

Appendix C. Watershed Water Quality Concerns

Technical Memorandum 1

TO: Stockton East Water District, Calaveras County Water District

CC: California Department of Water Resources

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RE: Watershed Water Quality Concerns

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1. PURPOSE

This Technical Memorandum (TM) reviews existing and publicly available information on water quality issues in the Calaveras Watershed to inform the Calaveras River Watershed Resilience Plan (WRP) Vulnerability Assessment. This TM also incorporates estimates of climate-induced changes in runoff from the hydrologic modeling on the sub-watershed level.

Results of the hydrologic modeling described in **Appendix E** indicate sub-watersheds in the upper watershed where runoff is expected to change under climate change. The scale of this analysis was extended across the full Watershed to evaluate potential impacts to water quality under climate change, as increases in runoff may have implications for the mobilization of contaminants from known point and non-point sources, as described in **Section 2**. A spatial overlay analysis indicates which sub-watersheds may be more or less vulnerable to these anticipated changes under the most probable scenario (T2P100) in relation to potentially high-risk water quality sites.

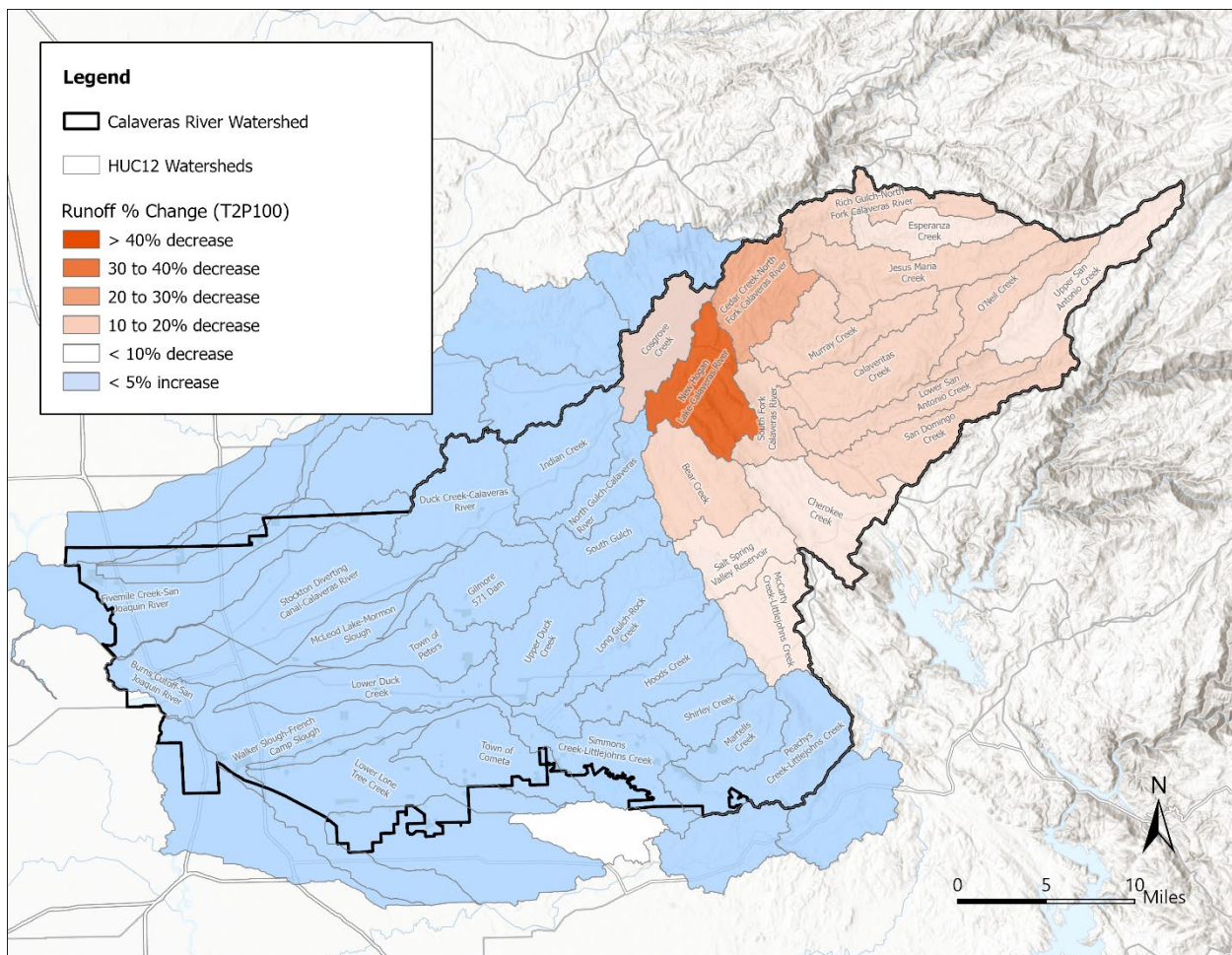
In water bodies already listed as impaired under Section 303(d) of the Clean Water Act, increased runoff, whether from urban or agricultural land uses, can exacerbate existing water quality problems in several ways:

- **Elevated pollutant loading:** Runoff commonly carries excess nutrients (nitrogen and phosphorus), sediments, pesticides, heavy metals, and oils from impervious surfaces. These additional loads can overwhelm a waterbody's remaining capacity to assimilate contaminants, making it even more challenging to achieve the Total Maximum Daily Load (TMDL) targets set under Section 303(d) (U.S. EPA, 2025a; U.S. EPA, 2025b).
- **Nutrient-driven eutrophication:** The influx of nutrients can promote algal blooms that reduce dissolved oxygen levels, resulting in eutrophication of the water body. Low oxygen conditions can stress or kill aquatic life and can shift the ecosystem balance in favor of tolerant but ecologically less beneficial species (U.S. EPA, 2025c).
- **Increased turbidity and sedimentation:** Sediment in runoff can cloud water in receiving bodies, which can reduce sunlight penetration, impair photosynthesis, and transport pollutants bound to the sediment particles (U.S. EPA, 2021).
- **System stress on already vulnerable waters:** Impaired waters are those where current regulatory controls are insufficient to meet water quality standards. Additional runoff pushes such systems further from recovery, potentially triggering further impairment listings or stricter regulatory measures (U.S. EPA, 1972).

