Sustainable Water
Resource
Management

DECEMBER 2025

WHITEWATER RIVER SUBBASIN

Preliminary Watershed Management Plan

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Photo Source: Desert Sun

Acknowledgements

This Preliminary Watershed Management Plan was prepared as a course project for Sustainable Water Resource Management, offered through the Master of Environmental Science and Management program at the Bren School, University of California, Santa Barbara.

We are deeply grateful to Professor Arturo Keller for his outstanding instruction, insightful guidance, and enthusiasm throughout the quarter. His expertise in water quality, hydrology, and watershed policy greatly shaped our understanding and the direction of this plan.

We also sincerely thank our Teaching Assistant, Trace Martin, for his generous time, thoughtful feedback, and steady support.

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Objectives:

Based on the comprehensive data collected for the Whitewater River Subbasin, including topography, climate patterns, hydrology, land use, water supply/demand dynamics, monitoring records, and pollutant analyses, the key issues center on water scarcity, quality degradation, ecosystem vulnerability, and data deficiencies in this arid desert watershed. These issues are largely watershed-wide but manifest more intensely in specific regions: groundwater overdraft and salinity increases are prominent in the lower valley floor around Indio and Thermal, where agricultural and urban demands are highest; water quality impairments from runoff and pollutants (e.g., bacteria, nutrients, sediments) concentrate in the Coachella Valley Stormwater Channel and downstream reaches near the Salton Sea; habitat fragmentation and erosion risks are acute in the steep mountainous headwaters of the San Jacinto and San Bernardino ranges; and monitoring gaps span the entire basin but are critical in mid-basin and lower valley areas for accurate recharge and flood assessments.

- **Reverse groundwater overdraft and enhance recharge**: Prioritize sustainable extraction to address the historical 4.8 million acre-feet deficit and declining water levels (over 60 feet in some areas), focusing on artificial recharge facilities like the Whitewater River Groundwater Replenishment Facility and natural infiltration from ephemeral flows in alluvial fan zones, while integrating recycled water to meet projected demand increases from 695,400 acre-feet in 2015 to 850,500 acre-feet by 2040.
- **Improve water quality and address impairments**: Reduce pollutants such as total coliform (mean 729 MPN/100mL), E. coli, nitrate (up to 24 mg/L), iron, and turbidity from urban and agricultural runoff, targeting 303(d) listings and TMDL requirements in the Coachella Valley Stormwater Channel through source control and treatment, to protect municipal supply, agricultural productivity, and downstream ecosystems like the Salton Sea.
- **Protect and restore sensitive habitats and species**: Safeguard endangered species (e.g., desert pupfish, Coachella Valley fringe-toed lizard) and habitats in protected areas like the Whitewater Floodplain Preserve and CVMSHCP conservation zones, mitigating threats from habitat loss, invasive species, and altered flows in riparian corridors and sand dunes, with emphasis on maintaining biodiversity hotspots in the valley floor and mountainous uplands.
- **Mitigate flood risks, erosion, and sediment transport**: Manage flash floods and erosion driven by the basin's steep topography (3,573m relief) and episodic precipitation (up to 170mm/month in headwaters), focusing on alluvial fans and bajadas where sediment mobilization impacts downstream channels, through structural controls and vegetation stabilization to enhance resilience in high-risk areas like Palm Springs and Cathedral City.
- **Expand monitoring and data collection**: Fill spatial and temporal gaps in flow, precipitation, and water quality monitoring (e.g., no continuous records across 1998-2025, limited stations in mid-basin), prioritizing new gages and sensors in headwaters, agricultural zones, and urban areas to enable accurate pollutant loading estimates, recharge assessments, and adaptive management for drought and storm events.

- **Promote water conservation and sustainable land use**: Balance growing urban (nearly doubling by 2040) and agricultural demands with conservation practices, including efficiency improvements in irrigation and golf courses, while aligning with SGMA plans and CVMSHCP to reduce overall consumption and support economic activities like tourism and farming.

These objectives provide a foundational framework for stakeholder discussions, incorporating regulatory contexts like SGMA and TMDLs to guide collaborative action toward long-term watershed sustainability.

1. Introduction

A watershed management plan is a strategic tool developed by local, state, and federal agencies, along with community stakeholders, to guide the sustainable use and protection of water resources within a defined area. The Whitewater River Subbasin WMP aims to address critical issues such as water scarcity due to prolonged drought, degradation of water quality from urban and agricultural runoff, and the preservation of sensitive ecosystems and wildlife habitats. Located in the arid Coachella Valley, this subbasin faces unique challenges including groundwater overdraft and erosion from steep mountainous terrain, necessitating a collaborative approach involving water districts, conservation groups, and residents. By integrating current scientific data and stakeholder input, this plan seeks to propose effective, long-term strategies to maintain the ecological balance and support the region's economic activities, such as agriculture and tourism.

1.1 Location

The Whitewater River Subbasin is situated in the Coachella Valley of Southern California, approximately 100 miles east of Los Angeles (Figure 1.1). It encompasses parts of western Riverside County, including cities like Palm Springs and Indio, and extends into southwestern San Bernardino County, with its headwaters originating in the San Bernardino Mountains. The subbasin covers an area of about 560 square miles, with the Whitewater River flowing approximately 54 miles from its source at Mount San Gorgonio (elevation 11,499 feet) down to its terminus near the Salton Sea, which lies 225 feet below sea level. The watershed features a dramatic elevation gradient, transitioning from rugged mountain peaks to the flat desert valley floor, and is part of the larger Colorado River Basin drainage system.

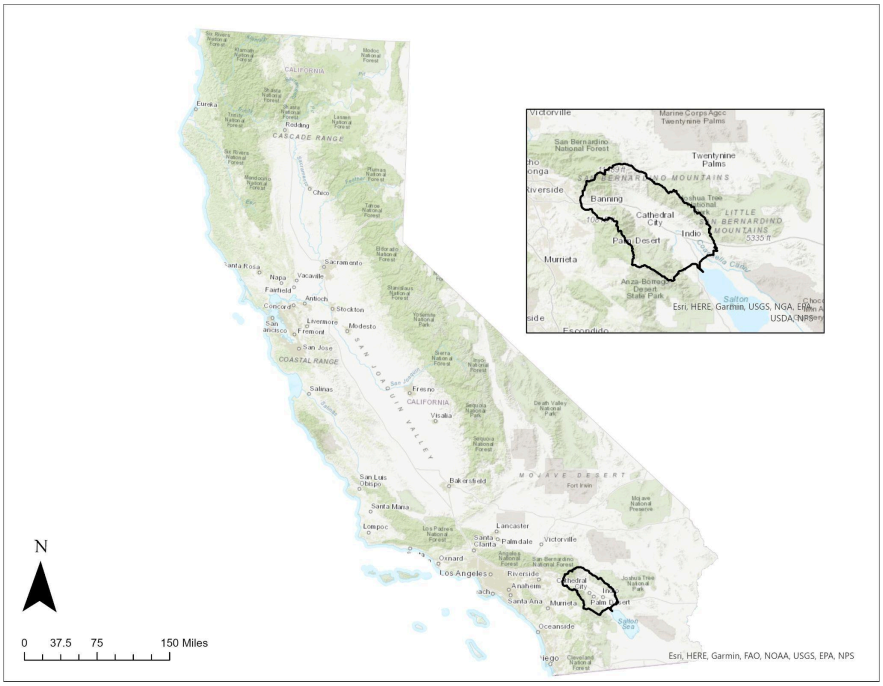


Figure 1.1 Whitewater River Subbasin Location

1.2 Topography

The Whitewater River subbasin exhibits dramatic topographic relief, ranging from 3,503 meters (11,499 feet) at the highest peaks in the San Jacinto Mountains to -69.8 meters (-229 feet) below sea level on the valley floor (Figure 1.2). This relief of approximately 3,573 meters over relatively short horizontal distances produces some of the steepest mountain fronts in southern California. The subbasin is bounded by the San Jacinto and Santa Rosa Mountains to the southwest and south, and the Little San Bernardino Mountains to the northeast. These ranges exhibit steep, fault-controlled escarpments that descend rapidly to the valley floor. The mountain fronts are deeply dissected by ephemeral and intermittent drainages that have formed extensive alluvial fans along the basin margins. These fans coalesce into bajadas that slope gradually toward the valley axis.

The valley floor displays relatively gentle gradients, with elevations decreasing from the northwestern boundary toward the southeast. The Whitewater River and other major drainages flow southeastward, following the regional topographic gradient and structural tilting of the valley (Dorsey et al., 2008). This pronounced topographic relief exerts primary controls on precipitation distribution, runoff generation, sediment transport, and natural groundwater recharge within the subbasin.

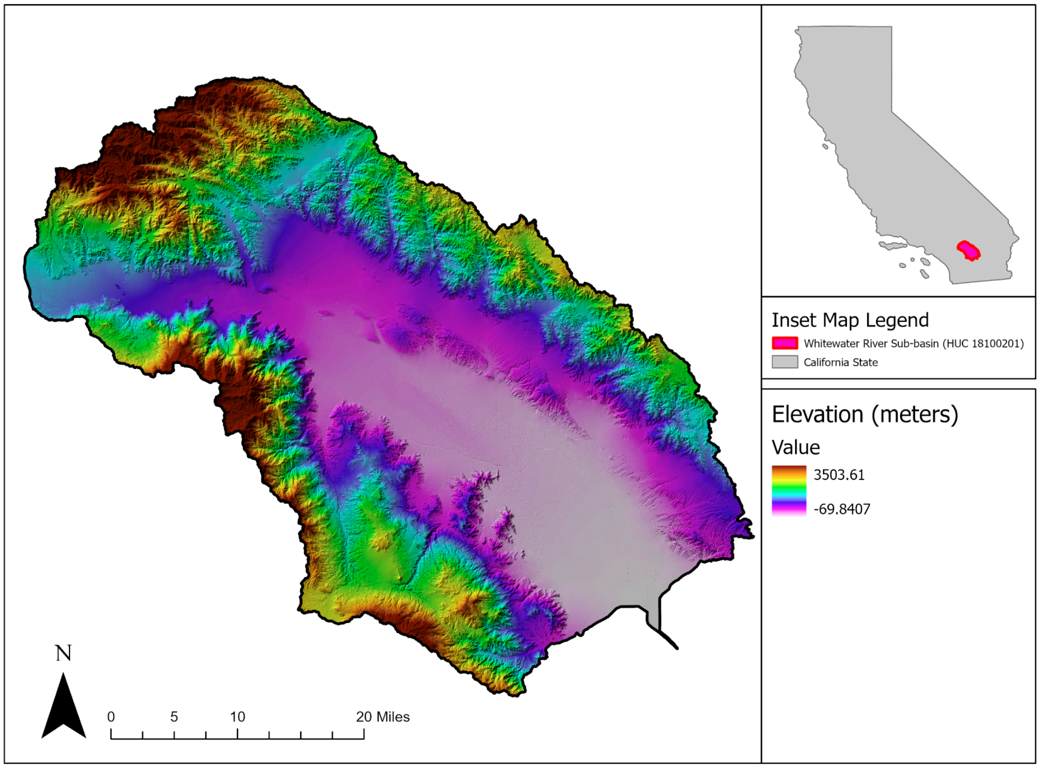


Figure 1.2 Digital elevation model of the Whitewater River subbasin showing topographic relief from 3,503 meters in the San Jacinto Mountains to -69.8 meters below sea level on the valley floor. Inset map shows subbasin location within California.

1.3 Climate

The climate of the Whitewater River Subbasin varies dramatically from its mountainous headwaters to its desert mouth at the Salton Sea, shaping water availability and watershed processes. Long-term precipitation and temperature data from PRISM, Parameter-elevation Regressions on Independent Slopes Model, (1991-2020 normals) reveal a stark gradient driven by elevation, with the upper watershed receiving significantly more precipitation than the lower valley. These climatic patterns influence runoff, erosion, and ecosystem resilience, making climate a key factor in managing the subbasin's water resources.

1.3.1 Precipitation

Precipitation in the Whitewater River Subbasin shows a clear elevational gradient, as depicted in Figure 1.3. At the headwaters near Mount San Gorgonio (5230 ft), annual precipitation averages 16.24 inches, with peaks in winter months like January (4.05 inches) and February (3.39 inches), reflecting snow accumulation and melt. In contrast, at the mouth near the Salton Sea (0 ft), annual precipitation drops to 2.87 inches, with the highest monthly total of 0.58 inches in January, indicating reliance on sporadic winter rains. Summer months at both locations see minimal precipitation (e.g., 0.07 inches in June at the headwaters, 0.00 inches in June at the mouth), though occasional monsoons can occur. This gradient drives significant runoff from the mountains, contributing to flash floods and sediment transport in the lower watershed, while limiting groundwater recharge in the arid valley.

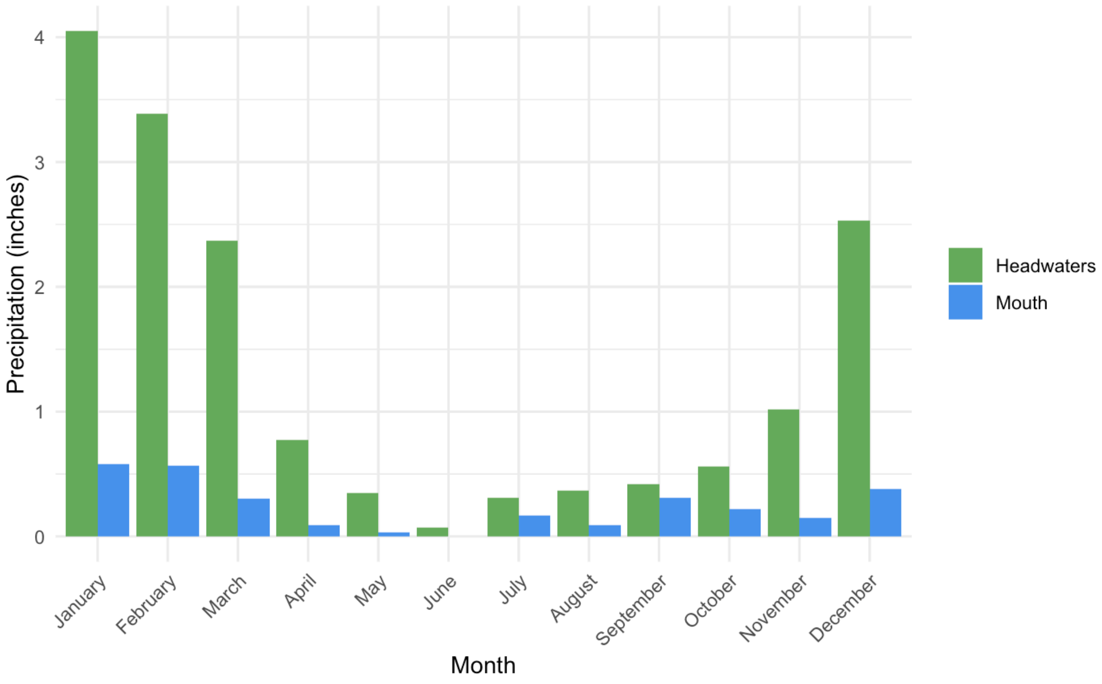


Figure 1.3.1 Long-term monthly precipitation chart for the Whitewater River Subbasin (PRISM 1991-2020)

1.3.2 Temperature

Temperature variations further define the subbasin's climate, as shown in Figure 1.3.2. At the headwaters, the annual mean temperature is 56.7°F, with cooler conditions ranging from 42.7°F in December to 74.2°F in July, influenced by higher elevation and snowmelt effects. At the mouth, the annual mean rises to 73.3°F, with extreme summer highs of 91.7°F in August and milder winters averaging 54.8°F in December. These temperature extremes accelerate evaporation in the valley, reducing surface water availability and stressing desert vegetation, while the cooler headwaters support more diverse ecosystems. The gradient also affects seasonal water flows, with spring melt from the mountains providing a critical, though limited, contribution to the river.

In summary, the Whitewater River subbasin's climate features a pronounced shift from a cooler, wetter upper watershed to a hot, arid lower valley. This variability drives runoff and erosion risks, particularly during winter storms, while high evaporation rates in the valley challenge water retention, necessitating targeted management strategies to protect aquatic and terrestrial habitats.

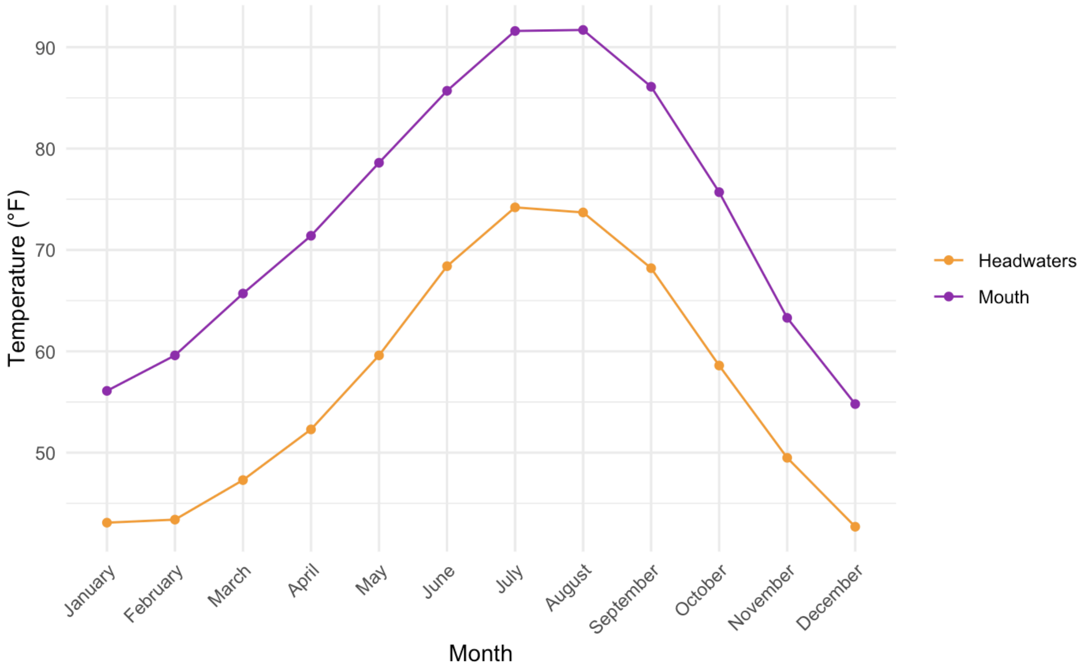


Figure 1.3.2 Long-term monthly temperature chart for the Whitewater River Subbasin (PRISM 1991-2020)

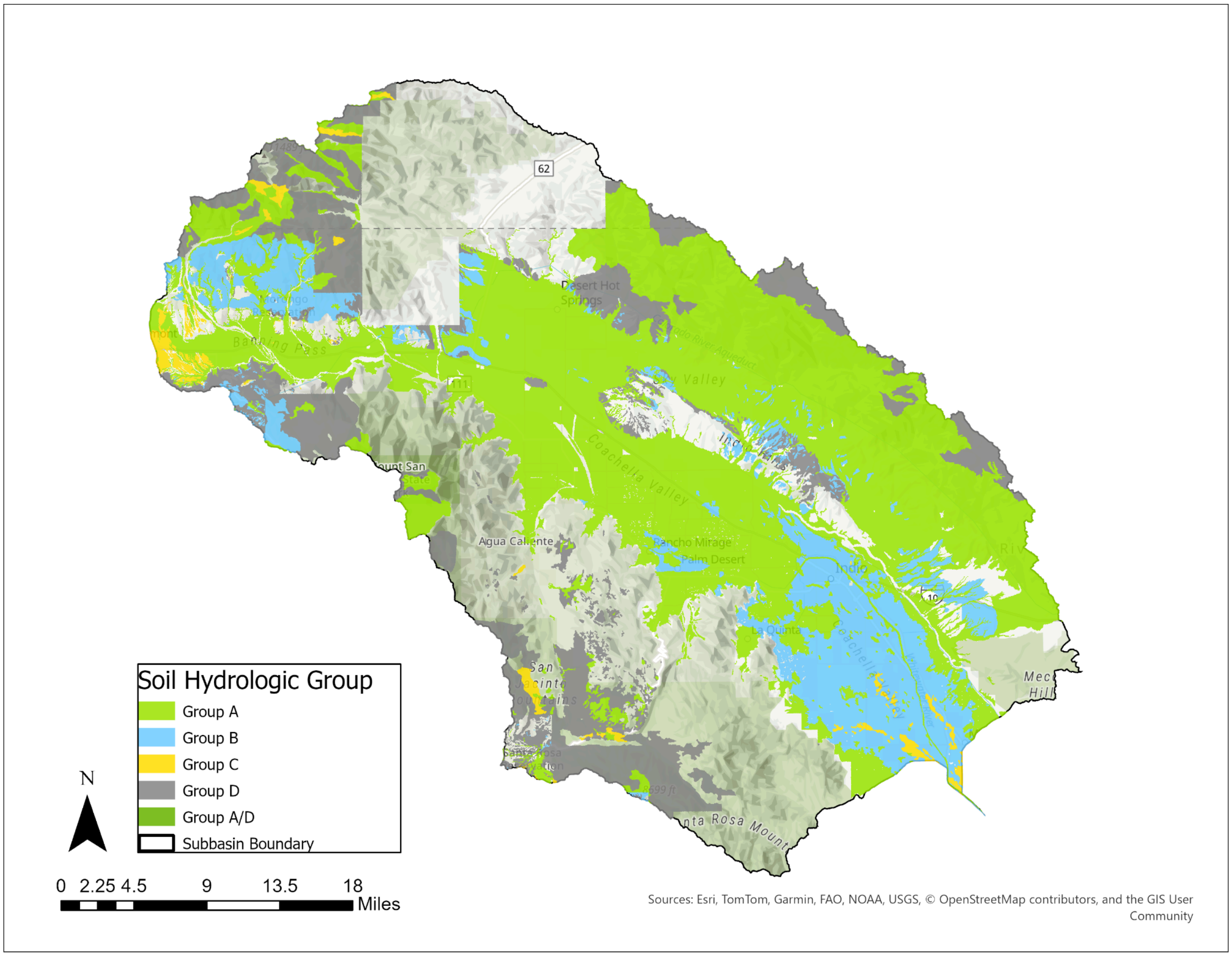
1.4 Geology

The Whitewater River subbasin is situated within the northern Salton Trough, a tectonically active pull-apart basin formed by the interaction between the San Andreas fault system and the northward propagation of spreading centers from the Gulf of California (Dorsey and Langenheim, 2015). The subbasin occupies a structurally complex portion of the northern Coachella Valley, bounded by steep mountain ranges and major active fault systems that exert primary controls on basin geometry, sediment accumulation, and groundwater hydrology.

The subbasin lies between two major fault systems: the San Andreas Fault zone along the northeastern margin and the San Jacinto Fault zone to the southwest (Matti and Morton, 1993). The San Andreas fault accommodates approximately 25-35 mm/yr of right-lateral slip (Keller et al., 1982), while the San Jacinto fault zone, which initiated at approximately 1.1-1.3 Ma, currently accommodates a significant portion of the plate boundary deformation (Janecke et al., 2010). Systematic northeastward tilting of the Coachella Valley between these faults has been documented and likely began around 1.2 Ma (Dorsey et al., 2008). These transform faults have created a deep structural trough that has accumulated sediment over the past several million years.

The surrounding San Jacinto and Little San Bernardino Mountains expose Precambrian crystalline basement rocks including biotite gneiss, schist, and Mesozoic granitic plutons of the Southern California Batholith (Spotila et al., 2007). These erosion-resistant rocks provide the primary source material for sediment delivery to the basin. Within the Coachella Valley, sediment thickness varies from approximately 4 km near the Salton Sea to less than 2 km at the northwestern end (Ajala et al., 2019; Langenheim et al., 2005). The basin fill consists primarily of late Tertiary and Quaternary alluvial deposits that vary significantly in grain size and hydrologic properties. Coarse-grained alluvial fan deposits dominate along the mountain fronts and exhibit high permeability, transitioning to finer-grained sediments toward the valley axis (Tyley, 1974). The spatial distribution of these sediments is reflected in the soil hydrologic group classifications (Figure 1.4), with more permeable Group A and B soils associated with recent alluvial fan deposits along the mountain fronts, and less permeable Group C and D soils corresponding to finer-grained valley floor deposits.

The geologic structure and stratigraphy of the Whitewater River subbasin exert primary controls on groundwater flow patterns, aquifer storage capacity, and natural recharge zones. The basin's structural asymmetry influences subsurface flow paths and the distribution of productive aquifer zones (Ajala et al., 2019). Natural groundwater recharge occurs primarily through percolation of streamflow from intermittent streams draining the San Bernardino Mountains. The high permeability of alluvial fan deposits along the mountain fronts facilitates rapid infiltration and recharge to the underlying aquifer system (California Department of Water Resources).



Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Figure 1.4.1 Hydrologic soil group classifications derived from 30 m rasters produced by the Natural Resources Conservation Service (NRCS).
Values are based on the gSSURGO map unit aggregated attribute field Hydrologic Group Dominant Conditions. Group A soils are deep, well-drained sands or gravelly sands with high infiltration and low runoff rates. Group B soils are deep, well-drained soils with moderately fine to moderately coarse textures and moderate infiltration rates. Group C soils have layers that impede water movement or are fine-textured, resulting in slow infiltration. Group D soils have very slow infiltration and high runoff potential, typically consisting of clays with high shrink-swell capacity, shallow soils over impervious layers, or soils with high water tables.

1.5 Soil Characteristics

The soils of the Whitewater River Subbasin exhibit a wide range of characteristics influenced by the region's steep topography, arid climate, and diverse geological origins, including erosion from igneous rocks in the San Jacinto, Santa Rosa, and Little San Bernardino Mountains. The soil infiltration map, derived from SSURGO data and converted from µm per second to inches per hour, reveals Ksat values ranging from 0.0014 to 59.95 inches per hour across the subbasin. In the upper watershed, soils are predominantly shallow and gravelly with low organic matter and water-holding capacity, averaging 0.4-0.8 inches per foot, where Ksat values of 0.0014 to 7.95 inches per hour indicate slow to moderate infiltration, contributing to rapid runoff and limited vegetation support in the mountainous headwaters. On the valley floor, dominant soil series such as Carsitas and Myoma feature highly pervious sands with Ksat values ranging from 7.95 to 20.126 inches per hour, promoting quick infiltration but posing risks of nutrient leaching, as shown in the infiltration map. Coachella series soils, concentrated along historic river channels, display moderate permeability with Ksat values of 2 to 6 inches per hour and water-holding capacities of 0.4-1.8 inches per foot. In contrast, finer soils like Gilman and Indio in the southeastern areas exhibit Ksat values of 0.6-2 inches per hour, offering better moisture retention but slower drainage, which increases susceptibility to compaction. The soil erodibility map, based on the K factor, shows values ranging from 0.02 to 0.55, with higher erodibility (0.32 to 0.55) in central and southeastern areas like Indio, reflecting greater erosion risk due to finer textures and lower infiltration rates, while lower values (0.02 to 0.17) in the mountainous north indicate more stable, coarse soils.

