing culverts. To be conservative, this maximum flood flow is used for the sizing of all the street crossing culverts.

The street crossing culvert into BF3 would need to have a hydraulic capacity to convey the stormwater from the three buildings (Buildings #11, #12, and #13) and the stormwater from a portion of the street. The three buildings have an estimated 100-year peak flow of about 1.2 cfs

(0.4 cfs × 3 = 1.2 cfs). The street portion has an estimated 100-year peak flow of about 0.5 cfs using the method described in Section 2.0 with data and results summarized below:

Top elevation: 400 ft NAVD88
Bottom elevation: 364 ft NAVD88
Flow path length: 540 ft
Slope: 6.7%
Area: 5,357 sf
Time of concentration (Tc): 8 minutes
100-year rainfall intensity (I): 4.22 in/hr
100-year peak flow: 0.5 cfs (Q = C·I·A = 0.95 × 4.22 in/hr × 5357 sf = 0.5 cfs)

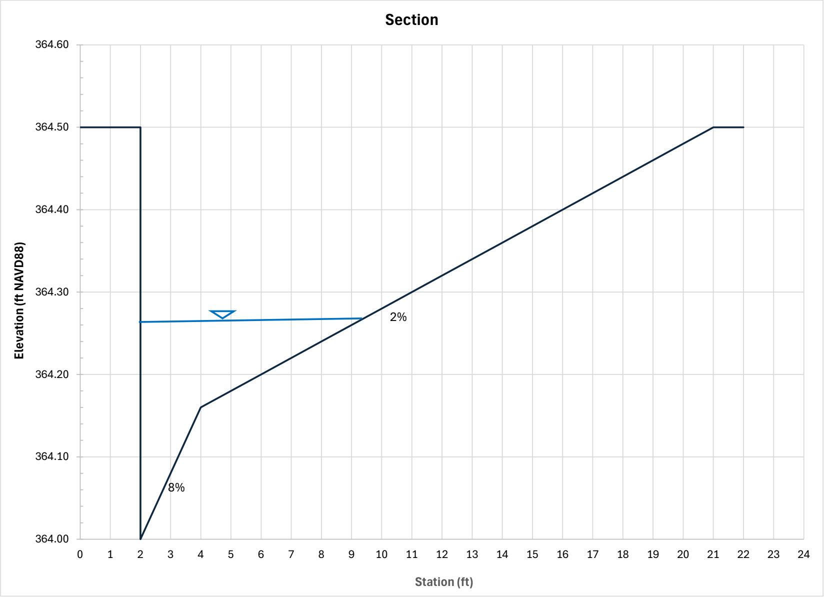
The total 100-year peak flow at the street crossing culvert into BF3 is estimated to be about 1.7 cfs (1.2 + 0.5 = 1.7). This estimate would be conservative since it assumed that all the peak flows from the three buildings and from the street portion arrive at the culvert at the same time.

Assuming the designed slope for the street crossing culvert is 2% and a Manning's n for the culvert is 0.013, the culvert was sized to be **8 inches** using the open channel Manning Equation.

Sizing of street gutters

As shown in Figure 10, the street gutter at the inlet of the street crossing culvert into BF3 analyzed above would also experience the maximum flood flow, compared to all other street gutters. To be conservative, this maximum flood flow, which was estimated at 1.7 cfs above, is used for the sizing of all the street gutters.

Assuming the designed gutter has the shape shown in the schematic below and a Manning's n for the gutter is 0.013, given the estimated 100-year peak flow of about 1.7 cfs, the water depth in the gutter is estimated to be about **0.22 ft** using the open channel Manning Equation. This water depth is well below the standard curb height of 0.5 ft, indicating the gutter has adequate capacity.

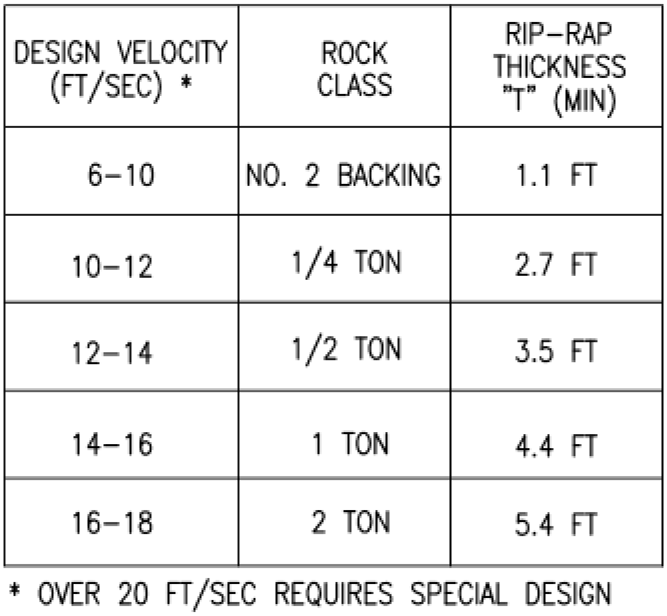


Street Gutter Schematic and Sizing

7.0 Sizing of Riprap for Energy Dissipation

There will be concentrated discharges into and out of the BFs by pipes. There is a need to place ripraps at these locations for energy dissipation and erosion control. The ripraps will be sized using the velocity criteria shown in the table below.

Velocity Criteria for Riprap Sizing



DESIGN VELOCITY (FT/SEC) *	ROCK CLASS	RIP-RAP THICKNESS "T" (MIN)
6-10	NO. 2 BACKING	1.1 FT
10-12	1/4 TON	2.7 FT
12-14	1/2 TON	3.5 FT
14-16	1 TON	4.4 FT
16-18	2 TON	5.4 FT

* OVER 20 FT/SEC REQUIRES SPECIAL DESIGN

Section 6.0 sized the representative street crossing culvert that conveys the estimated maximum stormwater flow of about 1.7 cfs into BF3 during the 100-year flood. Given the sized culvert at 8 inches, the flow velocity in the culvert (or flow velocity from the culvert into BF3) would be about 4.9 ft per second (fps).

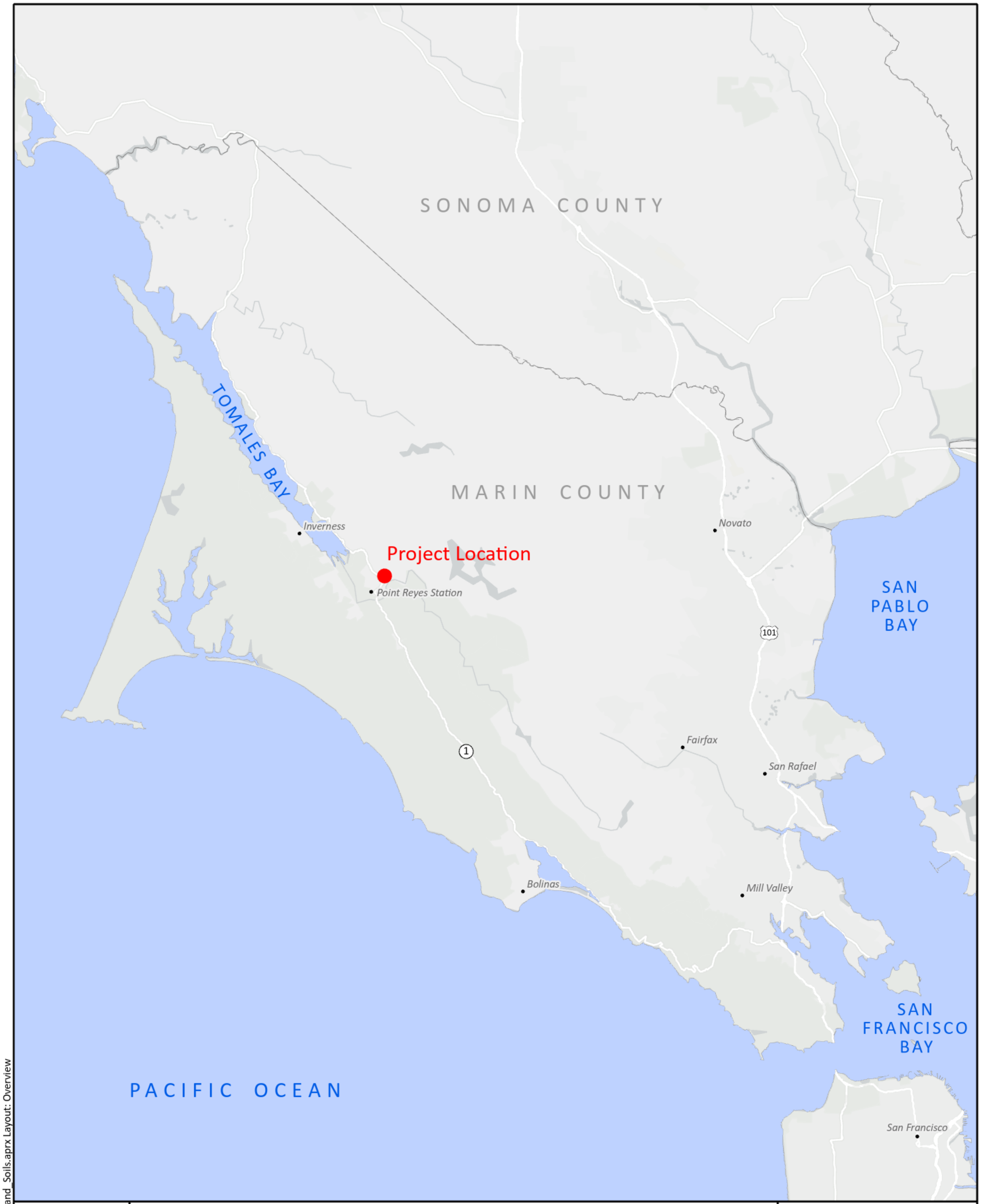
It is expected that the flow velocities into and out of all the BFs would be lower than 4.9 fps. Therefore, all the ripraps would be No.2 Backing in rock size (2 to 3 inches) and the minimum thickness would be 1.1 ft. This is the required minimum riprap size shown in the table above.