The above increased runoff impacts on water bodies can also significantly strain water treatment systems. The high loads of nutrients, sediments, and pollutants carried in runoff can elevate contaminant concentrations beyond what treatment facilities are designed to handle. Excess nutrients can trigger algal blooms and eutrophication, reducing dissolved oxygen and introducing toxins that require advanced treatment processes. Sediment increases turbidity, clogging filtration systems and raising operational costs for maintenance and chemical use.

The influx of pollutants can lead to more frequent violations of discharge permits, forcing utilities to invest in costly upgrades or additional treatment. These combined effects not only compromise water quality but also increase energy demand, usage of treatment chemicals, and overall treatment complexity, making compliance and recovery efforts more challenging. Under the most likely climate change scenario (T2P100), precipitation intensity during extreme storm events could increase by approximately 14%, increasing maximum river flows and increasing the likelihood of major flooding. **Figure 1** displays the projected change in runoff under T2P100 by sub-watershed.

FIGURE 1. PROJECTED CHANGE IN RUNOFF BY SUBWATERSHED



2. WATER QUALITY CONCERNS

The following section describes existing water quality conditions within the Watershed. While these water quality issues do not originate from climate change directly, they are major vulnerabilities to water purveyors within the watershed, and only more so in the case of climate-driven increases in runoff volumes. The figures in this TM show the sub-watersheds with anticipated increases or decreases in runoff

under the most probable climate scenario, overlaid with impaired water bodies and/or various known degraded water quality sites.

a. Point Source Pollution

Point source pollution is pollution that can be traced to a single known source, and is not directly caused by climate change. The following section focuses on local point sources and summarizes the Watershed's contamination risks which must be considered to ensure effective long-term planning.

As required by the federal Clean Water Act and California's Porter-Cologne Water Quality Control Act (Porter-Cologne Act), potential point source facilities must obtain permits under either the National Pollutant Discharge Elimination System (NPDES) or Waste Discharge Requirements (WDR) Program (U.S. EPA, 2025a; 33 U.S.C. § 1251 et seq., 1972; California Regional Water Quality Control Boards, 2025). NPDES permits are administered by the State Water Resources Control Board (SWRCB) on behalf of the U.S. EPA and only apply to facilities that discharge directly to "waters of the United States." All other discharges fall under the jurisdiction of the WDR program, which is managed jointly by SWRCB and the Regional Water Quality Control Boards (RWQCB). Through these programs, SWRCB and the RWQCBs can authorize permanent, long-term, and temporary allowances for stormwater and wastewater discharges. Within the Watershed, over 400 facilities hold either NPDES or WDR permits.

i. Treatment Facilities and Landfills

Several drinking water and wastewater treatment plants are located in the Watershed, as displayed in **Figure 2**. Wastewater treatment plants (WWTPs) are common point sources. Drinking water treatment plants (WTPs) are not commonly considered point sources, but may still discharge material to waterways. None of the Watershed's drinking water facilities are regulated under NPDES or WDR permits. Stockton East Water District (SEWD) and Calaveras County Water District (CCWD) own and operate a total of three WTPs within the Watershed (Johnson, 2021). SEWD manages the Dr. Joe Waidhofer (DJW) WTP, east of the City of Stockton, which conveys raw water from the Calaveras River downstream of New Hogan Reservoir through the Bellota Pipeline. DJW WTP serves over 500,000 people in the Stockton area. SEWD does not manage or provide wastewater service to its customers. Some of SEWD customers are served by the City of Stockton via the Stockton Regional Wastewater Control Facility (Stockton East Water District, 2021).

CCWD manages the Sheep Ranch and Jenny Lind WTPs. The Jenny Lind WTP is located between New Hogan Reservoir and the Bellota Weir and provides water service to approximately 10,000 people. Sheep Ranch WTP serves less than 100 people and is not pictured in **Figure 2**. CCWD also manages the La Contenta WWTP, which treats wastewater within the Jenny Lind area (Calaveras County Water District, 2021). Table 1 provides information on the Watershed's three drinking WTPs, and Table 2 summarizes WWTPs in the Watershed that hold NPDES or WDR permits (SWRCB, 2024). There is a particular risk of contamination from discharge in the upper watershed, where runoff is higher and treatment facilities are clustered. Landfills can also contribute to point source pollution. The landfills that hold permits within the Calaveras River Watershed are summarized and displayed in Table 3 and Figure 2 below (SWRCB, 2024). As shown in **Figure 2**, landfills do not pose an increased risk of contamination due to climate-change induced runoff as they are located in the lower watershed where runoff volumes are likely to increase by a small margin.

TABLE 1. DRINKING WATER TREATMENT PLANTS

Facility Name	Owner	Treatment Capacity
Dr. Joe Waidhofer (DJW WTP)	SEWD	65 MGD
Jenny Lind WTP	CCWD	6 MGD
Sheep Ranch WTP (not pictured)	CCWD	0.02 MGD

TABLE 2. WASTEWATER TREATMENT FACILITIES WITH DISCHARGE PERMITS

Facility Name	Type of Permit	Permit #
Linden Co Water District WWTF	WDR	5B390111001
CSA 15 - STP	WDR	5B391008002
Stockton Regional WW Control Facility	Co-Permittee ^a	5B390107001
DDJC, Sharpe - WWTP, Stormwater	WDR	5B390701002
Copper Cove WWRF	NPDES Permit	CA0084620
La Contenta WWT & RF	WDR	5B051012001
Toyon Middle School	WDR	5B050109001
Sierra Ridge WWTP	WDR	5B051013001
San Andreas SD WWTP	NPDES Permit	CA0079464
New Hogan Lake Recreational Areas	Enrollee – WDR	5B051027001
Valley Springs SD WWTF	Enrollee – WDR	5B050104001

