Memo

Date:	Tuesday, February 20, 2024
Project:	Sonoma County Water Agency (Sonoma Water) Contract No. 2223-058; Assessment of Flood Risk Management Services in Sonoma County
To:	Dale Roberts, Molly Oshun, and Sasha Ponomareva, Sonoma Water
From:	HDR
Subject:	Subtask 2.1 Deliverable – Desktop Analysis Memo
Purpose:	**Preliminary identification of existing and future flood risks in Sonoma County**

Situation

Over the past several decades, Sonoma County has incurred the highest recurrent flood damages of any county in the eleven western states (Corringham et al. 2019). These damaging floods are primarily caused by significant storm events known as atmospheric rivers (ARs). There is consensus among climate models used for the California Fourth Climate Assessment that ARs will increase in their intensity in the future, consequently exacerbating the impact of flooding in the county. Compounding this situation, flood risk management responsibilities in Sonoma County are spread across multiple agencies and levels of government. Increasing flood risk will put additional strain on services and resources.

Given this situation, Sonoma Water believes that there is a need to engage agencies with flood risk management responsibilities in a collaborative process to share experiences and ideas to collectively improve the effectiveness and efficiency of flood risk management. To accomplish this, Sonoma Water plans to convene partner agencies that provide flood risk management within Sonoma County, to identify potential overlaps and gaps in services, discuss the opportunities presented by new forecasting tools and technology, and consider ways to align resources and collaborate.

In recognition of key distinctions between the types of activities that occur before, during, and after a flood event, flood risk management activities are often grouped into four organizing pillars: Prevention, Preparedness, Response, and Recovery (Raikes et al. 2019). Sonoma Water plans to convene partner agencies with roles and responsibilities that cover all four of these pillars, including but not limited to, agencies that focus on planning, capital projects, emergency operations, and disaster recovery.

The findings from this assessment will eventually inform a Regional Flood Management Strategy, as recommended in Sonoma Water's 2021 *Climate Adaptation Plan* (Sonoma Water 2021).

Task

In preparation for convening partner agencies, HDR has completed a desktop analysis to support informed discussion amongst the parties. The desktop analysis (Subtask 2.1) consists of a preliminary assessment of current and future flood risk in different areas of Sonoma County, based on existing information; and an inventory of the existing authorities, roles and responsibilities, assets, funding sources, and standards held by each agency providing flood risk management services. The purpose of this memo is to present the results of the desktop analysis.

Actions

Review of Existing Resources

Sonoma Water provided a set of 15 documents, to be included in the desktop analysis. Documents included plans, studies, manuals, and scientific journal publications. HDR reviewed the documents for information on existing and future flood risk and the agencies that provide flood risk management services in Sonoma County.

HDR supplemented the information provided by Sonoma Water by reviewing the websites of agencies that provide flood risk management services and searching for additional detail regarding their respective authorities, responsibilities, funding sources, and policies and standards. In addition, HDR reviewed three spatial datasets with countywide coverage for additional information about existing flood exposure: special flood hazard areas (FEMA 2023), locally prepared maps of Flood Awareness Areas (Sonoma County 2021),[1] and levees and areas protected by levees (USACE 2023).

The document, website, and spatial data reviews were used to establish a preliminary understanding of current and future flood risks and responsibilities in Sonoma County.

Review by Partners

An administrative draft of the Desktop Analysis was prepared for Sonoma Water review on June 19, 2023. A revised, “discussion draft” of the Desktop Analysis was prepared on August 29, 2023, and distributed to partner organizations for review, to support subsequent discussions about flood risk management gaps, challenges, and opportunities. Ten partner organizations provided comments on the Desktop Analysis, and several partner organizations provided supplementary documents and spatial data for review and inclusion. This final version of the Desktop Analysis memo incorporates the information provided by partners.

[1] Flood Awareness Areas were originally created by Sonoma County Agricultural and Open Space District (Ag + Open Space) for the Vital Lands Initiative (Sonoma County 2021). The Sonoma County *Multijurisdictional Hazard Mitigation Plan* used Flood Awareness Areas to assess exposure of people and structures to flooding. Flood Awareness Areas can be viewed on the County’s Hazard Mapping Tool at https://experience.arcgis.com/experience/64d531fc0e654c19a40a172a074a5640/page/Hazards/?views=Flood

Limitations
The information summarized in this memo was developed by others. Except as specifically identified in this report, HDR has not performed independent validation or verification of data, modeling, or conclusions provided in the documents reviewed. HDR has assumed that the documents and websites reviewed are accurate, complete, and reliable.

A full list of the resources reviewed can be found in the References section.

Results

This section summarizes and synthesizes the information contained in the resources that were reviewed for the desktop analysis. Information is summarized first at the County level, then by watershed, and then by agency.

Countywide Overview

Sonoma County, California is the northernmost and largest county in the San Francisco Bay Area, covering more than 1,570 square miles. It is bordered by Marin County to the south, the Pacific Ocean to the west, Mendocino County to the north, Lake and Napa counties to the east, and the San Pablo Bay to the southeast.

The western portion of the county lies primarily in the forested, mountainous areas of the Coastal Range. A broad, flat valley extends north-south through the center of the County, traversed on its northern half by the Russian River. The Russian River watershed is roughly equal in area to the County itself, at 1,500 square miles, extending from Mendocino County to Sonoma County, and west to its mouth at the Pacific Ocean. Dry Creek and Mark West Creek are major tributaries to the Russian River that originate within the County, and which cover large watershed areas in their own right. The Petaluma River and Sonoma Creek watersheds are situated at the southern end of the north-south valley, enclosed by the Mayacamas Mountains to the northeast and rolling hills to the south, and separated by Taylor and Sonoma Mountains. The Petaluma River and Sonoma Creek flow through these valleys to the San Pablo Bay.

Sonoma County is home to approximately 488,000 people, concentrated in the valley and foothill cities of Cloverdale, Cotati, Healdsburg, Petaluma, Rohnert Park, Santa Rosa, Sebastopol, Sonoma, and Windsor. Despite its relatively low population density and rural character, Sonoma County has experienced the highest flood damages of any county in the Western U.S. over the past four decades (Corringham et al. 2019). The vast majority of repetitive loss properties in Sonoma County are located in unincorporated areas (Tetra Tech 2021, p. 10-8) and most are concentrated in Guerneville, Monte Rio, and other communities along the lower Russian River (Schichtel et al., 2024).

More than 99 percent of flood damages in Sonoma County have been attributed to atmospheric river events (Corringham et al. 2019). Atmospheric rivers are long bands of moisture-laden air that flow from the Pacific Ocean, releasing precipitation at landfall. Atmospheric rivers can result in storm events lasting multiple days, interspersed with periods of torrential rainfall. They have been identified as the primary cause of riverine flooding in California (Dettinger et al. 2011) and can also lead to stormwater flooding where the capacity of urban drainage systems is

exceeded. Sonoma County experiences the most atmospheric river landfall activity of any area along the Western U.S. (Corringham et al. 2019).

Climate change projections show the potential for greater atmospheric river activity, including more frequent, longer duration, and higher intensity storms (Sonoma Water 2021, pp. 3-13 – 3-14). Changes in the frequency, duration, and intensity of storm events creates challenges both to the effectiveness of existing facilities and for sizing facilities and infrastructure to manage flood risk. Future flood risk management will increasingly require improvements in forecast skill, to predict and prepare for major storms (Lamjiri et al. 2017). Changes in storm characteristics may also worsen flood risks and environmental effects associated with erosion, sedimentation, and channelization. According to the Sonoma Water *Climate Adaptation Plan*, "Future extreme precipitation is projected to increase by 10 to 30% and will exacerbate the detention basins, culvert, and channel capacity to manage high flows" (Sonoma Water 2021, p. 4-8).

Other sources of flooding in Sonoma County include coastal storms and tidal flooding along the ocean coast and San Pablo Bay shoreline (Tetra Tech 2021). Sea level rise is expected to exacerbate coastal flood hazards and increase risks for coastal development (OPC 2018). Sea level rise may increase riverine and stormwater flood risks by creating backwater effects and reducing the capacity of tidal rivers and streams (and connected drainage systems) to discharge flood flows.[2]

Watershed Level Flood Risk and Flood Risk Management

In 1958, under the authority of Sonoma Water's enabling legislation, the formation of nine geographical zones, each encompassing a major watershed (Hydrologic Unit Code 10), was proposed as a means of financing the construction and maintenance of flood protection works within Sonoma County (Figure 1).

Over the succeeding several years, Zones 1A, 2A, 3A, 5A, 7A and 8A were officially formed pursuant to the process outlined in the enabling act. The other zones have not been formed. At the time the existing zones were formed, the enabling act authorized Sonoma Water to annually impose up to twenty-five cents ($0.25) on each one hundred dollars ($100) of assessed valuation. In 1978, however, Proposition 13 passed limiting total property taxes to one percent of each parcel's value. As a result, the share that existing taxing entities would receive of the capped 1% (known as the Prop. 13 allocation) was frozen at the rate that existed at that time to set its percentage share of the 1%. This means that the zones that were formed and had imposed a tax/assessment pre-Prop. 13, continue to receive a share of property taxes as part of the Prop. 13 allocation. To augment the resulting limited funds received from its share of property taxes, in November 1986 and again in 1996, landowners in Zones 1A and 2A authorized the levying of special benefit assessments within these two zones for 10 years each. These assessments expired in 2006, and, due to the constraints imposed by Proposition 218 since its passage in 1996, Sonoma Water has not pursued any new flood management revenue measures.

[2] The Assessment of Flood Risk Management Services is primarily focused on riverine and stormwater flooding. Coastal flood hazards are treated at a higher-level in this memo, and this memo does not attempt to identify and summarize the many agencies involved in managing coastal flood risk.

Currently, five of the formed zones are funded through a share of property tax (the Prop. 13 allocation) within that zone ("Active") and one does not receive any property tax ("Inactive"). If a new zone was formed now, there is no funding that comes with simply "forming" a zone. Due to Prop, 13, Sonoma Water would not be able to follow the imposition process in the enabling act. Nor would the zone automatically receive a portion of the 1% property tax -- any share of that would require all the existing jurisdictions receiving property tax within the zone to voluntary shift its share to the zone.

Cities that are located within active Flood Control Zones may provide flood risk management services within their respective jurisdictions that are additional to the services provided by Sonoma Water or any other entities providing flood risk management services within the county. Major hydrologic features and jurisdictional boundaries for each watershed and flood control zone are depicted in Appendix A, Figure 4 through Figure 11.

Flood risk results from the desktop analysis are summarized by generalized watershed area.[3] Within each watershed, distinct characteristics within specific cities or Flood Control Zones are identified. Flood risks within Zone 9A Bay Watershed are discussed alongside flood risks for the upper Petaluma River (Zone 2A) and upper Sonoma Creek (Zone 3A). Table 1 identifies the generalized watershed areas used to organize the results, their component Flood Control Zones, and the status of the Flood Control Zones.

Table 1. General Watershed Areas, Component Flood Control Zones, and Zone Status

Watershed Areas	Component Flood Control Zones	Zone Status
Laguna de Santa Rosa/ Mark West Creek	Zone 1A Laguna de Santa Rosa Watershed	Active
Petaluma River	Zone 2A Petaluma River Watershed	Active
	Zone 9A Bay Watershed (lower Petaluma River only)	Not formed
Sonoma Creek	Zone 3A Valley of the Moon Watershed	Active
	Zone 9A Bay Watershed (lower Sonoma Creek only)	Not formed
Russian River	Zone 4A Upper Russian River Watershed	Not formed
	Zone 5A Lower Russian River Watershed	Active
Dry Creek	Zone 6A Dry Creek Watershed	Not formed
North Coast	Zone 7A North Coastal Watershed	Inactive
South Coast	Zone 8A South Coastal Watershed	Active

[3] This desktop analysis relies on information from plans and studies that were prepared at different geographic scales (e.g., Flood Control Zone scale, HUC-8 watershed scale, HUC-10 watershed scale, or HUC-12 watershed scale). Therefore, information in this memo is summarized by generalized watershed area, as noted in Table 1.

Figure 1. Overview of Hydrologic and Flood Control Zone Boundaries in Sonoma County

Laguna de Santa Rosa / Mark West Creek

DESCRIPTION

The Laguna de Santa Rosa / Mark West Creek watershed is a significant (more than 10 percent of total) drainage area to the Russian River, located in eastern Sonoma County. Major tributaries within the watershed include the Laguna de Santa Rosa, Copeland Creek, Santa Rosa Creek, Mark West Creek, and Windsor Creek. Mark West Creek flows from the Mayacamas Mountains in the east and joins the Laguna de Santa Rosa approximately 5 miles upstream of the Russian River. Windsor Creek flows from the Mayacamas foothills through Windsor, joining Mark West Creek near the confluence with the Russian River. Santa Rosa Creek and Matanzas Creek begin in the Mayacamas Mountains and flow west across the Santa Rosa Plain, and combine through the center of Santa Rosa, the County's largest city. Lower Santa Rosa Creek flows into the Laguna and northward to the Russian River confluence. Once water drains from the Laguna to the Russian River, it travels 24 miles to the Pacific Ocean (SFEI 2017, p. 5).

The Laguna de Santa Rosa is Northern California's largest freshwater wetland complex and is a prominent Pacific flyway stopover area for migratory birds. It is recognized as a Wetland of International Importance by the international Convention on Wetlands (Ramsar 2010). The Laguna is located at the western edge of the 254 square-mile Laguna de Santa Rosa / Mark West Creek watershed (SFEI 2017). The headwaters of the Laguna begin in the Sonoma Mountain foothills and flow through Cotati and Rohnert Park. Sebastopol is located on the west side of the Laguna de Santa Rosa, roughly four miles upstream of its confluence with Santa Rosa Creek.