7.0 Findings

Below is a summary of major findings:

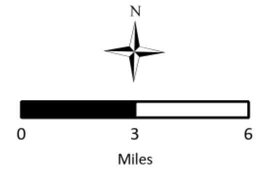
- The entire subject property is outside of the FEMA 100-year flood zone. The property elevation is at least 11 ft higher than the Base Flood Elevation (BFE) of the adjacent Lagunitas Creek. Future sea level rise would not have any effect on the project area since the 100-year water level along the adjacent Lagunitas Creek is much higher than the current 100-year sea level (10 ft NAVD88).
- The project would increase the 100-year peak discharge from the pre-development condition of about 169.7 cfs to the post-development condition of about 177.7 cfs, an increase of 8.0 cfs. The project would increase the 100-year stormwater runoff volume from the pre-development condition of about 145,242 cf to the post-development condition of about 147,733 cf, an increase of 2,491 cf. Mitigation to the increase in Q100 will be provided by designing additional storage volume at the top of selected BFs. Analysis indicates that less than 0.6 ft additional depths at the top of all selected BFs will provide adequate mitigation. This is easy to accommodate at the selected BFs.
- All existing culverts have adequate hydraulic capacities to convey the 100-year peak discharges received from respective sub-basins under both existing and post-development conditions.
- The total required minimum surface area of the proposed 11 BFs is estimated to be about 12,499 sf, ranging from 453 sf for BF11 to 1,601 sf for BF2. The proposed 11 BFs have sufficient surface area spaces to achieve both stormwater quality management and the hydromodification management objectives.
- The stormwater collection and conveyance system were conservatively sized using the representative facilities that convey the estimated maximum stormwater flows during the 100-year flood. The stormwater collection and conveyance system mainly include (1) stormdrain culverts/pipes conveying stormwater from buildings to street gutters, (2) stormdrain culverts crossing streets, and (3) street gutters. All stormdrain culverts conveying stormwater from buildings to street gutters were sized to be 4 inches. All stormdrain culverts crossing streets were sized to be 8 inches. All street gutters were designed as half V-shaped with standard curb height of 0.5 ft or 6 inches. The maximum water depth in the designed street gutters is estimated to be about 0.22 ft or about 3 inches during the 100-year flood.
- Ripraps were designed to adequately dissipate energy at the concentrated discharges into the 11 BFs and from the discharge locations out of the 11 BFs. All the ripraps would be No.2 Backing in rock size (2 to 3 inches) and the minimum thickness would be 1.1 ft.

Figure 1a



PROJECT LOCATION
POINT REYES STATION, CA

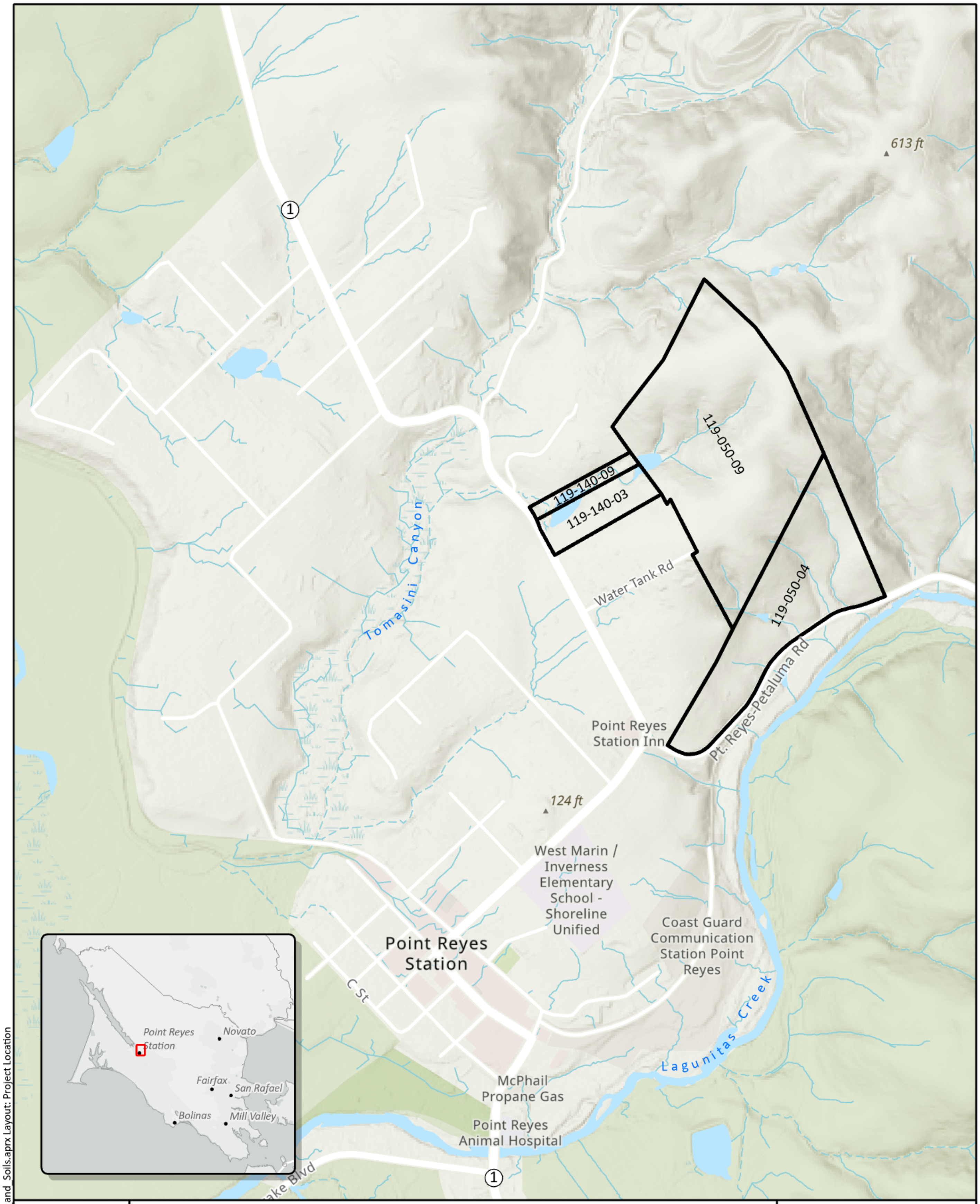
Note:



STETSON ENGINEERS INC.

Path: j:\Jn2904\Stormwater_and_Soils.aprx Layout: Overview

Figure 1b



Path: J:\jn2904\Stormwater_and_Soils.aprx Layout: Project Location

STETSON ENGINEERS INC.

PROJECT VICINITY AND EXISTING PROPERTY PARCELS

POINT REYES STATION, CA

Note: Parcel Boundaries from Marin County.

N

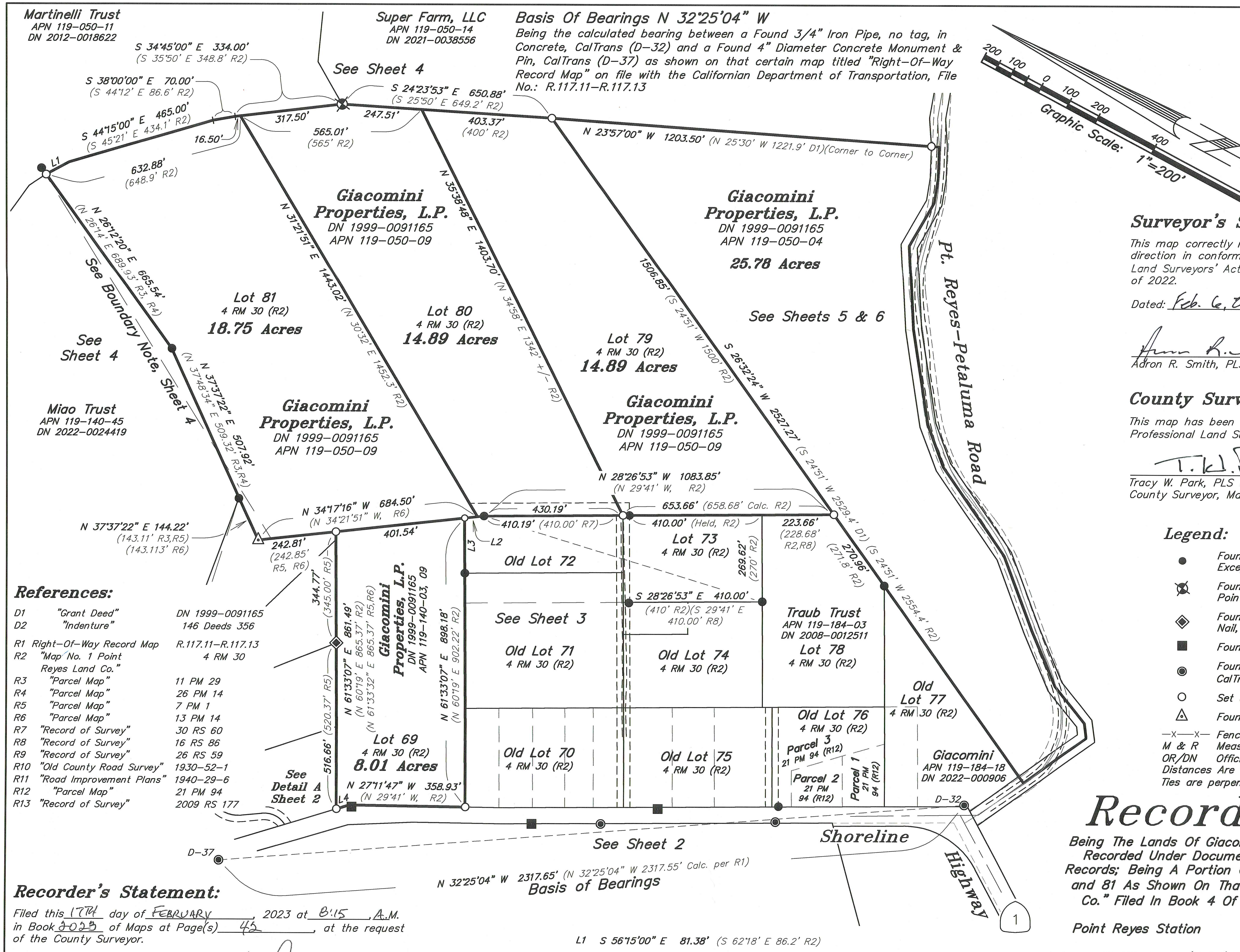
0 500 1,000

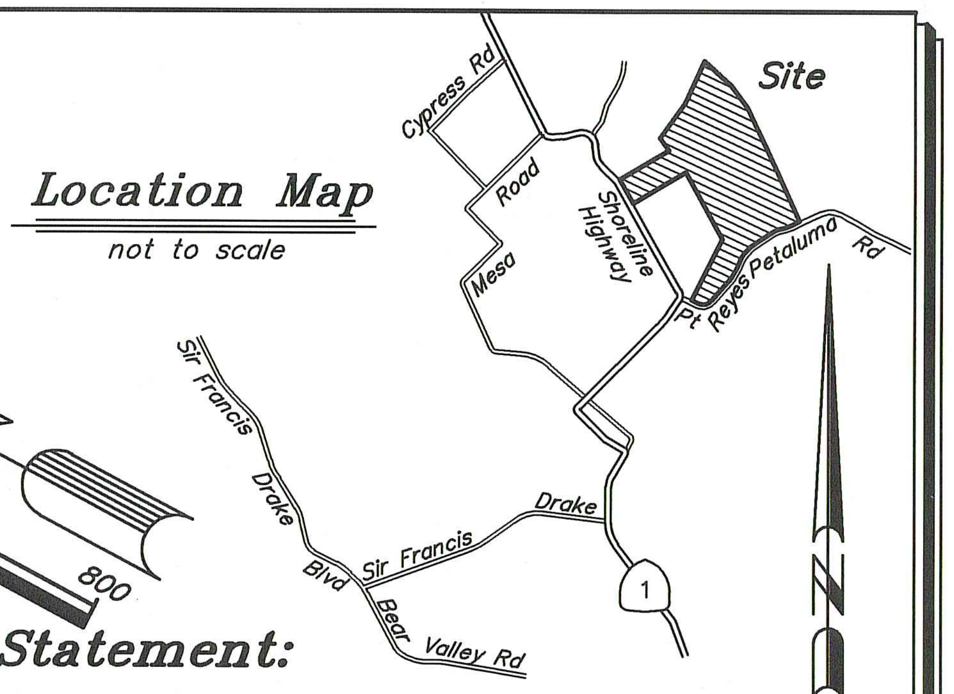
US Feet

Figure 2

Basis Of Bearings N 32°25'04" W

Being the calculated bearing between a Found 3/4" Iron Pipe, no tag, in Concrete, CalTrans (D-32) and a Found 4" Diameter Concrete Monument & Pin, CalTrans (D-37) as shown on that certain map titled "Right-Of-Way Record Map" on file with the Californian Department of Transportation, File No.: R.117.11-R.117.13





Location Map

not to scale

Surveyor's Statement:

This map correctly represents a survey made by me or under my direction in conformance with the requirements of the Professional Land Surveyors' Act at the request of Tony Giacomini in December of 2022.