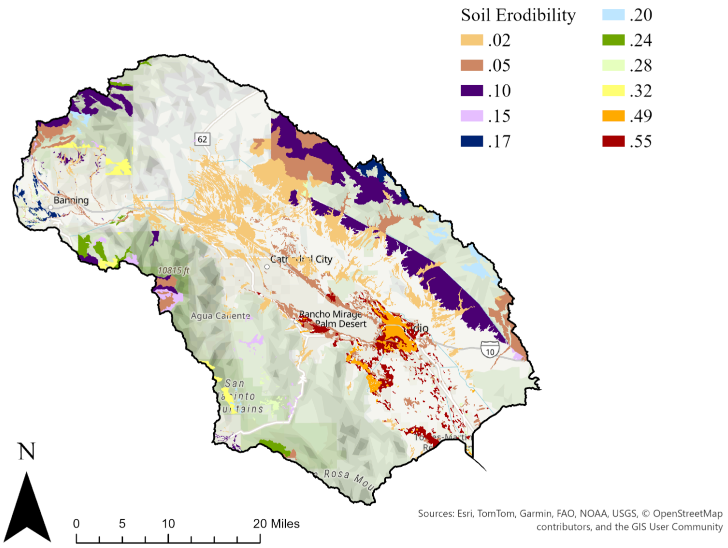


Figure 1.5a: Distribution of Soil Erodibility for the Whitewater River subbasin Watershed.
Very High > 0.45; High 0.35-0.45; Moderate 0.25-0.35; and Low-Very Low < 0.2

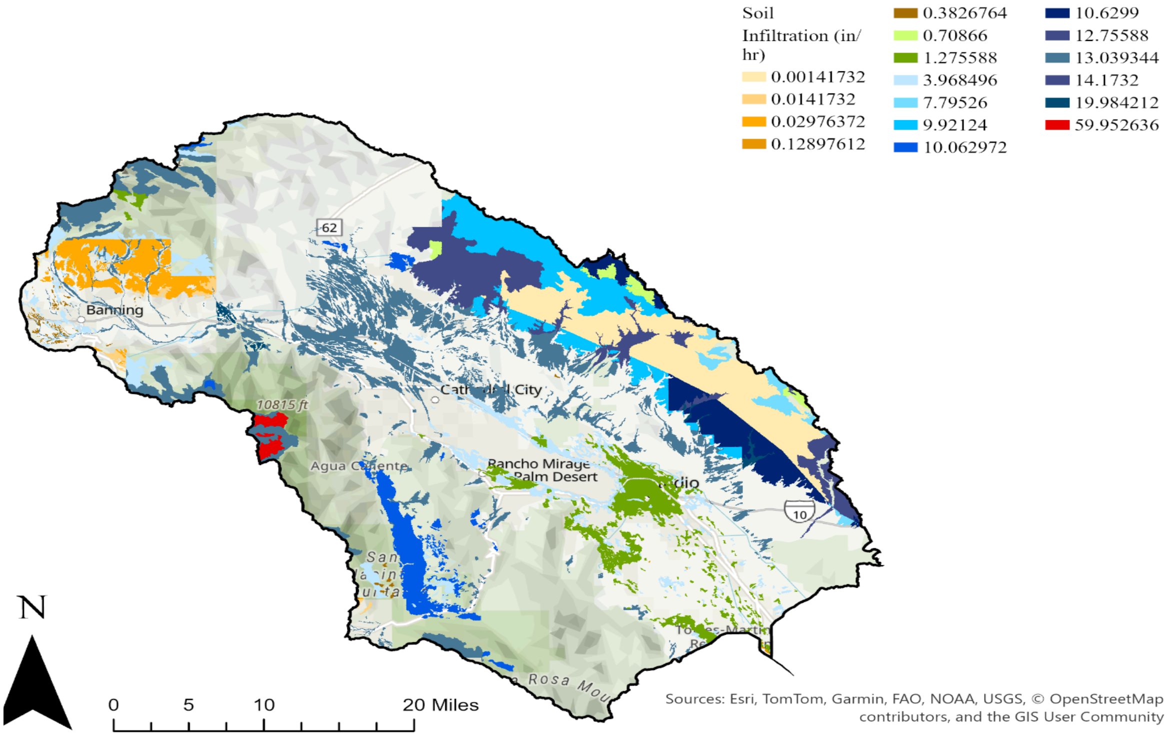


Figure 1.5b: Distribution of Representative Value Infiltration (Ksat). 0–0.5 inches/hour: Very slow infiltration (clays, high runoff risk), represented by yellow/orange tones.. 0.5–2 inches/hour: Slow to moderate (silts, loams, balanced drainage), represented by green tones.. 2–20 inches/hour: Moderate to fast (sandy loams, sands, good drainage), represented by blue tones. 20–60 inches/hour: Very fast (gravels, high leaching risk), represented by red tone.

1.6 Hydrology

Surface water in the Whitewater River subbasin largely originates in the San Jacinto and Santa Rosa Mountains to the southwest and south, and the Little San Bernardino Mountains to the northeast. The basin generally sees low rainfall, with an average annual high of 1.4 inches and a low of 0.0 inches in the city of Palm Springs (Weatherspark.com). The basin's various tributaries accumulate in the Whitewater River, which has seen discharge rates between 0 ft^3/s and 285 ft^3/s in the past 5 years (USGS). The Whitewater River drains into the Salton Sea, a saline endorheic lake. Decades of contamination from agricultural runoff in the basin have led to an ecological disaster in the Salton Sea, which has seen mass die-offs of wildlife and poor water quality. Additionally, drought conditions have led to dust storms that spread contaminants through the air (Doede & DeGuzman, 2020). Increasing populations in cities such as Cathedral City, Palm Springs, Rancho Mirage and Palm Desert have led to increases in both water demand and pollution from agricultural and urban runoff, perpetuating existing stresses and endangering local ecosystems. Riparian forest development is very limited due to flooding and shifting channels (Kuenzi 2025).

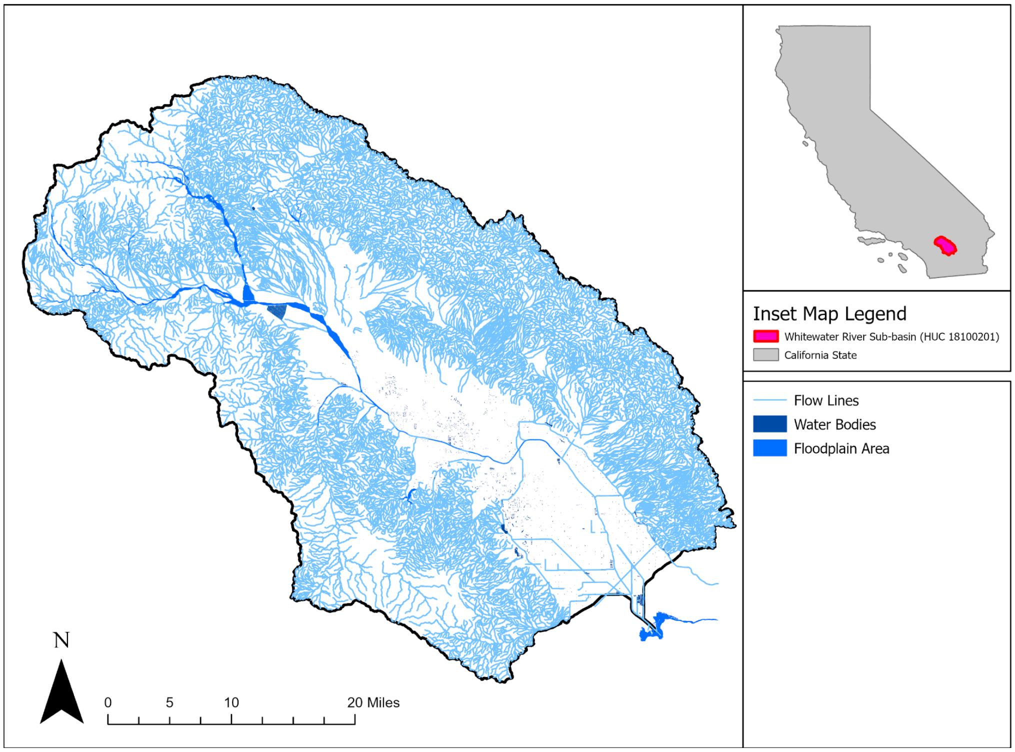


Figure 1.6: Hydrologic Flow Lines, Water Bodies, and Major Floodplain Areas in the Whitewater River Watershed (National Hydrography Dataset).

1.7 Land Use

Land use within the Whitewater River subbasin is predominantly characterized by shrub/scrub and grassland/herbaceous vegetation in the undeveloped upland and valley floor areas (Figure 1.7). The mountain slopes support mixed forest, evergreen forest, and deciduous forest communities at higher elevations, transitioning to barren lands on the steepest terrain.

Urban development is concentrated in the central and southeastern portions of the subbasin, with medium and high-intensity developed areas primarily located in the Palm Springs, Cathedral City, and Rancho Mirage areas along the valley floor. Low-intensity development and open space development extend into the alluvial fan regions. Agricultural land use, including cultivated crops and pasture/hay, occupies portions of the valley floor, particularly in areas with suitable soils and water availability. Woody wetlands and emergent herbaceous wetlands occur in limited areas, primarily associated with stream channels and low-lying areas on the valley floor. The spatial distribution of land use reflects the strong topographic controls, with development and agriculture restricted to the gentler valley floor and alluvial fans, while steeper mountain terrain remains largely undeveloped.

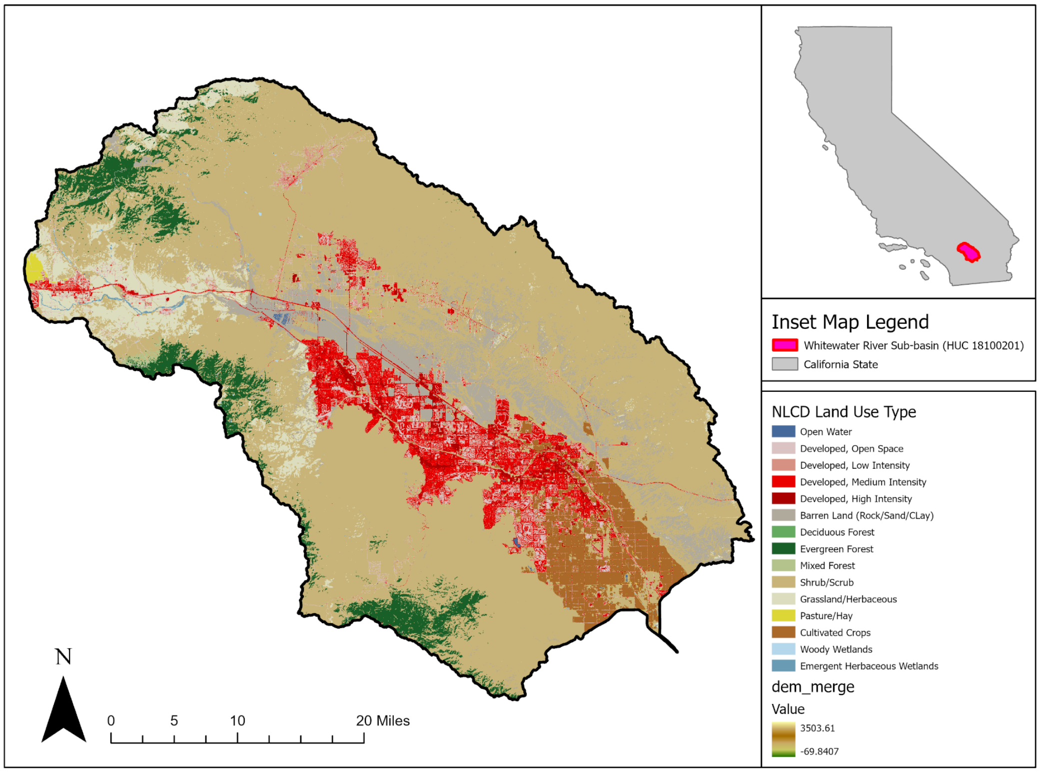


Figure 1.7 Land use and land cover in the Whitewater River subbasin based on National Land Cover Database (NLCD) classifications. Urban development is concentrated on the

valley floor, while upland areas are dominated by natural vegetation communities. Elevation gradient shown by underlying digital elevation model.

1.8 Biological Assets

1.8.1 Major Ecosystems

The subbasin encompasses several key ecosystems typical of the Sonoran Desert biome. Dominant on the valley floor is Sonoran creosote bush scrub, characterized by sparse shrubs like creosote bush (Larrea tridentata) and white bursage (Ambrosia dumosa), interspersed with annual wildflowers during wet years. This community covers alluvial fans and sandy plains, providing habitat for ground-dwelling species and aiding in soil stabilization against erosion. Colorado saltbush scrub occurs in floodplains and low-lying areas prone to periodic inundation, such as along the Whitewater River, where saline soils support salt-tolerant plants like arrowweed and saltbush. Higher elevations in the San Bernardino Mountains feature chaparral and mixed woody scrub, transitioning to pinyon-juniper woodlands. Sandy washes and alluvial plains, including those from Whitewater Canyon, act as wildlife corridors, conveying sediments and seeds during floods while supporting diverse invertebrates and reptiles. Desert sand fields and dunes, reliant on aeolian (wind-blown) processes, are biodiversity hotspots but increasingly fragmented by development. Riparian habitats along the river and intermittent streams add moisture-dependent vegetation, enhancing overall ecosystem connectivity and water quality by filtering runoff.

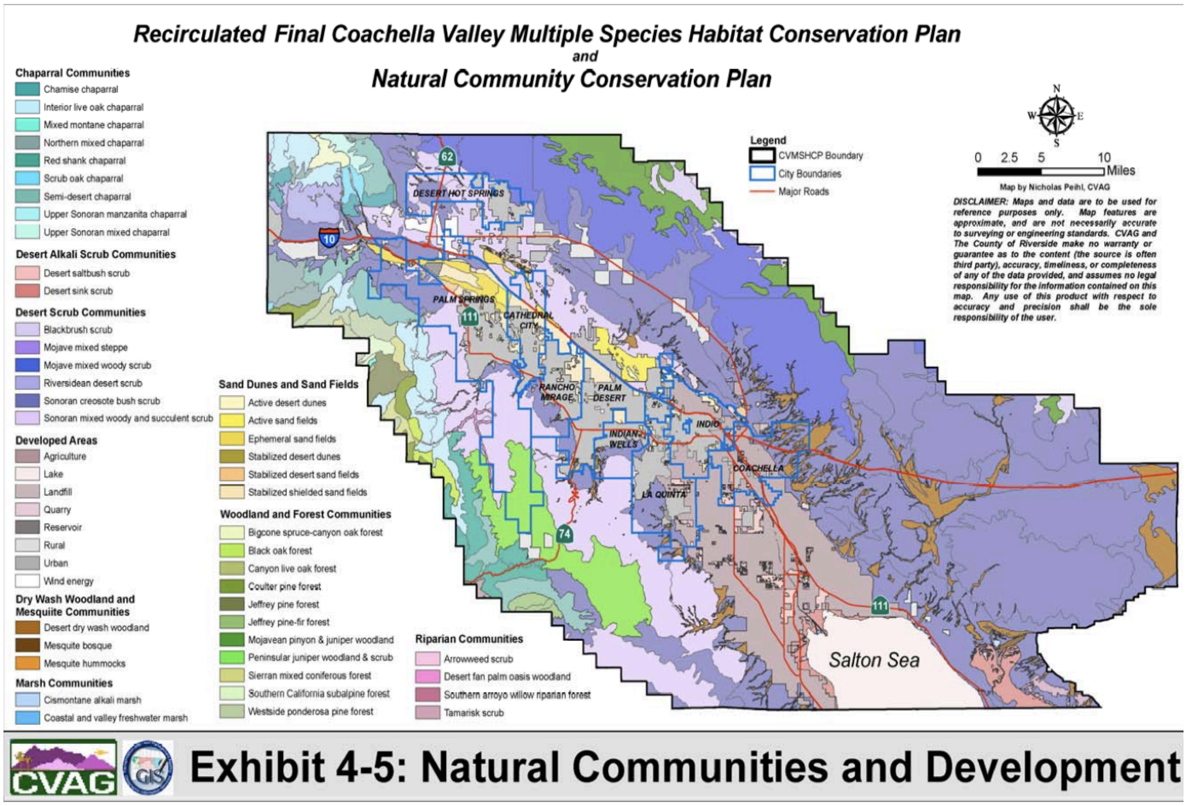


Figure 1.8.1a: Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP)

1.8.2 Species and Habitats at Risk

Several species and habitats in the subbasin are at risk due to groundwater overdraft, habitat fragmentation, invasive species, and altered hydrological flows. The Coachella Valley fringe-toed lizard (Uma inornata), federally threatened and state endangered, depends on fine, wind-blown sands in dunes and sand fields, where urban expansion and stabilized sands threaten its burrowing and foraging behaviors.

Figure 1.8.2a: Fringe-toed lizard (Uma inornata), image from wikipedia.org

Similarly, the desert tortoise (Gopherus agassizii), also federally and state threatened, inhabits desert scrub and washes, facing risks from off-road vehicles and disease. Plant species like the Coachella Valley milk-vetch (Astragalus lentiginosus var. coachellae), federally endangered, thrive in sandy washes but are vulnerable to erosion and water table declines. Avian species at risk include the burrowing owl (Athene cunicularia), a California species of special concern, which nests in open grasslands and agricultural fringes, and the Le Conte's thrasher (Toxostoma lecontei), reliant on sparse desert scrub for foraging. Mammals such as the Peninsular bighorn sheep (Ovis canadensis nelsoni), federally endangered, use rugged canyons and alluvial fans in the upper subbasin for lambing and foraging, threatened by habitat loss and barriers to movement. Habitats like mesquite hummocks and riparian corridors are particularly sensitive, serving as oases for pollinators and migrants but impacted by invasive tamarisk and reduced water flows.

Figure 1.8.2b: Peninsular bighorn sheep (Ovis canadensis nelsoni), image from Getty Images

1.8.3 Forests and Fish

Forests in the subbasin are limited, primarily consisting of sparse pinyon-juniper woodlands and interior live oak chaparral in the higher elevations of the San Bernardino Mountains, which provide shade and forage for species like mule deer. These areas contribute to watershed stability by reducing erosion on steep slopes. Fisheries are minimal due to the arid environment, but the desert pupfish (Cyprinodon macularius), federally endangered, persists in isolated pools, irrigation drains, and the Whitewater River delta, where it faces threats from salinity changes and predators. Other important resources include biodiversity hotspots in protected areas like the Whitewater Floodplain Preserve and Willow Hole Conservation Area, part of the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP), which safeguards 27 covered species through linkages and sand transport corridors. These areas support endemic invertebrates, such as the Coachella Valley giant sand-treader cricket, and serve as migratory stopovers for over 200 bird species.

Figure 1.8.3a: Desert pupfish (Cyprinodon macularius), image from wikipedia.org

1.9 Summary

The Whitewater River Subbasin Watershed Management Plan addresses the complex environmental, hydrological, and ecological challenges of the Coachella Valley in Southern California. Encompassing rugged mountain headwaters and an arid desert valley, the subbasin spans 560 square miles and exhibits dramatic elevation and climate gradients that shape water availability, erosion patterns, and ecosystem distribution. Groundwater overdraft, urban and agricultural runoff, habitat loss, and drought-driven climate stress are key concerns. The region's geology, including active fault systems and permeable alluvial deposits, influences aquifer recharge and sediment transport. Land use is a mix of natural desert scrub, mountain forests, expanding urban areas, and irrigated agriculture. Sensitive species, such as the Coachella Valley fringe-toed lizard and desert pupfish, depend on fragile habitats like sand dunes and riparian zones, which are increasingly threatened by development, invasive species, and water scarcity. This plan seeks to integrate scientific data and stakeholder input to promote long-term strategies for sustainable water use, ecological resilience, and balanced land management.

2.0 Introduction

The Whitewater River Subbasin Watershed, situated in the arid Coachella Valley of Southern California, spans portions of Riverside and San Bernardino counties, encompassing a dynamic landscape shaped by mountainous terrain, ephemeral river flows, and urban development. This preliminary watershed management plan, developed by Will Dean, Katerina Bischel, and Jackson Mills, aims to address the region's pressing water resource challenges, including groundwater overdraft, salinity increases, and balancing supply with escalating demand driven by population growth and economic activities. As of 2025, Riverside County's population is estimated at approximately 2,529,000, while San Bernardino County's stands at around 2,197,000, reflecting continued growth from the 2010 figures of 2,201,562 and 2,040,803, respectively. These trends underscore the need for sustainable strategies to manage water resources in this water-scarce environment

2.1 Current Population and Projected Growth

Table 1. Current Population and Projected Growth in Riverside and San Bernardino Counties (2010-2024). This table shows population trends for the two counties overlapping the Whitewater River Subbasin to highlight growing water demand pressures. Riverside County, which covers the majority of the subbasin (approximately 80% of the area), has seen faster growth (0.15 rate), with major population centers like Palm Springs and Indio within the watershed driving urban expansion. San Bernardino County contributes less area but still adds to regional demands. These data support the need for sustainable water management as the total population has increased 12% since 2010, exacerbating scarcity in this arid region. Source: U.S. Census Bureau (2024), Population Estimates Program.

County	2010	2015	2020	2024	Growth Rate (2010-2024)
Riverside	2201562	2344648	2424663	2529933	0.15
San Bernardino	2040803	2114352	2183526	2214281	0.09
Total	4242365	4459000	4608189	4744214	0.12

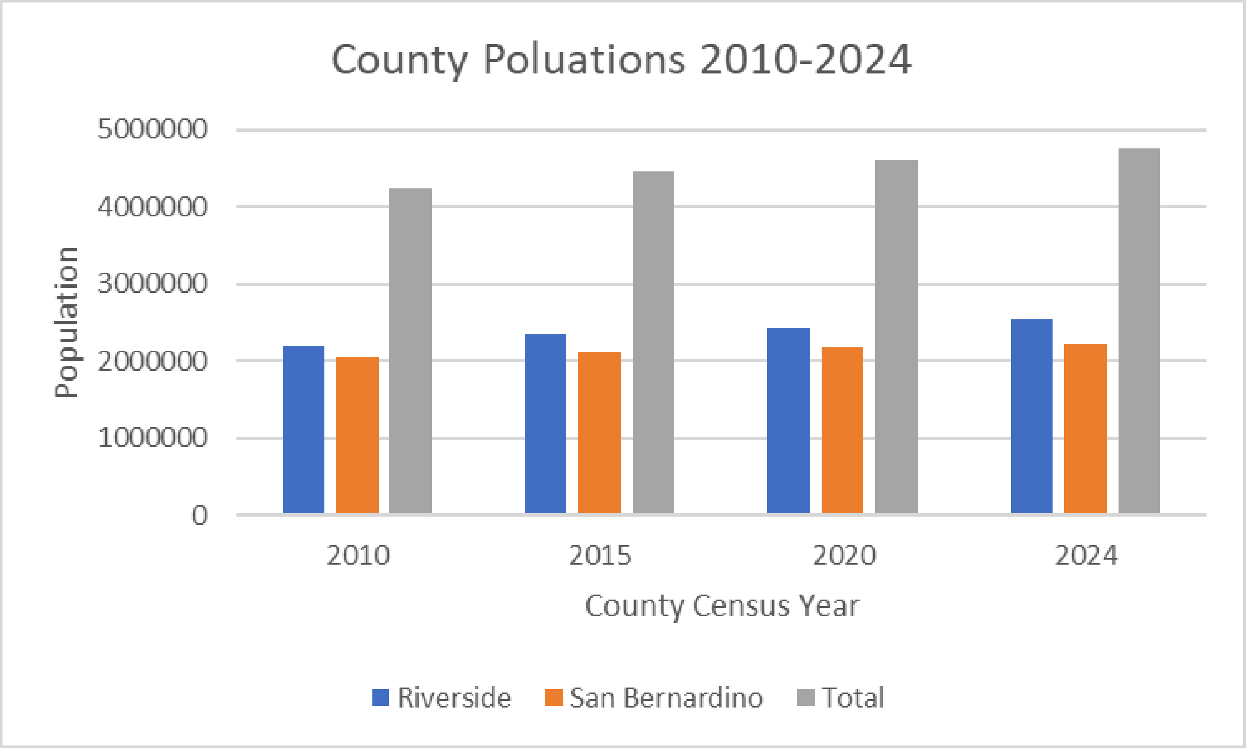


Figure 2.1.1 County Populations 2010-2024

Source: U.S. Census Bureau (2024), Population Estimates Program

Table 2. Per Capita Income and Median Age

Source: U.S. Census Bureau, American Community Survey (ACS)

County	Per Capita Income (dollars) Estimate	Median Age
Riverside	$37,162	36.7
San Bernadino	$33,180	34.9

2.2 Water Supply

The Whitewater River Subbasin, located in the arid Coachella Valley, relies primarily on groundwater as its main water source, supplemented by imported surface water from the Colorado River and the State Water Project (SWP) for replenishment and direct use. Groundwater extraction occurs mainly from the Indio Subbasin (part of the larger Coachella Valley groundwater basin), serving domestic, agricultural, and municipal needs. However, the basin has been in a state of overdraft since the early 1900s, with cumulative freshwater losses estimated at approximately 4.8 million acre-feet from 1936 to 1999, leading to declining water levels (over 60 feet in some areas of the lower valley since the 1980s), land subsidence, and increasing salinity (total dissolved solids rising from less than 250 mg/L in the 1930s to around 540 mg/L in the upper aquifer).

Imported water plays a critical role in replenishing the aquifer and offsetting overdraft. The Coachella Valley Water District (CVWD) and Desert Water Agency (DWA) hold a combined SWP entitlement of 194,100 acre-feet per year, exchanged for Colorado River water delivered via the Coachella Canal (completed in 1949). Under the 2003 Quantification Settlement Agreement, CVWD accesses an additional 35,000 acre-feet annually from the Colorado River for replenishment. Historical replenishment at facilities like the Whitewater River Groundwater Replenishment Facility (operational since 1973) and others has added over 2 million acre-feet in the first 35 years, with capacities up to 40,000 acre-feet per year at sites like the Thomas E. Levy Facility. Natural surface water from the Whitewater River (ephemeral flows from mountain runoff) contributes to recharge, but is highly variable and limited (historical averages 4,000–9,000 acre-feet per year).