An estimated 17 percent of the land cover in the watershed is urban, concentrated in Santa Rosa, Rohnert Park, Windsor, Cotati, and Sebastopol (Sonoma Water staff, *personal communication*, September 2023). The eastern side of the watershed is more rural, and includes recreational and educational open space uses, forest, and agricultural land. Historically, the extent of inundation in the Laguna dramatically varied throughout the year, with shallow open water covering an area between one-half mile and one mile wide during wet seasons (SFEI 2017). Population growth and development have resulted in the Laguna losing a substantial portion (54 to 73 percent) of native wetland and riparian habitats and caused stream channelization, streamflow alterations, and water quality impairment. Conversion of grasslands to ranches and agriculture has resulted in increased soil erosion, while impervious cover in urban areas has increased runoff and peak flows in channels. Both types of land cover change contribute to increased sediment deposition in downstream areas near the Laguna (SFEI 2017), reducing flood storage capacity. Reduced flood storage capacity in the Laguna also has downstream effects on flood stages in the lower Russian River.

FLOOD RISK

Flood hazards in the Laguna de Santa Rosa/Mark West Creek Watershed are driven by multiple sources. High flows on the Russian River can limit outflow from the Laguna, resulting in backwater conditions that can extend past Willowside Road (Sonoma Water 2020a, p. 3-7). The Laguna also receives tributary inflows that are influenced by stormwater runoff from Santa

Rosa, Rohnert Park, Cotati, Sebastopol, and large unincorporated developed areas, and that are separated from their floodplains by engineered or modified channels.

Western Rohnert Park, Cotati, and eastern Sebastopol experience the most impacts from floods along the Laguna and associated tributaries. During the February 2019 floods, the Barlow District in Sebastopol was inundated, severely impacting downtown businesses. Flooding has also caused water quality concerns in the Laguna. Despite efforts to mitigate flooding at the City of Santa Rosa's Regional Laguna Treatment Plant, it has flood repeatedly in the past (December 2005/January 2006) and is susceptible to future flooding (Tetra Tech 2021, p. 10-9 – 10-16). Additionally, ponds associated with local dairy farms are exposed to flooding, which could introduce untreated animal waste into the Laguna and the Russian River.

The historical flood inundation area overlaps portions of Rohnert Park, Cotati, and Sebastopol (SFEI 2017). However, Federal Emergency Management Agency (FEMA) 1 percent annual exceedance probability (AEP) floodplains and floodways are mapped in portions of all five municipalities in the watershed, as well as throughout the unincorporated areas of the valley floor (Figure 2). Both the County's Flood Awareness Areas and preliminary maps of the 1 percent AEP indicate that exposure in upstream areas could be more extensive than indicated on the effective FEMA maps (Sonoma County 2021).

The County's 2021 *Multijurisdictional Hazard Mitigation Plan* estimated that 592 buildings, 35 critical facilities (including three medical facilities), and 1,421 people would be exposed to the FEMA 1 percent AEP flood within incorporated areas in the watershed (Tetra Tech 2021, Appendix D). Of all incorporated areas in this watershed, Cotati has the greatest number and share of residents exposed (615 people, 8.2 percent). The socioeconomic characteristics of communities in central and southern Santa Rosa may also increase residents' vulnerability to flooding and make it more difficult to recover (ERG 2022, p. 93).

Recent hydrologic and hydraulic studies prepared for Sonoma Water indicate the potential for significant flooding of roadways throughout the Laguna de Santa Rosa/Mark West Creek Watershed (Sonoma Water 2023a, p. 4-18). Flooded roadways and stream crossings impact accessibility to medical and emergency facilities, including the City of Santa Rosa's primary Emergency Operations Center (City of Santa Rosa 2022, p. 22). Backwater conditions are highly dynamic near confluences with the Laguna, such as at the mouths of Calder Creek and Zimpher Creek, resulting in flooding at the Highway 12 and Occidental Road crossings.

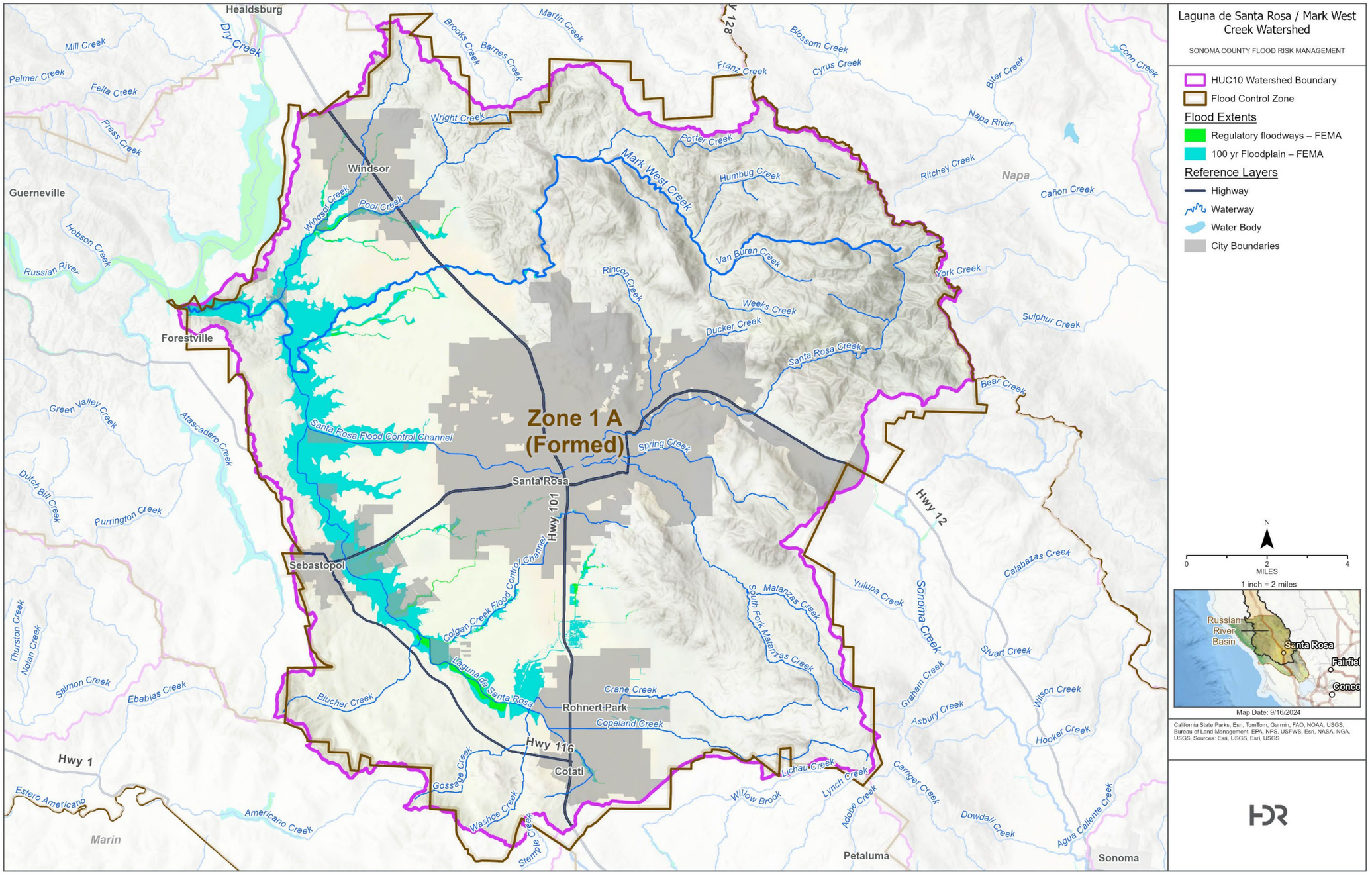

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Figure 2. Hydrologic and Flood Control Zone in Laguna de Santa Rosa / Mark West Creek Watershed

FLOOD RISK MANAGEMENT

Sonoma Water owns, operates, and maintains the Central Sonoma Watershed Project within this Flood Control Zone 1A. The Central Sonoma Watershed Project was constructed by Sonoma Water starting in the 1960s with assistance from the U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) to reduce flooding in the urbanizing Santa Rosa area (Sonoma Water 2021b). Sonoma Water was the local sponsor. The project consists of four main flood detention reservoirs – Santa Rosa Creek, Matanzas Creek, Piner Creek (on Paulin Creek), and Middle Fork of Brush Creek – as well as two diversions, bypass conduits, and numerous engineered flood control channels (Sonoma Water 2021b). Despite the upstream detention and diversion facilities, Santa Rosa Creek and Matanzas Creek pose a flood risk to the City of Santa Rosa. The Sonoma Water *Climate Adaptation Plan* states that the Central Sonoma Watershed Project facilities "…are currently unable to adequately manage flood flows greater than the historical 25-year flood on Santa Rosa Creek and Matanzas Creek."

Seven miles of levees along lower Santa Rosa Creek, Abramson Creek, and Peterson Creek are owned and maintained by Sonoma Water to contain the channel and protect adjacent agricultural land and rural residential uses (USACE 2023, Sonoma Water 2023b). The levees are not accredited, and the landside of the levees is therefore designated as being within the FEMA 1 percent AEP floodplain.

The Laguna de Santa Rosa and Mark West Creek Watershed boundary roughly corresponds to that of Flood Control Zone 1A. Flood Control Zone 1A has an Advisory Committee that reviews, recommends, and prioritizes improvement projects on an annual basis (Sonoma Water 2021, p. 2-4). Sonoma Water currently maintains engineered, modified, and natural flood control channels throughout this Flood Control Zone through its Stream Maintenance Program (Sonoma Water 2021, p. 2-4). A significant part of this maintenance includes the removal of coarse-grained sediment from the Laguna tributaries.

The NWS California-Nevada River Forecast Center (CNRFC) has forecast points on Santa Rosa Creek and within the Laguna. CNRFC, in coordination with the California Department of Water Resources (DWR), monitors weather conditions, rainfall, and river stage data, and issues official rainfall and river forecasts.

Table 2. Summary of Major Infrastructure Providing FRM in Zone 1A

FRM Infrastructure	Location	Responsible Entity
Central Sonoma Watershed Project	Santa Rosa Creek, Matanzas Creek, Paulin Creek, and Middle Fork of Brush Creek	Sonoma Water
Levees	Santa Rosa Creek, Abramson Creek, and Peterson Creek	Sonoma Water
Engineered, modified, and natural flood control channels	Certain channel reaches within Zone 1A, including within City of Santa Rosa	Sonoma Water
Engineered, modified, and natural flood control channels	Certain channel reaches within City of Santa Rosa	City of Santa Rosa
Forecast points	Santa Rosa Creek, Laguna de Santa Rosa (Cotati and Sebastopol), and Mark West Creek (Mirabel Heights)	CNRFC

Petaluma River

DESCRIPTION

The Petaluma River watershed covers 146 square miles in southeastern Sonoma County, of which roughly half is upland, one-third is valley, and the remainder is tidal marsh. The watershed is contained on the south by rolling hills along the Marin County border, and to the northeast by Sonoma Mountain. Major tributaries to the Petaluma River include Marin, Wilson, Wiggins, Liberty, Lichau, Willow Brook, Lynch, Corona, San Antonio, Adobe, and Capri Creeks. The lower Petaluma River is tidally influenced and flows through the Petaluma Marsh, discharging to San Pablo Bay.

The Petaluma River bisects the City of Petaluma, which is situated between the upper and lower reaches. Tides can reach upstream of downtown Petaluma (Sonoma Water 2020b). The remainder of the watershed is comprised of rural residential and agricultural land uses, as well as tidal marsh.

In 1880, US Army Corps of Engineers (USACE) dredged and straightened the river to improve navigation, widening the channel to 50 feet and deepening it to 3 feet. In 1931, USACE further widened the river channel to 100 feet and deepened it to 8 feet.

FLOOD RISK

Floods along the Petaluma River are typically short-lived episodic events characteristic of a small watershed's response to intense rainfall events. Urban development in and around the City of Petaluma has contributed to higher peak runoff, which is then constrained by bridges, engineered channels, and drainage infrastructure within the City of Petaluma. Additionally, high tides on the lower Petaluma River, and tributary inflows in certain upstream locations, can create backwater effects that restrict stormwater drainage and outflow from upstream tributaries (Sonoma Water 2020b).

Major floods occurred in 1982, 1986, 1997, 1998 and 2005 with various smaller flood events in other years. In January 1982, the Petaluma River overtopped its banks, inundating more than 50 city blocks, including the Payran neighborhood, with 2 to 5 feet of floodwaters. The event caused an estimated $28 million in damages to homes, businesses, and other property (City of Petaluma 2015). In February 1986, the river again overtopped its banks and flooded areas between the Lynch Creek confluence and the Lakeville Street Bridge up to five feet deep. A flood evacuation alert was issued and roughly 400 homes were evacuated by personal vehicle, bus, and boat. The flooding caused an estimated $1 million in damages (City of Petaluma 2015). Multiple storms spanning the 1997 and 1998 water year caused widespread flooding in the Petaluma watershed, concentrated in the Payran neighborhood. More than 50 homes, including a senior mobile home park, were evacuated on foot or by boat (City of Petaluma 2015).

The New Year's Eve storm of 2005 caused flooding within an outlet mall and three mobile home parks in north Petaluma with estimated damages of $56 million (City of Petaluma 2015). In December 2014, flooding caused road closures and evacuations but no structural damage

along Corona Creek in north Petaluma and along Lakeville Highway in east Petaluma (City of Petaluma 2015).

FEMA 1 percent and 0.2 percent AEP floodplain maps indicate that the confluence of the major tributaries with the Petaluma River, from Lynch Creek to Willow Brook, on the northwest side of the City of Petaluma, results in inundation outside of the channel (Figure 3). This flood prone area, Denman Flat, provides natural floodplain storage, reducing peak flows downstream. However, backwater from Willow Brook at this confluence point can cause overtopping and sheet flow to flood the area along North McDowell Boulevard between Highway 101 and the SMART railroad (City of Petaluma 2015).