Dated: Feb. 6, 2023

Aaron R. Smith, PLS 7901

AARON R SMITH
No. L 7901

County Surveyor's Statement:

This map has been examined in accordance with Section 8766 of the Professional Land Surveyors' Act this 3rd day of February, 2023.

Tracy W. Park, PLS 8176
County Surveyor, Marin County

TRACY W. PARK
L8176

Legend:

●	Found 3/4" Iron Pipe, LS 3775, (R8) Tag Destroyed, Except As Shown
⊗	Found Old 2" Iron Pipe, no tag, Held as Angle Point per R2.
◈	Found Old 2" x 2" Wooden Hub w/ Brass Tag & Nail, RCE 17480 in old fence line per R5 & R6.
■	Found 6"x 6" CalTrans Concrete Monument (R1)
◉	Found 3/4" Aluminum Cap in Concrete, Stamped CalTrans (R1) Except As Shown
○	Set 3/4" Iron Pipe tagged PLS 7901
△	Found 4"x 4" Fence Post, no tag set
—x——x—	Fencing
M & R	Measured and Record
OR/DN	Official Records/Document Number

Distances Are Shown In Feet & Decimals Thereof
Ties are perpendicular and/or radial, unless otherwise noted.

References:

D1	"Grant Deed"	DN 1999-0091165
D2	"Indenture"	146 Deeds 356
R1	Right-Of-Way Record Map	R.117.11-R.117.13
R2	"Map No. 1 Point Reyes Land Co."	4 RM 30
R3	"Parcel Map"	11 PM 29
R4	"Parcel Map"	26 PM 14
R5	"Parcel Map"	7 PM 1
R6	"Parcel Map"	13 PM 14
R7	"Record of Survey"	30 RS 60
R8	"Record of Survey"	16 RS 86
R9	"Record of Survey"	26 RS 59
R10	"Old County Road Survey"	1930-52-1
R11	"Road Improvement Plans"	1940-29-6
R12	"Parcel Map"	21 PM 94
R13	"Record of Survey"	2009 RS 177

Recorder's Statement:

Filed this 17th day of February, 2023 at 8:15 A.M. in Book 2023 of Maps at Page(s) 42, at the request of the County Surveyor.

Shelly Scott
Recorder

Deputy

Fee Paid $94-

Doc. No. 2023-0003181

L1	S 56°15'00" E	81.38'	(S 62°18' E 86.2' R2)
L2	N 34°17'16" W	60.14'	(N 35°35' W 60' R2) (S 35°35' W 60.32' R7,R8)
L3	S 61°33'07" W	171.13'	(S 60°19' W 171.13' R7)
L4	N 44°54'48" W	42.35'	(S 46°26' E, R2)

Record of Survey

Being The Lands Of Giacomini Properties, L.P. As Described By Deed Recorded Under Document Number 1999-0091165, Marin County Records; Being A Portion Of The Stocker Ranch And Lots 69, 79, 80 and 81 As Shown On That Map Titled "Map No. 1 Point Reyes Land Co." Filed In Book 4 Of Record Maps, At Page 30, Marin County Records.

Point Reyes Station County of Marin, State of California

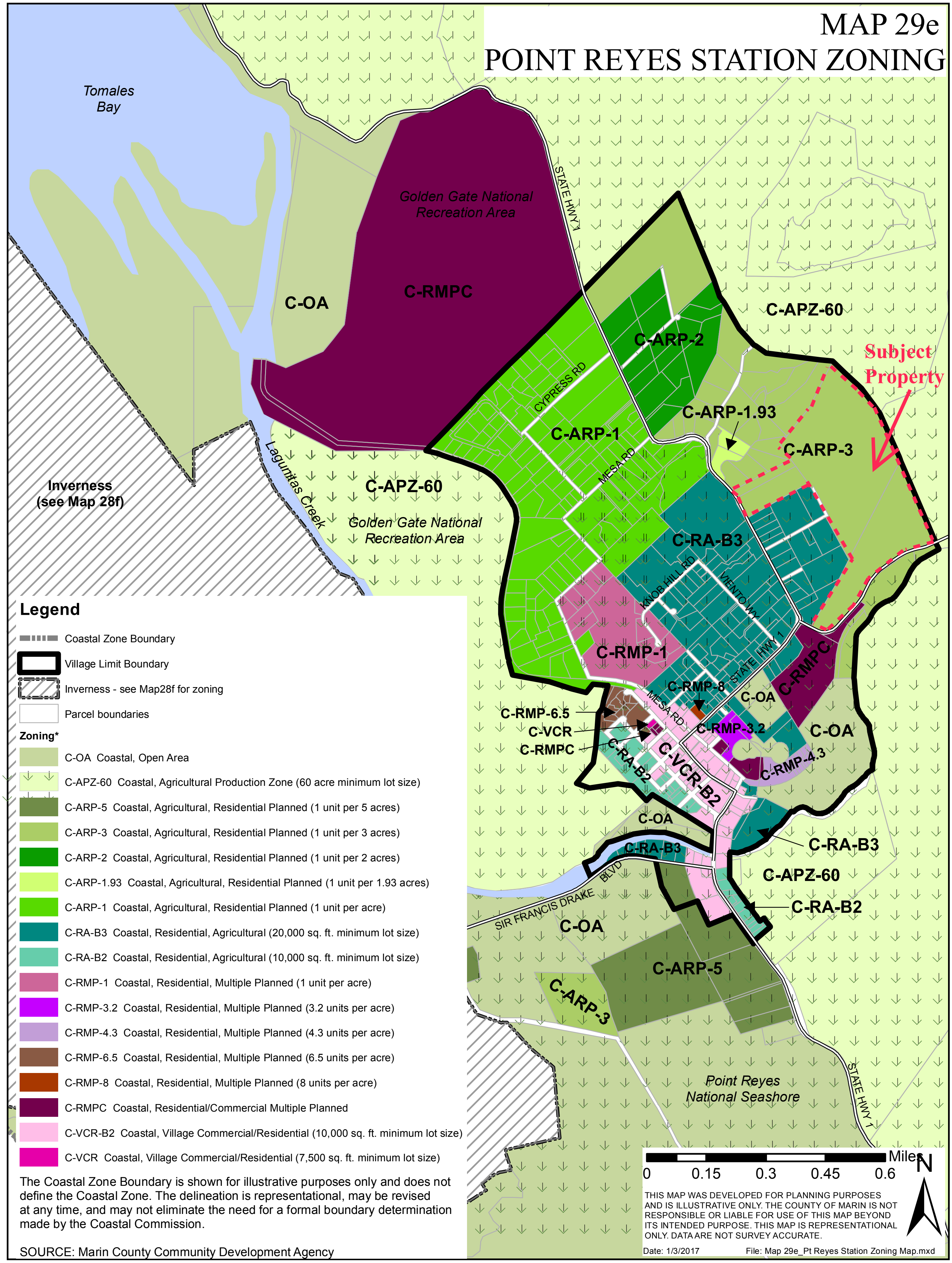
Area: 82.32 Acres (Total)
Date: December 2022
Scale: 1" = 200'

adobe associates, inc.
civil engineering | land surveying | wastewater
1220 N. Dutton, Ave., Santa Rosa, Ca. 95401
P (707) 541-2300; F (707) 541-2301

119-050-04 and 09
119-140-03 and 09

Job Number 22266-(Jaggs) DPW# 23-002 sheet 1 of 6

Figure 3a



MAP 29e
POINT REYES STATION ZONING

Legend

- Coastal Zone Boundary
- Village Limit Boundary
- Inverness - see Map28f for zoning
- Parcel boundaries

Zoning*

- C-OA Coastal, Open Area
- C-APZ-60 Coastal, Agricultural Production Zone (60 acre minimum lot size)
- C-ARP-5 Coastal, Agricultural, Residential Planned (1 unit per 5 acres)
- C-ARP-3 Coastal, Agricultural, Residential Planned (1 unit per 3 acres)
- C-ARP-2 Coastal, Agricultural, Residential Planned (1 unit per 2 acres)
- C-ARP-1.93 Coastal, Agricultural, Residential Planned (1 unit per 1.93 acres)
- C-ARP-1 Coastal, Agricultural, Residential Planned (1 unit per acre)
- C-RA-B3 Coastal, Residential, Agricultural (20,000 sq. ft. minimum lot size)
- C-RA-B2 Coastal, Residential, Agricultural (10,000 sq. ft. minimum lot size)
- C-RMP-1 Coastal, Residential, Multiple Planned (1 unit per acre)
- C-RMP-3.2 Coastal, Residential, Multiple Planned (3.2 units per acre)
- C-RMP-4.3 Coastal, Residential, Multiple Planned (4.3 units per acre)
- C-RMP-6.5 Coastal, Residential, Multiple Planned (6.5 units per acre)
- C-RMP-8 Coastal, Residential, Multiple Planned (8 units per acre)
- C-RMPC Coastal, Residential/Commercial Multiple Planned
- C-VCR-B2 Coastal, Village Commercial/Residential (10,000 sq. ft. minimum lot size)
- C-VCR Coastal, Village Commercial/Residential (7,500 sq. ft. minimum lot size)

The Coastal Zone Boundary is shown for illustrative purposes only and does not define the Coastal Zone. The delineation is representational, may be revised at any time, and may not eliminate the need for a formal boundary determination made by the Coastal Commission.

SOURCE: Marin County Community Development Agency

THIS MAP WAS DEVELOPED FOR PLANNING PURPOSES AND IS ILLUSTRATIVE ONLY. THE COUNTY OF MARIN IS NOT RESPONSIBLE OR LIABLE FOR USE OF THIS MAP BEYOND ITS INTENDED PURPOSE. THIS MAP IS REPRESENTATIONAL ONLY. DATA ARE NOT SURVEY ACCURATE.