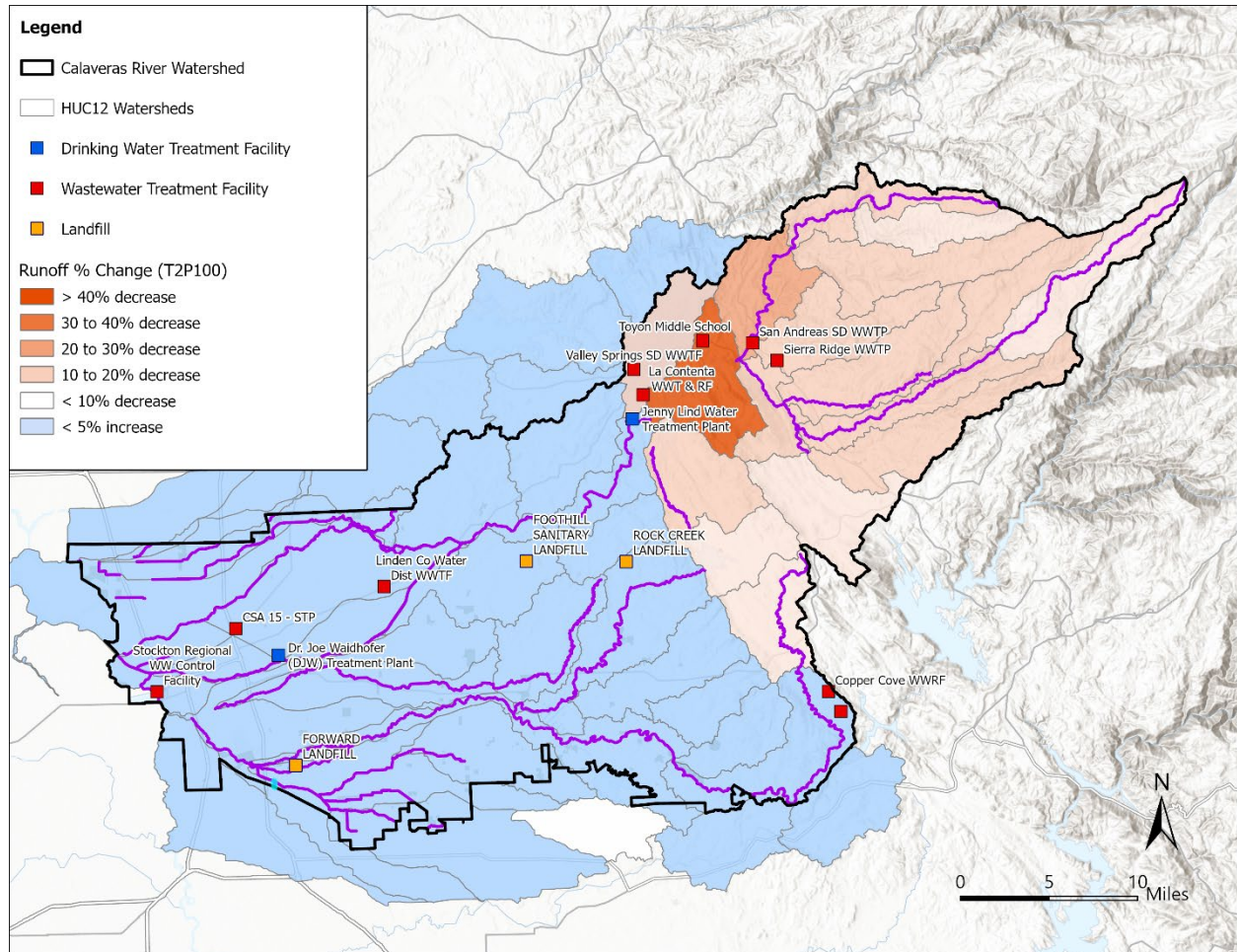
a. Co-Permittee refers to permits shared by multiple entities

TABLE 3. LANDFILLS WITH DISCHARGE PERMITS

Facility Name	Type of Permit	Permit #
Forward Landfill	WDR	5B390308001
Foothill Sanitary Landfill	Co-Permittee	5B390300001
Rock Creek Landfill	Co-Permittee	5B050302002

a. Co-Permittee refers to permits shared by multiple entities.