The County's 2021 *Multijurisdictional Hazard Mitigation Plan* estimated that 251 buildings (including 80 residential structures), 33 critical facilities (including two medical facilities), and 271 people would be exposed to the 1 percent AEP flood within the city limits (Tetra Tech 2021, Appendix D). There are also floodplains and floodways outside of the channel in unincorporated communities in the upper watershed, including Penngrove.

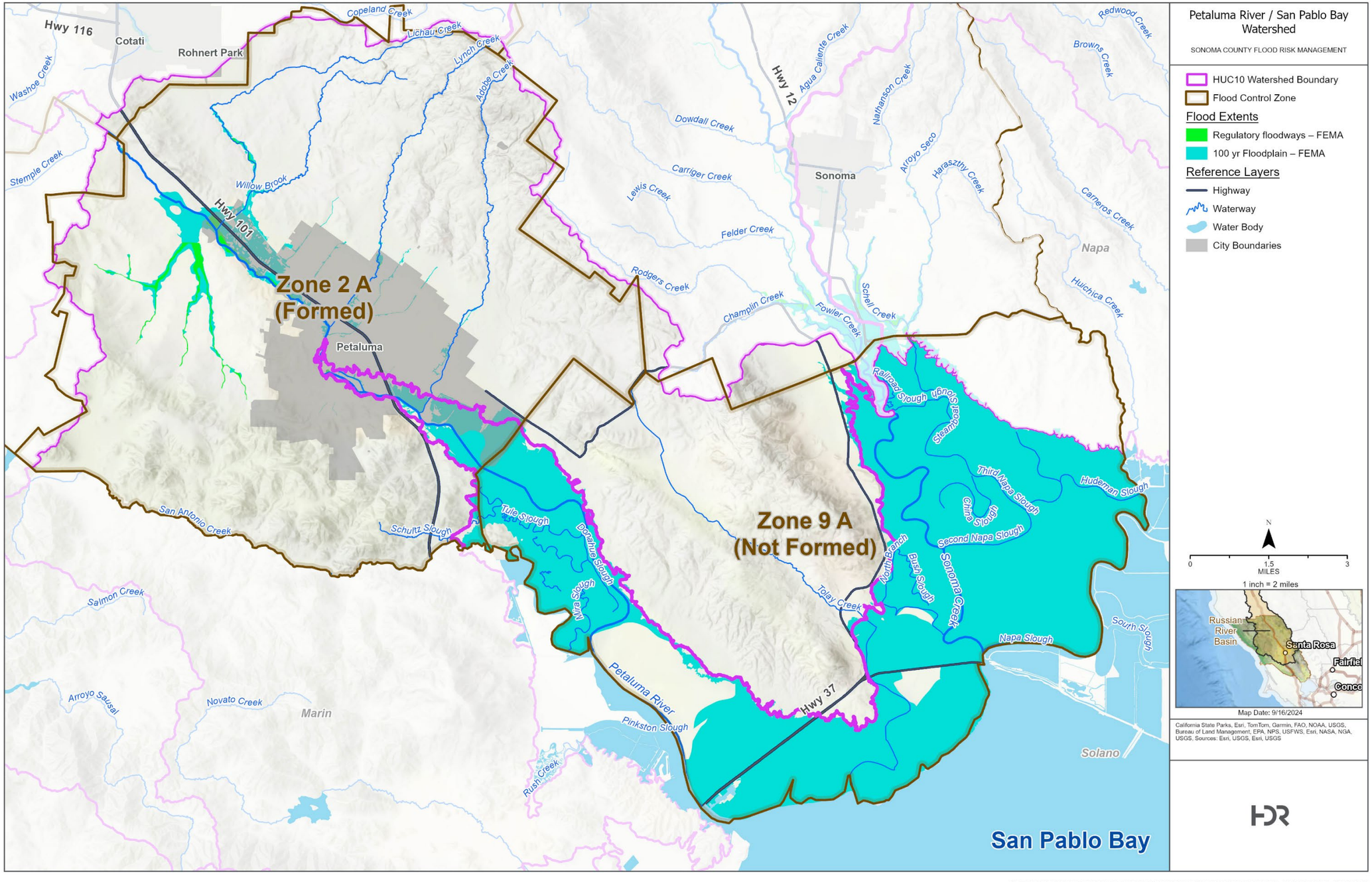

Figure 3. Hydrologic and Flood Control Zone Boundaries in the Petaluma River Watershed

FLOOD RISK MANAGEMENT

The upper Petaluma River watershed falls within Flood Control Zone 2A (Figure 3). Flood Control Zone 2A has an Advisory Committee that reviews, recommends, and prioritizes improvement projects on an annual basis (Sonoma Water 2021, p. 2-4).

After major flooding in 1982 and 1986, property owners in Zone 2A voted in favor of a 10-year benefit assessment to finance major flood control improvements, in partnership with the USACE. The assessment supported the local share of the federally authorized Petaluma River Main Channel and Flood Control Project and were renewed in 1996 for another 10 years. The Petaluma River Main Channel and Flood Control Project reshaped the Petaluma River channel, installed floodwalls and pump stations, and replaced the Payran and Lakeville Street bridges, removing the Payran neighborhood from the 1 percent AEP floodplain (downstream of Lynch Creek). Construction began in 1997, and the majority of the work was complete in 2008 (City of Petaluma 2015). A 2015 update to the FEMA Flood Insurance Rate Map (FIRM) accounts for these changes.

More recently, the City of Petaluma partnered with Sonoma Water and California Department of Water Resources (DWR) to implement the Petaluma River-Denman Reach project, to lower the base flood elevation in the Industrial Avenue and Corona Road area. The project widened the Petaluma River channel near Denman Flat, restored riparian habitat, and acquired and preserved the flood-prone areas around the channel (City of Petaluma 2020). The City of Petaluma owns and maintains the facilities associated with both the Petaluma River Main Channel and Flood Control Project facilities along Payran Reach and the Petaluma River-Denman Reach project (City of Petaluma 2015, USACE 2023).

Sonoma Water manages two conduits and owns multiple engineered flood control channels and maintenance easements over engineered channels that cross Highway 101 within the city limits (Sonoma Water 2021, p. 2-4). Sonoma Water also has maintenance easements over multiple modified reaches of the Petaluma River, Lichau Creek, Wiggins Creek, Wilson Creek, Corona Creek, and San Antonio Creek, and over multiple natural channel reaches in the upper watershed (Sonoma Water 2023b). Sonoma Water is exploring detention basin opportunities to manage stormwater runoff in the upper Petaluma River watershed before it enters the Petaluma River (Woodard & Curran 2023).

The lower Petaluma River watershed falls within Flood Control Zone 9A, which has not been formed (Figure 3). Many of the Baylands within the lower Petaluma River watershed are protected by privately-owned levees that are designed and maintained to varying levels of protection. The Sonoma Resource Conservation District (RCD) administers master permits that levee owners may elect to utilize for ongoing maintenance and repair needs (Southern Sonoma RCD 2013, p. 59).

USACE is authorized to conduct maintenance dredging of the Petaluma River on a regular cycle, though the actual frequency is dependent on available federal funding. The City of Petaluma is the local sponsor for the maintenance.

Other recent initiatives to manage flood risk in the watershed include the Southern Sonoma Storm Water Resources Plan (SWRP) and the Petaluma River Watershed Collaborative. The SWRP effort was led by Sonoma Water with input from a broad set of interested parties, covering both the Petaluma River and Sonoma Creek watersheds. A variety of projects, ranging from land management strategies to detention basins to urban stormwater projects, were identified and prioritized based on flood, water quality, ecosystem, and other benefits (Sonoma Water 2019. With regard to the Petaluma River Watershed Collaborative, the Sonoma RCD is leading an effort to build capacity of organizations within the watershed to implement priority projects through collaborative actions, include updating the *Petaluma River Watershed Enhancement Plan*.

Table 3. Summary of Major Infrastructure Providing FRM in Zones 2A and 9A

FRM Infrastructure	Location	Responsible Entity
Petaluma River Main Channel and Flood Control Project	Petaluma River, Payran Reach	City of Petaluma
Petaluma River-Denman Reach Project	Petaluma River, Denman Reach	City of Petaluma
Levees	Lower Petaluma River/San Pablo Bay	Private landowners, facilitated by Sonoma RCD
Engineered, modified, and natural flood control channels	Certain channel reaches within Zone 2A, including within City of Petaluma	Sonoma Water
Engineered, modified, and natural flood control channels	Certain channel reaches within City of Petaluma	City of Petaluma

Sonoma Creek

DESCRIPTION

The Sonoma Creek Watershed covers 170 square miles, contained between the Mayacamas Mountains on the east and Sonoma Mountain to the southwest (Sonoma Water 2021b). Sonoma Creek's headwaters start around Bald Mountain and Sugarloaf Ridge State Park, from which it flows south through the unincorporated communities of Kenwood, Glen Ellen, Eldridge, Fetters Hot Springs/Agua Caliente/Boyes Hot Springs/El Verano, the City of Sonoma, and the community of Schellville, before discharging to the San Pablo Bay.

Major tributaries of upper Sonoma Creek include Calabazas Creek, Carriger Creek, Nathanson Creek, Fryer Creek and Rodgers Creek (ESA PWA, 2012). Lower Sonoma Creek is tidally influenced and discharges to the San Pablo Bay. Schell Creek and Carneros Creek are major tributaries to Lower Sonoma Creek (Sonoma RCD 2013).

Much of the Sonoma Valley was historically marshland. The upper Sonoma Valley floor, near Kenwood, was historically an extensive freshwater marsh (Sonoma RCD 2013). Numerous highly erodible alluvial fans delivered sediment and flow to the marsh. The Lower Sonoma Creek drainage area was historically tidal marsh and mudflats. Starting in the mid-1800s, more than 3,000 acres of these Baylands were reclaimed for agriculture through the construction of levees and dikes (ESA PWA, 2012).

The watershed is characterized by high parallel ridges to the east and the west and a narrow, low lying valley floor. Approximately 51 percent of this land is used for agriculture, with the rest in rural and open space uses, including tidal wetlands and marsh (Sonoma Water 2019, p. 2-15).

FLOOD RISK

Similar to the Petaluma River, floods along Sonoma Creek are typically short-lived episodic events. Within the upper watershed, channel straightening has increased flow and sediment delivery to the historic marsh area, where significant rainfall volumes create a high-water table that can drive local flooding in the upper Sonoma Valley. Drainage infrastructure constraints in the developed areas of the watershed also contribute to localized flooding. Within the City of Sonoma, the most common flooding occurs along Nathanson Creek, which is a major tributary to Sonoma Creek.

The most flood-prone areas in Sonoma Valley are in the lower watershed, in the vicinity of Schellville and Highway 121 (Sonoma Water 2020b). Road closures on Highway 121 occur nearly annually due to flooding (Sonoma Water staff, personal communication). Flooding in the lower watershed is primarily driven by the backwater effects caused by high tides, and the differential in land and water elevations caused by land reclamation (ESA PWA 2012).

Major flood events have been recorded as early as 1824. Major recent events include the floods of 1982, 1998, 2003, 2005, and 2008. During the latter two events, flooding occurred in the lower watershed and Baylands area. The New Year's Eve 2005 event was a 100-year flood that resulted in several levee failures (Sonoma RCD 2013). In 2008, storm surge in the San Pablo Bay caused Sonoma Creek to overtop its banks upstream of Highway 121, with sheet flow flooding across Highway 121 and Highway 12 (Sonoma RCD 2013). The Schellville area has experienced recurring flooding from Sonoma and Schell Creek due to small winter storm events that result in bank overtopping, sometimes numerous times a year. Areas surrounding the historic Kenwood Marsh may be affected by floodwaters for multiple days. The middle reaches experience a relatively short duration of floodwaters. Backwater from San Pablo Bay has a large impact on flood duration in the lower river, where flooding may last several days. These hazards are anticipated to worsen as sea levels rise, pushing tidal effects further inland.

FEMA 1 percent AEP floodplain maps indicate that floodways and floodplains are mostly confined to channels in the upper watershed, with the exceptions of small areas in Kenwood and Sonoma (Figure 4). The County's 2021 *Multijurisdictional Hazard Mitigation Plan* estimated that 43 buildings and 81 people would be exposed to the 1 percent AEP flood within the City of Sonoma (Tetra Tech 2021, Appendix D). The socioeconomic characteristics of Boyes Hot Springs may increase residents' vulnerability to flooding, despite the low hazard potential (ERG 2022, p. 102).There are extensive floodplain and floodway areas mapped within the lower watershed, as few of the leveed areas provide 100-year protection.