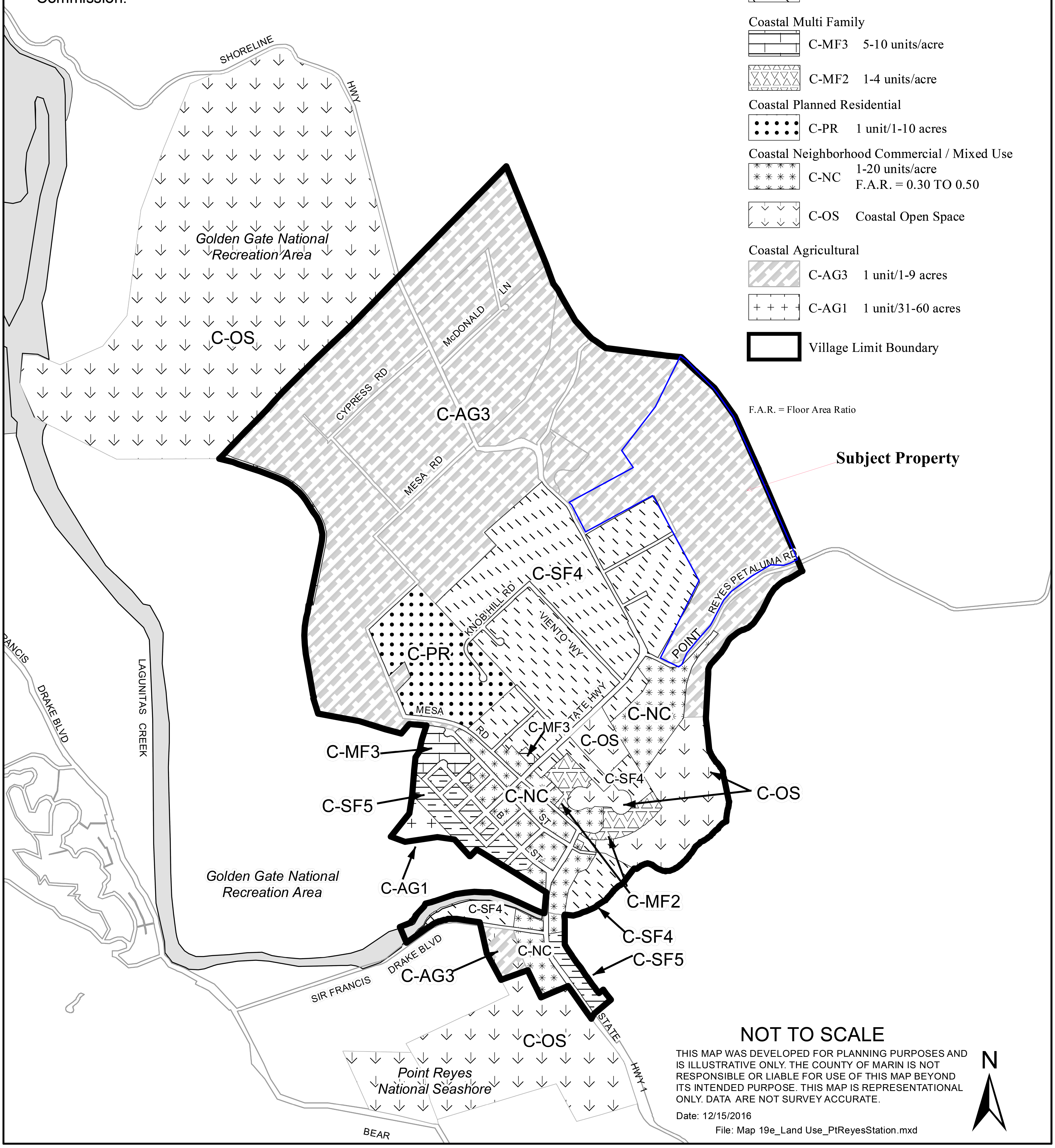
Date: 1/3/2017 File: Map 29e_Pt Reyes Station Zoning Map.mxd

Figure 3b

MAP 19e

POINT REYES STATION LAND USE POLICY MAP

The Coastal Zone Boundary is shown for illustrative purposes only and does not define the Coastal Zone. The delineation is representational, may be revised at any time in the future, is not binding on the Coastal Commission, and may not eliminate the need for a formal boundary determination made by the Coastal Commission.



Legend

Coastal Single Family

▤	C-SF5	2-4 units/acre
▧	C-SF4	1-2 units/acre

Coastal Multi Family

▦	C-MF3	5-10 units/acre
▧	C-MF2	1-4 units/acre

Coastal Planned Residential

●	C-PR	1 unit/1-10 acres

Coastal Neighborhood Commercial / Mixed Use

*	C-NC	1-20 units/acre F.A.R. = 0.30 TO 0.50
↓	C-OS	Coastal Open Space

Coastal Agricultural

▨	C-AG3	1 unit/1-9 acres
+	C-AG1	1 unit/31-60 acres
□		Village Limit Boundary

F.A.R. = Floor Area Ratio

NOT TO SCALE

THIS MAP WAS DEVELOPED FOR PLANNING PURPOSES AND IS ILLUSTRATIVE ONLY. THE COUNTY OF MARIN IS NOT RESPONSIBLE OR LIABLE FOR USE OF THIS MAP BEYOND ITS INTENDED PURPOSE. THIS MAP IS REPRESENTATIONAL ONLY. DATA ARE NOT SURVEY ACCURATE.