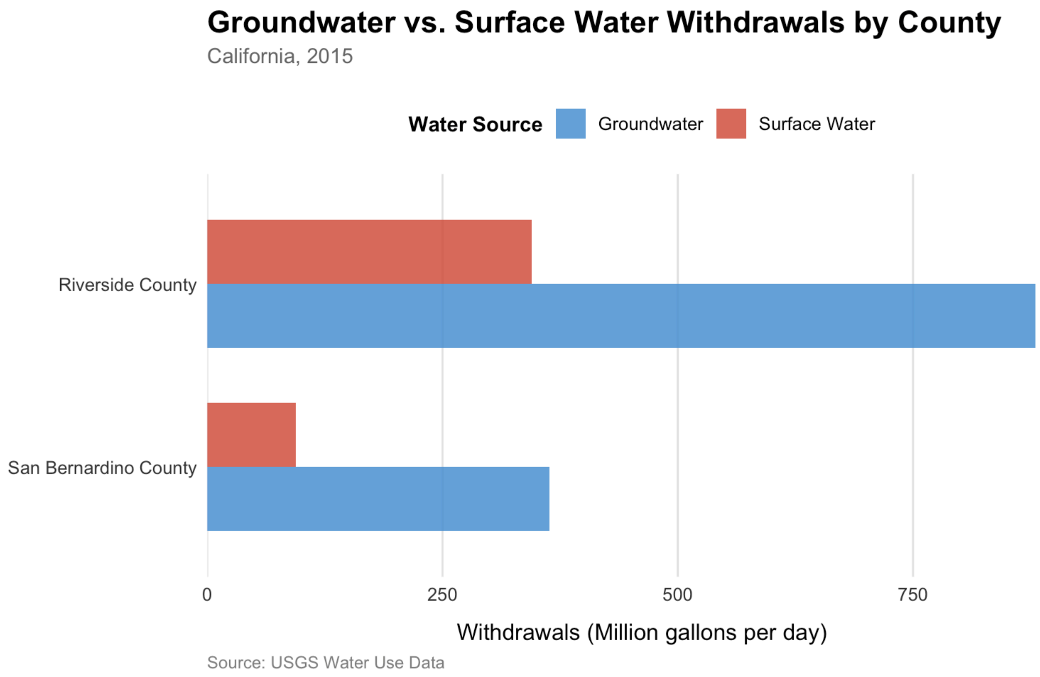
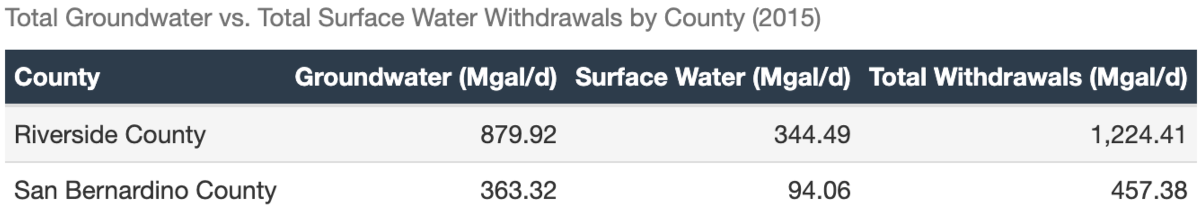


Figure 2.2.1 Total Groundwater vs. Total Surface Water Withdrawals by County (2015).
Source: U.S.Geological Survey data release (2018), https://doi.org/10.5066/F7TB15V5

Table 3. Total Groundwater vs. Total Surface Water Withdrawals (2015).
Source: U.S.Geological Survey data release (2018)



Total Groundwater vs. Total Surface Water Withdrawals by County (2015)

County	Groundwater (Mgal/d)	Surface Water (Mgal/d)	Total Withdrawals (Mgal/d)
Riverside County	879.92	344.49	1,224.41
San Bernardino County	363.32	94.06	457.38

2.3 Water Demand

The Whitewater River Subbasin, encompassing arid regions with significant agricultural, urban, and recreational activities, experiences high water demand driven primarily by irrigation, public supply, and other sectors. Based on 2015 U.S. Geological Survey (USGS) data, total water withdrawals in Riverside and San Bernardino counties—the primary areas contributing to the subbasin—amounted to approximately 2,471.4 Mgal/d, reflecting the region's reliance on water for sustaining population growth, economic activities, and ecosystems. Irrigation dominates demand in Riverside County due to extensive agriculture and golf courses in the Coachella Valley, while public supply supports urban centers like Palm Springs and San Bernardino. Smaller sectors such as livestock, mining, and thermoelectric power contribute variably, with aquaculture playing a minor role in both counties. Ongoing challenges include drought, overdraft, and increasing salinity, necessitating efficient management to balance demand with sustainable supply. Projected population growth at an average rate of 0.12 from 2010–2024 suggests potential demand increases of 10–15% by 2030 if per capita use remains constant, though conservation efforts and recycled water adoption could mitigate this. According to the Coachella Valley Water District (CVWD) Water Management Plan, total demand in the Coachella Valley is projected to rise from 695,400 acre-feet in 2015 to 850,500 acre-feet by 2040, with urban demand nearly doubling while agricultural use declines due to efficiency measures.

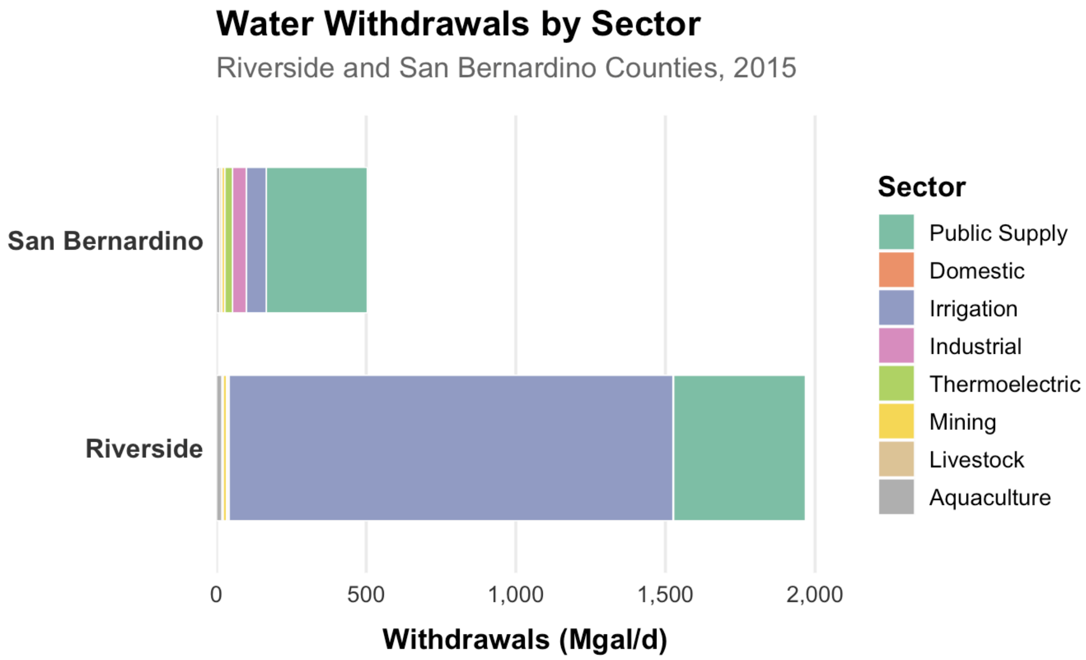
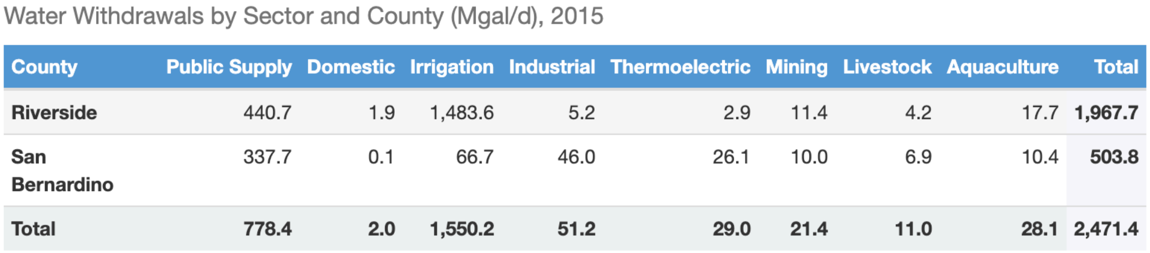


Figure 2.3.1 Whitewater River subbasin Water Use by Sector per County (2015). This stacked bar chart illustrates the distribution of water withdrawals across various sectors—Public Supply, Domestic (Self-Supplied), Irrigation, Industrial (Self-Supplied), Thermoelectric Power, Mining, Livestock, and Aquaculture—for Riverside and San Bernardino counties. Each bar represents a county, with segments colored distinctly to show the contribution of each sector, and data labels provide exact values for clarity. Riverside's bar is dominated by Irrigation (reflecting agricultural demand), while San Bernardino shows a more balanced distribution with notable Public Supply and Industrial use. *Source: U.S.Geological Survey data release (2018)*

Table 4. Water Withdrawals by Sector and County (Mgal/d), 2015. *Source: U.S.Geological Survey data release (2018)*



Water Withdrawals by Sector and County (Mgal/d), 2015

County	Public Supply	Domestic	Irrigation	Industrial	Thermoelectric	Mining	Livestock	Aquaculture	Total
Riverside	440.7	1.9	1,483.6	5.2	2.9	11.4	4.2	17.7	**1,967.7**
San Bernardino	337.7	0.1	66.7	46.0	26.1	10.0	6.9	10.4	**503.8**
Total	**778.4**	**2.0**	**1,550.2**	**51.2**	**29.0**	**21.4**	**11.0**	**28.1**	**2,471.4**

Table 5. Domestic Water Use: Self-Supplied and Deliveries from Public Supply (2015) Units: Millions of gallons per day (Mgal/day). *Source: U.S. Geological Survey data release (2018)*

County	Domestic Self-Supplied Total (Mgal/day)	Domestic Deliveries from Supply (Mgal/day)
Riverside County	1.94	277.71
San Bernardino County	0.08	217.55
Total (all counties)	2.02	495.26

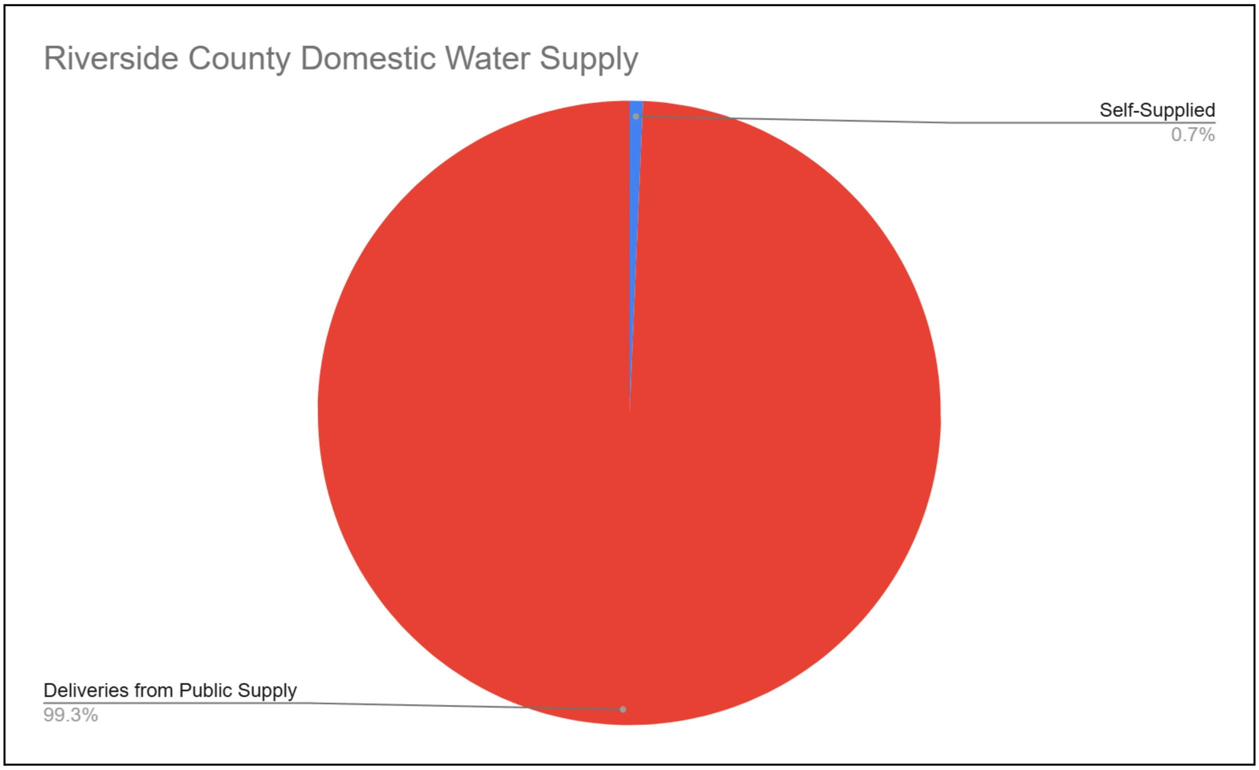


Figure 2.3.2. Riverside County Domestic Water Supply (2015). Percentage of domestic water supply that is self-supplied (blue) and delivered from public water supply sources (red). Less than 1% of domestic water supply in Riverside County is self-supplied, indicating very high reliance on public supply. *Source: U.S. Geological Survey data release (2018)*

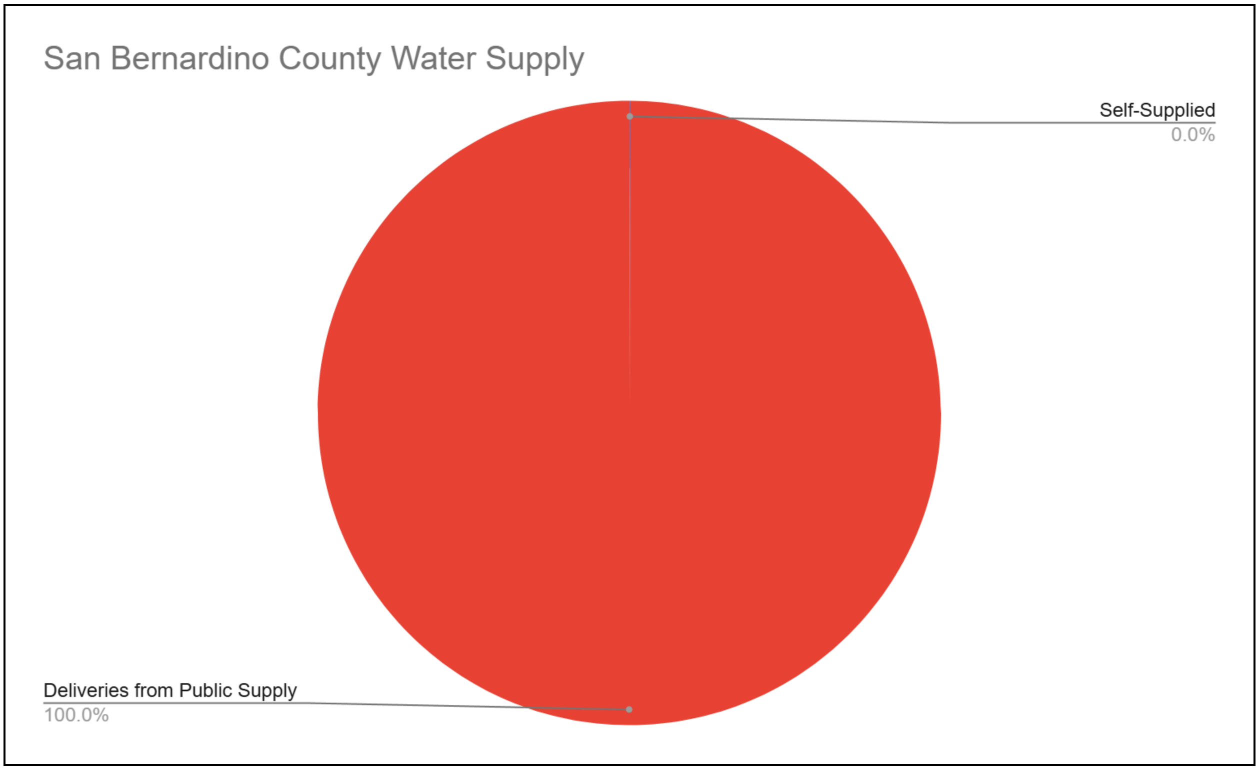


Figure 2.3.3. San Bernardino County Domestic Water Supply (2015). Percentage of domestic water supply that is self-supplied (blue) and delivered from public water supply sources (red). Nearly 0% of domestic water supply in San Bernardino County is self-supplied, indicating extreme reliance on public supply. *Source: U.S. Geological Survey data release (2018)*

Table 6. Irrigation by Type in Thousand Acres (2015). *Source: U.S. Geological Survey data release (2018)*

County	**Crop Irrigation - Sprinkler**	**Crop Irrigation - Micro Irrigation**	**Crop Irrigation - Surface (Flood)**	**Golf Irrigation - Sprinkler**	**Golf Irrigation - Micro Irrigation**	**Golf Irrigation - Surface (Flood)**
Riverside County	23.81	68.11	113.51	17.26	0	0
San Bernardino County	12.67	4.61	0.49	3.25	0	0
Total (all counties)	36.48	72.72	114	20.51	0	0

2.4 Summary

The Whitewater River Subbasin faces critical water management challenges stemming from its arid climate, historical overdraft, and continued population and economic growth. The region's approximately 370,000 residents, as of the 2020 Census, rely heavily on groundwater resources that have been in overdraft since the early 1900s, resulting in cumulative freshwater losses of 4.8 million acre-feet, water level declines exceeding 60 feet in some areas, land subsidence, and escalating salinity from less than 250 mg/L to around 540 mg/L (Wikipedia).

Water supply depends on a combination of groundwater extraction, imported Colorado River water, and State Water Project allocations totaling 229,100 acre-feet per year, along with variable natural recharge from the ephemeral Whitewater River. Demand, driven primarily by irrigation (particularly agriculture and golf courses) and public supply to growing urban centers, reached 2,471 million gallons per day in 2015. Projections indicate total demand will rise from 695,400 acre-feet in 2015 to 850,500 acre-feet by 2040, with urban demand nearly doubling despite anticipated declines in agricultural use through efficiency improvements.

Addressing these challenges requires integrated strategies emphasizing groundwater recharge, water conservation, recycled water adoption, and sustainable allocation practices to ensure long-term water security for the basin's diverse residential, agricultural, and recreational communities.

3.0 Introduction

This section describes the current land-use planning framework, flood control and groundwater management regulations, and other land use restrictions in the Whitewater River Subbasin. It identifies specific designated beneficial uses for the subbasin's rivers, streams, and reservoirs, and outlines the key state and federal water quality criteria associated with those uses. This information builds on previous deliverables by providing regulatory context to guide sustainable watershed management strategies addressing groundwater overdraft, water quality degradation, and habitat preservation in the arid Coachella Valley.

3.1 Existing Land-use Planning

Cathedral City

The City of Cathedral City adopted its 2040 General Plan in July 2021, establishing a comprehensive land use framework for approximately 14,557 acres within the city limits and sphere of influence. As shown in Figure 3.1.1, the plan designates a mix of residential densities ranging from low-density single-family (2-6 dwelling units per acre) to high-density multifamily development (18-30+ dwelling units per acre), concentrated primarily in the northern and central portions of the city. Commercial uses, including regional retail and tourist-serving facilities, are focused along major arterials such as Date Palm Drive, Ramon Road, and Perez Road. Industrial designations occupy areas adjacent to Interstate 10, supporting the city's economic base with business parks and light industrial uses. Significantly, the plan preserves open space and conservation areas in the southern cove areas along the base of the San Jacinto Mountains, consistent with CVMSHCP Conservation Areas. These hillside and alluvial fan areas provide critical habitat and natural flood control, while also serving as potential groundwater recharge zones. The plan's expanded mixed-use designations encourage higher-intensity, walkable development that may reduce per-capita water demand through compact urban form.

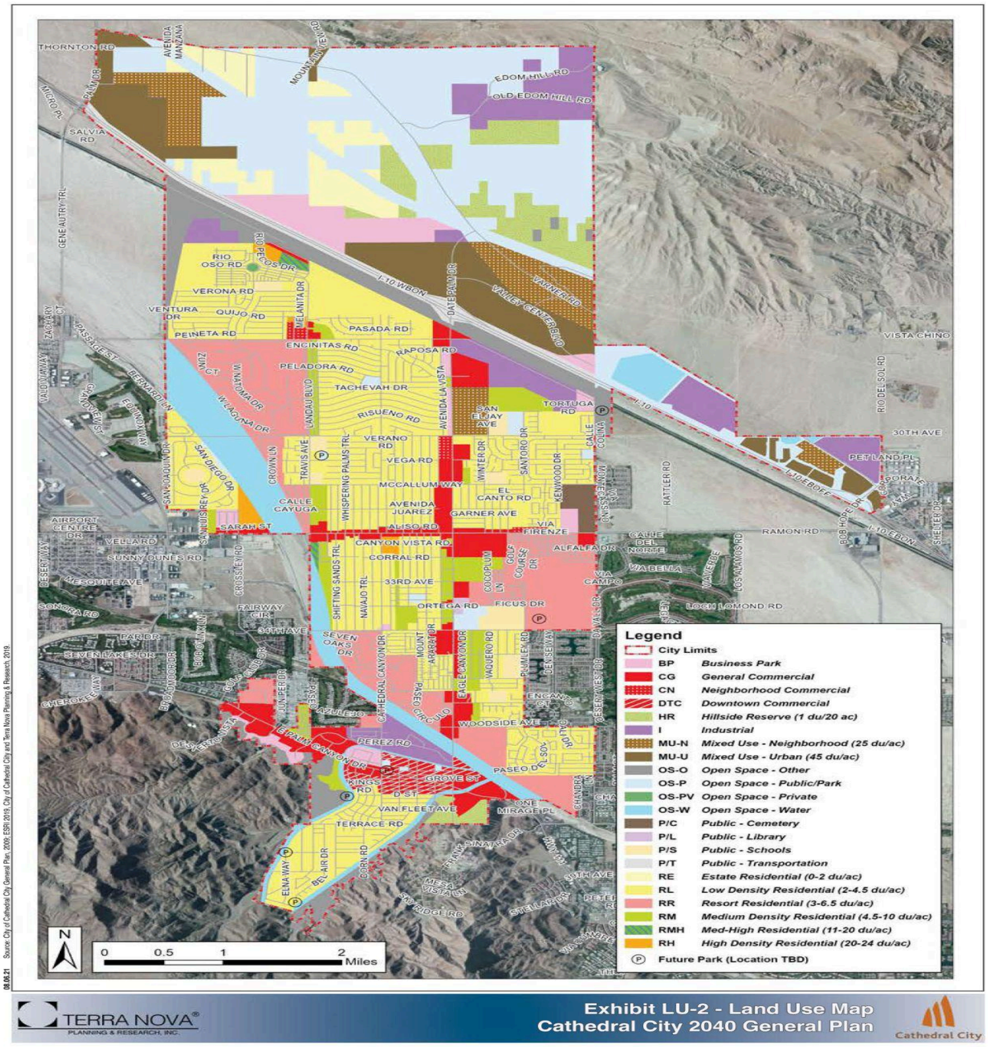


Figure 3.1.1 Cathedral City 2040 General Plan Land Use Map showing residential, commercial, industrial, and open space designations within the Whitewater River Subbasin. Source: Cathedral City, Exhibit IV-2, 2021.

Palm Desert

The City of Palm Desert adopted its current General Plan in 2016, providing a progressive framework for reimagining the city's urban core and guiding development through build-out. Figure 3.1.2 illustrates the city's land use pattern, which emphasizes transformation of the Highway 111 corridor into a mixed-use district complete with landscape and pedestrian improvements, and development of a multi-use University Neighborhood around the College of the Desert and California State University campuses along Cook Street. The General Plan designates the City Center Area Plan, a focused planning area intended to create a vibrant, pedestrian-oriented downtown with mixed residential and commercial uses, potentially reducing automobile dependence and associated water quality impacts from parking lot runoff. Medium- to high-density residential areas are concentrated in the northern portions of the city, while lower-density estate residential and open space designations predominate in the southern cove areas at the base of the Santa Rosa Mountains. Commercial designations include regional retail centers along Highway 111 and Gerald Ford Drive, tourist-serving facilities near resort areas, and neighborhood-serving commercial nodes. The plan preserves significant open space for habitat conservation, consistent with the CVMSHCP, particularly in hillside and wash areas that provide flood control benefits and groundwater recharge potential.

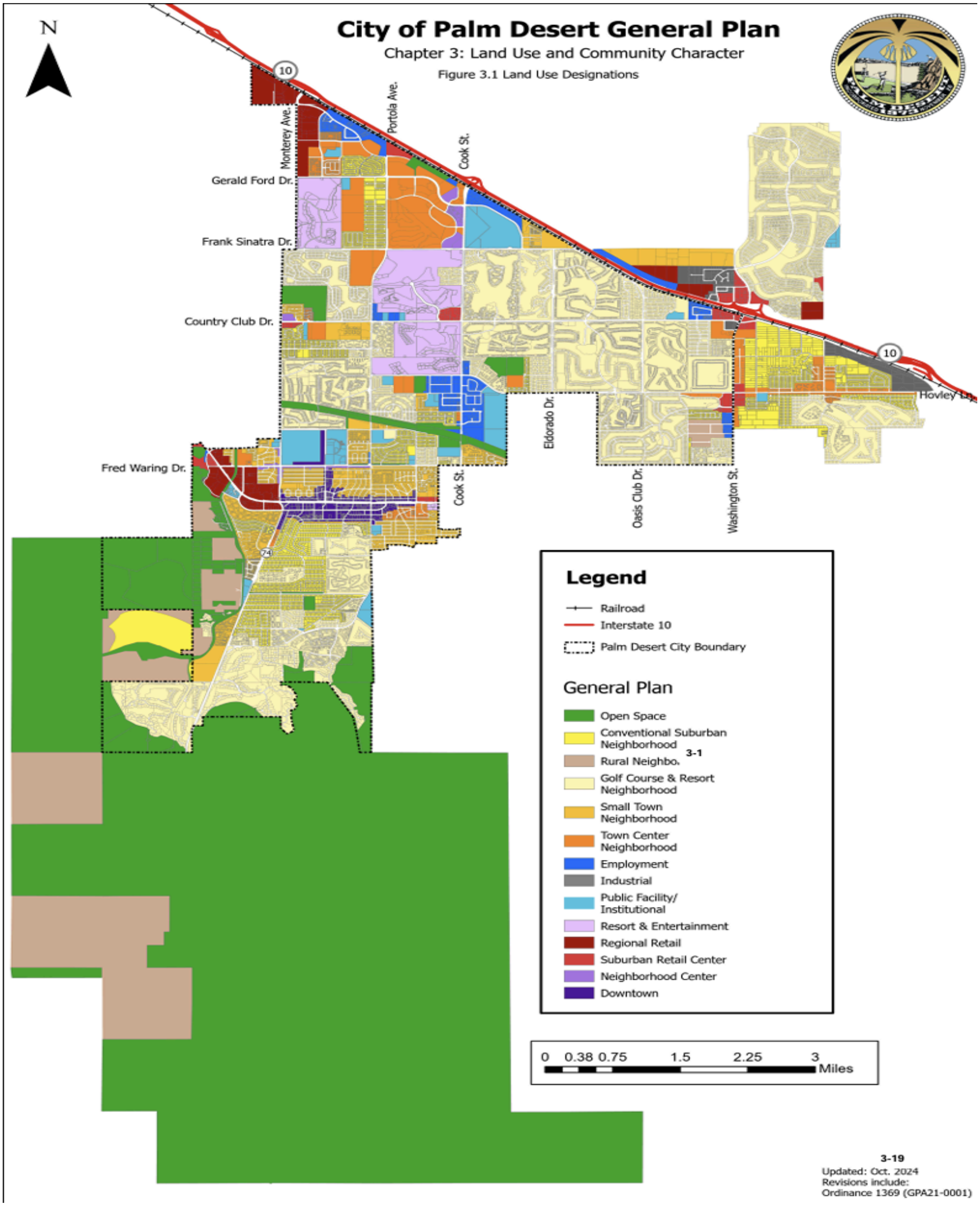


Figure 3.1.2 Palm Desert General Plan Land Use Map depicting mixed-use districts, City Center Area Plan boundaries, and university neighborhood zones within the subbasin. Source: City of Palm Desert General Plan, 2016.

Palm Springs

The City of Palm Springs is the gateway community to the Coachella Valley and encompasses diverse land uses ranging from dense urban development in the downtown core to pristine mountain conservation areas. As shown in Figure 3.1.3, the General Plan designates extensive conservation and open space areas along the frontal slopes of the San Jacinto Mountains and within the Whitewater River floodplain, consistent with CVMSHCP Conservation Areas and the city's commitment to preserving scenic resources. The Open Space-Conservation designation (1 dwelling unit per 20 acres) applies to gently sloping alluvial fan areas, including portions of the Whitewater Floodplain Conservation Area identified in Section 3.2, effectively limiting development in critical groundwater recharge zones where ephemeral flows percolate into the Indio Subbasin aquifer. Residential designations range from Estate Residential (0-2 dwelling units per acre) in hillside areas to High Density Residential (15-30 dwelling units per acre) in neighborhoods such as Warm Sands and near the downtown Central Business District. The downtown CBD allows the highest intensities, with floor area ratios up to 4.0 and residential densities up to 70 dwelling units per acre in mixed-use projects, concentrating water demand in areas served by centralized infrastructure. Tourist Resort Commercial and Commercial Retail designations dominate the Palm Canyon Drive corridor and areas near Palm Springs International Airport. The Regional Business Center designation north of Interstate 10 accommodates freeway-oriented commercial, office, and industrial uses. Significantly, the plan prohibits commercial wind turbine arrays east of Indian Avenue to protect residential character, and establishes Special Policy Areas in the Chino Cone, Palm Hills, and Oswit Cone to preserve archaeological, biological, and scenic resources while allowing limited low-density development.