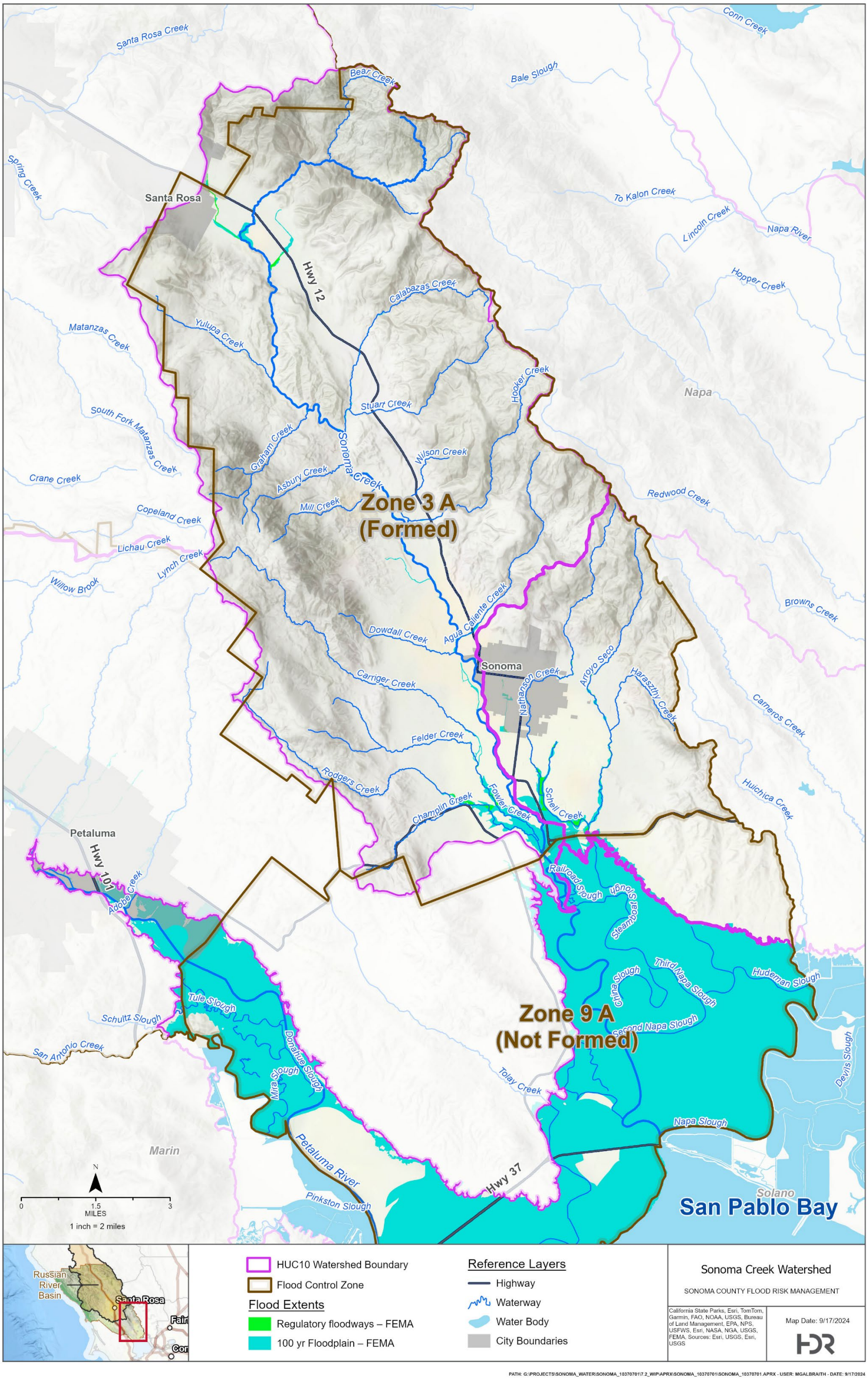

Figure 4. Hydrologic and Flood Control Zone Boundaries in the Sonoma Creek Watershed

FLOOD RISK MANAGEMENT

The upper Sonoma Creek watershed falls within Flood Control Zone 3A (Valley of the Moon Watershed) (Figure 4). Flood Control Zone 3A has an Advisory Committee that reviews, recommends, and prioritizes improvement projects on an annual basis (Sonoma Water 2021, p. 2-4). The Flood Control Zone has financed flood protection and drainage facilities, the maintenance of natural waterways, the preparation of master drainage plans for areas subject to flooding, and erosion and sediment control activities.

The Flood Control Zone has also financed the flood protection operation and maintenance activities of Sonoma Water. Sonoma Water maintains Kenwood Creek Bypass Conduit and engineered channels along Fryer Creek, Nathanson Creek, and Rodgers Creek (Sonoma Water 2021, p. 2-4). Sonoma Water also holds maintenance easements for numerous other modified and natural channel reaches throughout the upper watershed (Sonoma Water 2023b, “Flood Zone 3A”).

The lower Sonoma Creek watershed falls within Flood Control Zone 9A, which is not formed (Figure 4). Many of the reclaimed lands within the lower Sonoma Creek watershed are protected by privately-owned levees that are designed and maintained to varying levels of protection. The Sonoma RCD administers master permits that levee owners may elect to utilize for ongoing maintenance and repair needs (Southern Sonoma RCD 2013, p. 59). Although USACE has provided emergency levee repairs in response to past flood events, the levees are not federally authorized. Numerous studies have been conducted to establish federal interest, but adequate cost-benefit has not been identified (ESA PWA 2012).

As discussed in the Petaluma Watershed section above, the Southern Sonoma SWRP effort identified and prioritized a variety of projects in the Sonoma Creek watershed to manage flood risk, among other benefits (Sonoma Water 2019). In addition to the SWRP planning effort, Sonoma Water has recently invested in updated hydrology and hydraulic modeling for the Sonoma Valley. The study included an evaluation of mid-century climate change projections for the 24-hour rainfall event across a range of recurrence intervals and produced detailed maps of model results showing areas susceptible to inundation (ESA 2022).

Table 4. Summary of Major Infrastructure Providing FRM in Zones 3A and 9A

FRM Infrastructure	Location	Responsible Entity
Kenwood Creek Bypass Conduit	Kenwood Creek, from Highway 12 to Sonoma Creek	Sonoma Water
Levees	Lower Sonoma Creek/San Pablo Bay	Private landowners, facilitated by Sonoma RCD
Engineered, modified, and natural flood control channels	Certain channel reaches within Zone 3A, including within City of Sonoma	Sonoma Water
Engineered, modified, and natural flood control channels	Certain channel reaches within City of Sonoma	City of Sonoma

Russian River

DESCRIPTION

The Russian River Watershed encompasses roughly 1,500 square miles in Mendocino and Sonoma Counties. Approximately 650 square miles of the watershed lie in Sonoma County, including the Dry Creek and Laguna de Santa Rosa/Mark West Creek watersheds, which are discussed in separate sections of this memo due to their unique characteristics and flood risks. The Russian River is the second-largest river in the San Francisco Bay Area, flowing 110 miles from its headwaters to the Pacific Ocean, near Jenner (RRWA 2018). The primary land uses include rural residential, agriculture, and wine grape cultivation. Urban land uses are concentrated within the small cities of Cloverdale and Healdsburg, and within unincorporated communities, such as Mirabel Park, Forestville, Rio Nido, Guerneville, Monte Rio.

The portion of the Russian River watershed that lies within Sonoma County and above the confluence with Dry Creek, falls within proposed Flood Control Zone 4A (Upper Russian River Watershed, Figure 5), which is not formed. Within Zone 4A, the river flows south through a series of broad valleys. Primary tributaries include Big Sulphur Creek and Maacama Creek, which originate in the Mayacama Mountains in the northeastern portion of the County (Sonoma Water 2020b). At the Maacama Creek confluence, the river becomes more sinuous and turns west, flowing through Healdsburg. The Dry Creek confluence is located just downstream of Healdsburg. The Dry Creek watershed is discussed in a separate section, below.

The portion of the Russian River watershed below the Dry Creek confluence falls within the Flood Control Zone 1A (Laguna de Santa Rosa/Mark West Creek watershed, Figure 2) and Flood Control Zone 5A (Lower Russian River Watershed, Figure 6). The Laguna de Santa Rosa and Mark West Creek watershed is discussed in a separate section, above. The lower Russian River flows through a steep, narrow channel, terminating at Jenner. Major tributaries include Green Valley, Atascadero, and Austin Creek.

FLOOD RISK

Due to the size of the Russian River watershed, flood characteristics differ from the flashy behavior that occurs in the smaller Petaluma River and Sonoma Creek watersheds. Floods tend to be multi-day slow rise events. Significant flood events occurred on the Russian River in 1955, 1964, 1986, 1995, 1997, 2006, and 2019 with many other floods observed in the intervening years (Schichtel et al., 2024). During the February 1986 flood, stages reached 48.6 feet at Guerneville (Tetra Tech 2021, p.10-10). Additionally, seven flood events were recorded between October 1997 and February 2006 when atmospheric river conditions were present (Sonoma Water 2021, p. 3-18). The winter storms in December 2005 and January 2006 dropped more than 17 inches of rain, and all gauge stations on the Russian River rose above flood stage, peaking at 41.6 feet at Guerneville (Tetra Tech 2021, p.10-10). More recently, in February 2019, flood stage exceeded 45 feet at Guerneville, with impacts to more than 2,000 structures throughout the county (Schichtel et al., 2024).

Within the Upper Russian River watershed, FEMA Flood Insurance Rate Maps (FIRMs) indicate a broad 1 percent AEP floodplain area extending Cloverdale, Geyserville, and Healdsburg (Figure 5). The County's *Multijurisdictional Hazard Mitigation Plan* estimated that 44 and 14

structures and 133 and 3 people would be exposed within the mapped 1 percent AEP flood in Cloverdale and Healdsburg, respectively (Tetra Tech 2021). However, Sonoma County has questioned the accuracy of these maps (Tetra Tech 2021, p. 10-24). The County's Flood Awareness Areas show broader floodplain extents (Sonoma County 2021). West Cloverdale and northeastern Healdsburg have relatively high concentrations of people with disabilities, which may increase their vulnerability to flooding (ERG 2022, pp. 97, 109-110).

Riverine flood exposure within Cloverdale is limited by levees along the Russian River. However, there is residual risk behind the levees. In February 2019, the Cloverdale Water Treatment Plant levee was breached, causing extensive flooding of the treatment plant and surrounding park and recreation facilities, causing an estimated $1 million in damage. In the same event, a separate levee was breached resulting in the flooding of the airport (City of Cloverdale 2021). Additionally, some areas are exposed to stormwater flooding due to inadequate drainage capacity to accommodate current levels of urban development (City of Cloverdale 2021).

Riverine flood exposure in Healdsburg is driven by flashy stormwater runoff in developed areas and backwater effects from the confluence of the Russian River and Dry Creek with tributaries, such as Foss Creek. Major floods occurred in 2014 and 2019. In December 2014, intense rainfall caused flooding along Foss Creek that affected more than 300 buildings and caused an estimated $1.5 million in damage (City of Healdsburg 2023a, p. 4-18). Areas well outside the FEMA 1 percent AEP were inundated, even though the event was estimated as a higher probability (smaller) event (City of Healdsburg 2023a, pp. 4-20 to 4-23). In February and March of 2019, flooding along Foss Creek affected the Rivers Bend neighborhood and the City's water reclamation facility (City of Healdsburg 2023a, p. 4-18).

Floods in the lower Russian River Watershed are characterized by high velocity and depth due to the narrow floodplain. Areas within the watershed that are particularly prone to flooding include the unincorporated communities of Mirabel Park, Forestville, Rio Nido, Guerneville, Monte Rio, and Duncans Mills. These areas are susceptible due to both the nature of the flood hazard, the canyon-like geography, and the condition of many of the older structures in these communities, many of which have experienced repeated flood damage in the past, are not elevated, and are located on small lots, which makes mitigation measures more challenging (Sonoma County 1995). The socioeconomic characteristics of these communities may also increase residents' vulnerability to flooding and make it more difficult to recover (ERG 2022, p. 80). Flooding in these communities has also inundated and caused septic and sewage system overflows, leading to public health risks. River stages at Guerneville have exceeded flood stage in 34 of 59 years in the record (Tetra Tech 2021, p.10-11).

Sedimentation and backwater effects along tributaries also drives flooding. The FEMA 1 percent AEP floodplain includes areas adjacent to Green Valley Creek (in Forestville), Fife Creek (in Guerneville), and Austin Creek (in Cazadero). Green Valley Creek and Atascadero Creek flood regularly at their crossings at Ross Station Road and Graton Road, respectively, as well as Green Valley Road (Figure 6). In addition, sedimentation in the Laguna de Santa Rosa can influence flood stages on the Russian River, exacerbating downstream flooding.