Date: 12/15/2016

File: Map 19e_Land Use_PtReyesStation.mxd

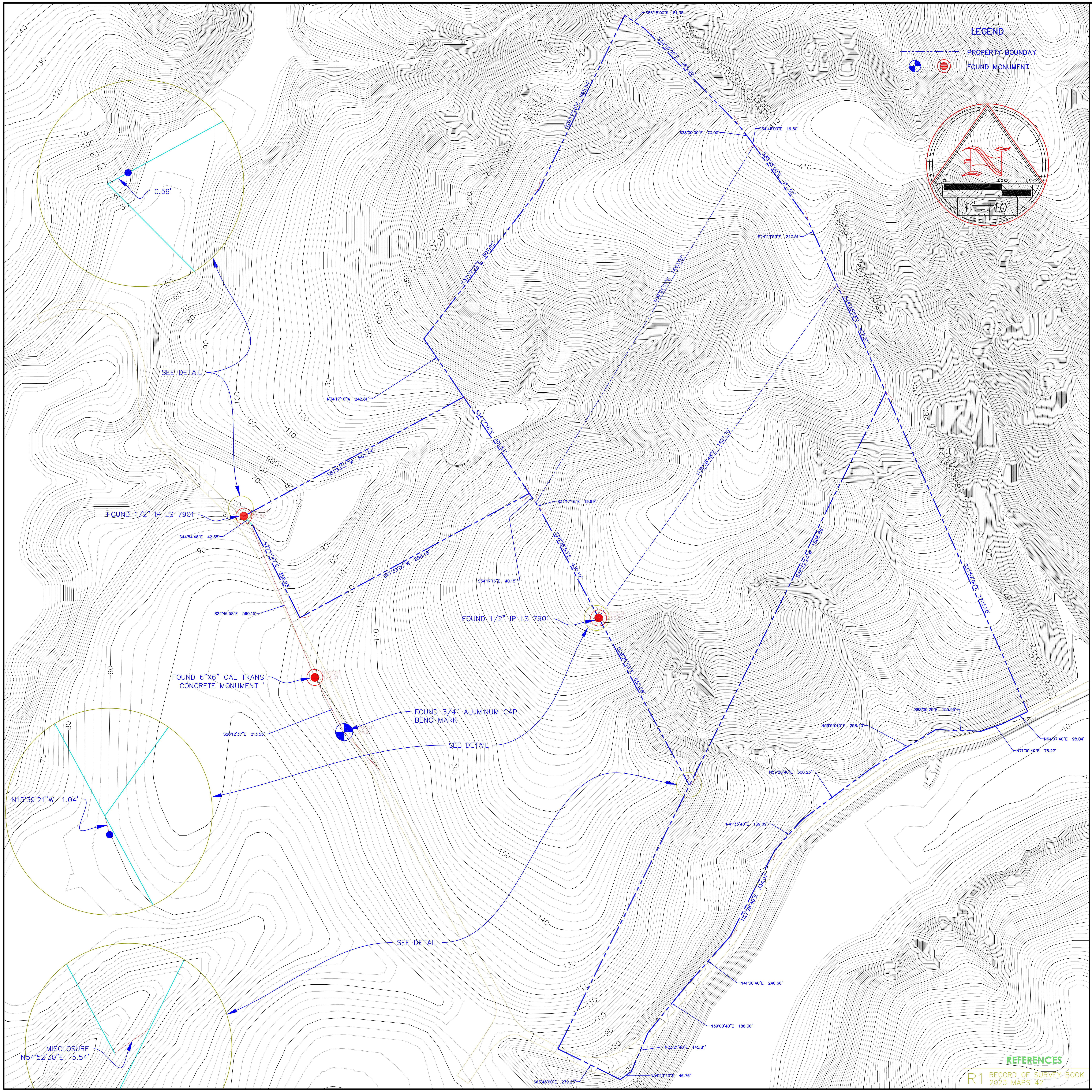
Figure 4
Preliminary Subdivision

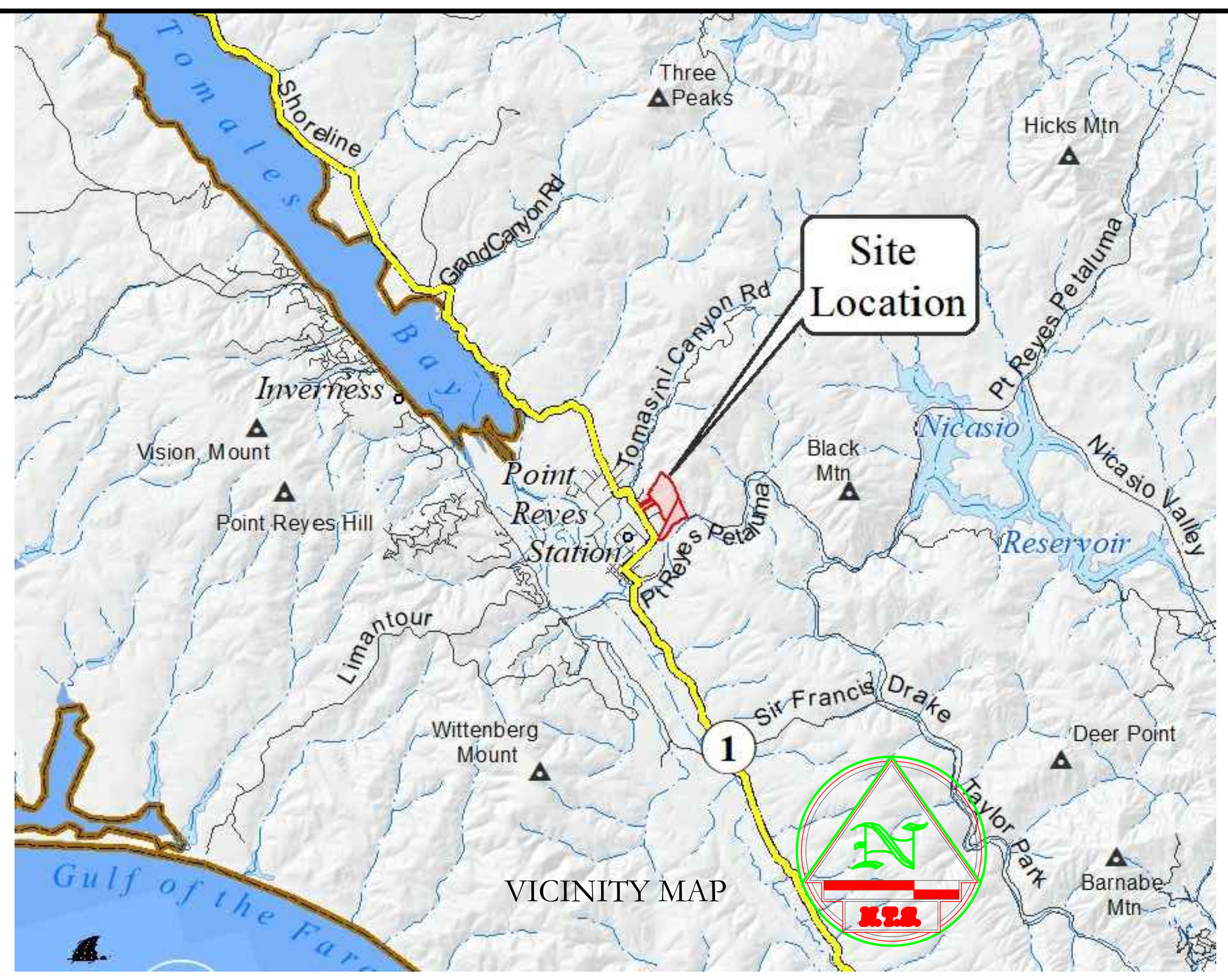
Project Data: Huffman Broadway Group; Base map: Esri Community Maps Contributors, County of Marin, California State Parks, © OpenStreetMap, Microsoft, Esri, HERE, SafeGraph, GeoTechnologies Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA; Imagery Date: 11/25/2021

Figure 5 Aquatic Resources and 100-Foot Buffers

Huffman-Broadway Group, Inc.

ENVIRONMENTAL REGULATORY CONSULATIONS





MAPPING NOTES

THE LOCATION OF UNDERGROUND STRUCTURES AND UTILITIES SHOWN HEREON HAS BEEN DETERMINED FROM SURFACE EVIDENCE OF THEIR EXISTENCE AND/OR FROM INFORMATION OBTAINED FROM PUBLIC AND/OR UTILITY AGENCIES. THE SURVEYOR ACCEPTS NO LIABILITY FOR THE LOCATION, EXISTENCE OR NON-EXISTENCE OF THOSE UNDERGROUND STRUCTURES, UTILITY LINES AND RELATED APPURTENANCES, ANY INDIVIDUAL, COMPANY OR AGENCY USING THIS MAP MUST CONFIRM THE LOCATION OF ALL UNDERGROUND LINES OR STRUCTURES PRIOR TO COMMENCING ANY EXCAVATION.

THE CONTENT OF THIS MAP WAS DEFINED BY CONTRACT AT THE SPECIFIC REQUEST OF THE CLIENT(S) AND/OR THEIR CONSULTANT(S). THE SURVEYOR ACCEPTS NO LIABILITY FOR USE OF THIS MAP BY ANY ONE OTHER THAN THE CLIENT(S) AND/OR CONSULTANTS FOR WHOM IT WAS PREPARED.

ANY BOUNDARY INFORMATION SHOWN HEREON IS RECORD DATA PER RS IN BOOK 2023 OF MAPS AT PAGE 42 MARIN COUNTY RECORDS AND DOES NOT REPRESENT A BOUNDARY SURVEY BY THE SURVEYOR.

ATTENTION

INFORMATION SHOWN HEREON HAS BEEN DERIVED FROM COLLECTED DATA AND PROCESSED IN ELECTRONIC FILE Boundary and Topograph with Yan Large Surface.dwg DATED 12/18/23. ALL AVAILABLE DATA MAY OR MAY NOT HAVE BEEN USED TO COMPILE THIS FINISHED PRODUCT. AN ELECTRONIC FORMAT OF THIS MAP WHICH CAN BE REFERRED TO FOR ADDITIONAL INFORMATION, HAS BEEN PROVIDED AS A COURTESY TO BC ENGINEERING AND SHALL BE CONSIDERED SUPPLEMENTAL TO THIS SIGNED AND SEALED PAPER ORIGINAL. A COPY OF THE SIGNED ORIGINAL HAS BEEN DELIVERED WITH THE ELECTRONIC DRAWING FILE AND CONSTITUTES THE DELIVERY PRODUCT OF PROFESSIONAL SERVICES AS PER OUR CONTRACT.

SURVEYOR'S STATEMENT

I, RAY C. CARLSON, A LICENSED LAND SURVEYOR IN AND FOR THE STATE OF CALIFORNIA, DO HEREBY STATE THAT THIS MAP WAS PREPARED BY ME, OR UNDER MY DIRECTION, AS REQUESTED BY YAN CUI IN SEPTEMBER 2023.

DATED: 12/14/2023

RAY C. CARLSON PLS 3890

RAY C. CARLSON
PLS 3890
EXP. 6-30-24

BENCHMARK NOTE

DESCRIPTION OF BENCHMARK:
ELEVATION: 124.9 FEET VRS GPS NAD83/NAVD88 CALIFORNIA ZONE III; EPOCH 2010.00, 18 GEOID, DECEMBER, 2023
CONTOUR INTERVAL = 2 FEET

(BOUNDARY AND) TOPOGRAPHIC MAP

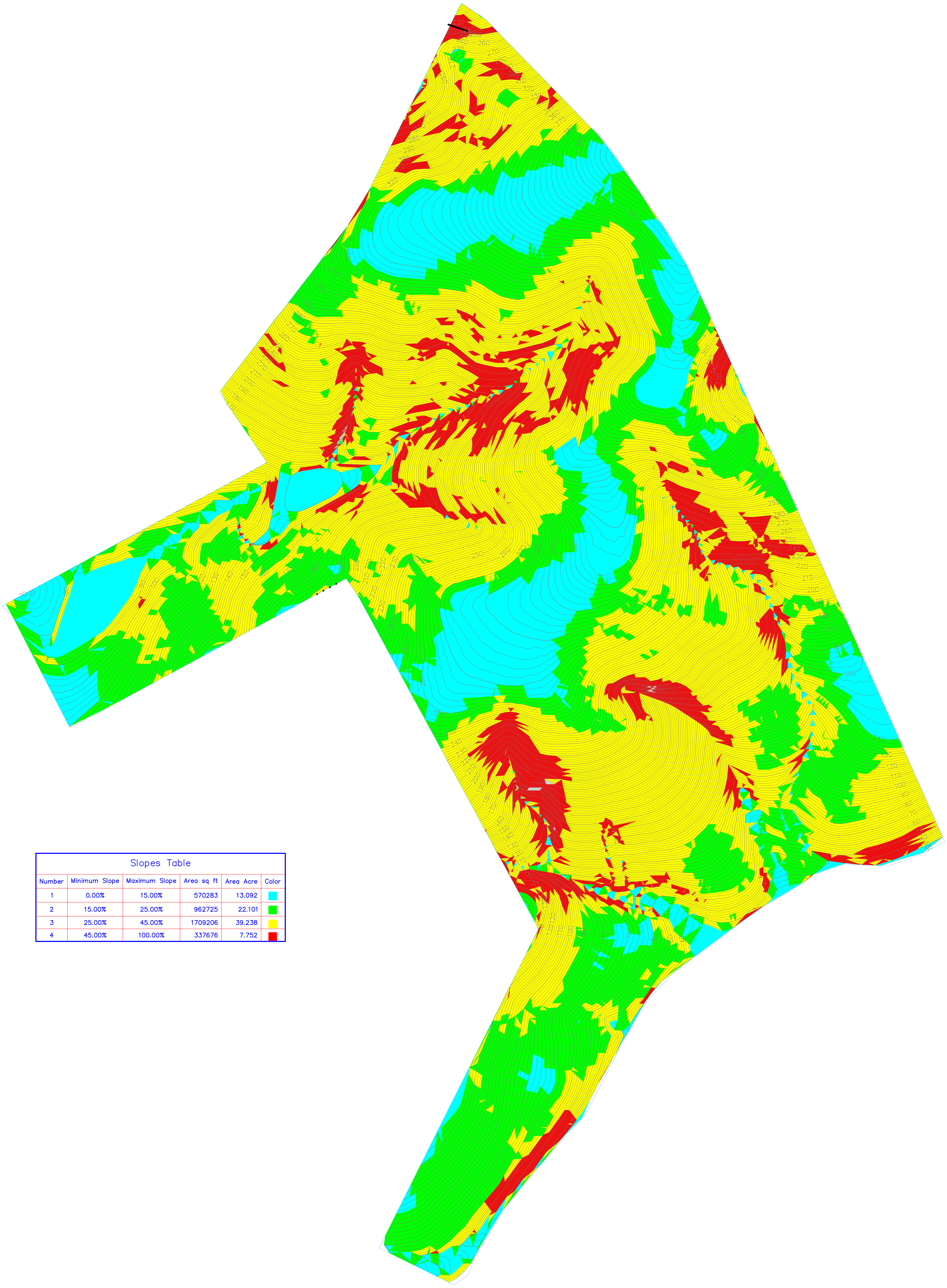
OF THE LANDS OF CUI AS DESCRIBED IN THAT DEED RECORDED IN OFFICIAL RECORDS AS DOCUMENT NUMBER 2023-0005225, MARIN COUNTY RECORDS.

POINT REYES STATION
COUNTY OF MARIN
STATE OF CALIFORNIA

RAY CARLSON
AND ASSOCIATES, INC.
Mapping for a Better World™
SURVEYING ▪ MAPPING ▪ GIS ▪ CONSULTING
411 RUSSELL AVENUE SANTA ROSA, CALIFORNIA 95403
(707) 528-7649 ▪ RCMAPS.COM

APN 119-050-004, 09 / 119-140-03, 09 DECEMBER 18, 2023 SHEET NO. 1 OF 1 JOB NO. 2023-092

Figure 6a Site Topography



Slopes Table

Number	Minimum Slope	Maximum Slope	Area sq ft	Area Acre	Color
1	0.00%	15.00%	570283	13.092	🟦
2	15.00%	25.00%	962725	22.101	🟩
3	25.00%	45.00%	1709206	39.238	🟨
4	45.00%	100.00%	337676	7.752	🟥

Figure 6b Site Slope Analysis

F:\DATA\2904\AutoCAD_ExistingDrainage.dwg

DESIGNED: GT. / XZ.
DRAFTED: GT.
CHECKED: XZ.

No.	DATE	REVISION	BY	APPR

STETSON
ENGINEERS INC.