FIGURE 2. LANDFILLS AND DRINKING WATER/WASTEWATER TREATMENT FACILITIES IN THE CALAVERAS RIVER WATERSHED



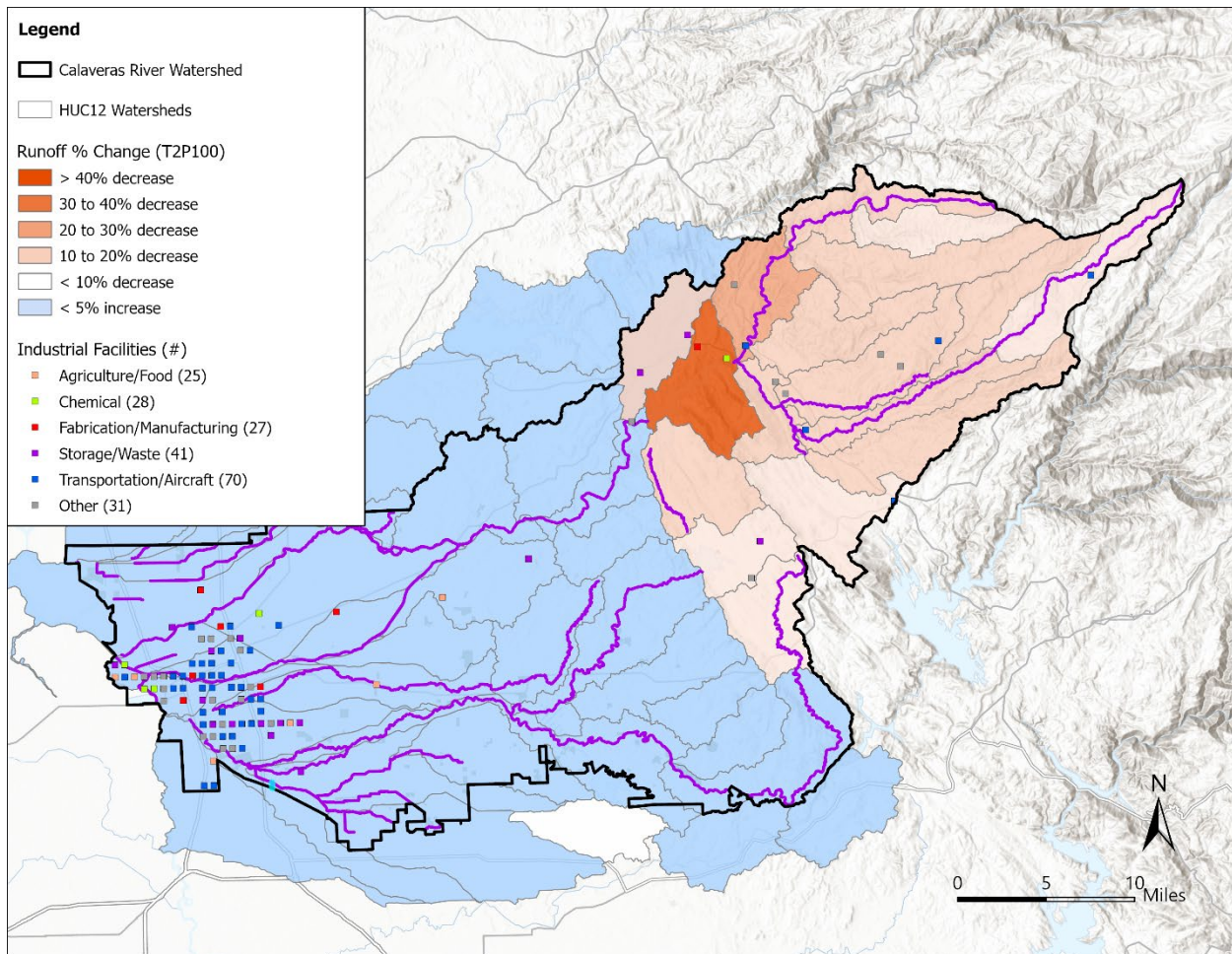
ii. Onsite Wastewater Treatment Systems

Private septic systems, also known as onsite wastewater treatment systems (OWTS), can negatively impact water quality, particularly if their locations are adjacent to water bodies or overlie groundwater basins (U.S. EPA, 2025b). In California, OWTS are regulated at the county level. In researching for this technical memorandum, Woodard & Curran staff were unable to establish contact with either the San Joaquin or Calaveras County Departments of Environmental Health regarding OWTS location data within the Watershed boundaries. Thus, Woodard & Curran has completed due diligence by referencing State Water Resources Control Board (SWRCB) databases and contacting SWRCB and Central Valley Regional Water Quality Control Board (Regional Board) staff in multiple divisions via phone calls and email correspondence. At the time of writing, detailed information on OWTS has not been obtained. Additionally, publicly available GIS databases from both Counties have been reviewed. If location data on OWTS is obtained, this section of the TM will be revised to reflect the latest information.

iii. Industrial Facilities

Industrial facilities can contribute to point source pollution, and thus often hold NPDES or WDR permits for waste management or discharge. 222 industrial facilities within the Watershed have discharge permits (SWRCB, 2024). For this study, industrial facilities were separated into the following categories: transportation and aircraft, storage and waste, chemical facilities, fabrication and manufacturing, and agricultural or food production. The locations of these facilities are shown in **Figure 3** (SWRCB, 2024). As displayed in **Figure 3**, the majority of sites are located in the lower Watershed in and around the City of Stockton, where runoff rates are projected to slightly increase in the most likely climate change scenario.

FIGURE 3. INDUSTRIAL FACILITIES WITH DISCHARGE PERMITS



iv. Agricultural Facilities

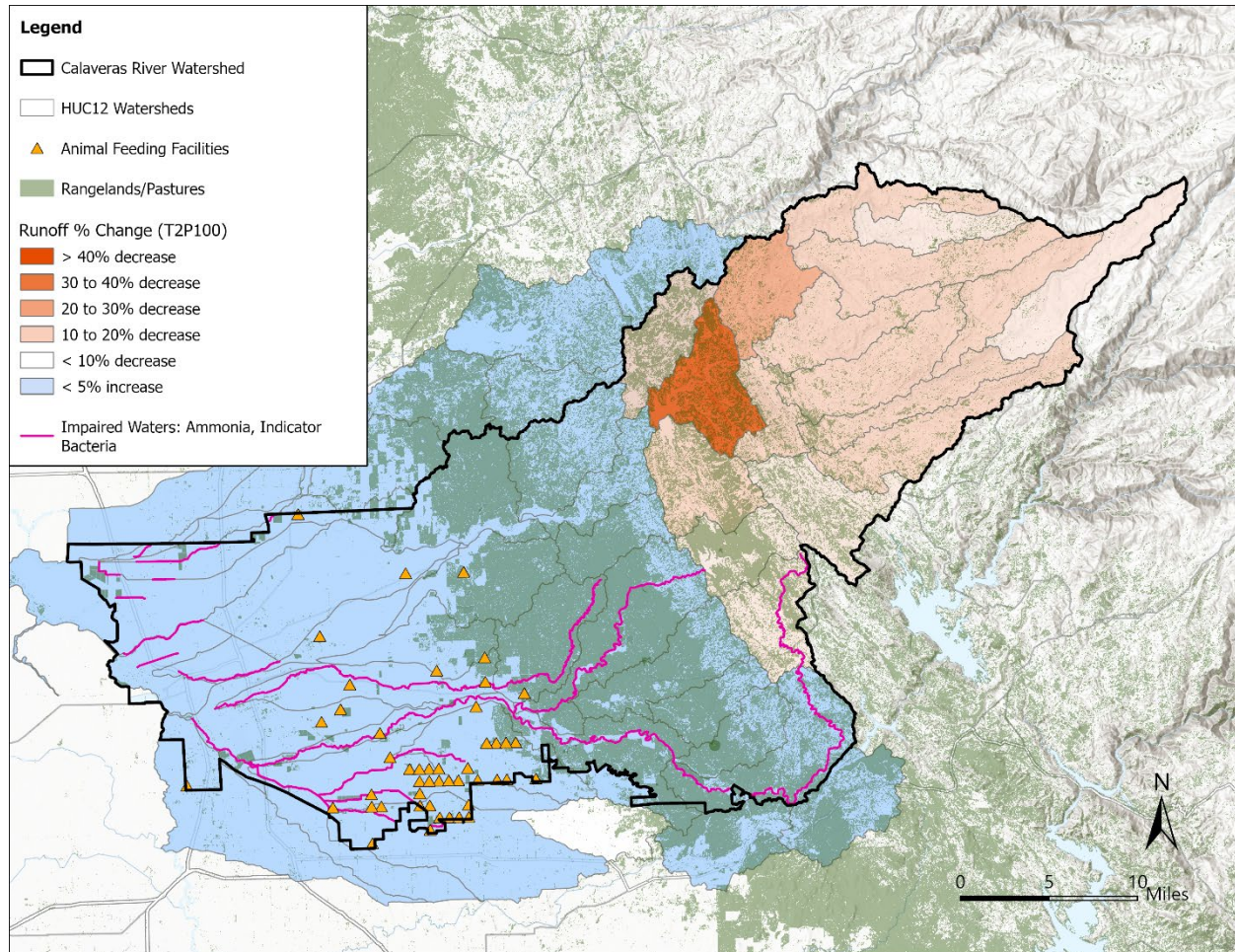
Agriculture can be a major contributor to water pollution. Agricultural pollution is typically categorized as non-point source pollution, which is discussed further in Section b below. However, there are a variety of agricultural activities which cause direct point source pollution, such as industrial agricultural