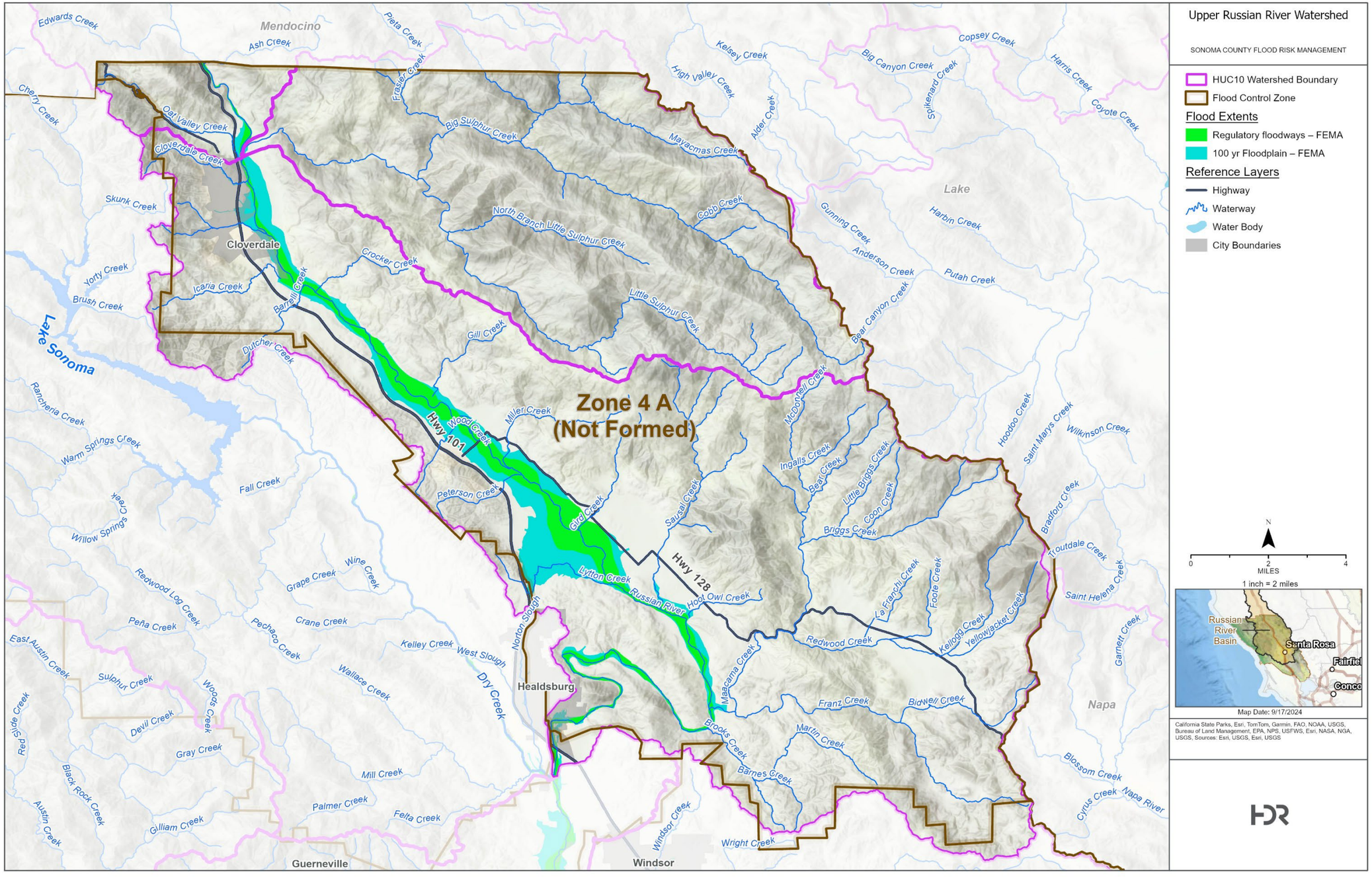

Figure 5. Hydrologic and Flood Control Zone Boundaries in the Upper Russian River Watershed (within Sonoma County)

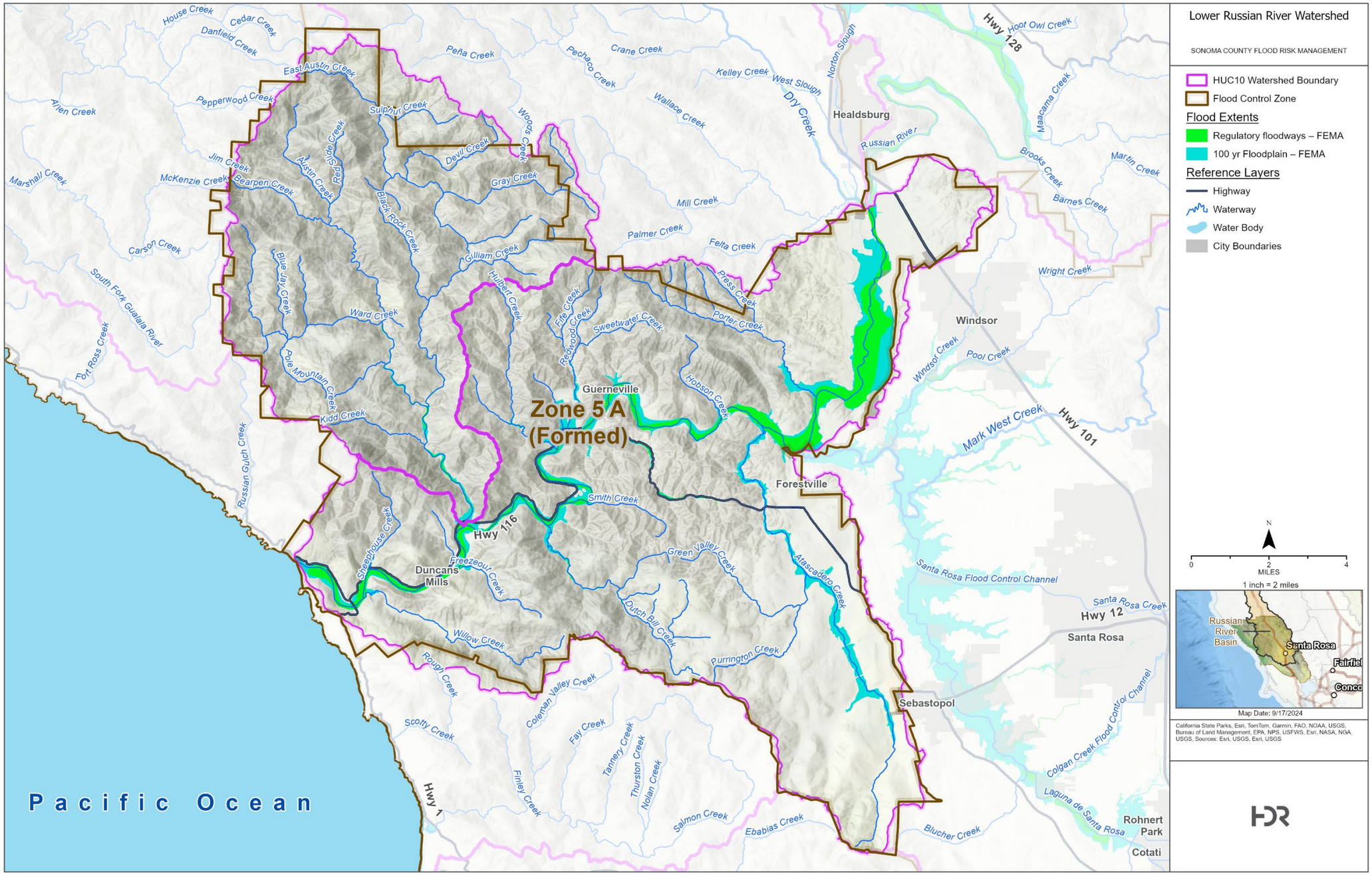

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Figure 6. Hydrologic and Flood Control Zone Boundaries in the Lower Russian River Watershed

FLOOD RISK MANAGEMENT

Two major reservoirs provide dedicated flood control space within the Russian River watershed: Coyote Valley Dam and Warm Springs Dam. Coyote Valley Dam is a federally authorized project located on the East Fork of the Russian River, five miles north of Ukiah, in Mendocino County. Coyote Valley Dam regulates 105 square miles of the Russian River watershed in Mendocino County and is authorized for flood control, water supply, recreation, and power. The dam impounds Lake Mendocino, which has a maximum capacity of 122,400 acre-feet. Flood control releases are managed by USACE and governed by the Water Control Manual (WCM). Sonoma Water is the project local sponsor, operating the reservoir for water supply. The City of Ukiah operates the reservoir for power generation. Warm Springs Dam, described in greater detail in the Dry Creek section of this memo, is a federally authorized project located on Dry Creek, within Sonoma County. As with Coyote Valley Dam, flood control releases are managed by USACE and governed by the WCM.

Additionally, the Central Sonoma Watershed Project provides flood control on major tributaries to the Laguna de Santa Rosa, which is, in turn, tributary to the Russian River. The Central Sonoma Watershed Project is described in greater detail within the Laguna de Santa Rosa/Mark West Creek Watershed section, above.

Presently, there is no comprehensive management plan for any levees along the upper Russian River. There were previously levees that were subject to the USACE Operations and Maintenance Manual for Construction of Coyote Valley Dam and the PL84-99 USACE levee maintenance program, that have since fallen out of the federal program. Though there are still numerous privately-owned levees along the Russian River in and around Cloverdale and Geyserville, none of them are within the PL 84-99 USACE program, nor do they fall under any agency's maintenance jurisdiction (USACE 2023).

Within the geographic area of unformed Flood Control Zone 4A, Sonoma Water owns maintenance easements or fee title over engineered channel reaches of Gill Creek, Wood Creek, and Lytton Creek (Sonoma Water 2023b). Within Flood Control Zone 5A, Sonoma Water owns maintenance easements over modified and natural channels on Fife Creek, Pocket Canyon Creek, and Hulbert Creek, near Guerneville (Sonoma Water 2023b).

The CNRFC, in coordination with the California Department of Water Resources (DWR), monitors weather conditions, rainfall, and river stage data, and issues official rainfall and river forecasts. CNRFC publishes forecasts for multiple points in the Russian River watershed, including Big Sulpher Creek (Cloverdale), Russian River (Geyeserville, Hacienda Bridge, Jenner), Maacama Creek, Santa Rosa Creek, Laguna de Santa Rosa (Cotati and Sebastopol), and Mark West Creek (Mirabel Heights). The U.S. Geological Survey (USGS) maintains three gauges in the watershed, at Cloverdale, Healdsburg, and Guerneville. The National Weather Service (NWS) defines the flood stage at Guerneville Bridge at 32 feet (Tetra Tech 2021, Vol. 1, pp. 10-8 – 10-9).

Forecasts typically provide sufficient time to warn and evacuate communities in advance of slow-rise floods, but residents are not always willing to evacuate. The Sonoma County

Emergency Operations Plan contains an annex specific to operations during Russian River floods, which identifies actions to be taken at specific river stages. Sonoma County and local fire protection districts have the capability to conduct some swift-water rescues and search-and-rescue, but also relies on mutual aid agreements with neighboring jurisdictions for major events. Very high stages (greater than 44 feet at Guerneville) can isolate downstream communities and require helicopter/airlift evacuations (Sonoma County 2023).

Sonoma Water has partnered with National Oceanic and Atmospheric Administration (NOAA) and the Scripps Institute for Oceanography's Center for Western Weather and Water Extremes (CW3E) to research and improve projections of future atmospheric river characteristics and improve forecast skill. Sonoma Water has also partnered with other Bay Area water agencies, NOAA, and DWR on an Advanced Quantitative Precipitation Information (AQPI) initiative, to improve high-resolution, low-level X-band and C-band radar coverage and storm monitoring capabilities throughout the Bay Area.

Leveraging these forecasting and monitoring initiatives, Sonoma Water is also partnering with USACE to explore the feasibility of using forecasts to improve reservoir operations at Coyote Valley Dam (Lake Mendocino). USACE approved a temporary deviation of the Dam's WCM to use forecast-informed reservoir operations (FIRO) to change the time of year during which the flood control space is utilized. While the primary objective of FIRO at Coyote Valley Dam is to improve water supply management, the ability to use forecasts to inform reservoir releases and any subsequent downstream flooding can also improve flood risk management on the Russian River (Sonoma Water 2021, pp. 3-2 – 3-3).

Table 5. Summary of Major Infrastructure Providing FRM in Zones 4A, 5A, 6A

FRM Infrastructure	Location	Responsible Entity
Coyote Valley Dam (Lake Mendocino)	East Fork of the Russian River, near Ukiah (Mendocino County)	USACE, Sonoma Water
Warm Springs Dam (Lake Sonoma)	Dry Creek (within Zone 6A)	USACE, Sonoma Water
Central Sonoma Watershed Project	Santa Rosa Creek, Matanzas Creek, Paulin Creek, and Middle Fork of Brush Creek (within Zone 1A)	Sonoma Water
Levees	Russian River, in and around Cloverdale and Geyserville	Private landowners
Engineered, modified, and natural flood control channels	Certain channel reaches within Zones 4A, 5A, 6A	Sonoma Water
Flood control channels	Certain reaches on Foss Creek	City of Healdsburg
Stream gages	Russian River at Cloverdale, Healdsburg, and Guerneville	USGS
Forecast points	Big Sulpher Creek (Cloverdale), Russian River (Geyeserville, Hacienda Bridge, Jenner), Maacama Creek, and points in Zone 1A	CNRFC

Dry Creek

DESCRIPTION

Dry Creek is a major tributary to the Russian River. Its headwaters are located in southern Mendocino County and its confluence with the Russian River is located just south of the City of Healdsburg. The Dry Creek Watershed covers roughly 220 square miles of forested, mountainous, unincorporated land, as well as vineyards and recreational lands. Much of the upper watershed is protected through conservation easements held by Sonoma County Agricultural and Open Space District (Ag + Open Space) and private conservation organizations (Ag + Open Space 2017, p. 49).

FLOOD RISK

Given the existence of Warm Springs Dam (described below) flood risk in the Dry Creek watershed is relatively low. The FEMA 1 percent and 0.2 percent AEP floodplain areas are both confined to the channel along most of Dry Creek (Figure 7). The County's Flood Awareness Areas extend to small tributaries as well as further downstream to the confluence with the Russian River, highlighting potential flood exposure along tributaries upstream of Dry Creek Road and West Dry Creek Road (Sonoma County 2021).