Stetson Engineers Inc.
2171 E. Francisco Blvd., Suite K
San Rafael, CA. 94901
(415) 457-0701

THIS BAR IS 1-INCH LONG
AT FULL SCALE

DRAFT

CUI FAMILY LAND SUBDIVISION

OWNER: YAN CUI

ADDRESS: ______________________

EXISTING DRAINAGE FACILITIES

DATE: SEPTEMBER 25, 2024

SCALE: AS INDICATED

PROJECT No.: 2904

Figure 7

EXISTING DRAINAGE SUB-BASINS INSIDE PROPERTY

SUB-BASIN No.	AREA (SF)	AREA (ACRES)	TOP ELEV	BOTTOM ELEV	LENGTH INSIDE PROPERTY (FT)	AVER SLOPE
1-1	247,393.42	5.68	404	234	578	29.41%
2-1	1,556,050.86	35.72	404	68	2,103	15.98%
3-1	78,056.62	1.79	368	304	168	38.10%
4-1	17,359.25	0.40	276	256	266	7.52%
5-1	551,670.64	12.66	368	32	1,434	23.43%
6-1	355,618.53	8.16	308	34	1,068	25.66%
7-1	417,763.20	9.59	280	34	1,004	24.50%
8-1	227,284.77	5.22	130	40	355	25.35%
9-1	96,954.61	2.23	128	58	289	24.22%
10-1	2,616.60	0.06	110	90	139	14.39%
TOTAL	3,550,768.50	81.51				

F:\DATA\2904\AutoCAD_ExistingDrainage.dwg

DESIGNED: GT. / XZ.	No.	DATE	REVISION	BY	APPR
DRAFTED: GT.					
CHECKED: XZ.					

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2171 E. Francisco Blvd., Suite K
San Rafael, CA. 94901
(415) 457-0701

STETSON
ENGINEERS INC.

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AT FULL SCALE

DRAFT

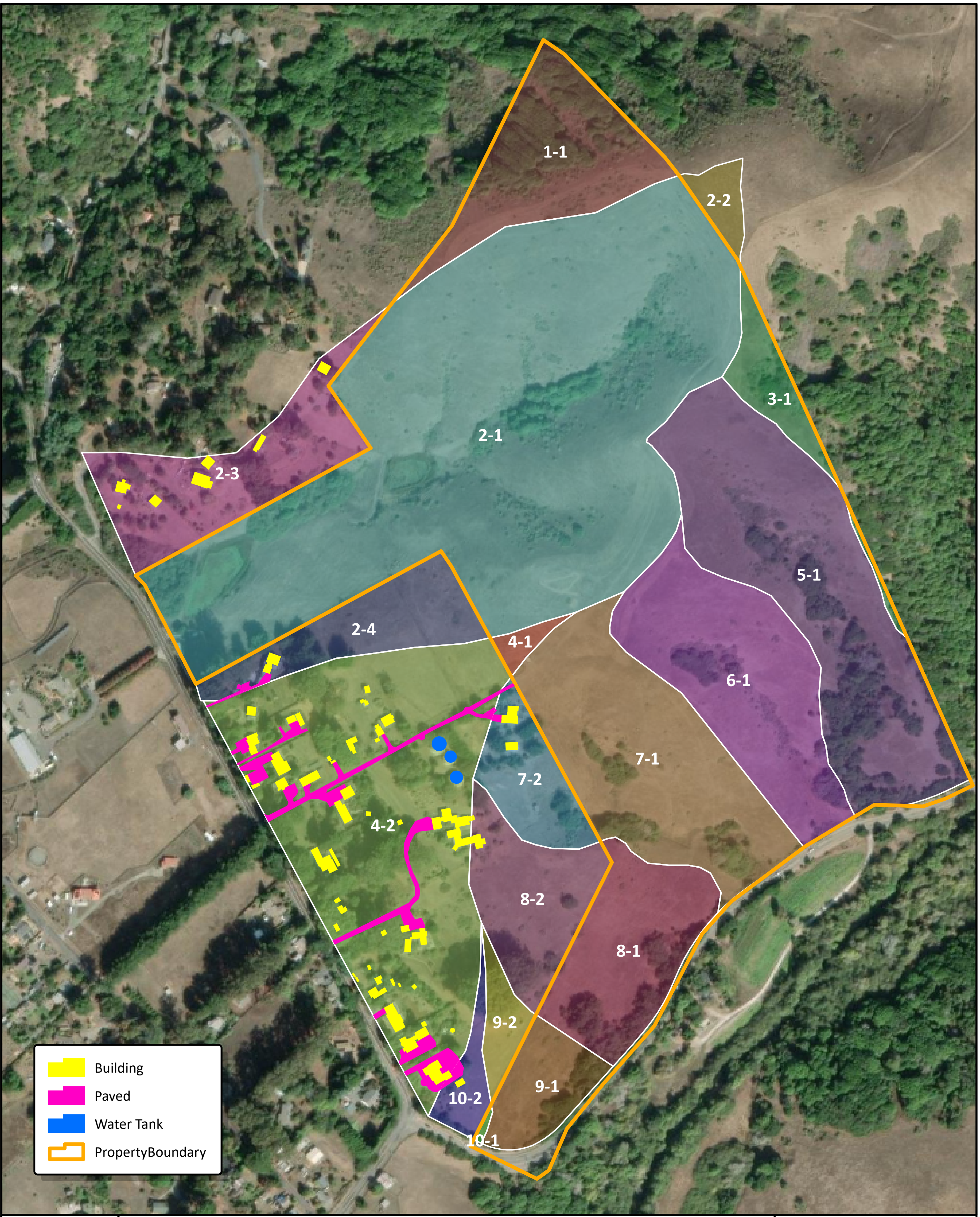
CUI FAMILY LAND SUBDIVISION
OWNER: YAN CUI
ADDRESS: ______________________

EXISTING DRAINAGE SUB-BASINS MAP

DATE: SEPTEMBER 25, 2024
SCALE: AS INDICATED
PROJECT No.: 2904

Figure 8

Figure 9



J:\jn2904\SubdivisionAnalysis2024.aprx ImperviousAnalysis

STETSON
ENGINEERS INC.

CUI FAMILY LAND SUBDIVISION

Drainage Basins/Subbasins and Existing Condition Impervious Areas

BIORETENTION FACILITY (BF)	ROAD AREA (SF)	BUILDINGS	NUMBER OF BUILDINGS	BUILDING AREAS (SF)	TOTAL IMPERVIOUS AREA (SF)	REQUIRED BF MINIMUM SURFACE AREA (SF)
BF1	17,087	4, 5, 6, 7, 9	5	20,000	37,087	1,483
BF2	20,022	1, 2, 3, 8,10	5	20,000	40,022	1,601
BF3	10,713	11, 12, 13, 14	4	16,000	26,713	1,069
BF4	10,600	21	1	4,000	14,600	584
BF5	25,529	15, 16, 17, 18	4	16,000	41,529	1,661
BF6	7,683	22, 23	2	8,000	15,683	627
BF7	22,097	19, 20, 24, 25	4	16,000	38,097	1,524
BF8	7,755	28, 29, 30, 31	4	16,000	23,755	950
BF9	23,562	26, 27, 32, 33	4	16,000	39,562	1,582
BF10	12,097	34, 35, 36	3	12,000	24,097	964
BF11	7,337	37	1	4,000	11,337	453
TOTAL	**164,482**		**37**	**148,000**	**312,482**	**12,499**

Table: BIORETENTION FACILITIES SIZING

DESIGNED: GT. / XZ.
DRAFTED: GT.
CHECKED: XZ.

No.	DATE	REVISION	BY	APPR

STETSON ENGINEERS INC.

Stetson Engineers Inc.
2171 E. Francisco Blvd., Suite K
San Rafael, CA. 94901
(415) 457-0701

THIS BAR IS 1-INCH LONG AT FULL SCALE

DRAFT

CUI FAMILY LAND SUBDIVISION

OWNER: YAN CUI

ADDRESS: ____________________

PROPOSED DRAINAGE FACILITIES

DATE: SEPTEMBER 25, 2024
SCALE: AS INDICATED
PROJECT No.: 2904

Figure 10

F:\DATA\2904\AutoCAD_ProposedDrainage.dwg

LEGEND

═	EXISTING CONTOUR LINES
—	EXISTING ROAD
—·· —	EXISTING CREEK FLOW LINE
—	EXISTING POND
— - - —	EXISTING RIDGE LINE
▬	EXISTING CULVERTS
—	TOPOGRAPHY DOMAIN BOUNDARY
—·—·—	PROPERTY BOUNDARY
→	DIRECTION OF FLOW
- - - -	ESHA 100 FT BUFFER
☐	C-ARP-3 BUILDING PAD
☐	AFFORDABLE HOUSING PAD
— - - —	PARCEL BOUNDARY LINE
▬	IMPERVIOUS AREA
▬	NEW DRAINAGE CULVERT
■	NEW BIORETENTION FACILITY (BF)

PROPOSED DRAINAGE SUB-BASINS

SUB-BASIN No.	AREA (SF)	AREA (ACRES)	IMPERVIOUS AREA (SF)	IMPERVIOUS AREA (ACRES)
1-1	247,393.42	5.68	0	0.00
2-1	1,556,050.86	35.72	132,354	3.04
3-1	78,056.62	1.79	26,713	0.61
4-1	17,359.25	0.40	0	0.00
5-1	551,670.64	12.66	56,129	1.29
6-1	355,618.53	8.16	38,097	0.87
7-1	417,763.20	9.59	23,755	0.55
8-1	227,284.77	5.22	24,097	0.55
9-1	96,954.61	2.23	11,337	0.26
10-1	2,616.60	0.06	0	0.00
TOTAL	**3,550,768.50**	**81.51**	**312,482**	**7.17**

F:\DATA\2904\AutoCAD_ProposedDrainage.dwg

DESIGNED: GT. / XZ.	No.	DATE	REVISION	BY	APPR
DRAFTED: GT.					
CHECKED: XZ.					

STETSON
ENGINEERS INC.