processes (shown in Figure 3 above) and animal agriculture. The facilities shown in Figure 4 are animal feeding facilities, defined by the EPA as agricultural operations where animals are kept and fed in confined quarters (U.S. EPA, 2025c; SWRCB, 2024). Within the Watershed, more than 2/3 of regulated animal feeding facilities are dairy operations. Animal feeding facilities are closely regulated under discharge programs due to the risk of contamination in nearby water sources. Associated pollutants differ depending on the type of livestock, but can include nitrogen, phosphorus, and harmful pathogens (U.S. EPA, 2025c).

Figure 4 shows current rangelands and animal feeding operations alongside impaired waters, specifically for ammonia and indicator bacteria. High expected runoff is collocated with impaired waters and substantial rangelands in the southeast portion of the Watershed. Similarly in Lower Lone Tree Creek, animal feeding operations are concentrated in an area with already heavily impaired water bodies and an expected increase in runoff. Runoff from rangelands and animal feeding operations can have the following impacts on surrounding water bodies:

- **Livestock Waste:** Both grazing animals on rangelands and concentrated animal feeding sites produce urine and feces rich in nitrogenous compounds, especially ammonium (NH_4^+), which can convert to toxic ammonia (NH_3), especially under alkaline conditions. Storm runoff carries these into nearby water bodies, elevating ammonia concentrations. Livestock directly deposit feces into rangelands and this is only more concentrated at animal feeding operations sites. During wet conditions, fecal coliform and E. coli from this waste are washed into nearby streams. These are commonly used as indicator bacteria for microbial pathogen contamination and human health risk (Cesoniene, Dapkiene, & Sileik, 2019; U.S. EPA, 2025d).
- **Seasonal Runoff Pulses:** Episodic large storm events can trigger spikes in various nitrogen species and transporting them downstream, including ammonia and nitrate.
- **Ammonia Toxicity for Aquatic Life:** Ammonia is acutely toxic to fish and invertebrates, and elevated levels require more stringent TMDL calculations and treatment requirements to meet water quality standards (U.S. EPA, 2025e).
- **Infrastructure Impacts:** Trails, corrals, and watering sites concentrate animal presence along streams on rangelands, exacerbating local runoff and bacterial loading during rain events.

FIGURE 4. ANIMAL FEEDING FACILITIES AND RANGELANDS



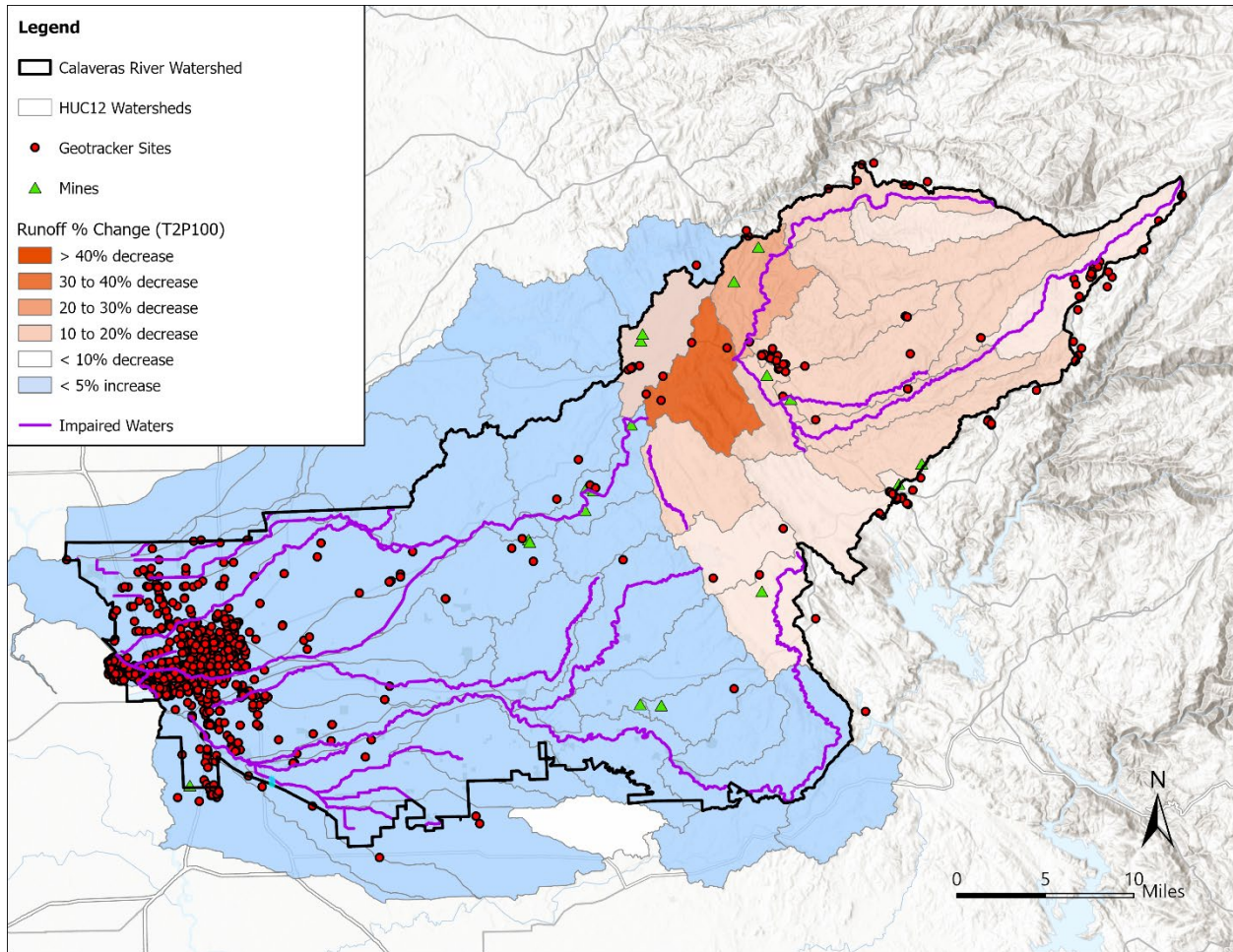
v. Reported Contaminated Waste Sites and Mines