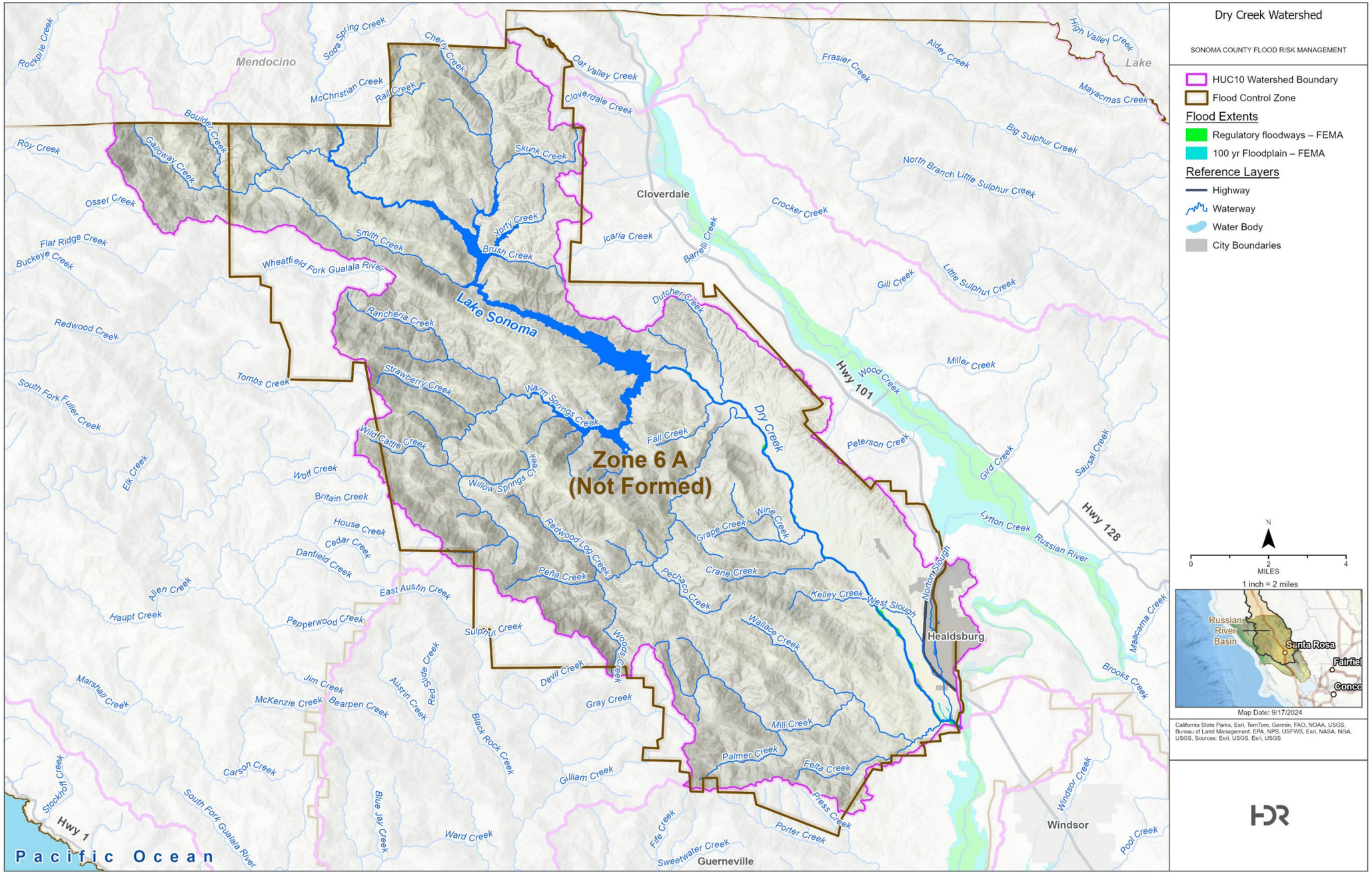

Figure 7. Hydrologic and Flood Control Zone Boundaries within the Dry Creek Watershed

FLOOD RISK MANAGEMENT

Warm Springs Dam is a federally authorized project that was constructed on Dry Creek between 1982 and 1984 for flood control, water supply, and recreation purposes. Warm Spring Dam is located 14 miles upstream of the confluence of Dry Creek and the Russian River and regulates 131 square miles of the Dry Creek watershed, including its namesake Warm Springs Creek. The dam impounds Lake Sonoma, which has a maximum capacity of 381,000 acre-feet of which 136,000 acre-feet is managed by the USACE as flood control space. Sonoma Water is the project local sponsor, operating the reservoir for water supply. Flood control releases are managed by USACE and governed by the WCM. USACE also manages the Warm Springs Fish Hatchery and the Lake Sonoma Recreational Area at the site to mitigate for fisheries impacts.

As discussed above, Sonoma Water has partnered with numerous organizations and agencies who have formed the Russian River FIRO Steering Committee to improve forecast and monitoring capabilities and explore opportunities to improve reservoir operations using this information. A FIRO viability analysis is being undertaken for Warm Springs Dam by the Russian River FIRO Steering Committee.

The Dry Creek Channel Improvement Project was constructed by the USACE as part of the Warm Springs Dam Project. This project was implemented by the USACE and included the addition of fish ladders, grade control structures, fencing, and bank stabilization infrastructure. As the local sponsor for the Dry Creek Channel Improvement Project, Sonoma Water has maintenance responsibility for the constructed features.

The Dry Creek watershed is located within proposed Flood Control Zone 6A, which is not formed (Sonoma Water 2021, p. 2-5) (Figure 7). However, as part of a three-way agreement between the California Department of Transportation (Caltrans), the City of Healdsburg, and Sonoma Water, Sonoma Water owns an engineered channel along Highway 101 and has a maintenance easement over a short reach of modified channel near the mouth of Dry Creek within this Flood Control Zone (Sonoma Water 2023b). Despite the unformed Flood Control Zone, Sonoma Water has an obligation to maintain these facilities (listed in table 6).

Table 6. Summary of Major Infrastructure Providing FRM in Zone 6A

FRM Infrastructure	Location	Responsible Entity
Warm Springs Dam (Lake Sonoma)	Dry Creek	USACE, Sonoma Water
Dry Creek Channel Improvement Project	Dry Creek	Sonoma Water
One engineered and one modified flood control channel reach	Along Highway 101, near the mouth of Dry Creek	Sonoma Water

North Coast

DESCRIPTION

The North Coastal Watershed is a rural, forested watershed in northwest Sonoma County that drains north via the Gualala River, before flowing to the Pacific Ocean. The area is bounded by the Gualala River (along the Mendocino County border) to the north and by the lower Russian River watershed to the south. The North Coastal Watershed has few population centers, except

for the vacation community of The Sea Ranch, which is located at the northwestern edge of the watershed. Large swaths of the watershed area are preserved through conservation easements or ownership held by Ag + Open Space or other conservation organizations.

FLOOD RISK

There are no mapped riverine flood hazard areas in the North Coastal watershed (Figure 8). FEMA 1 percent and 0.2 percent AEP floodplains are only mapped along the coast. The County's Flood Awareness Areas indicate riverine flood hazard areas within tributary channels and along the Gualala River (Sonoma County 2021). The County's Flood Awareness Areas also indicate that some roadways could be exposed to flooding adjacent to the Gualala River and its tributaries, but do not indicate significant flooding outside of the channel.

FLOOD RISK MANAGEMENT

The North Coastal Watershed falls within proposed Flood Control Zone 7A, which is not formed (Sonoma Water 2021, p. 2-5) (Figure 8). There are no facilities owned by Sonoma Water in fee or easement.

The CNRFC, in coordination with DWR, monitors weather conditions, rainfall, and river stage data; and issues official rainfall and river forecasts, including forecasts for the South Fork of the Gualala River and the mouth of the Russian River at Jenner.

Permit Sonoma is currently proposing amendments to the Sonoma County Local Coastal Program (LCP) which regulates land use and development along the ocean coast for consistency with the California Coastal Act. The California Coastal Commission's guidance recommends accounting for the effects of sea level rise on coastal flooding, bluff retreat, and other hazards in LCP policies (California Coastal Commission 2018).

Figure 8. Hydrologic and Flood Control Zone Boundaries within the North Coast Watershed (within Sonoma County)

South Coast

DESCRIPTION

The South Coastal Watershed drains numerous small creeks in southwestern Sonoma County to the Pacific Ocean. The watershed is bounded by the mouth of the Russian River (near Jenner) to the north and Americano Creek (along the Marin County border) to the south. Salmon Creek traverses the center, flowing east to west. The watershed is characterized by coastal foothills and small unincorporated communities including Occidental, Valley Ford, and Bodega Bay. Highway 1 runs north-south along the coastline, of which most is protected as State Parks land, State Beach, or regional parks.

FLOOD RISK

The only mapped riverine flood hazard areas in the South Coastal watershed are located at the confluence of Bloomfield Creek and Americano Creek (Figure 9). The FEMA 1 percent and 0.2 percent AEP floodplain areas are otherwise limited to coastal areas. The County's Flood Awareness Areas indicate additional flood exposure in the unincorporated town of Bodega, adjacent to Salmon Creek, and in the town of Salmon Creek near the creek mouth (Sonoma County 2021). Many low-lying rural roads are impacted by high intensity rainfall at creek crossings and drainages, affecting connectivity and emergency access during storm events. The unincorporated community of Bodega has a relatively high concentration of people with disabilities, which may increase vulnerability to flooding (ERG 2022, p. 75).

FLOOD RISK MANAGEMENT

The South Coastal Watershed falls within Flood Control Zone 8A, which is active (Sonoma Water 2021, p. 2-5) (Figure 9). Along the southern border of the watershed, a portion of Bloomfield Creek is engineered channel owned and maintained by Sonoma Water and a portion of Americano Creek is covered by a Sonoma Water maintenance easement (Sonoma Water 2023b).

Permit Sonoma is currently proposing amendments to the Sonoma County LCP which regulates land use and development along the ocean coast for consistency with the California Coastal Act. The California Coastal Commission's guidance recommends accounting for the effects of sea level rise on coastal flooding, bluff retreat, and other hazards in LCP policies (California Coastal Commission 2018).

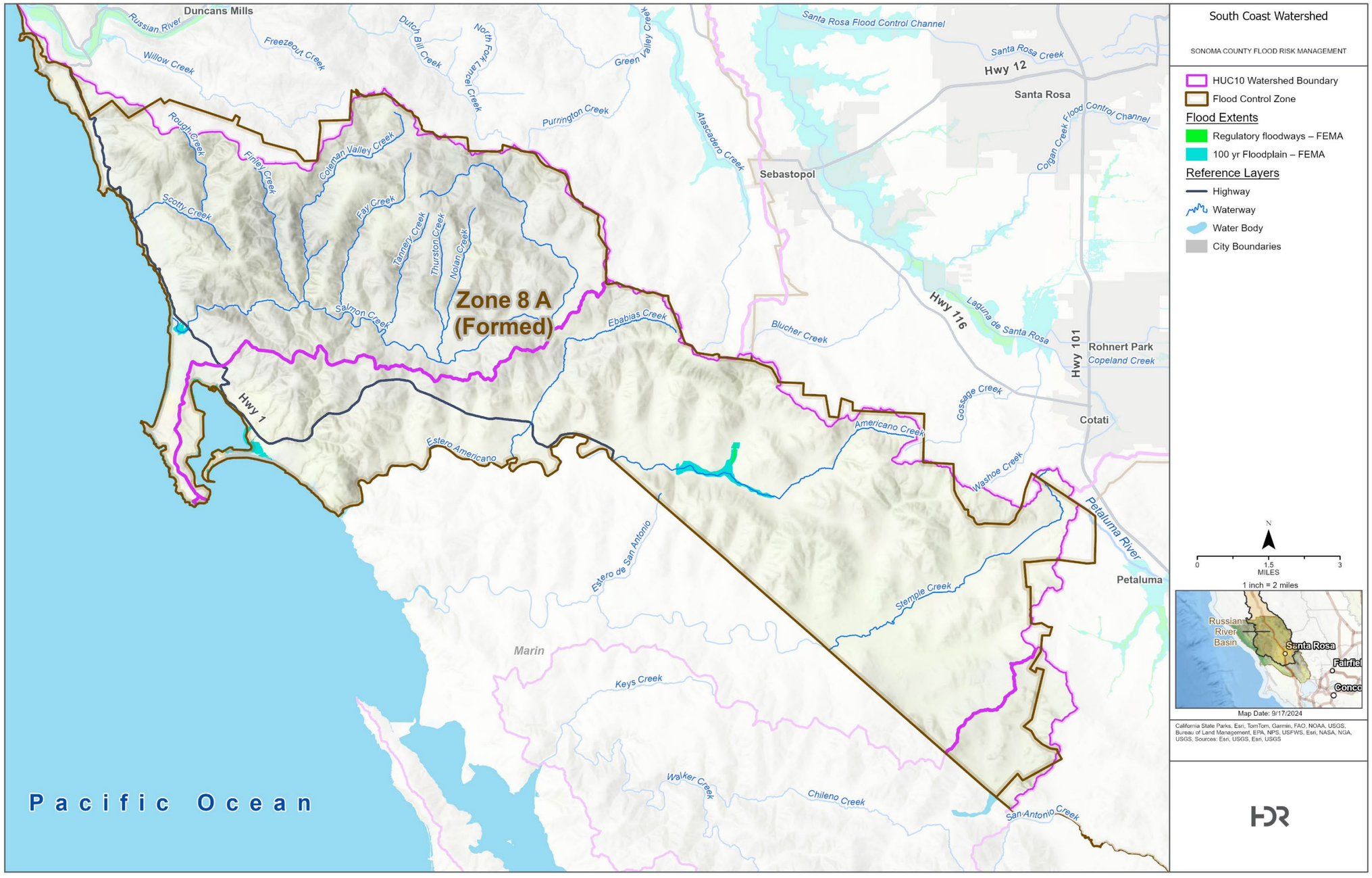

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Figure 9. Hydrologic and Flood Control Zone Boundaries in the South Coast Watershed (within Sonoma County)

Agencies that Provide Flood Risk Management in Sonoma County

Roles and Responsibilities

As previously noted, flood risk management activities are often organized into four pillars: Prevention, Preparedness, Response, and Recovery (Raikes et al. 2019). For purposes of this memo, the four pillars are defined as follows:

- **Prevention**: Actions taken to reduce the chance of a flood event happening or reduce the damaging effects of floods.
- **Preparedness**: Plans or preparations made to improve flood operations, which may include response and rescue operations. Preparedness activities take place before an emergency occurs.
- **Response**: Actions taken to save lives and prevent property damage in an emergency situation, including acting on the plans or preparations made before an emergency.
- **Recovery**: Actions taken to return to a normal or an even safer situation following a flood. This may include seeking financial assistance, such as disaster recovery funding.