Stetson Engineers Inc.
2171 E. Francisco Blvd., Suite K
San Rafael, CA. 94901
(415) 457-0701

THIS BAR IS 1-INCH LONG AT FULL SCALE

DRAFT

CUI FAMILY LAND SUBDIVISION

OWNER: YAN CUI

ADDRESS: ______________________

PROPOSED DRAINAGE SUB-BASINS MAP

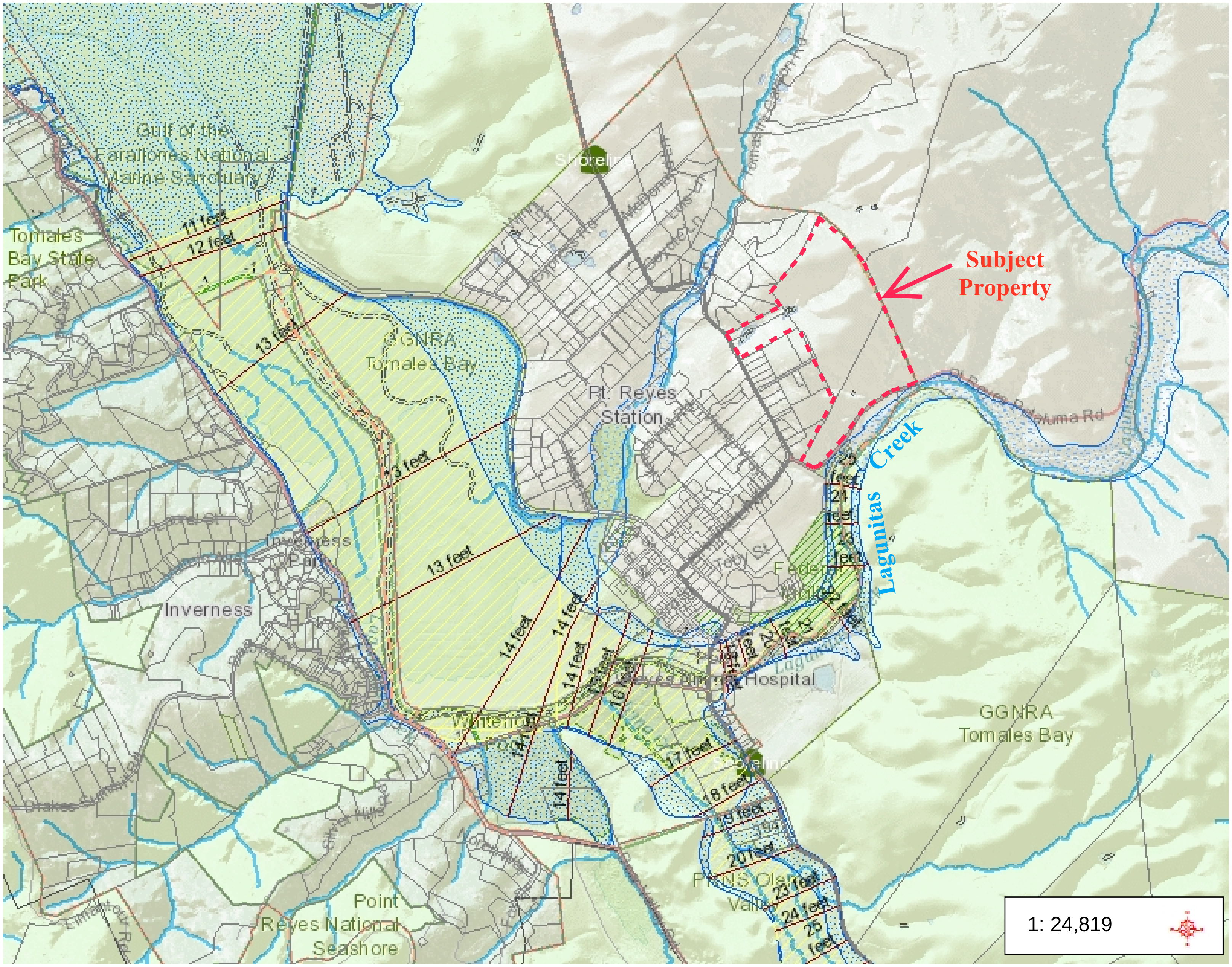
DATE: SEPTEMBER 25, 2024
SCALE: AS INDICATED
PROJECT No.: 2904

Figure 11

Figure 12

Marin Map

Map Report



Legend

Parcel Note
- ☐ easement
- ☐ centerline

- ☐ Parcel
- ☐ Condominium Common Area
- ☐ Mobile Home Pad
- ☐ City
- ☐ Community
- — Elevation_2017_10ft
- — Elevation_2017_idx_50ft
- ☐ Marin County Legal Boundary
- ☐ Other Bay Area County
- — Base Flood Elev, August 2017

Flood Hazard Zone, August 2017
- ▨ A
- ▨ AE
- ▨ AE, FLOODWAY
- ▨ AH
- ▨ AO
- ☐ D
- ▨ V
- ▨ VE
- ☐ X
- ▨ X
- ▨ X

Letter of Map Change: Valid Only
- ▨ LOMC Approved
- ▨ LOMC Denied

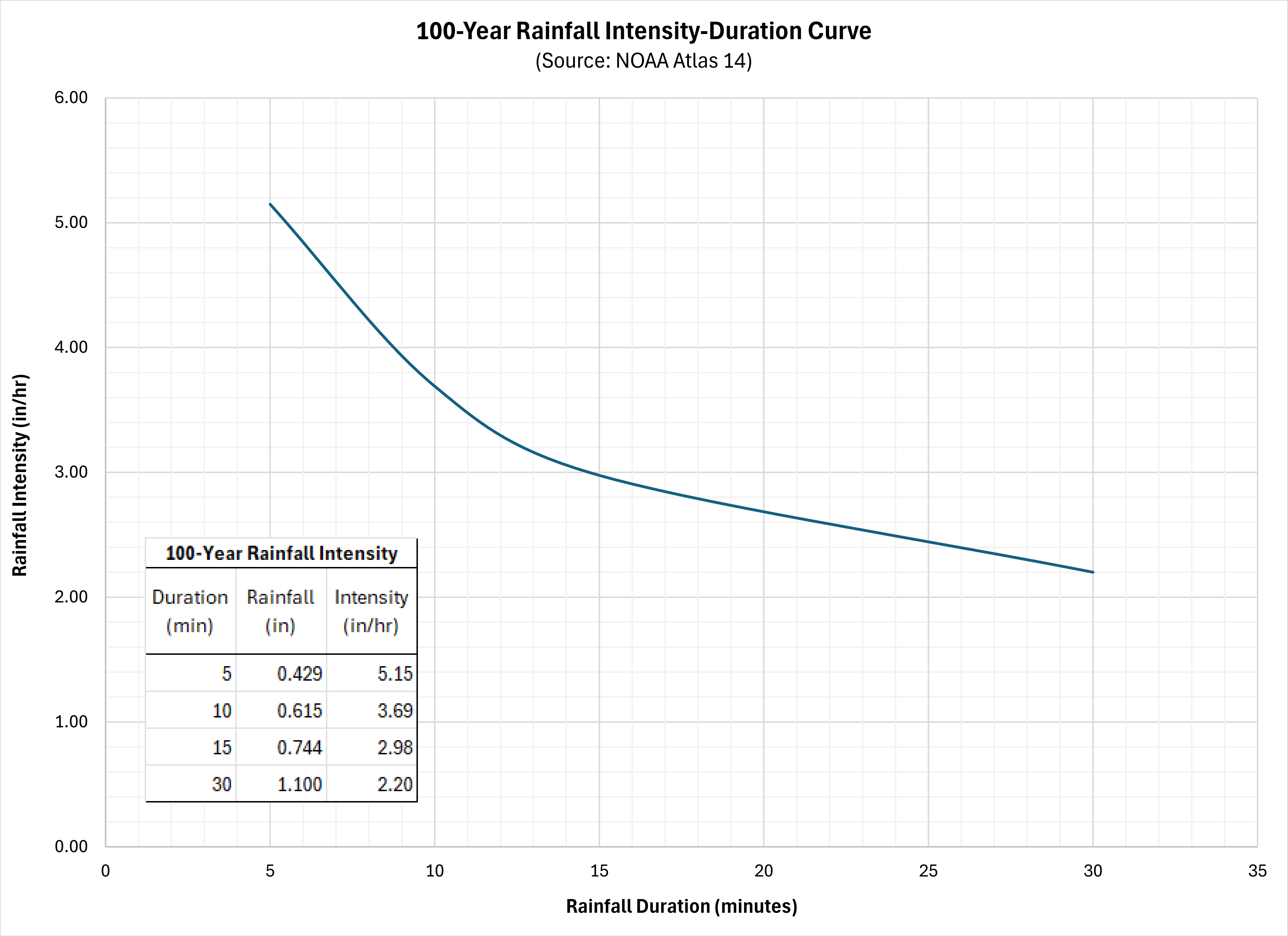
4,136.6 0 2,068.28 4,136.6 Feet

NAD_1983_HARN_StatePlane_California_III_FIPS_0403_Feet

Notes

FEMA 100-Year Flood Zone

Figure 13



100-Year Rainfall Intensity-Duration Curve

(Source: NOAA Atlas 14)

100-Year Rainfall Intensity

Duration (min)	Rainfall (in)	Intensity (in/hr)
5	0.429	5.15
10	0.615	3.69
15	0.744	2.98
30	1.100	2.20