Other sources of point source contamination include authorized or unauthorized discharges of waste to land or unauthorized releases of hazardous substances through underground storage tanks. These sites are monitored by SWRCB and are listed in the GeoTracker database (SWRCB, 2025). Special emphasis is placed on sites that have the potential to pollute groundwater. Most GeoTracker sites require some level of environmental cleanup, but the program tracks other locations, such as permitted landfills, oil and gas production, and active underground storage tanks. **Figure 5** shows active clean-up sites regulated by the State Water Resources Water Quality Control Board. Most cleanup sites are concentrated in the Stockton area where runoff is not anticipated to increase by more than 5%. These are primarily Leaking Underground Storage Tanks (LUSTs) and Cleanup Program Sites. However, the concentration of these sites over a small area could make Stockton more vulnerable to pollution than other parts of the Watershed.

Figure 5 also displays active and former mining sites known to the California Department of Conservation. All identified mines within the sub-watersheds of increased runoff are sand and gravel mines. Disturbed formations at these mines could potentially cause increased turbidity and sedimentation

to surrounding water bodies. Mines are located in the upper Watershed in areas where flooding is expected to decrease, in addition to the lower Watershed, where runoff will increase by a small margin.

FIGURE 5. MINES AND CONTAMINATED WASTE SITES IN THE CALAVERAS RIVER WATERSHED



b. Non-Point Source Pollution

Rather than originating from a known source, non-point source pollution is accumulated from many sources and enters waterways via runoff from precipitation or excess irrigation (U.S. EPA, 2024). Non-point source pollution is not directly regulated under the Clean Water Act. In California, SWRCB and the RWQCBs have the authority to regulate non-point discharges under the Porter-Cologne Act.

Runoff from wildfires and agriculture are the main drivers of non-point source pollution within the Watershed, since the upper and lower Watersheds are dominated by forested and agricultural lands, respectively. The lower Watershed consists of many agricultural parcels, including irrigated croplands and livestock rangelands. Runoff from irrigated agriculture is a major contributor to non-point source pollution, and can carry fertilizer, pesticides, and herbicides into water ways (U.S. EPA, 2025d). Permeable soils may

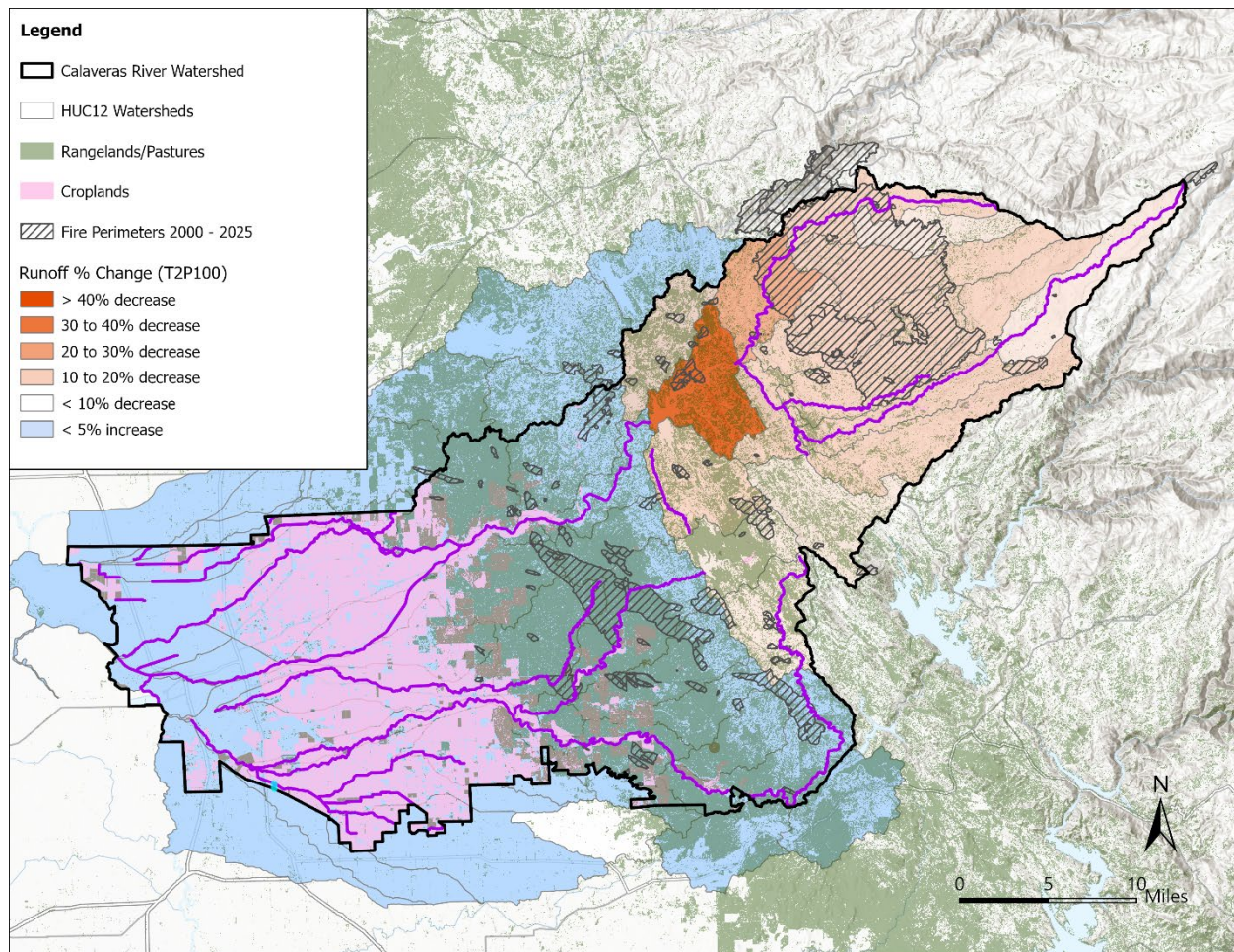
reach saturation during precipitation events or periods of excess irrigation, increasing the risk of agricultural runoff which can increase turbidity and nutrient loading. Furthermore, pesticides and herbicides can be carried by agricultural runoff into water bodies, and can be toxic to ecosystems and human health (U.S. EPA, 2025d). The Watershed's croplands are positioned in the lower Watershed, where runoff is expected to increase by a small margin. The risk of contamination by runoff may also be compounded by the high concentration of irrigated lands.