The desktop analysis identified seven categories of flood risk management activities in Sonoma County. Based on initial feedback provided by flood risk management agency staff, the activities were revised to the following six categories:

- **Coordination**: Interagency and interorganizational communication, strategic planning, and decision-making.
- **Information development**: Data collection and analysis, modeling, and synthesis of information.
- **Land management**: Regulation of development and land use (including floodplain management), land stewardship, and conservation.
- **Natural and built infrastructure**: Design, construction, and ownership of flood risk management facilities, including both natural infrastructure (e.g., stream channels, connected floodplains) and built infrastructure (e.g., levees, reservoirs).
- **Operations and maintenance**: Operation and maintenance of natural and built infrastructure, and emergency operations.
- **Training and awareness**: Developing and participating in trainings or developing and communicating information to raise awareness among organizations, property owners, tenants, and the public.

Flood risk management responsibilities in Sonoma County are spread across multiple entities and levels of government, including city and county governments, special districts, and state and federal agencies. While all of these entities play a role in flood risk management, their roles and responsibilities vary considerably. Therefore, each entity did not necessarily have roles and responsibilities in each category or in all areas of the county. The roles and responsibilities of each entity, as identified in the Desktop Analysis, are organized by pillar in Table 2, below to highlight the areas in which it may be more or less productive for them to collaborate based on their respective roles and responsibilities.

Table 7. Flood Risk Management Services, by Entity and Flood Risk Management Pillar

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
County	**Sonoma County Public Infrastructure** (formerly Transportation and Public Works)		• Conducts inspections and maintenance of County roads, bridges, culverts, and storm drain infrastructure.	• Closes flooded roads and implements traffic detours. • Distributes sandbags and other flood fighting materials.	
	Sonoma County Department of Emergency Management (DEM)	• Offers a program to elevate homes that are exposed to flooding on the Russian River.	• Maintains the County's Emergency Operations Plan. • Coordinates all emergency preparedness and response in the county.	• Operates the Sonoma County Emergency Operations Center when activated. • Designates individuals to activate the Emergency Alert System (EAS), Reverse 911. • Supplies messages through the public information officer (PIO). • Maintains evacuations webpage with maps, evacuation routes, open shelter locations, and other critical information.	
	Sonoma County Planning Division (Permit Sonoma)	• Regulates land development and enforces building codes in unincorporated areas. • Manages the County's National Flood Insurance Program (NFIP) and Community Rating System (CRS) participation.		• Provide staff support to the Emergency Operations Center, as needed. • Provide GIS support for emergency notifications.	• Conducts damage assessments in unincorporated areas. • Regulates land development and enforces building codes for rebuilding and repairs. • Updates and monitors implementation of the County's multijurisdictional hazard mitigation plan.

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	Sonoma County Climate Action and Resiliency Division (CARD)	• Supports community groups and agencies to achieve climate action and sustainability goals. • Provides education, outreach and resources to obtain rebates, incentives, and technical assistance to individual County residents and businesses.			
	Sonoma County Sheriff			• Coordinates evacuations and evacuation area security.	
City	**All cities in Sonoma County**	• Regulates land development and enforces building codes. • Develops and manages local drainage systems.		• Conducts flood response within city limits. • Provides situation reports to the Emergency Operations Center.	• Regulates land development and enforces building codes for rebuilding and repairs.
City	**Cloverdale**	• Conducts drainage design review using Sonoma Water standards.			• Updates and monitors implementation of the Local Hazard Mitigation Plan.
	Cotati				• Participates in the County's Multijurisdictional Hazard Mitigation Plan.
	Healdsburg	• Conducts drainage design reviews. • Maintains Foss Creek channel where it has permit coverage. •	• City recently updated its Emergency Operations Plan and Hazard Mitigation Plan.	• City is responsible for flooding response and will coordinate with Sonoma County EOC as necessary	• Updates and monitors implementation of the Local Hazard Mitigation Plan.
	Petaluma	• Local sponsor of the Petaluma River Main Channel and Flood Control Project. • Local sponsor of maintenance dredging on the Petaluma River.	• Owns and maintains more than 40 river, rainfall, and weather monitoring gages/stations.	• Maintains a computerized Flood Alert System to provide timely evacuation warnings.	• Updates and monitors implementation of the Local Hazard Mitigation Plan.
	Rohnert Park	• Collects development fees to implement Copeland Creek drainage plan.			• Updates and monitors implementation of the Local Hazard Mitigation Plan.

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	Santa Rosa	• Incorporates flood mitigation into creek restoration projects. • Seeks opportunities for hydraulic capacity studies as funding allows. • Identifies flood control/mitigation priorities in ongoing update to and current Citywide General Plan. • Plans and implements capital projects (currently developing a flood wall to protect the Regional Laguna Treatment Plant). • Develops sources of public flood risk information.	• Maintains the Citywide Emergency Operations Plan and some Department Emergency Operations Plans incorporating flood risk. • Utilizes Emergency Action Plans specifically for City dams. • Deploys flood barriers from Regional Laguna Treatment Plant. • Utilizes City weather stations (on MSCS and Fire Department mobile units). • Participates in Storm Ready and posts Weather Alerts to Fire Department social media. • Supplies a sandbag station free to residents during significant wet weather	• Implements Citywide and Department Emergency Operations/Action Plans as needed. • Maintains staffed and equipped specialized swift water rescue team.	• Participates in the County's Multijurisdictional Hazard Mitigation Plan. • Launches damage assessment of public assets and private facilities as needed.
	Sebastopol	• Conducts drainage design reviews.			• Updates and monitors implementation of the Local Hazard Mitigation Plan.
	Sonoma				• Participates in the County's Multijurisdictional Hazard Mitigation Plan.
	Windsor				• Participates in the County's Multijurisdictional Hazard Mitigation Plan.

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
Special District	**Sonoma County Water Agency (Sonoma Water)**	• Operates Lake Sonoma and Lake Mendocino for water supply in coordination with USACE, which operates the reservoirs for flood management. • Maintains over 80 miles of streams channels where it has ownership or easements. • Maintaining other facilities (e.g., conduits, detention basins, constructed channels, and bypass facilities) in the Central Sonoma Watershed Project. • Provides drainage design review and analysis for County projects and projects referred by certain local land use agencies. • Conducts surveys and H&H modeling to evaluate potential flood risk reduction plans and projects.	• Operates radar for precipitation forecasting. • Participates in the Advanced Quantitative Precipitation Information (AQPI) system. • Participates in annual DWR flood fight training. • Maintains materials stockpiles. • Maintains network of rainfall and stream gages across the County available via Sonoma OneRain.	• Governed by Sonoma Water Flood Response Plan (for the Central Sonoma Project). • Provides emergency response for facilities it owns, including portions of the Central Sonoma Watershed Project and water intakes and distribution infrastructure on the Russian River.	
	Fire Protection Districts			• Conduct rescues. • Perform first responder duties.	
	Ag + Open Space	• Purchases and protects agricultural and open space land from urban development. • Funds urban recreation projects.			

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	Sonoma RCD	• Provides technical assistance to landowners to develop conservation plans, manage nutrients, or restore habitat. • Conducts education and stewardship programming. • Convenes interested parties to conduct watershed assessments and develop and implement watershed plans. • Administers permits for levee maintenance activities being completed by landowners in the Petaluma River and Sonoma Creek watersheds.			• Provides technical assistance on flood recovery projects on private lands through Emergency Watershed Protection (EWP) funded projects.
	Gold Ridge RCD	• Provides technical assistance to landowners to develop conservation plans, manage nutrients, or restore habitat. • Conducts education and stewardship programming. • Supports stormwater management projects.			• Provides technical assistance on flood recovery projects on private lands through EWP funded projects.
State	**California Department of Water Resources** (DWR)	• Funds projects to study, plan, design, and implement certain types of flood risk management and integrated water resources management projects.	• Offers annual flood fight training. • Hosts the California Data Exchange Center (CDEC).	• Operates the Flood Operations Center, co-located with the CNRFC in Sacramento. • Provide access to prepositioned flood fight materials.	
	Division of Safety of Dams (DSOD), a division of DWR	• Regulates the safety of non-federal, jurisdictional dams.			

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	State-Federal Flood Operations Center (FOC), a division of DWR	• Monitors NWS forecast bulletins for expected precipitation timing, location, and quantity.		• Conducts high water notification calls to appropriate agencies that maintain local flood systems and those in charge of emergency response. • Coordinates with the Hydrology and Flood Operations Branch (HFO), NWS Sacramento Forecast Office, and Media and Public Information Branch of the Public Affairs Office for coordinated field operations or technical support. • Declares Flood Mobilization, allowing DFM to utilize any DWR personnel, in the event of high-water events and flood system threats. • Procures, tracks, and allocates resources needed to support flood fight and technical specialists in the field.	
	California Governor's Office of Emergency Services (CalOES)	• Provides guidance and technical assistance for applications for hazard mitigation and pre-disaster mitigation grant funding. • Regulates dam Emergency Action Plans	• Supports local emergency preparedness and response efforts.	• Coordinates state and federal resources during flood incidents. • Coordinates resources to assist reclamation and levee districts during emergencies.	• Assist with damage assessments. • Coordinates state and federal resources during flood recovery.
	California Department of Transportation (Caltrans)	• Plans, designs, and constructs improvements to the State Highway System to improve flood resiliency and address sea level rise risks	• Maintains roads, bridges, culverts, and drainage facilities associated with the State Highway System	• Closes flooded roads and implements traffic detours.	

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	California Highway Patrol (CHP)			• Coordinates with Caltrans to implement road closures and traffic detours. • Assists local law enforcement with providing door-to-door evacuation notifications and/or security for affected areas and, as appropriate	
Federal	**US Army Corps of Engineers** (USACE)	• Operates Lake Sonoma and Lake Mendocino for flood management. • Approves minor and major deviation requests for Lake Sonoma and Lake Mendocino. • Approves revisions to the Lake Sonoma and Lake Mendocino water control manuals. • Federal sponsor of the Petaluma River Main Channel and Flood Control Project. • Inspects and evaluates levees. • Conducts regular maintenance dredging on the Petaluma River.	• Provides flood operations at Lake Sonoma and Lake Mendocino in coordination with downstream communities.	• Provides emergency flood fighting assistance through PL 84-99.	• Provides emergency levee repairs through PL 84-99.
	Federal Emergency Management Agency (FEMA)	• As the administrator of the National Flood Insurance Program (NFIP), develops flood insurance studies (FIS) and flood insurance rate maps (FIRMs). • Administers hazard mitigation grant funds.	• Provides technical assistance and funding to support preparedness activities. • Coordinates the federal government's preparedness efforts.	• Coordinates the federal government's interagency support for emergency response, including search and rescue, public health and medical services, mass care, temporary housing, and other functions.	• Administers flood insurance payments and individual assistance payments. • Provides technical assistance to affected persons and government entities. • Provides recovery funding.
	US Department of Agriculture (USDA) **Natural Resources Conservation Service** (NRCS)	• Federal sponsor of the Central Sonoma Watershed Project. • Provides technical assistance and funding to landowners for conservation and erosion control projects.			• Funds RCDs, communities, and landowners to implement flood repairs such as debris removal, bank channel protection, and drainage and levee system repairs.

Entity Type	Entity	Prevention	Preparedness	Response	Recovery
	National Oceanic and Atmospheric Administration (NOAA) **NWS CNRFC**		• Provides precipitation and river forecasts.	• Operates in coordination with the State Flood Operations Center.	
	United States Geological Survey (USGS)	• Owns and maintains stream gages on the Russian River.		• Collects elevation-discharge rating data during highwater events. • Collects high watermark data during flood events.	
	Federal Energy Regulatory Commission (FERC)	• Issues operating licenses for hydropower projects. • Requires periodic, rigorous dam safety review and inspections.			
Non-Profit Organization	**Community Organizations Active in Disaster** (COAD)	• Educate homeowners and tenants about their rights and options related to flood insurance and housing quality issues. • Disseminate flood and storm safety messaging and help community members develop emergency plans.		• COAD coordinates the NGO response to disasters and represents NGOs within the County Emergency Operations Center. • Disseminate messaging developed by the NWS, County and municipal PIOs, and response partners. • Distribute emergency financial assistance and supplies to storm-impacted individuals, as resources are available.	• Provide disaster case management and long-term recovery assistance to storm-impacted community members months after flooding has subsided (e.g., who may have lost their home, lost wages, or sustained damages to home or property).

Legal Authority

Many of the differences in entity roles and responsibilities identified in Table 2 stem from differences in the powers granted to the agencies. Each entity has different legal authority to provide specific flood risk management services, generate and expend revenues for purposes of flood risk management, and adopt laws, regulations, or standards to manage flood risk. These factors control agencies' capacity to provide new types of flood risk management services or to adopt and enforce regulations.

Article XI Section 7 of the California Constitution grants city and county governments "police powers," meaning the authority to make and enforce police, sanitary, and other ordinances and regulations for public health and safety that do not conflict with general laws of the State. Among other responsibilities, city and county governments derive their authority to regulate development and land use, to build and own stormwater drainage facilities, and to issue evacuation orders from these powers. City and county governments also have the authority to collect general taxes subject to a majority vote in an election, impose special taxes subject to a two-thirds vote, impose regulatory fees, and issue debt, among other powers.