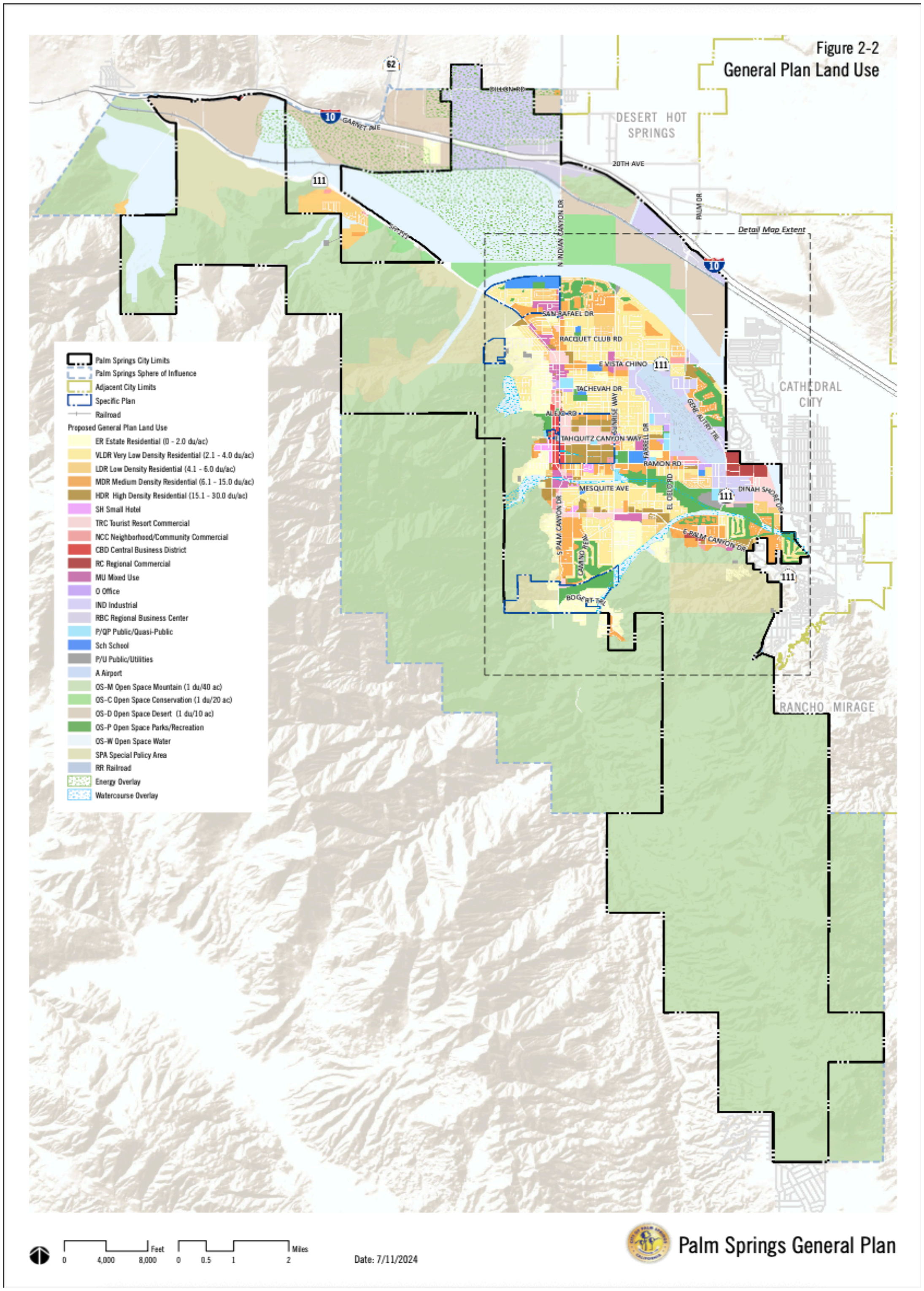
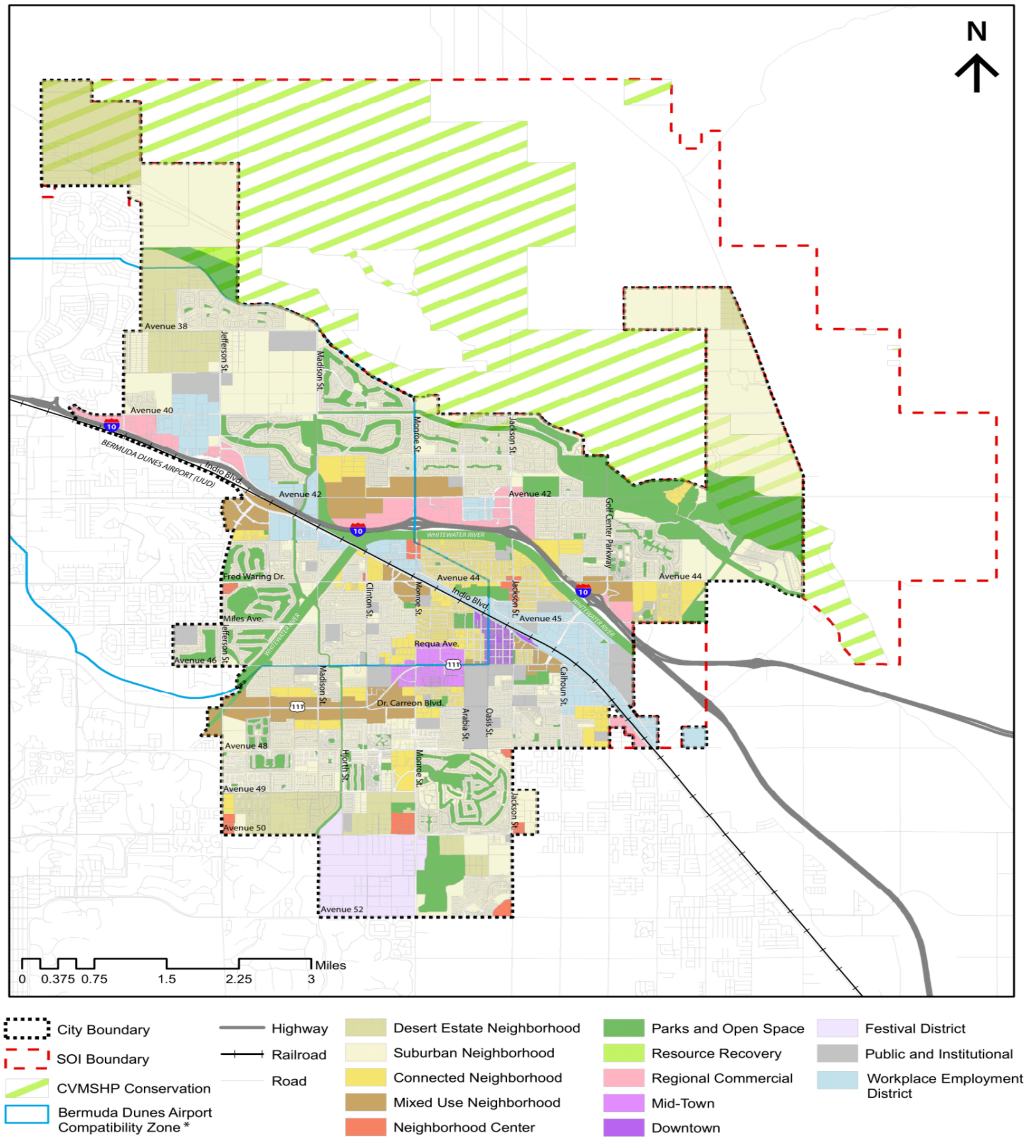


Figure 3.1.3 Palm Springs General Plan Land Use Designations illustrating estate residential, mixed-use areas, tourist resort commercial zones, and conservation areas including the Whitewater Floodplain Conservation Area. Source: City of Palm Springs General Plan Land Use Element.

Indio

The City of Indio, located in the eastern portion of the Whitewater River Subbasin, adopted its General Plan 2040 in September 2019. As the largest city in the subbasin by population (91,765), Indio's land use patterns significantly influence water demand and agricultural water use within the watershed. Figure 3.1.4 shows the city's land use map, which reflects the transition from the Coachella Valley's agricultural heritage to increasingly urbanized development. Agricultural preservation areas remain prominent in the eastern and southern portions of the city, where date groves, row crops, and other agricultural operations continue, though these areas face ongoing conversion pressure as the city grows. Residential designations range from low-density single-family development to high-density multifamily housing, with particular concentrations of medium- and high-density residential in the northwestern areas near Interstate 10 and along major corridors such as Highway 111 and Jackson Street. Commercial uses are focused along these same arterials, with regional retail and tourist-serving commercial near the Coachella Valley Stormwater Channel and downtown core. The plan designates industrial areas primarily in the northern portions of the city near the Interstate 10 corridor, supporting warehouse, distribution, and light manufacturing uses. Open space designations protect portions of the Coachella Valley Stormwater Channel corridor and habitat areas consistent with the CVMSHCP. The city's land use pattern, with intensive urban development in the north transitioning to agriculture in the south, creates distinct zones of water demand, with urban areas served by Colorado River and State Water Project imports delivered via the Coachella Valley Water District system, while agricultural areas rely on a mix of groundwater and surface water supplies.



*Densities, intensities, and prohibited uses shall be consistent with criteria of the Bermuda Dunes Airport Land Use Compatibility Plan, including applicable Countywide criteria as may exist at the time of project review. If the project is located in the Bermuda Dunes Airport Compatibility zones, please see ALUCP and Indio City Planning Staff for the most up-to-date regulations.

Figure 3.1.4 Indio General Plan 2040 Land Use Map showing agricultural preservation areas, residential development zones, and commercial corridors within the eastern portion of the Whitewater River Subbasin. Source: City of Indio General Plan 2040, Appendix A, 2019.

3.2 Flood control zoning, groundwater management & other criteria

Flood control in the Whitewater River Subbasin is governed by the Riverside County Flood Control and Water Conservation District (RCFCWCD) through Ordinance No. 458, a National Flood Insurance Program (NFIP)-compliant regulation that designates Special Flood Hazard Areas (SFHAs) across the region (Riverside County Flood Control and Water Conservation District, "Ordinance No. 458"). These zones include FEMA-defined 100-year floodplains (Zones

A, AE), state-identified DWR Awareness Floodplains, and county-specific RCFC Flood Zones, all visible in the interactive floodplain viewer (Riverside County Flood Control and Water Conservation District, "Floodplain Information"). As shown in Figure 3.2.1, the Whitewater River channel and its major tributaries, particularly from Palm Springs through Cathedral City, Rancho Mirage, and into the Coachella Valley Stormwater Channel, are overlaid with extensive FEMA and RCFC flood zones, indicating high flood risk due to ephemeral flows and alluvial fan dynamics. Development in these areas is strictly regulated: new construction must be elevated to or above the Base Flood Elevation (BFE), floodways must remain unobstructed, and fill is prohibited to preserve conveyance capacity (Riverside County Flood Control and Water Conservation District, "Ordinance No. 458" 12-15). The Coachella Valley Water District (CVWD) also manages downstream flood control infrastructure, including 173 miles of engineered channels along the lower Whitewater River to the Salton Sea (Coachella Valley Water District 22).

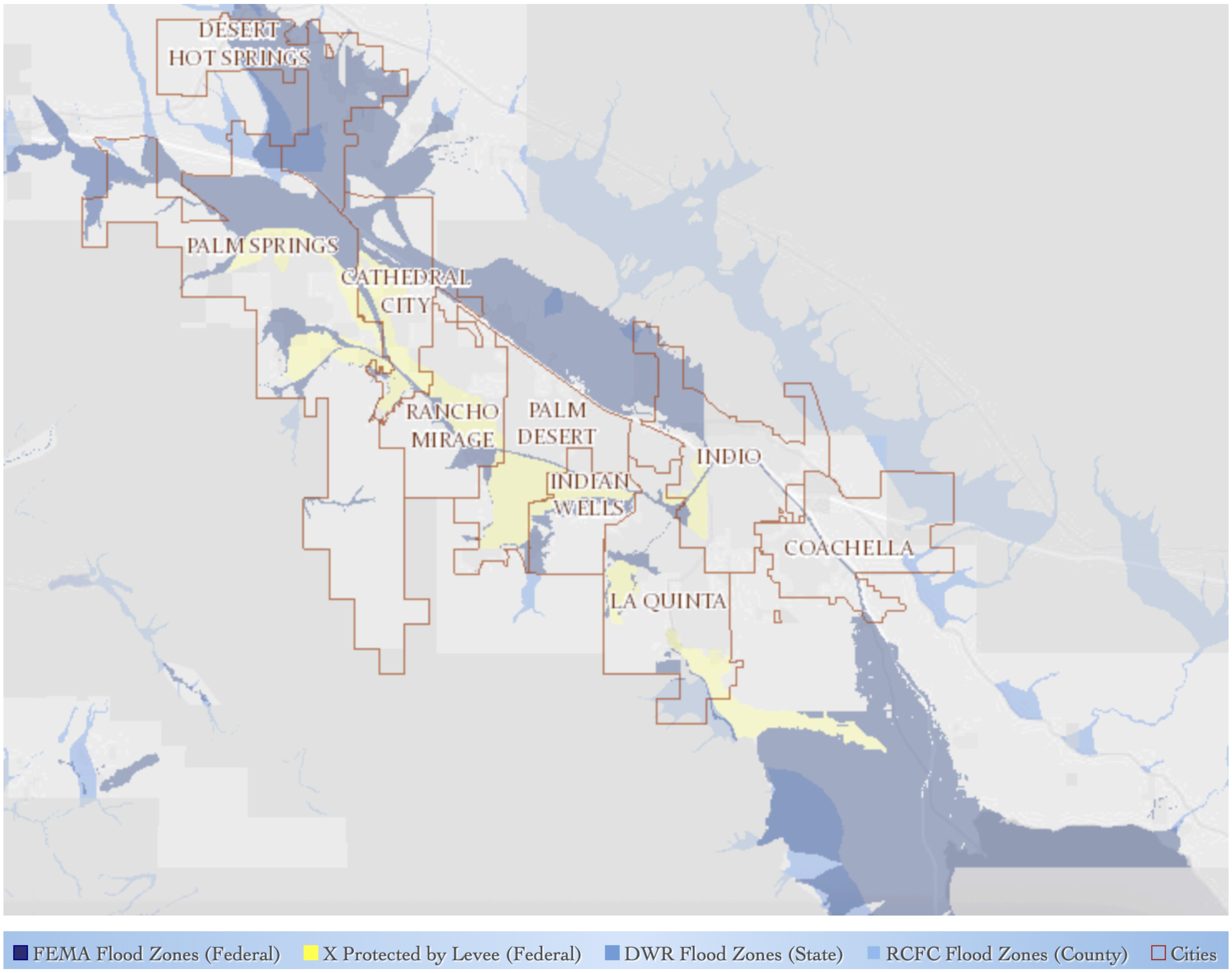


Figure 3.2.1 Currently Regulated Ordinance No. 458 floodplains within Riverside County.
Source: *Riverside County Flood Control and Water Conservation District, "Floodplain Map Viewer."*

Groundwater management is guided by the Sustainable Groundwater Management Act (SGMA), with the subbasin divided into the Indio and Mission Creek Subbasins, both classified as medium-priority. The Indio Subbasin Alternative Groundwater Sustainability Plan, updated in 2022 and approved by the California Department of Water Resources (DWR) in June 2024, serves as the primary management framework and relies on artificial recharge at facilities such as the Whitewater River Groundwater Replenishment Facility (operational since 1973) and the Thomas E. Levy Groundwater Replenishment Facility to deliver over 40,000 acre-feet annually of imported Colorado River and State Water Project water (Coachella Valley Water District and Desert Water Agency 18). This strategy has reversed historical overdraft trends, with groundwater levels rising in most monitoring wells since 2010 (Coachella Valley Water District and Desert Water Agency 45). Similarly, the Mission Creek Subbasin Alternative Plan, collaboratively managed by CVWD, Desert Water Agency, and Mission Springs Water District, emphasizes coordinated pumping, metering, and recharge to maintain sustainability (Mission Creek Subbasin GSA 12). Both plans require annual reporting and adaptive management to prevent undesirable results such as chronic lowering of groundwater levels or land subsidence.

Land conservation and habitat protection impose additional development restrictions through the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP), adopted in 2008. This regional plan preserves approximately 240,000 acres across 27 covered species, including the Whitewater Floodplain Conservation Area, a critical riparian corridor along the upper Whitewater River designated for permanent protection (Coachella Valley Association of Governments 4-11a). Any development within or adjacent to this area triggers mitigation fees and habitat compensation requirements, effectively limiting urban expansion into sensitive floodplains and recharge zones (Coachella Valley Association of Governments 5-3). Together, these layered regulations—flood zoning, SGMA compliance, and habitat conservation—create a robust framework to balance growth with resource protection in an arid, high-demand watershed.

3.3 Specific designated/beneficial uses

The Colorado River Basin Regional Water Quality Control Board is responsible for designating uses for water bodies within the Whitewater River Subbasin, to determine whether waters meet federal and state water quality standards. Unlike watersheds spanning multiple states with varying classification systems, the Whitewater River Subbasin falls entirely within California's Colorado River Basin Region (Region 7), and thus is subject to a single, consistent beneficial use classification system administered by the Regional Water Board.

The Regional Water Board classifies beneficial water uses into 13 different categories as defined in the Water Quality Control Plan for the Colorado River Basin (Basin Plan). Table 3.3.1 delineates these use categories and their definitions.

Table 3.3.1. Beneficial use classifications for water bodies in the Colorado River Basin Region. Data source: California Regional Water Quality Control Board, Colorado River Basin Region, Basin Plan Chapter 2 (2019).

Category	Abbreviation	Definition
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
Agriculture Supply	AGR	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
Aquaculture	AQUA	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.
Ground Water Recharge	GWR	Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting salt water intrusion into fresh water aquifers.
Water Contact Recreation	REC-I	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.

Non-Contact Water Recreation	REC-II	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Cold Freshwater Habitats	COLD	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat	WILD	Uses of water that support terrestrial ecosystems including, but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Hydropower Generation	POW	Uses of water for hydropower generation.
Freshwater Replenishment	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality.
Preservation of Rare, Threatened, or Endangered Species	RARE	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Present beneficial uses are designated by **X** in Basin Plan tables; potential beneficial uses are designated by **P**, and intermittent uses by **I**. Intermittent uses include those uses which occur only seasonally because of limiting environmental conditions (e.g., cold water habitat during winter months), and uses which are dependent on and occur only when sufficient flow exists. Major surface water bodies within the Whitewater River Subbasin and their designated beneficial uses are displayed in Table 3.3.2.

Table 3.3.2. Designated surface water beneficial uses for major water bodies in the Whitewater River Subbasin. X = existing use, P = potential use, I = intermittent use. Data sources: California Regional Water Quality Control Board, Colorado River Basin Region, Basin Plan Tables 2-3 and 2-4 (2019).

Waterbody	MUN	AGR	AQUA	FRSH	IND	GWR	REC1	REC2	WARM	COLD	WILD	POW	RARE
CVSC				X			X	X	X		X		X
Little Morongo Creek	P	X				X	X	X	X		X		
Palm Canyon Creek	P	X				X	X	X	X		X		
San Gorgonio River	P	X				X	X	X		X	X		
Tahquitz Creek	P					X	X	X		X	X		
Whitewater River	X	X				X	X	X	I	X	X	X	

Washes (Ephemeral Streams				**I**		**I**		**I**			**I**		

Footnotes:

1. Includes the section of flow from the headwaters in Mount San Gorgonio to (and including) the Whitewater Recharge Basins near Indian Avenue crossing in Palm Springs.
2. Section of perennial flow from approximately Indio to the Salton Sea.
3. Including the section of ephemeral flow in the Whitewater River Stormwater Channel and Coachella Valley Stormwater Channel from Indian Avenue to approximately 1/4 mile west of Monroe Street crossing.
4. Unauthorized use.
5. Rare, endangered, or threatened wildlife exists in or utilizes these waterways. If the RARE beneficial use may be affected by a water quality control decision, responsibility for substantiation of the existence of rare, endangered, or threatened species on a case-by-case basis is upon the California Department of Fish and Wildlife on its own initiative and/or at the request of the Regional Water Board.
6. Although it is not encouraged, children play in the water infrequently on the wildlife reserve.
7. Most of the creek is on National Forest Service land except one section which is owned by Desert Water Agency. This section provides the only reasonable access to the area. To enter Falls or Snow Creek through Desert Water Agency's land, a permit is required. The permit stipulates that persons entering through DWA's land must agree not to swim, fish, or wade in any portion of the creek.
8. The lake was experimentally stocked with trout during the winter of 1987/88. Cold water habitat is intermittent.
9. The water quality is satisfactory to support REC-I use, although such use is strictly prohibited and would be extremely dangerous.

Groundwater within the Whitewater River Subbasin is designated for multiple beneficial uses as shown in Table 3.3.3. The Whitewater hydrologic unit (719.00) is divided into four subunits, each supporting different beneficial uses based on water quality and existing extraction patterns.

Table 3.3.3. Designated groundwater beneficial uses for the Whitewater River Subbasin hydrologic units and subunits. Data source: California Regional Water Quality Control Board, Colorado River Basin Region, Basin Plan Table 2-5 (2019). Note: An "X" under MUN for a particular hydrologic unit indicates only that at least one of the aquifers in that unit currently

supports a MUN beneficial use. Groundwater is also important to sustain vegetation for wildlife habitat in areas where surface waters are not present.

Area Code	Hydrologic Unit/Subunit	MUN	IND	AGR
719	Whitewater hydrologic unit			
719.1	Morongo hydrologic subunit	X		
719.2	Shavers hydrologic subunit	X		
719.3	San Gorgonio hydrologic subunit	X	X	X
719.4	Coachella hydrologic subunit	X	X	X

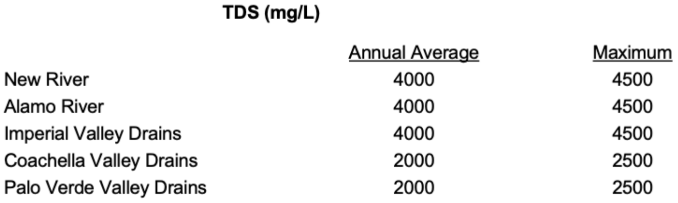
3.4 Water Quality criteria specific to the designated uses

Water quality criteria in the Whitewater River Subbasin are established primarily at the state level through the Water Quality Control Plan for the Colorado River Basin (Region 7), which sets narrative and numeric objectives to protect designated beneficial uses, with some referencing federal standards such as U.S. EPA Primary Maximum Contaminant Levels (MCLs) for drinking water. For municipal and domestic supply (MUN), a key use for groundwater and potential use for upper Whitewater River reaches, nitrate (as N) must not exceed 10 mg/L (equivalent to 45 mg/L as NO_3) to prevent health risks like methemoglobinemia, while total dissolved solids (TDS) are limited to an annual average of 2,000 mg/L (maximum 2,500 mg/L) for non-agricultural discharges to Coachella Valley drains and stormwater channels. For agricultural supply (AGR), prevalent in the Coachella Valley's farming areas, criteria include boron ≤ 0.75 mg/L (annual average) to avoid crop damage, and narrative prohibitions against excess salts or biostimulatory substances (e.g., nutrients like phosphate and nitrate) that could promote nuisance algae growth or impair irrigation suitability. Recreational uses (REC-1 and REC-2), designated for the Whitewater River and Coachella Valley Stormwater Channel (CVSC), are protected by bacterial indicators: for REC-1 in freshwater (salinity ≤1 ppt 95% of time), E. coli geometric mean ≤ 126 MPN/100 mL (30-day or six-week rolling) with a statistical threshold value (STV) ≤ 320 MPN/100 mL (not exceeded >10% of monthly samples), updated from older fecal coliform standards of ≤ 200 MPN/100 mL geometric mean and ≤ 400 MPN/100 mL single sample. These bacteria criteria are directly enforced through the Coachella Valley Stormwater Channel Bacterial Indicators TMDL (adopted 2007, approved by EPA 2012), which sets identical E. coli targets for REC-1 to address impairments from urban runoff, agriculture, and septic systems, with implementation via waste discharge requirements and monitoring. For warm freshwater habitat (WARM) and wildlife habitat (WILD), dissolved oxygen (DO) must be ≥ 5.0 mg/L at all times, pH between 6.0 and 9.0 (no change >0.5 units from natural), and waters free of toxic substances or suspended solids causing nuisance or reduced survival (evaluated via 96-hour bioassays). Additional chemical constituents for MUN follow EPA MCLs, such as arsenic ≤ 0.010 mg/L and selenium ≤ 0.05 mg/L, with no increases in hazardous levels in sediments or aquatic life. These criteria guide TMDL implementation, stormwater permits, and SGMA monitoring to mitigate degradation in this arid watershed.