Runoff from rangelands can carry constituents associated with manure, including microbial contaminants such as *E. coli* and *Cryptosporidium*, both of which cause illness in humans (Johnson, 2021). Livestock waste is also associated with ammonia, nitrates, and pharmaceuticals, all of which are potentially harmful to aquatic ecosystems and human health. Excess nutrient loads in waterways—from logging, wildfire, croplands, or cattle waste—can cause eutrophication, leading to anaerobic conditions in water bodies (U.S. EPA, 2025e). Runoff of non-chemical constituents can cause turbidity and decrease dissolved oxygen levels (U.S. EPA, 2021). Eutrophication and low dissolved oxygen can be harmful to both aquatic ecosystems and public water supplies. Rangelands are present in both the lower and upper Watersheds.

The upper Watershed has a significant logging industry. Regulations on timber harvesting have decreased the impact of the logging industry on water quality (Johnson, 2021). The region has been impacted by many wildfires in the last two decades. Vegetation loss caused by forest fires and logging causes soil erosion, increasing sediment and nutrient runoff into waterways (Stednick, 2000). Wildfires happen almost exclusively in the upper Watershed, where runoff volumes are expected to decrease as a result of climate change. However, lower rates of runoff may allow for continued accumulation of contaminants associated with wildfire, rangelands and point sources located in the upper Watershed. Thus, the expected increase in extreme precipitation events will cause pulse flows of contaminated runoff with elevated concentrations of constituents. Water quality in the initial flows of these extreme events is likely to be severely degraded and can cause further stress on ecosystems and treatment systems downstream.

These relative locations of these factors in the Watershed are displayed in Figure 6 below.

FIGURE 6. POTENTIAL NON-POINT SOURCE POLLUTION



c. Impaired Water Bodies

Section 303(d) of the Clean Water Act defines impaired waters as bodies of water with unsafe concentrations of certain pollutants. Total Maximum Daily Loads (TMDLs) establish the maximum concentrations of certain pollutants allowed in impaired waters. While TMDLs are mandated by the Clean Water Act, the Porter-Cologne Act allows SWRCB and RWQCBs to implement and enforce them in California’s impaired waters (California Regional Water Quality Control Boards, 2025).

Table 4 summarizes impaired water bodies within the Watershed, and Figure 6 displays their locations. The most common TMDLs within the Watershed are for chlorpyrifos, dissolved oxygen levels, indicator bacteria, insecticide, and mercury (SWRCB, 2024). Mercury contamination in the Watershed is likely caused by historical gold mining (USGS, 2018).

Increased runoff into water bodies already listed as impaired under Section 303(d) of the Clean Water Act can severely hinder progress toward meeting TMDL targets (U.S. EPA, 1972). Additional runoff introduces

higher loads of nutrients, sediments, and pollutants, which push contaminant levels beyond the limits established in TMDL allocations. This not only delays restoration efforts but can necessitate recalculating TMDLs, imposing stricter limits on point and nonpoint sources, and increasing regulatory and treatment costs. Ultimately, the added pollutant burden makes compliance more complex and prolongs the recovery timeline for impaired waters.

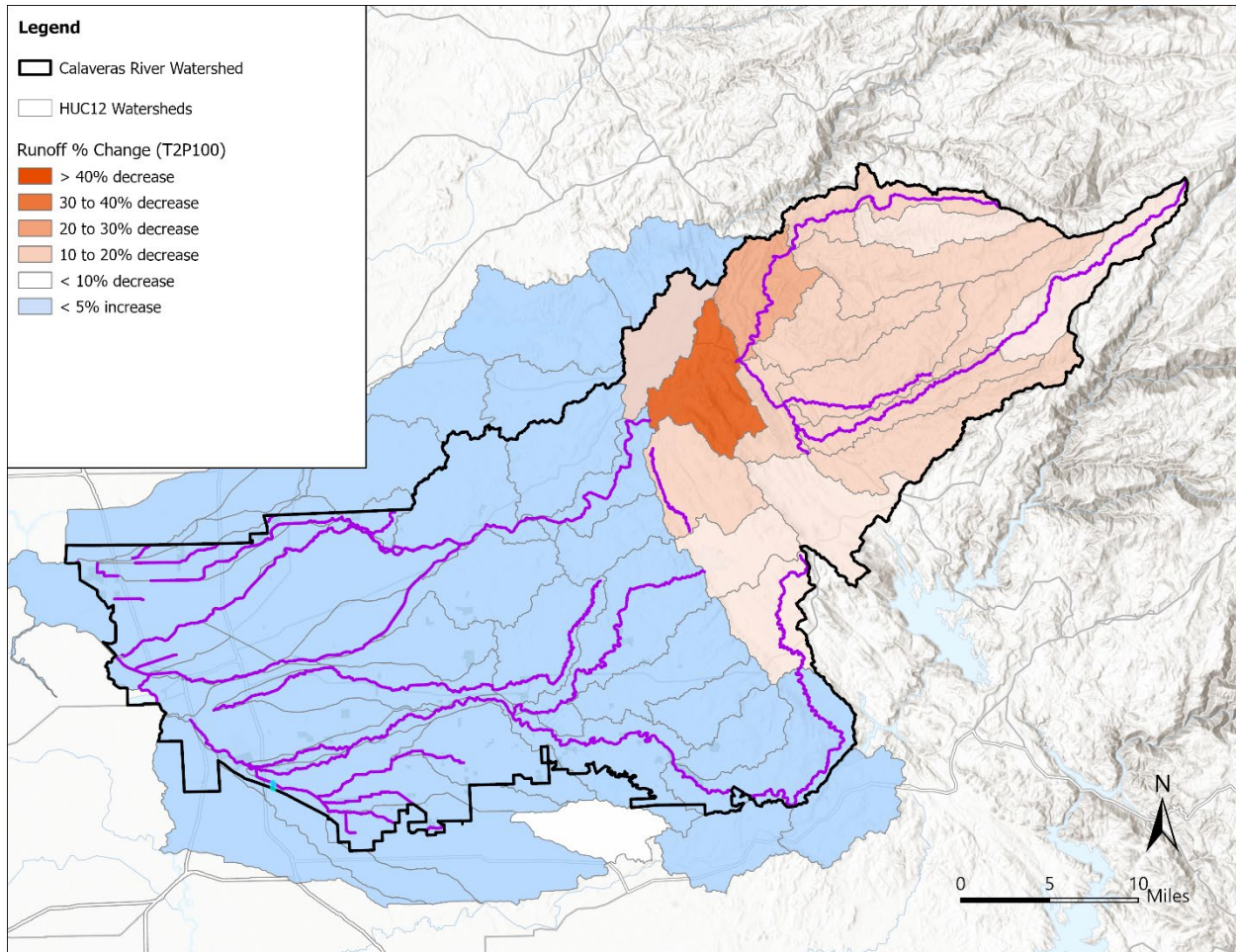
TABLE 4. IMPAIRED WATERS IN THE CALAVERAS RIVER WATERSHED