Although cities, counties, and special districts are considered local governments, their authority and powers differ. Special districts do not have the police powers granted to city and county governments and have relatively narrower purviews as prescribed in law. For example,

- Sonoma County Water Agency is a special district that was established in 1949 by the Sonoma County Flood Control and Water Conservation District Act for purposes of water conservation, control and disposition of floodwaters and stormwaters, and electricity generation (California State Statute 1949). Sonoma Water's powers are defined in the Act and include the power to acquire, lease, own, and sell property both within and outside of the county; to regulate encroachments; to construct and maintain levees, pumps, dams, and other flood control facilities; to issue bonds; and to levy assessments within formed Flood Control Zones consistent with current legal requirements.
- The Gold Ridge RCD was established in 1941 to facilitate natural resource conservation across western Sonoma County. Sonoma County RCD was formed more recently through a series of consolidations of smaller RCDs, dating back to 1946. Sonoma County RCD's service areas include Russian River, Petaluma River, Sonoma Creek, Stemple Creek, and Gualala River watersheds. Resource conservation districts are authorized in *Pub. Res. Code* §§ 9001 et seq. to conserve soil and water, control runoff, prevent and control soil erosion, manage watersheds, protect water quality, and develop water storage and distribution. RCDs may implement projects on publicly- or privately-owned land. RCDs can receive grant funding and collect fees for service.
- The Sonoma County Agricultural and Open Space Preservation District (Ag + Open Space) was established by voters in 1990 to protect and preserve working lands and open space between and around cities, stabilize agricultural uses, protect water and soil quality, and provide outdoor recreational opportunities. Open space districts in California are authorized in *Pub. Res. Code* §§ 5500 et seq. to purchase and protect open space lands in fee title or by easement or by funding other agencies to acquire or protect open

space lands that benefit the district. In Sonoma County, Ag + Open Space is funded by a 20-year sales tax and funding must be used according to a voter-approved Expenditure Plan (Ag + Open Space 2021). No more than 10 percent of tax proceeds may be spent on operations and maintenance (Ag + Open Space 2021).

Policies and Standards

The County of Sonoma and all of the cities it contains make use of their police powers to regulate land use and development to manage flood risk. Major flood risk management policies, and standards are summarized in Table 3, below. These include policies and standards to protect development and infrastructure from flood hazards, as well as policies and standards to protect drainage facilities and channels from the effects of development.

The Federal Emergency Management Agency sets minimum floodplain management standards for communities that participate in the National Flood Insurance Program (NFIP) in the Code of Federal Regulations (44 CFR 59.1). All of the municipal codes contain floodplain management ordinances that adhere to these standards. The County of Sonoma and four of the cities have adopted stricter freeboard standards, requiring the lowest floor elevation of structures to be at least one foot above the base flood elevation. In addition, at least eight of the municipalities have established stream setbacks to prohibit development and limit erosion and bank failure in areas immediately adjacent to natural channels.

The cities and County's standards are less consistent across municipalities, but generally require new development to provide drainage systems that either account for ultimate watershed development or that convey a particular design flow. Several codes state that drainage improvements must meet design criteria established by Sonoma Water. These encoded references support the discussion within Sonoma Water's *Flood Management Design Manual*, which states that the criteria apply when Sonoma Water reviews drainage designs, plans, or improvements for projects in the cities of Santa Rosa, Rohnert Park, Cotati, Sonoma, Petaluma, and Cloverdale and the Town of Windsor (Sonoma Water 2020a p. 1-2).

At least five of the municipalities delegate channel maintenance responsibilities, in whole or in part, to owners of property that is traversed by or adjacent to drainage channels or natural waterways.

Table 8. Flood Risk Management Policies and Standards by Local Agency

Agency	Channel Management	Drainage Management	Floodplain Management
County of Sonoma	• Requires riparian corridor setbacks of 50 ft from top of bank in urban and upland areas, 100 ft from top of bank in flatland areas, or 200 ft from the Russian River top of bank. Designates the setback area as a conservation zone (26C-232).	• Drainage facilities must meet *Flood Management Design Manual* criteria, and be designed for no less than: ○ For construction, the 10-year discharge (11.14.040). ○ For agriculture, the 25-year discharge (36.20.030).	• Authorizes the County Building Official to review all permit applications to determine if the development would adversely affect the flood-carrying capacity of the area (7B-7). • Defines notification procedures for watercourse alterations and changes to flood elevations (7B-7). • Requires 1 foot of freeboard (7B-11). • Requires subdivisions to develop and provide flood elevation data (7B-10). • Prohibits fill or encroachments within floodways, except as provided in code (7B-12). • Prohibits fill within the Laguna de Santa Rosa unless no reduction in flood storage capacity would result (26-56-030).
City of Cloverdale	• Establishes watercourse setbacks of 15 to 30 feet from top of bank (8.20.070). • Requires property owners to maintain natural drainageways clear of debris or obstructions (8.20.020).	• Requires property owners to maintain BMP facilities, channels, culverts and/or drainage systems on their property so as not to impair, impede or obstruct the natural flow in a defined channel, culvert, or drainage system (16.10.150). • Requires new subdivisions to place drainage systems in easements when public right-of-way is not available or adequate (17.12.080). • Establishes that off-site storm flow control measures may be required (17.20.110).	• Authorizes Public Works to review all permit applications to determine if the site is reasonably safe from flooding (15.20.130). • Defines notification procedures for watercourse alterations and changes to flood elevations (15.20.130). • Requires new subdivisions to provide flood elevation data (15.20.170). • Prohibits fill or encroachments within floodways, except as provided in code (15.20.190).

Agency	Channel Management	Drainage Management	Floodplain Management
City of Cotati	• Requires a streambed analysis and setbacks of 2.5 times the bank height or 30 feet for sites adjacent to Copeland, Cotati, or Washoe Creeks, or Laguna de Santa Rosa (17.50). • Requires property owners to maintain watercourses free of excessive vegetation or obstructions that restrict flow (13.68.070).	• Requires new subdivisions be graded so that no lot drains into a flood control channel (17.78.040). • Requires new subdivisions to provide drainage systems for ultimate development of the drainage area and protection of off-site property (17.78.050). • Establishes that developments may be required to improve drainage and flood control easements (17.78.050) or stabilize banks (17.50.040).	• Authorizes Public Works to review all permit applications to determine if the site is reasonably safe from flooding (15.04.140). • Defines notification procedures for watercourse alterations and changes to flood elevations (15.04.140). • Requires new subdivisions of more than 5 acres or 50 homes to develop and provide flood elevation data (15.04.190). • Prohibits fill or encroachments within floodways, except as provided in code (15.04.220).
City of Healdsburg	• Establishes setbacks of 100 feet from top of bank on the Russian River, 35 feet on Foss Creek, and 25 feet on all other creeks (20.24.090).	• Requires new subdivisions to contain the 30-year flow to underground drainage conduit and the 100-year flow to curbs, creeks, and channels (17.08.290). • Requires new subdivision improvements to meet the public works department's standard specifications and details (17.04.480).	• Authorizes Public Works to review all permit applications to determine if the site is reasonably safe from flooding (17.28.120-130). • Defines notification procedures for watercourse alterations and changes to flood elevations (17.28.130). • Requires 1 foot of freeboard (17.28.160). • Requires subdivisions of more than 5 acres or 50 homes to develop and provide flood elevation data (17.28.180). • Prohibits fill or encroachments within floodways, except as provided in code (15.20.210).
City of Petaluma	• Requires subdivisions to dedicate wooded ravines to public use via storm drainage easements (20.32.470).	• Requires drainage facilities not accepted by the city or Sonoma County water to be maintained by the property owner (17.31.280). • Requires new drainage systems be designed for the ultimate development of the drainage area (17.31.170).	• Establishes floodplain and floodway zoning combining districts (6.040-50). • Authorizes the Planning Director to review all permit applications to determine if the site is reasonably safe from flooding (6.080).

Agency	Channel Management	Drainage Management	Floodplain Management

		• Requires new subdivisions that drain to the Petaluma River to provide detention areas to accommodate excessive runoff (20.36.030).
		• Requires grading plans to design drainage channels to contain the:
		  ○ 100-year discharge in drainage areas more than 4 sq. mi.
		  ○ 25-year discharge, in drainage areas less than 4 sq. mi.
		  ○ 10-year discharge, in drainage areas less than 1 sq. mi. (17.31.170).
			• Defines notification procedures for watercourse alterations and changes to flood elevations (6.080).
			• Requires 2 feet of freeboard in the "zero net fill" area and 1 foot of freeboard elsewhere (6.070).
			• Requires subdivisions to provide flood elevation data (6.070).
			• Prohibits fill or encroachments within floodways, except as provided in code (6.050).
			• Prohibits net fill within a designated area along the Petaluma River (6.070).

City of Rohnert Park	• Establishes setbacks of 50 feet within creek protection zones and 25 feet from top of bank of all other creek areas (17.12.060). • Requires property owners to maintain natural drainageways clear of debris or obstructions (13.64.060).	• Requires new subdivisions to design drainage systems for the ultimate development of the drainage area (16.16.020).	• Authorizes the City Administrator to review all permit applications to determine if the site is reasonably safe from flooding (15.48.140). • Defines notification procedures for watercourse alterations and changes to flood elevations (15.48.140). • Requires 1 foot of freeboard (15.48.170). • Requires subdivisions of more than 5 acres or 50 homes to develop and provide flood elevation data (15.48.190). • Prohibits fill or encroachments within floodways, except as provided in code (15.48.210).

Agency	Channel Management	Drainage Management	Floodplain Management
City of Santa Rosa	• Establishes setbacks of at least 50 feet from top of bank or from the base flood elevation if bank is undefined (20-30.040).	• Prohibits the unpermitted obstruction of stormwater flow in defined channels or the drainage system (17-12.010). • Requires property owners to maintain culverts and private drainage systems clear of debris and obstructions (17-12.015).	• Authorizes the City Building Official to review all permit applications to determine if the site is reasonably safe from flooding (18-52.060, 18-52.070). • Defines notification procedures for watercourse alterations and changes to flood elevations (18-52.070). • Requires subdivisions to provide flood elevation data (18-52.100). • Prohibits fill or encroachments within floodways, except as provided in code (18-52.120).
City of Sebastopol	• Requires property owners to maintain watercourses clear of debris or obstructions (13.20.070). • Establishes setbacks of 30 feet from top of bank of Zimpher Creek, Calder Creek, or Atascadero Creek (17.100.060).	• Requires new subdivisions to convey the 10-year flow and protect off-site properties with BMP facilities or off-site stormwater system improvements (16.40.050). • Requires drainage improvements to meet Sonoma Water design criteria (16.40.050).	• Authorizes the City Building Official to review all permit applications to determine if the site is reasonably safe from flooding (15.16.140). • Defines notification procedures for watercourse alterations and changes to flood elevations (15.16.140). • Requires 2 feet of freeboard (15.16.170). • Requires all proposed development to provide flood elevation data (15.16.150). • Prohibits fill or encroachments within floodways, except as provided in code (15.16.220).
City of Sonoma	• Requires a streambed analysis and setbacks of 50 feet from top of bank on Sonoma Creek and 30 feet on all other creeks (19.40.020).	• Requires new subdivisions to provide drainage systems for ultimate development of the drainage area and protection of off-site property (16.03.140). • Requires drainage improvements to meet Sonoma Water design criteria (16.03.140).	• Authorizes the City Building Official to review all permit applications to determine if the site is reasonably safe from flooding (14.25.160). • Defines notification procedures for watercourse alterations (14.25.280). • Requires subdivisions to provide or develop flood elevation data (14.25.260).

Agency	Channel Management	Drainage Management	Floodplain Management
			• Requires floodway encroachment analysis for proposed development (14.25.280).
Town of Windsor	• Requires property owners to maintain natural drainageways clear of debris or obstructions (9-4-300).	• Requires new subdivisions to provide drainage systems for ultimate development of the drainage area and protection of off-site property (16-8-810)	• Authorizes the City Building Official to review all permit applications to determine if the site is reasonably safe from flooding (9-1-410). • Defines notification procedures for watercourse alterations and changes to flood elevations (9-1-425). • Requires subdivisions of more than 5 acres or 50 homes to provide flood elevation data (9-1-540). • Prohibits fill or encroachments within floodways, except as provided in code (9-1-560).

Note: All citations refer to sections of the municipal code of the corresponding jurisdiction. See references section for links to specific municipal codes.

Conclusions and Next Steps

The results of the desktop analysis illuminate key risks and issues within the different watersheds in Sonoma County. The Russian River watershed is dominated by riverine flooding, driven by atmospheric river events. Riverine flooding has had the greatest impacts on the lower Russian River but has also affected upstream communities. Russian River stages influence backwater flooding in the Laguna de Santa Rosa/Mark West Creek watershed, where there is far greater concentration of people and developed uses exposed. Land conversion to agriculture and urban uses in the Laguna, Petaluma, and Sonoma Creek watersheds has led to increased erosion and sedimentation, channelization, and higher peak runoff which are constrained by drainage capacity in developed areas. Flood risk within both the Petaluma and Sonoma Creek watersheds is adversely affected by tidal influence from the San Pablo Bay on the lower reaches. Finally, shifting hydrology and rising sea levels threatens to exacerbate these conditions throughout the county.

Investments in flood risk management facilities and operations over the past half-century by local and federal agencies have reduced certain riverine flood risks in Sonoma County, particularly within the Russian River, Petaluma, and the Laguna de Santa Rosa / Mark West Creek watersheds. Improved land management practices and conservation efforts of the RCDs, Ag + Open Space, and private landowners have also mitigated some erosion, sedimentation, and channelization issues. However, there are many remaining needs identified throughout the resources that were reviewed. Municipal governments have adopted local codes, submittal requirements, and standards to manage waterways and floodplains, but these only apply to new development and do not mitigate existing flood risks. Some areas, such as leveed areas along lower Sonoma Creek, have been unable to establish federal interest in cost-effective flood risk management projects. Other interventions, such as upstream detention and stormwater management require coordination with private landowners and other interested parties.

The next steps in the Assessment of Flood Risk Management Services are to engage partner entities and elicit additional input on existing and future flood risks, and on the challenges, gaps, and opportunities to improve flood risk management services. This memo will be shared with each partner entity for review and each entity will be asked to validate and supplement the information gathered through the resource review.

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Note: References provided by Sonoma Water for the desktop analysis are denoted in **bold font**.

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