Waters designated:

WARM	5.0 mg/l
COLD	8.0 mg/l
WARM and COLD	8.0 mg/l

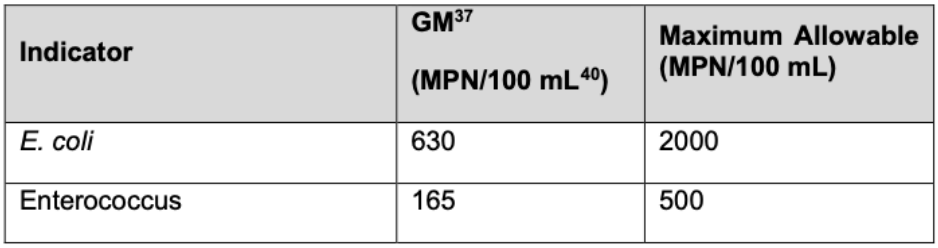
Figure 3.4.1 Dissolved Oxygen Minimum Levels. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



TDS (mg/L)

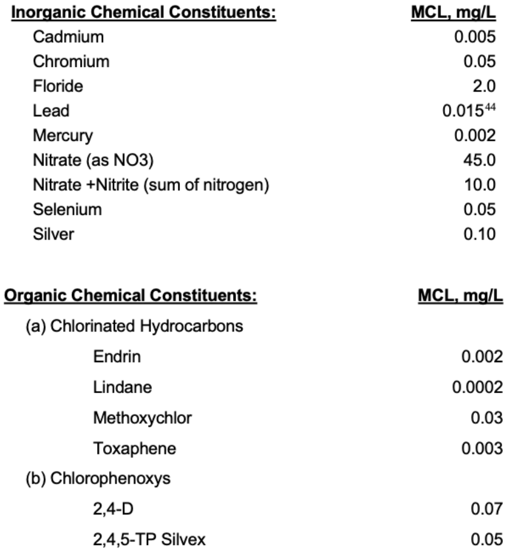
	Annual Average	Maximum
New River	4000	4500
Alamo River	4000	4500
Imperial Valley Drains	4000	4500
Coachella Valley Drains	2000	2500
Palo Verde Valley Drains	2000	2500

Figure 3.4.2 TDS (mg/L). Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



Indicator	GM[37] (MPN/100 mL[40])	Maximum Allowable (MPN/100 mL)
E. coli	630	2000
Enterococcus	165	500

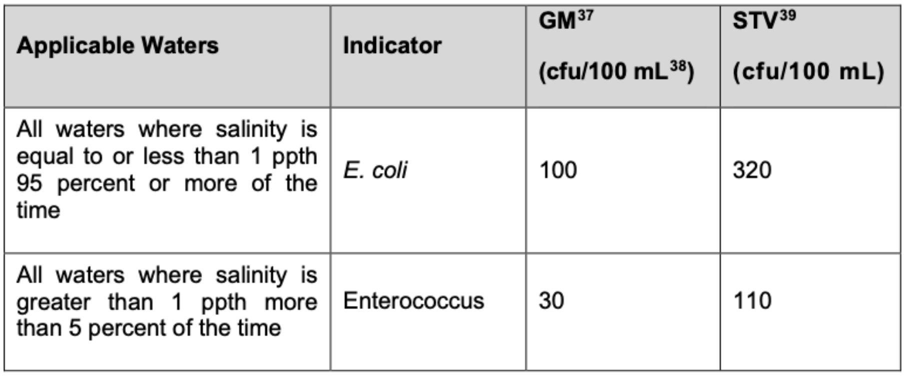
Figure 3.4.3 REC I BACTERIA OBJECTIVES. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



Inorganic Chemical Constituents:	**MCL, mg/L**
Cadmium	0.005
Chromium	0.05
Floride	2.0
Lead	0.015[44]
Mercury	0.002
Nitrate (as NO3)	45.0
Nitrate +Nitrite (sum of nitrogen)	10.0
Selenium	0.05
Silver	0.10

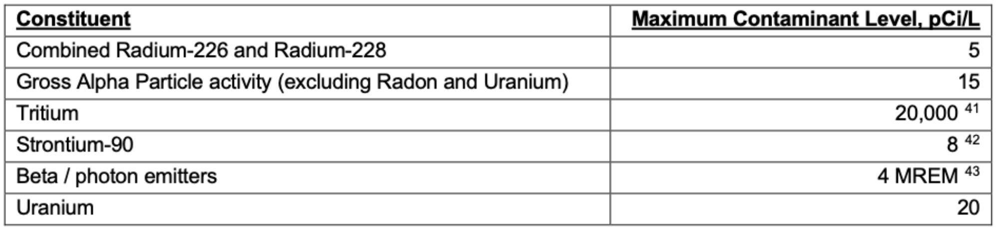
Organic Chemical Constituents:	**MCL, mg/L**
(a) Chlorinated Hydrocarbons	
Endrin	0.002
Lindane	0.0002
Methoxychlor	0.03
Toxaphene	0.003
(b) Chlorophenoxys	
2,4-D	0.07
2,4,5-TP Silvex	0.05

Figure 3.4.4 Chemical Constituents. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



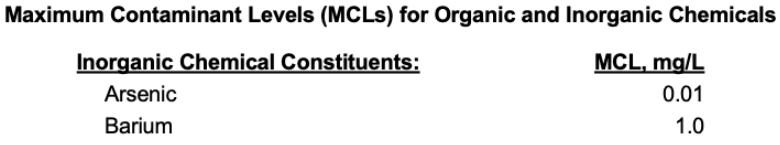
Applicable Waters	Indicator	GM[37] (cfu/100 mL[38])	STV[39] (cfu/100 mL)
All waters where salinity is equal to or less than 1 ppth 95 percent or more of the time	*E. coli*	100	320
All waters where salinity is greater than 1 ppth more than 5 percent of the time	Enterococcus	30	110

Figure 3.4.5 REC II BACTERIA OBJECTIVES. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



Constituent	**Maximum Contaminant Level, pCi/L**
Combined Radium-226 and Radium-228	5
Gross Alpha Particle activity (excluding Radon and Uranium)	15
Tritium	20,000 [41]
Strontium-90	8 [42]
Beta / photon emitters	4 MREM [43]
Uranium	20

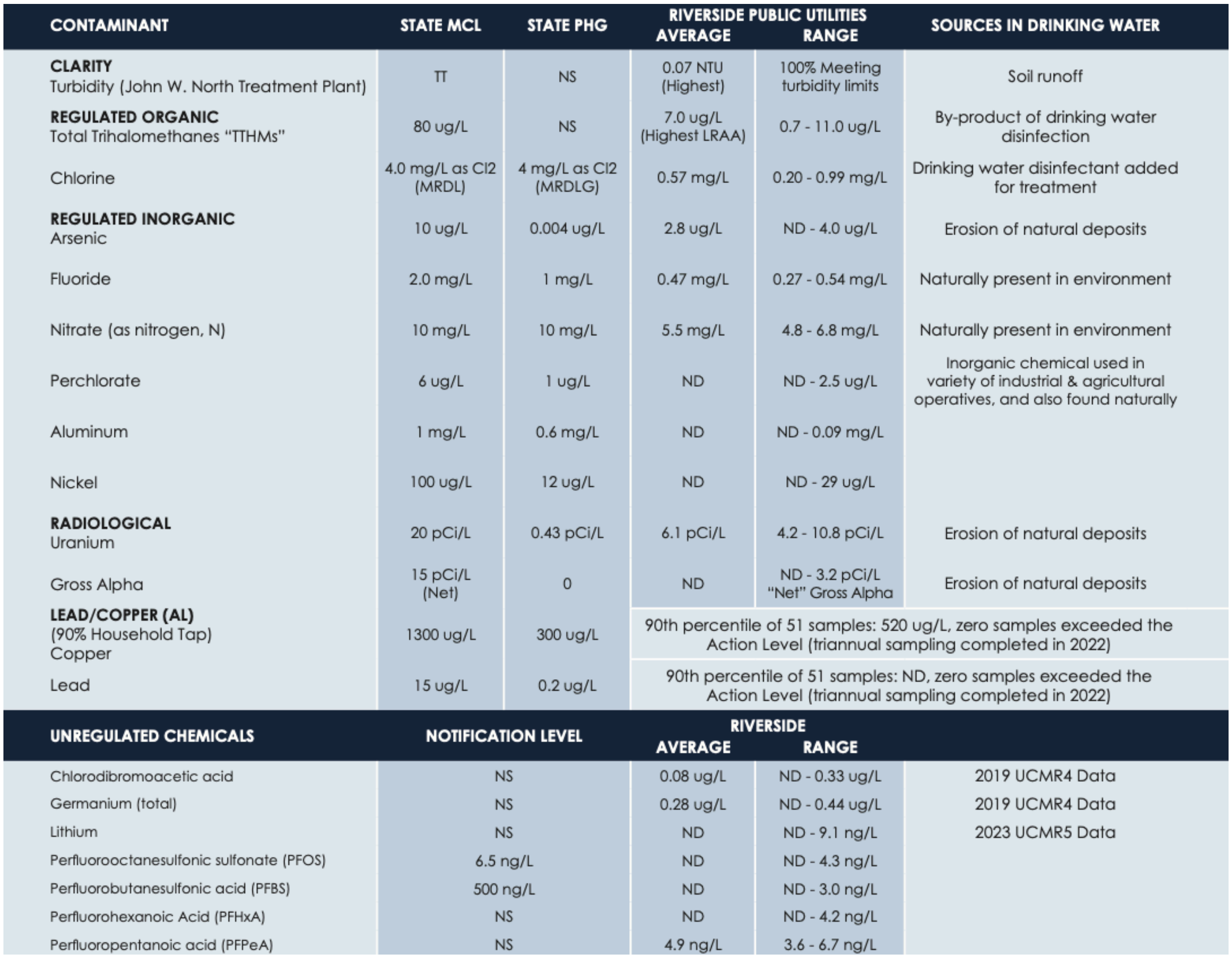
Figure 3.4.6 Radioactivity. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



Maximum Contaminant Levels (MCLs) for Organic and Inorganic Chemicals

Inorganic Chemical Constituents:	MCL, mg/L
Arsenic	0.01
Barium	1.0

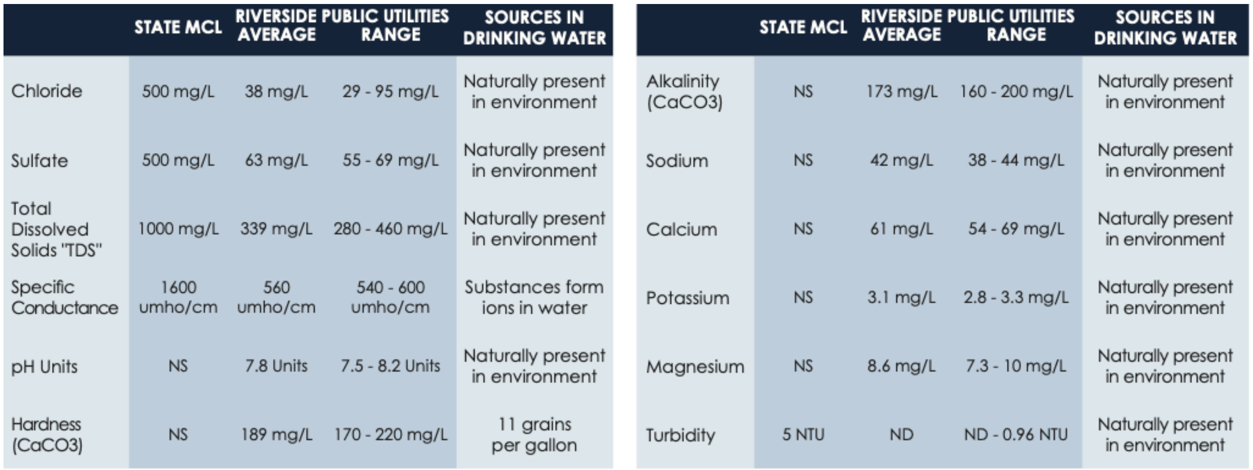
Figure 3.4.7 MCLs for Organic and Inorganic Chemicals. Source: *California Regional Water Quality Control Board, Colorado River Basin Region)*



CONTAMINANT	STATE MCL	STATE PHG	RIVERSIDE PUBLIC UTILITIES AVERAGE	RIVERSIDE PUBLIC UTILITIES RANGE	SOURCES IN DRINKING WATER
CLARITY Turbidity (John W. North Treatment Plant)	TT	NS	0.07 NTU (Highest)	100% Meeting turbidity limits	Soil runoff
REGULATED ORGANIC Total Trihalomethanes "TTHMs"	80 ug/L	NS	7.0 ug/L (Highest LRAA)	0.7 - 11.0 ug/L	By-product of drinking water disinfection
Chlorine	4.0 mg/L as Cl2 (MRDL)	4 mg/L as Cl2 (MRDLG)	0.57 mg/L	0.20 - 0.99 mg/L	Drinking water disinfectant added for treatment
REGULATED INORGANIC Arsenic	10 ug/L	0.004 ug/L	2.8 ug/L	ND - 4.0 ug/L	Erosion of natural deposits
Fluoride	2.0 mg/L	1 mg/L	0.47 mg/L	0.27 - 0.54 mg/L	Naturally present in environment
Nitrate (as nitrogen, N)	10 mg/L	10 mg/L	5.5 mg/L	4.8 - 6.8 mg/L	Naturally present in environment
Perchlorate	6 ug/L	1 ug/L	ND	ND - 2.5 ug/L	Inorganic chemical used in variety of industrial & agricultural operatives, and also found naturally
Aluminum	1 mg/L	0.6 mg/L	ND	ND - 0.09 mg/L	
Nickel	100 ug/L	12 ug/L	ND	ND - 29 ug/L	
RADIOLOGICAL Uranium	20 pCi/L	0.43 pCi/L	6.1 pCi/L	4.2 - 10.8 pCi/L	Erosion of natural deposits
Gross Alpha	15 pCi/L (Net)	0	ND	ND - 3.2 pCi/L "Net" Gross Alpha	Erosion of natural deposits
LEAD/COPPER (AL) (90% Household Tap) Copper	1300 ug/L	300 ug/L	90th percentile of 51 samples: 520 ug/L, zero samples exceeded the Action Level (triannual sampling completed in 2022)		
Lead	15 ug/L	0.2 ug/L	90th percentile of 51 samples: ND, zero samples exceeded the Action Level (triannual sampling completed in 2022)		

UNREGULATED CHEMICALS	NOTIFICATION LEVEL	RIVERSIDE AVERAGE	RIVERSIDE RANGE	
Chlorodibromoacetic acid	NS	0.08 ug/L	ND - 0.33 ug/L	2019 UCMR4 Data
Germanium (total)	NS	0.28 ug/L	ND - 0.44 ug/L	2019 UCMR4 Data
Lithium	NS	ND	ND - 9.1 ng/L	2023 UCMR5 Data
Perfluorooctanesulfonic sulfonate (PFOS)	6.5 ng/L	ND	ND - 4.3 ng/L	
Perfluorobutanesulfonic acid (PFBS)	500 ng/L	ND	ND - 3.0 ng/L	
Perfluorohexanoic Acid (PFHxA)	NS	ND	ND - 4.2 ng/L	
Perfluoropentanoic acid (PFPeA)	NS	4.9 ng/L	3.6 - 6.7 ng/L	

Figure 3.4.7 Riverside Primary Standards. Source: *Riversite Water Quality Report (2023).*



	STATE MCL	RIVERSIDE PUBLIC UTILITIES AVERAGE	RIVERSIDE PUBLIC UTILITIES RANGE	SOURCES IN DRINKING WATER
Chloride	500 mg/L	38 mg/L	29 - 95 mg/L	Naturally present in environment
Sulfate	500 mg/L	63 mg/L	55 - 69 mg/L	Naturally present in environment
Total Dissolved Solids "TDS"	1000 mg/L	339 mg/L	280 - 460 mg/L	Naturally present in environment
Specific Conductance	1600 umho/cm	560 umho/cm	540 - 600 umho/cm	Substances form ions in water
pH Units	NS	7.8 Units	7.5 - 8.2 Units	Naturally present in environment
Hardness (CaCO3)	NS	189 mg/L	170 - 220 mg/L	11 grains per gallon

	STATE MCL	RIVERSIDE PUBLIC UTILITIES AVERAGE	RIVERSIDE PUBLIC UTILITIES RANGE	SOURCES IN DRINKING WATER
Alkalinity (CaCO3)	NS	173 mg/L	160 - 200 mg/L	Naturally present in environment
Sodium	NS	42 mg/L	38 - 44 mg/L	Naturally present in environment
Calcium	NS	61 mg/L	54 - 69 mg/L	Naturally present in environment
Potassium	NS	3.1 mg/L	2.8 - 3.3 mg/L	Naturally present in environment
Magnesium	NS	8.6 mg/L	7.3 - 10 mg/L	Naturally present in environment
Turbidity	5 NTU	ND	ND - 0.96 NTU	Naturally present in environment

Figure 3.4.8 Riverside Secondary Standards. Source: *Riversite Water Quality Report (2023).*

3.5 Summary

The Whitewater River Subbasin's regulatory framework integrates land-use planning, flood management, groundwater sustainability, and water quality protection to balance urban growth with resource conservation in the arid Coachella Valley. General plans for Cathedral City, Palm Desert, Palm Springs, and Indio designate mixed-use development while preserving open space in hillside and floodplain zones that provide habitat, flood control, and groundwater recharge consistent with the CVMSHCP. Flood control is enforced through Riverside County Ordinance No. 458, which regulates development in FEMA Special Flood Hazard Areas. Groundwater management follows SGMA through Alternative Sustainability Plans utilizing artificial recharge facilities that deliver over 40,000 acre-feet annually of imported water to reverse historical overdraft. The Colorado River Basin Regional Water Quality Control Board designates beneficial uses, including municipal supply, agriculture, recreation, and habitat, and establishes corresponding criteria for water quality parameters such as nitrate, bactertial indicators and dissolved oxygen. These layered regulations, enforced through TMDLs, stormwater permits, and habitat conservation requirements, create a comprehensive governance structure to sustain water resources in this high-growth, water-limited watershed.

4.0 Introduction

Monitoring of water quality and quantity is the keystone of watershed management planning in arid and semi-arid regions. In the Whitewater River watershed of the Coachella Valley, flow and precipitation data are particularly critical given the desert environment and the watershed's dependence on snowmelt, occasional precipitation events, and groundwater contributions. These hydrological data provide insight into the seasonal and interannual dynamics of a watershed characterized by extreme variability in flow conditions. When paired with measurements of water quality, inferences can be made about the flux and routing of various pollutants within the system. Many of these pollutants pose threats not only to human health but also to sensitive desert ecosystems, the Salton Sea, groundwater recharge areas, and agricultural productivity in the Coachella Valley.

The Whitewater River watershed presents unique monitoring challenges due to its desert hydrology, urbanization pressures in the upper watershed near Palm Springs, extensive agricultural operations in the lower Coachella Valley, and the presence of the Coachella Valley Stormwater Channel. Urban runoff, agricultural return flows, and stormwater discharges contribute to water quality impairments that have resulted in 303(d) listings and Total Maximum Daily Load (TMDL) requirements for the Coachella Valley Stormwater Channel.

Monitoring stations within the Whitewater River watershed that provide complete and reliable records of flow, precipitation, and water quality data are limited. The ephemeral nature of many tributaries, combined with the engineered character of the main channel system, creates additional complexities for comprehensive watershed assessment. However, the data from existing stations are presented and analyzed below to characterize current conditions and identify critical data gaps that limit effective watershed management.

4.1 Flow Monitoring

Precipitation is the primary driver of surface runoff in the arid Whitewater River subbasin, where streamflow is ephemeral and strongly tied to rare, high-intensity storm events. The NOAA meteorological stations at Indio, Mecca, and Palm Springs provide the only continuous hydrologic input data for the watershed. Figures 4.1.b and 4.1.c illustrate monthly precipitation totals across two distinct periods: 2011–2025 and 1998–2010. Both intervals reveal a highly episodic rainfall regime, with most months receiving less than 20 mm and occasional extreme events exceeding 100 mm. Winter frontal systems (January–March) and summer monsoons (July–September) dominate the precipitation signal, consistent with known drivers of flash flooding in desert environments.

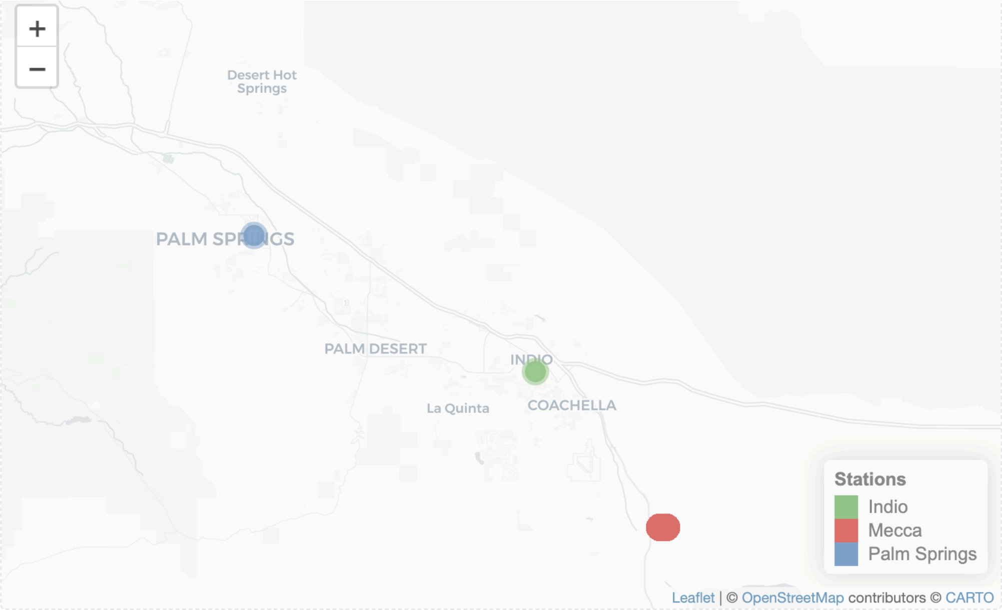


Figure 4.1.a Station Locations. This map displays the geographic distribution of the three NOAA meteorological stations within the Whitewater River subbasin. The Palm Springs station is situated in the upper watershed near the San Jacinto Mountains, while Indio and Mecca are located in the lower Coachella Valley, providing a representative cross-section of the basin's elevation and land use gradient.

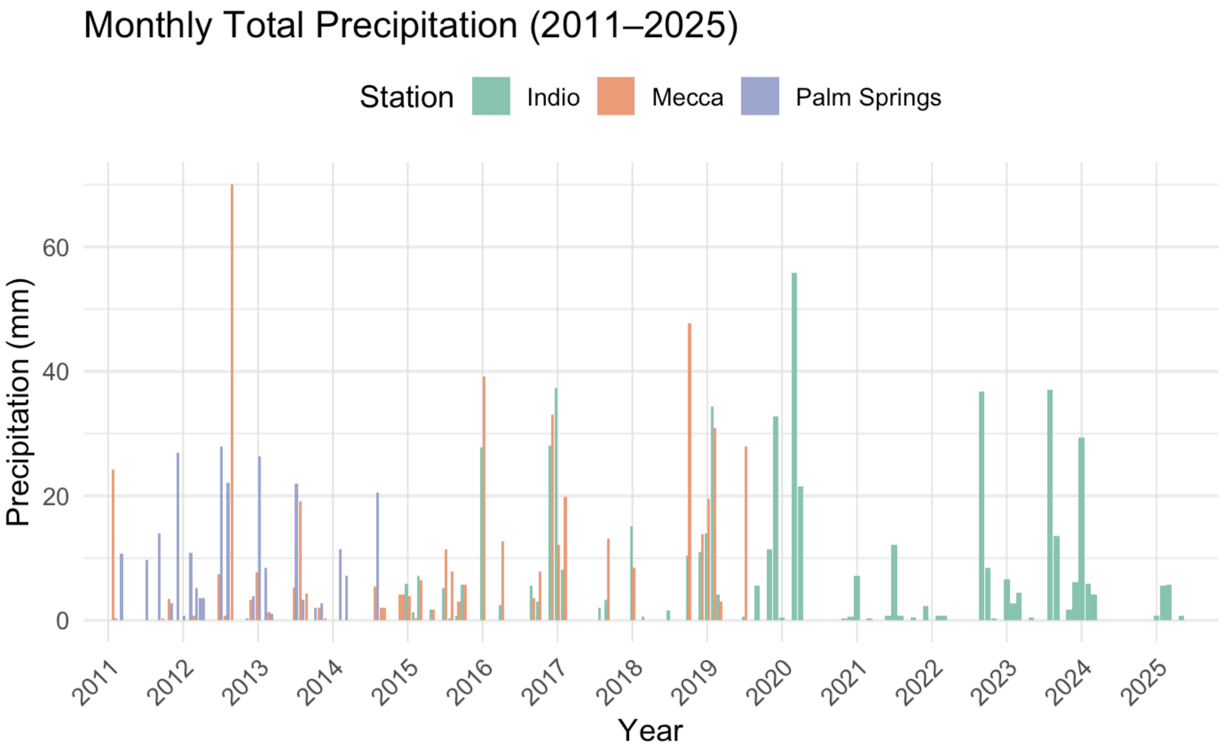


Figure 4.1.b Monthly Total Precipitation per Station (2011-2025). Monthly precipitation totals from 2011 to 2025 reveal a highly episodic pattern typical of arid environments. Most months receive less than 20 mm of rainfall, with significant events concentrated in winter (January–March) and late summer (July–September). Palm Springs consistently records the highest totals, reflecting orographic enhancement from the surrounding mountains. Indio and Mecca exhibit nearly identical low precipitation regimes, underscoring the extreme aridity of the valley floor.

A clear spatial gradient emerges across the stations. Palm Springs, located in the upper watershed near the San Jacinto Mountains, consistently records higher monthly totals and more extreme maxima (up to 170.4 mm in a single month during 1998–2010) due to orographic enhancement. In contrast, Indio and Mecca, situated on the valley floor, exhibit nearly identical low precipitation averages (approximately 4–5 mm/month), reflecting the hyper-arid conditions of the lower Coachella Valley. This gradient suggests that runoff generation is disproportionately concentrated in the headwaters, with rapid conveyance through engineered channels to downstream agricultural and urban areas.

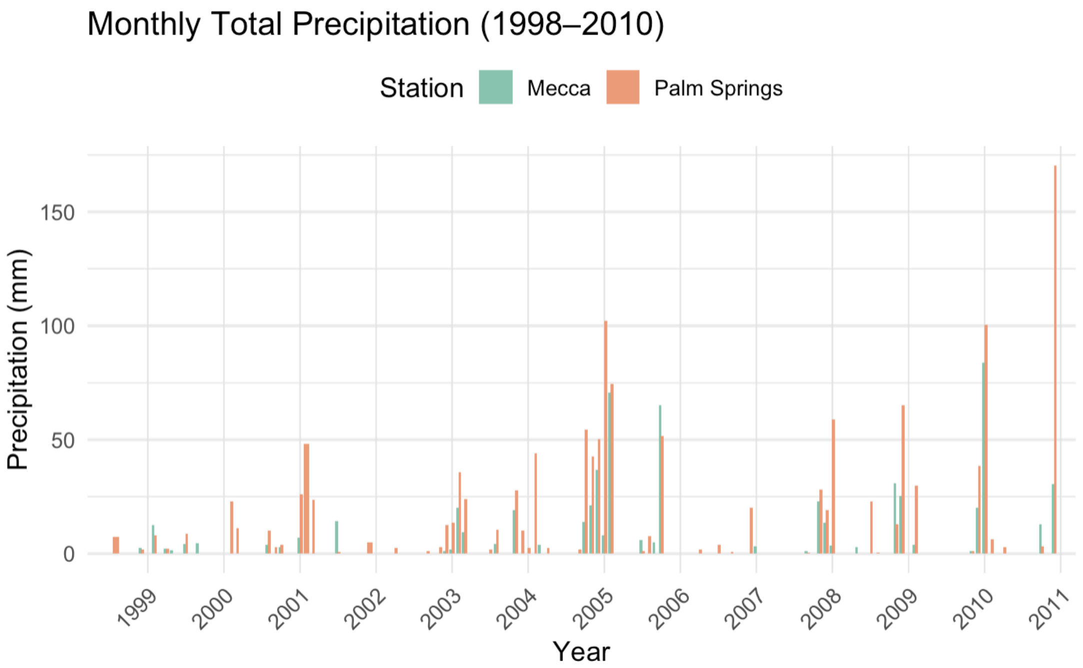


Figure 4.1.c Monthly Total Precipitation per Station (1998-2010). Historical precipitation data from 1998 to 2010 show similar episodic behavior but include several extreme events exceeding 100 mm in a single month, most notably at Palm Springs in December 2010. This earlier period appears wetter overall compared to the 2011–2025 interval, which aligns with broader regional drought trends in Southern California during the 2010s.

Temperature data (Figure 4.1.d) complement the precipitation record by highlighting the extreme climate that amplifies evaporation and limits soil moisture recharge. Daily maximum temperatures regularly exceed 45°C in summer across all stations, with Palm Springs showing slightly cooler medians due to its higher elevation. Winter lows occasionally drop below 10°C, creating large diurnal swings that further stress water resources.