Impaired Water Body	Type	Area (acres)	Length (miles)	Water Body TMDLs
Davis No 2, unnamed spillway (near N Podesta Lane)	Lake & Reservoir	125.66	-	Mercury
New Hogan Lake (Calaveras County)	Lake & Reservoir	2274.88	-	Mercury
Woodward Reservoir	Lake & Reservoir	1717.19	-	Mercury
San Joaquin River (in Delta Waterways, southern portion)	River & Stream	-	30.52	Temperature
Mormon Slough (from the Bellota Weir—Calaveras River to the Stockton Diverting Canal)	River & Stream	-	13.44	Chlorpyrifos, Dissolved Oxygen, pH
Calaveras River, Lower (in Delta Waterways, eastern portion)	River & Stream	-	5.66	Dissolved Oxygen, Indicator Bacteria, Mercury
Five Mile Slough (Alexandria Place to Fourteen Mile Slough; in Delta Waterways, eastern portion)	River & Stream	-	1.66	Indicator Bacteria, Dissolved Oxygen, Chlorpyrifos, Diazinon
French Camp Slough (San Joaquin County; outside Delta Waterways)	River & Stream	-	6.01	Chlorpyrifos, Diuron, Simazine, Dissolved Oxygen, Indicator Bacteria
Mormon Slough (San Joaquin County; outside Delta Boundary)	River & Stream	-	8.97	Indicator Bacteria
Rock Creek (Stanislaus County)	River & Stream	-	21.40	Dissolved Oxygen, Indicator Bacteria
Temple Creek	River & Stream	-	10.32	Ammonia, Chlorpyrifos, Diuron, Dissolved Oxygen, Indicator Bacteria

Impaired Water Body	Type	Area (acres)	Length (miles)	Water Body TMDLs
Lone Tree Creek	River & Stream	-	26.01	Ammonia, Biochemical Oxygen Demand, Biological Oxygen Demand, Chlorpyrifos, Diuron, Dissolved Oxygen, Indicator Bacteria
Pixley Slough (San Joaquin County; outside Delta Waterways)	River & Stream	-	15.31	Indicator Bacteria, Diazinon, Chlorpyrifos, Dissolved Oxygen
Calaveras River, Lower (from Bellota Weir to Stockton Diverting Canal)	River & Stream	-	22.09	Toxicity ^a
Avena Drain	River & Stream	-	5.99	Ammonia, Indicator Bacteria
Bear Creek (San Joaquin and Calaveras Counties; outside Delta Waterways)	River & Stream	-	51.21	Copper, Dissolved Oxygen, Indicator Bacteria
Littlejohns Creek	River & Stream	-	70.06	Chlorpyrifos, Dissolved Oxygen, Indicator Bacteria
Delta Waterways (Stockton Ship Channel)	Estuary	-	3.71	Diazinon, Furan, Pesticides, Chlorpyrifos, Dissolved Oxygen, Dioxin, PCBs, DDT
Mosher Slough (downstream of I-5; in Delta Waterways, eastern portion)	River & Stream	-	1.85	Dissolved Oxygen, Mercury, Indicator Bacteria
Duck Creek (San Joaquin County)	River & Stream	-	34.12	Mercury, Chlorpyrifos, Lead, Dissolved Oxygen, Indicator Bacteria
San Joaquin River from Delta Waterways to Stockton Ship Channel	River & Stream	-	36.72	Imidacloprid, Water Temperature
Mormon Slough (Commerce Street to Stockton Deep Water Channel; partly in Delta Waterways, eastern portion)	River & Stream	-	1.08	Dissolved Oxygen, Indicator Bacteria

- a. *"Toxicity" refers to a high concentration of pollutants that may cause harmful effects to aquatic life or human health, and is listed as a TMDL when waterways are impaired due to the cumulative effects of multiple toxic substances, or are contaminated by a mixture of different pollutants (U.S. EPA, 1994)*

FIGURE 7. IMPAIRED WATER BODIES IN THE CALAVERAS RIVER WATERSHED



3. RECOMMENDATIONS FOR FUTURE WORK

Climate change affects water quality through multiple pathways including altered flow regimes, increased water temperatures, and changes in pollutant loading and transport. Future assessments should develop fate and transport modeling capabilities to evaluate how climate scenarios affect constituent concentrations in streams and reservoirs. Key considerations include nutrient dynamics under varying flow conditions, salinity intrusion risks during low-flow periods, and temperature-dependent water quality parameters. A coupled hydrologic-water quality model would allow the evaluation of how adaptation strategies, particularly managed recharge and altered reservoir operations, affect downstream water quality conditions and beneficial use protections.

The impacts of water pollution in this vulnerability assessment are reported at a very high level in this Plan. The contaminant mobilization analysis stops short of assessing possible concentration changes or impacts

to contaminant loading because this watershed does not yet have existing technical tools developed in order to assess fate and transport of contaminants. A fate and transport model that is integrated into the hydrologic modeling toolset would greatly improve the watershed's ability to understand water quality impacts under climate change.

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