Appendix A

NOAA Atlas 14 Rainfall Intensity-Duration-Frequency Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Point Reyes Station, California, USA*
Latitude: 38.0758°, Longitude: -122.803°
Elevation: 127 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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.154** (0.138-0.175)	**0.189** (0.168-0.215)	**0.237** (0.210-0.270)	**0.277** (0.243-0.319)	**0.334** (0.281-0.401)	**0.380** (0.312-0.468)	**0.429** (0.342-0.544)	**0.481** (0.371-0.631)	**0.555** (0.407-0.765)	**0.614** (0.432-0.882)
10-min	**0.221** (0.197-0.251)	**0.271** (0.241-0.308)	**0.339** (0.301-0.386)	**0.397** (0.348-0.457)	**0.479** (0.403-0.574)	**0.545** (0.448-0.671)	**0.615** (0.490-0.779)	**0.690** (0.531-0.904)	**0.795** (0.583-1.10)	**0.881** (0.620-1.26)
15-min	**0.268** (0.239-0.304)	**0.328** (0.291-0.372)	**0.410** (0.363-0.467)	**0.480** (0.421-0.552)	**0.579** (0.488-0.695)	**0.659** (0.541-0.811)	**0.744** (0.593-0.942)	**0.834** (0.643-1.09)	**0.962** (0.705-1.32)	**1.06** (0.749-1.53)
30-min	**0.395** (0.351-0.447)	**0.483** (0.429-0.548)	**0.604** (0.535-0.688)	**0.707** (0.620-0.814)	**0.853** (0.719-1.02)	**0.971** (0.797-1.20)	**1.10** (0.873-1.39)	**1.23** (0.947-1.61)	**1.42** (1.04-1.95)	**1.57** (1.10-2.25)
60-min	**0.580** (0.517-0.658)	**0.710** (0.631-0.806)	**0.888** (0.787-1.01)	**1.04** (0.912-1.20)	**1.26** (1.06-1.50)	**1.43** (1.17-1.76)	**1.61** (1.28-2.04)	**1.81** (1.39-2.37)	**2.08** (1.53-2.87)	**2.31** (1.62-3.31)
2-hr	**0.857** (0.763-0.972)	**1.04** (0.925-1.18)	**1.28** (1.14-1.46)	**1.48** (1.30-1.71)	**1.76** (1.48-2.11)	**1.98** (1.62-2.43)	**2.20** (1.75-2.78)	**2.43** (1.87-3.18)	**2.74** (2.01-3.78)	**2.99** (2.10-4.29)
3-hr	**1.09** (0.968-1.23)	**1.32** (1.17-1.50)	**1.62** (1.43-1.84)	**1.86** (1.63-2.14)	**2.20** (1.85-2.63)	**2.45** (2.01-3.02)	**2.71** (2.16-3.44)	**2.98** (2.30-3.90)	**3.34** (2.45-4.60)	**3.62** (2.55-5.20)
6-hr	**1.53** (1.36-1.74)	**1.86** (1.65-2.11)	**2.28** (2.02-2.59)	**2.61** (2.29-3.01)	**3.06** (2.58-3.67)	**3.40** (2.79-4.18)	**3.74** (2.98-4.74)	**4.08** (3.14-5.35)	**4.54** (3.33-6.25)	**4.88** (3.44-7.01)
12-hr	**2.08** (1.85-2.36)	**2.57** (2.28-2.92)	**3.20** (2.83-3.64)	**3.69** (3.24-4.25)	**4.36** (3.67-5.22)	**4.85** (3.98-5.97)	**5.34** (4.26-6.77)	**5.84** (4.50-7.66)	**6.50** (4.76-8.95)	**6.99** (4.92-10.0)
24-hr	**2.84** (2.56-3.22)	**3.59** (3.22-4.07)	**4.55** (4.08-5.17)	**5.31** (4.73-6.09)	**6.33** (5.46-7.49)	**7.10** (6.00-8.57)	**7.87** (6.50-9.71)	**8.64** (6.96-11.0)	**9.67** (7.48-12.7)	**10.4** (7.83-14.2)
2-day	**3.69** (3.32-4.18)	**4.67** (4.20-5.30)	**5.93** (5.32-6.75)	**6.95** (6.18-7.97)	**8.31** (7.17-9.83)	**9.34** (7.90-11.3)	**10.4** (8.58-12.8)	**11.4** (9.20-14.5)	**12.8** (9.93-16.9)	**13.9** (10.4-18.9)
3-day	**4.24** (3.82-4.81)	**5.37** (4.83-6.09)	**6.83** (6.13-7.77)	**8.01** (7.13-9.18)	**9.59** (8.27-11.3)	**10.8** (9.12-13.0)	**12.0** (9.91-14.8)	**13.2** (10.6-16.8)	**14.9** (11.5-19.6)	**16.1** (12.1-21.9)
4-day	**4.66** (4.19-5.28)	**5.90** (5.31-6.70)	**7.52** (6.74-8.56)	**8.82** (7.85-10.1)	**10.6** (9.11-12.5)	**11.9** (10.1-14.3)	**13.2** (10.9-16.3)	**14.6** (11.7-18.5)	**16.4** (12.7-21.6)	**17.7** (13.3-24.2)
7-day	**5.56** (5.00-6.30)	**7.08** (6.37-8.04)	**9.05** (8.12-10.3)	**10.6** (9.46-12.2)	**12.7** (11.0-15.1)	**14.3** (12.1-17.3)	**15.9** (13.1-19.6)	**17.5** (14.1-22.1)	**19.6** (15.2-25.8)	**21.2** (15.9-28.8)
10-day	**6.42** (5.78-7.28)	**8.22** (7.39-9.33)	**10.5** (9.43-12.0)	**12.3** (11.0-14.2)	**14.8** (12.7-17.5)	**16.5** (14.0-20.0)	**18.3** (15.1-22.6)	**20.1** (16.2-25.5)	**22.4** (17.4-29.6)	**24.2** (18.1-33.0)
20-day	**8.53** (7.68-9.67)	**11.0** (9.87-12.5)	**14.0** (12.6-16.0)	**16.4** (14.6-18.8)	**19.4** (16.8-23.0)	**21.7** (18.3-26.1)	**23.8** (19.7-29.4)	**25.9** (20.9-32.9)	**28.6** (22.2-37.7)	**30.6** (22.9-41.7)
30-day	**10.4** (9.34-11.8)	**13.3** (12.0-15.1)	**17.0** (15.2-19.3)	**19.8** (17.6-22.7)	**23.3** (20.1-27.5)	**25.8** (21.8-31.2)	**28.2** (23.3-34.9)	**30.6** (24.6-38.8)	**33.5** (25.9-44.2)	**35.6** (26.7-48.5)
45-day	**12.9** (11.6-14.6)	**16.5** (14.8-18.7)	**20.8** (18.6-23.7)	**24.0** (21.4-27.6)	**28.1** (24.2-33.3)	**31.0** (26.2-37.4)	**33.7** (27.8-41.6)	**36.3** (29.2-46.0)	**39.4** (30.5-52.0)	**41.7** (31.2-56.7)
60-day	**15.4** (13.9-17.5)	**19.6** (17.6-22.2)	**24.5** (22.0-27.9)	**28.2** (25.1-32.3)	**32.8** (28.3-38.7)	**35.9** (30.4-43.3)	**38.9** (32.1-48.0)	**41.6** (33.5-52.8)	**45.0** (34.8-59.3)	**47.3** (35.5-64.5)

[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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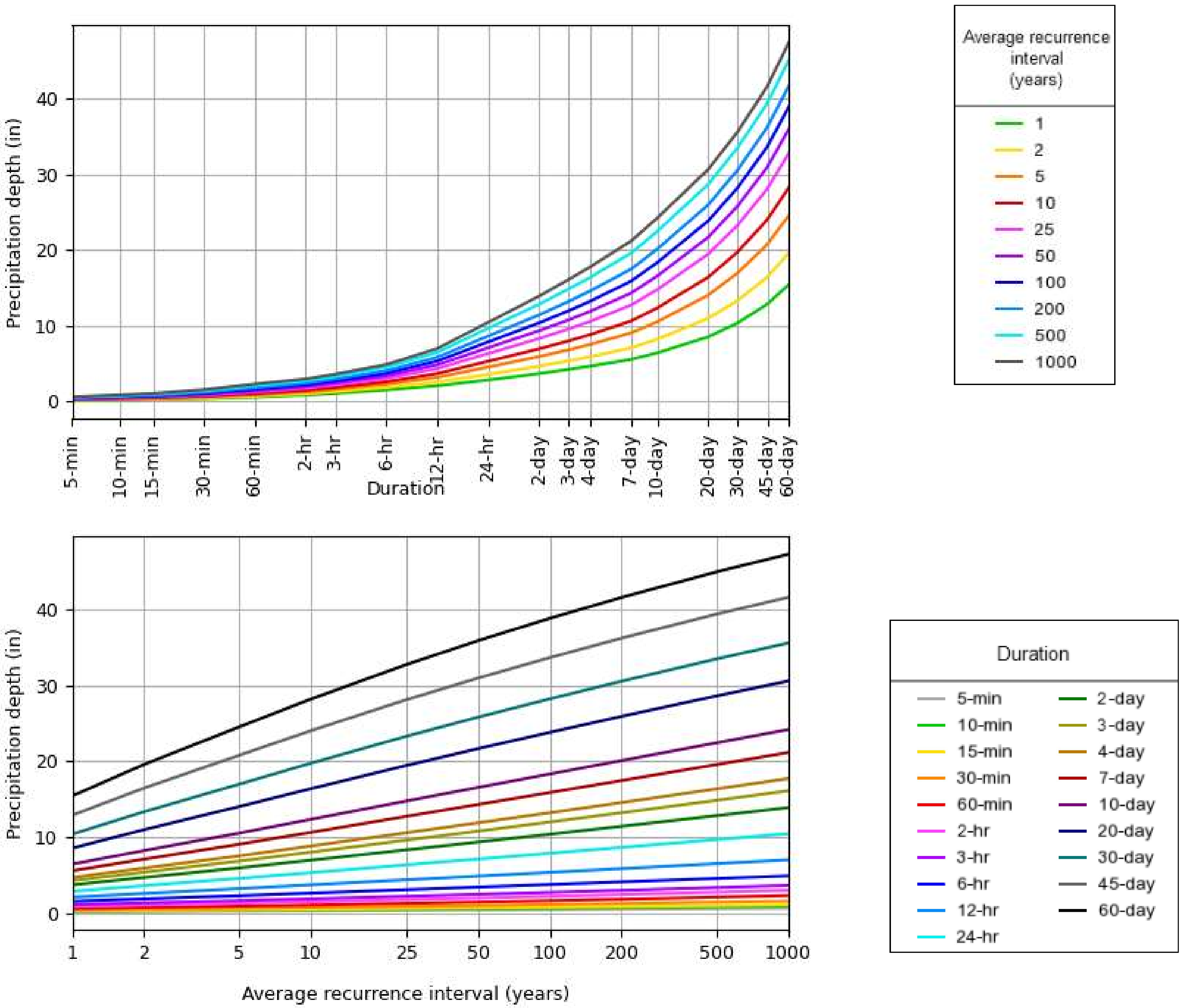
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 38.0758°, Longitude: -122.8030°



NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Sun Aug 25 20:25:18 2024

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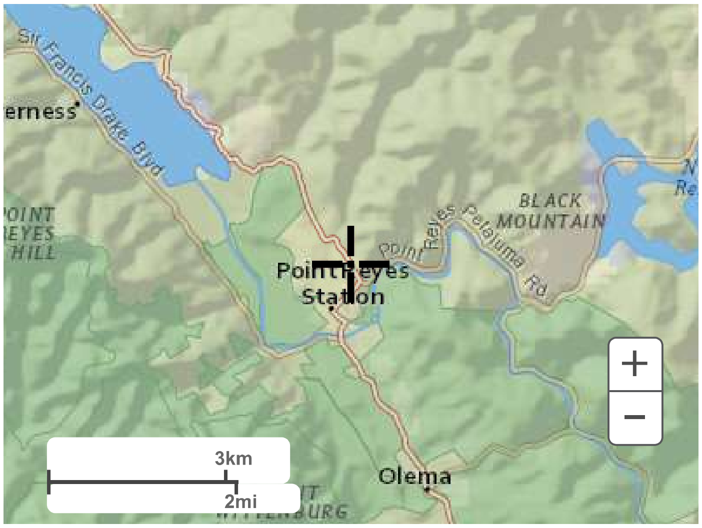
Maps & aerials

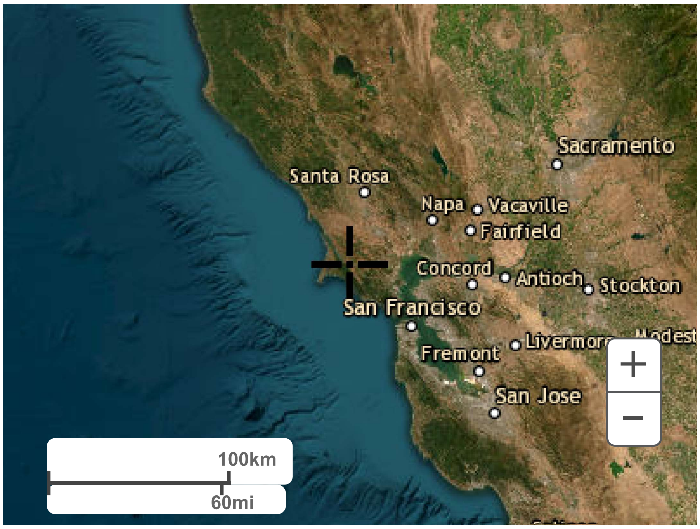
Small scale terrain



Large scale terrain

Large scale map

Large scale aerial



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