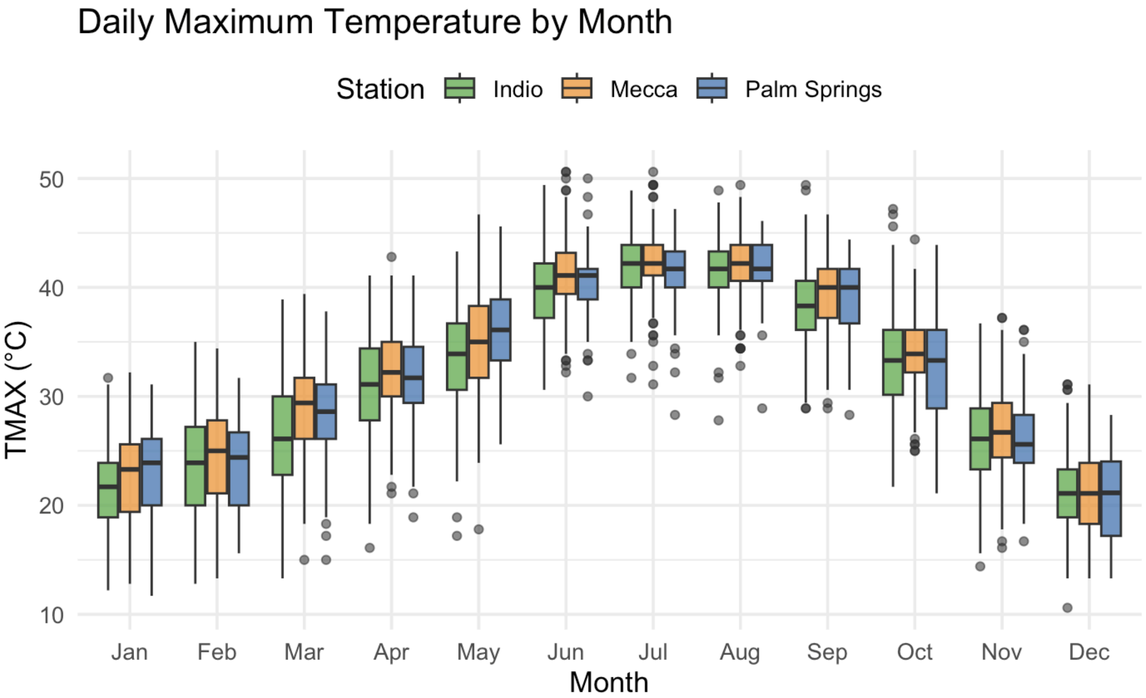


Figure 4.1.d Daily Maximum Temperature by Month per Station. Daily maximum temperatures exhibit a strong seasonal cycle, with summer highs regularly surpassing 45°C across all stations. Palm Springs shows slightly lower median temperatures than Indio and Mecca during peak summer months, likely due to its higher elevation and proximity to mountain slopes. Winter minimums occasionally drop below 10°C, highlighting the significant diurnal and seasonal temperature variability characteristic of desert climates.

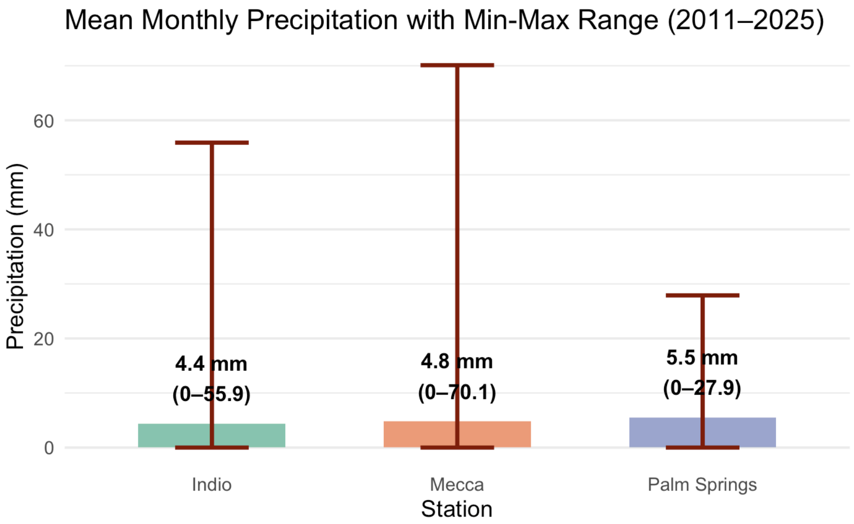


Figure 4.1.e Mean Monthly Precipitation with Min-Max Range (2011-2025). This summary illustrates the extreme variability in monthly precipitation. Indio and Mecca average approximately 4–5 mm per month, with maximum observed values near 70 mm during rare storm events. Palm Springs averages 5.5 mm per month but reaches up to 100+ mm in extreme cases, emphasizing its role as a precipitation hotspot within the watershed. The wide min–max ranges reflect the flash-flood potential inherent in desert hydrology.

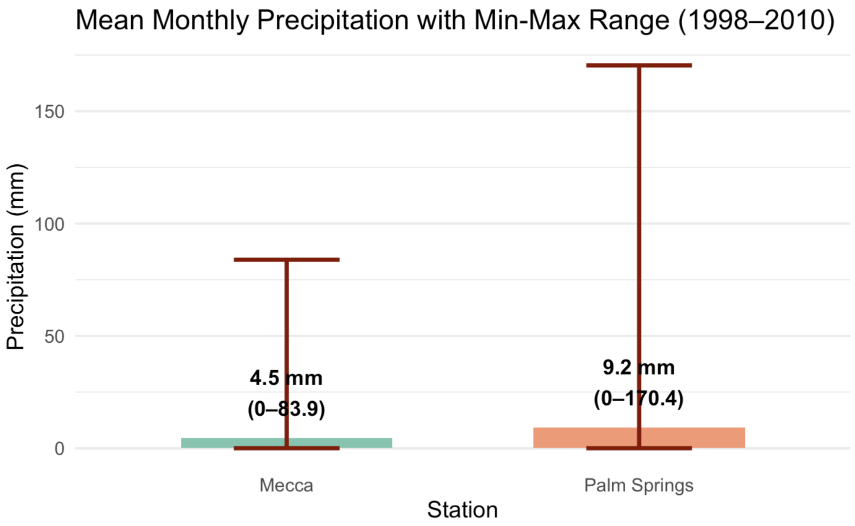


Figure 4.1.f Mean Monthly Precipitation with Min-Max Range (1998-2010). This summary illustrates the extreme variability in monthly precipitation during the earlier period of record. Mecca averaged 4.5 mm per month with a maximum of 83.9 mm, while Palm Springs averaged 9.2 mm per month and recorded an extreme event of 170.4 mm in a single month. The wide min–max ranges highlight the flash-flood potential and the significant influence of orographic effects at higher elevations.

Summary statistics (Figures 4.1.e and 4.1.f) underscore the high variability and flash-flood potential inherent in this system. Mean monthly precipitation is low (4.1–9.2 mm), but maximum observed values range from 55.9 mm (Indio, 2011–2025) to 170.4 mm (Palm Springs, 1998–2010). The earlier period (1998–2010) was notably wetter, with Palm Springs averaging nearly double the monthly total of the recent drought-dominated interval (2011–2025). This decadal shift aligns with broader regional trends of reduced storm frequency and intensity during the 2010s.

In the absence of direct streamflow measurements, precipitation timing serves as a qualitative proxy for potential runoff response. Given the steep topography, low infiltration capacity, and extensive impervious surfaces in the upper basin, peak runoff is expected within hours of significant rainfall events (>25 mm). The engineered Coachella Valley Stormwater Channel rapidly transmits these pulses downstream, amplifying flood risk and pollutant mobilization. While the meteorological data provide critical insight into the drivers and spatial patterns of runoff generation, the lack of corresponding flow records prevents quantitative validation of these relationships and limits the ability to assess flood magnitude, duration, or frequency.

4.2 Water Quality Monitoring

Table 4.2a Water quality monitoring stations in the Whitewater Basin.

ID	Organization	# Parameters	Example Parameters	Min Date	Max Date
CALWR_WQX-04S06E33J001S	California Department Of Water Resources	14	Sulfate, Fluoride, Alkalinity, total, Magnesium, Sodium	2/25/2004	2/25/2004
CALWR_WQX-06S07E13J003S	California Department Of Water Resources	14	Sulfate, Fluoride, Specific conductance, Magnesium, Potassium	5/11/2004	5/11/2004
CALWR_WQX-06S07E13J004S	California Department Of Water Resources	14	Sodium, Boron, Temperature, water, Fluoride, Arsenic	5/11/2004	5/11/2004
CALWR_WQX-07S08E09M004S	California Department Of Water Resources	14	Chloride, Boron, Total dissolved solids, Sulfate, Fluoride	5/12/2004	5/12/2004
CEDEN-719AV56DR	California State Water Resources Control Board	6	Phosphorus, Nitrogen, Kjeldahl nitrogen, Nitrate, Total dissolved solids	3/11/2021	10/7/2021

CEDEN-719CVSCLS	California State Water Resources Control Board	8	Nitrite, Phosphorus, Kjeldahl nitrogen, Total dissolved solids, Ammonia	3/11/2021	10/7/2021
CEDEN-719VSD002	California State Water Resources Control Board	7	Phosphorus, Dichlofenthion, Ammonia, Total dissolved solids, p-Terphenyl-d14	3/11/2021	10/7/2021
MORONGO1_WQX-HIR	Morongo Band of Mission Indians	28	Dissolved oxygen saturation, Mercury, Total dissolved solids, Selenium, Iron	4/24/2007	4/29/2014
MORONGO1_WQX-Millard Irrigation	Morongo Band of Mission Indians	33	Fecal Streptococcus Group Bacteria, Temperature, water, Escherichia coli, Nitrite, Enterococcus	4/26/2006	5/9/2013
MORONGO1_WQX-PIR	Morongo Band of Mission Indians	27	Selenium, Dissolved oxygen saturation, Salinity, Specific conductance, Dissolved oxygen (DO)	7/17/2007	5/9/2013
MORONGO1_WQX-Trough 3	Morongo Band of Mission Indians	19	Selenium, Chromium, Arsenic, Perchlorate, Iron	4/15/2009	4/15/2009
MORONGO1_WQX-Trough 4	Morongo Band of Mission Indians	19	Total Coliform, Copper, Escherichia coli, Perchlorate, Chromium	4/14/2009	4/14/2009
MORONGO1_WQX-WC000	Morongo Band of Mission Indians	34	Total Kjeldahl nitrogen (Organic N & NH3), Calcium, Specific conductance, Escherichia coli, pH	7/19/2010	7/23/2025

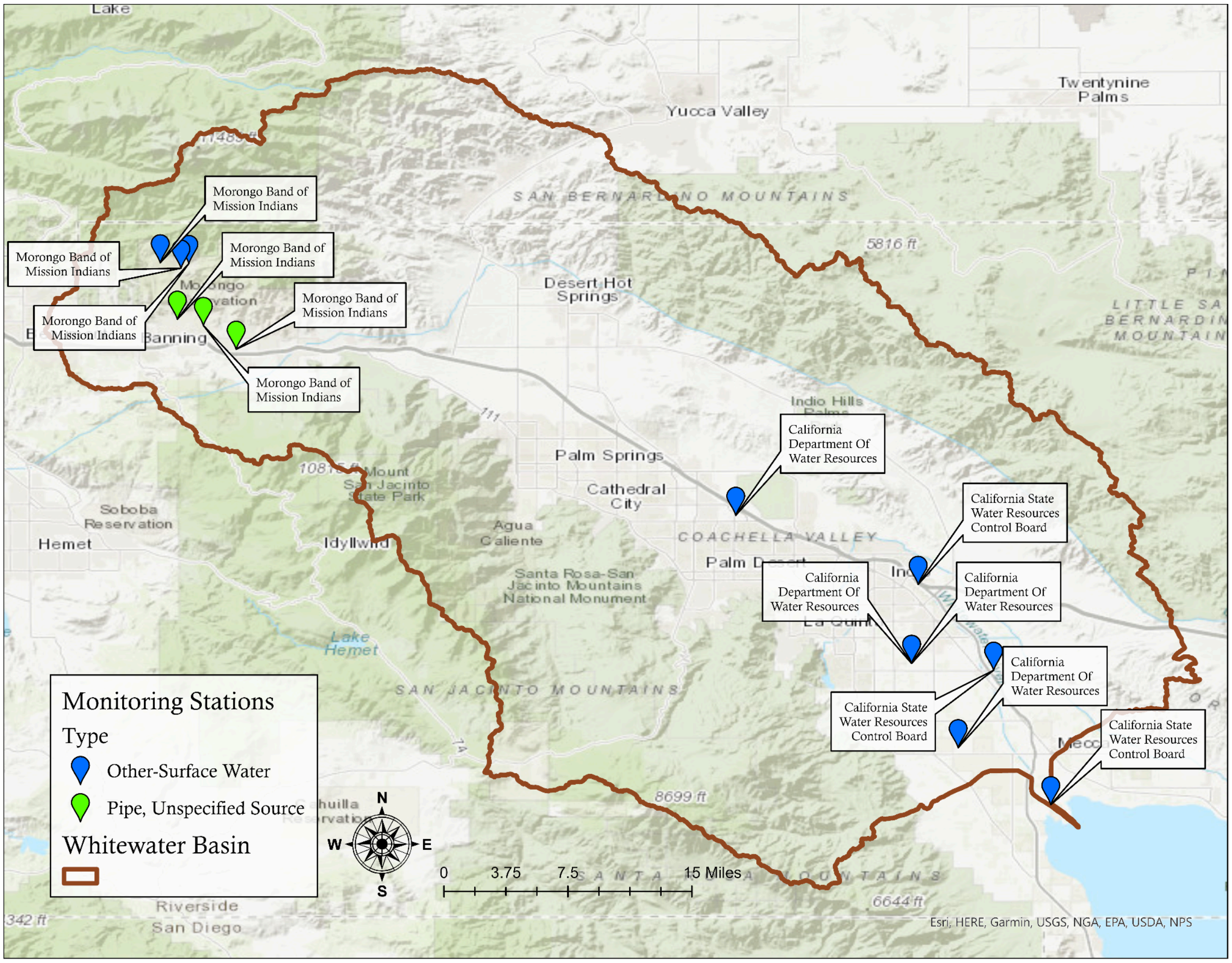


Figure 4.2a Locations of water quality monitoring stations in the Whitewater Basin. Surface water monitoring locations are shown in blue. Pipe monitoring locations are shown in green. Stations are labelled with the name of the controlling organization. HUC-08 level catchment boundary for Whitewater Basin is shown in brown.

Table 4.2b. Parameters of concern in Whitewater Basin. This table highlights key water quality parameters exceeding or approaching standards, based on min/mean/max values from monitoring data. These indicate potential risks from fecal contamination (coliform/E. coli), infrastructure damage (iron), ecosystem interference (turbidity), and health issues (nitrate), informing priority pollutants for management.

Parameter	Min	Mean	Max	Unit
Total Coliform	1	729	2600	MPN/100mL

Escherichia coli	2	36	97	MPN/100mL
Iron	22	341	3900	ug/L
Turbidity	0.13	11	187.9	NTU
Nitrate	0.23	2	24	mg/L

A simple preliminary overview of water quality data in the Whitewater Basin reveals total coliform, E. coli, iron, turbidity, and nitrate as parameters of potential concern. High total coliform and the presence of E. coli indicate potential health risks from fecal contamination. High iron can lead to corrosion, causing failure of pipes and other infrastructure. High turbidity can interfere with ecosystems and harbor harmful pathogens. High nitrate can cause health risks, particularly for infants.

4.3 Gaps in Monitoring

Flow Monitoring Gaps

Despite the value of the available NOAA precipitation record, significant temporal gaps in meteorological monitoring compromise long-term trend analysis and hydrologic modeling in the Whitewater River subbasin. The Indio Fire Station has no precipitation data prior to January 2015, eliminating over 15 years of potential overlap with the Mecca and Palm Springs records. This discontinuity prevents a complete basin-wide assessment of precipitation gradients during the wetter 1998–2010 period and obscures decadal-scale variability in storm frequency and intensity.

The Mecca Fire Station record terminates after December 2020, leaving a five-year gap in lower-valley precipitation data through 2025. This loss is particularly concerning given Mecca's role as a representative station for the agricultural and urbanized lower watershed, where runoff from upstream events converges with local drainage. Similarly, the Palm Springs station ceases precipitation reporting after 2015, truncating the record of the basin's primary rainfall hotspot during a critical drought recovery period.

These gaps create an incomplete and fragmented precipitation dataset:

- No station provides continuous coverage from 1998 to 2025.
- The 2011–2015 overlap is the only period with data from all three stations, severely limiting spatial interpolation and gradient analysis.
- Post-2020 lower basin conditions are unmonitored at Mecca, undermining flood forecasting and water quality assessments for the Coachella Valley Stormwater Channel.

The absence of pre-2015 Indio data is especially problematic for groundwater recharge estimation, as the lower valley relies on infiltration from rare storm events. Without a long-term record at this location, it is impossible to quantify changes in recharge potential or evaluate the impacts of land use intensification in the Coachella Valley.

To address these deficiencies, continuous precipitation monitoring should be restored or expanded at all three NOAA stations, with particular urgency at Indio (to establish a full historical record) and Mecca (to resume lower-basin coverage). Installation of additional rain gages at mid-elevation sites between Palm Springs and the valley floor would further improve spatial resolution of the precipitation gradient. These enhancements are essential for robust hydrologic modeling, flood risk assessment, and adaptive management in this highly variable desert watershed.

Water Quality Monitoring Gaps

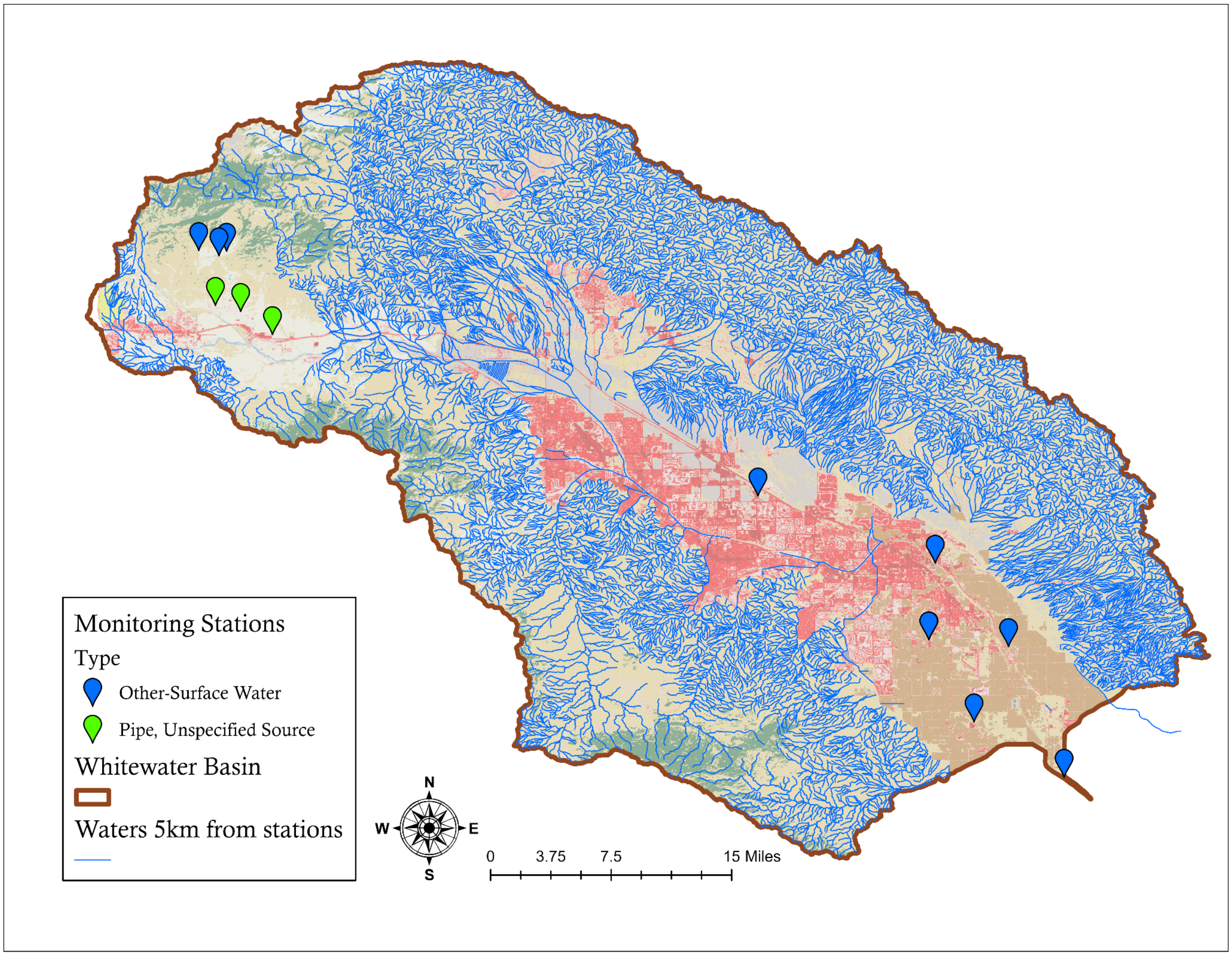


Figure 4.3a Map showing spatial gaps in water quality monitoring stations in the Whitewater Basin. Monitoring stations are shown as blue and green points. Surface water is shown as blue lines (note that many of these are not continuous and would only have water

during rain events). HUC-08 level catchment boundary for Whitewater Basin shown in brown. Data is shown atop NLCD land cover, with developed areas in red and agricultural areas in dark brown.

Water quality monitoring stations are mainly clustered around the Morongo Reservation in the northwest of the basin and the urban Coachella valley area in the southeast of the basin. While existing monitoring stations seem to be well-located near developed and agricultural areas, there are significant spatial gaps between these clusters. Large parts of the basin are unmonitored, both near the headwaters and further downstream. Additionally, there are significant temporal gaps, with some stations having data only as recent as 2004.

To address these gaps, additional water quality monitoring stations should be strategically placed in areas that are near vulnerable populations, or are expected to have poor water quality, such as highly developed areas and areas with high agricultural runoff. These stations should be monitored regularly throughout the year, and should include the parameters that are most likely to exist at unsafe levels.

4.4 Summary

Monitoring data from the Whitewater River subbasin reveals a watershed characterized by extreme hydrologic variability, significant data gaps, and emerging water quality concerns that collectively challenge effective watershed management in this desert environment.

Precipitation monitoring from three NOAA stations demonstrates the highly episodic nature of water inputs to the system. The strong spatial gradient, with Palm Springs recording up to 170.4 mm in a single month while valley floor stations average only 4–5 mm monthly, confirms that runoff generation is concentrated in the mountainous headwaters. The comparison between the 1998–2010 and 2011–2025 periods reveals a concerning drying trend, with recent precipitation averaging nearly half that of the earlier interval at Palm Springs. This shift aligns with broader regional drought patterns and has significant implications for groundwater recharge, flood frequency, and ecosystem sustainability. The extreme temperature regime further stresses water resources, with summer maxima regularly exceeding 45°C and promoting high evapotranspiration rates that limit effective precipitation. The winter-dominated precipitation pattern (January–March) and secondary light summer monsoon influence (July–September) create predictable seasonal windows for flash flooding, though the absence of direct streamflow measurements prevents quantification of actual runoff volumes, flood magnitudes, or pollutant loading rates.

Preliminary water quality analysis identifies five parameters of concern that pose risks to human health, infrastructure, and ecosystems. Total coliform bacteria (mean: 729 MPN/100mL, maximum: 2,600 MPN/100mL) and E. coli presence indicate fecal contamination likely originating from agricultural operations, urban runoff, or inadequate wastewater management. Elevated iron concentrations (mean: 341 µg/L, maximum: 3,900 µg/L) threaten infrastructure integrity through accelerated corrosion. High turbidity values (maximum: 187.9 NTU) suggest sediment mobilization during storm events that can harbor pathogens and degrade aquatic habitat. Nitrate levels reaching 24 mg/L approach or exceed drinking water standards, presenting particular risks to vulnerable populations including infants. These water quality impairments have contributed to 303(d) listings and TMDL requirements for the Coachella Valley Stormwater Channel, reflecting the cumulative impact of urban and agricultural pressures in the watershed.

The monitoring network suffers from severe temporal and spatial discontinuities that undermine watershed assessment and adaptive management. No precipitation station provides continuous coverage across the full 1998–2025 period, with Indio lacking any data before 2015, Palm Springs ending after 2015, and Mecca terminating in 2020. The brief 2011–2015 overlap period represents the only interval with complete three-station coverage, severely limiting long-term trend analysis and spatial interpolation of precipitation gradients.

Water quality monitoring exhibits similar deficiencies. Stations cluster around the Morongo Reservation and lower Coachella Valley, leaving vast portions of the watershed, including critical headwater areas and mid-basin reaches, completely unmonitored. Temporal gaps are equally problematic, with some stations providing only single-date snapshots from 2004 and others ceasing operation nearly a decade ago. This fragmented monitoring prevents assessment of pollutant transport pathways, identification of source areas, or evaluation of management intervention effectiveness.

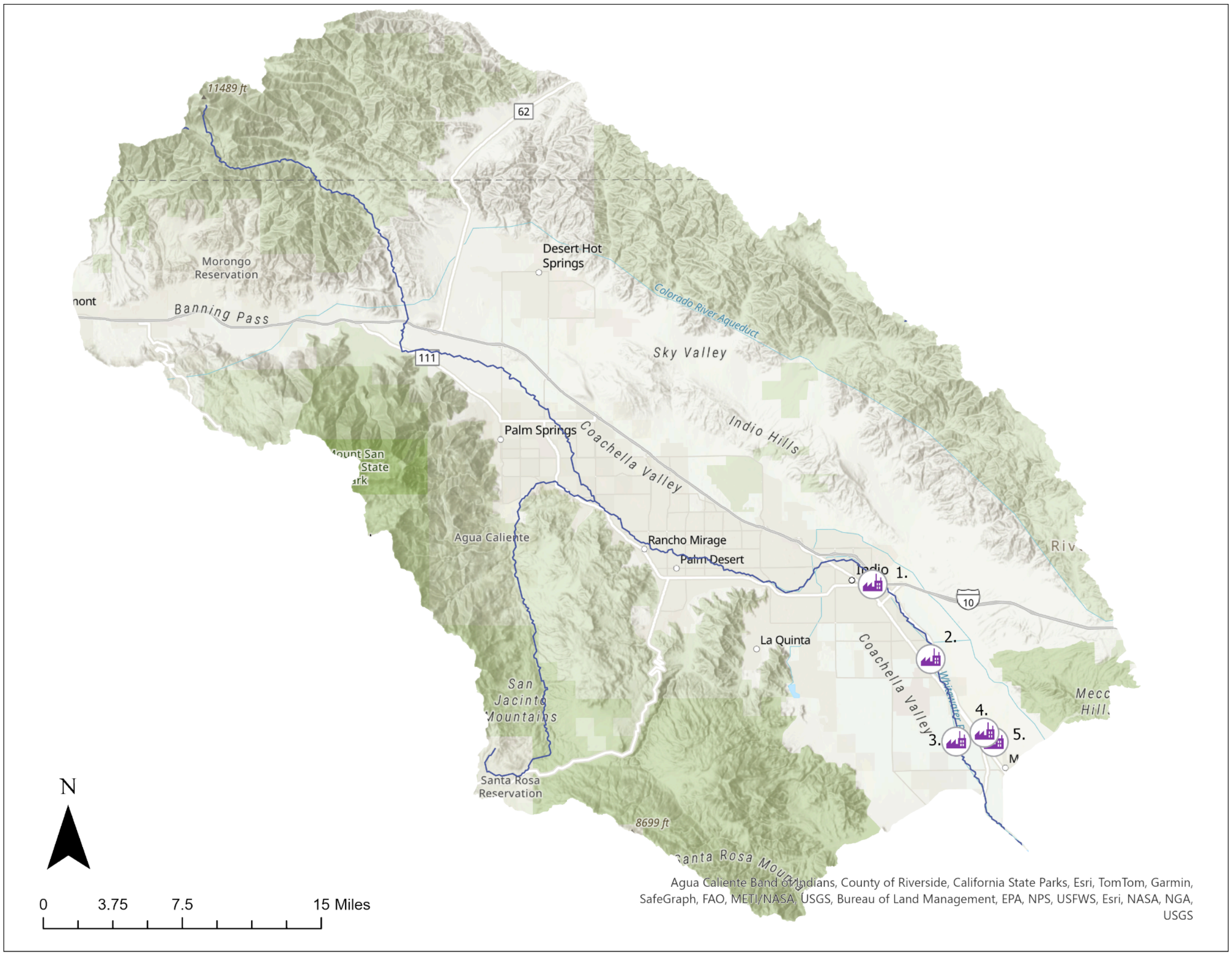
The combination of extreme hydrologic variability, emerging water quality threats, and inadequate monitoring infrastructure presents significant challenges for watershed management. Flash-flood potential remains poorly quantified without streamflow gaging, limiting flood forecasting capability and emergency response planning. Pollutant loading relationships cannot be established without paired flow and water quality measurements during storm events. Groundwater recharge estimation is compromised by precipitation data gaps in the lower valley where infiltration is most critical for water supply sustainability.

Addressing these deficiencies requires strategic investment in monitoring infrastructure. Priority actions include: restoring continuous precipitation monitoring at all three NOAA stations with retrospective data recovery where possible; installing stream gages at key locations to quantify flow magnitude, duration, and frequency; establishing additional water quality monitoring stations in unmonitored reaches, particularly near vulnerable populations and suspected pollutant source areas; and implementing event-based monitoring protocols to capture the dynamic relationship between storm hydrology and pollutant mobilization.

5.0 Introduction

Point sources of pollution are discrete, identifiable discharges from a single location, such as wastewater treatment plants or industrial outfalls, while non-point sources are diffuse and originate from broader areas, including agricultural runoff, urban stormwater, and atmospheric deposition. These sources introduce chemicals like nutrients, pesticides, and metals, as well as pathogens such as bacteria and viruses, into water bodies, potentially impairing water quality and ecosystem health. Information on point sources was obtained from the EPA's Enforcement and Compliance History Online (ECHO) database, which provides detailed effluent data for permitted facilities. Nonpoint source loads were estimated using the Pollutant Load Estimation Tool (PLET) model, which was also used to evaluate BMP effectiveness by comparing pre- and post-BMP pollutant reductions, which incorporates land use, precipitation, and soil characteristics to generate annual pollutant export estimates. This characterization builds on previous analyses of hydrology, water quality monitoring, land use patterns, and beneficial uses in the Whitewater River Subbasin to inform targeted management strategies for reducing pollutant loads and protecting groundwater recharge, agricultural productivity, and recreational resources in this arid watershed.

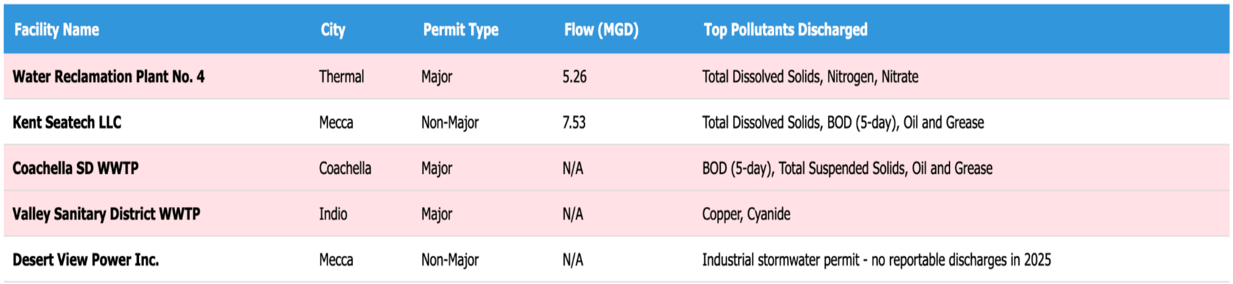
5.1 Point Sources



Agua Caliente Band of Indians, County of Riverside, California State Parks, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USFWS, Esri, NASA, NGA, USGS

Figure 5.1.1 Location of permitted point source discharge facilities in the Whitewater River Subbasin. Five NPDES-permitted facilities are shown: (1) Valley Sanitary District WWTP, (2) Coachella Sanitary District WWTP, (3) Water Reclamation Plant No. 4, (4) Kent Seatech LLC, and (5) Desert View Power Inc. Facility locations obtained from the EPA's Enforcement and Compliance History Online (ECHO) database and displayed over HUC-12 subcatchment boundaries within the Whitewater River Subbasin watershed.

Table 5.1.1 Permitted point source discharge facilities in the Whitewater River Subbasin, including facility name, permit number, facility type, and NPDES permit status. Data obtained from EPA ECHO database.



Facility Name	City	Permit Type	Flow (MGD)	Top Pollutants Discharged
Water Reclamation Plant No. 4	Thermal	Major	5.26	Total Dissolved Solids, Nitrogen, Nitrate
Kent Seatech LLC	Mecca	Non-Major	7.53	Total Dissolved Solids, BOD (5-day), Oil and Grease
Coachella SD WWTP	Coachella	Major	N/A	BOD (5-day), Total Suspended Solids, Oil and Grease
Valley Sanitary District WWTP	Indio	Major	N/A	Copper, Cyanide
Desert View Power Inc.	Mecca	Non-Major	N/A	Industrial stormwater permit - no reportable discharges in 2025

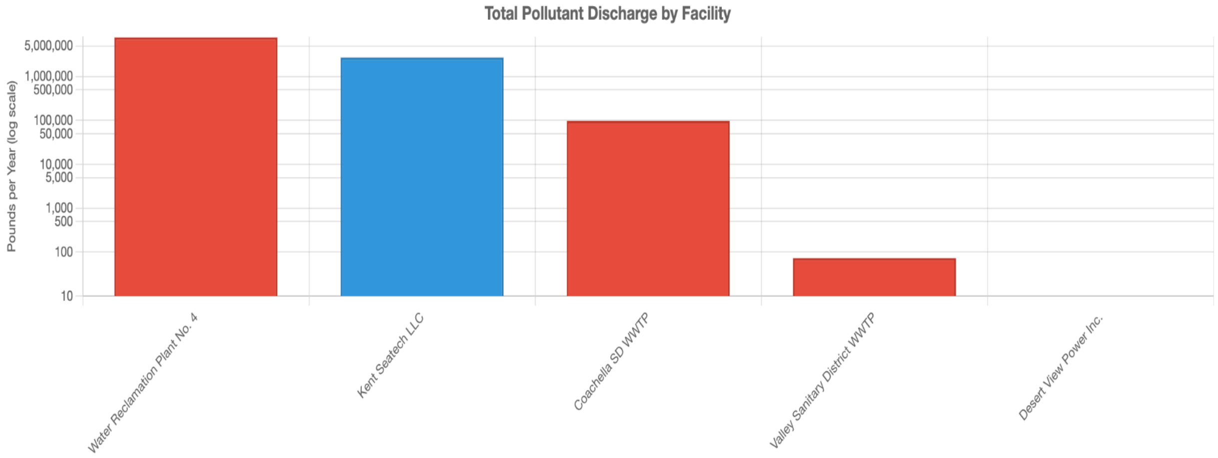


Figure 5.1.2 Total annual pollutant discharge by facility in the Whitewater River Subbasin. Total pollutant loads (in pounds per year) represent the sum of all reported pollutants discharged from each NPDES-permitted facility. Water Reclamation Plant No. 4 and Kent Seatech LLC are the largest contributors to total pollutant discharge, while Desert View Power Inc. contributes minimal loads. Data obtained from EPA ECHO database. Note: y-axis displayed on logarithmic scale.

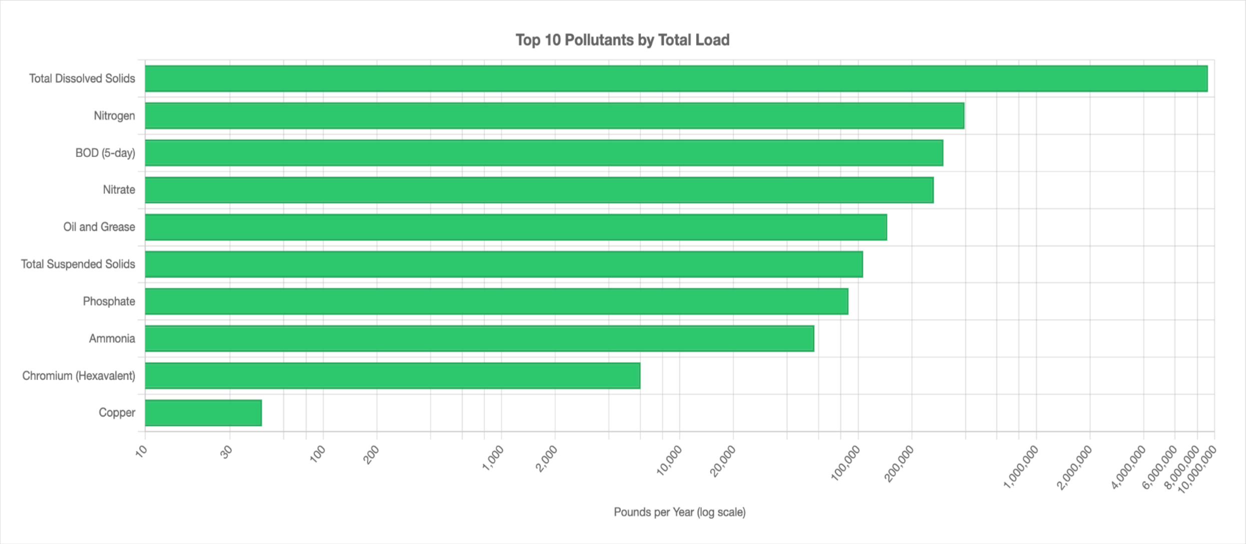
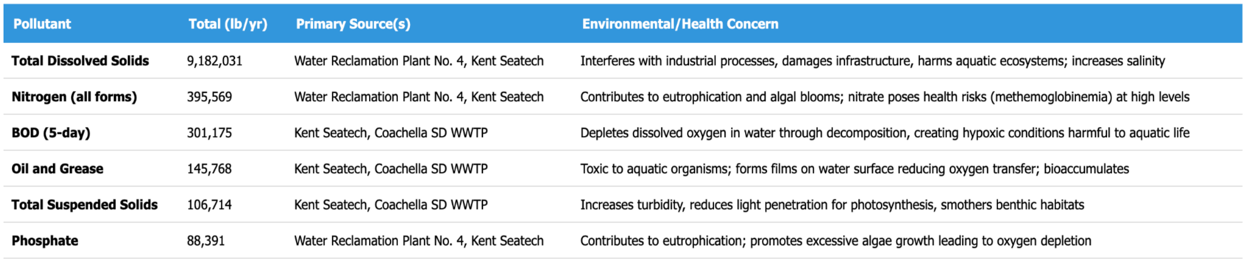


Figure 5.1.3 Top 10 pollutants by total annual load from point source discharges in Whitewater River Subbasin. Total dissolved solids, nitrogen, and biochemical oxygen demand (BOD 5-day) are the dominant pollutants by mass, followed by nitrate, oil and grease, and total suspended solids. Nutrient pollutants (nitrogen, nitrate, phosphate, and ammonia) and oxygen-demanding substances (BOD) represent key water quality concerns. Chromium (hexavalent) and copper are the only metals among the top 10 pollutants. Loads expressed in pounds per year on a logarithmic scale. Data obtained from EPA ECHO database.

Table 5.1.2 Annual pollutant loads from permitted point source discharges in the Whitewater River Subbasin, including total nitrogen (N), total phosphorus (P), biochemical oxygen demand (BOD), and total suspended solids (TSS). Values represent reported effluent discharge data from EPA ECHO database.



Pollutant	Total (lb/yr)	Primary Source(s)	Environmental/Health Concern
Total Dissolved Solids	9,182,031	Water Reclamation Plant No. 4, Kent Seatech	Interferes with industrial processes, damages infrastructure, harms aquatic ecosystems; increases salinity
Nitrogen (all forms)	395,569	Water Reclamation Plant No. 4, Kent Seatech	Contributes to eutrophication and algal blooms; nitrate poses health risks (methemoglobinemia) at high levels
BOD (5-day)	301,175	Kent Seatech, Coachella SD WWTP	Depletes dissolved oxygen in water through decomposition, creating hypoxic conditions harmful to aquatic life
Oil and Grease	145,768	Kent Seatech, Coachella SD WWTP	Toxic to aquatic organisms; forms films on water surface reducing oxygen transfer; bioaccumulates
Total Suspended Solids	106,714	Kent Seatech, Coachella SD WWTP	Increases turbidity, reduces light penetration for photosynthesis, smothers benthic habitats
Phosphate	88,391	Water Reclamation Plant No. 4, Kent Seatech	Contributes to eutrophication; promotes excessive algae growth leading to oxygen depletion

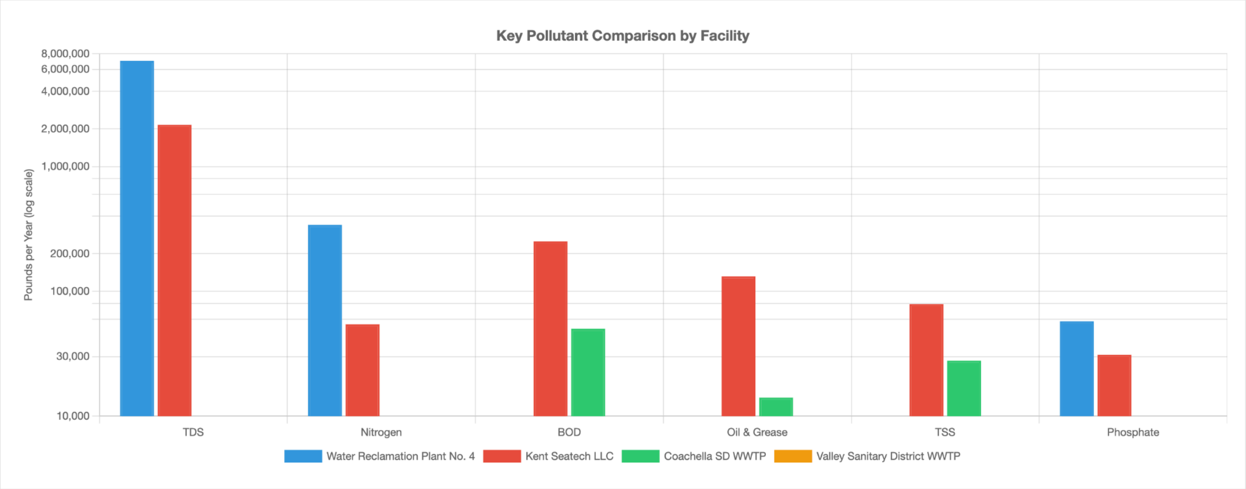
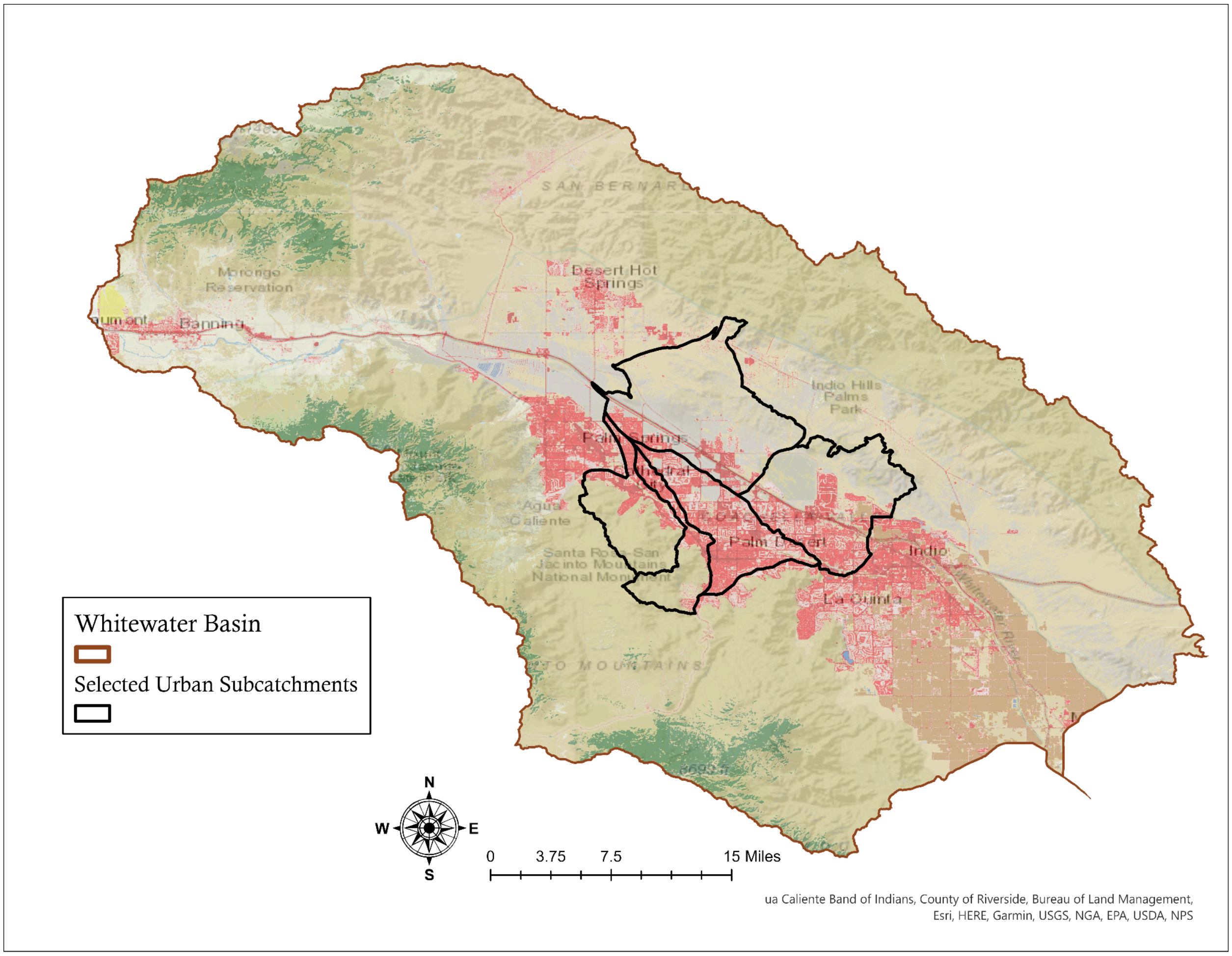


Figure 5.1.4 Key pollutant comparison by facility for major point source dischargers in the Whitewater River Subbasin. Six priority pollutants are compared across the four largest facilities: total dissolved solids (TDS), nitrogen, biochemical oxygen demand (BOD), oil and grease, total suspended solids (TSS), and phosphate. Water Reclamation Plant No. 4 is the dominant source of TDS and nitrogen, while Kent Seatech LLC contributes the highest loads of BOD, oil and grease, and TSS. Coachella Sanitary District WWTP contributes moderate loads across most pollutant categories. Valley Sanitary District WWTP contributions are minimal across all pollutants shown. Loads expressed in pounds per year on a logarithmic scale. Data obtained from EPA ECHO database.

5.2 Non-Point Sources

5.2.1 Urban Subcatchments

The central whitewater basin is dominated by a dense urban landscape, with cities like Palm Springs, Palm Desert, Indio and Rancho Mirage housing tens of thousands of residents. Pollutants of concern from urban runoff may include sediments from construction areas and bare ground, nutrients from fertilizers and animal waste, herbicides and pesticides from yards and green spaces, heavy metals from vehicles and industrial processes, and pathogens from animal waste and wastewater. Urban areas in the whitewater basin are notable for the high number of golf courses, which often use large amounts of pesticides, herbicides, and fertilizers to maintain. As such, these pollutants may be of particular concern for this area. Additionally, since precipitation in the basin exhibits a high degree of seasonality, pollutants may accumulate during dry periods, leading to high pollutant loads during extreme weather events.



ua Caliente Band of Indians, County of Riverside, Bureau of Land Management, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Figure 5.2.1. Five predominantly urban HUC-12 subcatchments in the Whitewater Basin. Urban land use areas shown in red.

Table 5.2.1a. Total loads of N, P, BOD and sediment for five predominantly urban HUC-12 catchments in the Whitewater Basin.

Watershed	N Load (lbs/year)	P Load (lbs/year)	BOD Load (lbs/year)	Sediment Load (tons/year)
181002010606 - Cathedral Canyon	1542	172	745	10
181002010607 - Cat Creek	4378	591	10684	69
181002010608 - Indian Wells	2244	392	6541	44

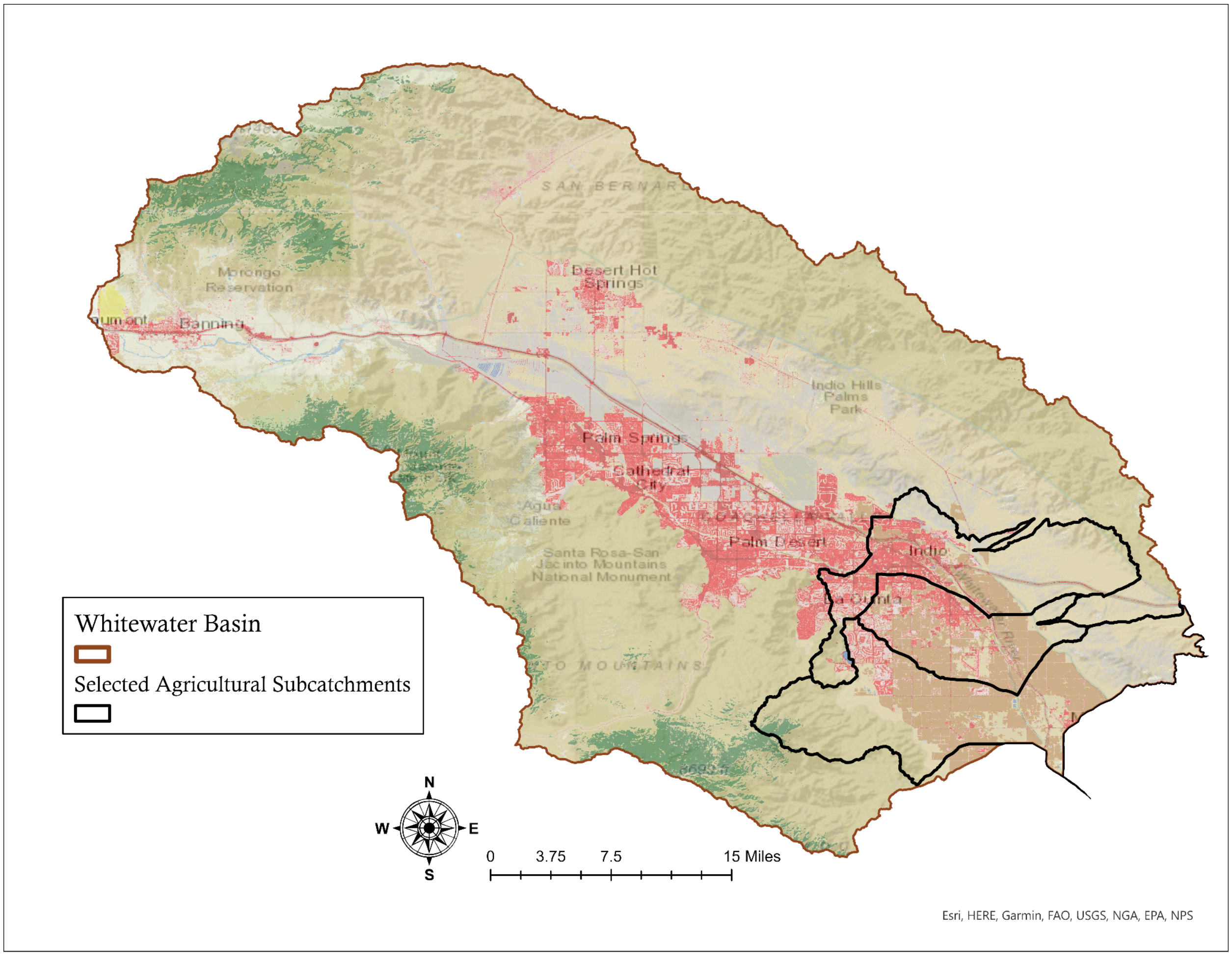
181002010609 - Biskra Palms	**4715**	**800**	**17394**	**116**
181002010602 - Town of Thousand Palms	**4828**	**645**	**10572**	**73**
TOTAL	**17707**	**2600**	**45936**	**312**

Table 5.2.1b. Total loads of N, P, BOD, and sediment by land use type across five predominantly urban HUC-12 subcatchments in the Whitewater Basin.

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (ton/yr)
Urban	**10646**	**1639**	**40424**	**245**
Cropland	**144**	**42**	**295**	**27**
Pastureland	**4.26**	**0.42**	**13**	**0.1**
Forest	**5960**	**556**	**1464**	**40**
Feedlots	**53**	**11**	**71**	**0**
User Defined	**0**	**0**	**0**	**0**
Septic	**898**	**352**	**3668**	**0**
Gully	**0**	**0**	**0**	**0**
Streambank	**0**	**0**	**0**	**0**
Groundwater	**0**	**0**	**0**	**0**
TOTAL	**17707**	**2600**	**45936**	**312**

Urban areas are the predominant source across the load types and selected subcatchments. Other significant sources include forest and septic systems. One might speculate that a significant amount of the urban load originates in runoff from golf courses, which may use high amounts of fertilizers that are high in N and P. However, this distinction is not made clear in the data.

5.2.2 Agricultural Subcatchments



Esri, HERE, Garmin, FAO, USGS, NGA, EPA, NPS

Figure 5.2.2. Three predominantly agricultural HUC-12 subcatchments in the Whitewater Basin. Agricultural land use areas shown in brown.

Table 5.2.2a. Total loads of N, P, BOD and sediment for three predominantly agricultural HUC-12 catchments in the Whitewater Basin.

Watershed	N Load (No BMP) (lbs/year)	P Load (No BMP) (lbs/year)	BOD Load (No BMP) (lbs/year)	Sediment Load (No BMP) (tons/year)
181002010705 - Town of Indio	5947	970	14537	221
181002010802 - Town of Thermal	6591	1478	16653	675

181002010804 - Guadalupe Creek	**6029**	**1747**	**12365**	**1012**
TOTAL	**18567**	**4196**	**43555**	**1907**

Table 5.2.2b. Total loads of N, P, BOD and sediment for three predominantly agricultural HUC-12 catchments in the Whitewater Basin.

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (ton/yr)
Urban	**4541**	**700**	**17210**	**105**
Cropland	**9115**	**2699**	**18606**	**1733**
Pastureland	**1005**	**120**	**3086**	**45**
Forest	**2266**	**219**	**605**	**24**
Feedlots	**961**	**192**	**1282**	**0**
User Defined	**0**	**0**	**0**	**0**
Septic	**678**	**265**	**2767**	**0**
Gully	**0**	**0**	**0**	**0**
Streambank	**0**	**0**	**0**	**0**
Groundwater	**0**	**0**	**0**	**0**
TOTAL	**18567**	**4196**	**43555**	**1907**

Table 5.2.2c. Pre-BMP vs. Post-BMP loads of N, P, BOD and sediment for three predominantly agricultural HUC-12 catchments in the Whitewater Basin.

Watershed	Pre-BMP Load				After BMP Load			
	N	P	BOD	TSS	N	P	BOD	TSS
181002010705 - Town of Indio	2669	411	10119	123016	2669	411	10119	123016
181002010802 - Town of Thermal	1873	288	7091	86371	1873	288	7091	86371
181002010804 - Guadalupe Creek	0	0	0	0	0	0	0	0

6.1 Introduction

Best Management Practices (BMPs) are structural or non-structural measures designed to prevent or reduce water pollution from various sources, with goals of improving water quality, reducing runoff, and protecting ecosystems. There are a number of BMPs that vary in their effectiveness depending on certain characteristics of the watershed where they are implemented. When deciding which BMPs to implement in their watershed, managers need to consider the frequency and severity of storm events, as well as predominant land cover types. Meteorology in the Whitewater Basin is characterised by infrequent, but sometimes extreme, storm events. Additionally, significant land cover types in the basin include dense urban areas in the central basin, agricultural areas in the lower basin, and natural vegetation in upland areas. It is crucial that these characteristics are considered for the selection of BMPs when developing a Watershed Management Plan.

6.2 Urban Stormwater Analysis

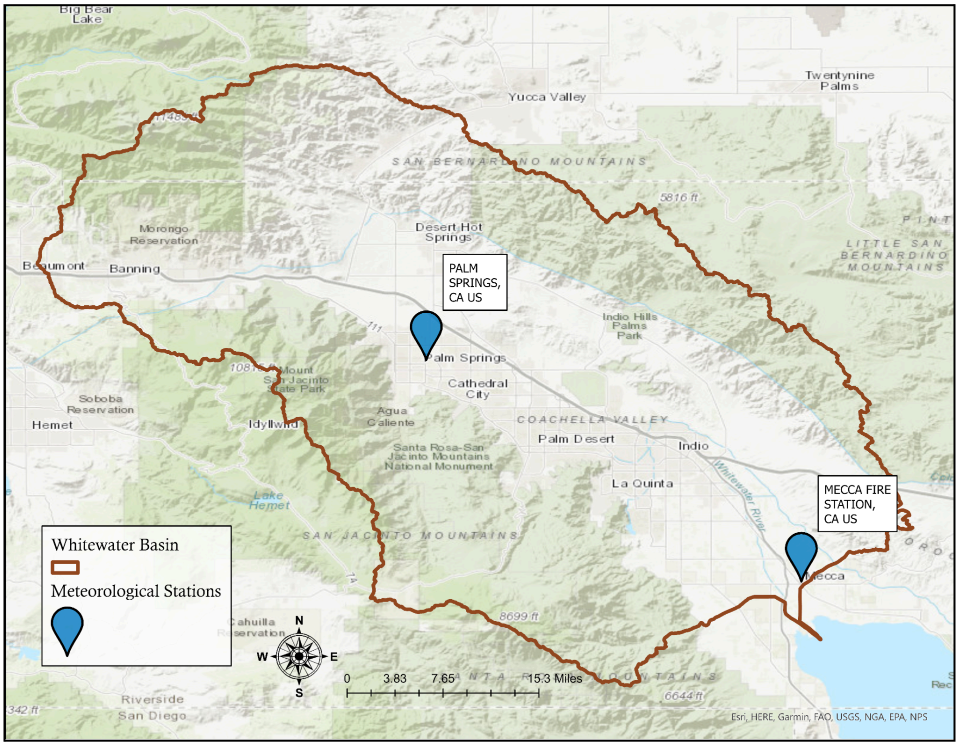


Figure 1.1 Location of two meteorological stations in the Whitewater Basin.

The meteorological stations selected for this analysis are Palm Springs and Mecca Fire Station. The Palm Springs station is located within the city of Palm Springs in the center of the basin, a predominantly urban area. The Mecca Fire Station meteorological station is located in the unincorporated community of Mecca in the lower basin, a mixed agricultural and urban area close to the Salton Sea.

Table 1. Storm frequency and intensity at two meteorological stations in the Whitewater Basin (data from 1/1/1999 to 9/9/2024). This table compares storm patterns to inform flood and erosion risks, showing higher frequency and intensity at Palm Springs (urban center) vs. Mecca (lower basin). Note: Total # Storms not summed as stations are close and likely detect the same events; instead, averages are provided for comparison.

Station	Date Range	# Storms	Storm Frequency (%)	# Storms < 2.5 cm	# Storms > 2.5	Frequency Storms > 2.5 cm (%)
MECCA FIRE STATION	1/1/1999 to 9/9/2024	222	2.4	97	125	56.3
PALM SPRINGS	1/1/1999 to 9/9/2024	339	3.6	107	232	68.4
AVERAGE	1/1/1999 to 9/9/2024	561	3	204	357	63.6

For the purpose of this analysis, a storm event was defined as one or more consecutive days with precipitation > 0.01 cm. Across over 25 years of meteorological data, 222 storms were recorded at Mecca Fire Station, and 339 storms were recorded at Palm Springs, for a total of 561 storms. Overall, 3% of days over this time period had a storm event. Among these storm events, a total of 357 days had > 2.5 cm of precipitation (63.6% frequency). Despite the overall low frequency of storms in the basin, the majority of days during storm events reported greater than 2.5 cm precipitation, with some days even exceeding 50 cm (Figure 1.2). As such, BMPs for the Whitewater Basin must be designed to handle infrequent yet extreme storm events.

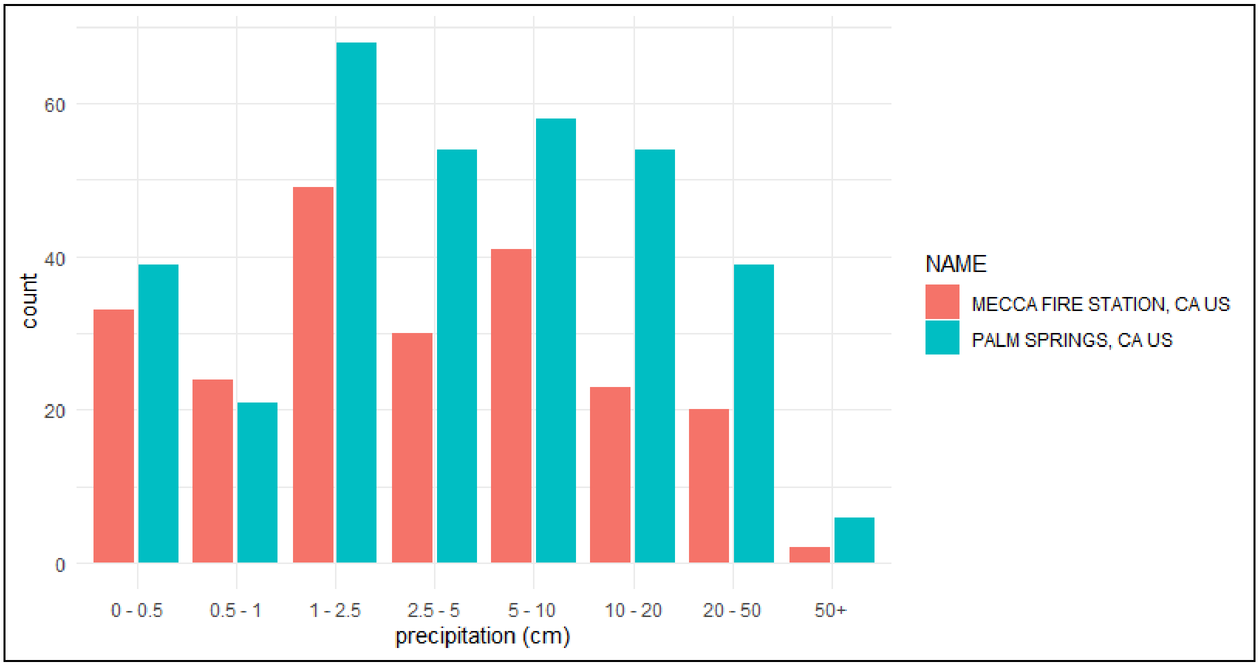


Figure 1.2 Precipitation (cm) during storm events at two meteorological stations in the Whitewater Basin.

6.3 Recommended BMPs

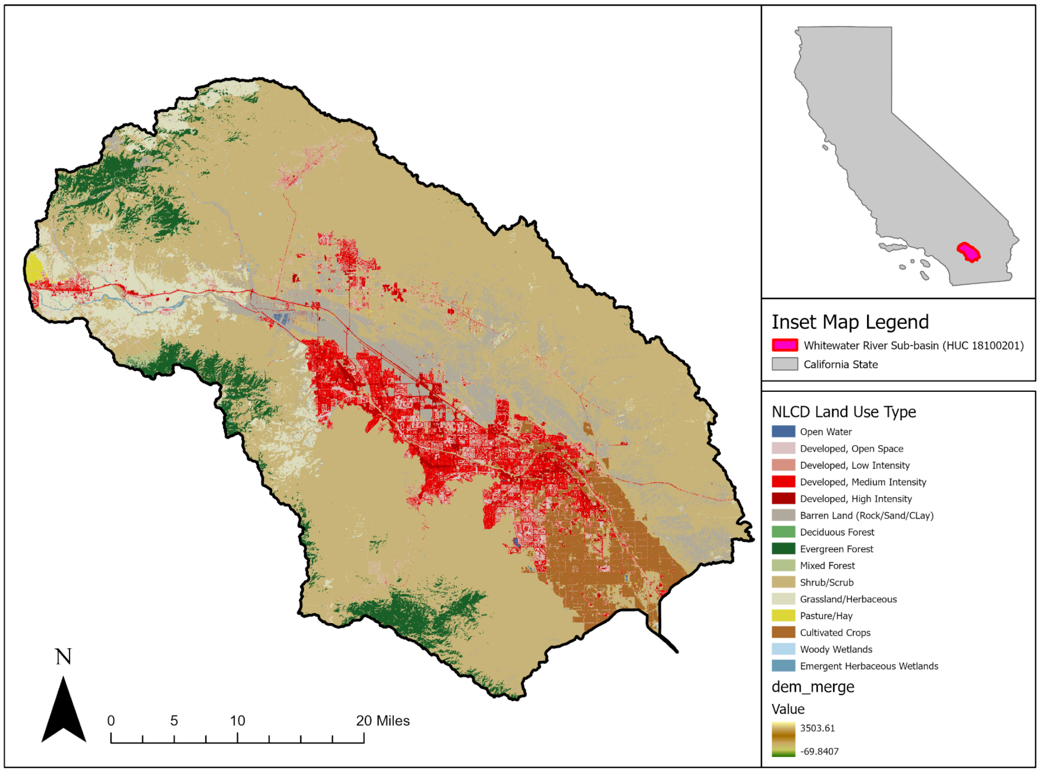


Figure 3.1 Land use and land cover in the Whitewater River subbasin based on National Land Cover Database (NLCD) classifications. Urban development is

concentrated on the valley floor, while upland areas are dominated by natural vegetation communities. Elevation gradient shown by underlying digital elevation model.

The selection of Best Management Practices (BMPs) for the Whitewater River subbasin requires careful consideration of the region's arid climate and diverse land uses. This analysis focuses on seven priority subwatersheds, ranging from the agricultural areas of Guadalupe Creek to the urbanized communities of Palm Springs and Indio. As demonstrated in Section 2, over 63% of storm events exceed 2.5 cm of precipitation, with some reaching 20-50 cm. These intense storms, separated by long dry periods (6-9 months), necessitate BMPs sized to capture large volumes while remaining functional after extended drought, when vegetation is stressed and soils develop infiltration-reducing crusts.

Agricultural areas face water quality challenges from irrigation return flows, fertilizer application, and storm runoff that transport nitrogen and phosphorus to the Salton Sea. This study modeled two agricultural BMPs: controlled drainage at 25-30% coverage in the town of Thermal (30%), Guadalupe Creek (25%), and the town of Indio (25%), and contour farming at 25% coverage in the town of Indio. Controlled drainage manages subsurface water tables through drainage water management structures, intercepting tile drainage flows to reduce dissolved nutrient transport (39% nitrogen removal, 35% phosphorus removal; Christianson et al. 2016; Evans et al. 1996). Contour farming creates physical barriers perpendicular to slopes, slowing runoff and trapping sediment (34% nitrogen removal, 46% phosphorus removal, 41% sediment removal; Evans, Lehning, and Corradini 2003).

Urban stormwater from impervious surfaces generates rapid runoff carrying multiple pollutants. This study modeled two urban BMPs at 20% application rates: vegetated filter strips in Cathedral Canyon and Biskra Palms (single-family residential areas), and concrete grid pavement in Cat Creek and Indian Wells. Vegetated filter strips slow runoff and filter pollutants through vegetation uptake and soil infiltration (40% nitrogen, 45% phosphorus, 51% BOD, 73% sediment removal; MDEQ 1999). Concrete grid pavement allows stormwater infiltration through void spaces, removing pollutants through soil filtration and biological processes (90% nitrogen, phosphorus, and sediment removal). The 20% urban application rate reflects realistic constraints, including available space, capital costs, and maintenance capacity in built-out areas.

Results presented in Tables 2a and 2b indicate that BMPs reduced nitrogen by 619 lbs/year (1.67%), phosphorus by 109 lbs/year (1.58%), BOD by 385 lbs/year (0.40%), and sediment by 18 tons/year (0.80%). While these basin-wide reductions appear modest, they reflect conservative implementation and reveal important patterns at the subwatershed scale.

Guadalupe Creek achieved the strongest nitrogen reduction (3.51%, 212 lbs/year) through 25% controlled drainage coverage, demonstrating the potential of agricultural BMPs at scale. However, 0% BOD and sediment reduction highlights controlled drainage's limitation in addressing subsurface nutrient flows but not surface runoff carrying sediment and organic matter.

The town of Indio demonstrated exceptional sediment control (6.00%, 13 tons/year) through agricultural (25% contour farming) BMPs. Indian Wells and Cat Creek achieved consistent results with permeable pavement alone (2.22% and 1.85% phosphorus reduction, respectively), showing that high-efficiency urban BMPs produce measurable results despite limited application area. Cathedral Canyon and Biskra Palms, relying on vegetated filter strips, showed more modest nutrient reductions (0.61-0.90% for nitrogen, 0.88-0.90% for phosphorus) but measurable BOD removal (1.34-1.43%), indicating filter strips' capacity for organic matter treatment. The town of Thermal, despite 30% controlled drainage coverage, showed only 1.94% nitrogen reduction and 0% BOD and sediment reduction, highlighting the need for complementary practices addressing surface flow pathways.

The 20-35% application rates represent realistic near-term targets, not theoretical maximums. Not all agricultural land suits controlled drainage due to lack of tile systems or unsuitable soils. Urban retrofitting faces space limitations, property owner acceptance challenges, capital constraints, and maintenance capacity limits. The arid climate presents additional challenges: long dry periods stress filter strip vegetation, soil crusting reduces infiltration, and intense storms can overwhelm BMP capacity. Despite these constraints, this analysis demonstrates that strategic BMP implementation achieves measurable improvements.

Future implementation should prioritize high-performing areas. Guadalupe Creek's 3.51% nitrogen reduction could reach 7-10% with expanded coverage (50-75%) and complementary practices (contour farming, vegetated buffers) to address current 0% sediment reduction. The town of Indio's 6% sediment reduction, achieved through agricultural BMPs alone, could reach 12-15% with expanded coverage and additional management strategies along drainage corridors. The town of Thermal needs complementary practices (contour farming, buffer strips, urban infiltration) to address surface pathways currently untreated by controlled drainage alone.

BMP treatment trains offer particular promise. Urban treatment trains might sequence filter strips (initial filtration), permeable pavement (infiltration and nutrient removal), and retention basins (final polishing for extreme storms). Agricultural treatment trains would layer contour farming (field-scale erosion control), vegetated buffers (edge filtration), controlled drainage (subsurface management), and edge-of-field basins (final capture). This multi-layered approach recognizes that no single BMP achieves perfect removal, but sequential practices attain high overall effectiveness.

Designing for arid climate success requires adaptations: desert-adapted vegetation (desert willow, fourwing saltbush) for filter strips, frequent vacuum sweeping of permeable pavement to prevent clogging from wind-blown sediments, larger storage in drainage structures for intense wet seasons, and sizing all BMPs for 2-3 inch design storms (63rd percentile) rather than the 0.5-1 inch typical in temperate regions. Adaptive management through monitoring at key subwatershed outlets would verify modeled reductions and provide local calibration data, addressing critical questions about actual performance in arid conditions.

The path forward requires strategic expansion (20-35% to 50-75% coverage in high-priority areas), diversification (complementary practices creating multiple treatment barriers), climate adaptation (designs suited to arid conditions), and integration with regional efforts (Coachella Valley Water Management Plan, Salton Sea Management Program, MS4 permits, agricultural coalitions). The 1-2% reductions demonstrated here represent a starting point, showing that measurable improvement is achievable. With strategic expansion, diversified treatment trains, and sustained implementation, reductions could grow to 5-10% or more, representing real progress in reducing loadings to the Salton Sea and demonstrating that effective watershed management is possible even in challenging arid watersheds with intense, infrequent storms.

Table 2a. Percent reductions in pollutant loads achieved through BMP implementation for seven priority subwatersheds in the Whitewater River subbasin. Values represent the percentage decrease from baseline loads after BMP application.

Watershed	N Load (No BMP) (lbs/year)	P Load (No BMP) (lbs/year)	BOD Load (No BMP) (lbs/year)	Sediment Load (No BMP) (tons/year)	N Reduction (lbs/year)	P Reduction (lbs/year)	BOD Reduction (lbs/year)	Sediment Reduction (tons/year)
Cathedral Canyon-Whitewater River	3540	486	8697	58	21	4.39	124	0.89
Cat Creek-Whitewater River	4083	553	9974	65	56	10	0	1.28
Indian Wells-Whitewater River	5073	854	18985	114	105	19	0	2.38
Biskra Palms-Whitewater River	4574	723	13505	99	31	6.37	180	1.29

Town of Thermal-Whitewater River	6591	1478	16653	675	128	18	0	0
Guadalupe Creek-Whitewater River	6029	1747	12365	1012	212	30	0	0
Town of Indio-Whitewater River	7191	1074	15609	220	66	21	80	13
TOTAL	37081	6915	95789	2242	619	109	385	18

Table 2b. Percent reductions in pollutant loads achieved through BMP implementation for seven priority subwatersheds in the Whitewater River subbasin. Values represent the percentage decrease from baseline loads after BMP application.

Watershed	% N Reduction	% P Reduction	% BOD Reduction	% Sediment Reduction
Cathedral Canyon-Whitewater River	0.61	0.9	1.43	2
Cat Creek-Whitewater River	1.38	1.85	0	2
Indian Wells-Whitewater River	2.06	2.22	0	2
Biskra Palms-Whitewater River	0.68	0.88	1.34	1
Town of Thermal-Whitewater River	1.94	1.23	0	0
Guadalupe Creek-Whitewater	3.51	1.72	0	0

River				
Town of Indio-Whitewater River	0.91	1.95	0.51	6
TOTAL	1.67	1.58	0.4	1

6.4 Summary

This analysis of urban stormwater patterns and BMP effectiveness in the Whitewater River subbasin provides essential guidance for watershed management planning in an arid climate. The stormwater analysis revealed that while storm events occur infrequently (only 3% of days over 25 years), 63.6% of these events exceed 2.5 cm of precipitation, with some storms reaching 20-50 cm. This characteristic pattern of intense, infrequent storms separated by extended dry periods (6-9 months) defines the primary design constraint for BMP selection and implementation in the basin.

BMP modeling across seven priority subwatersheds demonstrated that even conservative implementation scenarios (20-35% coverage) achieve measurable pollutant reductions: 1.67% for nitrogen, 1.58% for phosphorus, 0.40% for BOD, and 0.80% for sediment basin-wide. Individual subwatershed performance varied considerably, from 0.61% to 3.51% nitrogen reduction and 0% to 6.00% sediment reduction, highlighting the importance of matching BMP types to specific pollutant pathways and land use conditions. Agricultural BMPs, particularly controlled drainage, proved most effective for nitrogen and phosphorus in subsurface flows, while urban BMPs showed greatest effectiveness for sediment control through infiltration-based systems.

The results emphasize two critical findings for future implementation. First, no single BMP type addresses all pollutant pathways, controlled drainage effectively manages subsurface nutrients but provides no treatment for surface runoff carrying sediment and organic matter, while infiltration-based urban BMPs excel at sediment removal but require complementary practices for BOD control. Second, the arid climate necessitates specific design adaptations including larger storage capacities for intense storms, desert-adapted vegetation, and enhanced maintenance protocols to address soil crusting and wind-blown sediment accumulation during extended dry periods.

Strategic expansion to 50-75% coverage in high-performing subwatersheds, implementation of BMP treatment trains that sequence multiple practices, and integration with regional management efforts (Coachella Valley Water Management Plan, Salton Sea Management Program) offer pathways to achieve 5-10% or greater pollutant reductions. Adaptive management through water quality monitoring at key subwatershed outlets will be essential to verify modeled effectiveness and refine implementation priorities based on actual field performance in the basin's challenging arid conditions. While the modest reductions demonstrated in this analysis reflect realistic near-term scenarios, they establish a foundation for sustained water quality improvement through strategic, science-based BMP implementation tailored to the unique characteristics of the Whitewater River subbasin.

Recommendations:

To address the identified issues in the Whitewater River Subbasin, a suite of targeted actions and Best Management Practices (BMPs) is recommended, building on existing efforts like the Indio Subbasin Alternative Groundwater Sustainability Plan and Coachella Valley Water Management Plan while introducing innovative structural, behavioral, and policy approaches. These focus on high-priority areas such as the agricultural lower valley (e.g., Thermal, Guadalupe Creek), urbanized mid-basin (e.g., Palm Springs, Indio), and erosion-prone headwaters, with early demonstration projects to build momentum and verify effectiveness through expanded monitoring.

In agricultural zones like Thermal and Guadalupe Creek, implement controlled drainage systems at 25-30% coverage to manage subsurface water tables and reduce nutrient transport (39% nitrogen, 35% phosphorus removal), paired with contour farming on slopes to create barriers that slow surface runoff and trap sediments (34% nitrogen, 46% phosphorus, 41% sediment reduction). Complement these with behavioral education programs for farmers on precision irrigation and fertilizer application, potentially via partnerships with the Coachella Valley Water District, to minimize return flows carrying nitrates and phosphates to the Salton Sea.

For urban stormwater management in developed areas like Palm Springs and Indio, deploy vegetated filter strips along roads and channels at 20% coverage to filter pollutants through vegetation uptake (40% nitrogen, 45% phosphorus, 51% BOD, 73% sediment removal), and install concrete grid pavement in parking lots and low-traffic zones to promote infiltration and reduce impervious surface runoff. Launch community outreach campaigns, such as "Desert Smart Water" workshops, to encourage residents to adopt rain gardens and permeable driveways, reducing bacterial indicators like E. coli from septic systems and urban wash.

To enhance groundwater recharge and combat overdraft, expand artificial recharge basins in alluvial fan areas near Cathedral City and Rancho Mirage, using captured stormwater and imported Colorado River water, while piloting managed aquifer recharge (MAR) projects that inject treated wastewater in the Indio Subbasin for an additional 10,000-20,000 acre-feet annually. Policy-wise, advocate for incentives like rebates for water-efficient landscaping in high-demand golf courses and urban developments, aligned with SGMA requirements.

For habitat protection and erosion control in the mountainous headwaters (San Jacinto and San Bernardino ranges), restore riparian vegetation in key corridors like the Whitewater Floodplain Preserve using native species to stabilize soils and filter sediments, combined with check dams and gabions to reduce flash flood velocities. Initiate demonstration projects, such as a "Habitat Heroes" volunteer program with the CVMSHCP partners, to remove invasives and educate hikers on low-impact recreation.

Finally, to fill monitoring gaps, establish a network of five new automated stations in unmonitored mid-basin reaches and lower valley agricultural areas, equipped for real-time flow, precipitation, and water quality data (e.g., turbidity, nitrates), integrated with AI-driven predictive modeling for flood alerts. These recommendations emphasize specificity to regional challenges, such as arid-adapted designs for extended dry periods, and can be phased starting with pilot implementations in Thermal and Palm Springs to demonstrate quick wins in pollutant reduction and recharge enhancement.

References:

Ayers, R. S., and D. W. Westcot. *Water Quality for Agriculture*. FAO Irrigation and Drainage Paper 29 Rev. 1, Food and Agriculture Organization of the United Nations, 1994.

"California Water Conditions - USGS Water Data for the Nation." *U.S. Geological Survey*, n.d., https://waterdata.usgs.gov/state/california/#groupBy=huc6.

California Regional Water Quality Control Board, Colorado River Basin Region. *Water Quality Control Plan for the Colorado River Basin Region*. State Water Resources Control Board, n.d., https://www.waterboards.ca.gov/coloradoriver/water_issues/programs/basin_planning/docs/rb7-basin-plan.pdf.

Coachella General Plan Update (CGPU) Planning Area. "Biological Resources." n.d., https://cityofcoachellageneralplanupdate.weebly.com/uploads/1/2/1/2/12129446/4.3_-_biological_resources.pdf.

Coachella Valley Association of Governments. *Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP)*. CVAG, 2008, cvmshcp.org/plan-documents.

Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP). "Environmental Impact Report/Statement, Section 4.7: Biological Resources." n.d., https://cvmshcp.org/eir-s-&-ia-cd/Environmental-Impact-Report-Statement/12-EIR-S-Section-4-7.pdf.

Coachella Valley Water District. *2023-24 Annual Water Management Report*. CVWD, 2024.

Coachella Valley Water District. "West Whitewater River Subbasin Area of Benefit." 2021, https://www.cvwd.org/203/West-Whitewater-River-Subbasin-Area-of-B.

Coachella Valley Water District and Desert Water Agency. *Indio Subbasin Alternative Groundwater Sustainability Plan – 2022 Update*. CVWD/DWA, 2022, indiosubbasinsgma.org/documents.

Dieter, C.A., and K.S. Linsey. "Estimated Use of Water in the United States County-Level Data for 2015." Ver. 2.0, U.S. Geological Survey, June 2019, https://doi.org/10.5066/F7TB15V5.

Doede, A. L., and P. B. DeGuzman. "The Disappearing Lake: A Historical Analysis of Drought and the Salton Sea in the Context of the GeoHealth Framework." *GeoHealth*, vol. 4, no. 9, 2020, e2020GH000271, https://doi.org/10.1029/2020gh000271.

Kuenzi, D. "The Story of the Whitewater River Watershed – Riverside County Watershed Protection." *Riverside County Watershed Protection*, 18 May 2025, https://rcwatershed.org/2020/06/10/the-story-of-the-whitewater-river-watershed/.

Matti, J. C., and D. M. Morton. "Paleogeographic Evolution of the San Andreas Fault in Southern California: A Reconstruction Based on a New Cross-Fault Correlation." *The San Andreas Fault System: Displacement, Palinspastic Reconstruction, and Geologic Evolution*, edited by R. E. Powell et al., Geological Society of America, 1993, pp. 107–159. GSA Memoir 178, https://doi.org/10.1130/MEM178-p107.

"Palm Springs Climate, Weather By Month, Average Temperature (California, United States)." *Weatherspark.com*, n.d., https://weatherspark.com/y/2118/Average-Weather-in-Palm-Springs-California-United-States-Year-Round.

Riverside County Flood Control and Water Conservation District. "Floodplain Information." *RCFlood.org*, 2025, https://rcflood.org/floodplain-information.

---. "Floodplain Map Viewer." *RCFlood.org*, 2025, https://content.rcflood.org/floodplainmap/.

---. *Ordinance No. 458: Regulating Flood Hazard Areas and Implementing the National Flood Insurance Program*. Amended through Ordinance 458.17, RCFCWCD, 2023, https://rcflood.org/sites/g/files/aldnop291/files/2023-03/458.17.pdf.

Riverside Public Utilities. *Water Quality Report 2023*. Riverside Public Utilities, 2023, https://riversideca.gov/utilities/sites/riversideca.gov.utilities/files/pdf/Water%20Quality%20Report_2023_EnglishSpanish.pdf.

Spotila, J. A., et al. "Near-Field Transpressive Deformation along the San Andreas Fault Zone in Southern California, Based on Exhumation Constrained by (U-Th)/He Dating." *Journal of Geophysical Research: Solid Earth*, vol. 106, no. B12, 2007, pp. 30,909–30,922, https://doi.org/10.1029/2001JB000348.

Tyley, S. J. *Analog Model Study of the Ground-Water Basin of the Upper Coachella Valley, California*. U.S. Geological Survey Water Supply Paper 2027, U.S. Geological Survey, 1974, https://pubs.usgs.gov/wsp/2027/report.pdf.

U.S. Census Bureau. "Annual Estimates of the Resident Population for Counties in California: April 1, 2020 to July 1, 2024." *Population Estimates Program*, 2024, https://www.census.gov/data/tables/time-series/demo/popest/2020s-counties-total.html.

U.S. Environmental Protection Agency. "National Primary Drinking Water Regulations." *40 CFR Part 141*, EPA, 2023, www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations.

Wikipedia contributors. "Coachella Valley." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Coachella_Valley. Accessed 20 Oct. 2025.

Wikipedia contributors. "Coachella Valley Fringe-Toed Lizard." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Coachella_Valley_fringe-toed_lizard.

Wikipedia contributors. "Desert Pupfish." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Desert_pupfish.